FINAL

Daybreak Mine Expansion and Habitat Enhancement Project Habitat Conservation Plan

J.L. Storedahl & Sons, Inc.

Clark County, Washington

November 2003

J.L. Storedahl & Sons, Inc.
- Daybreak Mine -

Mine Expansion and Habitat Enhancement Project
Habitat Conservation Plan

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Cover Photo: Simulated aerial photo depicting post-rehabilitation site conditions

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TECHNICAL APPENDICES (bound separately)

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ABBREVIATIONS AND ACRONYMNS

afy	acre-feet per year
°C	degrees Celsius
°F	degrees Fahrenheit
CCC	Clark County Code
CFR	Code of Federal Regulations
cfs	cubic feet per second
CM	Conservation Measure
CMZ	Channel Migration Zone
CWA	Clean Water Act
DEIS	Draft Environmental Impact Statement
DNR	Washington State Department of Natural Resources
DO	Dissolved Oxygen
DPS	Distinct Population Segment
EA	Environmental Assessment
Ecology	Washington Department of Ecology
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FEMA	Federal Emergency Management Agency
ft	feet
GIS	Geographic Information Systems
GMA	Growth Management Act
gpm	gallons per minute
HCP	Habitat Conservation Plan
HEC	Hydrologic Engineering Center
ITP	Incidental Take Permit
LCFRB	Lower Columbia Fish Recovery Board
LCSCI	Lower Columbia Steelhead Conservation Initiative
LFA	Limiting Factors Analysis

LOMR	Letter of Map Revision
LWD	Large Woody Debris
MEM	Monitoring and Evaluation Measure
mg/l	milligrams per liter
ml	milliliter
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	Mean Sea Level
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA Fisheries	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Units
RCW	Revised Code of Washington
RM	River Mile
SCD	Shoreline Combining District
SCS	Soil Conservation Service
SEPA	State Environmental Policy Act
Services	U.S. Fish and Wildlife Service and the National Marine Fisheries Services
SFA	Sustainable Fisheries Act
SMA	Shoreline Management Act
SMP	Shoreline Master Program
Storedahl	J.L. Storedahl & Sons, Inc.
TMDL	Total Maximum Daily Load
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WDFW	Washington State Department of Fish and Wildlife
WRIA	Water Resource Inventory Area
WWTIT	Western Washington Treaty Indian Tribes

EXECUTIVE SUMMARY

This Habitat Conservation Plan (HCP) was developed to specify how J.L. Storedahl & Sons, Inc. (Storedahl) will operate its Daybreak Mine in Clark County, Washington and implement conservation measures in a manner that is consistent with the requirements of the federal Endangered Species Act. The Daybreak site is located near the East Fork Lewis River. A small tributary to the river, Dean Creek, flows along the northwest boundary of the site. Several threatened and candidate species under the Endangered Species Act could occur in the waters near the site, including Chinook, coho, and chum salmon; steelhead; and possibly bull trout (native char) and Oregon spotted frog. In addition, three fish species of concern, coastal cutthroat trout, and Pacific and river lamprey also could occur in these waters. The life histories, status, presence, and potential effects of implementing this HCP on these nine species are emphasized throughout this report.

Storedahl has operated a gravel processing plant at the Daybreak Mine since the late 1980s, although the Daybreak site was first mined in the 1960s. There is currently no active mining at the site, although past excavations have resulted in the creation of five ponds. Currently, only off-site materials are processed at the site. Storedahl proposes to expand the Daybreak site by mining aggregate for sand and gravel from a low terrace situated above the 100-year floodplain. Expansion of the project site would occur on approximately 178 acres, with mineral resources being extracted from approximately 101 of these acres. Concurrently and following completion of mining, aquatic and terrestrial habitat reclamation and enhancement will occur throughout the expanded area and the entire 300 acres of the Daybreak site.

Aggregate removed from the proposed mining areas are needed to meet the growing demands of regional construction projects and the rapid human population growth in Clark County and the surrounding area. The processed aggregate is used for production of asphalt and concrete in public and private work projects. The on-site mining activities are expected to occur over 10 to 15 years, depending on market conditions. The HCP will remain in effect for 25 years to ensure reclamation and monitoring is completed.

Past gravel mining and processing has occurred on approximately 87 acres of the Daybreak site. Because the ground water table is relatively close to the surface in this area, past excavations resulted in the creation of five open water areas. The expanded mining will result in the creation of five new ponds in an area that is further away from the river than the existing ponds and in an area outside of the 100-year floodplain. At the same time, the existing ponds will be reconfigured and the open water area reduced by creating approximately 22 acres of forested wetland and four acres of emergent wetland where it is now open water. In the mining expansion area, 64 acres of open water will be created, and 37 acres of mined land will be reclaimed as forested and emergent wetland. Within the 300-acre Daybreak site, 134 acres will be immediately preserved or rehabilitated as a mix of native valley-bottom forest and forested wetland. Following completion of mining and processing activities, the areas used for processing and storage and the temporary haul roads will be graded, amended, and planted in native forest cover.

The development of this HCP emphasizes the differences between past and future mining operations at the site. Past mining at the Daybreak site and throughout the areas near the lower East Fork Lewis River occurred outside of the flowing river, but within the historical channel migration zone and the 100-year floodplain. The five existing ponds on the site, known as the Daybreak ponds, are located on the southern portion of the site and are fairly close to the river. These ponds are no longer mined, although the ponds have been used for settling process water generated during sorting and washing of off-site aggregate.

One of the first concerns Storedahl addressed during the development of this HCP was the need to decrease the turbidity of the water released from the ponds to Dean Creek and the East Fork Lewis River. Past processing relied on passive settling of fine sediments in the process water as water flowed from pond to pond. However, during the development of this HCP, Storedahl began to voluntarily implement a revised system to reduce turbidity. This system has dramatically reduced the turbidity in the ponds and in the water released to the river since 1999, and the system has been approved by the Washington Department of Ecology. A commitment in this HCP will control turbidity even further by installing a site-specific, closed-loop system, which will result in the substantial reduction or elimination of process water released to the ponds.

Another major concern faced during the development of this HCP regards the potential for the East Fork Lewis River to migrate towards the existing ponds and eventually jump its channel, or avulse, into the existing ponds or the future ponds that will be created during aggregate excavation. To address this concern, Storedahl completed a detailed geomorphic and hydraulic study of the river to determine the risk of avulsion. Fortunately, most of the existing ponds are separated from the river by an access road, the Storedahl Pit Road, which currently provides some protection against an avulsion. However, preventing the river from eroding its banks and migrating within its historical channel migration zone limits the natural ecological functions of a floodplain river. In a case where a transportation corridor or housing exists within the area of historical channel migration, it typically is considered prudent to prevent a river from migrating into this location and destroying these structures. However, the existing Daybreak ponds could be considered to provide an opportunity where, if channel migration occurred, the natural ecological functions of large woody debris recruitment, and creation of complex off-channel habitat could take place. These potentially contradictory concerns to prevent a potential avulsion, while at the same time allowing natural channel migration, resulted in an agreement to commit to the following three steps:

1) resist a potential avulsion into the existing Daybreak ponds during the term of the HCP;
2) accommodate a potential future avulsion into the existing Daybreak ponds through reclamation designs which acknowledge that the existing ponds are within the historical channel migration zone; and
3) minimize adverse effects of a potential avulsion by reducing the recovery time. For example, reclamation designs should resist headcutting in the upstream reach and minimize sediment trapping that could adversely affect habitat in the downstream reach.

Implementation of the HCP will commit Storedahl to many on-site and off-site ecological enhancements including: management of water quality and quantity in Dean Creek; in-stream and riparian enhancements in Dean Creek; donation of funds for off-site floodplain enhancements; monitoring and management of non-native fish species in the site ponds and in the East Fork Lewis River; and the donation of water rights for instream use following completion of the project.

At the completion of all reclamation, the Daybreak property will be transferred with a conservation easement to one or two public or non-profit organizations. This will allow the property to be preserved for fish and wildlife habitat in perpetuity. Storedahl will also establish a one-million dollar endowment fund dedicated to monitoring and management of the site. Interest and appreciation earned on the endowment will also be available to enhance floodplain ecosystem functions throughout the East Fork Lewis River basin. The funds for this endowment will be generated through a surcharge on each ton of sand and gravel mined and sold from the Daybreak site.

The HCP is organized into 10 chapters and 8 appendices. Chapter 1 is an introduction. Chapter 2 discusses the Endangered Species Act, other rules and regulations addressed by the HCP, and the goals and objectives of the HCP.

The existing physical and biological conditions of the East Fork Lewis River basin are discussed in Chapter 3. This chapter includes a detailed discussion on channel migration zones and avulsion. An effort has been made in this chapter to point to areas where knowledge is incomplete or uncertainty exists, such as in the exact location and functions of the local hyporheic zone.

The 18 conservation measures that Storedahl is committing to implement over the 25-year duration of the HCP are described in Chapter 4. These efforts are grouped into water quality conservation measures, water quantity conservation measures, channel avulsion conservation measures, and species and habitat conservation measures. The commitment of each conservation measure is inscribed within a box, which is followed by a description of the rationale and ecosystem benefits of the measure.

Chapter 5 describes how Storedahl will monitor their commitment to implement each of the 18 conservation measures described in Chapter 4. The monitoring program is divided into compliance and effectiveness monitoring. A schedule for monitoring and reporting is included in the chapter, as well as a discussion of appropriate management responses to monitored conditions.

The combined impacts of Storedahl's mine expansion and habitat enhancement project on the fish and wildlife species covered by this HCP are analyzed in Chapter 6. The discussion of the impacts on fish and wildlife is organized by species and life stage. The chapter concludes with a quantification of take.

Chapter 7 discusses how Storedahl intends to fund implementation of the HCP. It provides estimated costs for the conservation measures, as well as costs for monitoring.

Three alternatives to the proposed mine expansion and habitat enhancement project are discussed in Chapter 8. One of the alternatives would be to develop the Daybreak site in 20-acre minimum parcels for rural residential or other uses permitted under current zoning and other local and state regulations instead of expanding the site for on-site mining. The second alternative is to implement a mine expansion and reclamation plan that meets local regulations as well as those of the Washington Department of Natural Resources, which avoids taking of listed species, but which does not implement a federally approved HCP. The third alternative is based on implementing an expanded mine and habitat enhancement design based on an HCP with fewer and less aggressive conservation measures than those described in this proposed plan.

The final two chapters include Chapter 9, which contains a list of references cited in the HCP, and Chapter 10, which is a list of the HCP document preparers.

A separate document provided on CD, contains eight technical appendices, which include: Appendix A – the life histories of the fish and wildlife species covered by the HCP; Appendix B – a conceptual restoration plan for the Ridgefield Pits; Appendix C – a detailed geomorphic analysis of the East Fork Lewis River; Appendix D – a storm water and erosion control plan and stormwater pollution prevention plan; Appendix E – correspondence from FEMA to Clark County regarding the 100-year floodplain; Appendix F – the Implementation Agreement for this HCP; Appendix G – a report on the process water treatment system, and Appendix H – a legal description for Conservation Measure 12.

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1. INTRODUCTION

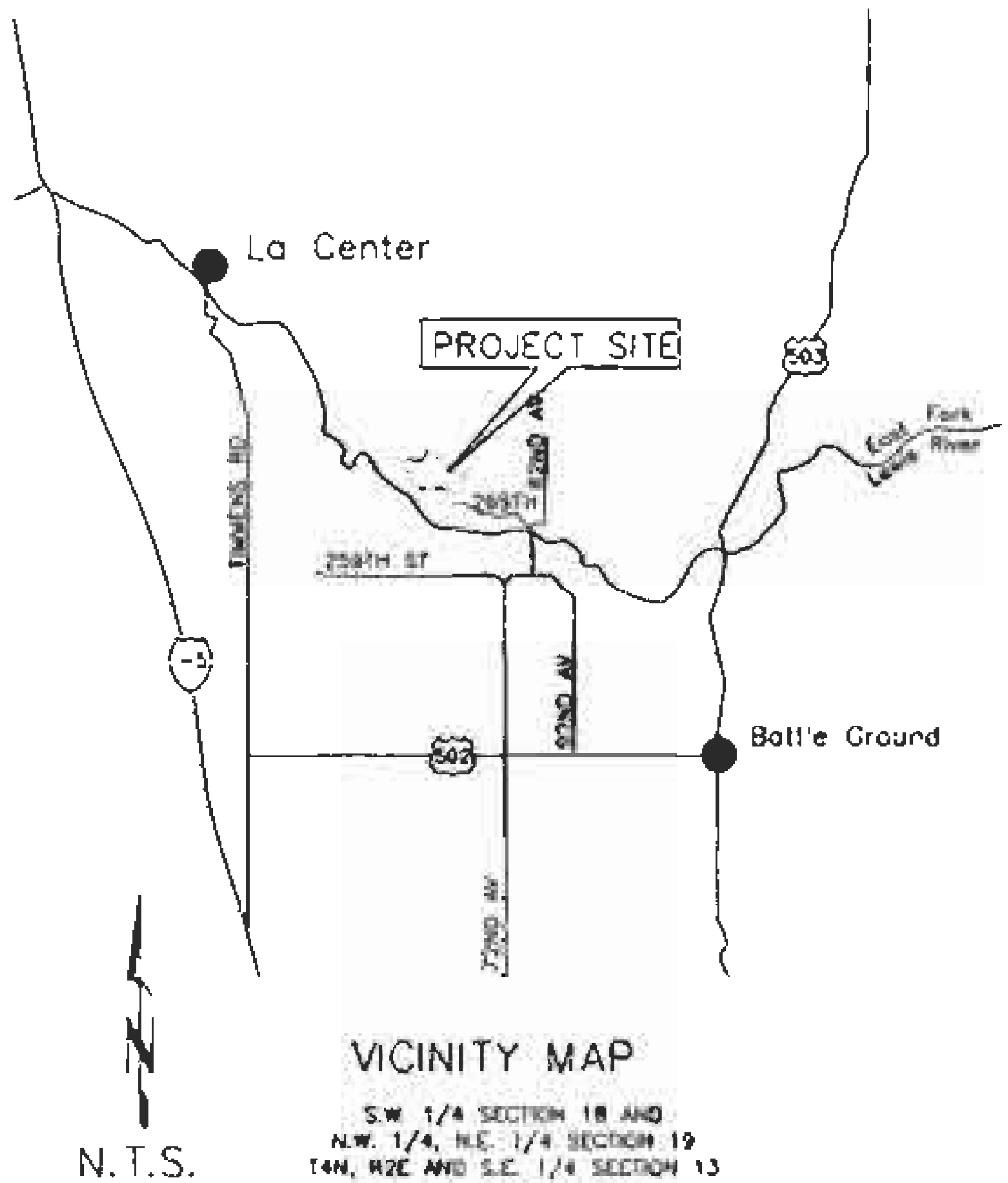
1.1 BACKGROUND

Storedahl Property L.L.C. owns and J.L. Storedahl & Sons, Inc. (Storedahl) operates a gravel processing plant in rural Clark County, Washington, near the East Fork Lewis River. This site is known as the Daybreak Mine.[1] It is located in the town of Battleground, approximately 4 miles southeast of the town of La Center, and approximately 1 mile downstream of Clark County's Daybreak Park (Figure 1-1). Current operations are limited to processing and distributing sand and gravel that is mined off-site. Sand and gravel from the Daybreak Mine have been mined since 1968, and the site has operated under a Washington Department of Natural Resource (WDNR) Surface Mining Permit since 1971. Storedahl began mining and processing on the site in 1987. In the 16 years prior to this, approximately 65 acres of land had been disturbed by mining conducted by two previous operators. Between 1987 and 1995, Storedahl continued mining on approximately 15 acres of the site. Since that time, no active extraction of gravel has occurred at the Daybreak Mine.

Immediately to the north and east of the mined areas, located on a low terrace above the 100-year floodplain, there are high quality sand and gravel deposits that have not been mined. Storedahl proposes to mine the on-site aggregate within these deposits concurrent with reclamation activities on Storedahl's 300-acre site (hereafter referred to as the Daybreak site). Reclamation, mitigation, and conservation activities are proposed to occur throughout the 300 acres.

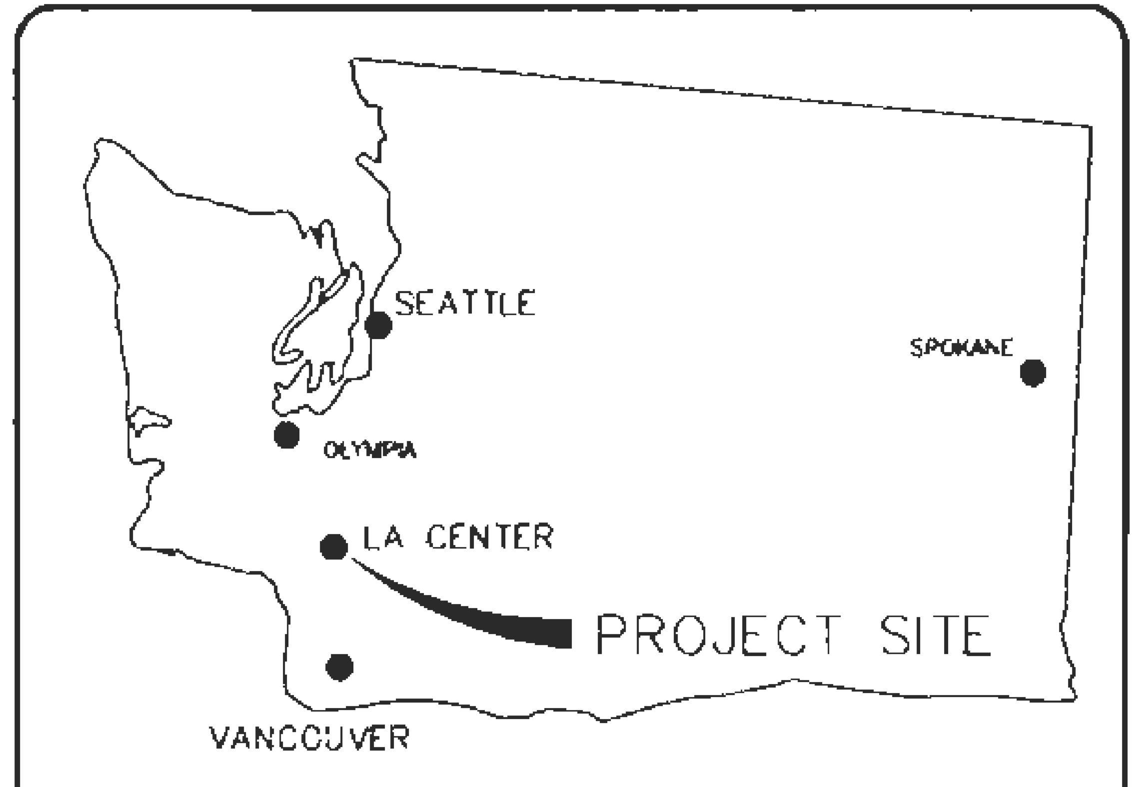
It is not known when gravel mining first began in the East Fork Lewis River basin. Aggregate resources in the lower basin currently represent a commercially valuable resource, due to the coincidence of a number of factors, including: proximity to the Vancouver-Portland metropolitan area major arterials and other urban centers; large deposits of concrete quality aggregate; little overburden; stable slopes; and processing capacity. Because gravel is a high-bulk, low-value product, the majority of the operating expenses are incurred from processing and distribution. Therefore, the most economical high-quality gravel deposits are those that are close to markets. However, as residential sites approach gravel mining areas, permitting difficulties become manifold. Gravel removed from the proposed mining site will be used to meet the growing demands of regional construction projects needed to support the

[1] Located at 27140 NE 61st Avenue, Battleground, Washington 98604.



VICINITY MAP

S.W. 1/4 SECTION 18 AND
N.W. 1/4, N.E. 1/4 SECTION 19
T4N, R2E AND S.E. 1/4 SECTION 13
AND N.E. 1/4 SECTION 24 T4N R1E



LOCATION MAP

WASHINGTON

the group

DATE 1/02
DWN SLW
APP
REV 1
PROJECT NO.

FIGURE 1-1
J.L. STOREDAHL & SONS
CLARK COUNTY, WASHINGTON
HABITAT CONSERVATION PLAN

DAYBREAK SITE VICINITY MAP

rapid population growth in Clark County and the surrounding area. Between 1990 and 2000, Clark County's population increased by 45 percent to some 345,000 residents, the fastest growth of any county in Washington (U.S. Census Bureau 2000) and the population has nearly doubled in the twenty years between 1970 and 1990, and it is continuing to grow at a rapid pace (Hutton 1995a).

Although the proposed mining and processing would take place outside of the 100-year floodplain, the project has a potential to affect the fish and wildlife associated with the East Fork Lewis River ecosystem. The majority of the gravel to be mined is located just below the water table in an unconsolidated sedimentary aquifer, and the proposed gravel mining and reclamation plan will create a series of open water ponds, and forested and emergent wetlands. The created ponds and wetlands will drain via a controlled outlet to a small creek (Dean Creek) and then to the East Fork Lewis River. The shallow aquifer is connected to the East Fork Lewis River and average groundwater seepage rates (discharge) into the river during low flows range from 0.58 to 1.59 cubic feet per second (cfs) per stream mile (McFarland and Morgan 1996). The proposed mining and reclamation plan has the potential to affect a suite of habitat conditions, including, but not limited to, water quality, channel morphology, riparian function, off-channel connections, and the conversion of pastureland and cultivated fields to forest, wetland, and open water habitats.

The East Fork Lewis River historically supported large runs of salmon and steelhead (Bryant 1949). However, today some populations of anadromous (ocean-rearing) fish in the East Fork Lewis River are listed as threatened under the Endangered Species Act (ESA). This includes Lower Columbia River steelhead (*Oncorhynchus mykiss*) (63 *Fed. Reg.* 13347, 9 March 1998), bull trout (*Salvelinus confluentus*) (63 *Fed. Reg*. 31647, 10 June 1998), Chinook salmon (*O. tshawytscha*) (64 *Fed. Reg*. 14308, 24 March 1999), and Columbia River chum salmon (*O. keta*) (64 *Fed. Reg*. 14508, 25 March 1999). Currently, coho salmon (*O. kisutch*) is a candidate species (64 *Fed. Reg*. 33466, 23 June 1999).

1.2 PURPOSE AND NEED FOR THE HABITAT CONSERVATION PLAN

Major goals of Storedahl's proposed plan to mine at the Daybreak site are to create, enhance, and conserve valuable fish and wildlife habitat. The recent and proposed listing of salmon and trout stocks in the Columbia River basin resulted in a decision by Storedahl to voluntarily formalize its habitat conservation activities, and in so doing, obtain an Incidental Take Permit (ITP) under Section 10(a)(1)(B) of the ESA. The ITP will allow Storedahl to operate its existing and proposed operations at the Daybreak Mine in a lawful manner without threat of prosecution for incidental take that may occur to species covered by the ITP. Further, the HCP will formalize Storedahl's voluntary efforts to conserve and enhance important fish and wildlife habitat on the site and in other areas of the lower East Fork Lewis River basin.

This HCP has been prepared in support of Storedahl's application for an ITP in conformance with Section 10(a)(2)(A) of the ESA. The listing of Lower Columbia River Chinook salmon, steelhead, bull trout, and Columbia River chum salmon as threatened under the ESA includes populations in the East Fork Lewis River and its tributaries. The existing operations and the proposed gravel mining and reclamation at the Daybreak site could potentially incidentally "take" a listed species, as the term is defined under the ESA and rules adopted thereunder. Conversely, avoiding the risk of take could ultimately cause Storedahl to curtail or cease gravel operations, thereby causing significant impacts on the gravel supply to the local region, and potentially fostering land uses less beneficial to fish and wildlife populations. Implementing this HCP and securing an ITP will ensure that activities to supply gravel for development in and around Clark County will include measures that benefit fish and wildlife resources over both the short- and long-term.

1.3 OVERVIEW OF THE EAST FORK LEWIS RIVER WATERSHED AND THE DAYBREAK MINE PROJECT

The East Fork Lewis River watershed is located in southwestern Washington, in the central portion of Clark County. The basin drains an area of 212 square miles and is cataloged by the state as belonging within the Water Resource Inventory Area (WRIA) 27. The East Fork Lewis River flows westward for 43 miles from an elevation of approximately 3,300 feet before it joins with the Lewis River just over three miles upstream from the Columbia River. The Columbia River then empties into the Pacific Ocean 87 miles downstream. The lower 5.9 miles of the East Fork Lewis River is tidally influenced (Hutton 1995b).

The East Fork Lewis River originates in the Gifford Pinchot National Forest. At its headwaters, the river generally flows through steep, mountainous terrain, restricted by narrow valley walls. Tributary streams in the headwaters are steep channels dominated by bedrock and boulders, eventually giving way to lower gradient, alluvial streams that cross the narrow upper valley before joining the main river. The flow regime is dominated by fall and winter rain events.

The land use in the East Fork Lewis River watershed is predominantly forestry in the upper watershed above Moulton Falls (River Mile 24.6) and agriculture and rural residential development in the lower watershed. The majority of the watershed is within the boundaries of Clark County. The upper watershed, including the portions that extend beyond Clark County, is predominantly within the Gifford Pinchot National Forest. The majority of this land is covered by 60-year old or older, second-growth forest (USFS 1995).

1.3.1 Fishery Resources

The East Fork Lewis River supports five anadromous salmonid species, including: Chinook, coho, and chum salmon; steelhead and coastal cutthroat trout (*O. clarki clarki*); and possibly bull trout. There are also resident populations of rainbow, coastal cutthroat, and possibly bull trout that spend their entire lives in fresh water. The Washington State Department of Fish and Wildlife (WDFW) does not distinguish between bull trout and Dolly Varden, and for the purposes of ESA considers Washington's native char populations to be predominantly bull trout (WDFW 1997a). Bull trout are present in the Lewis River but are not believed to be present in the East Fork Lewis River (Rawding 1999). Pacific lamprey (*Lampetra tridentata*) and river lamprey (*L. ayresi*) are two other anadromous species present in the river. Returning summer-run steelhead can access over 40 miles of mainstem river, although Lucia Falls at river mile (RM) 21.3 is a migration barrier to the other salmon and trout species. The river also supports a diversity of other native and non-native fish species that are not included as covered species for this HCP.

A small tributary of the East Fork Lewis River, Dean Creek, flows along the northwest border of the Daybreak site. During the summer, flow in Dean Creek is frequently intermittent for several hundred feet downstream of J. A. Moore Road, where there is a significant buildup of gravel. The lower 0.5 mile of the stream flows through a series of beaver ponds and grassy wetlands, and often lacks a defined channel. A November 1991 survey found the stream to contain cutthroat and rainbow trout, largescale sucker (*Catostomus macrocheilus)*, and sculpin (*Cottus* sp.) (EnviroScience 1996a). The stream is potentially accessible to several anadromous species, including coho salmon, steelhead, coastal cutthroat trout, chum salmon, and lamprey.

Various fish are also present in the five ponds that were formed by previous gravel mining on the Daybreak site. These existing ponds contain a variety of native fish including rainbow trout, northern pikeminnow (*Ptychocheilus oregonensis*), largescale sucker, sculpin, three-spine stickleback (*Gasterosteus aculeatus*), and four non-native species, which include largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), and brown bullhead (*Ameiurus nebulosus*).

The WDFW management efforts on the East Fork Lewis River are focused on fall Chinook salmon and winter- and summer-run steelhead. Currently, fall Chinook salmon production in the East Fork Lewis River is entirely natural, although prior to 1985 fall Chinook salmon were planted in the river. Steelhead stocks in the East Fork Lewis River subbasin are managed for a mixture of summer- and winter-run hatchery and wild fish. However, concern about potential negative impacts on wild steelhead stocks from the presence of hatchery fish has prompted ongoing debate, deliberation, and discussion on the management of the East Fork Lewis River fishery. The recently drafted Lower Columbia Steelhead Conservation Initiative (LCSCI) contains a proposal that this subbasin be managed as a sanctuary for wild fish by dramatically or completely reducing the number of hatchery steelhead released to the river (State of Washington 1998).

1.3.2 Gravel Mining and Reclamation

An existing on-site plant currently processes aggregate mined from off-site locations. This processed material is utilized elsewhere for production of asphalt and concrete in local public and private works projects. The expanded mining plan will continue to use the existing plant for processing, stockpiling, and distributing aggregate that will be mined from both on- and off-site locations. The expected life of the on-site mining activities is 10 to 15 years, depending on market conditions and other factors.

The East Fork Lewis River gradient abruptly decreases in the vicinity of the Daybreak site to less than one percent, resulting in deposition of coarse sediment transported by the river from upstream areas. This deposition has resulted in an area rich in gravel resources. Other than agricultural activities, which cleared, filled, and graded the natural features of the site, prior excavations and active gravel processing facilities comprise the major existing structural features at the Daybreak site. Previous mining of the Daybreak site resulted in the formation of five unnamed ponds (approximately 64 acres) that are in various stages of reclamation or that perform important functions for the ongoing processing of imported raw materials. An active gravel-processing area (approximately 23 acres) processes material imported from off-site. The processing area includes the Storedahl Road, storage areas for excavation equipment, aggregate processing equipment, processed sand and gravel, fuel, parking areas, temporary haul roads, and an office, scales, and a maintenance shop.

Expansion of mining activities will extend the surface mine and restoration activities over an additional 178 acres within the approximately 300-acre Daybreak site. Of this area, gravel extraction will occur on approximately 101 acres. The approximate acreages are based on aerial interpretation and have not been ground-truthed by surveying. Following reclamation, there will be approximately 64 acres of created open water and 37 acres reclaimed as forested and emergent wetland in the expanded mining area. The additional 77 acres of property within the 178 acres that will not be mined will be rehabilitated as wetland or valley-bottom forest.

Concurrent with mining and reclamation in the expanded area, the open water in the existing five ponds will be reduced to approximately 38 acres by creating emergent wetland (four acres), and forested wetland (22 acres) where it is now open water. The remaining 57 acres of the existing operational area will be preserved or rehabilitated as a mix of native valley-bottom forest and forested wetland with limited access, including an extension of the East Fork Lewis River greenbelt trail system.

Lands to be mined are north and east of the existing ponds, and generally away from the East Fork Lewis River. Five large and several smaller areas will be excavated forming ponds and emergent wetlands. Future mining will be conducted in phases and, as each mining phase ends, mined areas will be sequentially reclaimed. Areas not proposed for mining will be planted with native valley-bottom forest revegetation prior to or concurrently with mining. Reclamation goals are directed at the total ecosystem, to not only benefit fish and wildlife species covered under this HCP, but also general habitat and other native species. The rehabilitated habitat will take advantage of the ponds and wetlands created by gravel mining and the natural features of the project area. A detailed description of habitat enhancement elements is presented in Chapter 4.

1.4 AREA COVERED BY THE HCP AND ITP

The area covered by the HCP/ITP consists of approximately 300 acres owned by Storedahl, which includes:

- Approximately 101 acres affected by proposed gravel mining in the terrace above the 100-year floodplain;
- Approximately 87 acres affected by current gravel processing, haul roads, and the existing ponds; and

- The remaining 112 acres affected by preservation, site reclamation, and rehabilitation.

The HCP also includes all locations where actions will take place to minimize or mitigate the effects of Storedahl's mining and reclamation on the covered species. The ITP area for this HCP includes the same locations. These locations include:

- The mainstem and all side channels of the East Fork Lewis River (inundated at flows less than or equal to the 100-year event), from approximately one mile upstream of the project area (RM 10) downstream to the area of tidal influence (RM 5.9).
- Dean Creek, from J. A. Moore Road to its confluence with the East Fork Lewis River;
- The locations of on-site instream and riparian restoration, enhancement, and monitoring projects;
- The new open water ponds and emergent wetlands formed by mining;
- The existing ponds; and
- All Storedahl lands within the Daybreak Mine site.

1.5 ACTIVITIES COVERED BY THE HCP AND ITP

Activities covered by the HCP and ITP include the following:

- Gravel mining and attendant activities in the terrace above the 100-year floodplain;
  - ⊆ potential impacts on groundwater quality and quantity
  - ⊆ potential impacts on surface water quality and quantity
  - ⊆ potential influence on channel migration
  - ⊆ potential access to gravel ponds by anadromous salmonids
- Gravel processing;
- Site reclamation activities including, but not limited to the creation of emergent and open water wetland habitat, riparian and valley-bottom forest restoration, habitat rehabilitation, riparian irrigation and low flow augmentation of Dean Creek, and construction of facilities (i.e., trails and parking lots) to support future incorporation of the site into the open space and greenbelt reserve; and

- Monitoring and maintenance of conservation measures.

1.6 TERM OF THE HCP AND ITP

Storedahl is seeking an ITP for a period of 25 years to run concurrently with the implementation of the HCP. Mining activities are expected to last between 10 and 15 years depending on market conditions. Reclamation and monitoring activities will continue through year 25. Following mining and reclamation, the site will be conveyed in fee with an appropriate conservation easement and an endowment to cover monitoring and management costs to a public or private not-for-profit institution for use as a conservation reserve and incorporation into the open space and greenbelt reserve along the East Fork Lewis River.

1.7 SPECIES COVERED BY THE HCP AND ITP

1.7.1 Overview

Mining and reclamation of the Daybreak Mine could potentially influence habitat used by many species of fish and wildlife. There are a variety of lowland habitats within or close to the project site that are associated with streams and rivers, ponds, wetlands, riparian areas, and cultivated pastureland. These include habitats used by birds, fish, and amphibians for nesting, feeding, and dispersing. The site also supports habitat used by mammals, reptiles, and invertebrates.

Storedahl is seeking an ITP for eight fish species and one amphibian species that could potentially be influenced by the proposed project. The HCP is designed to avoid, minimize, or mitigate for any take of these covered species. This HCP is designed within a watershed context, which takes into account ecosystem interactions. Because of this approach, the proposed conservation measures are not merely designed to benefit the limited number of covered species, but are designed to promote properly functioning habitats that will benefit naturally occurring, multi-species assemblages.

1.7.2 Fish

The fish to be covered by the Storedahl Daybreak Mine HCP and ITP include the following species:

Name	Latin Name	Federal Status
Steelhead	*Oncorhynchus mykiss*	Threatened
Bull trout	*Salvelinus confluentus*	Threatened
Chum salmon	*Oncorhynchus keta*	Threatened
Chinook salmon	*Oncorhynchus tshawytscha*	Threatened
Coho salmon	*Oncorhynchus kisutch*	Candidate
Coastal cutthroat trout	*Oncorhynchus clarki clarki*	Species of Concern
Pacific lamprey	*Lampetra tridentata*	Species of Concern
River lamprey	*Lampetra ayresi*	Species of Concern

1.7.3 Wildlife

The wildlife to be covered by the Storedahl Daybreak Mine HCP and ITP include only one species, which is listed below:

Name	Latin Name	Federal Status
Oregon spotted frog	*Rana pretiosa*	Candidate and State Endangered

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2. REGULATORY REQUIREMENTS AND PROCESSES

2.1 FEDERAL ENDANGERED SPECIES ACT

2.1.1 Endangered Species Act of 1973

The Endangered Species Act of 1973, as amended (16 U.S.C. §1531 et seq.), provides "...a means whereby the ecosystems upon which endangered species depend may be conserved" (16 U.S.C. §1531[b]). The U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NOAA Fisheries) (collectively the Services) are responsible for listing candidate species, subspecies, or distinct population segments as threatened or endangered (16 U.S.C. §1533). Once a species is listed, the ESA, through several mechanisms, protects the species and its habitat (16 U.S.C. §§1538, 1540).

Under Section 7 of the ESA, federal agencies are required to further the purposes of the ESA and consult with the Services to ensure federal actions are not likely to jeopardize the continued existence of a listed species or adversely modify or destroy critical habitat (16 U.S.C. §1536[a][1] and [2]). The term "federal action" is defined by regulation so as to include actions such as the granting of permits, entering contracts or leases, or participating in projects or funding such projects (50 CFR §402.02). Approval of an incidental take permit is a federal action and, therefore, subject to consultation under Section 7 of the ESA (15 U.S.C. §1536[a][2]). Thus, federal agencies may engage in an activity or authorized activity that results in the take of listed species as long as such take does not "jeopardize" the continued existence or survival of the listed species.

Section 9 of the ESA prohibits, among other things, the unauthorized taking of endangered species (16 U.S.C. §1538[a][1][B]; 16 U.S.C. §1538[a][1][B]). The term "take" is defined to include "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" or attempt to engage in such activity, of a species listed as endangered under the ESA (16 U.S.C. §1532[19]). Generally, the USFWS extends such prohibitions by rule to threatened species. NOAA Fisheries does not automatically extend take prohibitions to threatened species, but applies them on a species-specific basis through rules adopted under Section 4(d) of the ESA. The USFWS, by rule, has defined "harm" to include habitat modification that actually results in death or injury to a listed species (50 CFR §17.3). NOAA Fisheries issued a proposed rule on 1 May 1998 defining "harm" that largely follows the USFWS definition but includes the term "migration" among those essential behavioral patterns that may be significantly impaired by habitat modification, and which may actually kill or injure fish and wildlife (63 *Fed. Reg.* 24148-24149) ("NMFS interprets the term ' harm' as an act that actually kills or injures fish or wildlife. Such an activity may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, and sheltering."). This proposed rule is now final and is codified at 50 CFR 222.102.

The regulatory definition of "harm" (as defined by the USFWS) has been upheld by the U.S. Supreme Court in Sweet Home Chapter of Communities for a Great Oregon v. Babbitt, 515 U.S. 687, 132 L.Ed. 597 (1995). The Sweet Home court held that "the broad purpose of the ESA supports the Secretary's decision to extend protection against activities that cause the precise harms Congress enacted the statute to avoid," (emphasis added).

Section 10 of the ESA authorizes the Services to issue permits for "incidental take," of listed species. An incidental take permit allows a non-federal entity to avoid Section 9 liability for take that might occur "incidental to, and not the purpose of, the carrying out of an otherwise lawful activity" (16 U.S.C. §1539[a][1][B]; 50 CFR §17.3). Without an incidental take permit, individuals and non-federal entities, who undertake otherwise lawful actions that may take a listed species, risk violating the Section 9 take prohibition and related sanctions. Congress established the incidental take permit to resolve this dilemma. To obtain an incidental take permit, the applicant must submit a "conservation plan" that specifies, among other things, the impacts that are likely to result from the taking and the steps that will be undertaken to minimize and mitigate such impacts (16 U.S.C. §1539[a][2][A]; 50 CFR §17.22[b][1]). However, agencies such as NOAA Fisheries and the USFWS may not issue ITPs or approve habitat conservation plans (HCPs) if so doing would jeopardize the continued existence of a listed species (16 U.S.C. §1539[a][2]). In short, this means that the proposed federal action would not "reasonably…be expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02).

Although recovery of listed species is not the primary objective of the conservation planning process, the ESA's HCP approval criteria help to ensure that HCPs are consistent with recovery goals prepared for each listed species. The HCP must show that the applicant's conduct "will not appreciably reduce the likelihood of the survival and recovery of the species in the wild" (16 U.S.C. §1539 [a][2][B][iv]). If there is no recovery plan for a species, an HCP should ensure that recovery opportunities are thoroughly "considered" based on known limiting factors for the species. At the same time, an HCP is not a replacement or substitute for a recovery plan. An HCP is only a small but consistent part of efforts to "recover" a species.

2.1.2 HCP Requirements

2.1.2.1 Criteria for Issuance of a Permit for Incidental Taking

In deciding whether to issue a Section 10(a) permit for the incidental take of federally listed species, the Services must consider five criteria set forth in the ESA (16 U.S.C. §1539[a][2][A]). If the applicant's habitat conservation plan satisfies these five criteria, the Services "shall" (must) issue the incidental take permit. The criteria are:

The taking will be incidental – All taking of listed fish and wildlife species as detailed in the HCP must be incidental to otherwise lawful activities and not the purpose of such activities.

The applicant will, to the maximum extent practicable, minimize and mitigate the impact of such taking – Under this criterion, the Services will determine whether the mitigation program the applicant proposes in the HCP is adequate to "protect" the species and meets statutory requirements.

The applicant will ensure adequate funding for the HCP – Funding sources and levels proposed by the applicant must be adequate to meet the purposes of the HCP.

The taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild – This criterion involves the effects of the project on the likelihood of survival and recovery of affected species.

The applicant will ensure that other measures that the Services may require as being necessary or appropriate will be provided – This criterion gives the Services flexibility to negotiate additional measures as necessary or appropriate among many different proposals affecting many different species. Region 1 of the USFWS (the West Coast region) believes it is generally necessary and appropriate to prepare an Implementing Agreement (IA) for Conservation Plans. The purpose of an Implementing Agreement is to ensure that each party understands its obligations under the Conservation Plan and Section 10(a)(1)(B) permit and to provide remedies should any party fail to fulfill their obligations.

2.1.2.2 Unforeseen Circumstances and No Surprises

The legislative history of the ESA addresses the desirability and need to address "unforeseen circumstances" during the term of an incidental take permit; that is, unforeseen circumstances which might jeopardize a listed or threatened species while the permit is in force. Planning for and becoming contractually bound to a method for dealing with some unforeseen future event is not easy. However, the uncertainty and unknown cost of dealing with an unforeseen occurrence or an event of unknowable dimensions happening at some unknown time cannot be allowed to curtail all human activity affecting the environment and/or forestall helpful efforts to protect threatened or endangered species.

The uncertainty problem is the subject of the "No Surprises" rule (formerly a USFWS/NOAA Fisheries policy) published on February 23, 1998 (63 *Fed. Reg.* 8859; 50 C.F.R. §17.22 & 17.32, 50 C.F.R. §222.22). The No Surprises concept is simply that "a deal is a deal." Under a properly functioning HCP, the Services will not ask the applicant for more mitigation or funding, even if the affected species should continue to decline. Even in "extraordinary" or "unforeseen" circumstances, the permit holder can only be <u>asked</u> to explore available alternatives for making previously agreed mitigation measures more effective, but no additional cost to the permit holder can be mandated once an HCP has been approved and is being implemented. This provides certainty to the permit holder and any different or additional mitigation or conservation measures becomes the responsibility of the Services, unless the permit holder agrees to such terms voluntarily. The terms of the No Surprises regulation will be built into the contractual language of the Implementation Agreement (50 CFR, Part 17). Without some meaningful certainty of the type provided by a concept like No Surprises rule, applicants have little incentive on ever agreeing to the commitments of an HCP.

2.1.2.3 Changed Circumstances

This HCP covers Storedahl's operation and habitat enhancement of the Storedahl Daybreak Mine under ordinary circumstances. In addition, Storedahl and the Services foresee that circumstances could change during the term of this HCP. Changed circumstances mean a change or changes in the circumstances affecting a covered species or the HCP area that can reasonably be anticipated by Storedahl and the Services, and that therefore can reasonably be, and has been, planned for in the HCP. Changed circumstances are different than unforeseen circumstances because they can be anticipated, and can include natural events such as wind, catastrophic floods, and channel avulsions. Such changed circumstances are described in this section, along with the measures Storedahl and the Services will implement in response to a changed circumstance. The ITP will authorize the incidental take of covered species under ordinary circumstances as well as these changed circumstances, so long as Storedahl is operating in compliance with this HCP, the ITP, and the IA.

Wind

Wind is an ever-present factor in the HCP area. Daily winds control the climate, growing conditions, and fire danger in the HCP area, while seasonal storms can damage or destroy capital improvements, interrupt electrical power, and uproot trees. In forested portions of the HCP area, wind can create habitat for fish and wildlife by killing live trees and/or toppling trees to create logs or large woody debris in streams. Extreme winds can eliminate habitat, however, by blowing down all or most trees in a given area.

None of Storedahl's conservation measures would be significantly affected by a temporary loss of electrical power. Temporary local power failures will not prevent Storedahl from fulfilling the mitigation requirements during the term of the HCP. Flow augmentation in Dean Creek is planned by electrical-powered pumping or passive methods. If electric pumps are used, Storedahl will rapidly respond to interruption in power. However, it is unlikely that trees and shrubs will reach sufficient height during the HCP term such that a high-wind event would interrupt electrical power and hence flow augmentation of Dean Creek.

Trees damaged or toppled by wind will not be removed within the rehabilitated valley-bottom forest, wetland, and riparian management areas. Damaged or toppled trees that could compromise the integrity of the conservation elements would, if necessary, be relocated and used as aquatic or terrestrial habitat enhancement within the HCP area.

Storedahl will reforest areas damaged by wind in the valley-bottom forest, wetland, and riparian management areas if Storedahl, the USFWS, and NOAA Fisheries determine reforestation is necessary to protect water quality or achieve the mitigation objectives of the HCP for one or more covered species.

Flood

The existing gravel ponds and portions of the HCP are within the 100-year floodplain of the East Fork Lewis River. All future mining will be located outside of the 100-year floodplain, where it is at less risk of flooding or erosion. Several conservation measures address the potential affects of flooding, including storm water and erosion control (CM-02), channel avulsion conservation measures (CM-04, CM-05, CM-06, CM-07, and CM-08), and control of non-native fish (CM-12). Following flood events, each of these measures will be monitored to ensure they are effective.

Channel Avulsion

Avulsion is a significant and abrupt change in channel alignment resulting in a new stream or river course. Avulsions can occur during extreme flood events, and their frequency can be increased due to the presence of gravel mines in the floodplain. In recent years, two instances of avulsion in the vicinity of the HCP area have been documented within the channel migration zone. An evaluation of the future avulsion potential near the HCP area identified the most likely locations where an avulsion could occur (Technical Appendix C). Five channel avulsion conservation measures (CM-04, CM-05, CM-06, CM-07, and CM-08) address this potential for avulsion.

Eminent Domain Affecting Lands within the HCP Area

The Storedahl HCP Area is adjacent to private land and lands owned by local government. The land is transected by utility lines and a county road. It is likely one or more parties have the power to acquire or affect lands within the HCP area for the purpose of creating or extending the existing road, public utility, or other public purpose. This could occur through eminent domain, or through voluntary transfer by Storedahl under threat of eminent domain. In the event lands within the HCP area are acquired or affected by any exercise of the power of eminent domain, Storedahl will not be obligated by the HCP or ITP to replace any mitigation provided by such lands. The incidental take coverage for such lands and corresponding HCP obligations may, at the discretion of the Services, be negotiated with and transferred to the recipient of such lands.

Permitting By State and Local Agencies

The Daybreak Mining and Habitat Enhancement project may depend on the approval of other federal or state and local permit issuances. Should the project, in whole or substantial part, fail to be implemented due to the failure of other federal, state, or local agencies to issue necessary permits, then Storedahl will, in consultation with the Services, implement those measures that are commensurate with the level of take that occurred as a result of the project and for which Storedahl received incidental take coverages under the permits. If no mining takes place, it is likely that none of the conservation measures will occur since the project is predicated on mining. If some mining occurs but not as anticipated under the proposed action, then Storedahl will, in consultation with the Services, implement those measures to account for the mitigation of take that was caused by Storedahl's activities.

2.1.2.4 Changes in the Status of Covered Species

The Services may from time to time list additional species under the federal ESA as threatened or endangered, de-list species that are currently listed, or declare listed species as extinct. In the event of a change in the federal status of one or more species, the following steps will be taken.

New Listings of Species Covered by the ITP

The ITP covers five species (coho salmon, coastal cutthroat, river and Pacific lamprey, and Oregon spotted frog) that currently are not listed as threatened or endangered under the federal ESA. The unlisted species covered by this HCP have been addressed as though they are listed. The ITP will take effect for listed covered species at the time it is issued. Subject to compliance with all other terms of this HCP, the ITP will take effect for any unlisted covered species upon the listing of such species.

New Listings of Species Not Covered by the ITP

If a species that is present or potentially present in the HCP area becomes a candidate for listing, is proposed for listing, is petitioned for listing, or is the subject of an emergency listing under the federal ESA, Storedahl will survey the HCP area to the extent it deems necessary, after coordinating with the Services, to determine whether the species and/or its habitat(s) are present. If the survey results indicate the species or its habitat(s) are present in the HCP area, Storedahl will report the results of surveys for the species to the Services. If the Services determine there is a potential for incidental take of the species as a result of Storedahl's otherwise lawful activities, Storedahl may choose to continue to avoid the incidental take of the species, or request the Services to add the newly listed species to the HCP and ITP in accordance with the provisions in the IA and HCP, and in compliance with the provisions of Section 10 of the ESA. If Storedahl chooses to pursue incidental take coverage for the species by amending this HCP or by preparing a separate HCP, all three parties (Storedahl, USFWS, and NOAA Fisheries) will enter into discussions to develop necessary and appropriate mitigation measures to meet ESA Section 10(a) requirements for incidental take coverage. All parties will endeavor to develop mutually acceptable mitigation measures and secure incidental take coverage prior to final listing of the species. Storedahl must implement take avoidance measures until the ITP is issued if it is not able to be secured before listing of the species. In determining adequate mitigation for the species, the Services will give Storedahl full mitigation credit for any and all benefits to the species that have accrued from the time the ITP was signed and this HCP was first implemented, although it is recognized that additional mitigation measures may be necessary to satisfy the requirements of the ESA.

De-listings of Species Covered by this HCP

If a species covered by this HCP is de-listed at both the state and federal levels, the Services and Storedahl will review the mitigation measures being implemented for that species to determine if they are still necessary to protect the species from being re-listed. If continued mitigation by Storedahl is necessary to avoid re-listing the species, mitigation by Storedahl will continue as specified in this HCP. If cessation or modification of the mitigation for that species would not lead to the re-listing of the species, the Services and Storedahl will revise the HCP to eliminate or otherwise modify the mitigation measures in question. However, if elimination or modification of mitigation measures initially implemented for the species being de-listed would substantially and adversely affect the mitigation benefits for another covered species, the mitigation measures will not be eliminated.

Extinction of Species Covered by this HCP

If a species covered by this HCP becomes extinct, the Services and Storedahl will review the mitigation measures being implemented for that species to determine if they are still necessary to meet the requirements of the ESA for the remaining covered species. If Storedahl and the Services mutually agree that elimination or modification of mitigation measures initially implemented for the extinct species would not materially reduce the mitigation for another covered species, the mitigation measures will be eliminated or modified.

2.1.2.5 The Process and Timing

From a process and timing perspective, the Section 10 permit process has three phases. During the preapplication phase, the applicant communicates and consults with the Services to ensure that the conservation plan will minimize and mitigate the effects of the proposed project on listed species. The applicant then prepares an HCP in satisfaction of the ESA requirements. In addition, an Implementation Agreement (IA) is prepared which, when signed by authorized representatives of the parties, represents a binding contract between the permittee and the government. The IA specifies the terms and conditions under which the HCP is implemented. This phase is complete when the application package is submitted to the Services. Typically, an application package includes the permit application (Form 3-200), a completed draft HCP, a draft NEPA document, and a draft IA.

The second phase in the process is the formal processing of the application. During this phase, the Services review the application package for biological and statutory completeness; announce in the *Federal Register* the availability of the draft HCP, IA, and NEPA documents for a public review and comment period; and the Service conducts the internal consultation required under Section 7 of the ESA. The final NEPA document must go through a 30-day public notice, often referred to as a 30-day wait period. Once the documents are determined to be complete and the public comments are received and considered, the Services determine whether the Section 10 permit criteria have been satisfied, finalizes the NEPA documents, and issues or denies the permit.

In the post-application phase, notice of the result of the permit application is given to the public and is placed in the administrative record. The Service may publish notice of the permit in the *Federal Register*, although this is not required by the ESA. This phase also includes monitoring of the implementation of the conservation plan, if required by the HCP or IA, and any adaptive actions that may be stipulated.

2.2 BALD EAGLE AND GOLDEN EAGLE PROTECTION ACT

The Bald Eagle and Golden Eagle Protection Act (BEPA) explicitly protects the bald eagle and golden eagle and imposes its own prohibition on any taking of these species. As defined in the BEPA, take means to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, or molest or disturb. Current USFWS policy is not to prosecute for take of bald eagles or golden eagles under the BEPA if the take is covered by an existing ITP. The proposed activity is not anticipated to affect such species, and therefore, they are not addressed in the HCP.

2.3 MIGRATORY BIRD TREATY ACT

The Migratory Bird Treaty Act (MBTA) of 1918 makes it unlawful to pursue, hunt, capture, kill or possess or attempt to do the same to any migratory bird or part, nest, or egg of such bird listed in wildlife protection treaties between the United States and Great Britain, United Mexican States, Japan, and the Union of Soviet States. As with the federal ESA, the MBTA also authorizes the Secretary of the Interior to issue permits for take. The procedures for securing such permits are found in Title 50 of the Code of Federal Regulations (CFR), together with a list of the migratory birds covered by the act. The USFWS has recently determined that an ITP issued under Section 10 of the ESA also constitutes a Special Purpose Permit under 50 CFR §21.27 and any take allowed under such a permit will not be in violation of the MBTA. Moreover, "take" under the MBTA has been construed not to cover habitat modification that may result in death or injury to MBTA-listed species (Seattle Audubon Soc. v. Evans, 952 F. 2d 297, 303 [9th Cir. 1991] [Habitat destruction causes "harm" to the owls under the ESA but does not "take" them within the meaning of the MBTA]). The proposed activity is not anticipated to adversely affect such species, and therefore, they are not addressed in this HCP.

2.4 CLEAN WATER ACT

The Clean Water Act (CWA) (33 U.S.C. §1251 et seq.) prohibits the discharge of pollutants to navigable waters of the United States unless such discharge is authorized pursuant to a National Pollution Discharge Elimination System Permit (NPDES) (33 U.S.C. §1341). Similarly, Washington statutes require a wastewater discharge permit before discharging pollutants to the waters of the state (Ch. 90.48 RCW). Storedahl currently operates under a NPDES and Waste Discharge Permit issued by the Washington State Department of Ecology. The HCP will take into consideration available opportunities to meet or exceed protections and requirements of the CWA and Washington law. The HCP's proposed fish and wildlife mitigation and enhancement efforts will meet or exceed the requirements of CWA. However, until federal efforts to coordinate and integrate ESA and CWA activities and requirements are made final, Storedahl will not at this time seek CWA coverage. Section 404 of CWA also requires, under certain conditions, that a permit be obtained prior to discharging dredge or fill material to waters of the United States (33 U.S.C. §1344). The mining proposed under the HCP would avoid all but one small wetland area, considered a "water of the U.S." However, the USACE has determined that because dredge or fill material would not be discharged to this wetland, a 404 permit is not required.

2.5 NATIONAL ENVIRONMENTAL POLICY ACT

Although not directly required from the applicant for an incidental take permit, the Services must comply with the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. §4321 et seq.), and the regulations of the Council on Environmental Quality in evaluating the impacts of issuing the take permits. The requirements of NEPA, described in Section 102 of the statute (42 U.S.C. §4332[C]), are normally triggered by any major federal action that significantly affects the quality of the human environment (see 40 CFR §1508.18 et seq.). Under the Department of Interior's guidance manual, any incidental take permit is categorically excluded from NEPA, unless issuing the permit may (i) result in cumulative or adverse effects on federally listed species; (ii) result in significant environmental, economic, social, historical, cultural, or cumulative impacts; or (iii) result in controversial environmental effects.

In the context of this HCP, the NEPA process is intended to foster an appropriately complete and full disclosure of the environmental issues surrounding the proposed federal action (i.e., issuance of an incidental take permit); to encourage public involvement in planning, identifying, and assessing a range of reasonable alternatives; and generally to explore all practical means to enhance the quality of the human environment and avoid or minimize adverse environmental impacts that may arise from the issuance of the permit.

The Services determine through both an internal and public scoping process the appropriate course of action relating to a proposed action and NEPA. Depending upon the scope and impact of the action, NEPA requirements can be satisfied in one of three ways: (1) categorical exclusion, (2) Environmental Assessment, or (3) Environmental Impact Statement. Storedahl has voluntarily chosen, and the Services concur, to accomplish NEPA compliance for the HCP process through the development of an Environmental Impact Statement (EIS).

NEPA requires the identification and discussion of probable significant adverse environmental impacts, so as to inform the federal decision maker. NEPA also requires an examination of environmental effects, including those not specifically addressed by other laws. This integrative assessment is an important aspect of the relationship between NEPA and HCPs. Together, these processes allow federal agencies and applicants to evaluate environmental impacts as a part of their planning and decision-making process.

2.6 1996 AMENDMENTS TO THE MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The Sustainable Fisheries Act (SFA) to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (16 U.S.C. §1801 et seq.) requires in certain instances, federal agencies to consult with NOAA Fisheries when undertaking actions that may adversely affect "essential fish habitat" (EFH). The EFH descriptions for salmon under the Pacific Salmon Fishery Management Plan of the Pacific Fishery Management Council have recently been approved by NOAA Fisheries. The EFH descriptions and recommended conservation measures are general and recognize the importance of "off-channel" salmon rearing habitat, oxbow, wetlands, and riparian vegetation that are an integral part of the HCP. NOAA Fisheries' participation in the HCP will include, as may be appropriate, SFA review requirements.

2.7 STATE ENVIRONMENTAL POLICY ACT

The State Environmental Policy Act (SEPA) has four main objectives as listed in the SEPA handbook (Ch. 43.21C RCW):

- to declare a state policy that will encourage productive and enjoyable harmony between people and their environment,
- to promote efforts that will prevent or eliminate damage to the environment and biosphere,
- to stimulate the health and welfare of people, and
- to enrich the understanding of ecological systems and natural resources important to the state and nation.

Keeping these purposes in mind ensures that state and local governments consider environmental issues in their decision-making processes. SEPA is similar to NEPA, which applies to federal rather than state permits. It is possible that some actions must comply with both SEPA and NEPA and related regulations. An environmental impact statement is being developed for the Daybreak project pursuant to SEPA (Ch. 43.21C RCW), due to consideration of (a) a site plan review application for the project, (b) a zone change application for portions of the project area, and (c) related permits. Storedahl has volunteered to complete a SEPA EIS rather than an environmental checklist under SEPA. Once the SEPA EIS is issued, it may be used jointly or adopted by incorporation for purposes of NEPA compliance during mining activities and following completion of mining and reclamation. On the other hand, if the NEPA EIS is completed prior to the completion of the SEPA EIS, the NEPA documents may be incorporated by reference or jointly used for purposes of compliance with SEPA.

2.8 WATER RIGHTS

Washington allocates water rights under the appropriative water rights doctrine in which water rights are determined based on "first in time, first in right" Ch. 90.42, RCW. Several water rights are appurtenant to the Daybreak site and it is estimated that approximately 330 acre-feet per year apply to such lands. These water rights include surface water, but are primarily groundwater rights. Storedahl has applied for a change in use of this water right for purposes of irrigation of riparian plantings, augmentation of stream flow in Dean Creek and for processing of aggregate. In addition, these changes would be necessary in order for Storedahl to commit to donating water rights under the Washington Trust Water Rights Act (RCW 90.42.080). Trust water rights may be used for instream flows or other beneficial uses with an issued water right for the new use. An appropriator who donates to the Trust may negotiate the terms and conditions of the donation to ensure that overall aims and goals of the donation are achieved. The donation under the HCP (see Chapter 4) would be predicated on use for instream flows in Dean Creek and the East Fork Lewis River within the HCP area.

2.9 GROWTH MANAGEMENT ACT AND ZONING

Effective 1 January 1995, pursuant to the Growth Management Act (GMA), Ch. 36.70A RCW, Clark County adopted a comprehensive land use plan. Under the GMA, each county using the GMA planning process must designate sufficient mineral resource lands sufficient to supply mineral (aggregate) needs over a twenty-year time horizon (RCW 36.70A.170[2]). The GMA further requires each county to designate "[m]ineral resource lands that are not already characterized by urban growth and that have long-term significance for the extraction of minerals" (RCW 36.70A.170[1][c]). Counties and cities "shall identify and classify aggregate and mineral resource lands from which the extraction of minerals occurs or can be anticipated" (WAC 365-190-070[1]). The Storedahl property at issue is not characterized by urban growth and has never been zoned for urban growth. The property is zoned AG-20, which limits newly created parcels to sizes of 20 acres or larger. Uses permitted in a AG-20 zoning district are those typically associated with agricultural activities including silviculture, farming, livestock production, pole yards, small saw mills, and residences, among others. Mining is allowed in AG-20 when a "mining overlay" is included with the zone. Clark

County designated 58 acres of the subject site as mineral resource lands and gave a surface mining combining district zoning overlay to such acreage (see Ch. 18.329 CCC).

As part of the GMA planning process, Clark County adopted Mineral Lands Policy 4.5.8 of the comprehensive plan which states: "Surface mining other than Columbia River dredging shall not occur within the 100-year floodplain." Further, in the course of implementing a new comprehensive plan, "mineral resource" designation was given only to those properties that met "matrix criteria."[1] Concurrent with the adoption of the GMA comprehensive plan in 1995, only 58 acres falling outside of the 270 acres previously zoned as AG-S/20 retained such zoning and were designated mineral resource lands. The AG-S/20 zoning authorizes surface mining as a permitted use and rock crushing as a conditional use of such property (CCC 18.329.020).

A recent in-depth hydraulic study has been completed, which demonstrates the location of the 100-year floodplain in the project vicinity, and this revised floodplain boundary has been accepted by the Federal Emergency Management Agency (FEMA) and Clark County. A complete physical map revision has been adopted by FEMA, effective on 19 July 2000. Storedahl has submitted to Clark County an application to change zoning from AG-20 to AG/S (Surface Mining Combining District Zoning) to those portions of parcels that are now known to be located outside of the 100-year floodplain. Further, the Clark County Director of Community Development determined on 28 February 1997 that nonconforming use rights exist for mining and processing on a portion of the site and may, if an appellate court adopted the “diminishing resources or diminishing assets doctrine” extend to the entire Daybreak site, regardless of changes in zoning or the policy (Clark County Comprehensive Plan's Mineral Policy 4.5.8) of no mining in 100-year floodplain. Recently, the Washington Supreme Court adopted the “diminishing assets doctrine” holding that nonconforming mining rights apply in Washington so as to expand the right to mine to the entirety of a parcel notwithstanding prohibitions to the contrary (City of University Place v. McGuire, 144 Wn.2d 640 (September 6, 2001). Nonetheless, Storedahl is proceeding with various permit applications at both the local and state levels.

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[1] The Clark County Comprehensive Plan's Mineral Policy 4.5.8 purports to prohibit mining in the 100-year floodplain. The comprehensive plan policy did not define "floodplain" or state how such floodplains would be designated. The County's position is that it will utilize the Federal Emergency Management Agency's (FEMA) Flood Insurance Study Maps, at least for purposes of its Floodplain Combining District Ordinance. CCC 18.327.055A. These maps are known as Flood Insurance Rate Maps or FIRMs.

2.9.1 Revised 100-Year Floodplain

Based on a 1996 flood event, which was well in excess of a 100-year flood (or a flood magnitude that is likely to occur once every 100 years), the unrevised FEMA 100-year floodplain was determined not to coincide with the actual 100-year floodplain. As a result, an analysis of the 100-year floodplain was undertaken.

In order to develop more refined reclamation plans for the Daybreak site, Storedahl engaged several environmental and engineering consultants who conducted analyses of the hydraulic and geomorphologic characteristics of the reach of the East Fork Lewis River adjacent to the Daybreak site. One of the initial findings of WEST Consultants, Inc. (WEST) was that the hydraulic model output data used by FEMA in producing its 1974 floodplain maps were erroneously transposed onto the floodplain maps.[2]

The erroneous nature of the FEMA floodplain maps for the property was subsequently underscored when a flood occurred on the East Fork Lewis River in February of 1996. Analysis by WEST, as well as Prof. Peter Klingeman of Oregon State University (who independently reviewed and concurred with the data, methodology, and conclusions of WEST), revealed that the February 1996 flood on the East Fork Lewis River was at least a 200-year flood event and possibly as large as a 1,000-year flood event. WEST obtained infrared aerial photographs of the property taken just two days after the extreme flood event. WEST determined the extent of the stream-derived floodwaters based on the infrared photographs (which showed inundated as well as recently inundated lands). WEST also conducted a field study of the property just a few days after the floodwaters receded and recorded high-water marks left behind from the flood. WEST also completed a topographic survey of the property using two-foot contour intervals rather than the more typical five-foot contour interval. The recorded empirical flood marks were then transposed onto the topographic survey maps. In short, the stream-derived floodwaters from the East Fork Lewis River flooded only a small portion of the FEMA-mapped 100-year floodplain on the parcels subject to this request. Again, WEST concluded, based on these data, that the FEMA mapped 100-year floodplain was substantially in error and grossly overstated the scope of the 100-year floodplain. These observations, in addition to a complete reanalysis with updated hydraulic data, refinement of hydraulic modeling, and detailed topographic data were submitted to FEMA.

[2] FEMA is the federal agency that administers the Federal Flood Insurance Program and Flood Insurance Rate Maps of the 100-year floodplain for purposes of this program. See 42 U.S.C. § 4001, et seq.; 44 CFR §59.1.

2.9.2 Approval of Physical Map Revision for Actual 100-year Floodplain

Based on WEST's analysis and submittal, FEMA determined:

> that we should revise and republish the FIRM [Flood Insurance Rate Map] FBFM [Flood Boundary and Floodway Map] and FIS [Flood Insurance Study] report. Based on the revised hydrologic and hydraulic analyses submitted [by WEST], the elevations and floodplain and floodway boundary delineation of the flood having a 1 percent chance of being equaled or exceeded in any given year (base flood) will be revised along the East Fork Lewis River, from approximately 17,000 feet downstream to just downstream of Daybreak Road. We will send preliminary copies of the revised FIRM, FBFM and FIS report to your community for review in approximately 30 days.

A copy of this letter from Mr. Fred H. Sharrocks, Jr., Chief, Hazard Identification Branch Mitigation Directorate, FEMA (23 January 1998) is provided in Technical Appendix E. After formal announcement of preliminary approval by FEMA an appeal was filed during the formal 90-day appeal period. In a letter from Mr. Michael K. Buckley, P.E., Chief of the Technical Services Division (Buckley 1999), FEMA issued notice to Clark County on 16 June 1999 that rejected all bases of the appeal, stating that "…we have completed our review of the submitted information and the flood hazard information shown on the preliminary form and in the preliminary FIS report and have determined that a revision (based on appeal) is not warranted at this time." Instead, FEMA gave notice that it accepted the 100-year floodplain map as submitted by WEST. Clark County similarly adopted the revised floodplain boundaries. A map of the revised floodplain is provided in Chapter 3, Figure 3-16. A Physical Map Revision implementing the new 100-year floodplain is effective on 19 July 2000.

2.10 WASHINGTON STATE SURFACE MINING ACT

The Washington State Surface Mining Act, Ch. 77.44 RCW, requires that, prior to conducting mining operation that exceeds 3 acres in total surface area, a mining reclamation plan be submitted and approved by the WDNR (RCW 78.44.081). However, the Surface Mining Act provides that surface mining operating permits issued prior to 1993 shall be considered reclamation plans (RCW 78.44.081). Storedahl has operated its mining activities at the Daybreak site under a surface mining operating permit issued by the WDNR in 1971. However, it is Storedahl's intent to submit a new updated reclamation plan to the WDNR that is consistent with this HCP. Generally, the requirements for a reclamation plan are somewhat basic, and the information and commitments set forth in this HCP and other corollary documents far exceed the reclamation requirements set forth in the Surface Mining Act (RCW 78.44.091). The Surface Mining Act also requires that, prior to conducting mining operations, a financial performance security instrument be posted by the applicant sufficient to complete reclamation activities for the next 12-24 months of anticipated mining activity. It would appear that the financial commitments necessary under the ESA and implementing regulations issued thereunder would far exceed the requirements set forth in the Surface Mining Act, Ch. 77.44, RCW (Chapter 7). Storedahl will coordinate demonstration of financial commitment under the ESA with such commitments set forth in the Surface Mining Act.

2.11 WASHINGTON STATE SHORELINE MANAGEMENT ACT

The Washington Shoreline Management Act (SMA) establishes a permitting process for development within the shorelines of the state (Ch. 90.58 RCW). Generally, this permitting process is delegated to local governments, such as Clark County, through their shoreline master programs and corresponding development regulations. Storedahl will not be conducting any mining activity within the shoreline. Further, because the permitting process under the SMA is delegated to, in this instance, Clark County, the SMA is discussed in greater detail under the following sections. However, Storedahl anticipates that sand and gravel would be conveyed to the extant processing facility by either a) a conveyor belt system or b) over existing roads by truck and trailer. Because the conveyor belt system would cross a small portion of the 100-year floodplain and assuming these activities are “substantial developments,” Storedahl is submitting to Clark County an application for a shoreline substantial development permit. In addition, various processing equipment or structures may lie within the area of shoreline jurisdiction and where these activities are “substantial developments” then one or more permits may be required under the local Clark County Shoreline Master Program and corresponding regulations.

2.12 CLARK COUNTY REGULATIONS

2.12.1 Habitat Conservation Ordinance

Clark County has developed a Habitat Conservation Ordinance (CCC Ch. 13.51) as part of its Growth Management Act development regulations. This ordinance includes procedural and substantive requirements for development and vegetation removal that serve to avoid or mitigate for deleterious impacts to private property supporting fish and wildlife (including salmonid) habitat in Clark County. The ordinance incorporates WDFW's Priority Habitat and Species (2000) criteria for the protection of riparian habitats.

2.12.2 Wetlands

Project activities are anticipated to require a wetlands permit (CCC 13.36.400). The project area contains approximately 1.53 acres of wetlands as determined by use of the U.S. Army Corps of Engineers (USACE) 1987 Wetlands Delineation Manual and as required by Ch. 13.36 CCC (Ecological Landscape Services 1998). The USACE has confirmed the wetland delineation. Under the current project design, only 0.25 acres of wetlands will be impacted. Generally, these wetlands are very disturbed to moderately disturbed. Most of the site has been subject to agricultural practices over the past half-century, and little mature native vegetation remains within the wetlands, wetland boundaries, or buffer area. The highest rating for wetlands on the site is Category 4 or at most Category 3 (CCC 13.36.420). Of the wetlands on site, some 0.25 acres will be disturbed. As noted elsewhere, the USACE has also determined that a Section 404 permit under the Clean Water Act is not required for these activities. However, the proposed reclamation plan will preserve and create approximately 32 acres of emergent wetlands and approximately 102 acres of open water habitat. Over the long-term other areas will be replanted with native vegetation to re-establish the native valley bottom forest community on unmined areas. These plantings will exceed the replacement and enhancement guidelines of Ch. 13.36 CCC. Overall, the HCP will exceed the benefits sought under the wetlands ordinance, as the project is designed to include the enhancement and mitigation of wetlands, increase total wetlands acreage on the site, enhance vegetation and plant communities associated with wetlands, institute storm water and pollution control measures during the operational phase of the project, and establish permanent wetland and riparian buffers as the project proceeds (see CCC 13.36.410).

2.12.3 Surface Mining Combining District

As noted in Section 2.9, the Clark County Code authorizes surface mining and processing on lands with the surface mining combining district zoning (Ch. 18.329 CCC). A recent amendment to the surface mining combining district ordinance requires “site plan approval.” The proposal before the County includes an application for site plan approval. Approximately 58 acres of land proposed for mining are zoned with the surface mining overlay. A request for a zone change for other parcels proposed for mining and falling outside the 100-year floodplain is currently pending before the County and undergoing the SEPA review process. Again, as noted elsewhere, because Clark County has determined that nonconforming mining rights apply to the property and because Washington as adopted the diminishing assets doctrine, mining rights may extend to the balance of the Daybreak site. Nonetheless, Storedahl is proceeding with these approvals.

2.12.4 Shoreline Master Program and Shoreline Management Combining District

The Shoreline Management Act (SMA) of 1971, Ch. 90.58 RCW, became effective on 1 June 1971. Clark County first adopted its Shoreline Master Program (SMP) in August of 1974, and the SMP was approved and adopted by rule according to the procedures set forth in the SMA on 18 December 1974 (WAC 173-19-140). Recently this rule was repealed and new procedural requirements were adopted regarding subsequent amendment of Shoreline Master Programs (see WAC 173-26-110, 120). Clark County has not amended its SMP since 1992, when it increased residential construction setbacks from shorelines (see WAC 173-19-140 [1995]).

Portions of the Daybreak site that fall within the 100-year floodplain are designated by the Clark County SMP as the "rural" shoreline environment (Clark County SMP Ch. V, plate 8). The Clark County SMP rural shoreline environment authorizes surface mining, subject to a conditional use permit. As noted, no mining is anticipated in the shoreline.

The Clark County SMP includes as a "stream shoreline," the

> East Fork Lewis River--from Gifford Pinchot National Forest Boundary (Sec. 24, T4N, R4E) downstream to confluence with Mason Creek (Sec. 14, T4N, R1E), including all lands situated within the floodplain (Clark County SMP at 10 [Aug. 1974]).

This area includes certain areas of the property adjacent to the East Fork of the Lewis River. Recent legislation modified the SMA's definitions of shorelines. Currently "shorelines" are defined as:

> all of the water areas of the state, including reservoirs, and their <u>associated shorelands</u>, together with the lands underlying them (RCW 90.58.030[2][d]; Laws of 1995, c. 382 §10 [emphasis added]).

In turn, "shorelands" means:

> those lands extending landward for two hundred feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward two hundred feet from such floodways; and all wetlands and river deltas associated with the streams, lakes, and tidal waters which are subject to the provision of this chapter; the same to be designated as to location by the Department of Ecology. Any county or city may determine that portion of a one-hundred-year-flood-plain to be included in its master program as long as such portion includes, as a minimum, the floodway and the adjacent land extending landward two hundred feet therefrom (RCW 90.58.030[2][f], Laws of 1995, c. 382 §10).

In short, the GMA and SMA provide that the Clark County SMP is the comprehensive plan for shorelines. The Clark County SMP and the SMA require that “development” taking place in the shoreline and costing in excess of $2,500 needs a substantial development permit. The HCP anticipates that the project will include construction of a conveyer belt system that crosses a short portion of the “shoreline” to convey mined material to the extant processing site. A shoreline substantial development permit application has been submitted for this conveyer system. Alternatively, in the event that the shoreline permit is not granted, the excavated material will be trucked over existing county roads to the extant processing site. Because such transport is not dependent on “substantial development” a shoreline permit is not required for trucking the material to the processing site. In addition, to the extent that various processing equipment or activities constitutes “substantial development” within the area of shoreline jurisdiction, then a shoreline permit application will also be obtained for such developments.

2.13 CLARK COUNTY CONSERVATION PROGRAMS

2.13.1 East Fork Lewis River Land Acquisition

Since 1992, Clark County has purchased approximately 1,500 acres of the East Fork Lewis River floodplain and lowlands. Clark County currently collects a 6.25 percent real estate transaction tax that goes toward the acquisition of open space lands. The primary acquisition need identified by Clark County is riparian corridor land, with the main emphasis on the East Fork Lewis River. Since 1992, Clark County has purchased approximately 1,500 acres of the East Fork Lewis River floodplain, with the intention of developing a greenway along the river (State of Washington 1998). Clark County's greenway initiative along the course of the river is likely to result in long-term improvement of steelhead and other salmonid and trout habitat. Clark County has initiated a similar program in Salmon Creek. Storedahl will convey the Daybreak property in fee to an acceptable non-profit conservation organization. Such conveyance may occur as various parcels are mined, regraded, reclaimed, and replanted with riparian vegetation and are no longer needed for mining operations or at a later date. Some portions of the property may be conveyed immediately upon approval of the mining plan, zoning action, site plan approval, and HCP/ITP, if appropriate, qualified recipients are identified. In all cases, the final reclamation and implementation of habitat conservation activity will be undertaken in accordance with commitments and coverage of this HCP and ITP.

2.14 HCP GOALS AND OBJECTIVES

The overall goal of the HCP is to implement conservation measures designed to protect and enhance habitat of the species identified and to implement Storedahl's proposed mining expansion and habitat enhancement activities within the HCP area. In short, the HCP would provide a formal mechanism for extensive ecological habitat enhancement and the conservation of listed species or species of concern.

The specific objectives of this HCP include the following:

- Meet all requirements of the ESA with respect to mine expansion and habitat enhancement in the HCP area;
- Meet all legal requirements for an ITP for species addressed in the HCP;

- Make an appropriate contribution to the conservation of unlisted species covered by the HCP and treat them as if they were listed, with the intent of reducing the likelihood that listing may become necessary for some species;
- Provide net benefits, compared to current conditions, for both listed and unlisted species covered by the plan, contributing to the recovery of any species that is now or, in the future, may be listed as threatened or endangered;
- Obtain agreement that no additional commitment of resources would be required of Storedahl should unlisted species covered by the HCP become listed during the term of the HCP;
- Implement scientifically and technically sound conservation measures and provide monitoring to ensure the HCP is working as intended;
- Recognize uncertainty and incorporate management responses that are adaptive enough to 1) respond to changes in regulations or conditions, 2) incorporate and make use of new scientific information, and 3) address contingencies;
- Ensure the ability of Storedahl to mine and process aggregate to provide a reliable and reasonably priced product;
- Develop cost-effective conservation measures that control overall costs of the HCP, yet accomplish its fundamental purposes; and
- Implement a mining and reclamation sequence that allows conservation easement(s) and fee simple conveyance of mined and reclaimed parcel(s) to appropriate, qualified non-profit organization(s) so that conservation benefits are permanent.

CONTENTS

FIGURES

TABLES

3. EXISTING CONDITION OF THE DAYBREAK MINE SITE AND EAST FORK LEWIS RIVER BASIN

3.1 ENVIRONMENTAL SETTING

3.1.1 Climate

The climate of the Daybreak site is dominated by maritime influences of the Pacific Ocean and its topographic location inland in the Willamette-Puget Lowlands near the Columbia River. Regional climate is characterized by cool, wet winters and mild, dry summers. Precipitation is mostly derived from cyclonic storms generated in the Pacific Ocean and Gulf of Alaska that generally move inland in a southwest to northeast direction across western Oregon and Washington. Over 80 percent of precipitation falls between the months of October and April. During summer months a regional high-pressure system generally resides over most of the Pacific Northwest, diverting storms and associated precipitation to the north.

This regional climatic pattern is modified by the presence of the Coast Range, which results in somewhat lower precipitation and greater temperature ranges inland from the coast region to the west. Although not having a major direct climatic effect on the Daybreak site, the influence of the eastward lying Cascade Mountains on precipitation and snowfall patterns is important to the seasonal discharge patterns in the East Fork Lewis River.

The Cascade Mountains rise to an elevation of approximately 4,200 feet at the eastern margin of the East Fork Lewis River drainage basin. Moist, maritime air cools and condenses as it moves up in elevation from west to east through the basin, resulting in decreasing temperatures and increasing precipitation up this elevational gradient. Winter snowfall is much higher in the upper portion of the basin. Melting of this snow and consequent surface runoff in spring is a major source of water to streams, and rain-on-snow events (like those of November 1995 and February 1996) can result in major floods.

At the Battle Ground climate station, located approximately 4 miles southeast of the Daybreak site, temperatures range from an average July maximum of 78.1°F to an average January minimum of 31.4°F. Mean annual precipitation at Battle Ground is 52.3 inches, with snowfall averaging 7 inches a year (Western Regional Climate Center 1998) (Figure 3-1).

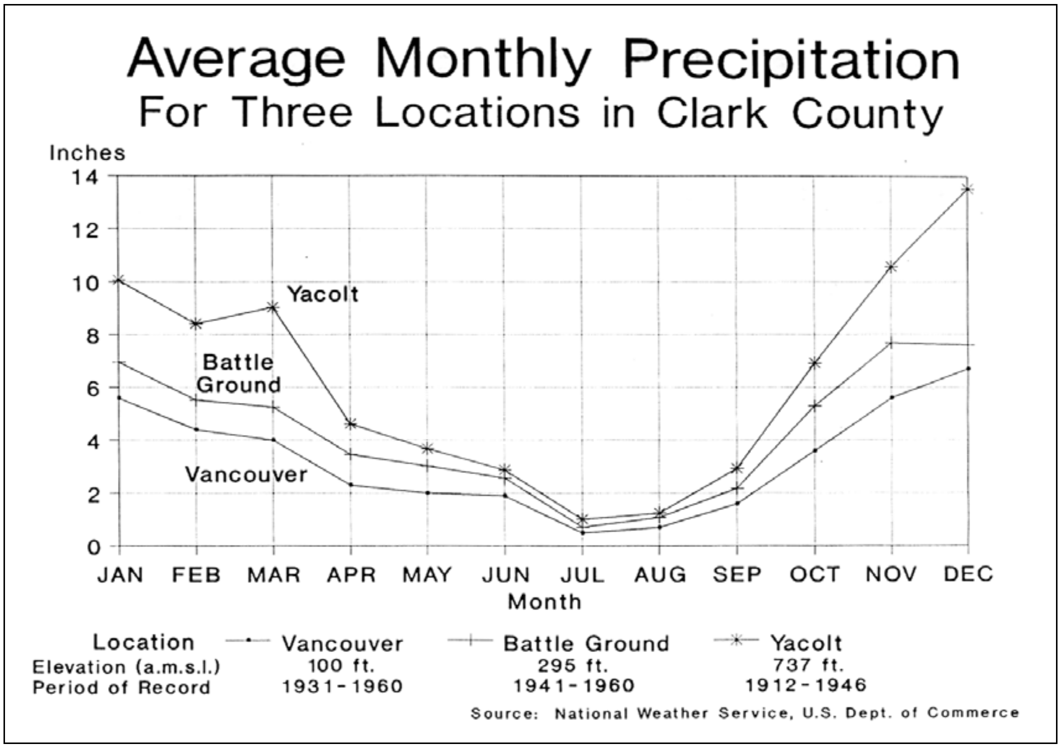


Figure 3-1. Average monthly precipitation in Clark County, Washington (Hutton 1995b).

3.1.2 Topography

The East Fork Lewis River originates in the foothills of the western Cascades, draining an area of 212 square miles (Figure 3-2). The river flows westward for 43 miles, joining the Lewis River approximately three miles upstream from the Columbia River. The Columbia River then empties into the Pacific Ocean 87 miles downstream. The lower 5.9 miles of the East Fork Lewis River is tidally influenced (Hutton 1995b), but the tidal influence can extend as far as RM 7.3 when flooding coincides with high tide (FEMA 1991).

At its headwaters, the East Fork Lewis River generally flows through steep, mountainous terrain, restricted by narrow valley walls. Tributary streams in the headwaters are steep channels dominated by bedrock and boulders. The two largest tributaries in the upper East Fork Lewis River basin are Copper and Rock creeks (Figure 3-2).

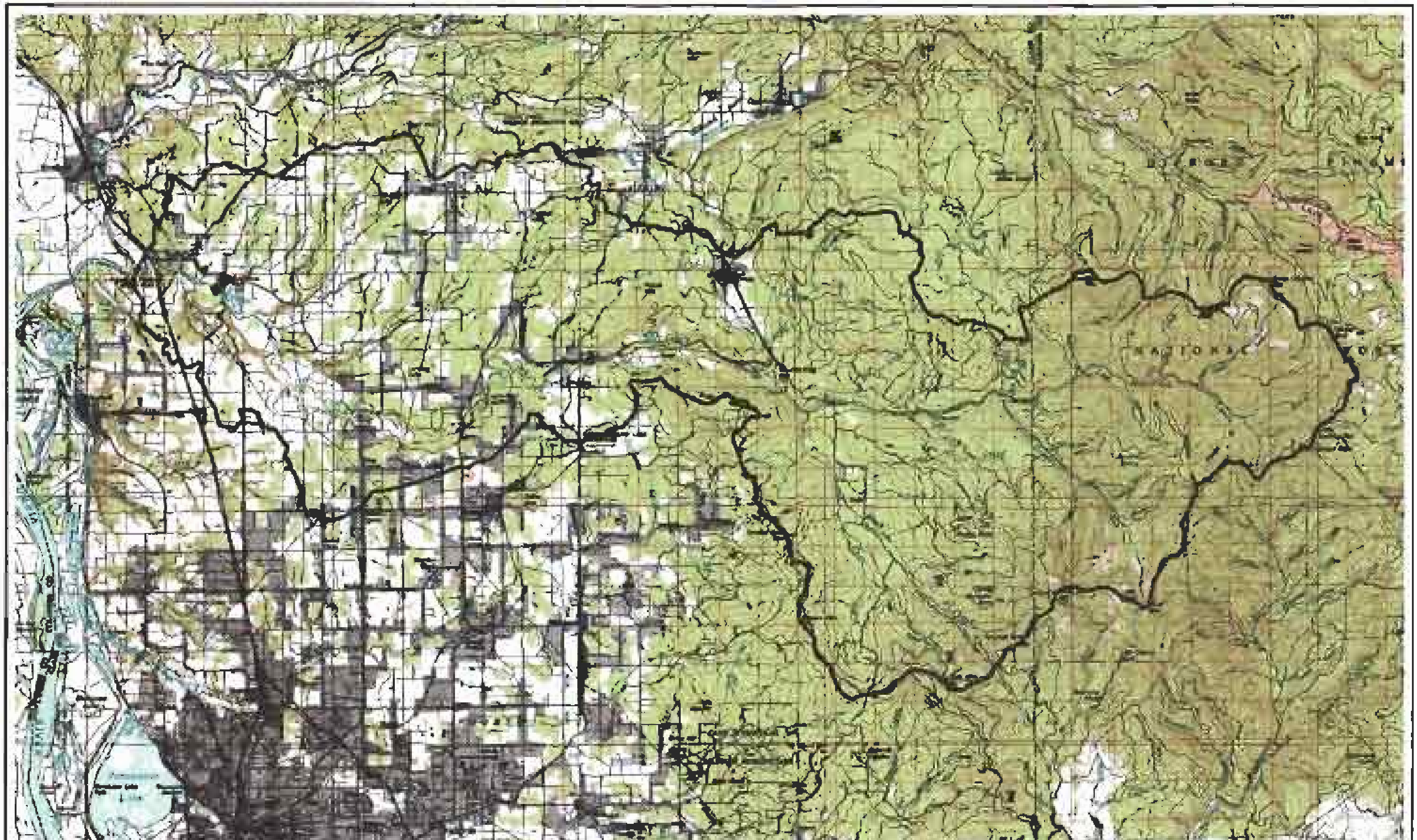


Figure 3.2. East Fork Lewis River Basin

Drainage Area = 212 Square Miles

1 0 1 2 3 4 5 Miles

WEST

Map Data Source: U.S.G.S. 1:100,000 Scale Map (Vancouver, WA, 1978)

Topography in the mid-section of the East Fork Lewis River drainage has been modified by glaciation. Although no glaciers formed within the East Fork drainage itself, a tongue of ice came down the Lewis River valley and covered a large portion of northeastern Clark County (Mundorff 1964). Ice marginal channels were cut along the north side of Bells Mountain south of the East Fork Lewis River, and a lobe of ice is believed to have extended up the East Fork Lewis River south of Yacolt (Mundorff 1964). Prior to glaciation, the East Fork Lewis River is believed to have flowed north into the Lewis River near Amboy (Mundorff 1964).

Since that time, the lower East Fork Lewis River has cut through a series of gently rolling high terraces and benches rising step-like from the present level of the Columbia River (McGee 1972). The terraces are dissected by steep-sided narrow tributary drainages such as Mill and Mason creeks (Figure 3-2). From RM 16.8 to RM 10.2, the river is confined to a narrow meander belt less than 1/4 of a mile wide. Approximately 1 mile upstream of the Daybreak site, the East Fork Lewis River emerges from a tightly confined canyon into an alluvial valley that ranges from 0.5 to 0.75 miles wide. Valley sideslopes are approximately 300 feet high, with gradients of 30 to 40 percent. The river gradient abruptly decreases, and sediment transported from the headwaters is deposited (Figure 3-3). The river transitions to a flat, tidally influenced sand and gravel bedded stream around RM 6 just downstream of the Daybreak site (Bradley 1996).

The Daybreak site is located within the flat alluvial valley (Figure 3-4). Surface elevations range from 30 to 60 feet mean sea level (MSL). Natural slopes are less than 4 percent, but manmade slopes may be as high as 25 percent on the edges of ditches, road cuts, berms, and stockpiles. Before the area was developed for agriculture, the East Fork Lewis River in the vicinity of the Daybreak site had a braided channel with extensive meanders and associated wetlands, as depicted on maps from 1858 (Figure 3-5). By 1951 the area was cleared, drained, and leveled for farming, primarily pasture (Collins 1997).

3.1.3 Geology and Soils

3.1.3.1 Geology

The geology of the East Fork Lewis River basin has been mapped and described by Mundorff (1964) and Phillips (1987), among others. The East Fork Lewis River basin contains three major types of geological deposits: volcaniclastic rocks forming the Cascade Mountains, sedimentary deposits of the Troutdale formation, and periglacial deposits from the Lake Missoula glacial outburst floods. The upper watershed contains minor inclusions of

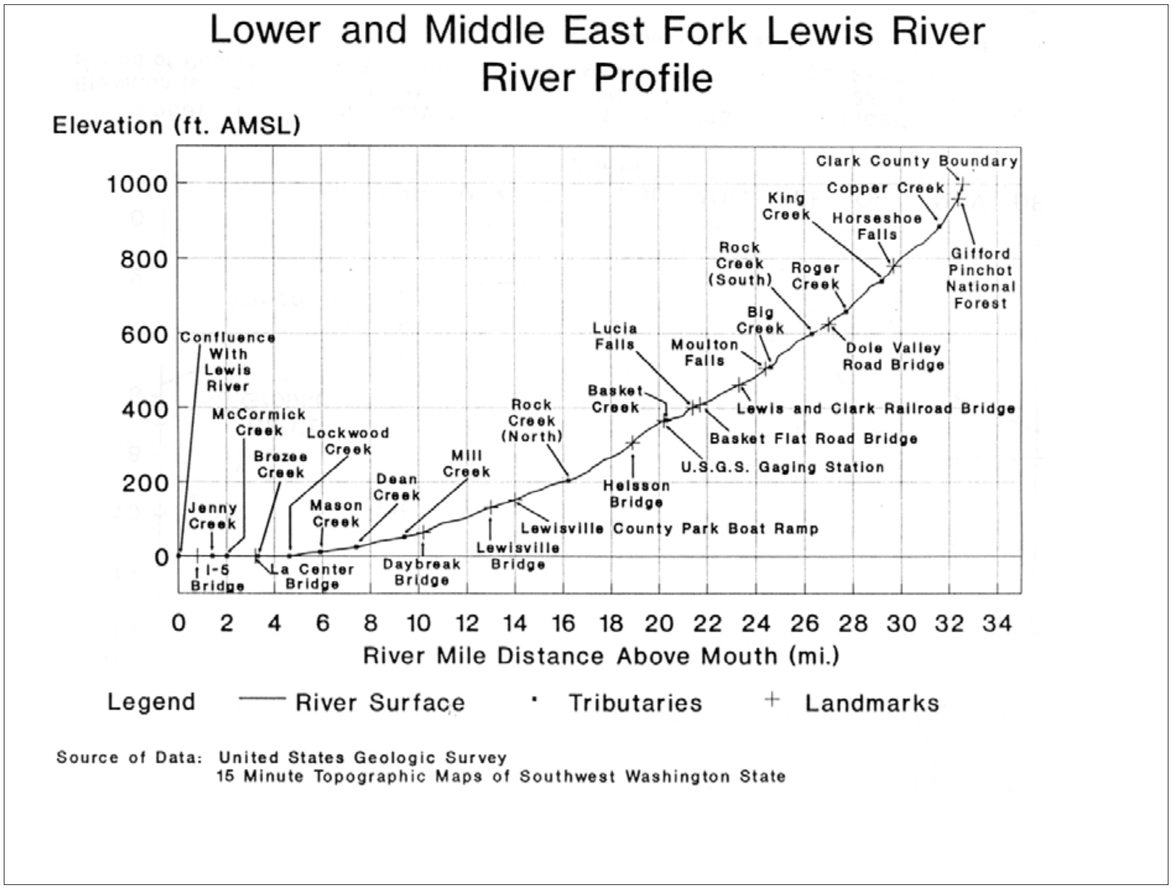


Figure 3-3. Profile of the lower and middle East Fork Lewis River, Washington (Hutton 1995b).

intrusive granitics of the Silver Star pluton and basalt flows of the Boring lavas. Alluvium, dating from the Holocene to the present, occupies the lower East Fork Lewis River Valley (Figures 3-6 and 3-7).

During the Tertiary period, repeated volcanic activity, with intervening periods of erosion, created the Cascade Mountains. The foothills of the Cascades extend into the eastern half of the basin, and bedrock there is predominantly basalt flows and volcaniclastic rock, 25 to 36 million years of age, dating from the Oligocene. To the southeast, in the headwaters of Copper and Rock creeks, granitic rocks of the Silver Star pluton intruded the volcanics in the early Miocene.

Of most importance in the HCP Area are the more recent deposits, dating from the late Miocene and early Pliocene to the present. During the late Miocene time a basin was formed in the Portland-Vancouver area by downwarping or faulting. A thick sequence (more than 1,000 feet) of clay, silt, and sand accumulated in a large shallow lake or estuary. This unit is referred to as the lower member of the Troutdale formation. The lower Troutdale crops out along the East Fork Lewis River valley and is visible on the north side of the valley upstream of the Daybreak Bridge as well as the south bank across from the Daybreak site. Mundorff (1964) mapped the upper surface of the lower Troutdale formation in Clark County. It crops out from about elevation 100 to 150 feet in the south bank of the East Fork Lewis River at the Daybreak site (see Ttl on Figures 3-7 and 3-8).

In later Pliocene or possibly early Pleistocene time, depositional conditions changed markedly. Widespread deposits of coarse gravel were laid down as a great fluviatile piedmont fan along the western foot of the Cascade Mountains. A major source of the gravel is the Cascade Range to the east, but it contains a considerable proportion of quartzite pebbles and cobbles that were transported from northeastern Washington by the Columbia River. This unit is known as the upper member of the Troutdale formation and it consists of cemented gravel and conglomerate, with lenses of sand and claystone. It occurs as a wedge of sediments throughout the Portland Basin, but is covered by younger deposits in the uplands adjacent to the Daybreak site.

Toward the end of Pliocene there was a period of volcanic activity in the area. Basalt flows, scoria, and breccia of the Boring lava were extruded over, and locally interbedded with the Troutdale gravel. A long period of weathering followed by glaciation in the Lewis River valley ensued. In Pleistocene time, ice extended down the Lewis River valley from the Mount St. Helens-Mount Adams area. The icesheet extended southward across the East Fork

Lewis River at least as far as the Lewisville Park, about 4 miles upstream from the Daybreak site.

Periglacial deposits from the Lake Missoula glacial outburst floods were left along the Columbia River between about 12,700 to 15,300 years ago. The material was deposited as a great delta or fan at the mouth of the Columbia gorge (Mundorff 1964). Within the East Fork Lewis River basin, these deposits are predominantly sand-sized. The Columbia River cut down through this formation, leaving a series of wide benches and terraces to the south of the Daybreak site. The course of the lower East Fork Lewis River appears to have been pushed to the north by these deposits, and has incised up to 300 feet through them. This unit is labeled as Qad on Figures 3-6 and 3-8.

Following the accumulation of the delta deposits, there was downcutting and some of the materials were reworked by the cut and fill process. Along larger rivers, such as the East Fork Lewis River, this resulted in fans, terrace deposits, and basin fill. These alluvial-fan and associated deposits are mapped on the basis of topography and lithologic characteristics (see the Qaf unit on Figure 3-6).

A Pleistocene alluvial deposit unconformably overlies the lower Troutdale formation on the south side of the East Fork Lewis River at the Daybreak site. The erosional unconformity is visible, and the terrace deposits consist of very coarse gravel in a sandy matrix. Pebbles include quartzite and granitic materials, which were reworked from the upper Troutdale formation and the periglacial drift. Notably, this terrace exhibits some instability. It is not clear if the mass wasting is due to erosion and undercutting in the erosive fine-grained lower Troutdale formation, slippage of terrace deposits from the angular unconformity at the surface of lower Troutdale, a block failure in the lower Troutdale material, and/or a combination of two more of these conditions (see Qt on Figures 3-6 and 3-8).

The river valley formed by the lower East Fork Lewis River has filled with alluvium dating from the Holocene to the present. The alluvium consists of gravel, cobbles, sand, and silt, and ranges from several feet to 50 feet thick at and near the Daybreak site. Gravels and cobbles are exposed in cut banks and on the river bottom in the immediate site area. Gravel bars are common in the river reach near the Daybreak site but are conspicuously absent downstream in the tidal influence zone, where silt, sand, and clay predominate.

Approximate Scale : 1" 1,340'

WEST CONSULTANTS, INC.

Figure 3.4 Composite aerial photo of East Fork Lewis River near Daybreak Mining Operation

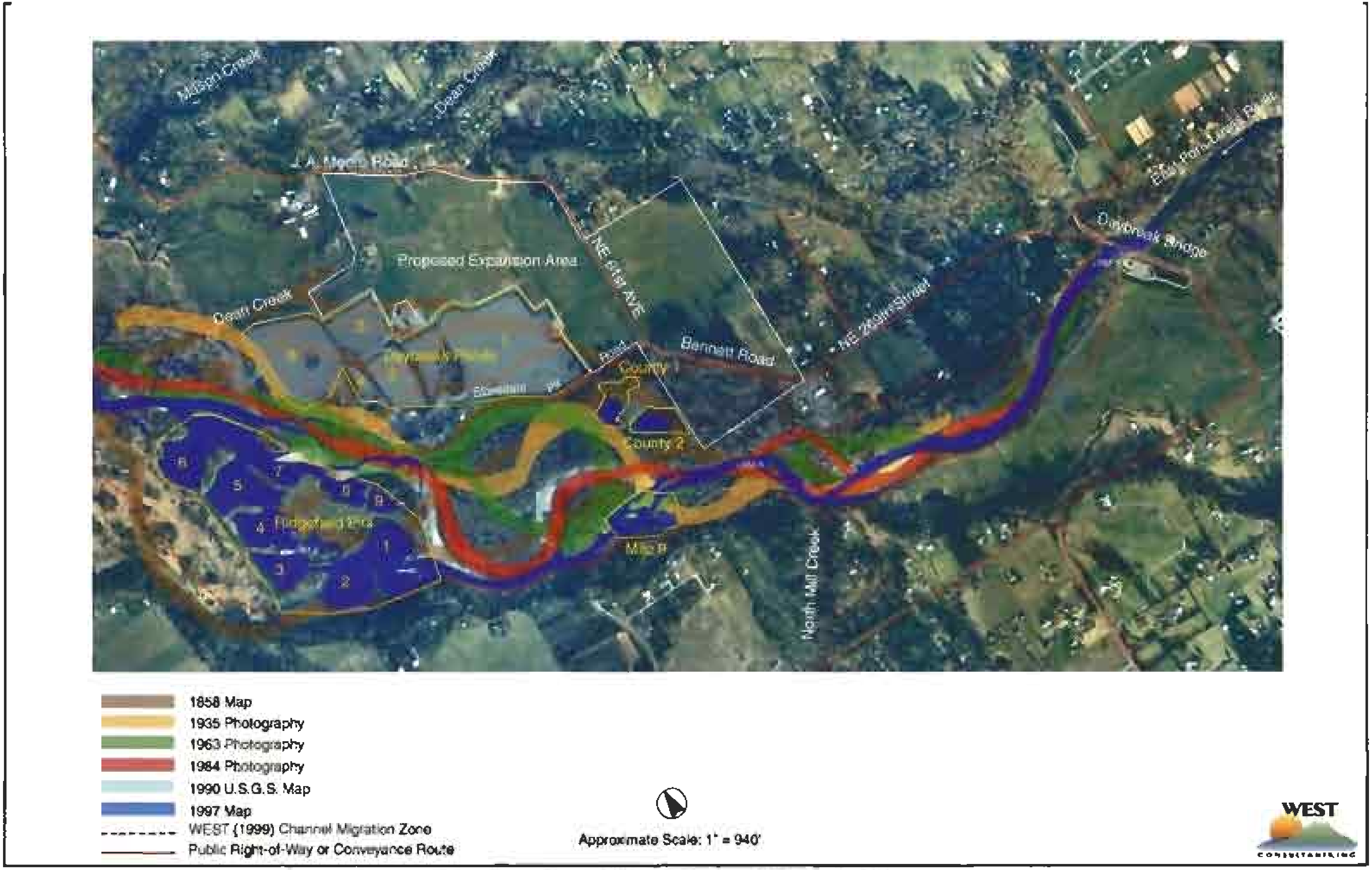
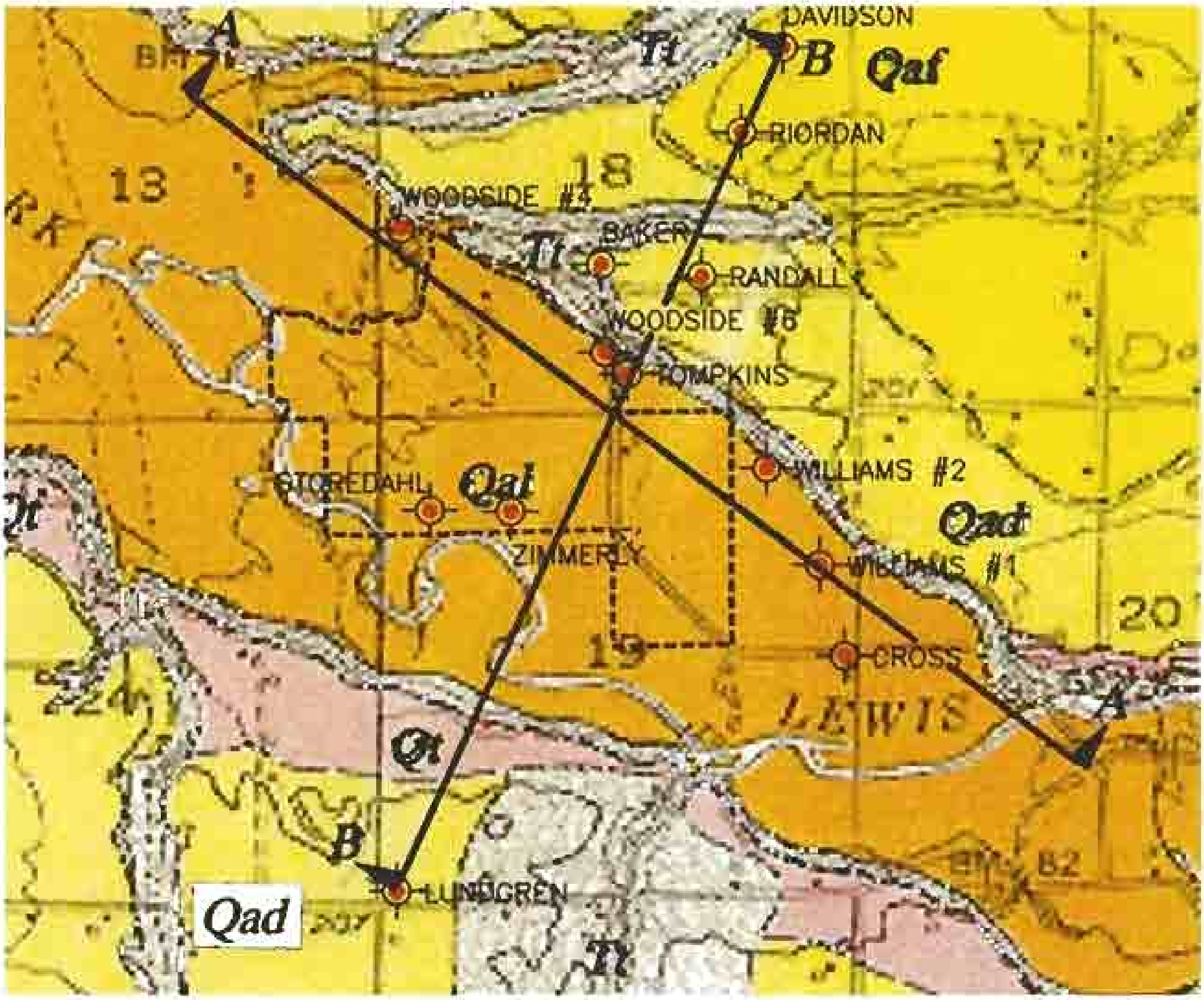


Figure 3-5. Approximate Historic Channel Locations of the East Fork Lewis River



EXPLANATION

Qal	FLUVIAL GRAVEL WITH SAND AND SILT
Qt	TERRACE DEPOSITS (GLACIAL OUTWASH DEPOSITS)
Qaf	ALLUVIAL-FAN AND ASSOCIATED DEPOSITS (FINE GRAINED SANDS AND SILT, SOME SAND AND GRAVEL)
Qad	ALLUVIAL DEPOSITS (SAND AND GRAVEL)
Tt	TROUTDALE FORMATION (UPPER MEMBER AND LOWER MEMBER)
WELL	WATER WELL NAME AND LOCATION
	SECTION LINE

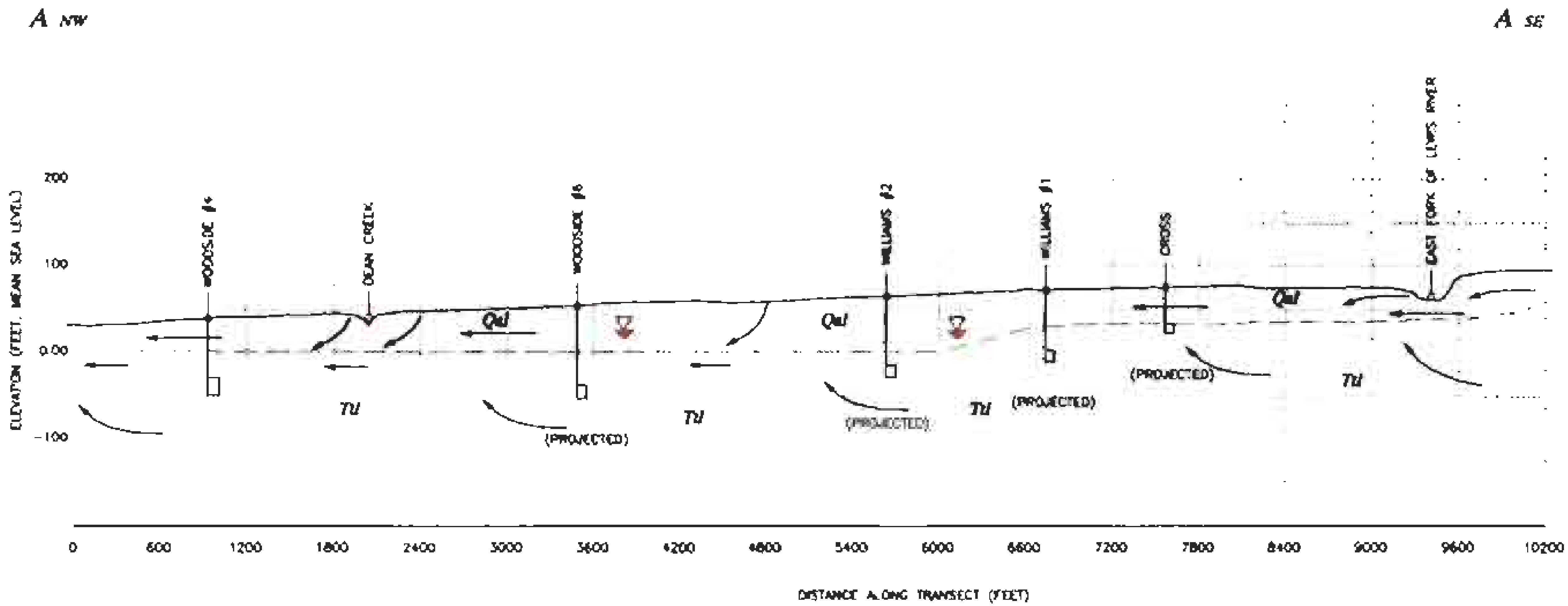
N

MAP ADAPTED FROM MUNDORFF, M.J. 1964, "GEOLOGIC AND GROUNDWATER CONDITIONS OF CLARK COUNTY", USGS WATER-SUPPLY PAPER 1600

the group
EMCON/OWT Solid Waste Services

DATE 1/02
DWN TLW
APP TJS
REV 1
PROJECT NO. 793584

FIGURE 3-6
J.L. STOREDAHL & SONS
CLARK COUNTY, WASHINGTON
HABITAT CONSERVATION PLAN
GEOLOGIC MAP OF THE EAST FORK LEWIS RIVER VALLEY IN THE VICINITY OF THE DAYBREAK SITE



EXPLANATION

Qal	FLUVIAL GRAVEL WITH SAND AND SILT
Qt	TERRACE DEPOSITS (GLACIAL OUTWASH DEPOSITS AND LANDSLIDE)
Qaf	ALLUVIAL-FAN AND ASSOCATED DEPOSITS (FINE-GRAINED SANDS AND SILT, SOME SAND AND GRAVEL)
Qad	ALLUVIAL DEPOSITS (SAND AND GRAVEL)
Ttu	TROUTDALE FORMATION (UPPER MEMBER, CEMENTED SAND & GRAVEL)
Ttl	TROUTDALE FORMATION (LOWER MEMBER, SILT AND CLAY)
PROJECTED	WELL OFFSET FROM SECTION LINE

INFERRED GROUNDWATER FLOW

WELL AND SCREENED INTERVAL

WL 1/7/99

BAKER WELL NAME

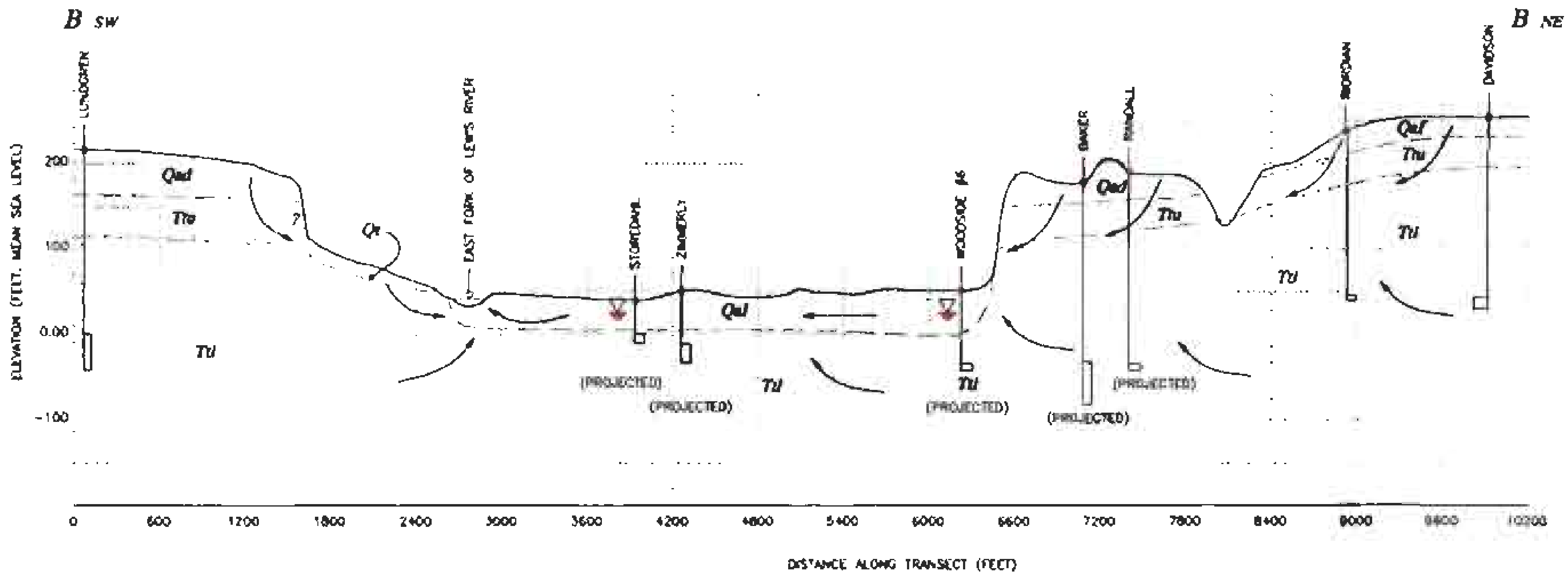
0 600 1200
SCALE IN FEET
HORIZONTAL SCALE 1"=600'
VERTICAL SCALE 3/4"=100'

the group
A MCNAUGHT Solid Waste Services

DATE 1/00
PROJECT NO. 793584

FIGURE 3-7
J.L. STOREDAHL & SONS
CLARK COUNTY, WASHINGTON
HABITAT CONSERVATION PLAN

GEOLOGIC SECTION A-A



EXPLANATION

Qal	FLUVIAL GRAVEL WITH SAND AND SILT
Qt	TERRACE DEPOSITS (GLACIAL OUTWASH DEPOSITS AND LANDSLIDE)
Qaf	ALLUVIAL-FAN AND ASSOCIATED DEPOSITS (FINE GRAINED SANDS AND SILT, SOME SAND AND GRAVEL)
Qad	ALLUVIAL DEPOSITS (SAND AND GRAVEL)
Tu	TROUTDALE FORMATION (UPPER MEMBER, CEMENTED SAND & GRAVEL)
Tl	TROUTDALE FORMATION (LOWER MEMBER, SILT AND CLAY)
PROJECTED	WELL OFFSET FROM SECTION LINE

INFERRED GROUNDWATER FLOW

WELL AND SCREENED INTERVAL

WL 1/7/99

BAKER WELL NAME

0 600 1200

SCALE IN FEET

HORIZONTAL SCALE 1"=800'

VERTICAL SCALE 3/4"=100'

Note: Localized channel migration and mass wasting has modified the lithologic sequence as compared to the southwest portion of section B-B on the Geologic Map.

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FIGURE 3-8
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GEOLOGIC SECTION B-B

The East Fork Lewis River channel typically ranges from 100 to 350 feet in width and averages approximately 4 to 6 feet in depth at bankfull stage. The banks are typically comprised of non-cohesive materials similar to the sediments found in the channel bed (sand, gravel, and cobble). The rapid reduction in river gradient through the reach downstream of Daybreak Park correspondingly reduces the sediment transport capacity of the river. The reduction in sediment transport capacity results in the deposition of sediments transported from upstream sources. The natural trend for sediment deposition along the river in this area results in a relatively high lateral migration rate, which tends to rework materials that have been deposited in the past. In the reach downstream of Mason Creek (near the typical upstream limit of the tidal influence zone), silt and sand are exposed on the river banks to heights of 5 to 8 feet above the river surface (see Qal on Figures 3-6, 3-7, and 3-8).

3.1.3.2 Soils

Soils in the upper East Fork Lewis River basin are generally deep, well-drained silt loams (McGee 1972). Soils formed on periglacial deposits adjacent to the lower river are deep, well to poorly drained silt and sandy loams. Soils formed on alluvium deposited by the East Fork Lewis River are generally excessively drained sandy loams underlain by gravelly sand or loamy sand at a depth of 16 to 40 inches (McGee 1972).

The soil types identified at the Daybreak site, as mapped by the Soil Conservation Service (SCS) (McGee 1972) are as follows: Washougal loam (WaA), Washougal gravelly loam (WgB, WgE), Puyallup fine sandy loam (PuA), and Pilchuck fine sand (PhB).

Washougal Loam and Washougal Gravelly Loam

The Washougal loam and Washougal gravelly loam consist of well-drained soils that overlie sands and gravel. The water-holding capacity of the loam is slightly higher than that of the gravelly loam. Permeability in the units is rapid in the substratum, and the surface runoff potential is low, making the erosion hazard slight to none (McGee 1972). The Daybreak site contains about 50 acres of Washougal loam, 50 acres of Washougal gravelly loam with 0 to 8 percent slopes, and less than one acre of Washougal gravelly loam with 8 to 30 percent slopes. The soils are classified as Capability Units IIIs-1 and IIIe-3. Class III soils generally have severe limitations that reduce the choice of plants, require special conservation practices, or both. Fertility for these soils ranges from low to moderate.

Puyallup Fine Sandy Loam

Puyallup soils are excessively well drained and overlay sands and gravel of moderately rapid permeability. Surface runoff is low and there is no erosion hazard (McGee 1972). The soils are assigned to Capability Unit IIIs-1, indicating low to moderate fertility. About 125 acres of Puyallup fine sandy loam occur on the Daybreak site.

Pilchuck Fine Sand

The Daybreak site contains about 40 acres of Pilchuck fine sand soil, which consists mostly of sand, with some cobbles and gravel. The soil has no farming value (indicating not suited for cultivation) according to the SCS.

3.1.4 Hydrology

3.1.4.1 Surface Water

East Fork Lewis River

The flow regime of the East Fork Lewis River is dominated by fall and winter rain events. The average discharge at the Heisson gage, approximately 12 miles upstream of the HCP area, is 738 cfs. Flows are generally lowest during August, which has a mean monthly flow of only 83 cfs. Flows are generally highest in December and January, when soils are saturated and rain-on-snow events may occur. In February 1996, a combination of heavy rainfall and snowmelt produced record setting discharges at many stations in the southern half of the state. At the Heisson gage, the February 1996 event was estimated to have a maximum discharge of 28,600 cfs and a recurrence interval of 500 years (Wiggins et al. 1997). The East Fork Lewis River has not been dammed and has no significant surface water diversion in the upper portion of the watershed (GeoEngineers 2001) and no known diversions upstream of the Heisson gage.

The Daybreak site is located directly north of the East Fork Lewis River between RM 7.2 and RM 9.0. Average monthly flow values were determined by direct scaling of measurements at the Heisson gage using drainage area. The mean annual discharge of the East Fork Lewis River at the Daybreak site was estimated to be 967 cfs, and average monthly flows range from 108 cfs in August to 1,909 cfs in December (Figure 3-9). A more detailed analysis of river flows is provided in Technical Appendix C.

The HCP area is located near a natural gradient break in the river profile. At RM 10.2 to RM 7.0 the transition to a much lower gradient results in reduction of the sediment transport capacity of the river. The natural trend for sediment deposition along the river in this location results in a relatively high lateral migration rate as discussed in more detail in Technical Appendix C. Bank protection composed of large riprap has been placed along the banks at several locations upstream and downstream of the HCP area, including near the bridge at Daybreak Park and along some outer bends in the tidal influence zone. Tidal effects are normally present up to approximately RM 5.9, which is near the outlet of Mason Creek, and can extend as far as RM 7.3 when flooding coincides with high tide (FEMA 1991).

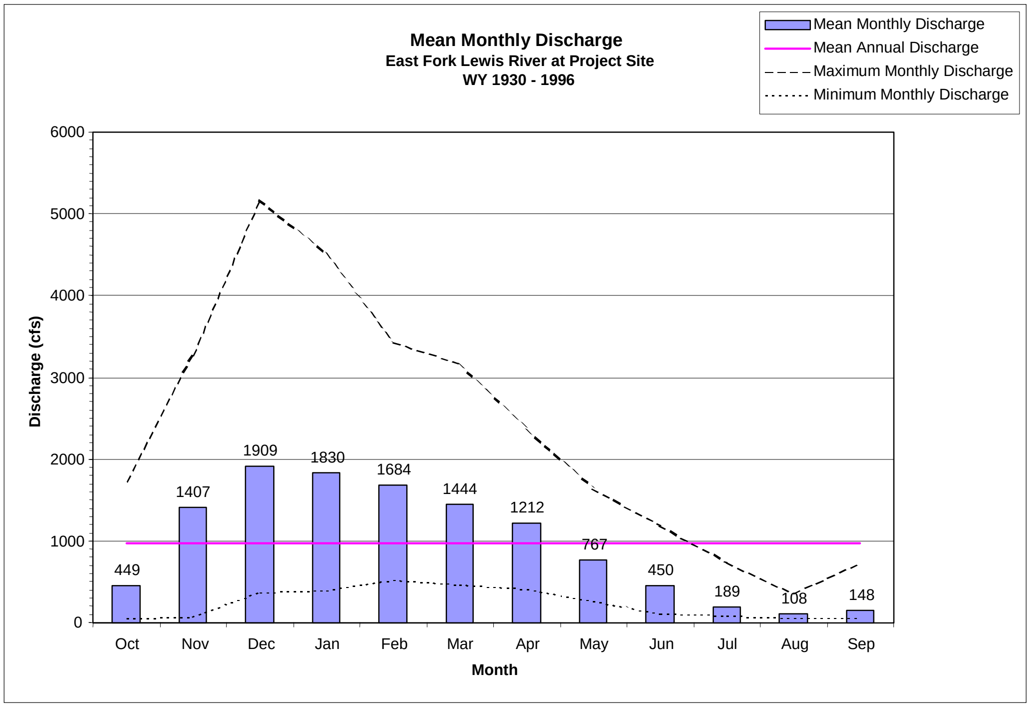

Figure 3-9. Annual and monthly flow characteristics of the East Fork Lewis River at the Daybreak site (Hutton 1995b).

During the development of the HCP, a concern was expressed about the effect of Columbia River flow regulation on bedload movement and sediment deposition in the lower East Fork Lewis River. Prior to dam-building and flow regulation on the Columbia River it is probable that flood events had a more frequent and more extensive backwatering effect on the lower East Fork Lewis River. This assumption led to a concern that although gravels were historically deposited in the area of the Daybreak site, the potentially reduced backwater influence may now allow gravel to move further downstream before being deposited. The potentially altered bedload movement is further confounded by the Ridgefield Pits, which are now acting to capture gravels that would otherwise be transported to the downstream reach now that backwatering has been reduced. Although the full context of this concern is unclear, it was assumed that these potentially contradictory phenomenons were brought to the Services attention so that baseline conditions could be fully described, and so that the potential effects of the HCP would address the baseline conditions, as they currently exist.

As described in Technical Appendix C, the existing morphology and gradient profile of the East Fork Lewis River exert strong influences on sediment transport. It is likely that these influences restrict much of the potential influence exerted by the reduced backwatering that has resulted from flow regulation of the Columbia River. In addition, the sediment characteristics of the lower East Fork Lewis River are strongly affected by the tidal influence zone, which has not been altered by flow regulation of the Columbia River. In the tidally influenced zone, velocities drop to zero twice a day and sand and some finer-sized particles drop out of the water column and become the dominant components of the substrate.

As discussed more fully in Technical Appendix C, sediment deposition is strongly affected by a relatively abrupt gradient change at RM 7.5, where the river channel changes from a gradient of approximately 7 feet per mile to a channel slope of approximately 18 feet per mile. This transition zone between the steeper and shallower slopes is the location where coarse sediments (sands, gravels, and cobbles) carried downstream by the East Fork Lewis River are deposited. The presence of the Ridgefield Pits and Daybreak Mine at this location is testimony to the abundant historical deposition of marketable-sized gravel in this transition zone by reducing the amount of gravel movement to the lower reach.

Although the potential effects on sediment transport and deposition from reduced backwatering as a result of regulation of the Columbia River is possible, its effects have not been quantified. However, because the channel now flows through the Ridgefield Pits, gravels are deposited in these pools (as is discussed in Technical Appendix C and in Section 3.3.2.2) and are prevented from being transported further downstream until the pools fill or the river again changes course. This sediment capture could be affecting the lower approximately 1.25 miles of spawning habitat immediately upstream of the tidal influence zone by limiting the delivery of coarse sediment, which could influence sediment size characteristics. However, direct sediment sampling (see Section 3.1.5) indicates no adverse effects to spawning gravel-sized material at this time.

Dean Creek

Limited flow data are available for Dean Creek, which borders the Daybreak site to the northwest. The drainage area of Dean Creek at the Daybreak site is approximately 3.6 square miles, and the monthly flow pattern is believed to be similar to that of the East Fork Lewis River. High flows occur during the winter months of November to February, while low flows occur during the late summer months of July and August. A more detailed analysis of Dean Creek flows is provided in Technical Appendix C.

In the summer, flows in Dean Creek near the J. A. Moore Road go dry or become subterranean. The gradient of the stream changes rapidly at this location where the stream enters the relatively flat East Fork Lewis River valley. Coarse gravel and cobble-sized materials are deposited, providing a highly porous medium for water to flow through. The stream is confined between low levees just downstream of the J. A. Moore Road bridge, and coarse material is frequently removed by Clark County to maintain the stream channel under the bridge (EMCON 1998). Historically, the stream likely braided across the valley floor at this point, but the flow is now confined by bank hardening at the J. A. Moore Road bridge and its position is confined between the Storedahl and Woodside properties. Periodic dredging of the channel above and below J. A. Moore Road by Clark County and discontinuous small levees likely have been instrumental in keeping the Dean Creek channel in its current location. In addition, a parallel ditch has been dug to the west of the channel below J. A. Moore Road, which routes overbank flows away from the existing home and dairy farm on the Woodside property.

The channel morphology of Dean Creek is pool-riffle with gravel-cobble substrate from the J. A. Moore Road crossing downstream approximately 1,350 feet where the stream channel bends sharply to the west. From the sharp bend to the west downstream to the outlet of Pond 5, the channel morphology is dune-ripple or palustrine (a channel type formerly designated as “regime” by Montgomery and Buffington [1993]). This reach has a sand-silt bed and is predominantly pool (65% by length). Downstream of Pond 5, the reach is braided and often ponded behind beaver dams. A private access road on a property to the west of the project area fords the stream causing the stream to back up and eventually overtop the road. The lower 0.5 mile of stream is dominated by beaver activities and the flow alternates between impounded areas and grassy channels, which change location frequently in response to beaver dam-building. The lower reach of Dean Creek can also back up due to high flow events in the East Fork Lewis River, especially when high flows coincide with high tides.

The original condition of Dean Creek prior to EuroAmerican settlement is unknown. However, numerous remnant channels are evident on aerial photographs, some of which appear to have merged with Mason Creek to the west. The surrounding forest likely transitioned from somewhat drier conditions on the well-drained alluvial fan to wetland conditions on the valley floor. The distinct break in slope from the alluvial fan about 500 feet below J. A. Moore marks where this transition would likely have occurred. Numerous beaver dams were likely present within these lower reaches of Dean Creek prior to settlement by EuroAmericans, which would have promoted the development of wetlands and impounded water.

Existing Daybreak Ponds

Five ponds that resulted from gravel mining at the Daybreak site are located just north of the East Fork Lewis River. Figure 3-4 shows the locations of these ponds. The bathymetry indicates that Pond 1 has been significantly shallowed along the southwestern shoreline since 1999 as a result of increased settling of solids in the process water that was recycled through this pond. Water enters the ponds primarily as groundwater seepage and incident precipitation. Pond 5 periodically receives inflow from Dean Creek during winter high flows. Water leaves the ponds by surface-water overflow, groundwater seepage, and evaporation. The contribution of each varies seasonally. The existing site ponds are hydraulically interconnected by overflow channels, culverts, or permeable rock barriers (Section 3.1.5.3). The water surface in the existing ponds generally corresponds to the local groundwater table.

Surface drainage from the ponds is controlled by the Pond 5 outlet conditions and beaver activity on the property downstream. Storedahl has done nothing to physically alter the discharge points from Pond 5 since Storedahl began operating on the Daybreak site in 1987. Pond 5 currently overflows at up to three locations: the southwest corner, the western edge, and at Dean Creek (Figure 3-10). Surface water discharging from the southwest and western outlets flows in a series of natural and man-made channels through an off-site lowland floodplain to the west. During much of the year, water flows slowly through the beaver-dammed and flooded lowlands and eventually joins Dean Creek before it flows to the East Fork Lewis River. Surface water also simultaneously flows seasonally into the northwest corner of Pond 5 at a direct hydraulic connection to the defined channel of Dean Creek, just upstream of an area that is typically inundated due to beaver activity. Pond 5 subsequently discharges at the western and/or southwestern outlets. During an extreme high flow event in

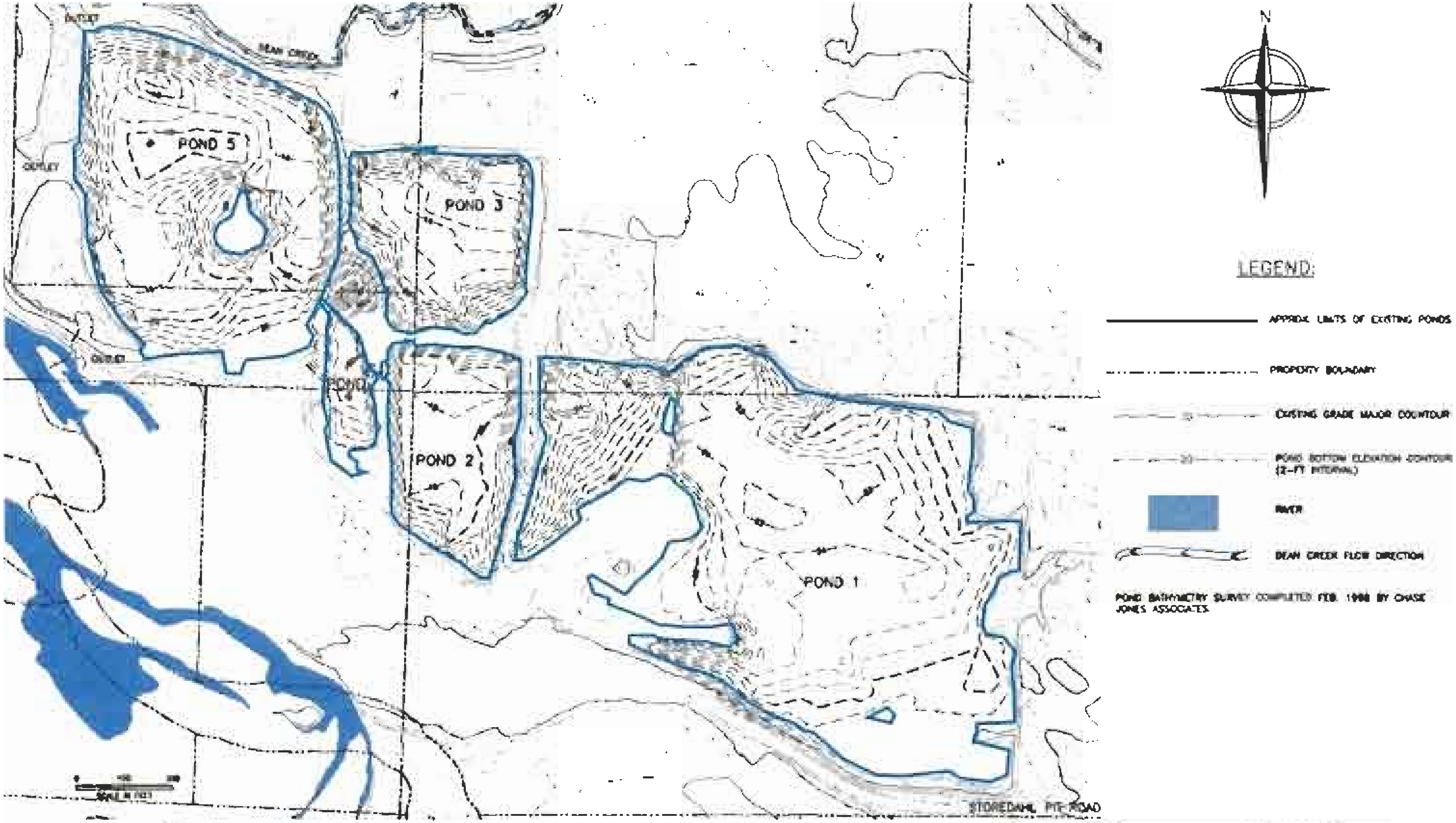

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FIGURE 3-10
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POND BATHYMETRY, 1999

December 2001, Dean Creek also overlapped its bank near the northeast corner of Pond 5 and spilled into Pond 5 at this location.

Beaver activity at the outlets to Pond 5 and in Dean Creek influences the water levels in the ponds and the characteristics of surface flow from the ponds. All of the outlets from Pond 5, and the outlet of Dean Creek, are currently controlled by beaver dams. Water spills over the beaver dams, and some water leaks through the dams. The nature of the flow from Pond 5 changes depending on the configuration of the beaver dams. In the past, the National Pollutant Discharge Elimination System (NPDES) monitoring point has been changed between the various sampling points at the Dean Creek northwestern outlet, the western, and the southwest discharge points to reflect the dominant flow. Site workers have estimated that beaver activity can cause the water level in Pond 5 to rise by more than a foot, resulting in backup and water level rises in Ponds 2, 3, and 4. During flood flows at approximately a 5-year return period, backwater from the East Fork Lewis River can result in flooding into Pond 5. These flood flows do not reach the other ponds, which are at slightly higher elevations.

Other Surface Water

Precipitation contributes to water flow in the ponds in direct proportion to the intensity and duration of the rainfall event. Short storms have little measurable impact on the flow; longer, more intense storms increase surface-water discharge from the ponds. Visual observations and analysis of the local drainage patterns and surface conditions show that there is some surface-water runoff delivered to the Daybreak site (see Technical Appendix D). However, overland flow generally infiltrates into the surface soils north of the ponds, and very little water enters the existing ponds.

An ephemeral stream crosses J. A. Moore Road through a culvert approximately 2,000 feet east of the Dean Creek crossing. This drainage flows into the Daybreak site from the north and subsequently runs west through an excavated ditch and then a shallow swale to a topographic low area just east of Dean Creek. The low area retains surface water during winter and spring months but is usually dry by early summer. In an aerial photograph taken on December 18, 1996 (Figure 3-4), considerable sediment deposition from a recent high flow event is evident in the portion of this drainage just below J. A. Moore Road.

3.1.4.2 Hydrogeology

The Daybreak site is located on the north edge of the Portland Basin (Mundorff 1964). Although several regional hydrogeologic units are defined in the Portland Basin, two of these units, the Unconsolidated Sedimentary Rock Aquifer and the Troutdale formation are relevant to this HCP. At the Daybreak site, the lower member of the Troutdale formation underlies and is hydraulically connected with the alluvial sediments that form the Unconsolidated Sedimentary Rock Aquifer. Alluvial sediments within the Daybreak site range from about 30 to 50 feet thick, as measured from the ground surface. The alluvium consists primarily of highly permeable gravel and cobbles, with a sand matrix. The underlying lower member of the Troutdale formation consists of fine sand, silt, and clay. The finer-grained nature of the lower Troutdale makes it much less permeable than the overlying alluvial sediments (Mundorff 1964).

Flow Systems

Recharge, movement, and discharge of groundwater is primarily controlled by the topography of the basin, which creates regional, intermediate, and local groundwater flow systems. A flow system is defined by the primary recharge and discharge areas of groundwater and by the hydrogeologic conditions under which flow occurs. The Columbia River is the regional discharge area for groundwater in Clark County. Much of the groundwater discharging to the Columbia River from Clark County enters the flow system in upland recharge areas along the western Cascade Range, moves downward and horizontally toward the river, and finally moves upward to discharge to the river. The Lewis River, East Fork Lewis River, and Salmon Creek are examples of discharge areas for intermediate groundwater flow systems. Groundwater enters the intermediate flow system through upland recharge areas in the drainage basin of the East Fork Lewis River. Local groundwater flow systems are much smaller in scale, and distances from recharge to discharge are on the order of hundreds or thousands of feet between recharge and discharge areas (McFarland and Morgan 1996).

The East Fork Lewis River is the ultimate discharge point for groundwater in both the intermediate and local flow systems governing the hydrogeology of the Daybreak site. Groundwater in the intermediate flow system recharges primarily by infiltration of precipitation where the alluvial fan and/or Troutdale formation are exposed in adjacent uplands and along valley slopes, and by infiltration of groundwater from overlying valley slope terrace deposits. Groundwater in the shallow local flow system recharges from direct infiltration of precipitation on the highly permeable surficial alluvial deposits, as well as from run-on and infiltration of surface water from smaller intermittent and perennial streams that flow onto the floodplain of the river. Recharge to the shallow alluvium from the East Fork Lewis River also undoubtedly occurs, especially during high-water periods (see discussion of hyporheic flow in Section 3.1.4.3 below). A secondary minor source of recharge is upward leakage from the underlying lower member of the Troutdale formation (intermediate flow system).

Local Groundwater Occurrence and Flow

Groundwater in the alluvial sediments (local flow system) occurs under water table (unconfined) conditions. Typical water table depth at the Daybreak site ranges from 1 to 13 feet below the ground surface. The water table fluctuates seasonally, with the highest elevations in the spring and lowest elevations in late summer and early fall.

The highly permeable nature of the Unconsolidated Sedimentary Rock or alluvial aquifer has been noted and evaluated by Mundorff (1964), and McFarland and Morgan (1996). McFarland and Morgan (1996) pointed out that this unit "has the highest median hydraulic conductivity (200 feet per day) and also the greatest variation in values…[in the basin]." A statistical distribution of hydraulic conductivity values for the unit show a range of 50 to 900 feet per day at one standard deviation. Mundorff (1964) reported on the specific capacity (i.e., discharge per unit drawdown) for wells completed in the East Fork Lewis River alluvial aquifer. The wells described ranged from shallow dug wells to deeper drilled wells. Analyses of the performance of the described wells employing standard equations (Driscoll 1986) results in calculated hydraulic conductivities from 70 to 1500 feet/day, potentially higher than the statistical range reported by McFarland and Morgan (1996). Considering the natural variability, as well as the finer-grained materials locally accumulated in the ponds, the median value reported for the basin (200 feet/day) was increased by 50 percent to calculate current and project future local groundwater flux. The value is supported by standard literature values reported for gravel and sand-gravel aquifers (Cedergren 1968; Driscoll 1986).

The water table surface in the alluvial sediments generally reflects the surface topography. Local groundwater flows primarily towards the East Fork Lewis River and its tributaries. Shallow groundwater discharges secondarily to evapotranspiration and wells. Figures 3-11 and 3-12 show late summer and winter water table surface contours for the alluvial aquifer at the Daybreak site. Dashed contour lines denote inferred water table contours. The groundwater contours indicate that flow is predominantly subparallel to and toward the East Fork Lewis River beside and downstream of the site, respectively. Groundwater flow in the alluvium near the site occurs under a hydraulic gradient ranging from approximately 0.003 to 0.008 feet/feet. Hydraulic gradient describes the relative change in pressure or head with a change in distance. In an unconfined or water table aquifer, such as the alluvial materials underlying the Daybreak site, the hydraulic head is the elevation of the groundwater surface as measured in a well. The hydraulic gradient or slope of the water table surface dictates the direction of flow and contributes to the calculation of both volume of flow and the seepage velocity of groundwater. Based on the measured gradient, estimated hydraulic conductivity of 300 feet/day (assumed to be 50 percent greater than the median value reported by McFarland and Morgan 1996), and an effective porosity of 0.2 (ratio of the volume of void spaces that conducts most of the fluid flow in the sediment to the total volume of sediment), the calculated groundwater seepage velocity ranges from 4.5 to 12 feet/day in the shallow alluvial aquifer. Local variations in seepage velocities are expected. For example, if a higher or lower hydraulic conductivity exists locally, the groundwater seepage velocity would increase or decrease proportionately. For example, the banks of Pond 5 are draped, and the bottom substantially filled, with accumulated fine sediment as a result of its historical use in treating process water. These finer grained silts and clays have a hydraulic conductivity orders of magnitude less than the alluvial aquifer (Cedergren 1968), and therefore the seepage velocity through these materials would be expected to be substantially less than the alluvial aquifer. Nevertheless, the seepage velocity of the alluvial aquifer is used as a conservative, i.e., high, rate in projecting groundwater movement downgradient of the ponds.

Groundwater in the underlying Troutdale formation (intermediate flow system) occurs under semi-confined conditions (Mundorff 1964; McFarland and Morgan 1996). Flow in this aquifer is primarily toward the East Fork Lewis River, with secondary upward leakage into the overlying alluvial sediments. Although minor, the upward flux of groundwater from the Lower Troutdale into the alluvium, with ultimate discharge to the East Fork Lewis River, is typical of groundwater flow patterns in similar hydrogeologic settings (McFarland and Morgan 1996).

Groundwater/Surface Water Connections

Like most large streams west of the Cascades, the lower reaches of the East Fork Lewis River and its tributaries are gaining streams (Mundorff 1964; McFarland and Morgan 1996). This means that on a net annual basis, the streams gain more volume from groundwater inflow than they lose to groundwater seepage.

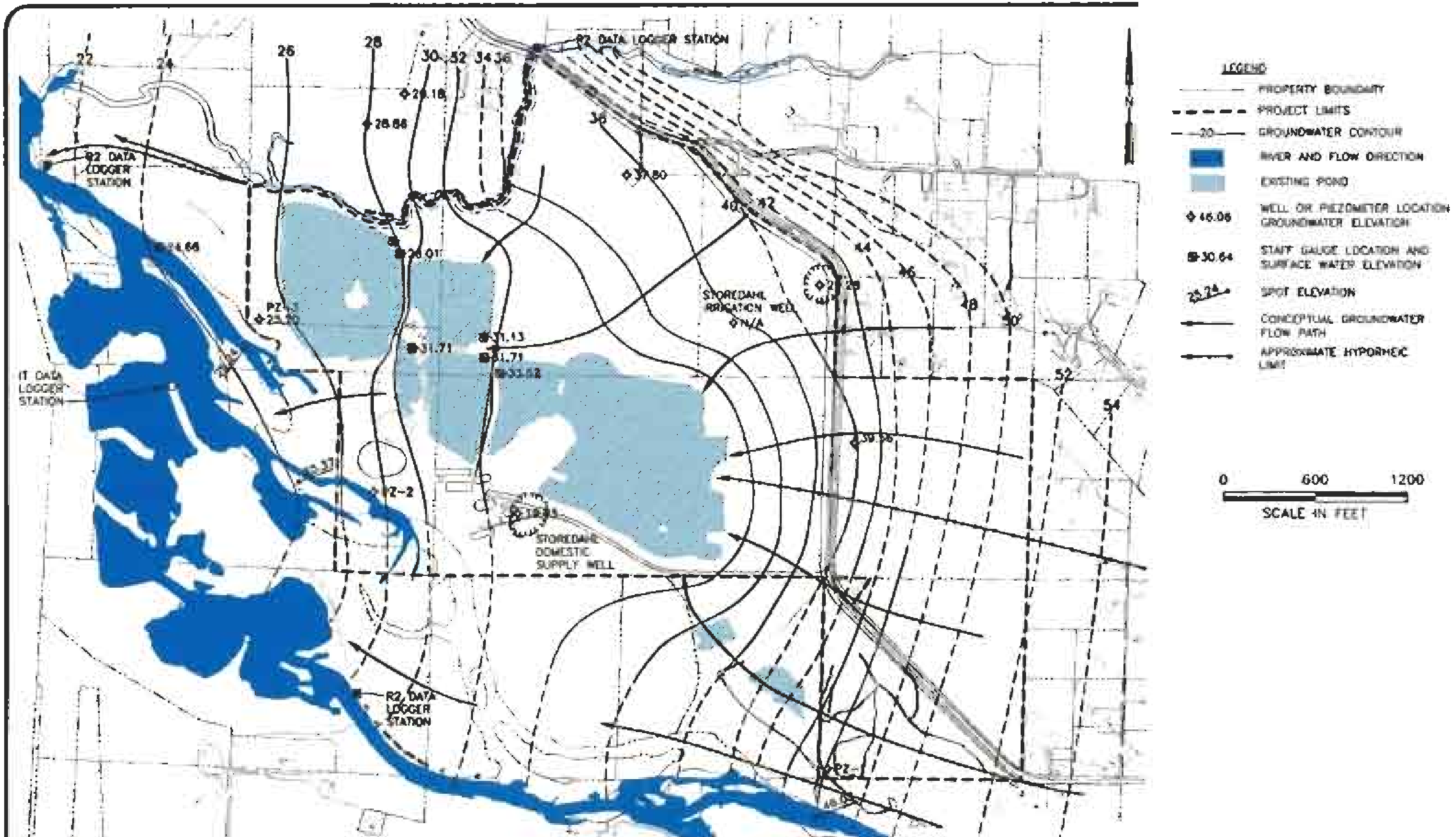

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FIGURE 3-11
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DECEMBER 1998
GROUNDWATER CONTOURS

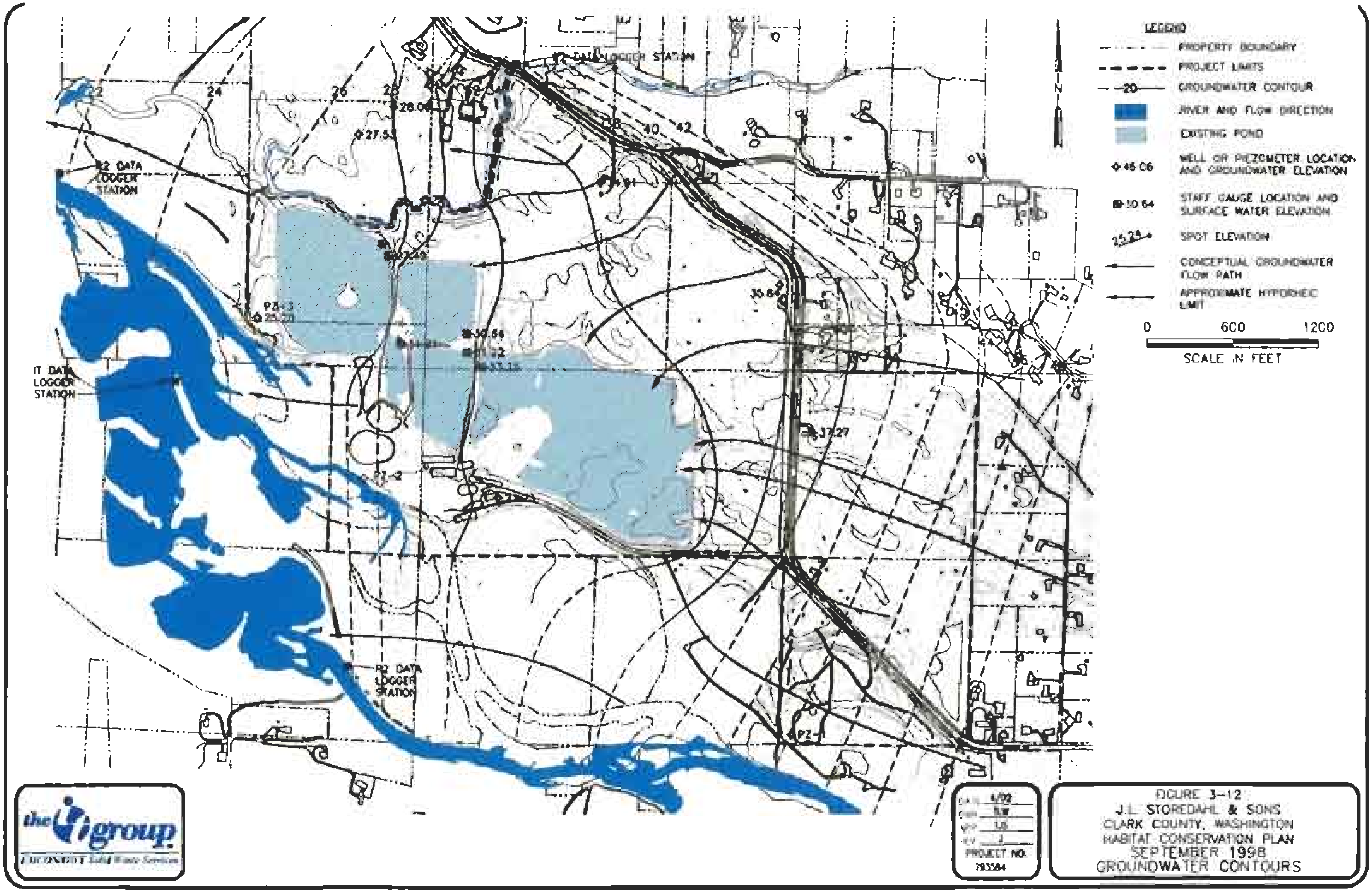

FIGURE 3-12
J.L. STOREDAHL & SONS
CLARK COUNTY, WASHINGTON
HABITAT CONSERVATION PLAN
SEPTEMBER 1998
GROUNDWATER CONTOURS

The U.S. Geological Survey (USGS) evaluation of groundwater flow in the Portland Basin included a detailed study of groundwater inflow to the East Fork Lewis River (McFarland and Morgan 1996). The USGS report shows that average groundwater inflow rates at RM 10.6 and at RM 6.5 were 0.58 and 1.59 cfs per stream mile, respectively. The USGS calculations were based on field data collected on the river during a relatively low flow period in October 1987 and 1988.

In its upper reaches above the J. A. Moore Road, Dean Creek is a losing stream during the winter when high precipitation results in runoff into the creek, and Dean Creek recharges the local shallow groundwater. The water table map for December 1998 (Figure 3-11) depicts the gradient from the creek to the water table. In the winter, the upper north-south reach is perched above the local water table and the lower east-west reach is coincident with the water table (see Figure 3-11). In the summer, Dean Creek remains perched above the water table. However, flow in the creek is greatly reduced, and the hydraulic gradient from the creek is lower (Figure 3-12). Consequently, Dean Creek's contribution to the recharge of the local water table is reduced during late summer.

Site water table maps (Figures 3-11 and 3-12) show that the existing ponds on the Daybreak site act as a local groundwater sink, and groundwater locally flows into the upgradient side of the ponds throughout the year. Under the current configuration, surface-water discharge from the ponds results in local suppression of the water surface and a net groundwater inflow to the ponds (i.e., groundwater inflow is greater than groundwater outflow). During the winter, the hydraulic gradient to the ponds is high, groundwater inflow is high, and most water drains from the pond system by surface flow. During the summer, the hydraulic gradient to the ponds is reduced, surface discharge from the ponds is low or absent, and most water exits the ponds as either groundwater seepage or evaporation.

Groundwater inflow into the ponds was estimated using the groundwater flow net, reported aquifer properties, local stratigraphy, and the configuration of the ponds. Groundwater seepage to the ponds was calculated as the groundwater flow through vertical planes in the flow net upgradient of the ponds. Stream lines in the flow net were selected to delineate a low-gradient and a high-gradient flow zone. The horizontal dimensions of the flow zones were the measured distances between the stream lines that were captured by the ponds. The vertical dimension of the flow zones was defined by the local stratigraphy and the estimated depth of influence of the ponds at the location of the vertical planes. Groundwater flow in each zone was calculated by Darcy's Law using the average gradient across the vertical planes. Assuming a hydraulic conductivity of 300 feet/day, groundwater inflow to the ponds was calculated to be approximately 3.2 cfs in winter and 1.2 cfs in the summer.

The total groundwater flow from the ponds was estimated using Darcy's Law in a manner similar to that used to calculate the groundwater seepage into the ponds. The groundwater contours suggest that most of the seepage from the ponds to groundwater originates from Pond 5. The calculated flux from the ponds to groundwater and then to the East Fork Lewis River was 0.9 cfs. The groundwater seepage rate from Pond 5 is affected by the water level in the ponds, which varies seasonally and depends on the height of the beaver dams. However, the seasonal variation of the hydraulic gradient is small, and groundwater seepage from Pond 5 is therefore assumed to be constant throughout the year. The fine-grained underlying lower member of the Troutdale formation and accumulated fine-grained sediments in the ponds limit groundwater seepage through the bottom of the ponds, and thus most groundwater seepage likely occurs through the pond sidewalls, and from infiltrating surface water that accumulates at the southwest and west outlets of Pond 5. Groundwater seepage out of the ponds ultimately reaches the East Fork Lewis River or is taken up by evapotranspiration. Additional measurements of the water table, pond, and river elevations were collected on December 8, 2000, by WEST Consultants. The 2000 data (Technical Appendix C, Addendum 1) confirmed the water table map and flow net developed from the December 1998 data (Figure 3-11). Visual observations of water flowing out of the gravels at the upstream edges of the Ridgefield Pits and beaver ponds located in the old river channel support the mapped flow path of groundwater movement parallel to the river. On December 8, 2000 discharge in the East Fork Lewis River was measured at three sites within the HCP area, including at the Daybreak Park upstream of the project area, adjacent to the Daybreak site, and downstream of the Daybreak site just upstream of the mouth of Dean Creek. The calculated discharges at all three sites were similar and differences in measured flow were within the expected error of the calculation. This indicated that although the existing ponds may locally affect the groundwater flow path, there was no significant loss or gain to groundwater exhibited in the river adjacent to the Daybreak site.

The existing ponds at the Daybreak site constitute a series of floodplain lakes or ponds, which are primarily fed by incident precipitation and groundwater. The one exception is Pond 5 with its surface connection to Dean Creek, which seasonally discharges to Dean Creek and which receives significant surface water inflow from Dean Creek during the winter months. The existing ponds have a volume of approximately 535 acre-feet. Almost 39 percent of that volume is in Pond 5, which contains approximately 208 acre-feet of water. During the winter, complete recharge of the existing ponds by groundwater inflow and precipitation is estimated to occur every 73 days, as discussed in more detail in Section 6.2.1. This estimate is based on a set of assumptions described below, however it should be kept in mind that the existing ponds are affected by a range of conditions. Ponds 1 and 3 are located upgradient of the other existing ponds. As such they are groundwater sinks, receiving the groundwater seepage from the east and north (Figures 3-11 and 3-12). Pond 1 has a volume of approximately 202 acre-feet and receives about 2.45 cfs of winter groundwater recharge as well as 3.22 feet of incident precipitation. Under current conditions this would result in the complete recharge or turnover of Pond 1 every 37 days. However, this does not take into account the return flow from the recycling of process water which reduces the winter recharge or turnover time in Pond 1 to 19 days or less. Pond 3 has a volume of about 70 acre-feet and receives approximately 0.8 cfs of winter groundwater discharge. This groundwater, coupled with incident precipitation, results in a total recharge or turnover period of 44 days for Pond 3. However, during the winter months Pond 3 receives surface water overflow from Pond 2 and this may reduce the recharge or turnover time to as little as 6 days. Pond 5 has the shortest winter recharge or turnover period. It receives a significant amount of Dean Creek inflow during storm runoff, as noted in Table 6-2 in Section 6.2.1. The surface inflow from Dean Creek results in a potential for recharge or turnover every 4 to 18 days in Pond 5 during the winter months.

During the summer months, there is a significant increase in evaporation, reduction in the rate of groundwater inflow, and consequently an increase in the residence time in all of the existing ponds. Using the same assumptions described above and detailed in Section 6.2.1, the total recharge or turnover period is 279 days. The Pond 1 recharge period increases to 115 days when the process water is not being recycled. During the recycling of process water, the recharge or turnover period would be 29 days. Pond 3 receives no significant overflow from Pond 2 during the summer months and the rate of groundwater discharge to the pond decreases, resulting in a recharge or turnover period of 259 days. During the summer months there is no significant discharge of Dean Creek surface water into Pond 5. Therefore, the turnover period is 108 days. As discussed in Section 3.1.5.3, the residence time in the ponds is reflected in the amount of heat accumulated in the ponds during the summer.

3.1.4.3 Hyporheic Zone

Over the past two decades, stream and riparian ecologists have recognized the importance of the hyporheic zone to the stream ecosystem (e.g., Stanford and Ward 1988, 1993). The hyporheic zone has been defined differently by various investigators, based on biological, biogeochemical, and hydrologic criteria. The WAC 222-16-010 General Definitions states that the hyporheic zone is "…an area adjacent to and below channels where interstitial water is exchanged with channel water and movement is mainly in the downstream direction." White (1993) conceptually defines the hyporheic zone "…as the saturated interstitial areas beneath the stream bed and into the stream banks that contain some proportion of channel water or that have been altered by channel water infiltration (advection)." More rigorous definitions of the hyporheic zone generally reference Triska et al. (1989) and the inclusion of advected channel water found within the streamside aquifer. Wondzell and Swanson (1996) further refined Triska et al. (1989) in defining the hyporheic zone as "… the zone beneath, and to the side of the stream, where subsurface water is a mixture of at least 10 percent advected channel water and groundwater is the hyporheic zone." Wroblicky et al. (1998) also supports this definition in that they describe it as "…bi-directional exchange between surface and subsurface (groundwater) systems in near-stream groundwater regions containing water that originated from the stream." The hyporheic zone generally refers to the subsurface mixing zone or interface of groundwater and surface water and the associated biological and chemical processes (Stanford and Ward 1993; Triska et al. 1989). The hyporheic zone potentially influences stream ecosystem processes in a variety of ways, such as providing a:

- source or sink of biological productivity;
- refuge for benthic invertebrates during high flows; and
- location for biogeochemical processes such as nitrogen transformations and retention, which affect stream productivity and growth of riparian plants.

The hyporheic zone occurs at different spatial scales ranging from the channel and its adjacent sediments to the floodplain of large gravel-bed rivers (Woessner 2000). Investigations into hyporheic processes have occurred over the same range of spatial scale, with some studies focusing on mixing of channel water and near-channel water (D'Angelo et al. 1993; Wroblicky et al. 1998) and others taking a more extensive approach across the floodplain (Stanford and Ward 1988; Wondzell and Swanson 1996). White (1993) suggests that the scale of the hyporheic zone would be expected to increase with stream order; a scale of centimeters for headwater streams, meters for mid-reach pool-riffle sequences, and hundreds of meters for larger rivers with well-developed floodplains.

Recent research into the importance of riparian-river interactions suggests that dissolved organic matter is leached from riparian soils to the hyporheic zone. Microbial activity in the hyporheic zone retains and transforms nutrients before it is distributed into surface waters via upwelling (Clinton and Coe 2002). This source of nutrient cycling in floodplain rivers can be a substantial contributor to the overall productivity in many nutrient-limited rivers in the Pacific Northwest. Studies have also identified the importance of sediment-buried wood as an indirect or direct source of food for invertebrates residing in the hyporheic zone (Clinton and Coe 2002).

The East Fork Lewis River runs parallel to the Daybreak site, and as discussed above, it is a gaining stream located within a valley of fluvial deposits approximately 0.75 miles wide. Water table maps and associated flow nets show the paths for winter and late summer groundwater flow down the East Fork Lewis River valley is generally subparallel to the river in the vicinity of the Daybreak site, with a portion of the flow directed toward the river at the lower end and downstream of the site (Figures 3-11 and 3-12). In addition, groundwater flow that originates from the adjacent uplands above the valley generally moves perpendicular to the geomorphic floodplain until it merges with the shallow alluvial aquifer.

The extent of hyporheic flow in the groundwater moving parallel in the East Fork Lewis River in the vicinity of the Daybreak site can be generally delineated based on the channel and floodplain configuration, and on limited observations of groundwater elevations. The hydrogeomorphic setting of the river and its valley upstream of the Daybreak site suggest that hyporheic flow occurs within the active hydrologic floodplain, and could be on the scale of the geomorphic floodplain (hundreds of meters) (as discussed in Section 3.3.2). The hydrologic floodplain is the region of frequent flooding, or the land that is inundated about two years out of three (USDA 1998). The hydrologic floodplain includes the area below gravel bars and side channels that flow with surface water only during high flows. Downstream of the bridge at Daybreak Park (RM 10), the river crosses from the north to the south side of the valley and the valley widens. This setting provides the potential for a flow-through reach (*sensu* Woessner 2000), where exchange of groundwater and surface water is likely to occur. In addition, the highly permeable sediments downstream of this location and the likely occurrence of relict channel beds (see Figure 3-5) provides favorable conditions for continuous hyporheic flow to the Daybreak site. As the groundwater contours in Figures 3-11 and 3-12 indicate, this hyporheic flow likely intersects the existing Daybreak Pond 1 under both existing and built conditions, and may intersect some of the Phase 1 and 2 forested and emergent wetland in the southeastern part of the site (Section 3.5 and Figure 3-34). In the area of the future ponds, groundwater is primarily recharged from infiltrating precipitation, run-on, and from groundwater discharge from upland sources (i.e., is non-hyporheic) and moves toward the existing ponds and the East Fork Lewis River. This hypothesized hyporheic flow pattern is supported by recent results of groundwater elevation monitoring at the Daybreak site (Figures 3-11 and 3-12).

Fluctuations in elevations (stage) and water temperatures in the East Fork Lewis River and the groundwater at three wells were monitored in July 2000 and during November 2000 through December 2001. Two wells are located within the presumed path of hyporheic flow (Piezometers PZ-2 and PZ-3) (Figure 3-11). Piezometer PZ-2 is located about 550 feet southwest of the southwest corner of Pond 2, adjacent to a secondary channel and within the hydrologic floodplain. Piezometer PZ-3 is located about 100 feet away from the river in the 100-year floodplain, about 200 feet west of the southwest edge of Pond 5. The third well (irrigation well) is located outside of the 100-year floodplain and near the break between the Phase 4 and 6 areas to be excavated for aggregate, approximately 500 feet north of the northeast corner of Pond 1. The river stage was monitored within the Ridgefield Pit reach west of the southwest corner of Pond 5.

The results of the groundwater elevation monitoring indicate that the hyporheic flow path likely intersects the existing Pond 1, as the water flows parallel to the river (Figure 3-11). Fluctuations in groundwater elevations in Piezometers PZ-2 and PZ-3 which are located adjacent to and about 100 feet away from the river, respectively, closely followed the diurnal patterns observed in the river, indicating an intimate relationship between the river and groundwater in these locations (Figure 3-13). The hydraulic coupling in water elevations suggests that the groundwater at these two locations is hyporheic. In contrast, the dampened variations in groundwater elevations observed in the irrigation well indicate that this location is outside of the immediate influence of the river and is likely not hyporheic water. Fluctuations in water temperatures collected from these same locations further support this delineation of hyporheic water. These data are presented in the following Section 3.1.5.1 on water quality.

Secondary channels, such as the one to the southwest of existing Pond 5, are often areas of upwelling where hyporheic water enters the channel system from floodplain sediments (Wondzell and Swanson 1996). The head differential between Pond 5 and Piezometer PZ-3 near this secondary channel shows that there is a potential gradient from Pond 5 toward the secondary channel (Figure 3-11). In addition, the general groundwater gradient and secondary channel beds may provide suitable conditions for a more permeable flow path towards the west of Pond 5. Thus, it appears that the flow path of groundwater from Pond 5 to the river in this area describes the flow path of hyporheic water.

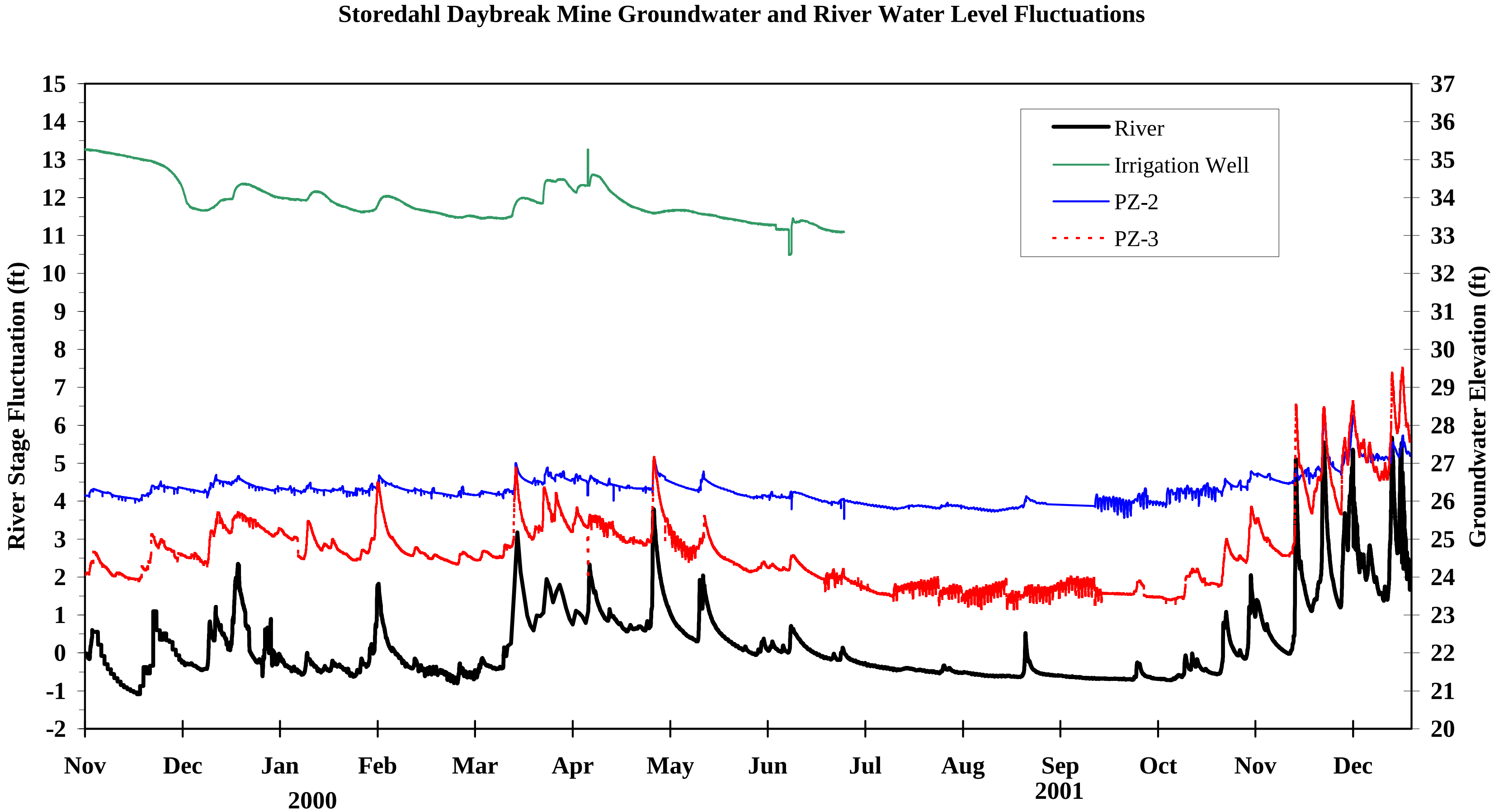

Figure 3-13. Fluctuations in groundwater elevations in Piezometers PZ-2, PZ-3, the irrigation well and in the river stage measured from November 2000 through December 2001.

Although the existing ponds are likely located within the path of the hyporheic flow, the effect on the hyporheic flow path is believed to be localized (Figures 3-11 and 3-12). The specific effect of the existing Daybreak ponds on the characteristics of the hyporheic flow are not quantifiable, but they are expected to be similar in principle to those of a flow-through reach, where hyporheic water enters a river channel on the upstream side and goes subsurface on the downstream side. Due to differences in water quality and surface area between ponds and rivers, however, the existing ponds might have different effects, than a river, on the hyporheic and surface water, although discharge measurements in the river upstream, adjacent to, and downstream of the Daybreak site indicate that there is no loss or gain of groundwater in this area as a result of the existing ponds and the Ridgefield Pits. One obvious effect is that the existing ponds have effectively replaced hyporheic volume that was present before the ponds were excavated. As a result, biogeochemical processes, such as nitrification (metabolism of nitrogen by oxygen consuming bacteria into nitrates and nitrites) and denitrification (reduction of nitrate by bacteria to gaseous nitrogen) rates, and species composition of interstitial invertebrates in the hyporheic zone downstream and between the ponds might be altered compared to the pre-pond conditions.

Decomposition by microbial organisms in the hyporheic waters results in the conversion of organic matter, such as leaf litter from the riparian forest, into useable nutrients that are released to the stream channel. These nutrients support algal growth, which provides a food source for grazing stream insects, which, in turn, become food sources for fish. Because mineralization in hyporheic waters is rapid relative to flow velocities, microbial activity in the hyporheos can create an enriched source of nitrate and other nutrients that are released to the stream channel (Edwards 1998). For this nutrient cycle to function, hyporheic invertebrates need water, food, and dissolved oxygen (Bayley 2001). This requires sufficient hydraulic conductivity, water velocity, and close access to the surface, so that fresh organic matter, which is produced above ground through photosynthesis, can be transported below surface to the animals as food (Clinton and Coe 2002). In alluvial Pacific Northwest rivers, sufficiently high velocities would be expected to exist in frequently flooded areas under or laterally close to coarse substrate (such as within the hydrologic floodplain). In areas more distant from the active river channel, such as outside the 100-year floodplain, it is increasingly unlikely that hyporheic flow velocities are high enough to support significant quantities of hyporheic microbial colonies or invertebrates.

Invertebrates found in hyporheic areas distant from the active channel zone are most likely to be localized hypogean species that are not found in open flowing waters (Stanford et al. 1994), and are therefore not accessible to salmonids. For example, the hyporheic invertebrate community in a forested floodplain terrace adjacent to the Queets River, Washington was dominated by cyclopoid copepods, copepod nauplii, and rotifers (Clinton and Coe 2002). These small zooplankton organisms are typically not found in flowing water. However, the flux of useable nutrients from the hyporheic zone to areas of upwelling in the river can support the base of the food chain and eventually the invertebrates, which are preyed on by fish. Although the effect that the existing ponds have had on nutrient delivery to hyporheic invertebrates and eventually to the East Fork Lewis River is unknown, it is likely that the abundant algae production and emergent and submerged aquatic vegetation produced in the Daybreak ponds contribute organic matter to the hyporheic zone in a manner similar to when the area was covered in forest. However, because the ponds and their shorelines lack large trees, the contribution of buried wood to the hyporheic food web has obviously been altered.

Since Dean Creek is a small, intermittent stream and lacks a well-defined floodplain in the reach adjacent to the Daybreak site, its hyporheic zone is likely to be limited to vertical and lateral exchange of channel and subsurface water in near-channel sediments (Woessner 2000). Shallow or perched groundwater flow (groundwater that is not in a direct hydraulic connection with the local water table) in upper Dean Creek are likely to be partially controlled by the depositional pattern of the subsurface gravels. The alluvial fan of Dean Creek, which originates at the J. A. Moore Road crossing, would support a dominant north-south subsurface flow. The preponderance of well-graded, highly permeable cobbles and gravel in the stream bed downstream of the bridge provide an ideal setting for infiltration of surface flow near the bridge, downstream hyporheic flow through the riffle, and upwelling in the lower portion of this section of the stream (Stanford and Ward 1993; White 1993). This vertical exchange of surface and hyporheic flow is probably most important during winter, when stream flow in Dean Creek is highest. During late summer, the channel through most of the upper reach is dry, because the highly permeable channel substrate does not retain the small flow entering the reach below the bridge. As this surface flow reaches the groundwater table, its contribution is small relative to the volume of groundwater (flowing from the uplands), the flow is not bi-directional, and consequently would no longer be considered hyporheic flow.

Finer-grained sediments dominate the east-west section of Dean Creek’s streambed where the stream takes on the characteristics of a palustrine channel. The hydraulic conductivity or permeability of the streambed at this location is significantly lower than the cobbles and gravels upstream. This reduces the potential for advective subsurface flow and consequently the extent of the hyporheic zone. This section of the stream also has an increased accumulation of small organic material in the streambed, which probably increases oxygen demand and decreases the biological productivity within the limited hyporheic zone.

3.1.5 Water Quality

Descriptions of water quality conditions affecting the species covered by this HCP are divided into the three different water bodies within or adjacent to the site: East Fork Lewis River, Dean Creek, and the existing ponds created by previous gravel mining. The amount of information pertaining to these water bodies is relatively limited and is derived primarily from the East Fork Lewis River Water Quality Assessment by Hutton (1995d), the 1998 Section 303(d) list for the Washington Resource Inventory Area (WRIA) 27 (Ecology 2001), the Level I Technical Assessment for WRIAs 27 and 28 (GeoEngineers 2001) and from unpublished data collected by EMCON and R2 Resource Consultants.

The water quality parameters emphasized in this section include temperature, dissolved oxygen, turbidity, and fecal coliform, as these are the parameters most likely to be of concern in the water bodies in and around the Daybreak site and the East Fork Lewis River basin (Hutton 1995c, 1995d). In addition, the composition of spawning substrates upstream and downstream of the outlet of Dean Creek was recently investigated and are discussed in this section.

3.1.5.1 East Fork Lewis River

Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201A), classify the East Fork Lewis River from Moulton Falls (RM 24.6) to the mouth, which includes the Daybreak area, as Class A, or excellent (Hutton 1995d). The highest rating is Class AA (extra-ordinary), which includes the East Fork Lewis River upstream of Moulton Falls (RM 24.6). Surface water quality standards in Class A waters meet or exceed the state’s requirements for substantially all uses (e.g., water supply, fish and shellfish habitat, wildlife habitat, and recreation). However, water quality in Class A water may be limited to beneficial uses of the river during certain times of the year. Classification of surface waters depends on water quality criteria for fecal coliform, dissolved oxygen, temperature, pH, turbidity, toxic or radioactive material concentrations, and aesthetic value. The specific criteria for water quality parameters are established in conformance with present and potential beneficial uses of surface waters and do not necessarily define natural conditions.

Water bodies in the state of Washington are also categorized by how well they support designated uses, referred to as the designative use support status. This status is determined by comparing available water quality information to the state's water quality standards. Based on the degree to which one or more beneficial uses are supported, water bodies are categorized as supporting, partially supporting, or overall threatened. In the 1992 Statewide Water Quality Assessment 305(b) Report, Ecology determined that the overall designated beneficial uses for the lower East Fork Lewis River are partially supported for 14.5 miles below Moulton Falls, with the remaining 10.1 miles unassessed (Hutton 1995d). More recent 305(b) reports by Ecology (1995, 1996, 1998) have not included support of beneficial uses by individual river.

In 1996, the East Fork Lewis River from the mouth to Moulton Falls (RM 24.6) was listed under Section 303(d) of the Clean Water Act as an impaired waterbody, due to water quality exceedances for temperature, pH, and fecal coliform (Ecology 1996). However, the 1998 Section 303(d) list included only exceedances for temperature and fecal coliform for the same reach of the East Fork Lewis River (Ecology 2001). The observed impairments are believed to be the result of agricultural practices, failing or improperly located septic systems, construction land clearing, and grading (Hutton 1995d).

Once a waterbody is placed on the Section 303(d) list, the state is required to establish a Total Maximum Daily Load (TMDL) for all listed waterbody segments. The TMDL includes an analysis of the amount of pollution a waterbody can incur while retaining its beneficial uses (e.g., recreation, industrial, or the support of aquatic life). The TMDL also includes controls needed to prevent or limit pollution and a monitoring plan to test the effectiveness. TMDLs for the East Fork Lewis River have not been established. Due to the number of TMDLs and allocations of waste load required, Ecology will require 15 or more years to complete the TMDL waste load allocation process.

Temperature

High temperature during summer months is one of the most important water quality issues in the lower East Fork Lewis River (WCC 2000). The temperature standard for Washington State Class A waters states that water temperature shall not exceed 18°C (64.4°F) due to human activities. The USEPA has recently released draft guidance for water temperature standards (USEPA 2001). This guidance recommends that states and Tribes develop subbasin specific criteria based on a system's estimated thermal regime after all reversible anthropogenic sources of heat are removed. In general, these criteria should protect each of the salmonid life stages. For example, the USEPA recommends that for juvenile rearing, the seven-day average of daily maximum temperatures should not exceed 16ºC. Temperatures in the East Fork Lewis River commonly exceed 18°C during late summer (Hutton 1995d; Ecology 2001; GeoEngineers 2001; R2 Resource Consultants, unpublished data). In long-term records taken at Daybreak Park, located 1 mile upstream of the Daybreak site, water temperatures exceeded 18°C in 13 out of 16 years of monitoring, and sometimes exceeded 22°C (Hutton 1995d; GeoEngineers 2001). Ecology (2001) cited a total of six excursions beyond criterion at the Daybreak Park station (RM 10) from 1991 to 1996 in its Final 1998 Section 303(d) List. Summertime water temperatures were recorded on a continuous basis (every 36 minutes) by R2 Resource Consultants during 2000 and 2001. The water temperature recorders were placed at locations upstream and downstream of the Ridgefield Pits (at approximately RM 8.3 and RM 7.5) (Figure 3-11). Daily maximum water temperatures are shown in Figure 3-14. Unfortunately, the upstream recorder was vandalized in 2000 and therefore the 2001 data are more complete. The data recorder at the upstream location from mid-August 2001 through December, however, was lost in a log jam. In general, water temperatures at both locations exceeded 18°C almost daily from mid-July to mid-August. Water temperatures in the East Fork Lewis River generally increase as one moves downstream, due to a combination of reduced streamside shading and higher air temperatures (Hutton 1995d).

Temperature effects may also result from the river flowing through the Ridgefield Pits following avulsion into the site in 1996. The pools formed by the former Ridgefield Pits have a larger surface area than the previous channel, resulting in higher inputs of solar radiation and transfer of heat from the air. Summertime water temperatures measured in 2001 appear to support this hypothesis (Figure 3-14).

Because high temperatures are stressful, and water temperatures above 23°C can be lethal to anadromous salmonids (Bjornn and Reiser 1991), temperature effects on the covered species are of particular concern. Clearly, the temperature regime in the lower East Fork Lewis River is problematic and likely will continue to be a problem in the future.

Effects of groundwater and hyporheic flow are not easily quantified but may influence surface water temperatures on a local scale in the East Fork Lewis River. Because the existing Daybreak ponds intercept groundwater and expose it to warming influences of solar radiation and higher ambient air temperatures, temperatures in the East Fork Lewis River could potentially increase downstream of the site. However because the groundwater gradient parallels the river in the summer (Figure 3-12), most groundwater seepage from the ponds likely enters the river considerably downstream of the Daybreak site, after attenuation of any temperature increases. The amount of time it takes for water from the ponds to travel

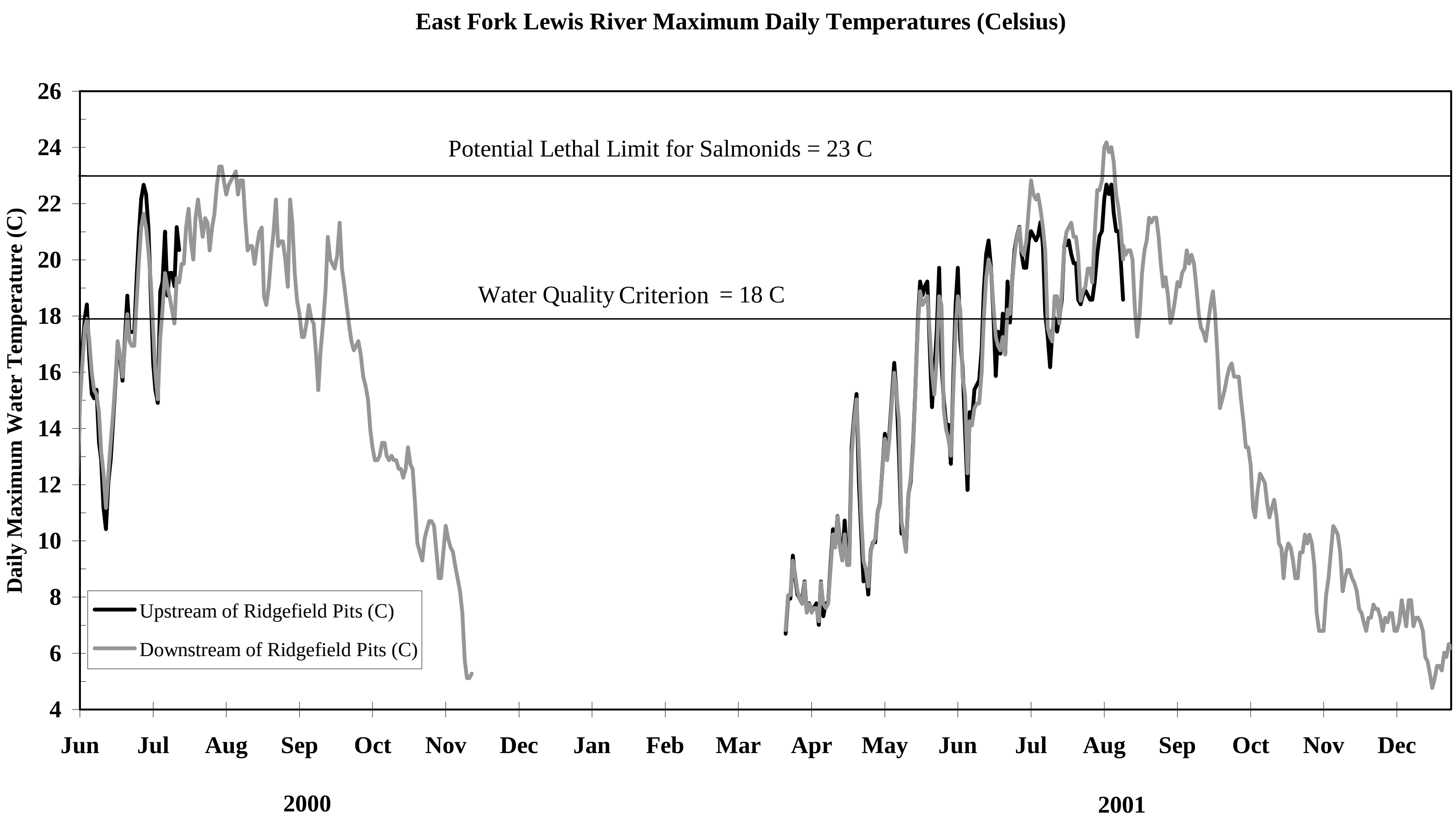

Figure 3-14. Daily maximum water temperature (C) in the East Fork Lewis River upstream and downstream of the Ridgefield Pits in the summers of 2000 and 2001.

subsurface before entering the river was estimated using the aquifer constants discussed in Section 3.1.4.2 and the late summer groundwater gradients illustrated in Figure 3-12. It is estimated that it takes from 70 to more than 200 days for groundwater to travel from the ponds to the East Fork Lewis River, and could be even longer if one considers the fine-grained sediment accumulation in Pond 5. Groundwater seepage leaving Pond 5 in early August would reach the river in October or later, after the critical warm temperature period in the river is past. In addition, seepage from the ponds is estimated to be only 0.9 cfs in summer, which is less than 1 percent of mean summer low flow and therefore would have minimal effect on the East Fork Lewis River even if subsurface water temperatures are higher as a result of the existing ponds.

Additional evidence from the groundwater monitoring wells indicates that the temperature of surface water is moderated as it flows through the ground. A discrete measurement of groundwater temperature in the piezometer immediately west of Pond 5 (PZ-3) during late-summer was 16°C compared to surface water temperatures of 19°C in Pond 5 and in the East Fork Lewis River, indicating that the ponds do not contribute to higher temperatures in the East Fork Lewis River via groundwater input. Continuous water temperature recorders that were placed in PZ-2 and PZ-3 and in the river lend additional support (Figure 3-15). The location of the river data loggers and PZ-2 and PZ-3 are shown on Figure 3-11. Figure 3-15 shows how groundwater temperatures are dampened in comparison with the daily fluctuations in surface water temperatures in the river. Notably, the groundwater temperatures are 9 to 11°C lower than the river water temperatures in the critical mid-August period of low flow and high water temperatures in the river. Similarly, ongoing studies in the upper Willamette River also indicate that hyporheic flow through point bars in the active channel has a dampening effect on diel temperature changes observed in secondary channels connected to the river (Landers 2000).

Dissolved Oxygen

Dissolved oxygen (DO) concentrations typically decrease as temperature increases, due to the inverse relationship between solubility of oxygen in water and water temperature. Because oxygen is a by-product of photosynthesis, photosynthetic rates of aquatic plants and algae also contribute to DO levels. Photosynthetic rates increase with light levels and with temperature (up to a point, whereupon they decrease again). Turbulence contributes to higher DO levels due to mixing-in of atmospheric oxygen. Low DO levels can result in stress or mortality to fish and other aquatic animals. The Washington State criterion for DO

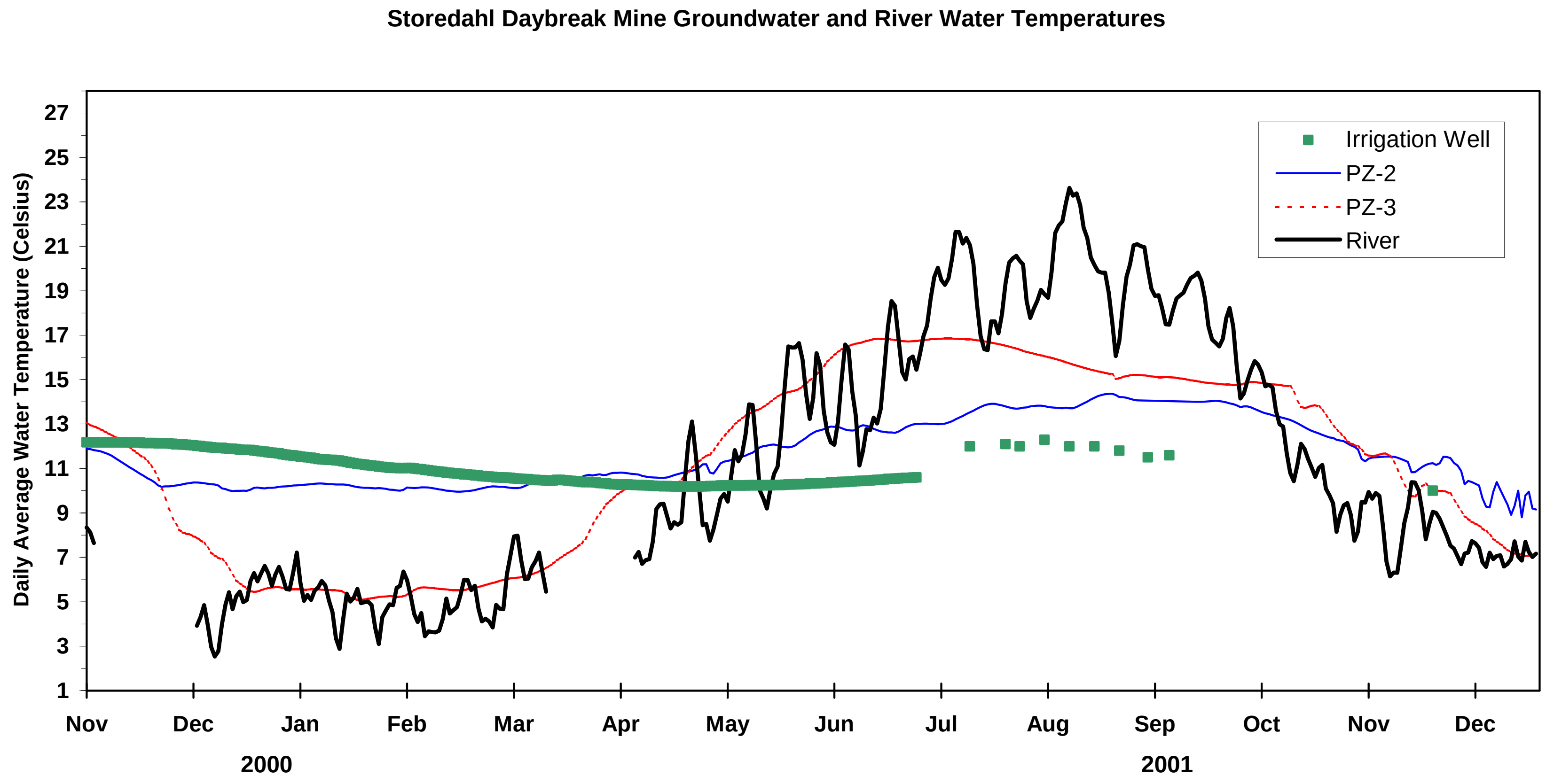

Figure 3-15. Water temperature comparisons between the East Fork Lewis River, a groundwater well, and two hyporheic wells during November 2000 through December 2001.

in Class A waters is 8 milligrams per liter (mg/l), with exceedance of the criterion meaning DO levels are less than 8 mg/l.

Dissolved oxygen levels in the East Fork Lewis River fluctuate daily, but were not recorded less than the Class A criterion in monthly monitoring between 1976 and 1992 at the Daybreak Park station (Hutton 1995d). The relatively high DO levels are likely the result of turbulent flowing water and carryover from higher DO levels upstream (Hutton 1995d). Data collected from the Ridgefield Pits in August 1999 by R2 Resource Consultants indicate that DO levels exceed 8 mg/l even in warmer, low velocity sections of the channel. Low DO levels do not appear to be a water quality issue in the East Fork Lewis River in the vicinity of the Daybreak site.

Turbidity and Deposition of Fine Sediments

Turbidity in water is a result of materials such as clay, silt, particles of organic matter, soluble colored organic compounds, and plankton that are suspended in the water column. Since turbidity reduces light penetration, it can cause a reduction in photosynthesis and productivity of a water body. Turbidity is not necessarily directly harmful to fish, although turbidity that results from suspended sediments can affect feeding efficiency (Sykora et al. 1972), predation (Gregory 1993), respiration (Sigler et al. 1984), and migration and distribution (Waters 1995). In general, deposited sediments have a greater impact on fish than do suspended sediments specifically through its direct impacts on spawning and incubation habitats (Spence et al. 1996). Fine textured sediments associated with turbidity can deposit on spawning habitat reducing reproductive success. Turbidity impacts can be expected when excessive runoff occurs over land surfaces that have lost vegetation cover due to land clearing activities.

Because turbidity is discharge dependent and highly variable throughout a region, turbidity standards are usually stated as an allowable increase over background levels. For Washington State Class A waters, the maximum allowable turbidity level is 5 NTU (nephelometric turbidity units) over background levels when the background turbidity is 50 NTU or less, or a 10 percent increase in turbidity when background levels are more than 50 NTU (WAC 173-201A). The turbidity criterion for the East Fork Lewis River watershed used by Clark County is 5.5 NTU (Hutton 1995d).

No exceedances in turbidity were recorded in monthly monitoring by Ecology from 1986 to 1997 (Hutton 1995d; Ecology 1998). Monitoring conducted by the Clark County Water

Quality Department in a water quality assessment of the East Fork Lewis River watershed also found no exceedances in turbidity (Hutton 1995d). The lower East Fork Lewis River is not on the 1998 Section 303(d) list for high turbidity. From this information, turbidity does not presently seem to be a problem in the lower East Fork Lewis River near the Daybreak Park station.

During the development of this HCP, several comments were received indicating a concern that releases of fine sediments from the Daybreak ponds has degraded spawning substrates in the East Fork Lewis River. To address this concern, the substrate composition upstream and downstream of the mouth of Dean Creek was investigated. At the same time, analyses were completed on the sediment transport conditions of the East Fork Lewis River in the vicinity of the Daybreak site (Technical Appendix C, Addendum 1). The results of these investigations are discussed below.

The supply of fine sediments to the East Fork Lewis River comes from many sources within the watershed. Sediment is naturally supplied to the river from hillslope erosion, rill and gully erosion, riverbank erosion, mass wasting, and the failure of natural controls, such as beaver dams and log dams. These processes can supply large-scale, short-term introductions of sediment into the channel as well as long-term, chronic supplies of sediment, as in the case of bank erosion. Fine sediments from these processes are deposited throughout the East Fork Lewis River floodplain, including in naturally occurring oxbows, side channels that convey flow during floods, backwater areas and locations upstream of beaver dams, such as at the mouth of Dean Creek. Depositional areas also include large areas of agricultural fields in the lower East Fork Lewis River basin, which contain soils developed from natural and ongoing deposition of fine sediments on the floodplain. Within the 4-mile reach in the HCP area, fine sediment deposition is evident along the inner bends of the river, backwater eddies, and along and on top of the banks. These sandy deposits are clearly visible on aerial photographs (Figure 3-4). Within the Ridgefield Pit reach, a large amount of deposited fine sediments have substantially filled in the former gravel ponds with fines eroded from a high sandy bank just upstream of the avulsed reach.

Where fine sediments are deposited in salmonid spawning areas, it can be deleterious to developing embryos and alevins. The primary adverse effect is suffocation, as a result of fine sediments filling in the interstitial spaces in the redd (gravel nest), which results in reduced intragravel velocities and a consequent reduction in the amount of dissolved oxygen (Reiser and White 1988). The natural deposition of fine sediment in slack water areas is likely the major reason why most salmonids do not dig their redds in the freshwater reaches where the flow is influenced by tidal fluctuations. In the East Fork Lewis River, the upstream extent of the tidal influence zone (approximately RM 5.9) is visually evident as a dusting of sand on the gravel substrate within the main channel as a result of the tidal fluctuations, which causes twice daily backwatering. Between this location and the mouth of Dean Creek, approximately 1.25 miles of potential spawning habitat exists (Figure 3-16). Spawning habitat also exists upstream of the confluence with Dean Creek and the downstream end of the avulsed reach. Further upstream, gravel substrates are lacking where sand substrates dominate the Ridgefield Pit reach, although spawning habitat has become reestablished in the upper portion of the avulsed reach (in the thalweg through the former Pit 1; Figure 3-16). Areas potentially used for spawning continue upstream to the Daybreak Park bridge. The majority of salmonid spawning habitat in the East Fork Lewis River is upstream of the Daybreak Park bridge, but these reaches are beyond the boundaries of the HCP area.

The substrate composition of the first riffle downstream of Dean Creek was compared with the substrate composition in the first riffle upstream of Dean Creek to determine if water released from the Daybreak site and into Dean Creek has resulted in deposition of fine sediments on spawning habitats. On March 27, 2001, three 12-inch McNeil core sediment samples were collected from each riffle (Figure 3-17). Visual observations estimated embeddedness in both riffles as less than 25 percent (Figure 3-18). Sieve analyses of the mean particle size distributions from the sample sites are plotted in Figure 3-19. There was no significant difference between the samples collected upstream or downstream of Dean Creek ($p=0.06$, t- test). The particle size distributions indicate that the average percent of fine sediments typically defined as potentially deleterious to incubating salmonid eggs (<0.84 mm) was less than 10 percent at each sample site. The total amount of sand-sized particles (up to 2.5 mm in diameter) was also less than 10 percent at both locations. Medium-sized gravel (35 mm or 1.4 inch diameter) particles up to small cobbles (105 mm or 4 inch diameter) comprised over 40 percent of the substrate in the riffles above and below Dean Creek. In general, NOAA Fisheries and the USFWS consider spawning habitats with less than 12 percent fines to be properly functioning (NMFS 1996; USFWS 1998a). The analyzed and observed substrate compositions of the riffles upstream and downstream of Dean Creek appear to provide suitable salmonid spawning habitat, which confirmed prior visual observations that this reach of the river supports salmonid spawning. During a float survey of the river on November 16, 2000, R2 Resource Consultants and WDFW biologists observed recently constructed redds (presumed to be coho salmon redds) in this same reach of river.

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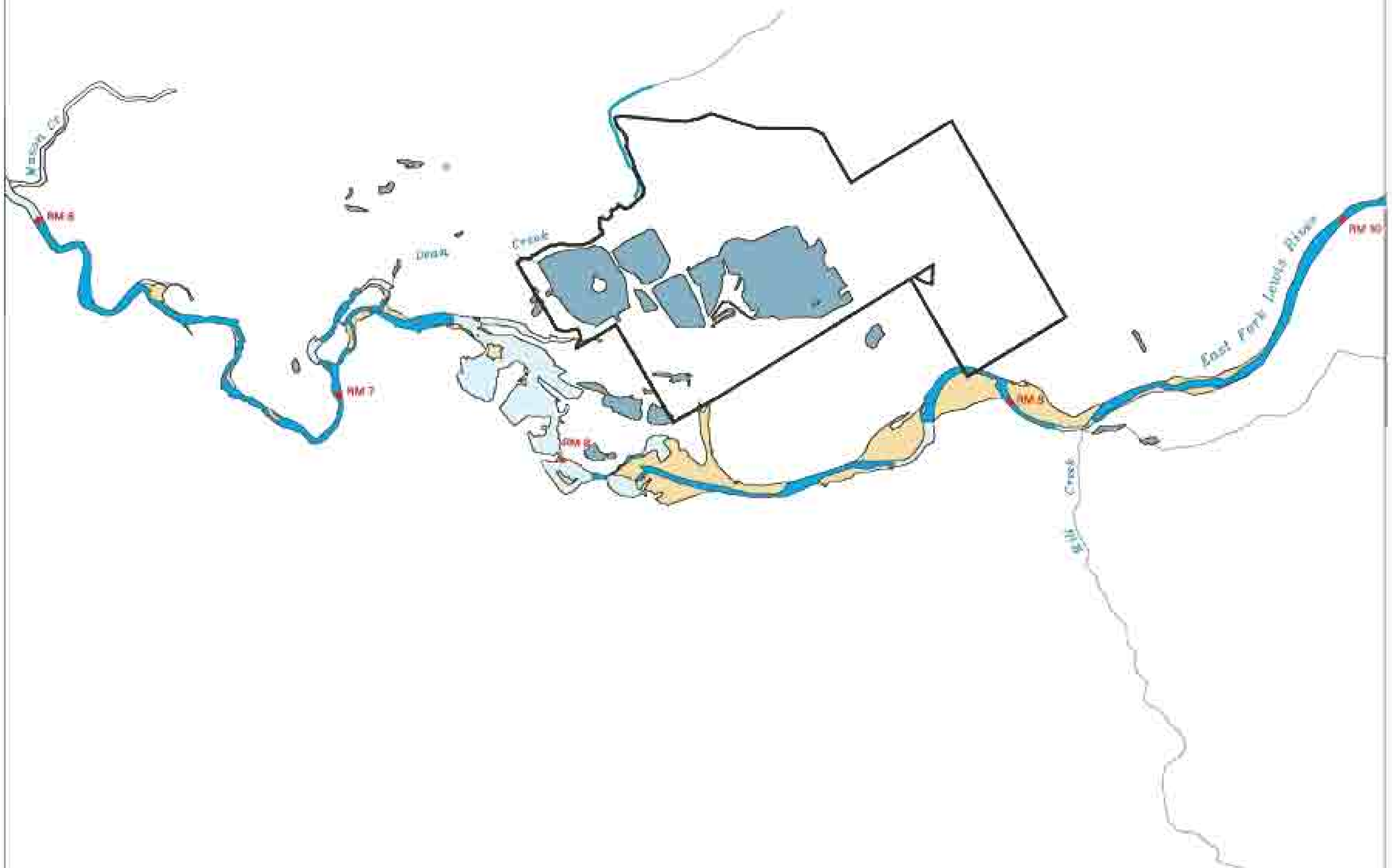
Figure 3-16

Map of the East Fork Lewis River between RM 6 and RM 10 indicating the current extent of potential salmonid spawning habitat.



LEGEND

- Property Boundary
- Sandbar
- Spawning Habitat
- Pool or Low-Flow Habitat
- Ponds and Off-Channel Water

NOTE: Data depicted on this map is intended for planning purposes only, and is NOT guaranteed to show accurate measurements.

SCALE 1" = 1,340'

0 1000

Feet

map: spawnhab.aml, 16 Oct 03

GIS Map Composition By:
R2 Resource Consultants, Inc., Redmond, WA

Figure 3-17. Collection of sediment samples on the East Fork Lewis River on March 27, 2001, with a 12-inch diameter McNeil core sampler.

Figure 3-18. Representative photograph of the substrate composition in the first riffle upstream of Dean Creek.

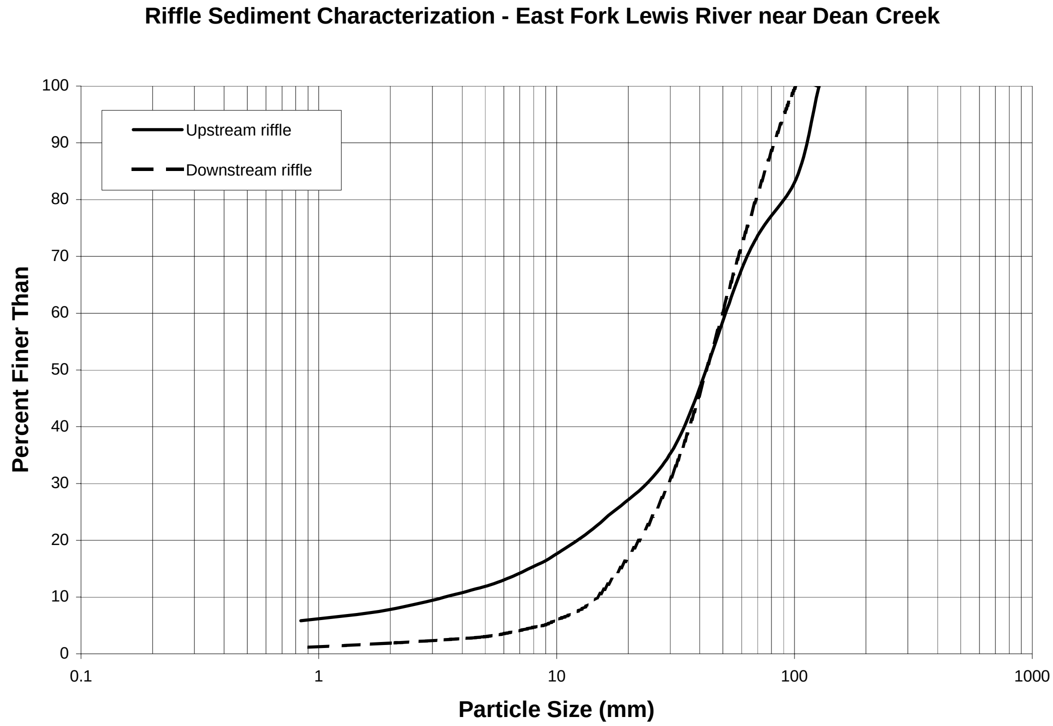


Figure 3-19. Sediment characterization of the first riffle in the East Fork Lewis River upstream of Dean Creek (solid line) compared to the sediment characterization of the first riffle downstream of Dean Creek (dashed line). The plotted lines represent the mean values of three McNeil core samples.

Prior to the development process of this HCP and implementation of the wash water flocculation system, water with increased amounts of fine sediments is known to have been discharged from the Daybreak ponds into Dean Creek and the East Fork Lewis River. Although discharges to Dean Creek were typically within the limits of Storedahl's NDPES limit of 50 NTU, this permitted amount of turbidity generally contains higher levels of fine sediments than normally occurs in the river. However, observations and substrate analyses indicate that fine sediments have not settled out on the available spawning habitat downstream of Dean Creek. This is because the flow and configuration of the East Fork Lewis River enables it to transport much greater amounts of sediment than is supplied to it (Technical Appendix C, Addendum 1). In fact, the capacity of the river to transport bed material in the vicinity of the Daybreak site was estimated to be approximately 145,000 tons per year. The capacity of the river to transport material finer than that found in the gravel bed portions of the river (and which is the fraction released from Pond 5) is considered to be virtually unlimited, until these fine particles reach the tidally influenced portion in the lower 6 miles of the river.

The size fraction of the materials that are not settled out in the Daybreak ponds and are released from the Daybreak ponds during wet processing are quite fine and mostly remain in suspension until they are carried into the tidal influence zone. Concerns have been raised about the potential for a large amount of accumulated sands and fine sediments deposited in the Daybreak ponds to be released to Dean Creek and the East Fork Lewis River during major flood events. If an avulsion into the Daybreak ponds occurred, it is likely that an additional amount of fine sands and silts would temporally be added to the wash load of the river. The potential for these sediments to be deposited within the 1.25 miles downstream of Dean Creek and upstream of the tidal influence zone were assessed using several conservative calculations (Technical Appendix C, Addendum 1).

The calculations used in Technical Appendix C to estimate potential sediment deposition considered the potential effects on downstream spawning habitat if the total volume of material proposed to be deposited in the existing Daybreak ponds was released during an avulsion. The sediment composition of Pond 1 (Figure 3-20), which is rapidly filling in with fines from washed aggregate, was determined to be 100 percent sand-sized particles and smaller (Figure 3-21). Of this material, approximately 48 percent (156,100 tons) is medium silt or smaller and would be expected to be transported as suspended sediment all the way out of the East Fork Lewis River. Approximately 15 percent (48,800 tons) is coarse silt that could potentially deposit in the tidal influence zone of the East Fork Lewis River. The remaining 37 percent (120,300 tons) is very fine sand-sized and larger. Using the most conservative calculation, this fine sand-size and larger material could deposit within the 1.25 miles of spawning habitat downstream of Dean Creek. Likely mitigating factors that would reduce the amount of this potential deposition are discussed in Technical Appendix C, Addendum 1. For example, if this release of sediments occurred during a flow of 579 cfs, which occurs 50 percent of the time (Table 3-6 in Technical Appendix C), the river would be able to transport the entire volume of very fine sand-sized material and larger in approximately 3.2 days. For a larger flow event, such as the 2-year flood, the river has the capacity to transport the entire volume in approximately 1.1 days. If the release of sediments by an avulsion occurred during a larger flood event, which would be the most likely scenario, the entire volume of released sediments is calculated to be transported in suspension to locations downstream of the remaining 1.25 miles of spawning habitat.

Fecal Coliform

Fecal coliform are indicators of the presence of potential pathogens in water. Fecal coliform are bacteria that live in the guts of warm-blooded animals and are present in bird, livestock,

Figure 3-20. This photograph of Pond 1 taken on July 31, 2001, shows a vegetated island and an increasing band of emergent wetland.

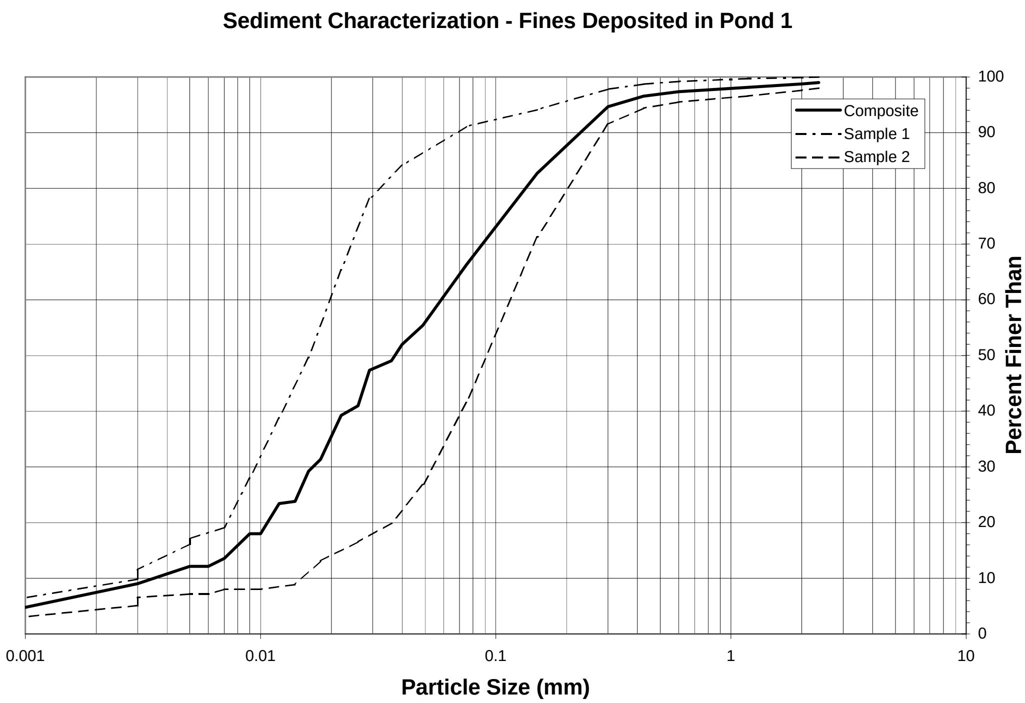


Figure 3-21. Sediment characterization of the bottom sediments deposited in Daybreak Pond 1. Two samples were collected, one from the channel outfall of Pond 1 and one from the primary settling channel (Technical Appendix G).

and human feces. By themselves, fecal coliform are not typically pathogenic, but if they are present there is a greater chance that human health could be compromised by disease-causing bacteria, viruses, and parasites that are also likely present. Typical sources of fecal coliform in rural watersheds include improperly managed dairy wastes, inadequate pasture management, failing septic systems, and wildlife use of surface water. The water quality standard for Washington State Class A waters states that fecal coliform levels shall not exceed a geometric mean of 100 colonies/100 ml, and not have more than 10 percent of the samples used in generating the mean exceed 200 colonies/100 ml.

Fecal coliform is one of the most common and pervasive water quality problems in the East Fork Lewis River basin (Hutton 1995d). In monthly monitoring by Ecology on the East Fork Lewis River at Daybreak Park, excursions beyond criteria for fecal coliform were frequent but sporadic up to 1983 and have been less frequent from 1983 to 1997 (Ecology 1998, 2001; Hutton 1995d). The lower East Fork Lewis River is not on the 1998 Section 303(d) list for fecal coliform, although the East Fork Lewis River above the Moulton Falls monitoring station and below Pollack Road near La Center is listed.

The reach of the East Fork Lewis River in the vicinity of the Daybreak site does not presently appear to have water quality problems due to fecal coliform. However, high fecal coliform levels in the past and elsewhere in the basin suggest that fecal coliform may still be a potential water quality concern in the East Fork Lewis River.

Other Water Quality Parameters

The lower East Fork Lewis River was on the 1996 Section 303(d) list for pH based on two excursions beyond the criterion (pH between 6.6 and 8.5) in 1989 and 1990 (Ecology 1996), but lack of excursions from 1991 to 1997 resulted in its exclusion from the 1998 candidate Section 303(d) list for pH (Ecology 1998, 2001). The overall lack of pH problems in the East Fork Lewis River basin indicates that the area is fairly well buffered by natural geochemical processes (Hutton 1995d).

Relatively high levels of total suspended solids (up to 94 mg/l) have been recorded sporadically at Daybreak Park in the past (Ecology 1998; Hutton 1995d). Since there are no state criteria for total suspended solids, however, it is difficult to assess the extent or severity of the problem except in relative terms.

Nutrients such as ammonia, nitrate/nitrite, and phosphorus do not appear to be water quality problems in the lower East Fork Lewis River. Although elevated levels of these nutrients sometimes occur in tributaries, dilution appears to adequately lower their concentrations in the mainstem river (Hutton 1995d).

3.1.5.2 Dean Creek

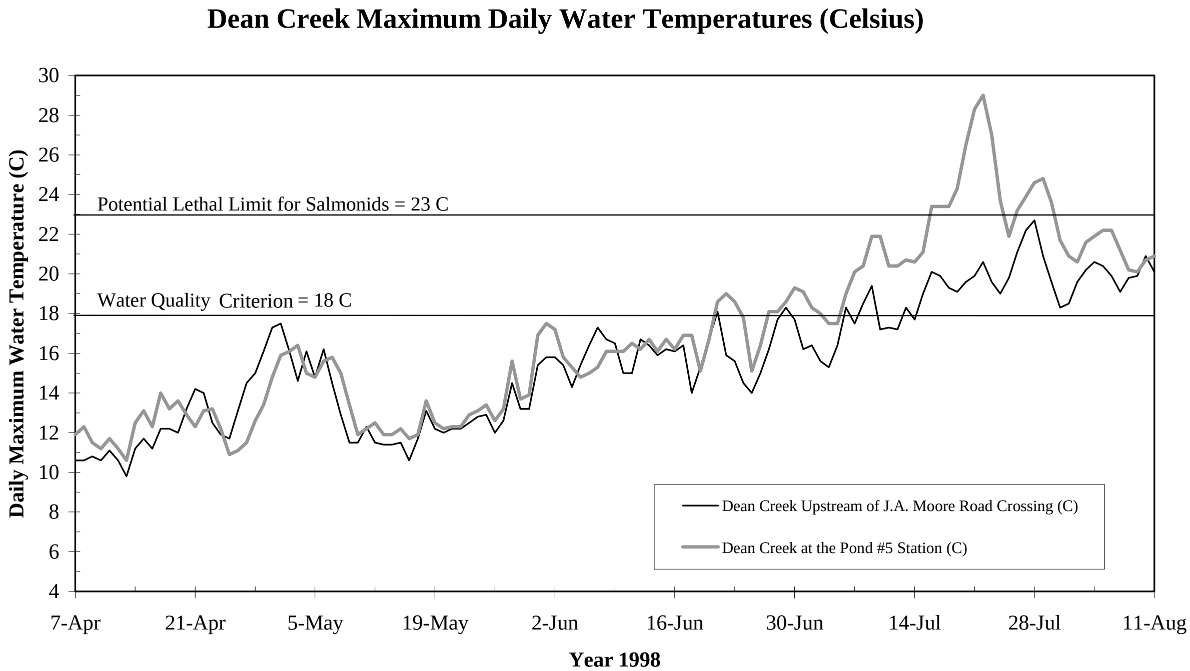
Water quality data on temperature, dissolved oxygen, and turbidity in Dean Creek were collected by EMCON and R2 Resource Consultants in 1998. These data are from two stations, one upstream of the Storedahl property above the J. A. Moore Road bridge and the second at the inlet/outlet to existing Pond 5 (Pond 5 station). Water quality data is also collected in compliance with the NPDES permit monitoring and to track general trends and the performance of the site's treatment system. In addition, continuous water temperatures were recorded in 2000 and 2001 at the location upstream of the J. A. Moore Road bridge.

Land use upstream of the Daybreak site affecting water quality in Dean Creek includes low-density residences, pastureland, and an active excavation site immediately upstream of the J. A. Moore Road bridge. The stream flows through forested land for most of its length upstream of the J. A. Moore Road. After the creek flows under the J. A. Moore Road, forested cover becomes discontinuous and the creek flows through pastureland historically used by dairy cattle. Flow is generally subsurface in late summer from the J. A. Moore Road to approximately 1,350 feet downstream.

Temperature

Water temperature in Dean Creek upstream of the Daybreak site is warmer than 18°C on many days during the summer based on continuous monitoring from April to August 1998 (Figure 3-22). Water temperatures in Dean Creek during 1998 at the Pond 5 station were similar to temperatures upstream at the bridge station through June but were higher in July and August (Figure 3-22). The lower velocities and greater water surface area behind beaver dams are conditions that typically result in warmer water temperatures. Exceedances of 23°C (potentially lethal to salmonids) were recorded at the Pond 5 station, but not at the J. A. Moore Road station. In late summer, there is typically no water in Dean Creek between these two stations.

Under present conditions, lower Dean Creek apparently has unsuitable water temperatures for salmonids in summer months. However, lower water temperatures upstream suggest that with increased shade from riparian vegetation, temperatures could be low enough to provide suitable habitat for juvenile salmonids during most summers, provided sufficient flow is present in the creek.



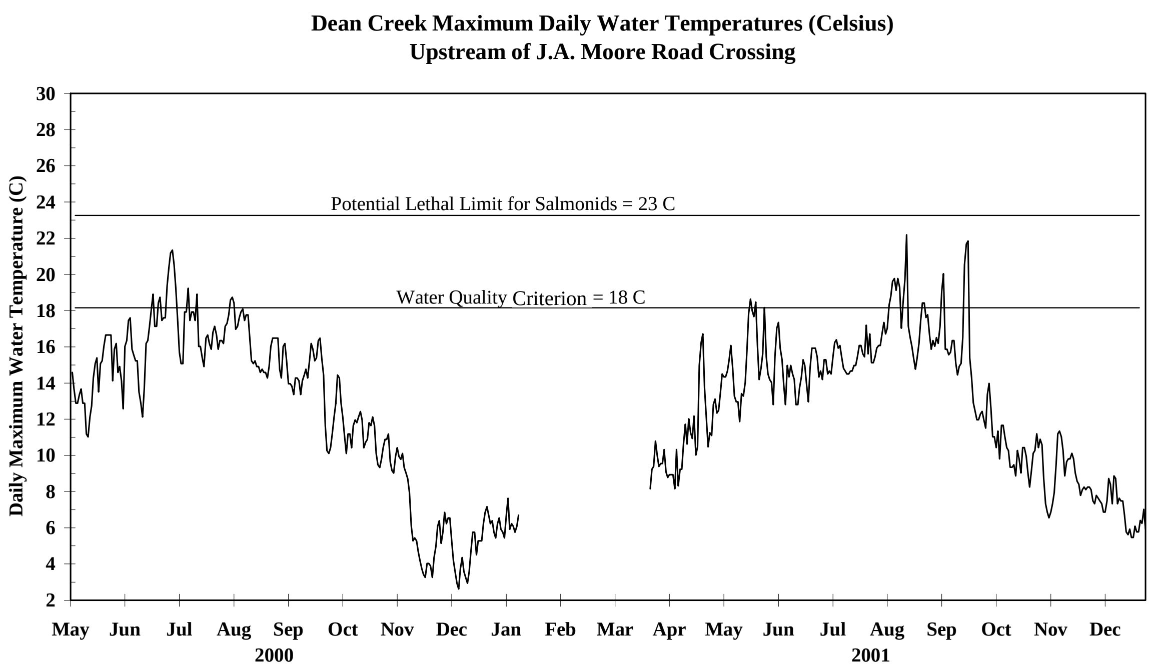


Figure 3-22. Continuous summertime water temperature in Dean Creek during 1998, 2000, and 2001. In 1998, water temperatures were recorded at two stations upstream of the J. A. Moore Road crossing and near the inlet/outlet of Pond 5. In 2000 and 2001, temperatures were recorded only above the road crossing.

Dissolved Oxygen

Data for dissolved oxygen in Dean Creek consist of five measurements at each of the two stations monitored by EMCON in 1998 (Table 3-1). These data suggest that DO levels decline to levels stressful to fish (< 8.0 mg/l) during summer months in Dean Creek downstream of the J. A. Moore Road bridge, but that waters remain well oxygenated above the bridge. This pattern is likely explained by the shading (maintaining lower temperatures) and higher gradient (providing turbulence and reoxygenation) of the upper reaches.

Table 3-1. Water quality data collected in Dean Creek, 1998.[1]

Location	Parameter	Date of Measurement				
		3/12/98	4/6/98	8/11/98	9/24-25/98	12/21/98
Dean Creek at the J. A. Moore Road Bridge	Temperature (°C)	11.4	11.2	20.6	15.4	0.4
	Dissolved Oxygen (mg/l)	11.10	9.67	10.3	10.79	13.73
	Conductivity (μS)	56	50	77	82	122
	pH	7.70	7.68	8.07	no data	7.06
Dean Creek at Pond 5 Station	Temperature (°C)	10.5	11.0	21.2	15.8	0.1
	Dissolved Oxygen (mg/l)	11.97	12.11	7.85	5.69	12.58
	Conductivity (μS)	56	57	115	117	75
	pH	7.76	8.31	7.46	7.09	6.61
	Turbidity (NTU)	4.8	no-data	65.6	no data	no data
	Fecal coliform (colonies/100 ml)	7	no-data	500	no data	no data

[1] Data collected by EMCON for J.L. Storedahl & Sons, Inc.

Turbidity

Turbidity in Dean Creek was measured in March and August 1998 at the Pond 5 station (Table 3-1). Measured turbidity levels in the creek at this location closely match the turbidity levels of the discharge from Pond 5 at the same time (Figure 4 in Technical Appendix G). The springtime measurement was relatively low (4.8 NTU), but the summertime sample was high (65.5 NTU). More recent turbidity monitoring has been conducted in Dean Creek at the J. A. Moore Road crossing, at the Pond 5 outlet to Dean Creek, and at the Ponds 3 to 5 overflow. Dean Creek measurements on November 14 and 28, 2001 and January 7, 2002 were 25.2, 88.4, and 41.4 NTU, respectively. On November 14 and 28, 2001 the turbidity at the Pond 5 outlet was 13.5 and 14.0 NTU, respectively. On November 14, 2001 and January 7, 2002 the turbidity at the Pond 3 overflow was 12.0 and 10.0, respectively. All of these measurements were taken during periods of heavy rainfall and there was some flow from Dean Creek into Pond 5.

High turbidity levels have also been observed in other nearby tributaries. For example, Lockwood Creek (2 river miles downstream) and Rock Creek (9 river miles upstream) exceeded the county's criterion turbidity level (5.5 NTU for the East Fork Lewis River basin) in 10 and 30 percent of measurements made in 1991 and 1992, respectively (Hutton 1995d). However, Mason Creek (about 1 river mile below Dean Creek) had no excursions above 5.5 NTU. The Dean Creek water sampled in August of 1998 was predominately discharge from Pond 5, as Dean Creek flow is typically low or subsurface in the reach upstream of where it is adjacent to Pond 5. As discussed in the following section (Section 3.1.5.3), a new water treatment system now controls turbidity in the discharge from Pond 5 during wet processing to levels that are consistently lower than 25 NTU and generally below 10 NTU.

Currently, high turbidity in Dean Creek is likely to be episodic and in association with high runoff periods, as it is in the other tributaries. The forested riparian zone associated with Dean Creek upstream of J. A. Moore Road could reduce upper basin sediment inputs, although an active excavation site upstream of the road may be a sediment source to the creek during heavy rain events.

Turbidity effects of pond discharge on Dean Creek vary depending on flow through the hydraulic connection between Pond 5 and the creek. As explained in more detail in the previous Section 3.1.4, flow between Dean Creek and Pond 5 is dependent on water surface elevations of the two water bodies, which in turn are dependent on Dean Creek discharge, recent precipitation, and the condition and location of beaver dams below Pond 5 and along the creek. When flow does occur from Pond 5 into Dean Creek, there is potential for increased turbidity in Dean Creek. However, since June 1999 and when wet processing is occurring, Storedahl's water treatment system reduces turbidity to levels significantly lower than the NPDES permit level (i.e., less than 20 percent of the NPDES permit limit).

Fecal Coliform

Based on March and August 1998 measurements, fecal coliform levels in Dean Creek at the Pond 5 station vary dramatically (Table 3-1). The March measurement was relatively low, but in August fecal coliform levels were 500 colonies/100 ml, which exceeds the state criterion of 100 colonies/100 ml. This high value is not surprising, since Dean Creek flows through a dairy cattle pasture immediately upstream of the station. Fecal coliform often exceeds the state criterion (100 colonies/100 ml) in tributaries monitored in the Clark County study, and fecal coliform is considered one of the most pervasive water quality problems in the basin (Hutton 1995d).

Given the widespread occurrence of high fecal coliform levels in other tributaries of the East Fork Lewis River with similar land-use characteristics, and the location of a portion of the creek adjacent to a dairy cattle pasture, fecal coliform levels are likely to be an ongoing problem in Dean Creek as it flows adjacent to the Storedahl property. However, a recently installed fence on the west side of Dean Creek now excludes cattle from the creek, which may lead to reductions in fecal coliform levels in the creek.

3.1.5.3 Existing Daybreak Ponds

Water quality data on the existing ponds on the Daybreak site were collected in 1998 by EMCON and R2 Resource Consultants. Although the ponds are no longer being mined, Pond 1 is used for primary settling of storm water and recycled wash water from wet processing of aggregate. The water is connected by surface flow to Ponds 2, 3, and 5. An NPDES discharge permit (Permit Number WAG-50-1359) covers mining and processing operation and discharge of surface water from the settling ponds. The discharge permit is a general permit for process water and storm water associated with sand and gravel, and other types of surface mining operations in the state of Washington. However, the new location of the surface water discharge monitoring point is the southern overflow from Pond 3 to Pond 5. The change in the monitoring point was made because the existence of three possible surface water discharge points, the presence of groundwater seepage, the seasonal changes in water levels, offsite activities changing the flow regimen, and periodic inflow from Dean Creek, did not provide ideal monitoring conditions. Occasional turbid Dean Creek discharges into the Pond 5 had caused elevated turbidity measurements for the surface water discharge. The new surface water discharge monitoring point between Pond 3 and Pond 5 is a more conservative point of compliance, as it is closer to the source (i.e., the upgradient ponds and the operations area) and will not be compromised by Dean Creek inflow or the offsite activities. Prior to January 2002, surface water discharge was monitored at the outlets of Pond 5. Discharge during processing is monitored twice monthly for turbidity, monthly for pH, weekly for temperature during July through September, and quarterly testing for total suspended solids. When wet processing is not ongoing, total suspended solids monitoring is not required. The results are submitted to Ecology quarterly.

Turbidity standards under Ecology rules do not apply to discharges into gravel ponds, such as those at the Daybreak site, if they are consistent with pond reclamation. After reclamation of the ponds, however, any discharges into the ponds would need to fully comply with surface water quality-based standards.

Temperature

Temperatures in the ponds follow patterns typical of water bodies in temperate climates. In winter and spring, depth profiles of temperatures are nearly uniform (Figures 3-23 and 3-24). In summer, the deeper ponds (Ponds 3 and 5) become stratified. For example, surface water temperatures in Pond 5 during mid-August were well above 20°C but were approximately 12°C near the bottom (22 feet depth). In contrast, the shallower ponds (Ponds 1, 2, and 4, which are all less than 15 feet deep), show little stratification. Ponds 1 and 2 lack of stratification is undoubtedly influenced by mixing as a result of process water recycling during wet processing. Mid-August temperatures in Pond 4 during 1998, for example, varied only from 19.4 to 21.2°C from the surface to the bottom (8 feet depth) (Figure 3-24). In fall and winter, as water temperatures cool, water in the deeper ponds mixes and returns to a uniform temperature profile.

It appears that water temperatures in the ponds typically exceed 18°C in summer months throughout the shallower ponds and near the surface in the deeper ponds (> 20 feet depth). In 1998, temperatures in shallow ponds and surface temperatures in deeper ponds were above 18°C from the first half of June through late September. In 1998, water temperatures near the surface sometimes exceeded 25°C, temperatures, which are typically avoided by salmonid fish. However, in deeper ponds colder water was present at depth due to the stratified conditions discussed above.

With the exception of Pond 1, which is influenced by process water recycling, the residence time of water in the ponds is effectively equal to, or greater than summer period of increased solar warming, or about 108 days (Sections 3.1.4.2 and 6.2.1). This longer residence time results in warming of the surface water layer in all the existing ponds. In Pond 5, the most down gradient pond, this results in a pronounced late-summer thermal stratification.

Dissolved Oxygen

Dissolved oxygen levels in ponds and lakes are a function of several factors, including temperature, the degree of mixing due to wind and waves, photosynthetic activity, and

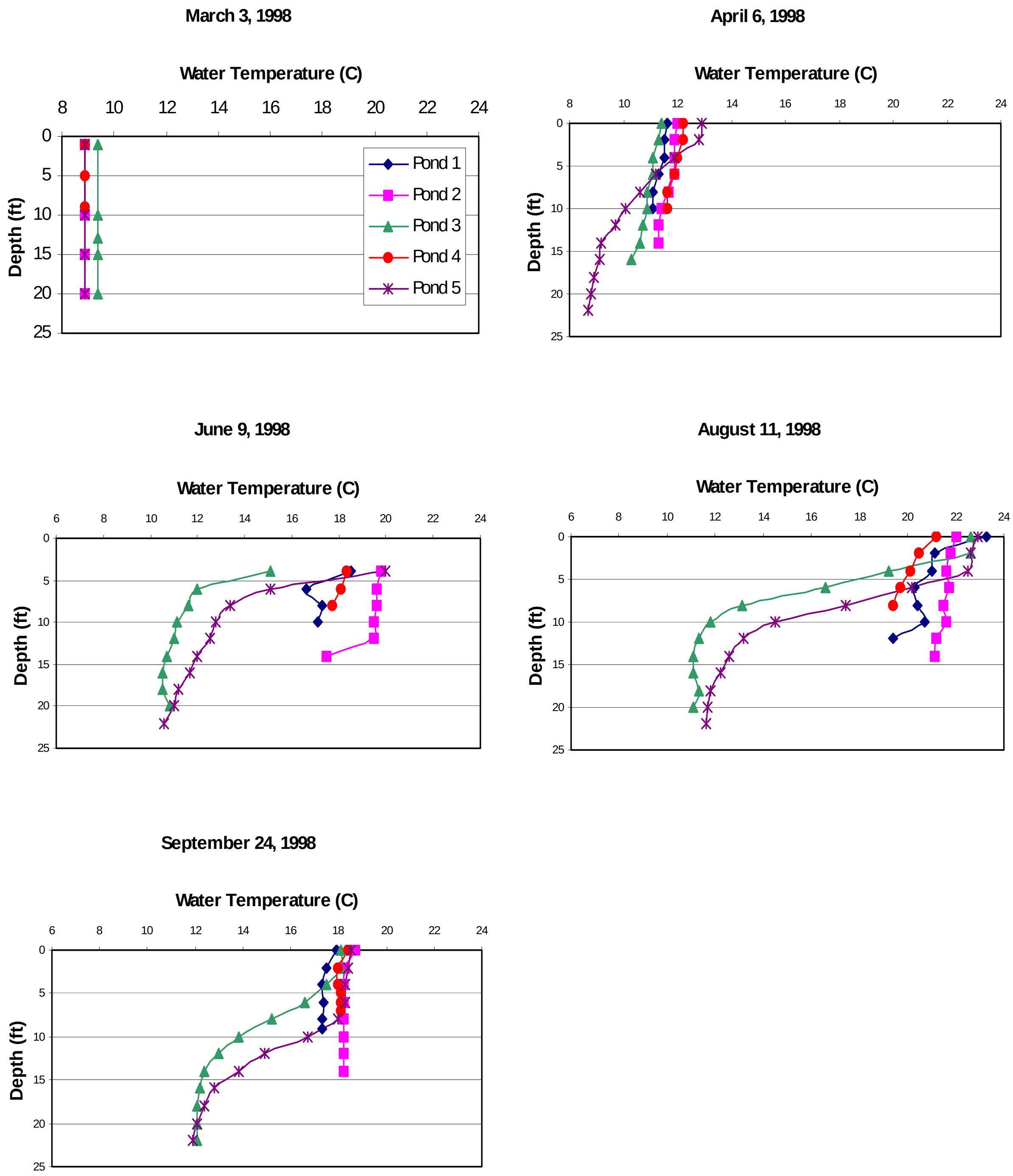


Figure 3-23. Water temperature (C) profiles in the existing Daybreak site ponds, 1998.

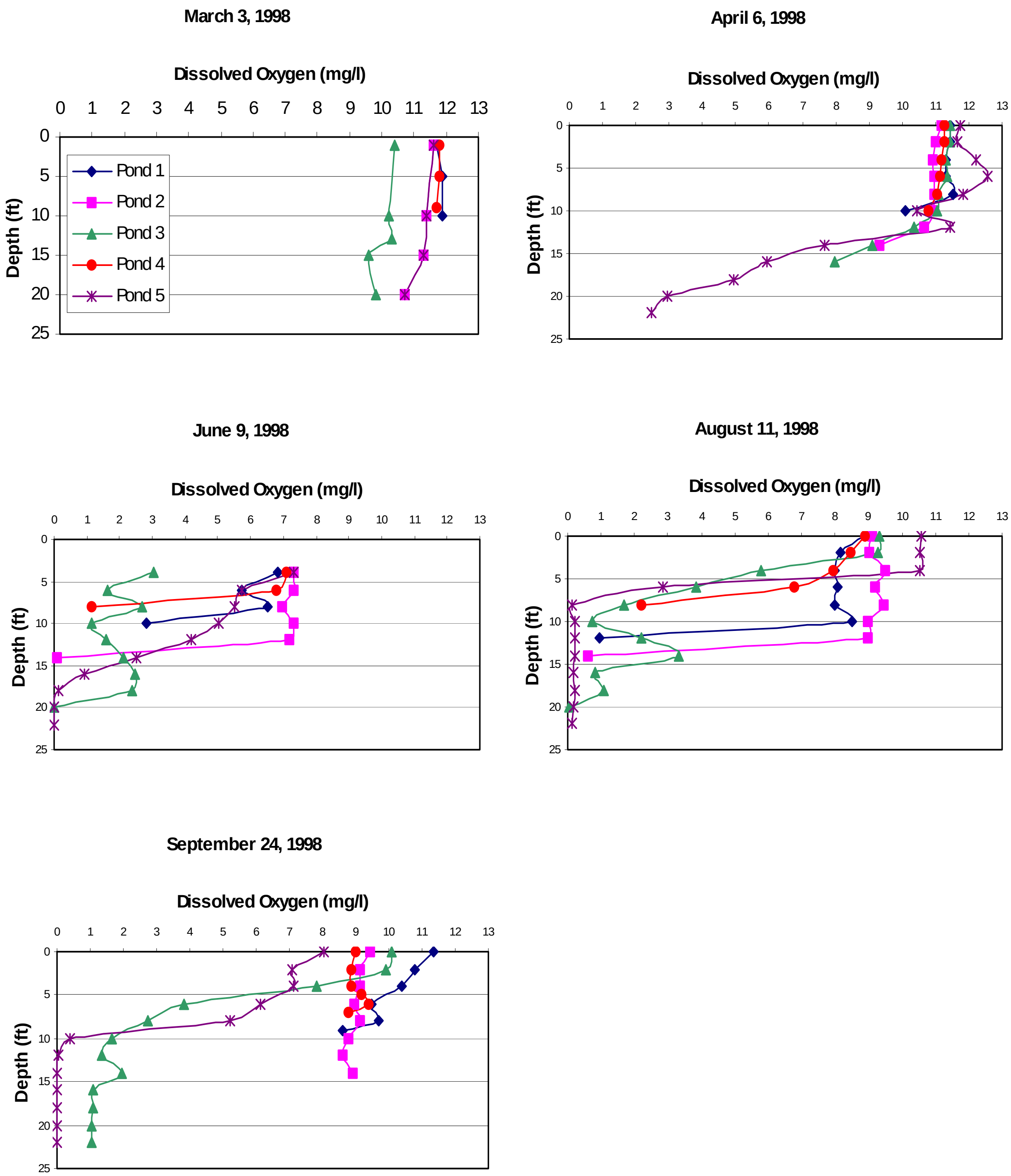


Figure 3-24. Dissolved oxygen (mg/l) profiles in the existing Daybreak site ponds, 1998.

organic material decomposition rates. When water bodies become stratified due to temperature, DO levels at depth often decline dramatically, as oxygen consumed in decomposition processes is not replaced by either photosynthesis or mixing with more oxygenated water (Wetzel 1983). Mixing of surface waters with air due to wave activity contributes to higher DO levels near the surface. Dissolved oxygen levels can fluctuate substantially on a diurnal time frame due to high photosynthetic activity during the day and respiration at night. Eutrophic water bodies often have low DO levels when high levels of algal and plant biomass decompose.

In all five of the existing Daybreak ponds, DO levels were generally above 10 mg/l in March 1998, well above the 8.0 mg/l criterion for Class A waters. In the deeper ponds (Ponds 3 and 5), DO levels had markedly declined by early June at lower depths, where temperature stratification was developing. By mid-August, in the deeper ponds, DO levels were very low below 8 feet of water (near 0 mg/l in Pond 5). In contrast, the shallower ponds (Ponds 1, 2, and 4) had dissolved oxygen levels above 8.0 mg/l across their depth profiles through the summer, except near the bottom of the ponds. Mixing of recycled water may influence the more uniform DO levels in Ponds 1 and 2. Low DO in water near the pond bottom was probably due to relatively high decomposition rates in the bottom sediments.

It appears that under present conditions low DO is a water quality issue during summer in deeper ponds but not in the shallower ponds. Adequate mixing and possibly higher photosynthetic activity due to a higher abundance of submerged aquatic macrophytes are possible factors responsible for maintenance of DO levels above 8.0 mg/l in the shallower ponds. Low DO in groundwater entering the ponds (EMCON 1998) combined with stratification during the summer accounts for the extremely low DO levels in the deeper ponds below water depths of 8 feet.

pH

In pond and lake water, pH levels are directly related to the photosynthesis rate of algae. Through photosynthesis, plants and algae, with the use of sunlight, reduce carbon dioxide (CO_2), construct carbohydrates, and release oxygen (O_2) as a by-product. High levels of algae or plant production can elevate pH levels in a pond or lake by removing acidic carbon dioxide from solution during periods of intense sunshine. The summer months provide ideal conditions for photosynthesis in the Daybreak ponds with abundant solar radiation. In contrast, the pH of flowing waters, such as the East Fork Lewis River, typically do not fluctuate to the same extreme as in a pond or lake because the flowing water limits the buildup of nutrients and algal production, and dissolved gases are quickly replenished through turbulence and atmospheric mixing.

During the summer, the pH levels in a pond or lake can fluctuate widely over the course of one day. It is typical for ponds to have high pH levels in their surface waters during the afternoon at the peak of photosynthetic activity and then to have extremely low pH levels in the early morning after a night of respiration and decomposition. This phenomenon is recognizable to people with fish tanks who struggle between the desire to have abundant plants in their aquariums and the need to maintain suitable pH and DO levels for their fish during the night.

Because of the dynamics of natural pH cycles in lakes and ponds, Ecology does not have an absolute criterion or range of criteria for pH in lakes. Rather the water quality standards (WAC 173-201A) state that there shall be "no measurable change from natural conditions." The Daybreak ponds are monitored for pH under the conditions of Storedahl's NPDES permit since the ponds function as storm water and process water treatment ponds. The NPDES permit requires that water in the ponds maintain a pH between 6.0 and 9.0 for surface water and between 6.5 and 8.5 for groundwater. However, during the summer, the pH in the existing Daybreak ponds can exceed a pH of 8.5, although this is apparently the result of natural fluctuations resulting from algal production and is not a result of processing operations.

Turbidity

During the development of this HCP, Storedahl significantly reduced the amount of turbidity in the existing Daybreak ponds during wet processing of the gravel with the initiation of the treatment program in June 1999. This in turn significantly reduced the turbidity levels of the water that was eventually released to Dean Creek and the East Fork Lewis River. Turbidity in the ponds is strongly affected by whether wet processing of the aggregate is occurring on the site and the amount of silts and clays associated with the aggregate. During wet processing, recycled process wash water is discharged to Pond 1 to settle fine sand and silt. Although most of the sediment settles out in Pond 1, the other ponds receive suspended sediment as water flows sequentially from Pond 1 through Ponds 2, 3, and 5 prior to discharging from Pond 5. Although Pond 4 has no outlet, there is a seasonal hydraulic connection between Ponds 2 and 4, and water levels in Ponds 2 and 4 equilibrate during high water periods. Turbidity in the ponds may also be affected by runoff from surrounding land. This is limited to the processing area and is a function of precipitation.

Wet processing and the discharge of process wash water was discontinued at the site in May 2001. Prior to this, however, a new system was installed in June of 1999 to treat the wash water with a flocculant at the discharge to Pond 1 to increase the removal of fine sediments and to improve water clarity. Most chemical compounds used to reduce turbidity act by both coagulating and flocculating. Coagulation is the process by which the negative charges on particles are neutralized, which destabilizes the suspension. Flocculation is the process by which destabilized particles are bound together to form larger particles that then rapidly settle out of the water column. Flocculation can be enhanced through gentle mixing of the destabilized suspension or through the use of an organic polymer that binds the smaller particles together to create a dense floc that rapidly settles. Typical chemical coagulant/flocculant systems combine settling areas where the appropriate chemical is applied with a process to remove the precipitated sediments. The remaining clarified water is then available to be recycled or discharged. Since the removed sediment still has a high water content, the material is typically stockpiled for free drainage and/or processed by other equipment to dewater the material prior to its reuse in reclamation efforts.

Although no process water has been discharged from the site into the existing ponds since May 2001, the following text discusses the procedures in place to reduce turbidity when wet processing occurs.

A large variety of flocculants are available to treat suspended solids in water and final selection of the most appropriate compound is dependent on the characteristics of the sediment in the water being treated. Flocculant selection and process design for the current system were based on literature review and tests using on-site water to determine the correct dosage and required settling times, as well as to assess any potential water quality impacts. A recent study conducted for the City of Redmond, Washington (Resource Planning Associates and HoweConsult 1999) tested the usefulness and practicality of four different cationic polymer compounds and process designs for controlling turbidity at construction sites prior to release to surface waters. The turbidity in storm water runoff from some of the construction sites studied were in the same range as that observed for aggregate processing. The study was conducted under an administrative order issued by Ecology, which modified the conditions of the general NPDES permit specifically for enhanced settlement using polymers.

The results of the Redmond study showed that polymer addition was very effective at lowering turbidity to median levels of 4 to 11 NTU. Aquatic toxicity testing, using rainbow trout and *Daphnia magna* or *D. pulex*, was conducted on all the polymers used. For all of the compounds tested, none were found to be toxic at the levels of dosage used in the field tests. In order to provide realistic results of actual site conditions, field samples were used to conduct the toxicity testing. Results of this study also indicated that phosphorus concentrations were typically reduced by 95 to 99 percent. Removal of phosphorus by flocculation is a widespread lake management technique used to reduce algal production and improve water clarity.

The use of chemical coagulant and/or flocculants in the existing system at the Daybreak site were and will continue to be screened accordingly to meet the following three criteria (Resource Planning Associates and HoweConsult 1999):

- the polymer is not petroleum-based;
- bench test results indicate that turbidity reduction meets NPDES limitations (tests use on-site process water indicative of field conditions); and
- the dosage at which the polymer becomes toxic will be required to be at least twice the anticipated operational dose (polymer-treated water is tested for toxicity using applicable procedures defined in the current revision of WAC 173-205 “Whole Effluent Toxicity Testing and Limits).

Although wet processing and discharge of process wash water is currently not being used, the present Daybreak water treatment system, which was installed in June of 1999 under the approval of Ecology, includes a number of steps. First, recycled process water is released into a long, sinuous receiving channel that allows the heaviest solids to settle (see Figure 3, Technical Appendix G). Following this initial settling, additives are introduced into a mixing chamber to increase the settling efficiency of the solids in the water. As the treated water exits the mixing chamber, flocculated solids are removed in a secondary settling channel. The water then enters Pond 1, where further settling occurs until the water from Pond 1 is recycled back to Pond 2 for reuse in the gravel processing operation. A portion of the water in Pond 2 eventually flows into Pond 3 and then into Pond 5 before being released to Dean Creek. The settled material in the primary and secondary channels are periodically removed with an excavator and allowed to dry in stockpiles. During the initiation of water treatment in 1999, until wet processing was suspended in May 2001, the increased efficiency of solid precipitation in Pond 1 resulted in significant localized reductions in pond depth and the natural creation of additional emergent wetland habitat within the pond (Figure 3-20).

Toxicity testing was conducted on treated recycled process water from the existing Daybreak ponds to determine the potential toxic effects of the flocculent additives on rainbow trout fry and two zooplankton species, *Daphnia magna* and *Ceriodaphnia dubia*. Reasons for selecting these organisms include the following: 1) they represent taxa that are commonly used for standardized acute toxicity studies; 2) they are abundant and easily acquired (in comparison to acquiring federally-listed salmon specimens); 3) rainbow trout fry are sensitive to chemical changes in water; and 4) rainbow trout are the same genus as Pacific salmon (*Oncorhynchus*), and therefore should be physiologically comparable. The acute tests were performed in accordance with the current Washington Administrative Code (WAC 173-205, Whole Effluent Toxicity Testing and Limits) and the results are given in Table 3-2. Test results using *Ceriodaphnia dubia* and a highly turbid water sample from June 9, 1999 showed significant mortality. *Ceriodaphnia dubia* is extremely sensitive to total dissolved solids, therefore its use as a test organism for this study was discontinued and replaced by a more turbid-tolerant species, *Daphnia magna*. It should be emphasized that these tests were not designed to assess the potential toxic effects of remaining turbidity in the treated water, but rather to examine the potential toxic effects of the treatment additives on the test organisms. During wet processing, Storedahl used combinations of two or three chemicals to reduce turbidity. These additives were grouped in the following manner: 1) NALCO 7888 and 9806 (manufactured by NALCO); 2) Cat Floc 4900, Cat Floc L, and Pol E-Z 7736 (manufactured by Calgon); and 3) Poly Alum 60 and Photafloc 1123 (manufactured by Wesmar). Toxicity testing results indicated that the water treated with these chemicals was not toxic to rainbow trout fry (100 percent survival) or *Daphnia magna* (95 percent survival).

On January 25, 2001, R2 Resource Consultants collected invertebrate samples from Ponds 1, 2, 3, and 5. Samples were collected with a D-frame net used in a sweeping motion along the shoreline and with a plankton tow net also used from the shoreline. Samples were combined for each pond and the most common invertebrates identified. A relatively wide variety of aquatic organisms were found in each pond. The most common invertebrates included Cladocera (*Daphnia*); the water scuds *Hyalella* and *Gammarus* (Amphipoda); aquatic flies (Chironominae, Tanypodinae, Orthocladiinae); caddisflies (*Polycentropus, Clostoeca, Limnophora, Grammotaulius*); dragonflies (Lestidae); mayflies (*Caenis*); snails (*Fluminicola*, Physidae, Planorbidae); beetles (Sphaeriidae); and alderflies (Sialidae).

The efficiency of this system in reducing turbidity prior to the release of water to Dean Creek is illustrated in Figure 3-25, Table 3-3, and Figure 4 of Technical Appendix G. Since the existing process water treatment system has been initiated, turbidity levels at the outlet to Dean Creek are typically less than one-fifth (i.e., less than 10 NTU) of the NPDES regulated limit of 50 NTU. The dramatic improvement in water clarity in the Daybreak ponds is evident in the comparison of aerial photos taken of the site prior to the enhanced recycling

Table 3-2. Whole effluent toxicity test results from treated process wash water at the Storedahl Daybreak Mine.

Sample Date	Additive Supplier	Product Name	Organism	Percent Survival
5/19/99	NALCO	NALCO 7888 and 9806	*Ceriodaphnia dubia* *Oncorhynchus mykiss*	95 98
6/1/99	NALCO	NALCO 7888 and 9806	*Ceriodaphnia dubia*	70
6/4/99	NALCO	NALCO 7888 and 9806	*Oncorhynchus mykiss*	100
6/9/99	NALCO	NALCO 7888 and 9806	*Ceriodaphnia dubia* *Oncorhynchus mykiss*	20 100
6/21/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	*Daphnia magna*	100
6/23/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	*Daphnia magna* *Oncorhynchus mykiss*	100 100
7/13/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	*Ceriodaphnia dubia* *Oncorhynchus mykiss*	95 100
7/21/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	*Daphnia magna* *Oncorhynchus mykiss*	100 100
8/3/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	*Daphnia magna* *Oncorhynchus mykiss*	100 100
8/25/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	*Daphnia magna* *Oncorhynchus mykiss*	* 100
9/7/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	*Daphnia magna* *Oncorhynchus mykiss*	90 100
9/21/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	*Daphnia magna*	90
11/15/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	*Daphnia magna* *Oncorhynchus mykiss*	90 100
12/29/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	*Daphnia magna* *Oncorhynchus mykiss*	95 100
2/7/00	Wesmar	Poly Alum 60 and Photafloc 1123	*Daphnia magna* *Oncorhynchus mykiss*	95 100

* *Daphnia magna* test invalidated due to mortality level of control group. An additional sample was collected 9/21 and tested with *Daphnia magna*.

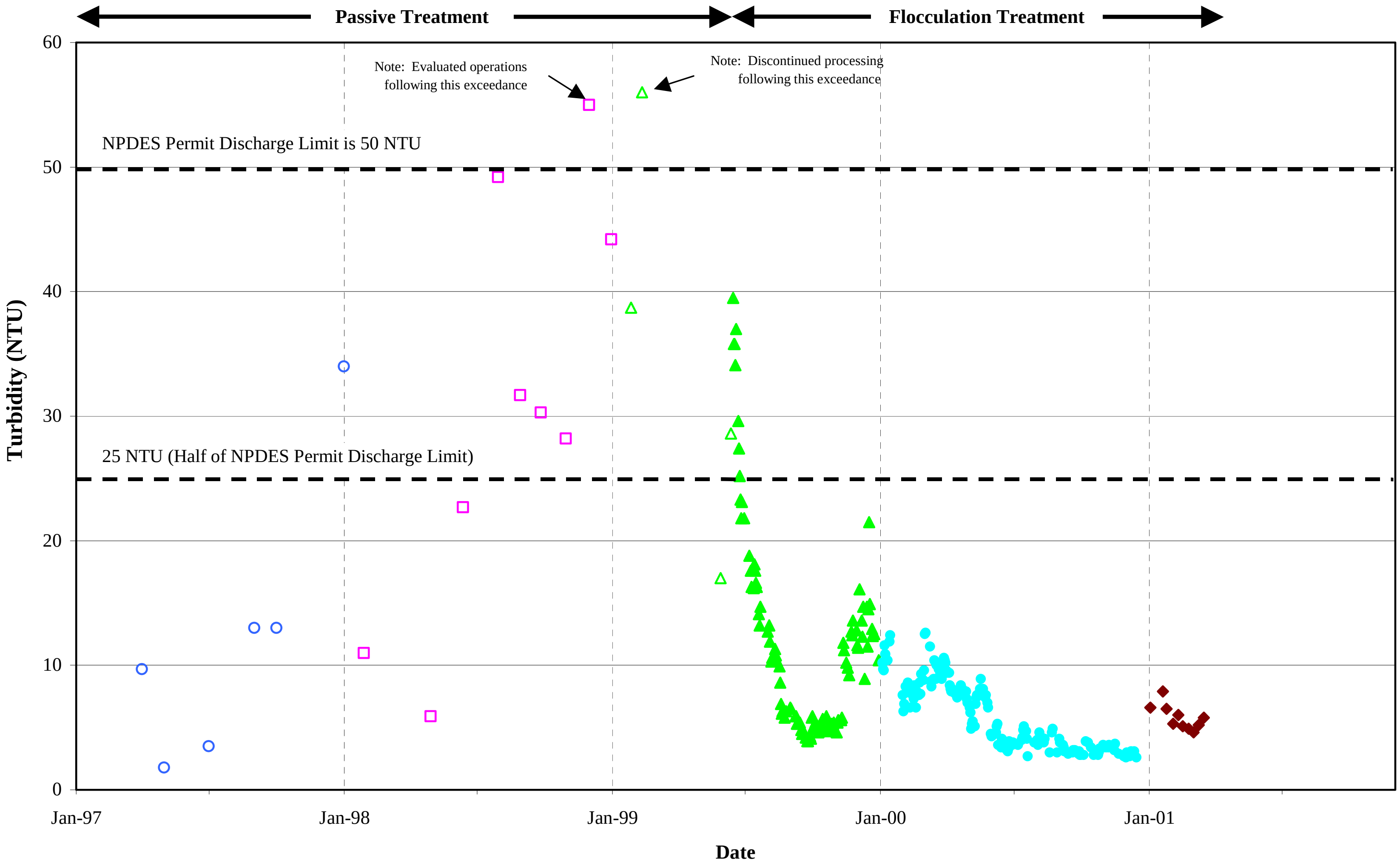


Figure 3-25. J.L. Storedahl & Sons Daybreak Mine – Comparison of outfall turbidity during 1997 through March 2001 (quarterly). Process water treatment began in May 1999.

Table 3-3. Turbidity levels at the Pond 5 outlet reported quarterly during 1997 through March 2000 to comply with the Daybreak NPDES permit.

Date	Turbidity (Max NTU)
1 Jan – 31 Mar 1997	9.7
1 Apr – 30 Jun 1997	3.5
1 Jul – 30 Sep 1997	13
1 Oct – 31 Dec 1997	34
1 Jan – 31 Mar 1998	11
1 Apr – 30 Jun 1998	22.7
1 Jul – 31 Oct 1998	30.3
1 Jan – 31 Dec 1998	44.2*
1 Jan – 31 Mar 1999	56
1 Apr – 30 Jun 1999	28.6
1 Jul – 30 Sep 1999	10.7
1 Oct – 31 Dec 1999	12.8
1 Jan – 31 March 2000	8.9

* Yearly report

system and following the implementation of the current system. Figure 3-26 is an aerial photograph of the Daybreak ponds taken by Friends of the East Fork Lewis River most likely in November 1998, prior to the installation of the current treatment system. As shown on the graph in Figure 3-25, the Pond 5 discharge was near the NPDES limit at that time. Two months later the processing operation was shut down to allow the ponds to settle out. At that time, cessation of wet processing was the only option available to reduce high turbidity.

Figure 3-27 is an aerial photograph of the site taken on September 20, 2000, 16 months after the process wash water treatment system was installed. It is evident from both photographs, that the water in Ponds 1 and 2 prior to and following the implementation of the current system are brown with high turbidity. Ponds 1 and 2 are configured to provide primary and secondary settling of the fine sediments in the process wash water and the storm water runoff. However, the 1998 aerial photograph shows that suspended solids remained in the pond water as it flowed out of Pond 2 and into Ponds 3, 4, and 5. This is in contrast to the September 2000 aerial photograph, which shows that turbidity is dramatically reduced as water flows from Pond 1 to Pond 2 and even more so as the water flows to Ponds 3 and 5. The September 2000 photograph is representative of the current conditions in the Daybreak ponds during aggregate washing as shown on the graph in Figure 3-25. As further evidence of the improved removal of fine sediments from the water discharged to the ponds, the

Figure 3-26. Aerial photograph of the Daybreak ponds in November 1998. The limited ability to passively settle turbidity is evident by the similarly high turbidity in each pond.

Figure 3-27. Aerial photograph of the Daybreak ponds on September 20, 2000, following the implementation of wash water flocculation. Turbidity is high only in Ponds 1 and 2.

shoreline bathymetry of Pond 1 has shallowed considerably as a result of increased deposition of fine sediment (Figure 3-20).

The turbidity levels of the water discharged to Pond 5 during wet processing are monitored monthly for compliance with Storedahl's NPDES general permit (WAC-50-1359). According to the permit, turbidity levels of the discharge must remain less than 50 NTU. This level accounts for subsequent dilution as the discharged water mixes with the flow of the East Fork Lewis River. Past control of turbidity at the outlet has relied on long settling times (passive treatment) for the recycled process water prior to its release at Pond 5 and/or on alteration or cessation of processing operations. These methods provided limited control to maintain operations and reduce turbidity, and when turbidity became too high Storedahl had no option other than shutting down operations and allowing the ponds to settle for a period of months, prior to restarting the processing operation.

Fecal Coliform

Fecal coliform data for the existing Daybreak ponds are available from one sampling period in March 1998. Maximum fecal coliform levels (most probable number) from this sampling were 11 colonies/100 ml in Pond 5. The higher of two samples in Ponds 3 had 4 colonies/100 ml, and Ponds 1 and 2 had levels below the reporting limit. These values are well below the 50 colonies/100 ml criterion for Class A waters in the state of Washington.

From these data it is difficult to conclude whether or not high fecal coliform levels ever occur in the existing Daybreak ponds. Pond 5 is the most likely pond to have elevated fecal coliform levels, since it receives, on occasion, waters from Dean Creek at high flows after the creek passes through a dairy farm. As mentioned above, fecal coliform levels were relatively high in Dean Creek during August 1998. Use of the ponds by large numbers of waterfowl, especially Canada geese (*Branta canadensis*), could also result in elevated fecal coliform levels, although there are no reports of extraordinarily heavy waterfowl usage in the ponds to date. Consequently, although high fecal coliform levels have not been detected in the ponds, there is a potential for levels to exceed the state criterion to occur.

3.1.6 Land-Use

Previous and current land-use on the Daybreak site includes past gravel mining operations, an ongoing gravel processing operation, and agriculture. The processing area includes such features as the Storedahl Road, storage areas for excavation equipment, aggregate processing equipment, storage of processed sand and gravel, fuel storage, parking areas, temporary haul roads, an office, scales, and a maintenance shop. These facilities and equipment would remain in use when mining resumes at the site. Mining and processing of sand and gravel at the site began at least in 1968. The site has operated under a WDNR Surface Mining Permit since 1971. Storedahl began mining and processing on the site in 1987. No active extraction of gravel has occurred at the site since 1995. Previous mining has resulted in the formation of five unnamed ponds on approximately 64 acres. The rest of the processing area occupies approximately 23 acres, including haul roads and parking areas. Clark County has determined that this land area has existing, nonconforming (grandfathered) use rights.

Approximately 178 acres of the Daybreak site not currently occupied by ponds or under use for processing is used for pasture, corn, and hay production. Prior to acquisition by J.L. Storedahl and Sons, this agricultural land was part of a dairy operation. Livestock pasturing was discontinued in 1996 after Storedahl acquired the site, but hay and crop production continues on the unmined portion of the site with one or two cuttings per year. Most of the Daybreak site is zoned for agriculture (zoned as Agriculture 20 by Clark County), with approximately 58 acres of the site having a Surface Mining Combining District overlay, which allows surface mining subject to approval of a site plan application. An application is pending for a rezone designation of areas now Agriculture 20 and outside of the 100-year floodplain to Agriculture 20 with a Surface Mining Combining District overlay. As noted elsewhere, Clark County has determined that non-conforming use rights apply to portions of the property. Moreover, the Washington Supreme Court has adopted the “Diminishing Asset Doctrine” which authorizes the expansion of non-conforming mining to contiguous parcels (City of Univ. Place v. McGuire, 1442 d 640 [6 September 2001]).

Adjacent and surrounding land-use is generally rural residential to the north and east (zoned as Rural Estate 5 by Clark County), and rural residential, agricultural (livestock grazing), and open space to the northwest. The site is bordered on the south and southeast by undeveloped land and the East Fork Lewis River. Property boundaries, streets, driveways, and utilities are shown in Figure 3-28. A single family residence on a 0.8-acre parcel in the southeast part of the site will likely remain independently owned. A residence, outbuildings, and pasture associated with the previous dairy operation are situated on adjacent land to the northwest.

In addition to previous mining at the Daybreak site, a gravel mine known as the Ridgefield Pits previously operated immediately across the East Fork Lewis River (Figure 3-4). Several other, smaller gravel pits are located on county lands in the floodplain immediately upstream of the Daybreak and Ridgefield sites (Figure 3-4). Areas within the Daybreak site and

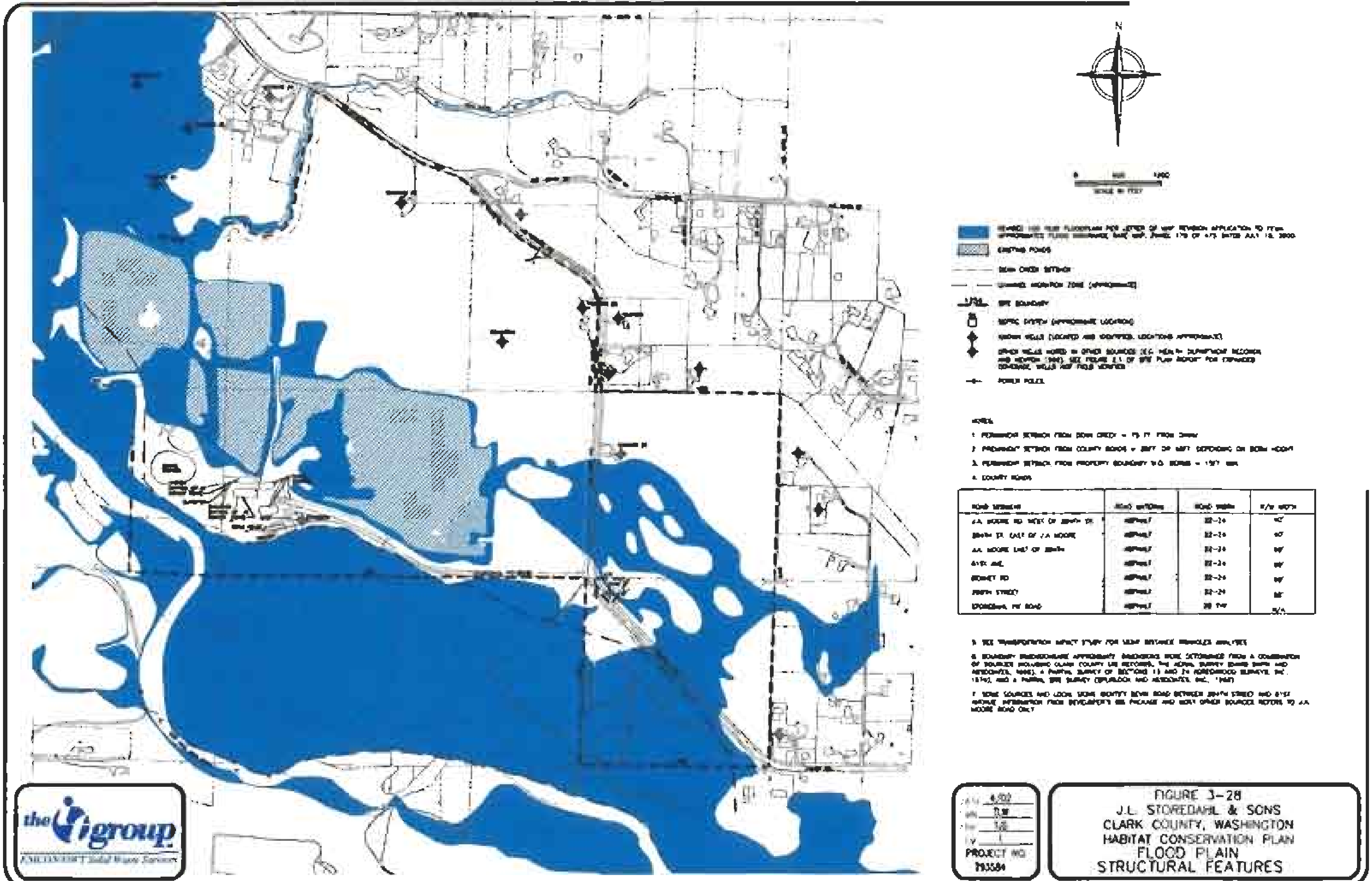


FIGURE 3-28
J.L. STOREDAHL & SONS
CLARK COUNTY, WASHINGTON
HABITAT CONSERVATION PLAN
FLOOD PLAIN
STRUCTURAL FEATURES

Ridgefield Pits are utilized for recreational fishing, although no facilities or formal access is provided to the public.

Daybreak Park, a Clark County facility, is located 1 mile upstream on the East Fork Lewis River and provides a boat ramp, picnicking, ball fields, playgrounds, and swimming and fishing access. Another county-owned park, Lewisville Park, is located approximately 3 miles upstream of the site. The Daybreak site is at the eastern or upstream end of a series of recent land acquisitions by public agencies, including the Vancouver-Clark Parks and Recreation Department. An extensive greenbelt park is planned for this acquired area along the East Fork Lewis River.

Surrounding land-use on the uplands above the river valley are primarily small farms and low-density residential. In addition to agriculture, a small amount of timber harvest occurs on remnant stands of forest. There is currently one open excavation north of the J. A. Moore Road, and two gravel/sand mines located approximately 2 to 3 miles east of the Daybreak site.

3.2 BIOLOGICAL SETTING

Fish and wildlife species that are candidate, proposed, or listed species under the ESA and which could potentially be affected by the operation and reclamation of Storedahl's Daybreak Mine are covered by this HCP. Other species covered by this HCP have a high potential or are considered to be at the greatest risk of being listed under the ESA in the near future. Nine species are included in this HCP, including eight fish and one amphibian species.

3.2.1 Fisheries

A total of eight fish species are covered by this HCP and associated ITP. These species were selected to be included in the HCP because of their known or probable occurrence in the East Fork Lewis River and their status as USFWS and NOAA Fisheries species of concern; or listed, proposed, or candidate species under the ESA. Additional detailed information on the life history, distribution, and stock status of the eight East Fork Lewis River basin fish species that are covered in this HCP is provided in Technical Appendix A. The species include six salmonids: coho, Chinook, and chum salmon, steelhead, coastal cutthroat, and bull trout; and two petromyzontids: Pacific lamprey and river lamprey. Seven of these species are anadromous or contain individuals with anadromous life histories. Anadromous fish spawn in fresh water after rearing for some portion of their life in the ocean. One species, bull trout, exhibits a predominantly freshwater life history. Although bull trout are known to stray between watersheds, the existence of anadromous bull trout populations is uncertain (McPhail and Baxter 1996). Both the steelhead and coastal cutthroat trout are anadromous forms of species that also exhibit freshwater life histories. The freshwater (resident) form of steelhead is known as rainbow trout.

Evolutionarily Significant Units (ESUs) of the Lower Columbia River steelhead, Chinook salmon, and Columbia River chum, and the Distinct Population Segment (DPS) of the Columbia River bull trout are listed as threatened under the ESA. The steelhead ESU was listed as threatened by the NOAA Fisheries under the ESA on 19 March 1998 (63 *Fed. Reg.* 13347-13371), and the bull trout DPS was listed by the USFWS on 10 June 1998 (63 *Fed. Reg.* 31647-31674). On 24 March 1999 (64 *Fed. Reg.* 14307-14328), Lower Columbia River Chinook salmon and Columbia River chum salmon were listed as threatened under the ESA. The East Fork Lewis River contains or potentially contains each of these fish populations.

Southwestern Washington/Columbia River coastal cutthroat trout were jointly proposed as threatened by NOAA Fisheries and USFWS on 5 April 1999 (64 *Fed. Reg.* 16397-16414). Subsequently, the USFWS assumed jurisdiction over coastal cutthroat trout (65 *Fed. Reg.* 20,915 - 20,918 [19 April 2000]). On 26 June 2002, the USFWS announced that the listing of this species was not warranted under the ESA (67 *Fed. Reg.* 44,933-44,934). It is unknown if native coho salmon still exist in the Southwest Washington/lower Columbia River ESU. Currently, this ESU is a candidate species for listing under the ESA. The two lamprey species are NOAA Fisheries and USFWS species of concern. Although the USFWS was petitioned in February 2003 to list both lamprey species under the ESA, the USFWS has not made any decisions on this petition due to budgetary constraints.

Other fish occur in the East Fork Lewis River and other waters in or near the HCP area that are not covered by this HCP and the associated ITP. These fish include native freshwater species such as minnows (Cyprinidae), suckers (Catostomidae), sculpins (Cottidae), freshwater western brook lamprey (*Lampetra richardsoni*), and the freshwater forms of rainbow and cutthroat trout. Additionally, non-native (introduced) species, such as bass, crappie, and sunfish (Centrarchidae) that potentially occur in or near the HCP area are not covered by this HCP. The HCP is expected to benefit all native species through the implementation of the conservation measures discussed in Chapter 4. These measures were developed to protect and enhance habitat and ecosystem functions that will benefit not only the covered species but also the fish and wildlife that comprise the natural diversity in the HCP area.

Fish are an important component of the ecosystem of the East Fork Lewis River basin. In Pacific Northwest watersheds, anadromous fish are a critical link in the aquatic and riparian food web. Adult anadromous fish, after rearing in the ocean, return to streams with ocean nutrients that enrich the food web from primary producers to top carnivores. At the top of the food web, at least 22 species of wildlife, including black bear, mink, river otter, and bald eagle, feed on salmon carcasses (Cederholm et al. 1989). At the base of the food web, salmon carcasses provide a substantial amount of nitrogen to streamside vegetation, and large amounts of carbon and nitrogen to aquatic insects and other macroinvertebrates (Bilby et al. 1996). Some researchers suggest that a minimum escapement level for natural spawners may be needed to maintain the integrity of the aquatic food chain. Anadromous lamprey also return ocean nutrients to the freshwater ecosystem when they spawn and subsequently die. The contribution of lamprey to the food web has not been investigated.

Fish in the Pacific Northwest are also a major component of the human ecosystem. Local salmon and steelhead harvests provide commercial, sport, subsistence, and cultural uses to people of the lower Columbia River basin and the East Fork Lewis River. In the past, native people relied on salmon and steelhead populations for their subsistence lifestyle and economy (USFS 1995). Currently, the East Fork Lewis River offers a year-round steelhead sport fishery known for the large size of its fish (USFS 1995). This fishery targets hatchery raised steelhead that are released to the East Fork Lewis River. Fishing for wild summer-run steelhead has been restricted since 1986, and fishing for wild winter-run steelhead has been restricted since 1991 (Rawding 1997). However, a recent draft recovery plan for Lower Columbia River steelhead (State of Washington 1998) identifies the East Fork Lewis River as a candidate sanctuary water, because of the lack of dams, high proportion of federal ownership, and absence of existing hatcheries. If the East Fork Lewis River is designated as a steelhead sanctuary, it is probable that hatchery steelhead would not be released into or allowed access to natural production areas in the river and fishing would likewise be restricted (see Section 3.4.1.1 for more detail).

Although there are no hatcheries on the East Fork Lewis River, there are two salmon hatcheries and one steelhead and trout hatchery located on the North Fork Lewis River. Two are located below Merwin Dam (Lewis River Hatchery and Ariel Hatchery) and one on the north shore of Merwin Reservoir (Speelyai Hatchery). The Lewis River Hatchery was built on the North Fork Lewis River in 1930 to produce spring Chinook and coho salmon (WDF

1990), and it is currently one of the major coho producers on the Columbia River (WDF 1990). The only hatchery fish currently released to the East Fork Lewis River are spring- and winter-run steelhead. Fall Chinook salmon were historically released in the Lewis River, but they have not been released since 1985 to avoid potential impacts with the healthy wild spawning population (WDF and WDW 1993).

Dean Creek is potentially accessible to several anadromous species, including coho salmon, steelhead, coastal cutthroat trout, chum salmon, and lamprey. A November 1991 stream survey found cutthroat and rainbow trout, largescale sucker, and sculpin in Dean Creek (EnviroScience 1996a).

Fish habitat near the project site has been severely altered since EuroAmerican settlement. Historically, the lower reach of the East Fork Lewis River was a braided river with abundant wetlands and off-channel areas, as discussed in Section 3.1 (Figure 3-5). In the Pacific Northwest, complex networks of wetlands, beaver ponds, and side channels provide important rearing habitat for juveniles of several salmonid species (Li et al. 1987; Beechie et al. 1994; Sommer et al. 2001). By the time the first fisheries survey was conducted in the East Fork Lewis River in 1936 and 1937, most of the beaver and wetlands were gone, and the valley along the lower 6 miles of the river had been converted to pastureland (Bryant 1949). Undoubtedly, the draining of wetlands for agriculture and the conversion of the river to a single thread channel resulted in reduced area and quality of rearing habitat for many fish in the river, and it also probably reduced the number and quality of deep pools for rearing and side channels used for spawning.

This historic simplification of properly functioning river channels, which occurred in the East Fork Lewis River and in Dean Creek, also occurred in most major river systems in the Pacific Northwest. The effects of these alterations on fish habitats have been described most thoroughly for the Skagit River basin in Washington (Beechie et al. 1994; Halbert 1995) and the Willamette River in Oregon (Lyons and Beschta 1983; Sedell and Froggatt 1984; Benner and Sedell 1997). In the Skagit River, the majority of rearing habitat loss for coho salmon, was the result of disconnection of the river from floodplain habitats through ditching, dredging and diking to accommodate agricultural and urban lands (Beechie et al. 1994). The Willamette River has similarly been disconnected from its off-channel habitats as a result of the deliberate closing off of channels and sloughs to create a single channel. Between 1854 and the mid-1900s, these efforts resulted in reduced river length by approximately 50 percent between the towns of Eugene (RM 175) and Albany (RM 117) as secondary channels were cut off and the multiple channels were converted to a single thread (Benner and Sedell 1997).

In the East Fork Lewis River, similar to other rivers in the region, the watershed conditions were also changing at the same time that the configuration of the channels were being simplified. As discussed in Section 3.1, a large part of the East Fork Lewis River basin burned in 1902, and the remnants of this fire and other smaller fires was noted in the early fisheries survey (Bryant 1949). Since this time, the watershed has also been altered by road building and development. Of significance for steelhead, a natural barrier to migration at Sunset Falls (RM 32.7) was notched in 1982, providing additional upstream areas for spawning.

Another major change in fish habitat occurred 1996, when the East Fork Lewis River broke through its channel banks and avulsed into the abandoned Ridgefield gravel pits on the opposite side of the river from the Daybreak site. This resulted in the conversion of approximately 3,200 linear feet of riffle habitat (used primarily for spawning) into low-velocity pool habitat (used primarily for rearing) (Norman et al. 1998). Approximately 900 linear feet of this new pool habitat has subsequently filled in with bedload deposited gravel and is again riffle habitat (discussed further in the following Section 3.3). The new pool habitat in this reach of the river is primarily rearing and holding habitat. Although this type of habitat is limiting in the river due to the historical loss of large wood and the draining of wetlands, the pool habitat in the Ridgefield reach is different than the historical pre-agricultural off-channel and in-river pool habitat. Although some smaller pools and interconnecting channels exist in this reach, the most obvious difference is the larger areas of open water, which historically would have been a network of frequently flooded terrestrial vegetation, ponds, channels, and woody debris.

3.2.1.1 Steelhead

The Lower Columbia River steelhead are listed as threatened under the ESA (63 *Fed. Reg.* 13347-11809 [18 March 1998]). Many factors have contributed to the decline of lower Columbia River steelhead. In particular, NOAA Fisheries has listed the following five major reasons: 1) universal and often dramatic population declines since mid-1980s; 2) 19 of 21 Washington populations are depressed; 3) Wind River stock has declined from “depressed” to “critical”; 4) hatchery transplants are compromising local populations; and 5) a high percentage of hatchery fish are present on the spawning grounds.

The East Fork Lewis River system supports wild and hatchery summer- and winter-run steelhead stocks (WDF and WDW 1993). The two stocks are differentiated by the timing of adult returns, but share common juvenile behavior patterns. Additionally, the hatchery populations have advanced spawning times, which reduces their interactions with the wild fish. Winter-run steelhead return to the Lewis River basin from December through April, and summer-run adults return between May and November (WDF and WDW 1993). Spawning occurs in the first part of January for the hatchery fish, and the native fish spawn from early March to late May or June (Rawding 1999). The available spawning habitat for steelhead was expanded in 1982 when Sunset Falls (RM 32.7) was notched to facilitate passage. Currently, approximately 12 percent of the spawning in the East Fork Lewis River occurs upstream of Sunset Falls (WCC 2000), which is not accessible to other anadromous salmonids. In the Lewis River, most steelhead migrate to sea after rearing for two years in freshwater habitat (WDF 1990). Juveniles rear in both riffle and pool habitat (Roper et al. 1994). Steelhead are capable of repeat spawning, but rarely spawn more than twice.

The East Fork Lewis River summer-run steelhead stock is primarily comprised of non-native hatchery origin fish, with some natural spawning (WDFW 1994). The hatchery fish originate from Elochoman, Chambers Creek, Cowlitz, and Skamania hatchery brood stocks (WDF and WDW 1993). Historically, an average of approximately 90,000 summer-run steelhead smolts were released annually into the East Fork Lewis River system, although current stocking is around 40,000 smolts (Rawding 1999). The escapement goal for the East Fork Lewis River summer-run steelhead is 814 wild adults (WDF and WDW 1993). The wild summer-run stock is identified as depressed by the WDFW (State of Washington 1998). The number of summer-run steelhead returning to the East Fork Lewis River is relatively unknown, although WDFW conducts summertime snorkel surveys in select index reaches. Based upon index counts, the LCSCI reported that between 1996 and 1998 the average escapement of summer-run steelhead to the East Fork Lewis River was 80 wild fish and 167 hatchery fish (State of Washington 1998).

The East Fork Lewis River winter-run steelhead is of mixed hatchery and native origin. To supplement the naturally reproducing fish, approximately 100,000 hatchery-origin smolts are planted annually. Escapements of wild winter-run steelhead have ranged from 72 to 140 fish, which is well below the escapement goal of 204 fish (WDF and WDW 1993). The winter-run steelhead stock is identified as depressed by the WDFW.

3.2.1.2 Chum Salmon

The Columbia River chum salmon population was listed as threatened by the NOAA Fisheries on 25 March 1999 (64 *Fed. Reg.* 14508-14517). This listing includes chum salmon in Lewis River and East Fork Lewis River basins. Early hatchery production on the Lewis River included chum salmon, up until 1940. This led to the development of a large population of hatchery chum salmon in the Lewis River watershed. However, today, chum salmon are a rarity in this system. Factors thought to contribute to this population decline include predation by hatchery Chinook and coho salmon, and habitat alteration and destruction (WDF 1990). At the time of the ESA listing, only three systems on the Washington State side of the Columbia River were recognized as containing native chum salmon - Hamilton and Hardy creeks and Grays River.

Although their exact distribution in the East Fork Lewis River is unknown, chum salmon spawn in the mainstem Lewis River in November and December. Chum salmon have only been observed in the East Fork Lewis River occasionally since the 1950s (Rawding 1999). In the spring of 2000, however, 78 chum salmon fry were trapped in the WDFW smolt trap located upstream of Mason Creek (Rawding 2000). It is believed that chum spawning habitat exists primarily in side-channels and upwelling areas between RM 6 and RM 10, although available habitat could potentially exist up to Lucia Falls (RM 21.3; WCC 2000). Juvenile chum salmon leave the freshwater environment soon after emerging from the gravel before beginning a longer period of estuarine residence. The estuarine rearing period is the most critical phase of their life history and often determines the size of subsequent adult returns (Johnson et al. 1997). Downstream chum salmon migration (smolts and juveniles) peaks in late January to May (Johnson et al. 1997). There is no commercial or sport fishery targeting chum salmon, but they are taken as by-catch during the late coho salmon gill-net fishery in the Columbia River (WDF and WDW 1993).

3.2.1.3 Chinook Salmon

The Lower Columbia River Chinook salmon ESU were listed as threatened under the ESA on 24 March 1999 (64 *Fed. Reg.* 14307-14328). This listing includes both fall and spring Chinook salmon in the East Fork Lewis River. Currently, fall Chinook salmon production in the East Fork Lewis River is entirely natural, with no hatchery influence. However, prior to 1985, fall Chinook were planted in the East Fork Lewis River with stocks supplied from both the Lewis River and Speelyai hatcheries (WDF 1990). Fall Chinook escapements in the East Fork Lewis River averaged 598 fish between 1967 and 1991. WDFW does not have escapement goals for fall or spring Chinook salmon. The fall-run in the East Fork Lewis River is considered healthy and, together with fish in the mainstem Lewis River, is considered to be the only healthy native run in the Lower Columbia ESU (Myers et al. 1998). However, the abundance of Chinook salmon in the entire ESU has declined substantially, and both long- and short-term abundance trends are predominantly downward. The ESU includes all native populations of Chinook salmon from the mouth of the Columbia River to the crest of the Cascade Range, excluding populations above Willamette Falls. Parts of this ESU are affected to varying degrees by habitat degradation, stemming from passage barriers, urbanization, and forest practices.

The Lewis River watershed supports populations of both spring and fall Chinook salmon, with the run distinction based on the timing of river entry. Adult fall Chinook enter freshwater, and begin their upstream migration in September and October, while spring Chinook freshwater entry occurs between May and July. Spawning for both runs takes place from mid-September through mid-November. Juvenile Chinook rearing in fresh water is generally associated with pool habitat (Roper et al. 1994). The embryos develop and hatch in approximately one to five months depending on temperature (Healey 1991). Juvenile Chinook may migrate to the ocean in the first few months of life (ocean type), or remain in fresh water until the following spring and migrate as yearlings (stream type).

The predominant Chinook run in the Lewis River is fall Chinook salmon. Native spring Chinook were the predominant run at one time in the mainstem Lewis River, but construction of Merwin Dam drastically reduced the population. Few, if any spring Chinook return to the East Fork Lewis River today, and there is the possibility that the native run is extinct (Myers et al. 1998). No hatchery Chinook are released currently into the East Fork Lewis River (Rawding 1999). Chinook use spawning habitat in the main channel of the East Fork Lewis River from Mason Creek as far upstream as Lucia Falls (Rawding 1999). Regular spawning surveys for fall Chinook focus on the reach between Lewisville Park (RM 15) and Daybreak Park (RM 10) (WCC 2000).

3.2.1.4 Coho Salmon

Although NOAA Fisheries did not identify any remaining natural coho populations in this ESU that warranted protection under the ESA, NOAA Fisheries is concerned about this species' overall health. Therefore, this ESU has been added to the candidate list until further information is available and the native population issue can be resolved (Weitkamp et al. 1995).

Historically, the East Fork Lewis River supported a large run of coho (Bryant 1949). Coho salmon migrate as far upstream in the river as Lucia Falls at RM 21.3 (WCC 2000). The Lewis River coho are typical of Columbia River stocks with regard to their life histories.

They spend 18 months in freshwater followed by 18 months in saltwater (or up to 3 years) (Sandercock 1991). Adult coho spawning occurs from October through December (WDF and WDW 1993), with peak smolt out-migration occurring during May and June (EnviroScience 1996a). Coho salmon typically spawn in tributaries to the main channel although they could also spawn in pool tailouts within the mainstem East Fork Lewis River between RM 6 and RM 21.3. Juvenile coho prefer to rear in slow water habitats with complex structure such as off-channel areas and beaver ponds (Bustard and Narver 1975).

Coho salmon of the Lewis River system are divided into two stocks, north-turning, and south-turning, based on where they contribute most heavily to the ocean fisheries. Both stocks are managed as hatchery stocks in the Lewis River. On average, one million juvenile coho are released annually into the East Fork Lewis River. Both the Speelyai and the Lewis River hatcheries rear coho. Coho production in the East Fork Lewis River has been estimated as 2,000 naturally spawning fish (Johnson et al. 1997). The WDFW does not have an escapement goal for coho salmon in the East Fork Lewis River.

3.2.1.5 Coastal Cutthroat Trout

The status of coastal cutthroat trout stocks in the lower Columbia River tributaries is poorer than any other river system in Washington (Leider 1997). On 5 April 1999, NOAA Fisheries and USFWS jointly proposed to list the Southwestern Washington/Columbia River population of cutthroat trout as threatened under the ESA (64 *Fed. Reg.* 16397-16414). Subsequently, USFWS assumed jurisdiction over coastal cutthroat trout and on 26 June 2002 announced that the species did not warrant listing under the ESA.

Coastal cutthroat have the most variable life history of the indigenous anadromous salmonids (Grette and Salo 1986). Coastal cutthroat trout exhibit early life history characteristics similar to steelhead. Spawning occurs in the Lewis River from March through early May. Juveniles rear in freshwater for more than one year, generally from two to nine years (Wydoski and Whitney 1979). The seaward migration of smolts peaks in May and coincides with steelhead smolt emigration (Grette and Salo 1986).

The East Fork Lewis River historically supported a “fair run of sea-run cutthroat” (Bryant 1949). Coastal cutthroat trout are believed to still be present in the East Fork Lewis River; this is based on angling reports, occasional sightings, and fish trapped on the Cedar River, which is a tributary to the North Fork Lewis River (Rawding 1999). However, little information exists on their current status. Coastal cutthroat trout are known to utilize Mason, Mill (Rawding 1997), and Dean creeks. However, these populations may be resident and not anadromous (EnviroScience 1996a).

3.2.1.6 Bull Trout

Bull trout are one of two char species native to Washington State. The closely related Dolly Varden is the other native char in the state of Washington. Because of their morphological similarities, bull trout and Dolly Varden were previously considered to be a single species (Cavender 1978). Currently, WDFW manages Dolly Varden and bull trout as one species, and for the purposes of the ESA, considers Washington State's native char populations to be predominantly bull trout (WDFW 1997a). Prior to dam construction, anadromous and fluvial bull trout populations were present in the Lewis River (WDF and WDW 1993). Bull trout and Dolly Varden are currently only present in the mainstem Lewis River in the reservoirs above Merwin, Yale, and Swift dams. A wild, naturally reproducing stock of bull trout/Dolly Varden is present in the North Fork Lewis River (WDW 1992). There is no present or historical documentation of a bull trout population in the East Fork Lewis River (Weinheimer 1998; Rawding 1999), however, straying into the East Fork Lewis River may occur.

Lewis River bull trout are considered part of the Columbia River bull trout DPS, and due to several detrimental factors (including forest management and road building, mining, increased stream temperatures, and loss of habitat) have been listed as threatened under the ESA (63 *Fed. Reg.* 31647-31674). Dam construction could also have contributed to the decline in bull trout populations (USFWS 1998b). Fishing for bull trout/Dolly Varden has been closed in the Lewis River since 1992. The WDFW Enforcement Program has been very active in protecting bull trout and Dolly Varden in the reservoirs and tributaries of the Lewis River.

Spawning in most bull trout populations occurs during the fall, mainly in September and October. Spawning areas are primarily tributaries to the Lewis River and North Fork Lewis River. Preferred spawning areas are characterized by low gradient, and cold groundwater influence (Fraley and Shepard 1989). The eggs incubate in the gravels for an extended period of time before hatching in late winter, or early spring. Anadromous juvenile bull trout may remain in freshwater two to three years (or longer) before migrating to the ocean.

The habitat preferences of bull trout are similar to other salmonid species, but are more strict. Bull trout, more than other salmonid species, require cold water to initiate spawning, and for incubation and juvenile rearing (USFWS 1998b). Optimal spawning temperatures are under

9-10°C, incubation temperatures range from 2-4°C, and juvenile rearing temperatures are between 4 and 10°C (USFWS 1998a). Suitable temperatures to support a bull trout population may not be currently present in the East Fork Lewis River (Rawding 1999). They exhibit a long incubation period, making the developing embryos vulnerable to sediment deposition, and temperature. Bull trout also rely on a large prey base to maintain populations (USFWS 1998b).

3.2.1.7 Pacific Lamprey

Pacific lamprey are a species highly prized by Native Americans as a ceremonial and subsistence food (Jackson et al. 1996). However, currently, they are not largely utilized or valued by people other than Native Americans. Recent declines in lamprey populations have gone largely unnoticed by fishery managers (Jackson et al. 1996). The USFWS was petitioned in February 2003 to list this species under the ESA. The USFWS has not yet initiated a status review of Pacific lamprey due to budgetary constraints.

Adult Pacific lamprey are parasitic in marine environments, and enter freshwater to spawn and rear (Wydoski and Whitney 1979). Adult Pacific lamprey migrate upstream in late spring and early summer in search of spawning areas. The adults die shortly after spawning. Juvenile lamprey, termed ammocoetes, remain buried in the substrate for 5 or 6 years (Wydoski and Whitney 1979). During this benthic residence, juvenile lamprey are highly susceptible to increased pollutants and sediments (StreamNet 1998). Increased stream temperatures and lack of instream cover can also reduce food supplies for the lamprey (StreamNet 1998).

Juvenile lamprey metamorphose in July through October, and they migrate within the next year to the ocean. Seaward migration usually occurs during high water periods, in late winter or early spring (StreamNet 1998). They may remain in the marine environment for up to three and a half years before returning as adults to spawn. Pacific lamprey require many of the same habitat characteristics as the salmon species. Good quality spawning and rearing habitat, passage corridors, and productive ocean rearing habitat are all necessary for a healthy population (Jackson et al. 1996).

3.2.1.8 River Lamprey

Like Pacific lamprey, river lamprey are considered a species of concern by USFWS. The USFWS was petitioned in February 2003 to list this species under ESA. The USFWS has not yet initiated a status review of river lamprey due to budgetary constraints.

River lamprey are similar to Pacific lamprey in their life history patterns. However, unlike Pacific lamprey, river lamprey may spend their entire life in freshwater. River lamprey also become predacious in freshwater, often feeding on juvenile salmonids (Beamish 1980).

3.2.1.9 Non-Native Fish Species

Several species of non-native fish are present in the lower Columbia River, East Fork Lewis River, and ponds on the Daybreak site. Although none are species of concern, these fish potentially interact with several of the native species of concern.

Stocking of non-native fish species in Washington State began in the late-1800s with the introduction of American shad (*Alosa sapidissima*) from the U.S. Atlantic coast. Since then, approximately 31 non-indigenous fish species have been added, in varying degrees, to Washington's fish community (Zook 1998). These include nine members of the sunfish family, two perch, six catfish, two pike, eight salmonids, and four others. Although some of these 31 species currently have restricted distribution within the state, many are more widespread and actively managed by WDFW as long-term recreational fisheries (Zook 1998).

In Oregon State, preliminary estimates indicate that at least 24 non-native species of game fish have been introduced to that state, and that most were introduced legally near the turn of the century (Daily et al. 1999). Four of the species are salmonids (brook, brown, and lake trout, and Atlantic salmon), and the other 20 species are spiny-rayed fish, commonly referred to as warmwater game fish. In the Pacific Northwest, the first recorded stocking of exotic fish was in 1880 when German carp were brought in to stock a nursery pond (WDFW 1999a). Other fish species soon followed, and many were brought by rail under the direction of the U.S. Fish Commission (WDFW 1999a).

Non-native game fish populations known to occur in the lower Columbia River in Clark County, include largemouth and smallmouth bass, yellow perch, black and white crappie, bluegill, brown bullhead, walleye, and channel catfish (WDFW 1999b). These species, typically prefer waters that are relatively warm and slow moving. The extensive reservoir system on the Columbia River provides abundant preferred habitat for these fish, although they are also found in the free-flowing portions of the Columbia River and several of its tributaries. Hybrid, non-native tiger muskellunges are also found in Lake Merwin, a reservoir on the Lewis River (WDFW 1999b). All of the warmwater fish found in the Columbia River may also be present in the East Fork Lewis River. However, the East Fork Lewis River contains, in general, more swiftly flowing water than the Columbia River, and is therefore less suitable than the Columbia River for supporting warmwater fish populations. In the Daybreak ponds, four non-native fish species have been observed. These include largemouth bass, black crappie, bluegill, and brown bullhead.

Non-native fish species including hatchery fish can potentially interact with the native species of concern, covered by this HCP, primarily through competition for resources or by direct predation. The non-native species associated with off-channel habitats in the lower Columbia River basin generally considered to be most problematic to salmon recovery efforts is the largemouth bass, due to its widespread distribution and predaceous feeding habits.

Largemouth bass were first transplanted to Washington State in 1890 by the U.S. Fish Commission, and in the years since, largemouth bass have been extensively transplanted throughout the state (WDFW 1999a). In Clark County, largemouth bass populations are managed by WDFW for sport fishing in 14 lakes plus the Columbia River (WDFW 1999b). Current state regulations prohibit the unauthorized release or introduction of fish, such as largemouth bass, into Washington waters. Nonetheless, the illegal transportation of largemouth bass and other popular game fish into favorite fishing spots is presumed to be widespread. For example, largemouth bass are found in the existing Daybreak ponds although there are no records of this species being stocked in this location. In general, largemouth bass in southwest Washington are believed to exist in all suitable habitats, or if not present, they will move into or be transplanted (illegally) to all suitable habitat in the near future (Weinheimer 1999).

Suitable habitat for largemouth bass includes slow-moving backwater areas in streams and rivers, and ponds and lakes that are deep enough to maintain oxygenated water throughout the year. During the cold winter months, largemouth bass typically stop feeding and move into deeper water habitat. Observations indicate that largemouth bass stop feeding when water temperatures fall below 47°F (approximately 8°C) (Bonar 1999). As water temperatures increase in the spring, the fish move back into shallower, slow-moving areas to feed and spawn. Largemouth bass initiate spawning activities when water temperatures reach 60 to 65°F (15.5 to 18.3°C). Largemouth bass are highly predaceous, and they commonly feed on fish, crawfish, frogs, large insects, and other small animals. During the feeding months, largemouth bass are generally near cover such as vegetation, logs, docks, points, or rocks. Largemouth bass have been observed in the East Fork Lewis River from Lewisville Park all the way down to the mouth (Weinheimer 1999). They also occur in the existing Daybreak ponds where they are popular with local anglers.

WDFW is currently conducting studies on the interactions between largemouth bass and juvenile salmon (Bonar 1999). A primary question being investigated is the amount of temporal separation between these fish due to the relative inactivity of largemouth bass when water temperatures are low and juvenile salmon are migrating downstream. Nighttime and daytime snorkeling observations in the Ridgefield reach of the East Fork Lewis River indicated that numerous young-of-year Chinook salmon were present along the pool margins of the Ridgefield Pits during April, May, June, and July 2000 and in July 2001, and during the same times no largemouth bass or any other non-native fish species were observed (R2 Resource Consultants unpublished data). The snorkeling surveys focused on assessing presence/absence of fish species and their habitat use within the Ridgefield Pit reach.

3.2.2 Wildlife

The Daybreak site is located near the East Fork Lewis River, and the floodplain forests provide foraging, breeding, and dispersal habitat for numerous wildlife species. A database review of sensitive, threatened, and endangered wildlife observations within the project area was performed by WDFW and the Washington State Natural Heritage Program (WDFW 1997b). Although no state- or federal-listed species were identified within the project area, adjacent lands contain important habitat for a variety of species. The forested riparian corridor along the East Fork Lewis River is identified as a priority habitat that provides “high quality habitat with multiple layered canopy” (WDFW 1997b). The wetland and forested lands adjacent to the East Fork Lewis River are mapped by WDFW as priority areas that support breeding and wintering concentrations of geese, duck, cavity nesting ducks, and wintering populations of tundra swans (*Cygnus columbianus*). This database also records breeding osprey (*Pundion haliaetus*), breeding bald eagles (*Haliaeetus leucocephalus*), and winter concentrations of sandhill cranes (*Grus canadensis*) in the surrounding area.

The mixture of upland and riparian habitat in the project site and surrounding area supports a variety of additional resident and wintering birds, as well as large and small mammals, amphibians, reptiles, and invertebrates. This HCP seeks ESA coverage for only one wildlife species that potentially exists on the project site, the Oregon spotted frog, which is a candidate for federal ESA listing and a State endangered species. Storedahl is not seeking an ITP for any other listed or proposed ESA wildlife species, because the existing and proposed mining and reclamation activities are not expected to result in increased risk of "take" of such animals. Additional information on the life history and stock status for the Oregon spotted frog in particular is discussed below, and further detail on this species is provided in Technical Appendix A.

3.2.2.1 Oregon Spotted Frog

Due to declines in populations, the Oregon spotted frog (*Rana pretiosa*) is a federal candidate for listing and a State endangered species (McAllister and Leonard 1997). The reason for their decline is not known, but degradation of wetlands and introduction of the bullfrog (*Rana catesbeiana*) have likely been contributors (Hayes and Jennings 1986). Historically, the Oregon spotted frog ranged from southwestern British Columbia to the northeast corner of California, including the Puget Sound Lowlands, Willamette Valley, and Cascade Mountains of south-central Oregon (McAllister and Leonard 1997). It has been extirpated from much of its historic range in Washington State, which was west of the Cascades in the Puget Trough. Presently, Oregon spotted frogs have been found at only four sites in Washington State (McAllister 1999). The documented sightings closest to the project area are in Thurston and Klickitat counties. The frog is more abundant in Oregon, but populations in Oregon tend to occupy higher elevation sites, which in Washington would be occupied by Cascade frogs (*R. cascadae*) (McAllister 1999).

The Oregon spotted frog is highly aquatic, nearly always found in marshes or on the edges of lakes, ponds, and slow streams with non-woody wetland plant communities including sedges, rushes, and grasses (Corkran and Thoms 1996). Adults usually feed on insects captured from the water or within 2 feet of the shoreline. Wetlands in Washington State that support spotted frogs are usually shallow emergent wetlands associated with prairie or sparse grasslands that become inundated during high water (McAllister 1999). Adults use these inundated areas for egg-laying. The frogs typically deposit eggs in February or March (Leonard et al. 1993). Adult spotted frogs are active from February through October, and hibernate the remainder of the year in muddy bottoms of ponds near breeding sites.

An amphibian survey in Clark County conducted in February 1998 indicated that frog egg masses potentially believed to be those of the Oregon spotted frog were located at several sites within the county, including the Daybreak site (Corkran 2000). During this survey, a total of five eggs were collected from the egg mass found at the Daybreak site for rearing and identification. Unfortunately, a positive species confirmation could not be made. A subsequent survey for tadpoles and adults by county and WDFW staff failed to observe any Oregon spotted frogs within Clark County (McAllister 1999). During a follow-up survey in March 1999, potential Oregon spotted frog eggs were collected from a site on private land approximately two miles south of the Daybreak site. However, identification of these using DNA testing revealed the eggs to be those of the common red-legged frog (*R. aurora*; Corkran 2000). At this time, it is unknown whether Oregon spotted frogs occur at the project site or elsewhere within Clark County. The Daybreak site contains habitat that could potentially support the frogs, although the rarity of the species within the state and the presence of highly predatory bullfrogs and largemouth bass in the existing ponds makes it doubtful that a self-sustaining population of Oregon spotted frogs exists at the Daybreak site.

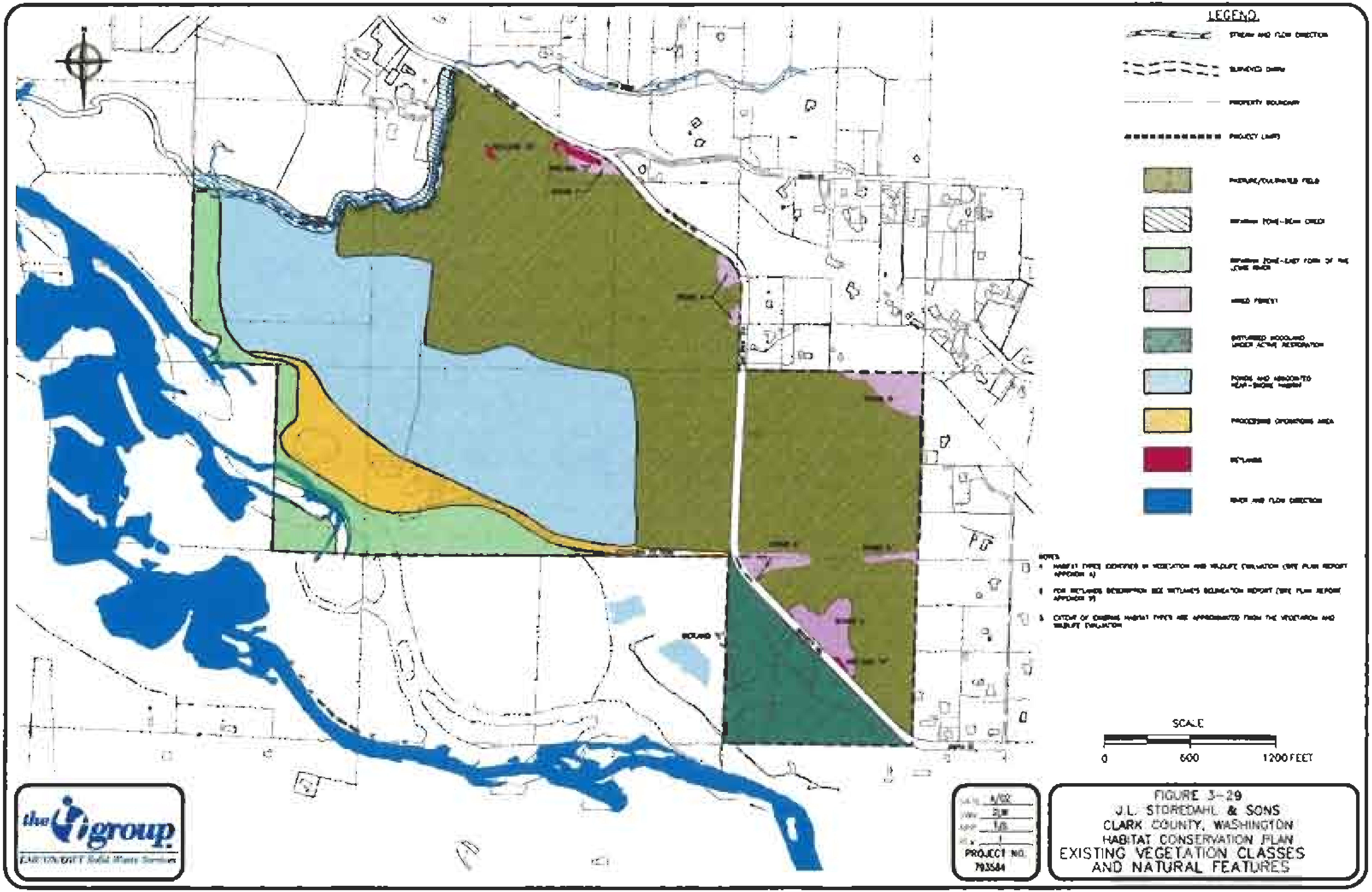
3.2.3 Vegetation

The Daybreak site occurs within the *Tsuga heterophylla* Forest Zone (Franklin and Dryness 1973). The *Tsuga heterophylla* Forest Zone is characterized by climax western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*) forests and sub-climax Douglas-fir (*Pseudotsuga menziesii*) forests. Although western hemlock is the potential climax species in this zone, Douglas-fir forests cover large areas of the landscape.

Topography, aspect, geology, soil, and available soil moisture all influence plant community patterns at the local level, particularly for understory species. Common understory species include sword fern (*Polystichum munitum*) in moist sites, salal (*Gaultheria shallon*) in dry sites, and Oregon grape (*Berberis nervosa*) in sites with intermediate moisture status. Vine maple (*Acer circinatum*) is a common shrub in the middle understory.

Hardwood forests in the *Tsuga heterophylla* Forest Zone are commonly restricted to moist, early successional sites, where black cottonwood (*Populus trichocarpa*) and red alder (*Alnus rubra*) often dominate in fluvial settings and red alder and big-leaf maple (*Acer macrophyllum*) are common in moist upland settings.

The Daybreak site is situated in a relatively narrow river valley, where fluvial disturbance and subsequent succession are important ecological processes that historically determined vegetation structure. Human disturbance has had a major effect on native vegetation in the area, which is now a mix of relatively intact native plant communities and moderately to severely disturbed communities (Figure 3-29). Vegetation descriptions presented in this


LEGEND
PROCESSING OPERATIONS AREA
SCALE
0
600
1200 FEET
PROJECT NO.
FIGURE 3-29
J.L. STOREDAHL & SONS
CLARK COUNTY, WASHINGTON
HABITAT CONSERVATION PLAN
EXISTING VEGETATION CLASSES
AND NATURAL FEATURES

HCP are derived from a vegetation and wildlife habitat report by EnviroScience (1996b) based on 1991 and 1996 field visits, a wetlands delineation by Ecological Landscape Services (1998), and 1998 site visits by R2 Resource Consultants.

3.2.3.1 Terrestrial Plant Communities

Pasture/Cultivated Fields

The highly disturbed community type of pasture/cultivated fields occupies the largest area within the Daybreak site. Much of the site consists of open, herbaceous dominated vegetation used as pasture for dairy cattle or cultivated for silage. In 1991, the vegetation within the pasture and grass fields consisted of quackgrass (*Agropyron repens*), barnyard grass (*Echinocloa crusgalli*), Italian rye grass (*Lolium multiflorum*), perennial rye grass (*Lolium perenne*), white clover (*Trifolium repens*), Canada thistle (*Cirsium arvense*), dandelion *(Taraxacum officinale*), and mallow (*Malva neglecta*). Within the cultivated areas, alfalfa (*Medicago* sp.) and wheat (*Triticum* sp.) were dominant. In 1996, the fields were less diverse. The fields still contained clover, thistle, and dandelion, but the grasses were almost completely dominated by Kentucky bluegrass (*Poa pratensis*). Most recently, approximately one-half of the cultivated acreage has been used for silage corn production. Other species which were noted in 1996, included peppercress (*Cardamine* sp.), chickweed (*Stellaria media*), reed canarygrass (*Phalaris arundinacea*), and curly dock (*Rumex crispus*).

Mixed Forest

A mixed forest community type is found in small stands up to a few acres in size scattered along the northern perimeter and southeast corner of the Daybreak site. These areas are likely remnants of native mixed forest typical of later successional conditions that are commonly found on terraces above the active floodplain areas. The tree overstory in this community type was dominated by Douglas-fir, big-leaf maple, and Oregon ash (*Fraxinus latifolia*). There was a well-developed shrub understory consisting of big-leaf maple saplings, hazelnut (*Corylus cornuta*), vine maple, red huckleberry (*Vaccinium parviflorum*), snowberry (*Symphoricarpos albus*), Oregon grape, Himalayan blackberry (*Rubus discolor*), and trailing blackberry (*Rubus ursinus*). The herb layer was dominated by sword fern, bracken fern (*Pteridium aquilinum*), piggy-back plant (*Tolmeia menziesii*), fringecup (*Tellima grandiflora*), and Pacific bleedingheart (*Dicentra formosa*). Species in wetter areas included willow (*Salix* sp), waterweed (*Elodea canadensis*), and stinging nettle (*Urtica dioica*).

Disturbed mixed forest was found in the southeast portion of the site in 1998, southwest of Bennett Road. Aerial photographs indicate that this area was once contiguous with the mixed forest stand on the north side of Bennett Road. This area had been disturbed by logging and recreational motorcycles and bicycles and was dominated by species characteristic of disturbed areas. Scattered black cottonwood and big-leaf maple saplings dominated the tree overstory. Dominant shrubs growing on the site included snowberry, Himalayan blackberry, vine maple, and Scots broom (*Cytisus scoparius*). The herbaceous layer was well-developed and dominated by Canada thistle *(Cirsium arevense*), bull thistle (*Cirsium vulgare*), varileaf phacelia (*Phacelia heterophylla*), goldenrod (*Solidago canadensis*), St. John's wort (*Hypericum perforatum*), tansy (*Tanacetum vulgare*), toad rush (*Juncus bufonius*), and a variety of grass species. This area has subsequently been graded and planted with native species, and has been under active restoration since the spring of 2000.

3.2.3.2 Wetland and Riparian Plant Communities

Wetlands

Four small areas of isolated jurisdictional wetland (< 0.5 acres each) and one intermittent stream were found within the mixed forest, disturbed mixed forest, and pasture cultivated field community types on the Daybreak site. The wetlands were situated in slight depressions, which appeared to be relict channels of the East Fork Lewis River. The wetland in mixed forest (located just north of Bennett Road) had an overstory dominated by Oregon ash, cottonwood, and red alder, with a dense shrub understory of trailing blackberry, snowberry, and red-osier dogwood (*Cornus sericea*). A nearby wetland outside of the HCP area in disturbed mixed forest also had cottonwood and Oregon ash in the overstory, but was heavily dominated by reed canarygrass in the understory. The wetland in the pasture-cultivated field was dominated by herbaceous species, including western marsh cudweed (*Gnaphalium palustre*) and water pepper (*Polygonum hydropiperoides*). This wetland receives surface water from an unnamed seasonal drainage extending from a culvert under J. A. Moore Road into pasture lands on the subject property (see Section 3.1.4.1 for a description of this drainage). Overflow from Dean Creek may also collect in this wetland as a result of high-flow events. The fourth wetland is an isolated scrub-shrub wetland located adjacent and parallel to the J. A. Moore Road. It has been previously altered and partially disturbed by an old driveway that crosses the western half. Dominant vegetation included

Oregon white oak (*Quercus garryana*), hazelnut, red-osier dogwood, vine maple, and a variety of herbaceous species.

Wetland areas also occur along shorelines of the existing excavated ponds, although some of the shoreline is steep-banked and dominated by dry-site species, such as Scots broom. Wetland areas along the shoreline included such species as cattail (*Typha latifolia*), soft rush (*Juncus effusus*), small-fruited bulrush (*Scirpus microcarpus*), and several species of sedges (*Carex* spp.) and rushes (*Juncus* spp.). There were also dense patches of willow (*Salix hookeriana = S. piperi*) and Himalayan blackberry along some shorelines.

Riparian Areas

There are two types of riparian communities within and adjacent to the Daybreak site. A very narrow riparian band was identified along Dean Creek, which forms the northwest border of the site. A much larger riparian zone is associated with the East Fork Lewis River, located along the southwest property boundary.

Dean Creek. The riparian zone along Dean Creek has been heavily disturbed by grazing and other agricultural land-use. Along the upper, straight reach of Dean Creek that extends south of J. A. Moore Road, the riparian plant community was dominated by dense shrubs, including Himalayan blackberry, willow, and Scots broom, interspersed with wild rose (*Rosa pisocarpa*) and red-osier dogwood. Reed canarygrass, teasel (*Dipsicus sylvestris*), Canada thistle, and Queen Anne's lace (*Daucus carota*) dominated the herb layer within this community.

Grazing impacts were especially evident in the reach north of existing Pond 5, downstream of where it bends west from the straight reach south of J. A. Moore Road. This riparian community had scattered Oregon ash, red alder, and Pacific willow (*Salix lasiandra*) trees. The shrub layer was poorly developed and consisted of small, isolated patches of Himalayan blackberry, Pacific ninebark (*Physocarpus capitatus*), and snowberry. The herb layer was also poorly developed due to intensive grazing and erosion. Common plants within this layer included a variety of grasses and Canada thistle. Grazing in this area has contributed to bank slumping, excessive erosion, and large unvegetated areas adjacent to Dean Creek. A fence to exclude livestock has recently been installed along this reach.

Downstream of the heavily-grazed reach of Dean Creek and immediately north of existing Pond 5, the riparian zone along Dean Creek is in much better condition. This area is dominated by a patchy tree overstory of red alder, Oregon ash, and Pacific willow. There was a dense, well-developed shrub layer composed of Himalayan blackberry, snowberry, red-osier dogwood, wild rose, and hazelnut. Himalayan blackberry was especially prevalent along the edge of the riparian zone adjacent to the cultivated field habitats. The herb layer was moderately developed and was dominated by reed canarygrass, bittersweet nightshade (*Solanum dulcamara*), horsetail (*Equisetum arvense*), sword fern, Canada thistle, and teasel.

Dean Creek continues west of the Daybreak site for approximately 1/3 mile before it flows into the East Fork Lewis River. The channel of the creek becomes diffuse and runs through an area dominated heavily by reed canarygrass, with scattered patches of alder, Oregon ash, and various shrubs.

East Fork Lewis River. The southwest portion of the Daybreak site is bordered by riparian cottonwood-alder forest adjacent to the East Fork Lewis River. Areas with this community type are primarily located immediately west of existing Pond 5 and south of the gravel processing area. Although there were some areas moderately disturbed by dirt roads and other human activity, this riparian community type is relatively intact where it occurs on the Daybreak site. It represents a natural, early successional forest common on floodplains of mid-sized to large rivers throughout the Willamette-Puget lowlands of western Oregon and Washington.

This plant community was dominated by an overstory of black cottonwood and red alder, with scattered Oregon ash. The shrub layer was well-developed and formed dense thickets that were interspersed among the trees. The shrub layer consisted of snowberry, Pacific nine bark, Indian plum (*Oemleria cerasiformis*), ocean spray (*Holodiscus discolor*), Himalayan blackberry, and salmonberry *(Rubus spectabilis*). The herbaceous layer was dominated by curly dock, sword fern, horsetail, stinging nettle, early blue violet (*Viola adunca*), and fringecup.

The cottonwood-alder riparian forest adjacent to the Daybreak site continues off the site both upstream and downstream. Although cottonwood-alder forest was likely once continuous along this portion of the East Fork Lewis River, it has become fragmented primarily due to agricultural disturbance and is now much less prevalent than would be expected prior to settlement by EuroAmericans.

3.3 FACTORS AFFECTING NATURAL PROCESSES IN THE EAST FORK LEWIS RIVER WATERSHED

Extensive changes have taken place in the East Fork Lewis River watershed and ecosystem since EuroAmerican settlement began more than a century ago. Land- and water-use activities such as logging, residential development, agriculture, municipal and industrial water-use, and flood control have all influenced the processes regulating the flow of water, sediment, energy, and nutrients throughout the basin. These processes govern the underlying production potential of the system and directly influence fish and their food. Direct manipulation of fishery resources, including the establishment and operation of hatcheries, and commercial, sport, and tribal fishing have all influenced population sizes. As a consequence, many features of the East Fork Lewis River’s fisheries habitat and production potential have been influenced, compromised, or reduced. This section reviews the changes, summarizes how they have influenced fish and their environment, and identifies what is being done to reverse some of the impacts. In so doing, the framework is set for understanding the context of the effects of Storedahl's gravel mining operations and associated conservation and monitoring measures.

3.3.1 Upper Watershed

Salmonid habitat and production in the accessible reaches of the East Fork Lewis River are controlled according to basin-scale characteristics of sediment sources, transport, and deposition, prevailing climate and hydrology, and nutrient supply. Because andesitic and pyroclastic parent materials are less weathered and more stable than similar materials in other watersheds in western Washington, the potential for mass-wasting in the upper East Fork Lewis River basin is considered low to moderate (USFS 1995). The steep, bedrock- and boulder-dominated headwater streams are generally sediment supply limited. Coarse sediments that enter the stream system by means of periodic landslides, rock fall, and soil creep are rapidly transported to lower gradient reaches. Fine sediment production is low relative to other nearby, glacially fed rivers.

3.3.1.1 Anthropogenic Influences

EuroAmerican settlement has been associated with substantial changes to the East Fork Lewis River basin over the last approximately 150 years. Many physical changes to the hydrology, sediment supply and transport characteristics, floodplains, and stream channels have occurred, as have other direct and indirect impacts to fish and their habitat. The changes are summarized by category below, in no particular order of importance.

3.3.1.2 Fire

Vegetation patterns within the upper watershed have been shaped by fire. The Yacolt burn of 1902 covered an estimated 239,000 acres, including much of the upper East Fork Lewis River basin (USFS 1995). Subsequent burns in 1927 and 1929 destroyed much of the younger forest vegetation that was revegetating the 1902 burn (USFS 1995). As a result, most of the watershed is covered by young, even-age stands, and shrub/forb seral stages still dominate on some of the ridges where the fires were hottest (USFS 1995). The fires of the early 1900s are believed to have been started by humans burning debris (USFS 1995). A recent analysis of aquatic habitat limiting factors mentions that the multiple fires in the East Fork Lewis River watershed have had significant impacts on the hydrology and the structure, composition, and age-class distribution of the plant communities as well as riparian and instream habitat (WCC 2000).

3.3.1.3 Mining

In the late 1890s, copper and gold associated with the Silver Star pluton were discovered near the headwaters of the East Fork Lewis River (USFS 1995). Several hundred mining claims were staked, and small mining communities such as Copper City and Texas Gulch were established (USFS 1995). The Yacolt burn of 1902, and subsequent fires, brought an abrupt halt to mining activities by destroying mine structures and the timber that provided a source of construction materials (USFS 1995). Mining activities in the area largely ceased during the depression of the 1930s, although there are approximately 300 active claims within the basin (USFS 1995).

3.3.1.4 Roads and Railroads

Road construction in the upper East Fork Lewis River basin began in the 1940s, primarily to support recreation and timber harvest (USFS 1995). The current road network has increased sediment delivery and the drainage density as a result of ditch runoff and direct delivery of fine sediment to stream channels (USFS 1995). Water quality also may be influenced by spills and runoff of hydrocarbons, other organic compounds, and metal pollutants from road surfaces. Impassable culverts may restrict access to tributaries by spawning fish and migrating juveniles. Several roads in the upper East Fork Lewis River basin have been constructed directly adjacent to stream channels, permanently reducing inputs of large woody debris.

3.3.1.5 Logging

Because of the extensive fires in the early 1900s, vegetation within the upper East Fork Lewis River basin is composed primarily of early- to mid-successional conifer stands, and hardwoods. As a result, little timber harvesting has occurred within the upper watershed. Timber harvest activities are expected to increase in the future as timber in the existing stands matures. Twenty percent of the land in the upper East Fork Lewis River basin is within the Gifford Pinchot National Forest. Other major landowners in the upper basin include the state of Washington and large private timber companies (Hutton 1995b).

3.3.2 Lower Watershed

The ability of a stream to move sediment depends on the transport capacity, which is a function of discharge and slope. Sediment carried by the stream deposits in reaches where the stream gradient decreases abruptly. Floodplains composed of alluvial deposits typically form where rivers emerge from mountainous terrain onto more gently sloping lowlands. Floodplains are often bordered by slightly steeper alluvial fans that form where smaller tributary streams emerge from the valley sideslopes, and deposit their own sediment before flowing across the floodplain to join the mainstem river.

3.3.2.1 Floodplain and Channel Migration Zone

There are a number of ways to describe a floodplain bordering a mainstem river or an area within which a river is likely to move (see Technical Appendix C, Section 8.3 for a more detailed discussion). In general, one first needs to define a time period. The **hydrologic floodplain** is defined by a relatively short interval between flood events, and includes the land adjacent to the baseflow channel that is inundated in about two years out of three (USDA 1998). For the purposes of this HCP, the hydrologic floodplain along the East Fork Lewis River is mapped as the area inundated by the 2-year flow event, or within 80 feet (2 times the average lateral migration rate of approximately 40 feet per year) of the existing low-flow channel, whichever is less (Figure 3-30).

The **channel migration zone** (CMZ) is defined as the area that the river has recently occupied (in the last few years or decades) and would reasonably be expected to occupy again in the near future (i.e., over a period of decades) (WFPB 1997). The zone within which the active channel migrates is also termed the "meander belt" (Kondolf et al. 2002). For the purpose of this HCP, the CMZ is mapped as the area inundated by the 20-year flow event, or within 800 feet (20 times the average lateral migration rate of approximately 40 feet per year) of the existing low-flow channel, whichever is less (Figure 3-30).

As discussed previously in Section 2.9.1, a **100-year floodplain** is the area along a river that has a 1 percent chance of flooding each year. As can be seen by comparing Figures 3-30 and 3-28, the CMZ or 20-year floodplain is somewhat smaller than the recently revised FEMA 100-year floodplain along the East Fork Lewis River. The most substantial differences between the two floodplain boundaries are in the area east of existing Pond 1 and north of Bennett Road. The CMZ does not include ineffective backwater areas such as the Daybreak ponds or intermittent overflow paths that cross roads or other anthropogenic developments, which can reasonably be assumed to be maintained indefinitely into the future and limit the CMZ. There are no topographic or development features that would potentially divert the river beyond the CMZ, as defined here.

On a much longer time frame, the **geomorphic floodplain** refers to the landforms constructed by the existing flow network over geologic time, and includes the alluvial valley bottom and alluvial fans formed by lateral tributaries. The geomorphic floodplain does not include high terraces formed by glaciation or by the Lake Missoula outburst floods, even where they are directly adjacent to the existing channel. Although all land within the geomorphic floodplain may be considered over geologic time to be at risk to channel migration and avulsion, only a portion of the geomorphic floodplain is at significant risk over time scales relevant to land-use planning.

One final concept that is often used to describe floodplain features is the **topographic floodplain**. The topographic floodplain includes land adjacent to the channel up to the elevation reached by a flood-peak with a given return frequency, for example the 100-year floodplain (USDA 1998). This is essentially a regulatory concept used to assess the potential risk of damage to structures erected by humans, much as the hydrologic floodplain and CMZ are used to rate the risk of channel avulsion for this HCP (a channel avulsion is a rapid and unexpected shift in channel position that causes a portion of the existing channel to be abandoned). The 100-year and 500-year floodplains are commonly used in the development of land-use planning and regulation standards (USDA 1998). A discussion of the FEMA 100-year floodplain in the vicinity of the Daybreak site is found in Chapter 2.

Figure 3-30. Two- and 20-year floodplain used to define the limits of the hydrologic floodplain and channel migration zone in the vicinity of the Daybreak site.

3.3.2.2 Channel Migration and Avulsion

Historically, the East Fork Lewis River has been an actively migrating channel. Over geologic time, the channel has migrated from valley wall to valley wall in the reach encompassing the Ridgefield Pits, Daybreak ponds, and project site. In the recent past, the channel has tended to stay along the south valley wall. Historic maps and photographs show that the channel has migrated and shifted position several times along this reach. In the 1854-era maps, the channel is documented to have had a braided channel pattern (Figure 3-5), and was bordered by riparian wetlands along most of the lower 13 miles (Collins 1997). Due to the limitations of historic data, for most of the period of record, it is not known where avulsions, if any, took place. However, it is certain that significant channel shifting and abandonment have occurred. These avulsions were probably due to obstruction of the flow by debris jams, or by the breaching of a natural levee that separated the river channel from a topographic low, such as a former channel.

Channel migration and avulsion on the East Fork Lewis River are important processes for creating off-channel and riparian habitat in riverine ecosystems. Secondary and relict channels provide habitat that are protected from high velocities and are rich in invertebrate food and function as important rearing areas for juvenile salmonids. Erosion and sediment deposition that accompany channel migration and avulsion are important for colonization by riparian plant species and necessary for creating a mosaic of early to late successional stages of riparian vegetation.

In recent years, two instances of avulsion on the East Fork Lewis River have been documented. Each of the documented avulsions is associated with the migration of a river meander into abandoned gravel pits that were in close proximity to the main river channel. The first documented avulsion involved the Mile 9 Pit in November 1995. The Mile 9 Pit is located approximately one-half mile upstream of the Ridgefield Pits (Figure 3-4). This event caused the channel to shift to the south, abandoning approximately 1,700 feet of channel (Norman et al. 1998). The second documented avulsion involved the Ridgefield Pits in November 1996. The channel avulsed into the southeastern corner of the southern Ridgefield Pit 1. This changed the course of the river, which was formerly flowing to the north along the southern boundary of the Daybreak site. After the avulsion, the channel flowed through a complex of six deep pools formed by former ponds (Figure 3-4) and approximately 3,200 feet of channel was abandoned (Norman et al. 1998). Since this time, the upper two pools have filled significantly with deposited sand and gravel, and the upper approximately 900 feet of the avulsed reach has naturally reclaimed to a shallow riffle with a connected off-channel pool (Figures 3-31 and 3-32).

Other minor avulsions or pit breaches were documented from examination of historic maps and aerial photos. Sometime between 1984 and 1990 the river migrated into the northeastern Ridgefield Pit 8. Although this did not cause the channel to change course, a connection was created between the pit and the main channel. Between 1990 and 1995, the river broke into the southeast corner of the northwest Ridgefield Pit 7, flowing back into the channel at its northern-most point. This caused the abandonment of approximately 1,500 feet of channel located south of the Daybreak site. However, the majority of the former channel remained submerged and connected to the main channel.

By strict definition, neither the avulsion into the Mile 9 Pit nor the Ridgefield Pits, was an "unexpected" shift in channel position. In both cases a meander of the river migrated toward the pits over a period of time. In fact, the river's migration into the Ridgefield Pits was predicted several years in advance (Bradley 1996). The historic migration path of the river had been documented to be in the direction of the Ridgefield Pits for a period of over 60 years.

3.3.2.3 Potential for Gravel Pond Capture

Because avulsions are triggered by unpredictable, random events such as log jams, landslides, large floods, or upstream changes in river position, it is not possible to predict when or if an avulsion will definitely occur (Shannon & Wilson 1991). However, the relative risk of one location along the river versus another can be qualitatively evaluated to determine the potential locations of future avulsions. An evaluation of the avulsion potential in the vicinity of the Daybreak site was conducted based on available information and historic trends (Technical Appendix C). This analysis does not imply that an avulsion will definitely take place at the indicated locations in the future, but rather suggests if an avulsion were to occur, the indicted sites are the most likely locations.

Daybreak Bridge (RM 10) to North Mill Creek (RM 9.2). The planform analysis demonstrated that the river channel within this reach has moved very little in the 145 years since the survey of 1854/1858. The channel profile is relatively steep and shows only minor changes in bed elevation except at the confluence with North Mill Creek. Aggradation within this reach could cause increased lateral migration. However, no obvious alternative flow paths exist that would allow the river channel to connect to the Daybreak site.

Figure 3-31. Naturally reclaimed riffle habitat on July 31, 2001, at the site of the historical 1996 avulsion into Ridgefield Pit 1 on the East Fork Lewis River. The pool, which remains, is to the right of the photo behind the new channel bank.

Figure 3-32. Panoramic view of Ridgefield Pit 1 on July 31, 2001, which has reverted to off-channel habitat after five years of natural deposition. The main channel of the East Fork Lewis River is behind the viewer.

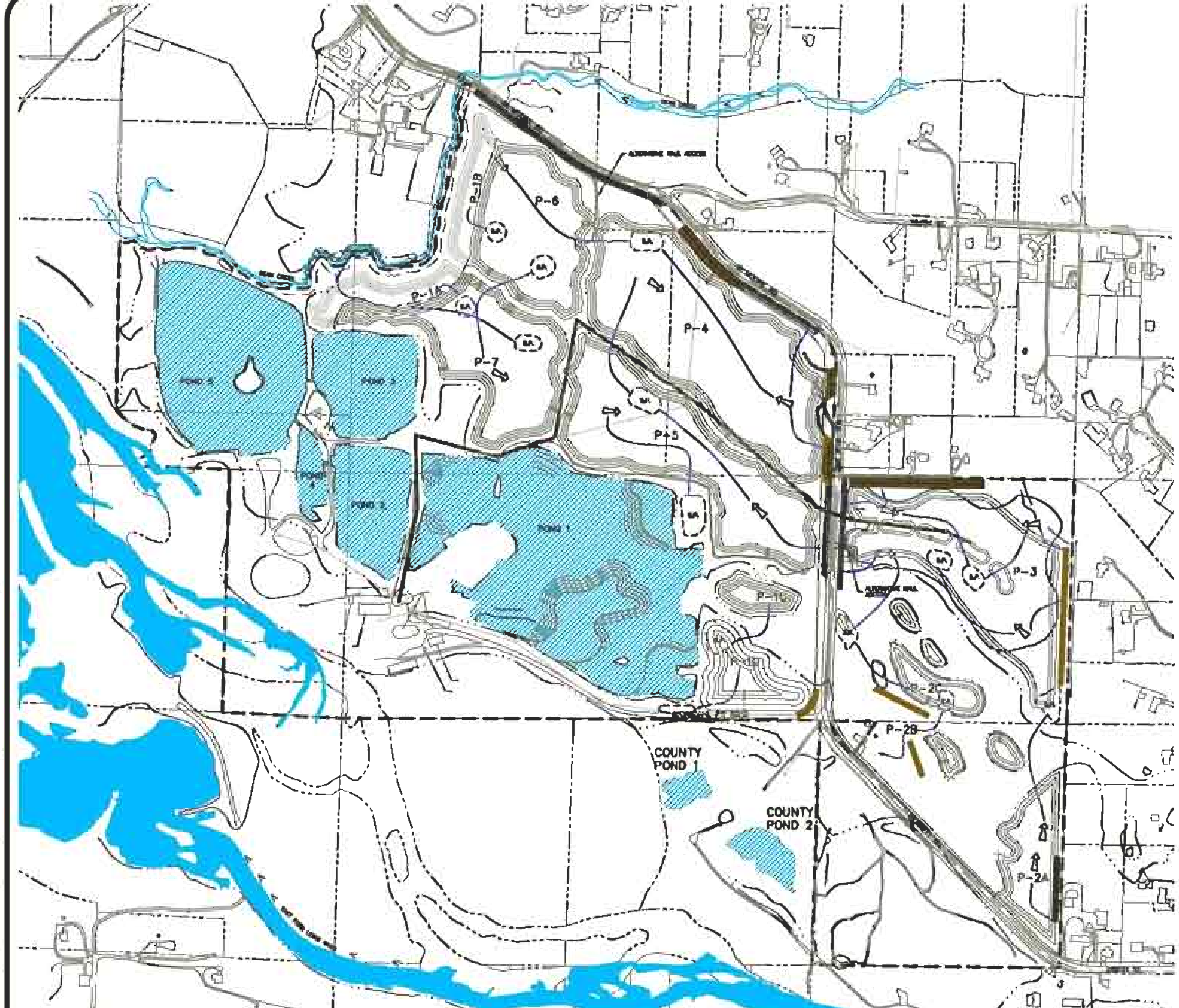
Minor overland flows may occur to the north of the river between Sites A and B along this reach during major floods (Figure 3-33). Following expansion of the Daybreak Mine, the flow could enter the Phase 2 wetlands and/or Phase 3 pond (Figure 3-34) and cause head cutting similar to that which occurred in the existing Daybreak Pond 1 during the 1996 flood. However, the existence of residential development and county roads (NE 269th St., Bennett Rd. and NW 61st Ave.) effectively prohibit the shifting of the channel to the north of its current and historic locations, and prevent any future avulsion into the Daybreak site along this route; thus, this flow path is effectively outside of the CMZ. Additionally, the overland flow that occurs along this path has relatively minor erosive capability. Although flood waters may flow along this path, this is not considered to be a potential avulsion site.

North Mill Creek (RM 9.2) to Ridgefield Pits Entrance (RM 8.3). The planform analysis indicates that the channel has had a trend of northward migration in the upstream portion of this reach in the recent past (Technical Appendix C). The slope upstream of the Mile 9 Pit is slightly lower than the slope upstream of RM 10, causing increased sediment deposition. Recent field investigations have shown that the channel continues to deposit material on a point bar located on the south side of the main channel. The buildup of sediment on this point bar is causing erosion along the opposite bank at Site C. From recent field investigations, it is estimated that the river channel has migrated approximately 200 feet to the north at Site C since 1996. Headcutting caused by the capture of the Mile 9 Pit in 1995 does not appear to have caused the channel to incise upstream or to have reduced the rate of deposition and lateral migration along this reach. The East Fork Lewis River is expected to continue its northward migration at this location.

Downstream of the Mile 9 Pit, the south bank of the river is confined by the Pleistocene terrace and the underlying lower member of the Troutdale formation. Periodic undercutting and erosion have recently reactivated mass wasting in this area and have accelerated the rate of erosion and undercutting in the fine-grained lower Troutdale unit.

The 1854-era map (Collins 1997) shows a former channel that flows to the west and northwest at approximately RM 9 (Figure 3-5). The abandoned county gravel pits (County 1 and County 2) were excavated from within this former channel. In the vicinity of the county pits, the 1854 channel splits again to the west and northwest. The westerly path flows along a relict meander bend located just south of the Storedahl Pit Road, and modeling indicates it is currently within the hydrologic floodplain and CMZ (Figure 3-33). The northwesterly path was directed toward Pond 1 and is no longer detectable on the ground outside of the CMZ.

Figure 3-33. Composite aerial photo of East Fork Lewis River near Daybreak mining operations showing overflow path and potential paths of future avulsions.



LEGEND:

P-1A	MINING PHASE AND DIRECTION OF MINING.
	SITE BOUNDARY
	DEAN CREEK SETBACK
	DIRECTION OF OVERBURDEN STRIPPING AND STOCK PILING
S.P.	TOPSOIL AND REJECT STOCK PILE AREAS.
	APPROXIMATE CONVEYOR ALIGNMENT
	EXISTING DRIVEWAYS TO BE USED FOR ACCESS
	10–15 FOOT HIGH NOISE REDUCTION EARTHEN BERM
	5–10 FOOT HIGH NOISE REDUCTION EARTHEN BERM
	SOUND WALL
	VISUAL BUFFER (5 FOOT TALL EARTHEN BERM OR VEGETATED ZONE)

NOTES:

1. CONSTRUCTED BERM WIDTH IS PROPORTIONAL TO HEIGHT ASSUMING A 2:1 SLOPE AND A 5 FOOT WIDE LEVEL CAP. 5 FOOT TALL BERMS ARE 25 FEET WIDE. 10 FOOT TALL BERMS ARE 45 FEET WIDE.
2. BERMS FOR NOISE AND VISUAL BUFFERS ARE TEMPORARY. BERM MATERIAL WILL BE USED TO CONSTRUCT RECLAMATION ELEMENTS AFTER MINING IS COMPLETE IN THE ADJACENT PHASE.
3. SECURITY FENCES WILL BE INSTALLED ALONG ROADWAYS AT THE DISCRETION OF STOREDAHL.
4. MINIMUM MINE SETBACK FROM PROPERTY BOUNDARY IS 15 FEET. SETBACK FROM COUNTY ROADS IS FUNCTION OF BERM WIDTH. SETBACK FROM DEAN CREEK IS 75 FEET FROM OHWM.
5. CONVEYOR ALIGNMENT IS APPROXIMATE. FINAL ALIGNMENT OF CONVEYOR SEGMENTS WILL BE DETERMINED DURING MINING. FINAL MINING, GRADING, AND RECLAMATION OF PONDS ALONG CONVEYOR ALIGNMENT WILL OCCUR AFTER CONVEYOR IS DISMANTLED.
6. BERM HEIGHTS BASED ON USE OF KOMATSSU PC650 EXCAVATOR. USE OF QUIETER EXCAVATOR COULD REDUCE BERM HEIGHT.
7. SCREENED CONTOURS REPRESENT PHASE-1 RECLAIMED MINE CUT.

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the group
EMCON/OWT Solid Waste Services

DATE 4/02
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REV
PROJECT NO. 793584

FIGURE 3–34
J.L. STOREDAHL & SONS, INC.,
CLARK COUNTY, WASHINGTON
HABITAT CONSERVATION PLAN
EXPANSION OF THE DAYBREAK MINE
AND MINING SEQUENCE PLAN

If the East Fork Lewis River continues to migrate north and captures the abandoned county pits at Site D, the new preferred flow path would most likely be from Site D to Site F (Figure 3-33), as the slope between these points is relatively steep. However, it is also possible that a significant proportion of the flow could be routed through the relict meander just south of the Storedahl Pit Road between Site D and Site H (Figure 3-33). If this relict meander were to begin to consistently transmit a large proportion of normal flood flows, the risk of an avulsion into the Daybreak site along the Storedahl Pit Road would increase.

Another potential avulsion path is the meander bend abandoned in 1995 that contains Site F (Figure 3-33). Further sediment deposition in the Mile 9 Pit could cause the channel to shift back to the north through this meander. However, the recent movement of the river into the Ridgefield Pits has substantially increased the slope of the channel between Sites C and I. Sediment that would otherwise deposit in this section of channel is now carried downstream and deposited in the Ridgefield Pits. The potential for northward migration of the channel in this reach of the East Fork Lewis River has been significantly reduced by the capture of the Ridgefield Pits, and is not expected to increase until the Ridgefield Pits fill, which could take decades (Technical Appendix C).

Ridgefield Pits Entrance (RM 8.3) to Ridgefield Pits Exit (RM 7.6). The avulsion of the East Fork Lewis River into the Ridgefield Pits in 1996 effectively reduced the risk of avulsion into the Daybreak site at Sites H and J in the near future. The abandoned channel between Sites I and J remains within the CMZ. However, at Site H, the Daybreak ponds are separated from the baseflow channel by approximately 425 feet of land, thus the path from Site H to the Daybreak ponds is considered to be outside of the CMZ under existing conditions.

The potential avulsion path between Site J and Pond 5 is within the CMZ. Although a breach into Pond 5 could occur at Site J, the East Fork Lewis River would not avulse through the other ponds since that would require upgradient flow. It is most probable that the river would form a connection with Pond 5 similar to the former connections of Ridgefield Pits 7 and 8 with the former river channel.

3.3.2.4 Ability to Mobilize Existing Bank and Levee Sediments

The bank material in the vicinity of the Daybreak site is sediment that was previously deposited by the river as it migrated back and forth along the valley bottom. These unconsolidated sediments are easily eroded by the river. The bank material is more vulnerable to erosion along the outside of meander bends. It should be noted that the "levees" between ponds and between the ponds and the river were not constructed by adding material along the riverbanks, but rather are remnants of the former land surface. Therefore, the levee sediments are comprised of the same sediments as the bank sediments and, as such, have the same erosion potential. Trees and other vegetation located along the riverbanks provide some resistance to erosion, although field observations suggest that the river can effectively undermine trees and transport them downstream. The existence of vegetation can influence the direction and extent of river migration. Log jams are known to be significant influences on the geomorphology of rivers in Washington State (Abbe and Montgomery 1996).

3.3.2.5 Anthropogenic Influences

Floodplain function and habitats in many Pacific Northwest rivers, including the East Fork Lewis River, have been dramatically altered by human activity. Human use of the floodplain generally takes political and social priority over the benefits of channel migration, thus even natural migrations are generally considered undesirable and are often prevented (Golder and Associates 1998). In 1854, nearly the entire valley bottom between RM 6 and RM 10 was described as wetlands, and the upstream portion of the reach included an extensive system of channel braids (Collins 1997). By 1937, the mainstem was a single-thread channel, and all that remained of the former channel braids was a system of floodplain sloughs (Collins 1997). Conversion of the channel from braided to a single thread morphology has substantially reduced the complexity of habitat and largely eliminated side-channel and backwater habitats (Norman et al. 1998), while providing agricultural and development property.

Gravel Mining

Commercial floodplain gravel mining commenced in about 1940 in most Washington river basins (Collins 1997). Mines were developed in abandoned channels of the formerly braided system along both sides of the river. Gravel was also taken from within the active river channel during summer low flows. Gravel mine ponds now cover approximately 200 acres of the East Fork Lewis River valley bottom between RM 6 and 10 (Norman et al. 1998).

Since 1935, channel migration in the vicinity of RM 8 has largely been restricted to a several hundred foot wide band, although one large meander bend located just south of the Daybreak site abandoned its former course and shifted over 1,000 feet to the south between 1935 and 1963 (Bradley 1996). In 1996, the channel eroded an embankment between the river and two old gravel pits southeast of the Daybreak site, forming a new channel with a bed elevation that was several feet lower than the old channel (Bradley 1996). Immediately prior to the avulsion, the secondary channel abandoned between 1935 and 1963 was noted to be flowing full (Bradley 1996). In November 1996, the river avulsed through six gravel ponds at the Ridgefield site, southwest of the Daybreak site. It was estimated that more than 2 million cubic yards of material is required to refill those ponds (Norman et al. 1998). However, mass wasting of high stream adjacent bluffs just upstream of the Ridgefield site and near Daybreak Park (noted during reconnaissance surveys conducted in August 1999) suggests that the pits may be filling more rapidly than expected. Failure of these bluffs was observed to be contributing large amounts of fine sediments to the river during recent high flow events, and depths in the Ridgefield Pits are currently less than 15 feet, with a substrate composed primarily of sand and clay, overlain by gravel in the upper portion of the reach. Until the Ridgefield Pits refill, the likelihood of the channel migrating from this site towards the Daybreak site remains low.

Agriculture

By 1951, most of the valley bottom had been cleared, drained, and leveled for farming. Conversion of the floodplain to agricultural land has impacted aquatic habitat in a number of ways including: 1) disconnection of side-channel habitat; 2) destabilization of stream banks by livestock; 3) runoff of fertilizer, pesticides, and fecal coliform bacteria into the river; and 4) altering of the temperature regime by preclusion of riparian succession.

Rural residential development

Expanding populations in nearby cities such as Portland and Vancouver have resulted in conversion of farmland and wetlands into low-density residential area. Primary effects of residential development on river ecosystems include: 1) changes in the flow regime; 2) water quality degradation through sewage discharge and septic tank seepage, spills of pollutants, and runoff over fertilized surfaces; 3) increased fishing pressure as the population expands; 4) filling of wetlands and drainage channels for development; and 5) removal of riparian vegetation that may lead to increased summer water temperatures, reduction in LWD recruitment, increased potential for streambank erosion, reduced allochthonous inputs, and alterations to other important geomorphic and biological functions. Pollutants associated with residential development that influence water quality include petrochemicals and related byproducts, herbicides and pesticides, other organic compounds, and nutrients.

Development of low density residential areas has increased dramatically in recent years. Growth continued gradually throughout the region, but in the 1970s growth in the region accelerated greatly; the population of Clark County increased by 154 percent between 1960 and 1990 (Hutton 1995b). Today, the majority of the population is concentrated in the western two-thirds of the basin.

3.4 STRUCTURAL SETTING

The existing structural setting for the Daybreak Mine is associated with mining, which dates from 1968 and possibly earlier. Previous excavations and active gravel processing facilities comprise the major existing structural features at the Daybreak site. Expansion of the mine will result in reclamation of the existing ponds, additional areas of excavation, increased amount of wetlands, and changes in the existing processing facilities. The Daybreak site property boundaries include approximately 300 acres.

3.4.1 Daybreak Mine – Existing Conditions

Gravel mining and processing has occurred intermittently on over 80 acres of the Daybreak site, resulting in the excavation of five ponds, which contain approximately 64 acres of open water. None of the existing ponds are currently being mined, but previous operators, as well as Storedahl, have mined and/or imported materials for processing for the past several decades at the site. The maximum water depths in the ponds range from approximately 11 feet in Pond 1 to greater than 20 feet in Pond 5 (Figure 3-10). Pond 1 is used for primary settling of recycled process wash water during wet processing, and as a result has become shallower and has developed an interspersion of wetland vegetation and open water. Only Pond 5 has a surface water discharge, which has been historically covered by NPDES general permit WAG-50-1359 and is described in Section 3.1.4.1.

There is an active gravel-processing area (approximately 23 acres) on the site that currently processes material imported from off-site. The processing area includes Storedahl Pit Road, storage areas for excavation equipment, aggregate processing equipment (pumps, classifier, process water treatment system, electrical systems and transformers, etc.), processed sand and gravel stockpiles, fuel storage, parking areas, temporary haul roads, an office, scales, and a maintenance shop. Processing requires the transfer of a portable screening and crushing machine to the site. This equipment is moved to the site intermittently, in response to market demand and the available stockpiled reserves at the site. Since 1987, when Storedahl began operations at the site, processing periods at the site have ranged from 4 to 10 months in duration.

On-site buildings consist of a vehicle and equipment repair shop and an office/scalehouse. The shop is constructed of metal frame and wood siding, has a floor area of 3,200 square feet, and is used for maintaining and repairing equipment and vehicles. The office is a mobile commercial coach constructed of wood frame and siding, with a floor area of approximately 384 square feet. The site is served by a well and septic system. Employee vehicle parking is located just south and west of the office and shop.

Existing roads within and adjacent to the Daybreak site include a public road along the northern perimeter (J. A. Moore Road) that continues as NE 61st Avenue and Bennett Road, crossing the Daybreak site toward its eastern side. The Storedahl Pit Road, a private, asphalt-surface road, enters the site off NE 61st Avenue.

3.4.2 Daybreak Mine – Expansion Area/Site Plan

Expansion of the Daybreak Mine will occur on approximately 178 acres of land to the north and east of the existing ponds, with gravel extraction from approximately 101 acres outside the 100-year floodplain and CMZ (Figure 3-34). The equipment proposed for excavation is capable of reaching 30 feet below the water table. However, based on drilling logs, excavation of sand and gravel would create ponds anticipated to have an average depth of 25 to 35 feet below the original ground surface. Final configuration of the reclaimed excavated areas will include a variety of habitat enhancement features, which are described in detail in Chapter 4.

The existing processing facilities and equipment will continue to operate intermittently, in response to market demand and available product reserves, when mining resumes at the site. Conveyors will be utilized for efficient loading and transport of gravel to the processing area. Approximate conveyor alignments are shown in Figure 3-34. Where necessary, temporary haul roads will be constructed to move gravel from the mining area to the conveyor loading area. Alternatively, if permits are not issued for the use of conveyors, gravel will be trucked over temporary on-site and existing county roads to the processing area. If temporary haul roads are required to be constructed within the 100-year floodplain, appropriate shoreline permits will be obtained as necessary.

A conveyor crossing NE 61st Avenue will be used for delivery of materials from Phases 2 and 3 to the processing area (see Section 3.3 and Figure 3-34 for description of phased mining). If the conveyor crossing is not permitted by the county, then gravel from Phases 2 and 3 will be trucked over on-site and existing county roads to the conveyor or processing area. Trucks would use existing driveways for access to and from the areas being mined. Gravel from Phases 1C and 1D will be trucked to the processing area over temporary haul roads and the Storedahl Pit Road. Where necessary, haul roads will be constructed and graded to minimize erosion and other impacts.

Setbacks and buffers will be created for noise control, visual screening, environmental protection, and security. A setback is defined here as the distance between the edge of a mine excavation and the property line. No excavation will occur in the setback. A buffer is defined here as a constructed feature that minimizes the impact of mining on the surrounding areas. For this project, buffers are either vegetated strips of land designed to protect sensitive areas such as streams, or constructed, vegetated berms that serve as visual or noise screens. Neither Clark County codes nor state and federal surface mining laws specify permanent setbacks in the permit area. However, the width of the setback will minimize possible adverse environmental impacts, particularly for adjacent properties, and meet the practical requirements of mining, such as equipment maneuvering. Buffers will be maintained for purposes of acoustical, visual, and security screens between the project site and neighboring properties. In some areas (e.g., along Dean Creek), the buffers, when vegetated, will enhance natural riparian function and will provide wildlife habitat.

3.4.3 Ridgefield Pits

In addition to the existing five ponds on the Daybreak site, previous gravel mining directly to the south of the Daybreak site also created several deep ponds (Figure 3-4). This area, known as the Ridgefield Pits, was mined by a number of operators, dating back to at least 1971. The East Fork Lewis River now flows through these pools, as described in Section 3.3.

3.5 OPERATIONAL SETTING

Existing operations on the Daybreak site are limited to processing of gravel transported from off-site. Future operations include a detailed mining and processing plan, which is summarized here.

3.5.1 Aggregate Processing – Existing

Since May 2001, aggregate processing on the site has not included washing and there has been no discharge of process wash water to the ponds. Typically, water for processing is pumped from the existing Pond 2 and recycled through Pond 1 for primary settling with overflow to Pond 2 for reuse. Both wet and dry aggregate processing currently utilizes material imported from off-site. Aggregate processing is conducted as a pre-existing, nonconforming use. After processing, the sand and rock is stockpiled before being loaded and trucked to customers.

3.5.2 Mining Plan/Operation – Future

The expanded Daybreak Mine will operate as an open excavation. Surface overburden will be removed using dozers or pan scrapers before recoverable deposits are excavated. Overburden will be segregated into two categories: high-grade topsoil, and culled (reject) aggregate material not suitable for processing and sale. Overburden materials will be stockpiled for later use in the reclamation part of the project. Stockpiling will occur on-site outside of the 100-year floodplain.

After overburden is removed from a working area, aggregate will be excavated from designated areas using a trackhoe excavator and/or a dragline. Gravel will be excavated to a typical final depth of approximately 30 feet below the working bench elevation (typical total excavation depths ranging from 31 to 38 feet below the original ground surface). The water table at the site ranges from approximately 2 to 12 feet below the ground. Therefore, much of the mine excavation will be below the water table, resulting in the formation of the series of ponds of varying depths. Past experience, known gravel reserve depths, and practical constraints indicate that mining depths will likely be limited to approximately 30 feet below the water table. Mining will progress in phases as depicted on Figure 3-34. The proposed mining sequence is described in Section 3.5.4. The approximate final grading plan for the mine excavations is shown on Figure 3-35 (see map pocket). Reclamation features shown on the drawing are discussed in Chapter 4.

Mine cutslopes above the seasonal low water table will be approximately 2 feet horizontal to 1 foot vertical (2:1), and cutslopes below the water table will be approximately 1.5:1. Previous mining operations at the site have demonstrated that similar cutslopes are stable. The shallower slopes above the waterline are designed to allow egress and will be reduced even further in places (to 5:1 slopes) as part of the reclamation plan. Adjacent mined areas will be separated by native earthen material that is left in place and will have a minimum

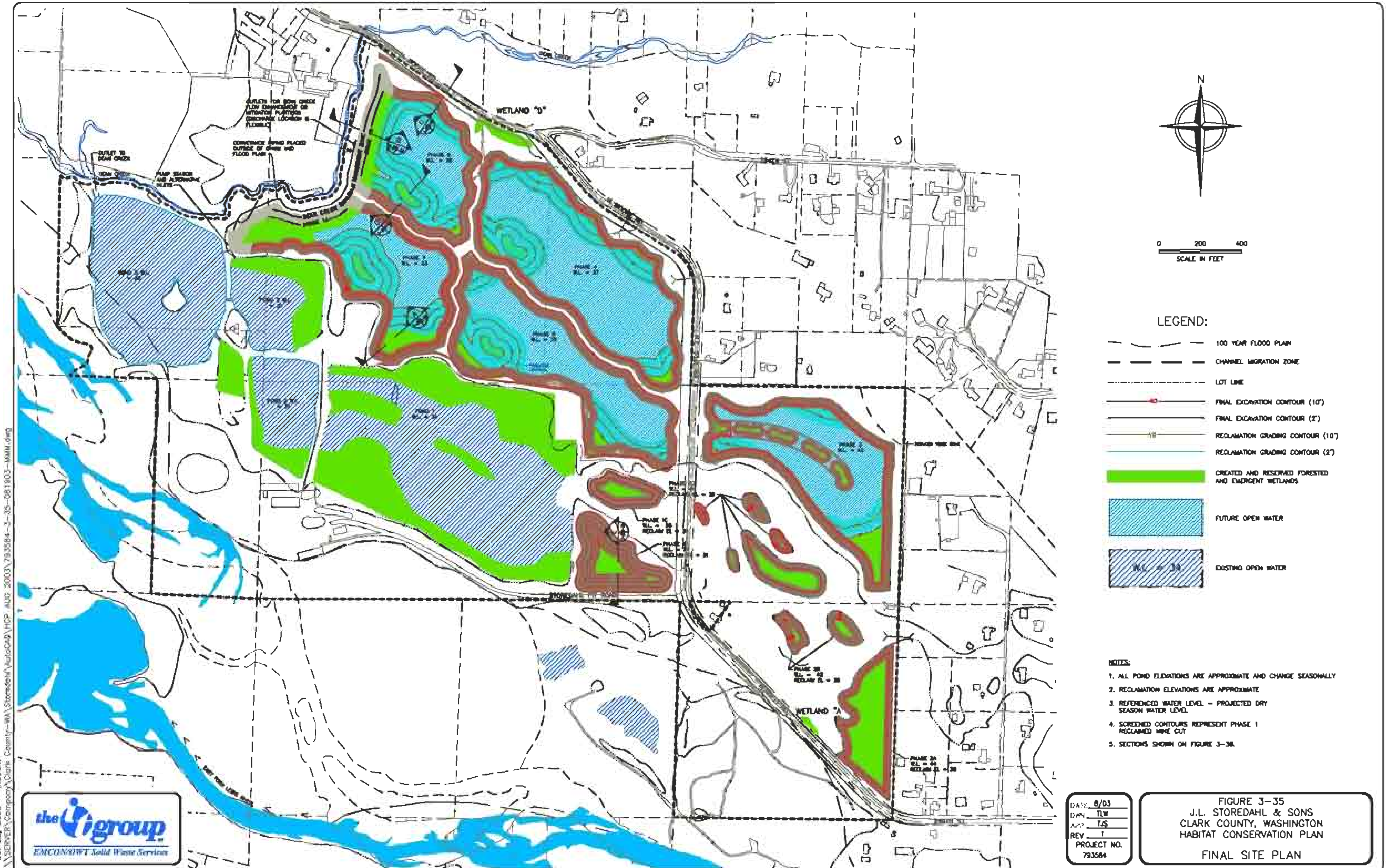


FIGURE 3-35
J.L. STOREDAHL & SONS
CLARK COUNTY, WASHINGTON
HABITAT CONSERVATION PLAN

FINAL SITE PLAN

width at the top of approximately 20 feet. Figure 3-36 shows typical cross-sections of the mine cutslopes. Reclamation features shown on the cross-sections are discussed in Chapter 4.

Mined materials will be temporarily stockpiled and preferably transported by truck or loader to a belt-and-roller conveyor. Alternatively, gravel may be trucked over temporary on-site haul areas and existing county roads to the processing area.

Existing on-site equipment will be used to process the gravel. The daily amount of aggregate processed will be similar to the amount processed with the existing operations. The future difference will be the source of the aggregate and the installation of an improved wash water treatment system. Within three years after issuance of the ITP, a closed-loop clarifier system will be installed, in which process water is recycled internally and process water is not released to the ponds. Flocculated sediments recovered from the process wash water will be used to create shallow water habitat in the reclaimed ponds.

3.5.3 Reclamation and Habitat Enhancement

Prior to the start of expanded mining activity, approximately eight (8) acres of existing forested land not proposed for mining will be preserved; 20 acres of active forest restoration will continue in the area south of Bennett Road; and about 53 acres of forest will be planted in areas not proposed for mining. An additional 24 acres of forested wetland and riparian habitat will be preserved south of the haul road and in the area south and west of the existing Pond 5. Areas that are mined will be sequentially reclaimed at the end of each mining phase. Following mining, approximately 33 acres will be reclaimed as valley-bottom forest in the area of the haul road and the processing area. An additional six (6) acres of forested wetland and riparian habitat will be created along Dean Creek. Approximately 22 acres of forested wetland will be created as the existing ponds 1 through 4 are narrowed and reclaimed. Along the edges of the new ponds, an additional 32 acres of emergent wetland will be created and somewhat less than one (1) acre of existing emergent wetland in the expanded mining area will be preserved. Following reclamation there will be approximately 64 acres of open water in the new ponds and 38 acres of open water in the reconfigured existing ponds. These activities will result in a total of approximately 114 acres of valley-bottom forest, 52 acres of forested wetland, 32 acres of emergent wetland, and 102 acres of open water on the 300-acre Daybreak site.

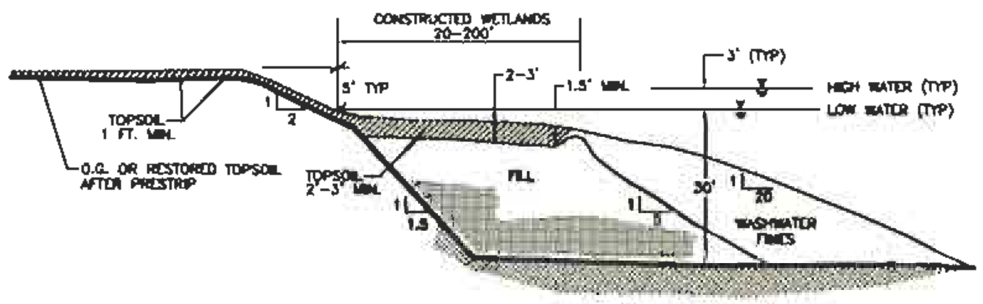
The typical sequence of reclamation activities will be as follows:

1. Remove temporary berms and buffers and move material stockpiles as needed for constructing reclamation features.
2. Use designated reject stockpiles to create the interior (geotechnically stable) cores of reclamation elements, such as islands and wetlands. Smooth and contour cutslopes to provide sinusoidal shorelines and acceptable slopes around ponds and wetlands.
3. Use fines recovered from the process water treatment system to create shallow water areas.
4. Construct hydraulic structures as required to route and control water flow through the pond system to meet water quality requirements and final-use objectives. In general, hydraulic connections between ponds will be managed to minimize the discharge of suspended solids to the receiving water.
5. Redistribute stockpiled topsoil to provide a root zone for reclamation plantings.
6. Plant and seed according to the reclamation revegetation plan.
7. Monitor and maintain reclamation elements and plantings, as required, to support the final use. If erosion or undesirable runoff patterns are detected, runoff will be redirected. If plantings do not develop adequately, the area will be reseeded or replanted.

Over the long-term, reclamation will enhance habitat and ecosystem functions for species covered under this HCP, as well as other native species. The habitat enhancements will incorporate the ponds created by gravel mining and the natural features of the project area. Enhancement elements in this plan include the following:

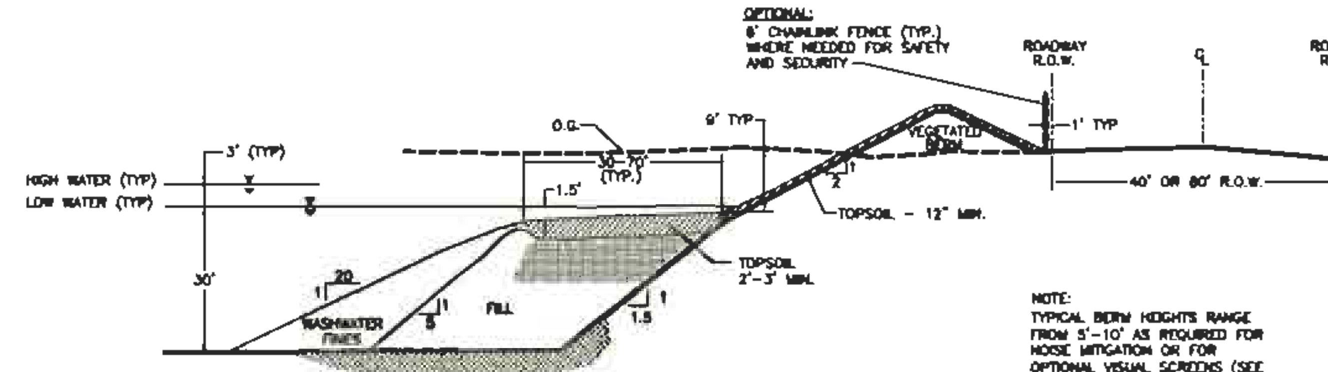
- ***Channel Improvements to Dean Creek.*** The habitat value of Dean Creek along the property has been substantially reduced from its natural state by sediment deposition, prior removal and continued lack of riparian vegetation, and livestock grazing and trampling. The proposed improvements will enhance instream, floodplain, and riparian habitat.

- ***Additional Wildlife Habitat.*** Expanded amounts of valley-bottom forest and aquatic and wetland habitat will increase the value of the Daybreak site for waterfowl, shorebirds, amphibians, and terrestrial wildlife. The existing pastureland on the site is largely homogeneous, with few landscape features, and has low habitat value for wildlife.



CUTSLOPE AND
CONSTRUCTED WETLANDS

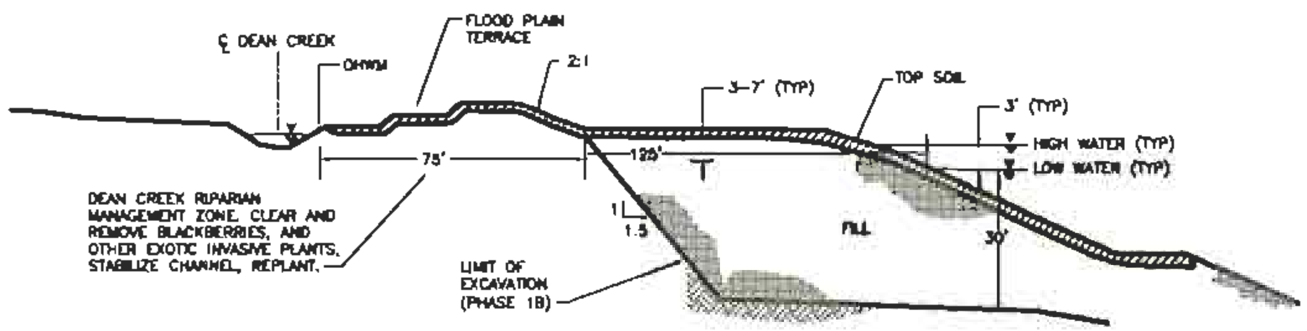
SECTION A
SCALE: NTS



NOTE:
TYPICAL BERM HEIGHTS RANGE FROM 5'–10' AS REQUIRED FOR NOISE MITIGATION OR FOR OPTIONAL VISUAL SCREENS (SEE SITE PLAN). BERMS WILL BE REMOVED DURING FINAL GRADING AND INCORPORATED INTO RECLAMATION ELEMENTS.

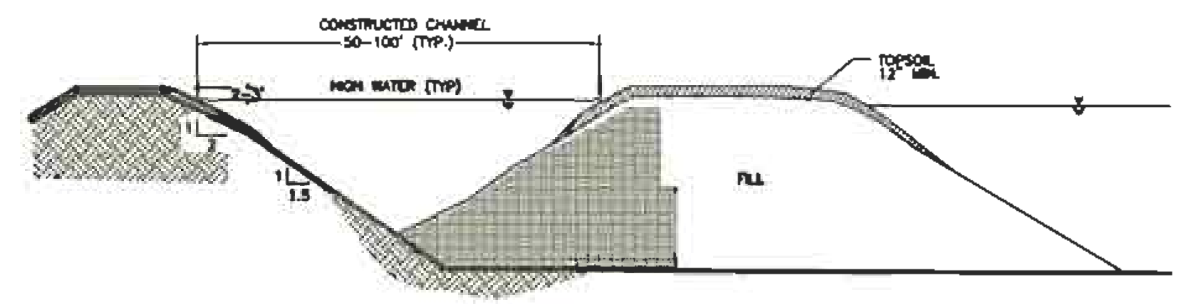
ROADWAY BUFFER AND
CONSTRUCTED WETLANDS

SECTION C
SCALE: NTS



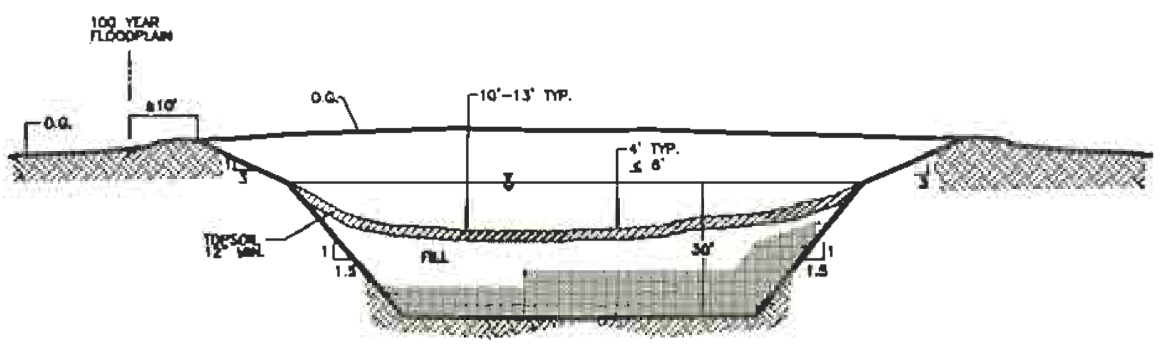
DEAN CREEK SECTION (TYP.)

SECTION B
SCALE: NTS



CONSTRUCTED ISLAND

SECTION D
SCALE: NTS



MINE & RECLAMATION

SECTION E
SCALE: NTS

LEGEND:

- NATIVE OR EXISTING MATERIAL
- FILL (IMPORTED AND/OR MINING REJECT)
- FILL (TOPSOIL)
- OHWM — ORDINARY HIGH WATER MARK
- O.G. — ORIGINAL GROUND

NOTES:

1. SEE FIGURE 3–35 FOR SECTION LOCATIONS.
2. FILL IS FINE-TEXTURED SOILS FROM IMPORT AND/OR EXCAVATIONS.

the group
EMCON/OWT Solid Waste Services

DATE	8/03
DWN	TLW
APP	TJS
REV	1
PROJECT NO.	793584

FIGURE 3–36
J.L. STOREDAHL & SONS
CLARK COUNTY, WASHINGTON
HABITAT CONSERVATION PLAN

RECLAMATION SECTIONS

Aug 29, 2003 – 3:50pm

- ***Off-Channel Ponds and Wetlands.*** Off-channel habitat has been identified as a limiting factor for salmonids in the East Fork Lewis River (WCC 2000). If the limnological conditions and species composition in one or more ponds are suitable, these ponds could be developed to provide protected, food-rich habitat for salmon or steelhead juveniles, or both. Although not included as a conservation measure in this HCP, the use of one or more ponds as off-channel habitat is an option for implementation in the future should they be determined to be beneficial during the adaptive management of the property.

- ***Increased Buffer Widths and Narrowing of Ponds.*** The existing Daybreak ponds will be substantially altered to minimize the potential for an avulsion and to avoid or minimize potential adverse impacts if an avulsion were to occur.

Detailed descriptions of habitat enhancement measures are presented in Chapter 4.

3.5.4 Mining Sequence

Mining would progress in phases, with reclamation and habitat enhancement implemented sequentially on each phase (Figure 3-25). Seven mining phases are planned, each expected to have a life span of approximately one to three years. The expected life of the project depends on market demand for aggregate products and the rate at which different areas of the site are mined and subsequently reclaimed. Based on current and projected demand for the aggregate products, the expected life of the project ranges from 10 to 15 years.

The expanded mining would be conducted in a sequence designed to minimize impact to neighboring property owners and to expedite selected conservation and enhancement measures. Reclamation measures deemed important to minimizing avulsion risks, habitat enhancement, and aesthetics will be conducted first. The approximate time frame of mining and reclamation is summarized below. The actual time to complete mining would depend on the processing capacity of the plant and the market demand.

- Narrowing and shallowing of the existing Daybreak ponds 1, 2, 3, and 4 would begin in the first year as part of the effort to reduce the risk of avulsion.

- Noise attenuation berms, sound walls, and visual buffers would be established in the first year, along with planting of all areas not planned for mining. Phases 1 and 2 would be mined during the first one to three years of the project, and the associated wetland and riparian areas would be established as part of sequential reclamation. Wetland areas near the entrance road would also be established early.

- Phases 1A and 1B will be excavated and reclaimed early in the mining program to establish the riparian management zone along Dean Creek. The riparian management zone would be created to establish riparian vegetation and habitat along Dean Creek (see CM-13, Chapter 4). The riparian management zone would include the recontoured floodplain terraces, valley-bottom forest, and wetlands along the subject property side of Dean Creek. By approximately the fifth year of expanded mining, the entire 200-foot wide riparian management zone along Dean Creek would be planted with vegetation typical of native valley-bottom forest. Emergent wetlands would be established when Phase 6 and Phase 7 mining is complete.

- After Phase 1 mining is complete, the conveyor would be extended to the east under NE 61st Avenue to the Phase 2 and Phase 3 mining areas. Mining of Phases 2 and 3 would take approximately two to three years and would be complete approximately three to five years after the project begins. Phases 2 and 3 would be reclaimed concurrent with mining.

- After mining in the Phase 3 area is complete, the conveyor segment that crosses under the road would be removed, and mining would start in the Phase 4 and Phase 5 areas. After mining Phases 4 and 5 are complete, mining would move to Phases 6 and 7. Construction of wetlands and reclamation of the pond areas would begin during mining and completed soon after mining of the phase is complete. Mining and reclamation of Phases 4 through 7 would take between 6 and 10 years.

- Final reclamation would include removal of all buildings and revegetation of haul roads and processing areas.

3.5.5 Final Use

Potential uses of the Daybreak site after completion of mining and reclamation have been discussed with a wide range of interested parties. Storedahl will sequentially, or at the completion of all mining, reclamation, and habitat enhancement, establish conservation easement(s) and place the property in the hands of a private, non-profit organization(s) to ensure that the property will enhance the extensive open space and greenbelt reserve along the East Fork Lewis River. The primary use would be for fish and wildlife habitat with a secondary element potentially including limited recreation and education.

Establishment of a mixed forest environment that maximizes vegetative screening, riparian shading, enhanced wetlands, and other habitat values is the major goal of the reclamation plan. Reclamation is planned to be sequential; planting of those areas not scheduled for mining will commence as soon as the site is permitted. This will allow 10 to 15 years for the establishment of a significant amount of the mixed forest before mining and reclamation are completed. Under the conservation reserve use, the property will have a trail connecting the Clark County parcels to the south and east with the neighboring property to the west. This will provide access for future continuation of the East Fork trail system, while minimizing disruption of the reclaimed habitat. Following the completion of all mining and reclamation, all of the property will ultimately be deeded to one or two non-profit organizations for long-term management.

The ponds should continue to provide an informal fishing opportunity while significantly expanding the wetlands and open water habitat, with associated opportunities for wildlife observation and birding. As such, it will be a demonstration and education project and may provide a model for future reclamation.

3.6 EXISTING OR PROPOSED RESTORATION AND ENHANCEMENT PROJECTS

3.6.1 Federal Agencies

Federal lands within the East Fork Lewis River watershed are managed in accordance with the Northwest Forest Plan (USDA 1994). The East Fork Lewis River basin is considered a "Key Watershed" because of the high proportion of federal ownership, presence of at-risk fish species, and habitat that is either in good condition or has a high restoration potential (USDA 1994). Under this designation, timber harvest on federally-owned land is prohibited in 100 to 300 foot wide riparian reserves and on unstable lands; watershed analysis must be completed prior to further resource management activities; and new road construction in roadless areas is prohibited.

The USFS is conducting a number of habitat enhancement activities in the East Fork Lewis River basin, including road decommissioning, riparian planting and thinning, bank stabilization, and in-stream habitat improvement (State of Washington 1998). Habitat inventories are being completed at the rate of 5 to 10 miles of stream per year, and a comprehensive barrier assessment is planned. The USFS is also working cooperatively with WDFW to monitor adult steelhead escapement and smolt production.

3.6.2 State of Washington

Lands owned by the state of Washington are managed under a Habitat Conservation Plan approved in 1996. The HCP includes measures such as riparian buffers and harvest restrictions on unstable lands. These measures are designed to provide large woody debris (LWD) and shade, maintain bank integrity, and reduce sediment inputs.

In response to state and federal concerns regarding the decline and proposed ESA listing of many salmon and steelhead stocks, Governor Gary Locke formed a Joint Natural Resources Cabinet in 1997. The Joint Cabinet drafted a recovery plan for steelhead, called the Lower Columbia Steelhead Conservation Initiative (State of Washington 1998). The LCSCI identifies factors thought to be responsible for the decline of wild steelhead stocks, outlines general conservation strategies and establishes specific objectives regarding habitat, fish management, and dams and hydropower. As part of this strategy, the East Fork Lewis River was identified as a candidate sanctuary water, because of the lack of dams, high proportion of federal ownership, and absence of existing hatcheries. If the East Fork Lewis River is designated as a sanctuary it is probable that hatchery steelhead would not be released in or allowed access to natural production areas (State of Washington 1998). This recovery plan has been submitted to NOAA Fisheries for review.

As a part of the LCSCI, Ecology and WDFW have proposed to initiate or continue a number of conservation actions specific to the East Fork Lewis River basin. Ecology proposes to continue to monitor water quality and will conduct studies to determine appropriate instream flows. Until instream flows are determined and adopted, Ecology will withhold action on future and pending water rights.

In addition, the Lower Columbia Fish Recovery Board (LCFRB) was established in 1998 by state law. The mission of the 15-member board is to recover steelhead and other species listed under the ESA through the development and implementation of a comprehensive recovery plan. The board is authorized to establish criteria for habitat projects and to prioritize and approve projects, acquire and distribute funds for projects, enter into contracts on behalf of project sponsors, and assess and monitor project results. To date, several projects in the Lewis River basin have been funded by the LCFRB, totaling approximately, \$500,000. Two projects have been completed, or are near completion, on Lockwood Creek and in the La Center bottoms, and initial restoration efforts on the Ridgefield Pits were initiated in the fall of 2002.

In cooperation with Ecology, city and county governments, and local landowners, the WDFW will determine where levees can be removed or set back to increase riparian habitat and increase floodplain connectivity. The WDFW and the Washington Department of Transportation (WDOT) have assembled a database on fish passage problems on roads managed by state or local governments in the East Fork Lewis River watershed, and efforts are underway to replace or repair man-made barriers. In addition, WDFW will work with LCFRB, Ecology, the USFS, and local conservation districts to complete a watershed analysis of the entire East Fork Lewis River basin and will participate in cooperative habitat enhancement and restoration efforts (State of Washington 1998). The state recently completed a limiting factors analysis for the East Fork Lewis River in cooperation with the LCFRB (WCC 2000). This report identified that the lower 10 miles of the East Fork Lewis River provided most of the limited floodplain habitat and critical fall Chinook and chum spawning habitat. Recommendations in this report for addressing limiting factors include monitoring conditions in the Ridgefield Pits, reducing water temperatures and augmenting low-flows, and reconnecting and enhancing off-channel and floodplain habitat. Finally, the LCFRB recently completed a Level I Technical Assessment for WRIA 27 and 28 (GeoEngineers 2001), which includes the East Fork Lewis River. The report was completed under the provisions of the 1998 Watershed Management Act (RCW 90.82). Its purpose was to evaluate water resources for both groundwater and surface water and to identify watersheds where there is a significant potential for current or future (20-year) water-resource conflicts between water-supply, water rights, water quality, instream flow and other out-of-stream demands, based solely on existing available data.

3.6.3 Local Government

In the early 1990s, Clark County obtained a state grant to fund nine water quality monitoring stations on the lower East Fork Lewis River. Water quality monitoring activities, including installation of an automatic sampler, are expected to continue.

Since 1996, Clark County has passed a number of ordinances to protect the East Fork Lewis River. These new regulations include more stringent storm water and erosion control requirements, limitations on the location of potential contaminants within designated critical aquifer recharge areas, and a prohibition of mining within the 100-year floodplain (State of Washington 1998). In 1995, Clark County completed the East Fork Lewis River Watershed Action Plan, designed to develop comprehensive, workable solutions to nonpoint source pollution problems (Hutton 1995a).

The county also currently levies a conservation futures tax, i.e., 6.25 percent real estate transaction tax. This tax, authorized under RCW 84.34.230, funds the acquisition of open space lands. The primary acquisition need is riparian corridor land, with the main emphasis on the East Fork Lewis River. Since 1992, Clark County has purchased approximately 1,500 acres of the East Fork Lewis River floodplain, with the intention of developing a greenway along the river (State of Washington 1998).

The Clark County Conservation District has recently completed a floodplain restoration project on Lockwood Creek, similar to that proposed in this HCP for Dean Creek, funded by the LCFRB. Lockwood Creek enters the East Fork Lewis River at RM 4.5. A portion of the excavation and earth work was donated by Storedahl for that project, and the topsoil excavated from that project has been stockpiled at the Daybreak site for future use in planned reclamation and habitat enhancement.

3.6.4 Private Entities

Major Federal Energy Regulatory Commission (FERC) relicensing proceedings, which often require that certain fish and wildlife protection or mitigation measures be undertaken, are underway within the Lewis River basin. PacifiCorp owns three of the four hydroelectric dams that make up the North Fork Lewis complex (Merwin, Yale, and Swift No. 1). PacifiCorp has begun consultation on relicensing its Lewis River projects. As part of the relicensing activities, PacifiCorp has committed to completing a Watershed Analysis (State of Washington 1998). The Watershed Analysis will identify resource issues, list potential impacts from PacifiCorp's projects, and ultimately recommend and implement enhancement measures. In addition, PacifiCorp will provide partial funding, technical assistance, and LWD from Swift Reservoir for habitat restoration efforts undertaken by the USFS in key tributaries to the Lewis River, including the East Fork Lewis River (State of Washington 1998).

Several other small private organizations are taking actions to protect and restore steelhead habitat in the East Fork Lewis River basin (State of Washington 1998). The Lewis River Ranch, a privately held natural resource based business owns approximately two miles of shoreline on the East Fork Lewis River. It has engaged in various riparian restoration projects ranging from streamside planting to surface mining restoration and enhancement of off-channel habitat. Fish First, a partnership of businesses, nonprofit organizations, school groups, and government agencies, served as primary sponsor for two riparian and wetland planting projects along the East Fork Lewis River near La Center. The group implemented an outdoor education partnership program in 1998 and will continue to support land acquisitions and habitat enhancement projects. A third organization, the Pacific Rock Environmental Enhancement Group, Inc., acquired the 125-acre Ridgefield Pit site and worked with the LCFRB, WDFW, USFWS, Clark County and other resource agencies to implement aspects of the conceptual plan developed by Storedahl to enhance the site (Technical Appendix B). Initial work at the site was completed in the fall of 2002, with Storedahl donating equipment and services to Pacific Rock Environmental Enhancement Group in a cooperative effort to accelerate project completion. Friends of the East Fork Lewis River received a grant from the LCFRB in 2000 to assess the East Fork Lewis River basin and develop a strategic restoration plan from the Heisson Bridge to La Center. However, the results of this study are not yet available, and are pending peer review.

Private forestlands within the East Fork Lewis River basin are currently managed according to the Washington Forest Practices Act. With the listing of several salmonid species under the ESA, future timber harvest on private lands will likely be subject to more stringent forest practice regulations than were observed in the past. A number of emergency rules have been implemented to provide increased protection in ESUs with listed fish. Permanent revisions to the Washington State Forest Practice rules have been proposed and are currently under review.

CONTENTS

FIGURES

TABLES

4. J.L. STOREDAHL DAYBREAK MINE CONSERVATION MEASURES

The Daybreak site conservation plan is comprised of a suite of conservation measures that will contribute to regional and local conservation efforts to protect and restore the covered species and their habitats. Many of the conservation measures described in this chapter were established in consultation with the Services to develop, protect, or enhance aquatic, wetland, and floodplain habitats or to address ecosystem functions such as channel migration. A number of considerations influenced the conservation measures in the HCP, including the geographical setting of the Daybreak site along the East Fork Lewis River and restoration and recovery efforts by governmental agencies and other groups. The draft Lower Columbia Steelhead Conservation Initiative (State of Washington 1998) identified the East Fork Lewis River as important habitat for efforts to restore wild steelhead. The LCFRB is the lead entity responsible for regional recovery planning in the East Fork Lewis Basin. In addition, Clark County is developing a series of greenways, or open space, along the East Fork Lewis River, and local conservation groups, Fish First and Friends of the East Fork, have been active in restoration activities in the Lewis River basin. The Pacific Rock Environmental Enhancement Group, with the voluntary support of Storedahl, have initiated enhancement efforts for the Ridgefield Pits, located to the west of the Daybreak site.

Storedahl's conservation measures are intended to meet the standards set forth in the ESA for HCPs, which require that the impacts of take of covered species be minimized and mitigated, to the maximum extent practicable, and that the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild (16 U.S.C. § 1539 [a][2]). The conservation measures included in the Daybreak HCP will provide net benefits to species covered by the HCP, as well as other fish and wildlife, and ensure that the project does not interfere with the recovery of the covered species. The conservation measures listed in Table 4-1 are grouped into the following four categories:

- Water Quality Conservation Measures
- Water Quantity Conservation Measures
- Channel Avulsion Conservation Measures
- Species and Habitat Conservation Measures

Each of the above categories encompasses a range of specific measures. The conservation measures were developed in an integrated manner with the mining and reclamation site plan being developed for submittal to Clark County (EMCON 1998). However, some of the conservation measures were modified or arose subsequent to discussion and deliberation with the Services. Some measures will begin prior to initiation of mining activities, however some measures will be initiated concurrent with mining activities. The implementation of each conservation measure includes the use of specific monitoring and evaluation measures (Chapter 5) and consultation with the Services, the LCFRB, and other appropriate agencies, such as Ecology, WDFW, and Clark County.

This chapter describes the conservation measures and the rationales used for implementing each measure. Each measure has been given an identification number consisting of the letters CM (Conservation Measure) followed by a number (e.g., CM-XX). Specific details of the monitoring and adaptive management associated with the conservation measures are provided in Chapter 5. The effects on and benefits of these measures to the eight fish and one amphibian species covered by this HCP are discussed in Chapter 6.

Table 4-1. Description and benefits of conservation measures in the Storedahl HCP.

	Conservation Measures	Description and Benefits
		Water Quality Conservation Measures
CM-01	Wash water clarification process	Install and operate a closed-loop wash water clarification process to: • substantially reduce or eliminate turbidity discharged from the process water and the discharge of process water to receiving waters; • increase transparency of pond water, which could potentially increase the photosynthesis/respiration quotient and increase associated DO concentrations; and • precipitate dissolved phosphorus, resulting in decreased algal growth, decreased deposition of organic matter, and decreased depletion of DO in the ponds from resultant decomposition.
CM-02	Storm Water and Erosion Control Plan and Storm Water Pollution Prevention Plan	Implement a Storm Water and Erosion Control Plan and a Storm Water Pollution Prevention Plan to minimize impacts on surface water quality by: • isolating impacts to surface water from mining and reclamation operations; • containing and pretreating surface runoff and associated sediment inputs to streams through the use of bioswales; • revegetating bare soils; • preventing and managing oil and fuel spills; • installing a conveyor to transport mined aggregate; • maintaining asphalt/gravel surfacing on active roads; • having a water truck and, as necessary, a street sweeper on-site; • decommissioning unused haul roads; and • specifying conditions that would result in the suspension of operations.

Table 4-1. Description and benefits of conservation measures in the Storedahl HCP.

	Conservation Measures	Description and Benefits
		Water Quantity Conservation Measures
CM-03	Donation of Water Rights	Contingent on approval of an application for change of water rights by Ecology, and the implementation of a closed-loop wash water system, donate a portion of the water rights to the State Trust at the completion of conversion to a closed-loop system with the balance being donated at the term of the ITP: • augment groundwater discharge to Dean Creek and the East Fork Lewis River.
CM-04	Water management plan	Complete restoration work to control the water flow from Pond 5, establish a temporary seasonal pump station, and implement a water management plan to: • minimize water use from site ponds; • restrict inflow of Dean Creek to Pond 5; • restrict outflows from Pond 5; • manage pond water levels; and • augment Dean Creek flows and irrigate revegetated buffer along upper Dean Creek.
		Channel Avulsion Conservation Measures
CM-05	Conservation and habitat enhancement endowment	Create up to a $1,000,000 endowment authorized to: • provide for habitat monitoring, management, and response to unforeseen circumstances (e.g., avulsion); and • supplement CM-12 (Conservation Easement) by providing excess funds from the endowment, at the discretion of the trustee and in consultation with the Services, for enhancement of floodplain functions in the lower East Fork Lewis River basin.
CM-06	Native valley-bottom forest revegetation	Establish an early-successional mixed conifer and hardwood forest within the 100-year floodplain, along the existing and created ponds, and in the upland areas to: • increase resistance to channel migration. Additionally, this conservation measure will: • provide terrestrial wildlife habitat for nesting, dispersal, and foraging; • enhance ecological watershed functions; • provide shade to help moderate water temperatures; • help control erosion from surface runoff; • provide a future source of roots and large woody debris and resultant habitat complexity; • improve habitat for amphibians, birds, and aquatic organisms; • increase availability of terrestrial invertebrate prey items for fish; • enhance linkages among upland and aquatic ecosystems; and • extend the greenbelt of restored habitat along the East Fork Lewis River corridor.

Table 4-1. Description and benefits of conservation measures in the Storedahl HCP.

	Conservation Measures	Description and Benefits
CM-07	Floodplain reestablishment between Dean Creek and the created ponds	Create floodplain terraces for overbank flow and augment the buffer between Dean Creek and the created ponds with soil excavated from the mining area to: • enhance the interactions between the stream and its floodplain; • enhance topsoil to support successful revegetation; and • reduce the likelihood of movement of Dean Creek into the new ponds.
CM-08	Mining and reclamation designs to reduce the risk of an avulsion and to ameliorate negative effects of potential flooding or avulsion of East Fork Lewis River into the HCP Area	Incorporate mining and reclamation designs that: • forego mining in the current channel migration zone and in areas outside the 100-year floodplain that are not separated from the river by established roads; • conduct approximately 86 percent of all surface excavations outside of the pre-settlement channel migration zone, as defined by 140 years of historical observations, and reclaim all excavated areas within the historical channel migration zone to forested or emergent wetland; • reduce existing open water areas from approximately 64 acres to approximately 38 acres by significantly narrowing and reshaping the existing ponds; • create a wider (approximately 4 acres), vegetated buffer between the existing ponds and river channel and between the proposed ponds and the existing ponds (approximately 9 acres); • minimize size of created open water areas and configure new ponds parallel to the river channel; • establish shoreline vegetation communities similar to natural off-channel habitats; • stabilize pond bank areas that are most susceptible to headcutting; • establish a valley bottom forest (CM-06) to reduce erosion potential; and • adaptively manage reclamation activities based on study results of CM-10.
CM-09	Contingency plan for potential avulsion of the East Fork Lewis River into the existing or proposed gravels ponds	Implement a contingency plan to: • reduce the potential for an avulsion of the East Fork Lewis River into the Daybreak site; and • mitigate for negative effects in the event that an avulsion occurs into the ponds.

Table 4-1. Description and benefits of conservation measures in the Storedahl HCP.

	Conservation Measures	Description and Benefits
CM-10	Study of the Ridgefield Pits and East Fork Lewis River	Investigate water temperature, DO, fish use, and geomorphology associated with the nearby Ridgefield Pits to: • assess the influence of pools on fish habitat and fish use; • assess the influence of pools on East Fork Lewis River water temperatures and DO; • assess pool volume, channel shape, and sediment infill rates; and • provide information to refine the contingency plan to minimize negative effects of potential future avulsions into the Daybreak site.
	Species and Habitat Conservation Measures	
CM-11	Off-site floodplain enhancement	Provide labor, equipment, and/or materials to public and private non-profit groups to: • enhance floodplain functions related to protection and recovery of the covered species within the East Fork Lewis River basin.
CM-12	Conservation easement and fee-simple transfer	Establish a conservation easement on a discrete parcel of the Daybreak property not proposed for mining or processing and establish a similar conservation easement on the remainder of the property after the completion of reclamation activities. Transfer all Daybreak property (with conservation easement) in fee to one or more public or non-profit organizations together with the endowed funds from CM-05 at the completion of all reclamation to: • preserve the property as fish and wildlife habitat in perpetuity
CM-13	Riparian management zone on Dean Creek	Establish a forested two-zone, 200-foot riparian management area along the southwest bank of Dean Creek to: • provide shade to help minimize water temperatures; • enhance bank stability and promote undercut bank habitat in Dean Creek; • help control erosion from surface runoff; and • provide a future source of roots and large woody debris for habitat complexity.
CM-14	In-channel habitat enhancement in select reaches of Dean Creek	Improve habitat quality and bank stability using natural materials and bio-stabilization to: • reduce the rate of localized bank erosion and sedimentation; • improve off-channel and instream fish habitat for resident and anadromous species; • help maintain clean gravel substrates; • improve low-flow habitat quality by supporting a narrower, deeper channel; and • help prevent potential channel migration into the proposed mining and reclamation site.

Table 4-1. Description and benefits of conservation measures in the Storedahl HCP.

	Conservation Measures	Description and Benefits
CM-15	Shallow water and wetland habitat creation	Create approximately 84 acres of forested and emergent wetland habitat to provide: • habitat suitable for Oregon spotted frogs; • potential habitat for a variety of juvenile fish; and • increased trophic complexity.
CM-16	Control of non-native predatory fishes	Reduce the potential for predation by non-native fishes on covered species in the East Fork Lewis River and Dean Creek by: • reducing the quantity of existing habitat available to non-native predatory fishes in the existing ponds by narrowing the ponds; • reducing the quantity of potential habitat available to non-native predatory fishes in the event of an avulsion by narrowing the ponds; • reconfiguring the western berm and installing a single outlet point from Pond 5 to reduce the frequency of backwater flood flows into the pond; • targeted harvest of non-native predatory fishes in the existing ponds to reduce population numbers; • installing rock barriers between the created and existing ponds to restrict fish movement • installing educational signs to warn the public about the dangers of releasing non-native fish species to the ponds and the adjacent stream and river.
CM-17	Create habitat suitable for Oregon spotted frogs.	If Oregon spotted frogs are determined to be present in Clark County by WDFW, survey the Daybreak site and if Oregon spotted frogs are present, minimize impacts by: • installing exclusion fences to restrict breeding frogs from mining and reclamation activities; and • timing mining and reclamation activities, to the maximum extent practicable, to avoid impacting breeding frogs.
CM-18	Control public access	Decommission unnecessary roads, create foot trails, and instruct the on-site security agents to restrict trespass in sensitive areas to: • control and minimize destructive vehicle and foot traffic to riparian habitats; and • control and minimize access to covered species from potential poachers.

4.1 WATER QUALITY CONSERVATION MEASURES

Gravel mining and reclamation activities have the potential to affect the levels of turbidity and temperature in the surface waters on and near the Daybreak site. Two conservation measures will be implemented under the HCP to minimize the level of turbidity generated at the site and restrict the release of warm and/or turbid water into Dean Creek and the East Fork Lewis River by managing pond elevations. Controlling pond elevations will allow the discharge of cool water into Dean Creek during the summer when it will be most beneficial to flow and water quality.

Turbidity can affect the salmonid species covered by this HCP and their habitat in a number of ways. High levels of turbidity, or loss of light transmission, can impair salmonid feeding efficiency and growth by reducing their ability to visually locate prey (Sykora et al. 1972; Berg 1982, as cited in Waters 1995). Conversely, high turbidity can make these same fish more susceptible to being preyed on from unseen predators (Gregory 1993). Salmon, trout, and char may also respond by leaving or avoiding highly turbid reaches. High levels of turbidity caused by suspended sediments can also cause respiratory impairment, reduced tolerance to disease and toxicants, and physiological stress (Lloyd 1985 cited in Waters 1995). High levels of turbidity can also negatively affect salmonid reproductive success, most directly as a result of suspended sediments filtering through the gravel spaces and smothering the developing embryos and alevins.

The effects of turbidity on the Oregon spotted frog are unknown as are the effects of turbidity on the two lamprey species covered by this HCP. As juveniles, lamprey live within the fine stream substrates where they filter-feed on microscopic plants and animals (Scott and Crossman 1973). It is possible that high turbidity could reduce growth of these food sources by reducing light levels in the water. Also, while unknown, it is possible that high turbidity could affect lamprey behavior during migration and distribution.

4.1.1 CM-01 – Wash Water Clarification Process

WASH WATER CLARIFICATION PROCESS
CM-01

During the first three years of the ITP, Storedahl will develop a site-specific, closed-loop clarification system that will effectively eliminate process water discharge. A closed-loop system will remove solids from the process water and re-circulate this water within the

CM-01 (continued on next page)

CM-01 (continued)

closed-loop system. Solids will be removed after they settle out, and a belt press or other suitable system will be used to decrease the water content in the solids. Water from the press will be re-circulated to the treatment system. The final design of the closed-loop system will be developed in consultation with the Services and Ecology, and all other appropriate permitting agencies. The closed-loop system will be implemented to treat all process water from mining and processing activities at the Daybreak site as soon as approved by the Services and the permitting agency. Monitoring for this conservation measure will be conducted as described in Monitoring and Evaluation Measures (MEM-01).

Rationale

The most common method of reducing turbidity that results from construction, mining, or increased surface water runoff is the use of long detention and settling times that allow suspended sediments to settle out of the water column. This is the historic method used to control turbidity generated by aggregate processing at the Daybreak site. The Daybreak Mine process and storm water management system has demonstrated compliance with the NPDES requirements by using natural settling under long detention times. However, this passive method provided little opportunity to increase or improve water clarity when desired or needed. At the Daybreak site, processing of imported sand and gravel materials with higher levels of fines than on-site aggregate may result in increased turbidity and the opportunity for reductions in settling efficiency. The high suspended solids content and the flow rate from the process units make the historic detention system less than optimal and sometimes ineffective in meeting effluent limitations, and allowed limited flexibility to achieve clearer pond water. In order to significantly improve pond water quality, a more aggressive treatment system is required, such as the system used between May of 1999 and May of 2000. An even more aggressive closed-loop clarifier system will be implemented by at least year three of the ITP.

As of May 2001, Storedahl suspended wet processing and discharge of process water to the Daybreak ponds. Since this time, aggregate on the site has been processed without washing. When wet processing occurs, the current Daybreak water treatment system, in place since May of 1999 includes a number of steps. First, recycled process water is released into a long, sinuous receiving channel that allows the heaviest solids to settle (see Figure 3, Appendix G). Following this initial settling, additives are introduced into a mixing chamber to increase the settling efficiency of the solids in the water. As the treated water exits the mixing chamber, flocculated solids are removed in a secondary settling channel. The water then enters

Pond 1, where further settling occurs until the water from Pond 1 is recycled back to Pond 2 for reuse in the gravel processing operation. A portion of the water in Pond 2 eventually flows into Pond 3 and then into Pond 5 before being released to Dean Creek. The settled material in the primary and secondary channels are periodically removed with an excavator and allowed to dry in stockpiles. During the time that this improved water treatment system was used, between 1999 and May 2001, the increased efficiency of solid precipitation in Pond 1 has resulted in significant reduction in the turbidity of discharge water, as well as pond depth and the natural creation of emergent wetland habitat within the pond.

After approval of the HCP and issuance of an ITP, Storedahl will continue to dry process or to use the existing wet processing, additive-enhanced settling system until a closed-loop system specifically designed and constructed for the materials processed at the site can be tested and permitted. It is assumed that this process will take from one to three years to fully implement. During this time, Storedahl will monitor the effectiveness of the current system during wet processing and the potential adverse effects on aquatic organisms (MEM-01). Monitoring of the existing wet processing system is needed during the first one to three years of the HCP not only to ensure proper operation of the treatment system, but also because adjustments to the current chemical combination and chemical dosage may be required to effectively reduce turbidity as new sources of aggregate are mined and processed.

In a closed-loop system, the discharge of process water is virtually eliminated. A closed-loop system for an aggregate wash water system has been used for over four years at a sand and gravel mine near Issaquah, Washington with the consent of Ecology. That treatment system utilizes an anionic polyacrylamide (PAM) coagulant to help remove sediment and lower turbidity. The dry polymer is mixed with water and then metered into a static mixer, which starts the flocculation process. The water is settled in long tanks with a chain drive sediment removal system in the bottom. Water from the settling tanks is recycled to the aggregate processing equipment. An additional amount of polymer is added to the sediment prior to processing the material in a belt press to reduce water content. Water from the dewatering process is recycled to the treatment system and is not discharged to settling ponds. Although toxicity testing results were not available, generally, anionic polymers are less toxic than the cationic polymers used in the Redmond study described in Section 3.1.5.3.

Storedahl will operate a site-specific closed-loop system for the Daybreak site that will be designed to process aggregate without any substantial release of process water to the ponds. Monitoring related to this conservation measure (MEM-01) will monitor effectiveness and toxicity. Since little water will be discharged, bioassay monitoring will focus on potential toxicity and bioaccumulation of the treatment additives that are bound to the solids, which are recovered from the system. Based on preliminary tests of flocculated sediments in Pond 1, it is expected that the recovered solids will, in general, not provide an adequate growing medium for revegetation efforts. However, emergent vegetation, such as cattails, has voluntarily colonized areas of flocculated and deposited fines in Pond 1. It may be necessary to mix sand, topsoil, or other coarse materials into the recovered solids to create a more suitable soil structure for plant growth, particularly for shrubs and trees.

The closed-loop clarifier treatment system implemented at the Daybreak site will contain the following components or similar components that achieve the same objectives:

- a pre-settling basin or tank that will remove coarser solids such as sand from the wash water;
- a flocculant/coagulant injection system consisting of an additive storage tank or drum and a metering pump. A mixing tank may be required for sufficient contact between the wash water and the additive. The additive will enhance the formation of floc particles and subsequent separation of solids from the wash water;
- a clarifier that will settle out flocculated materials. The clarifier will have a continuous solids removal system to clean sediments from the clarifier; and
- a belt press that will press the sediments to decrease its water content. Water from the press will be recirculated to the treatment system.

Implementation of a closed-loop system will substantially reduce or eliminate discharge of process water, because effectively, the water is recirculated within the treatment system. Conservation measure CM-01 (Closed-Loop Clarification) will reduce turbidity levels of the water that eventually reaches Dean Creek and the East Fork Lewis River. Use of the existing chemical-aided clarification system and the more intensive closed-loop system will minimize turbidity to levels one-half of or even less than the current permitted NTU level. This significant reduction in turbidity will result in less fine sediments being released to or suspended in Dean Creek and the East Fork Lewis River. It will also result in increased transparency of the water in the existing ponds, which could enhance the oxygen content by stimulating increased photosynthesis. Implementation of CM-01 (Closed-Loop Clarification) will benefit the water quality of the ponds and adjacent surface waters and the aquatic organisms in these water bodies throughout the duration of mining and processing activities at the Daybreak site.

4.1.2 CM-02 – Storm Water and Erosion Control Plan and Storm Water Pollution Prevention Plan

STORM WATER AND EROSION CONTROL PLAN AND STORM WATER POLLUTION PREVENTION PLAN
CM-02

A Storm Water Pollution Prevention Plan and a Storm Water Pollution Prevention Plan for Erosion and Sediment Control (SWPPP/ESC) will be implemented. The plans that comprise this conservation measure are subject to approval and oversight by Ecology, and are required components of Storedahl's NPDES general permit. The complete text of Storedahl's SWPPP/ESC is provided in Technical Appendix D.

As detailed in the SWPPP/ESC, Storedahl will:

® sequentially develop and reclaim ponds and create wetlands to minimize the area susceptible to erosion;

® prevent turbid surface water discharge from active mining and reclamation sites from reaching Dean Creek and the East Fork Lewis River by isolating the sites or by conducting mining and reclamation during May through September when surface water is not discharged to Dean Creek (see CM-04) via the Pond 5 outlet;

® use created ponds for settling and detention of storm water;

® implement operational best management practices (BMPs) to prevent or reduce water pollution including: use of a conveyor to transport mined aggregate whenever possible; maintain a trained on-site, pollution prevention team; implement preventative maintenance; develop and periodically update a spill prevention and emergency cleanup plan; train employees about the SWPPP/ESC; and inspect on-site erosion and sediment control measures and maintain a log of observations;

® implement source control BMPs, including temporary and permanent seeding of exposed soils, shaping of slopes above the water to a maximum of 3H:1V slope, and maintenance of appropriate vehicle access road surfacing; and

® implement structural BMPs including measures to divert flows from exposed soils, store flows, and limit runoff and the discharge of pollutants from exposed areas of the site. This will include the use of silt fences, straw bale barriers, drainage ditches, sediment ponds, and rock outlet protection.

Rationale

Surface runoff and mining and reclamation activities are potential sources of turbidity and suspended sediments. These sources are in addition to the turbidity generated from the process wash water, which was discussed in Section 4.1.1 above. Silt-laden runoff can result from heavy rains that flow over exposed soils, the gravel yard, and any other unvegetated areas. During reclamation, turbidity could be generated during the process of contouring and revegetating the excavated ponds. Conservation measure CM-02 (Storm Water and Pollution Plan) is designed to control runoff and turbidity by a combination of BMP, and sequential, isolated mining locations.

Mining activities will occur in a phased approach to minimize the area of surface water connections among exposed soils. As each pond is excavated, recovered soils created from the wash water process will be placed in previously excavated ponds to create contoured shorelines and emergent wetland habitat. Additionally, the SWPPP/ESC (included as Technical Appendix D) contains a suite of requirements to control storm water flow, discharge, and quality. These actions will minimize turbidity in the ponds, and in the water discharged to Dean Creek.

4.2 WATER QUANTITY CONSERVATION MEASURES

Flows in the East Fork Lewis River and Dean Creek have considerable seasonal variation. Flows increase with the start of the fall rains in October or November and then decline again throughout the spring and summer. Flows in the East Fork Lewis River and Dean Creek are also augmented by groundwater that contributes to summer baseflow conditions, as discussed in Section 3.1.4.1. However, flows in much of Dean Creek are subsurface during the summer, and the measured discharge of Dean Creek to the East Fork Lewis River is as low as 0.10 cfs (McFarland and Morgan 1996).

Flow volumes in a channel determine water depth and velocity, which are important ecosystem components for the fish species covered in this HCP. The selection of spawning sites by salmonids is generally related to the size of the fish, with larger species spawning in water that is deeper and faster than the sites used by smaller species. Fish passage and available rearing habitat are also dependent on flow volumes.

Mining activities have the potential to affect the quantity of surface water flow in the East Fork Lewis River and Dean Creek. The new ponds may affect the local hydrology by creating a pond perimeter upgradient from the existing ponds and therefore intercepting groundwater further upgradient. Also, the new ponds will have a greater surface area exposed to direct precipitation and evaporation. Additionally, as discussed in Section 4.1.1, pond water is used to wash the mined gravel. The potential effects of this process on the water available to flow in Dean Creek and the East Fork Lewis River will be minimized by the implementation of a measure designed to augment seasonal low flows in Dean Creek.

Following the completion of processing operations, all water rights on the property will be donated to augment instream flows in Dean Creek and the East Fork Lewis River.

4.2.1 CM-03 – Donation of Water Rights

DONATION OF WATER RIGHTS **CM-03**
Contingent on approval of an application for change of water rights by Ecology, 237 acre-feet per year (afy) of water rights on the property will be donated to the State Trust for the enhancement of instream flows in the East Fork Lewis River and Dean Creek. All water rights associated with the property (330 afy) will be transferred to the State Trust for instream flow purposes at the completion of processing operations or the term of the ITP, whichever comes first. The transfer of the water right to the State Trust will be based on the condition that the water is used for instream flow purposes only.

Rationale

Until 1997 there were 165 or more acres irrigated on the Storedahl portion of Daybreak property, and water rights exist for at least a total of 330 afy (165 acres at 2 afy) for agricultural irrigation on the Storedahl property. Groundwater has been historically pumped and used on 165 acres during the period May through September for crop irrigation. Storedahl has applied for a partial transfer of this water right of 330 afy from agricultural to industrial use for purposes of aggregate processing and to implement riparian area irrigation as well as flow augmentation in Dean Creek. As part of the water rights transfer, significant ecological benefits will be immediately achieved through a reduction in water use and donation of a portion of the water rights to increase flow in Dean Creek. At the completion of aggregate processing, or the term of the ITP, Storedahl will donate the total water right to instream flow purposes, in perpetuity.

Water can be transferred to instream flow purposes through the Trust Water Rights Act (RCW 90.42). Under this act, Ecology may acquire water rights for trust water rights (RCW 90.42.080). Trust water rights may be used for instream flows, or other beneficial uses with an issued water right certificate for the new use. An appropriator who gives a water right to the state to be put in the trust may negotiate the terms and conditions of the trust water right (Ecology 1992). Storedahl's agreement to donate the rights to the State Trust would be based on a condition that its water right certificate be issued only for instream flow purposes in Dean Creek and the East Fork Lewis River within the HCP area.

Storedahl's current application with Ecology is for a temporary transfer of the 330 afy of agricultural water rights to industrial use for aggregate processing and instream flow enhancement for Dean Creek. The water used for aggregate processing will initially be recycled through the ponds until the closed-loop system (CM-01) is implemented, by year 3 of the ITP. During this initial period, a maximum of 93 afy of water will be used or lost through processing, conveyance loss, and evaporation of the recycled pond water. The instantaneous rate of withdrawal of makeup water, in addition to the recycled water is and will be 240 gpm (0.53 cfs or 0.44 acre-feet per day during the hours of operation) prior to implementation of CM-01. This rate is based on an operating season of 209 days per year and 10 hours per day. There will be short periods when the instantaneous rate will reach 690 gpm, such as during start-up to recharge the sand classifier.

Following the temporary transfer of water rights, riparian zone restoration and augmentation of flow in Dean Creek will be possible. With the transferred water right, approximately 103 afy will be stored in Pond 5 under a new water management plan (CM-04). Of this 103 afy, approximately 21 afy will be lost to evaporation and approximately 80 afy will be released to Dean Creek for flow augmentation and/or riparian restoration. The instantaneous rate of withdrawal from Pond 5 or Pond 3 will average 0.3 cfs (135 gpm). However, the withdrawal rate from the ponds will vary according to the natural flow in Dean Creek and the potential benefits of the specific habitat needs of the listed aquatic species. The maximum withdrawal will be limited to 0.5 cfs (224 gpm). The initial total combined annual use of water for aggregate processing and augmentation of Dean Creek will not exceed 196 afy (93 afy for aggregate processing and 103 afy storage for Dean Creek discharge) and an instantaneous rate of 690 gpm. These quantities are well within the existing 330 afy water rights associated with the site based upon historical and continuous beneficial use. Thus, the initial water available for transfer to the State Trust is 237 afy (103 afy stored in Pond 5 and used for Dean Creek enhancement plus the remaining 134 afy available from the transfer of the existing water right that will no longer be used for irrigation or needed for aggregate processing).

Converting an agricultural consumptive use of water and selectively managing it to augment distressed instream flows will support other conservation measures in this HCP (CM-13 and CM-14) that will enhance the aquatic and riparian habitat of Dean Creek. In addition, seasonal management of the water will significantly benefit the East Fork Lewis River. Increased water storage during the wet winter months and curtailed irrigation during the summer will increase local groundwater discharge to the East Fork Lewis River.

Upon the implementation of CM-01 (Closed-Loop Clarification) by year 3 of the ITP, the use of water needed for aggregate processing will be further reduced from 93 afy to 45 afy. An additional 30 afy are projected to be needed for forest irrigation use in establishing new upland forest plantings for environmental enhancement of the site. This estimated 30 afy will be used for up to 7 years. At the end of that period, the 30 afy, plus the water conserved by implementing CM-01, will be available for a total additional donation of 78 afy to the State Trust.

At the completion of processing and reclamation (projected to be 15 years) or term of the ITP, whichever is first, the balance of all water rights will be transferred to the State Trust. The donation of this 330 afy will result in a potential increase of up to 330 afy of critical instream low flow additions, in perpetuity, for Dean Creek and the East Fork Lewis River.

4.2.2 CM-04 – Water Management Plan

WATER MANAGEMENT PLAN
CM-04

The discharge of water from Pond 5 will be managed to provide seasonal benefits to Dean Creek.

Surface-water discharge between and from the ponds will be controlled by site grading, and pond construction (berm construction, outlet elevation, and placement of fine sediments). Surface outflow from Pond 5 will be restricted to a single location and controlled by installation of a gravity-fed outlet structure at the northwest corner of Pond 5. Use of the controlled pond levels and the single release point will direct pond discharge directly to Dean Creek during the fall, winter, and spring. An emergency spillway will be constructed to allow spilling of water from Pond 5 during high-water conditions. The spillway invert elevation will be set to control outflows from the pond and potential inflows from the East Fork Lewis River during floods less than approximately a 17-year return period.

During warmer months (May through September), the gravity-fed outlet structure will be closed, and an average flow of 0.3 cfs will be pumped from the bottom of Pond 5 or Pond 3 to augment flow in Dean Creek below J. A. Moore Road. The pump will draw cool water from the bottom of the pond and spill the water onto cobbles and boulders to dissipate energy and aerate the water. The location of the discharge to Dean Creek will depend on where summer flow is subsurface and the permeability characteristics of the channel bed. If the temperature of the pond water discharge exceeds the temperature in Dean Creek during the summer, direct discharge to Dean Creek will be stopped.

Rationale

Implementation of the water management plan will provide a means to increase flows, irrigate newly planted riparian vegetation, and moderate water temperatures, thereby enhancing the habitat value of the lower reaches of Dean Creek. Pond 5 currently has three outlets (Figure 3-10) and intercepts surface flow from Dean Creek when stream flows are high. The northeast corner outlet is connected directly to Dean Creek. The outlets on the southwest corner and western side flow into a defined channel and shallow wetland, respectively, eventually draining to a recently excavated ditch on the adjacent property and bypassing most of Dean Creek. The amount and primary location of discharge are dependent primarily on beaver activity (e.g., dam building) and pond elevations.

As part of this conservation measure, the western berm of Pond 5 will be reconstructed to replace the two outlets on the southwest corner and western side with spillways having an invert elevation of 3.1 ft MSL. The southern, western and northern berms will also be regraded to a minimum elevation of 32 ft MSL. A spillway will be constructed at the Dean Creek outlet with an invert elevation of 30.5 ft MSL, and surface water will be discharged during normal fall, winter, and spring months (October through April) only from the northernmost outlet into Dean Creek. The Pond 5 berm and spillway elevations were analyzed based on a stage-discharge relation developed from detailed hydraulic modeling of the East Fork Lewis River. Specifically, the stage-discharge relation fro Cross Section T of the Flood Insurance Study for the watercourse (FEMA 2000) was used to define the discharge that would result in a water surface elevation of 30.5 MSL in the vicinity of Pond 5. This discharge was determined to be approximately 21,400 cfs. Based on a flood-frequency relation established for the East Fork Lewis River (Technical Appendix C, Table 3-3) a discharge of 21,400 cfs has an exceedance probability of about 6 percent, which is equivalent to a return period of approximately 17 years. The outlet from Pond 5 will be designed so that the pond level can be controlled and inflow from Dean Creek prevented under typical flow conditions, i.e., less than a 17-year event (Figure 4-1). Emergency spillways will direct outflow from the pond over the western berms during extreme high water conditions, preventing erosion and overtopping of the pond banks.

Placement of fine sediment at the downgradient edges of selected existing ponds and along each new pond will significantly reduce groundwater seepage rates in direct proportion to reduced hydraulic conductivity. In addition, a more efficient recirculating wash water treatment system (CM-01, Closed-Loop Clarification) will greatly reduce consumptive use of water for gravel processing. Controlling outflows and reducing consumptive use of water for

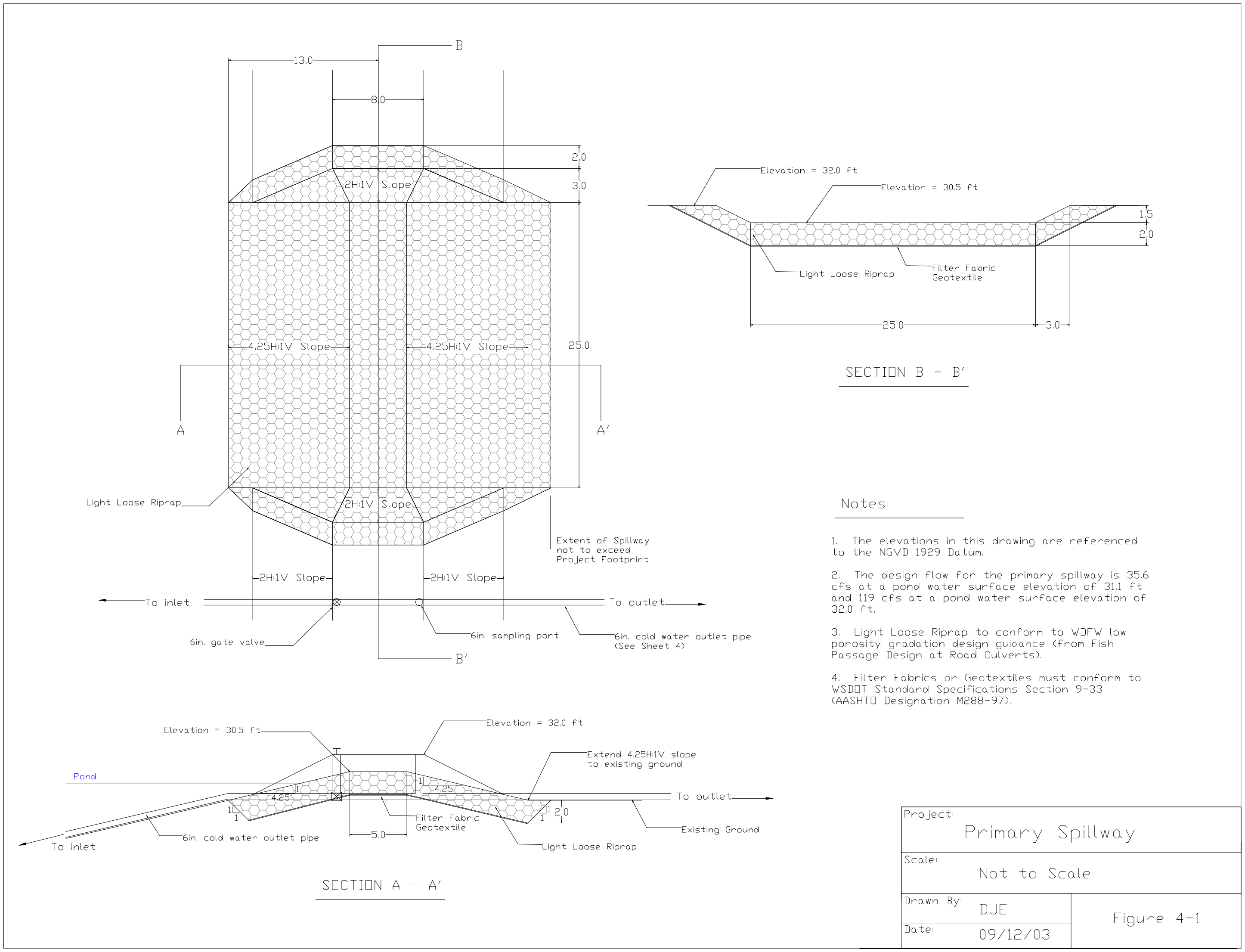


Figure 4-1. Conceptual design for the Pond 5 outlet structure.

processing will provide the opportunity to raise summer pond water levels up to 2 feet, making additional water available to the upper reach of Dean Creek during water-deficit months (i.e., May through September, when evaporation is greater than precipitation). It is estimated that with this conservation measure, it will be possible to discharge an average of 0.3 cfs to Dean Creek for five months during May through September. The discharge rate can be varied according to the flow in Dean Creek. For example, assuming that the flow in Dean Creek is reduced as the precipitation deficit is increased, pond discharge would be greatest (approximately 0.5 cfs) in the month of July (Table 4-2). Discharges to Dean Creek of this magnitude could represent a significant augmentation to the surface flows in upper Dean Creek where the stream flow is typically dry during the summer. Total discharge at the mouth of Dean Creek was observed to be as low as 0.10 cfs during the late summer (McFarland and Morgan 1996).

Table 4-2. Example of managed discharge rate from the Daybreak ponds to Dean Creek.

Month	Deficit (inch)[1]	Discharge Percent[2]	Monthly discharge (million cfs)	Monthly Discharge (cfs)
May	0.93	7	0.25	0.09
June	1.86	14	0.50	0.19
July	4.59	35	1.24	0.45
August	4.12	31	1.12	0.42
September	1.78	13	0.48	0.17
Totals	13.28	100	3.60 [3]	0.27 [4]

[1] Deficit is difference between precipitation and evaporation.

[2] Discharge percent calculated as monthly fraction of the seasonal deficit.

[3] Assumes two feet of storage in 5 ponds and 80 percent available storage.

[4] Average discharge rate over season.

To obtain optimal benefit from the available 0.3 cfs of summer water, Storedahl will construct a pumping station and pipe system to withdraw cool water from the bottom of existing Ponds 3 or 5 and discharge it upstream in Dean Creek during summer months. While temperatures at the pond surface can exceed 20ºC in the summer, water temperatures in Pond 5 are below 15ºC at depths below 5 to 10 feet (Figure 3-23) and can provide a source of cool water for Dean Creek. Should the deeper pond water temperatures exceed the ambient temperature in Dean Creek, discharge into the creek will be restricted to prevent potential adverse temperature impacts, and the water will be used instead to irrigate the revegetated riparian zone. Although water drawn from the pond bottom may be low in DO during summer, discharge of the water onto boulders and cobbles in Dean Creek should quickly oxygenate the water, as well as prevent erosional impacts.

The location for the outlet of the augmented summer discharge will depend on where flow in Dean Creek is subsurface during summer and where channel substrate conditions will allow sufficient surface flow from the pumped discharge. It is anticipated that this location will be approximately 1,000 feet downstream of the J. A. Moore Road, but some trial and error may be necessary to determine where discharge will result in the highest benefit.

The augmented summer discharge to the upstream reach of Dean Creek will benefit habitat in a variety of ways. It will provide a source of surface flow of relatively low temperature, where none now occurs in summer. The extent of surface flow that will be maintained during the summer will depend on the distance between the discharge point and the upstream end of permanent water under pre-project conditions. The discharged water will also contribute to the successful revegetation of native riparian communities along Dean Creek (CM-13) by increasing soil moisture in the channel banks. In the long-term, restored canopy over Dean Creek will help maintain cooler water temperatures in the stream.

4.3 CHANNEL AVULSION CONSERVATION MEASURES

Channel migration across the floodplain over a period of years or decades via progressive bank erosion or avulsions over geologic time is a naturally occurring process. Channel migration into the existing or proposed gravel ponds could occur as a result of either process. Typically, avulsion into gravel ponds occurs during floods when flows breach the banks surrounding the ponds. Generally, this happens when the hydraulic gradient into or through the pond is steeper than the hydraulic gradient along the existing river channel. Channel avulsion can impact instream habitat in a number of ways. For example, if the gravel pond bottom is lower than the riverbed, the reach upstream of the avulsion could experience rapid bed scour and incision in the form of a headcut, as the river gradient reestablishes its equilibrium. Benthic organisms and salmonid redds can be destroyed if the old river channel is partially or completely abandoned (Woodward-Clyde Consultants 1980; Norman et al. 1998). Bedload sediment may eventually fill the pond into which the river avulsed, but this may take decades depending on the upstream bedload supply and pond volume. Transport of sediment along the river, downstream of the avulsion is interrupted and may result in coarsening or erosion of the downstream bed and gravel bars (Collins 1997; Woodward-Clyde Consultants 1980). Where the ponds are substantially wider and deeper than the former channel, the reduced velocity and greater surface area may result in increased water surface temperatures (Woodward-Clyde Consultants 1980). However, temperature increases resulting from increased solar heating may be confounded by cooler temperatures associated with deep pools and groundwater inflows. If the ponds contained non-native species prior to avulsion, those species could be released by the avulsion into the river system, where they can prey on juvenile salmonids. However, habitats in the East Fork Lewis River that are suitable for non-native species are believed to already be occupied by these same species. This includes low velocity and backwater areas, such as side channels and beaver ponds.

Six conservation measures will be implemented to reduce the likelihood of avulsion into the existing or proposed ponds, or to ameliorate negative impacts in the unlikely event that pond capture occurs. These conservation measures are discussed below.

4.3.1 CM-05 – Conservation and Habitat Enhancement Endowment

CONSERVATION AND HABITAT ENHANCEMENT ENDOWMENT

CM-05

Storedahl will establish a conservation and habitat enhancement endowment and contribute up to $1,000,000 into the endowment, control of which will be conveyed to a non-profit organization at the completion of all reclamation and habitat enhancement, or the 25-year term of the ITP. The endowment funds would be generated solely by a surcharge of seven cents on each ton of sand and gravel mined from the Daybreak site and sold by Storedahl. The endowment funds will be placed in a dedicated account and will accrue surcharge deposits and earnings or interest. The endowment will be irrevocable. The endowment funds may be used to monitor and, as necessary, adaptively manage the conservation measures and habitat enhancement on the property following completion of mining and reclamation activities. Funds within the endowment fund will first be dedicated to habitat monitoring, management, and response to changed circumstances (e.g., avulsion) within the HCP area. The interest and appreciation earned on the endowment fund will also be available to supplement CM-12 (Conservation Easement) at the discretion of the trustee and in consultation with the Services and the LCFRB, for enhancement of floodplain ecological functions within the HCP area and the East Fork Lewis River basin, which are important to the protection and recovery of the covered species.

Rationale

Storedahl will implement a number of conservation and monitoring measures within the HCP area during the term of the ITP. At the end of the reclamation and habitat enhancement activities, or the ITP permit term, Storedahl would provide a dedicated source of funding for continued management of the site to help protect and aid recovery of the covered species.

The classic definition of "endowment" is a gift made on the stipulation that the principal is maintained in perpetuity and that only income from investment of the gift is expended. Storedahl's endowment will be granted to an appropriate non-profit organization without this stipulation, meaning that the interest and principle could both be used. However, the principle is to be used primarily to monitor and manage for changed circumstances on or adjacent to the project site. Both the principle and the earned income from the investment of endowment funds must be used for the benefit of the covered species within the East Fork Lewis River basin.

Nonprofit organizations that would be considered to receive this endowment must have an endowment policy in place that is suitable for overseeing the investment and distribution of the funds, and a mission statement that is compatible with the stated appropriate and inappropriate uses of the fund as detailed in the IA. Examples of appropriate uses that the endowment monies can be used for include: habitat monitoring, land management, response to changed circumstances, and enhancement of floodplain ecological functions within the HCP area, and if excess funds accrue, for habitat enhancement in the East Fork Lewis River basin, at the discretion of the then Trustee. Examples of inappropriate uses that the endowment monies cannot be used for include: trustee salaries or reimbursements, travel, construction of permanent buildings, expansion of impermeable surfaces, or decrease of floodplain ecological function unless short-term decrease is necessary to gain long-term increased functions.

Funds for the endowment will be generated during the term of the HCP and ITP through the addition of a surcharge of seven cents per ton of sand and gravel mined from the Daybreak site and sold by Storedahl. Funds generated from the surcharge will be deposited in a dedicated interest-bearing account or an account managed by a financial advisor. Reports on the financial status of the endowment account will be submitted to the Services on an annual basis, as detailed in Section 5.3.10 (MEM-10). Assuming that the existing plant operates at two-thirds of its capacity, contributions and interest (at 6 percent) would generate $1 million by the eleventh year of the ITP. Accrued principal and interest, with the same assumptions, would total more than $2.25 million by the end of the twenty-fifth year, i.e., the term of the ITP. Once funds have reached $1 million, the surcharge will be terminated, notwithstanding whether the term of the HCP is completed. Similarly, if the HCP term is reached and the one million dollar ceiling is not reached, (e.g., unforeseen natural catastrophic disaster, market and economic factors or collapse), no additional funds would be deposited in the endowment fund to attain the one million dollar goal. In other words, the one million dollars would serve as a surcharge ceiling. Monies will accrue in the fund solely from the noted surcharge and accrued earnings and/or interest. A natural catastrophe or market or economic downturn or other factors during the term of the ITP may result in less mining over the term of the HCP and, consequently, less disturbed land area requiring less need or funds for future management. In addition, the surcharge would be terminated and the endowment transferred to an appropriate trustee when all reclamation and habitat activities are completed, or the ITP term is completed or terminated.

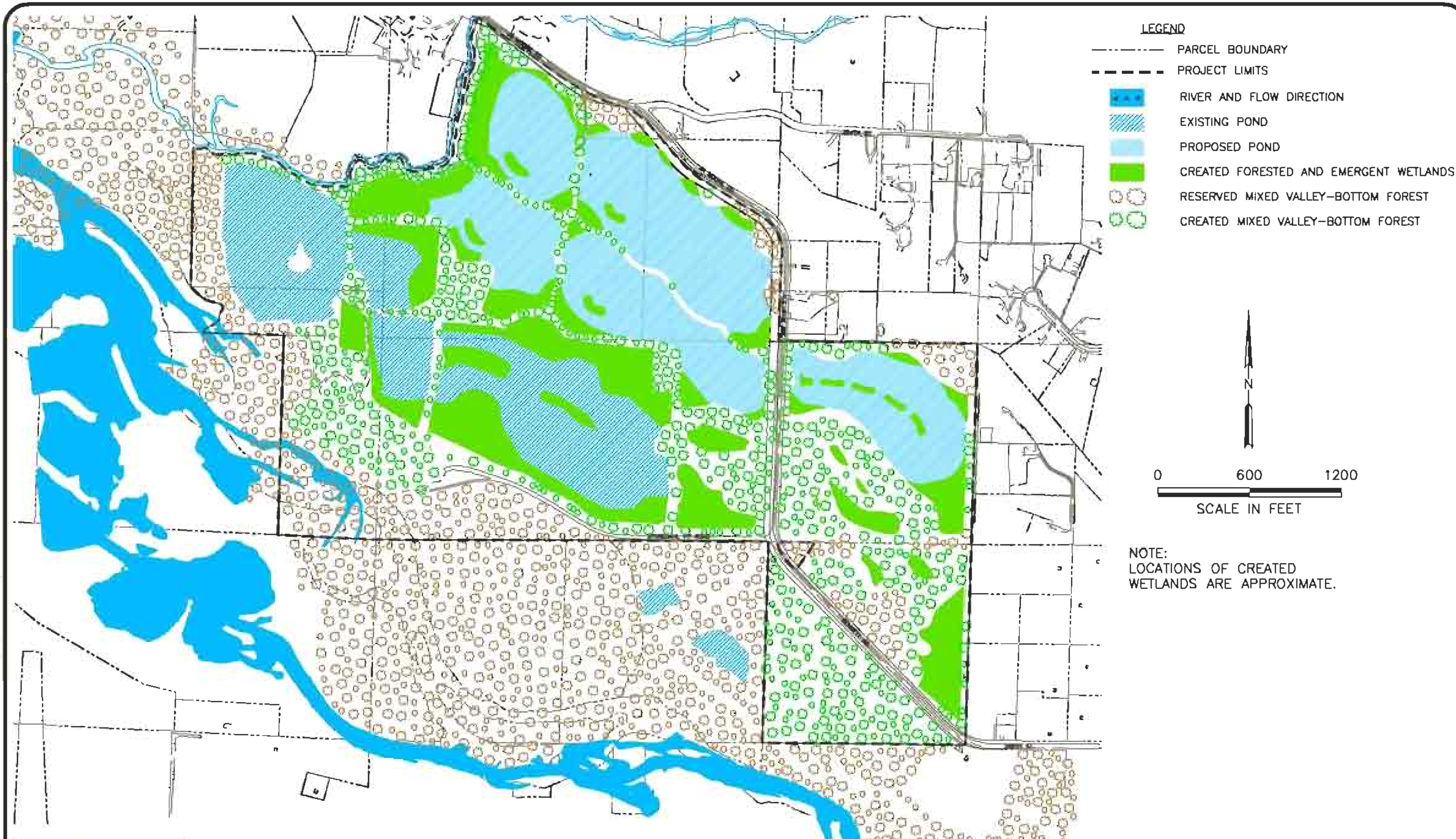
4.3.2 CM-06 – Native Valley-Bottom Forest Revegetation

NATIVE VALLEY-BOTTOM FOREST REVEGETATION
CM-06

Approximately 134 acres of vegetation typical of early-successional mixed conifer and hardwood forest (106 acres) and forested wetland (28 acres) will be restored. Restoration will occur within the 100-year floodplain, along the existing and created ponds, and in the upland areas outside of the 100-year floodplain to increase bank resistance and to provide overbank roughness elements in the vicinity of the Daybreak site.

Rationale

Replanting efforts in locations within the Daybreak site that will not be impacted by or otherwise interfere with mining and processing activities will be initiated in the first year following issuance of the ITP (Section 3.5.3). Eight acres (8) of existing forest will be preserved to provide seed and establishment of uneven-aged stand. An additional 106 acres of mixed conifer-hardwood forest will be planted on the Daybreak site during reclamation, including along and between the existing ponds and in other unexcavated areas (Figure 4-2). An additional 28 acres of native forest will be planted adjacent to the created emergent wetland to create forested wetland habitat. This will be in addition to 24 acres of riparian forest that will not be disturbed. Native valley-bottom forest represents a typical plant community that is found on river valleys and floodplains throughout the Pacific Northwest, including the lower Columbia River watershed. When the trees become established, they



the group
EMCON/OWT Solid Waste Services

DATE 8/03
DWN TLW
APP TJS
REV 1
PROJECT NO.
793584

FIGURE 4-2
J.L. STOREDAHL & SONS, INC.
CLARK COUNTY, WASHINGTON
HABITAT CONSERVATION PLAN
LOCATION OF AREAS TO BE
RESTORED AND REVEGETATED

will provide dense root mats that bind the soil and slow bank erosion and increase overbank roughness, helping to dissipate the energy of flood flows.

- In addition to the benefit of increasing resistance to channel migration and overbank flows, implementation of conservation measure CM-06 (Valley-Bottom Forest) will enhance the ecological function of the site and support Clark County's planned expansion of restored habitat along the East Fork Lewis River. The ecological functions of the site and the East Fork Lewis River will be enhanced from this conservation measure, because it will:
- provide terrestrial wildlife habitat for nesting, dispersal, and foraging;
- provide shade to help minimize water temperatures;
- help control erosion from surface runoff;
- provide a future source of roots and woody debris for habitat complexity;
- improve habitat for amphibians, birds, and aquatic organisms;
- increase availability of terrestrial invertebrate prey items for fish; and
- enhance linkages among upland and aquatic ecosystems.

At present there is a limited amount of valley-bottom forest on the Daybreak site and surrounding area, as most has been removed due to agricultural and residential land-use and timber harvest. Pasture and hay land occupies most of the site, with only remnant patches of cottonwood-alder and mixed forest remaining (Section 3.2.3). Much of the existing cottonwood-alder forest near the East Fork Lewis River has been disturbed by human activity and subsequently invaded by exotic species, such as Himalayan blackberry and reed canarygrass. Other portions of the East Fork Lewis River above and below the Daybreak site also have substantially reduced amounts of valley-bottom forest, resulting in a very fragmented and diminished distribution of this important ecosystem component.

Restoration Plan

Most of the area to be restored as mixed conifer-hardwood forest on the Daybreak site is upland, with some low lying areas closer to the water table. Soils are generally Puyallup fine, sandy loams. Remnant mixed forest stands on the site provide additional information about conditions in the area to be restored (EnviroScience 1996b; Ecological Landscape Services, Inc. 1998). Tree species in these remnant stands include Douglas-fir, Oregon ash, big-leaf maple, red alder, and black cottonwood. Native shrub species include hazelnut, vine maple, red huckleberry, snowberry, and Oregon grape. Although some areas of mixed forest on the Daybreak site may be second-growth stands or areas where selective harvest took place, they do provide an indication of what species are likely to do well in the restored valley-bottom forest.

An inherent difficulty in restoring any vegetation type is the desire to achieve late-successional, "climax" communities in a much shorter time frame than natural successional processes would require. Life history, physiological, and morphological characteristics of late seral species are often not suited to establishment, rapid growth, and perhaps even survival in open, early seral conditions. For example, conifers such as western hemlock and western red cedar are usually slower growing than hardwood trees, such as black cottonwood and red alder. Conversely, weedy, herbaceous, and some non-native species are highly adapted to invading open areas and often outcompete late successional species that are planted or seeded. In addition, previous restoration efforts on the Daybreak site have found that small mammals, such as voles and rabbits, which use the herbaceous vegetation for cover, browse on woody plants causing high mortality.

With these considerations in mind, preservation of existing mature stands and a restoration design emphasizing rapid development of a forest canopy is likely to be most successful. Tree species need to grow rapidly to be less affected by herbaceous competition and herbivory. Rapid tree growth is also needed to develop a canopy to facilitate establishment of native understory shrubs. It is likely that some site preparation and maintenance, using either mechanical methods or herbicides, is likely to be needed for the first five years to reduce herbaceous competition and the establishment of non-native plant species. NOAA Fisheries will not provide ESA coverage for the use of herbicides.

Douglas-fir and red alder will be used in establishing an initial tree canopy on most of the upland areas. These species grow relatively rapidly and can tolerate some late summer drought, which is expected on the well-drained soils of the site. On lower sites, western red cedar, Oregon ash, and black cottonwood will be emphasized. These species are characteristic of wetter areas and can be expected to survive and grow only where sufficient moisture is available through the growing season.

In upland and swale areas, a shrub understory subsequently will be incorporated into the planting scheme to initiate understory development. Timing of understory plantings will be delayed in upland and swale sites until the initial stand of saplings is well established and canopy closure has occurred. Until canopy closure occurs, herbaceous competition and herbivory by small mammals are likely to greatly reduce the establishment of planted shrubs. The shrub understory will consist of species with a range of moisture requirements. In lower spots where the water table is near the surface, salmonberry and vine maple will be planted. In higher elevation areas hazelnut, snowberry and Nootka rose will be planted. Shrubs will be planted in dispersed patches that will provide heterogeneity and a closer matching of species and moisture conditions.

Along pond margins, a straw mulch will be applied at a rate of 2 tons/acre to exposed soil surfaces immediately following bank contour reclamation. Establishment of a grass ground cover by seeding would be an alternative erosion control, but the grasses would likely result in severe competition to the shrub and tree plantings planned for the pond margins. Grasses also provide cover for herbivores, such as voles and rabbits.

Dense shoreline shrub communities will be established on the margins of the banks of the proposed ponds and wetlands created on the Daybreak site. The planting scheme uses species characteristic of wetter areas near the shoreline (Hooker's or Sitka willow), species of intermediate tolerance in transition zones (red-osier dogwood, spiraea), and species characteristic of somewhat drier conditions at slightly higher elevations but still within the riparian zone (Pacific ninebark). In order to utilize locally adapted plant stocks, cuttings and rooted plants salvaged from the site will be used for plantings to the extent possible. Willow and Pacific ninebark occur along existing pond shorelines at the Daybreak site, indicating their suitability to local conditions and providing a potential source of cuttings for restoration plantings.

The plantings will be grouped to create patches oriented parallel to the shoreline and dominated by a single species, with patches interspersed among one another (Figure 4-3). This kind of pattern is more representative of natural communities than a mixing of species on a finer scale. All of these species have been observed at the site, indicating that they are likely to be well suited to site conditions. Tree densities along pond margins will be lower (Table 4-3), as a dense shrub community is intended to be the dominant vegetation in those areas. Tree species used in planting along pond margins will be similar to those used in the wetter, swale areas but will be at about half the density of upland and swale areas. If necessary, blackberry and other invasive non-native weeds will be controlled. As the shrubs mature and the canopy closes in, these herbaceous weeds will tend to be shaded out.

In addition to plantings, there may be some natural recruitment of tree and shrub species from nearby seed sources. Black cottonwood and willow are the woody species most likely to become established from natural seed fall, as they have light, wind-borne seeds that can travel relatively long distances. Areas having bare mineral soil with a water table at or near

Table 4-3. Specifications for plantings in mixed conifer-hardwood forest restoration on the Daybreak site.

Community/Species	Site Type	Planting Density	Average Spacing	Planting Material
TREE STRATUM				
Pseudotsuga menziesii (Douglas fir)	• upland	• 350 trees/acre	8 feet	18-24 inch bare root
Alnus rubra (red alder)	• upland • swales • pond margins	• 350 trees/acre • 175 trees/acre • 90 trees/acre	8 feet	18-24 inch bare root
Fraxinus latifolia (Oregon ash)	• swales • pond margins	• 175 trees/acre • 90 trees/acre	8 feet	18-24 inch bare root
Thuja plicata (western red cedar)	• swales • pond margins	• 175 trees/acre • 90 trees/acre	8 feet	18-24 inch bare root
Populus trichocarpa (black cottonwood)	• swales • pond margins	• 175 trees/acre • 90 trees/acre	8 feet	18-24 inch bare root
SHRUB STRATUM				
Symphoricarpos albus (snowberry)	• upland	• 10 shrubs/ 360 ft^2	6 feet	bare-root
Rosa nutkana (Nootka rose)	• upland • upper pond margins	• 10 shrubs/ 360 ft^2	6 feet	bare-root
Corylus cornuta (hazelnut)	• upland	• 10 shrubs/ 360 ft^2	6 feet	bare-root
Rubus spectabilis (salmonberry)	• swales	• 10 shrubs/ 360 ft^2	6 feet	bare-root
Acer circinatum (vine maple)	• swales	• 10 shrubs/ 360 ft^2	6 feet	bare-root
Salix hookeriana (Hooker's willow)	• lower pond margins	• 10 shrubs/ 360 ft^2	6 feet	cuttings
Cornus sericea (red-osier dogwood)	• intermediate pond margins	• 10 shrubs/ 360 ft^2	6 feet	cuttings
Spiraea douglasii (Douglas spiraea)	• intermediate pond margins • swales	• 10 shrubs/ 360 ft^2	6 feet	bare-root
Physocarpus capitatus (Pacific ninebark)	• upper pond margins	• 10 shrubs/ 360 ft^2	6 feet	bare-root/cuttings

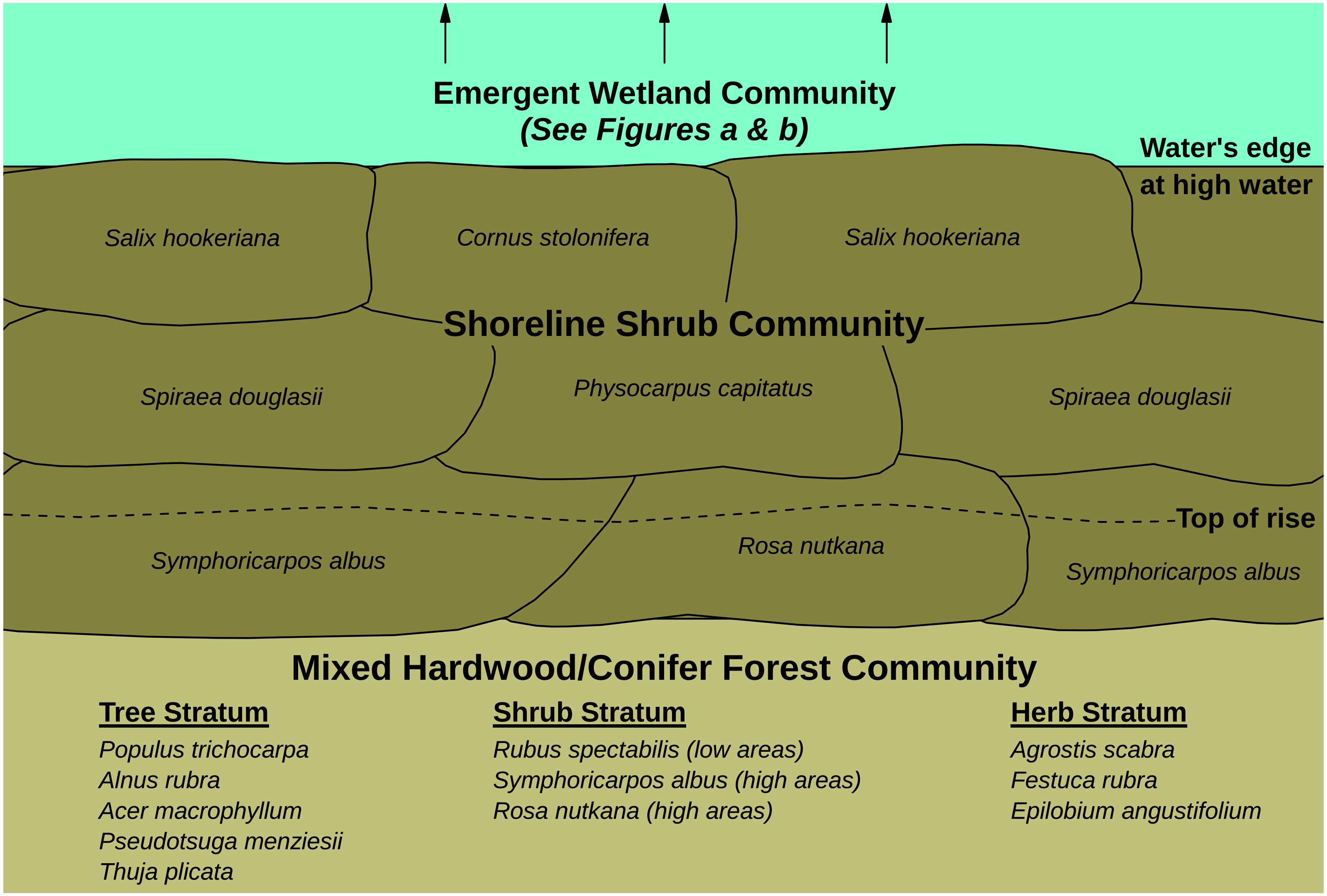


Figure 4-3. General planting scheme for shoreline shrub and mixed forest plant communities at the Daybreak site.

the surface during spring and early summer (e.g., pond margins) are where these species are most likely to colonize. Such natural colonization should be monitored and steps taken to encourage the survival and spread of these plants. Once established, naturally colonizing plants are likely to grow more vigorously and have a higher chance of survival than planted stock.

Specifications for Site Preparation, Planting, and Maintenance

In upland and swale areas, site preparation will consist of removing existing herbaceous cover where it is judged to be detrimental to establishment and growth of woody species. Removal will generally be accomplished by scarifying with hand tools around planting locations. If scraping with heavy equipment is necessary to clear larger areas (e.g., large blackberry dominated areas), scraping will be followed by tilling to loosen compacted soils. Trees will be planted in fall (October-November) or early spring (March-April) at approximately 8 feet spacing, with actual spacing somewhat irregular to create heterogeneity in the density and appearance of the restored floodplain forest. An auger will be used to excavate planting holes. Total density of trees will be approximately 700 trees/acre. In upland areas, Douglas fir and red alder will comprise about 50 percent each of the plantings, with each species planted in clusters to reduce interspecific competition. In swales, western red cedar, black cottonwood, Oregon ash, and alder will comprise about 25 percent each of the plantings. Interspersed within areas planted with trees, shrubs will be planted in scattered patches of approximately 10 to 12 feet diameter (density of 10 shrubs/360 square feet) covering half of the upland and swale areas. As with trees, shrub plantings will be done in fall or early spring.

Along shorelines, shrubs will be planted in the fall or spring after reclamation. Shrubs will be planted at approximately 6-foot spacing, clumped in monospecific patches along the shoreline, with an average patch size of 12 by 30 feet (10 shrubs/360 square feet). Concurrent and mixed in with shrub plantings, trees will be planted at a total density of approximately 350 trees/acre (i.e., half the density of upland and swale areas). Along pond shorelines, western red cedar, black cottonwood, Oregon ash, and alder will comprise about 25 percent each of the plantings.

Table 4-3 summarizes the species, site conditions, density, spacing, and planting material to be used in the mixed conifer-hardwood forest restoration plan. These specifications are subject to modification depending on local site conditions, availability of plant materials, and the results of monitoring within the HCP adaptive management process.

4.3.3 CM-07 – Floodplain Reestablishment Between Dean Creek and the Phase 6 and 7 Ponds

FLOODPLAIN REESTABLISHMENT BETWEEN DEAN CREEK AND THE PHASE 6 AND 7 PONDS CM-07

The floodplain along the eastern bank of Dean Creek will be reestablished through regrading and contouring to create a series of low terraces to provide overbank functions. These terraces will be planted with species typical of the native riparian zone to enhance stability and flow resistance during high flows.

Rationale

The location of Dean Creek downstream of the bridge at J. A. Moore Road has been stable for at least 38 years. Prior to modifications by humans since EuroAmerican settlement, the creek channel likely changed locations periodically in response to sediment deposition on the alluvial fan downstream of the bridge (Technical Appendix C). The confinement and direction of the stream at the J A. Moore Road bridge, discontinuous levees along the reach of the creek below the bridge at J. A. Moore Road, periodic dredging of sediments in the channel, and construction of a ditch to route floodwaters are all thought to contribute to the channel's present stable location. Specifically, the bridge at J. A. Moore Road constrains Dean Creek's movement laterally across the alluvial fan, as well as limiting the vertical movement of the stream at the bridge crossing where sediments naturally accumulate. The existing channel migration zone (CMZ) of Dean Creek below the bridge is severely restricted to its current straightened channel, and is defined by the bankfull channel edge (Technical Appendix C). Because the alluvial fan generally slopes to the west, flooding in Dean Creek under present conditions tends to flow toward the Woodside property to the west rather than to the Storedahl property to the east.

Despite the tendency of flood waters to flow west in the upstream reach of Dean Creek, Storedahl will ensure that flooding of Dean Creek towards the east and into the new gravel ponds will not occur by regrading a series of low terraces along the eastern riparian corridor prior to revegetation so that the ground slopes gently upward from the stream channel. The net effect of the regraded terraces will be a slope, which approximates 12H:1V from the existing OHWM to approximately 75 feet away from the stream channel. This gentle slope will result in the ground elevation being approximately 5 feet higher at a location 60 feet away from the stream than at the OHWM on the eastern bank (Figure 3-27, Section B).

In addition to the bridge at J. A. Moore Road, the discontinuous levees immediately adjacent to Dean Creek reduces the opportunity for the stream to migrate by maintaining the stream in its channelized condition. Straightened channels typically have uniform hydraulic characteristics and increased velocities compared to natural channels during high flows. These hydraulic characteristics degrade habitat conditions in Dean Creek by altering natural patterns of erosion, transport, and deposition of sediment. By removing the discontinuous levees and creating a riparian corridor that slopes gently away from the streambanks, natural channel dynamics will be enhanced, restoration of native riparian vegetation will be facilitated, and the risk that Dean Creek could avulse into the ponds will be minimized.

The regraded floodplain terraces along Dean Creek will be covered with topsoil to a depth of at least 18 inches prior to revegetation. The planted terraces will provide dense root mats that bind the soil, resist bank erosion, and increase roughness, thereby helping to dissipate the energy of overbank flows. Similar to the revegetation efforts discussed for CM-06 (Valley-Bottom Forest), the regraded slope will be seeded and then planted with a mixture of native trees and shrubs. Periodic overbank flows onto this primarily terrestrial habitat can benefit the natural aquatic ecosystem by enhancing biological productivity and maintaining diversity (Bayley 1995). Vegetated overbank areas can provide feeding areas and food resources for juvenile fish during flood conditions (Bayley 1995), and these areas can provide slow water refuge when velocities are swifter in the main channel.

4.3.4 CM-08 – Mining and Reclamation Designs to Reduce the Risk of an Avulsion and to Ameliorate Negative Effects of Potential Flooding or Avulsion of the East Fork Lewis River into the Daybreak Site

MINING AND RECLAMATION DESIGNS TO REDUCE THE RISK OF AN AVULSION AND TO AMELIORATE NEGATIVE EFFECTS OF POTENTIAL FLOODING OR AVULSION OF THE EAST FORK LEWIS RIVER INTO THE DAYBREAK SITE
CM-08

New ponds resulting from future gravel extraction at the Daybreak site will be designed and reclaimed in a manner that enhances site stability and creates potential off-channel habitats in the unlikely event that avulsion should occur. The existing Daybreak ponds will be substantially altered to minimize the potential for avulsion and to avoid or minimize

CM-08 (continued on next page)

CM-08 (continued)

potential adverse environmental impacts that could be associated with an avulsion into a floodplain gravel pit.

- ® ponds developed in Phases 3, 4, 5, 6, and 7 will be excavated or reclaimed so that the length exceeds the width and they will be oriented roughly parallel to the East Fork Lewis River;
- ® the Phase 1 and 2 excavations will be reclaimed as emergent wetland and valley-bottom forest;
- ® the slope of the pond margins will vary from 2:1 to 10:1; with at least 50 percent of the new pond margins shaped to a slope of ≥ 5:1 following excavation;
- ® the existing Ponds 1, 2, 3, and 4 will be significantly shallowed, narrowed, reshaped, and the shoreline revegetated as emergent and forested wetlands;
- ® the buffers between the existing ponds and the river channel and between the existing ponds and the new ponds will be expanded and vegetated; and
- ® native valley-bottom forest vegetation will be established on the pond margins and berms left between the ponds to provide shade and enhance bank stability.

Rationale

Possibly the greatest concern for the ecological health of the East Fork Lewis River and recovery of the listed species that has been voiced regarding this HCP and ITP is the potential effects of an avulsion into the existing and/or new gravel ponds on the Daybreak site. This concern has been raised by local, state, and federal agencies as well as by numerous advocacy groups and private citizens. In response to this concern, Storedahl has committed to several major HCP modifications that will minimize the risk of avulsion, as well as, the potential effects and recovery time in the unlikely event of an avulsion.

The potential for an avulsion into the existing ponds on the Daybreak site presented a unique set of challenges during HCP development. An evaluation of the avulsion potential within the HCP area was conducted to identify the locations associated with the Daybreak site that were most likely to be involved in the event of an avulsion. The results of this evaluation are discussed in Section 3.3.2 and in Technical Appendix C. In summary, the recent avulsion of the East Fork Lewis River into the Ridgefield Pits located south of the Daybreak site suggests that the river could also avulse into the existing ponds on the Daybreak site at some time in the future. However, the avulsion into the Ridgefield Pits shifted the river further away from the Daybreak site and lowered the bed elevation by several feet, thereby reducing the risk of avulsion onto the Storedahl property in the short-term, or during the life of this project. Nonetheless, the existing Daybreak ponds are within the historical CMZ, and it is possible that at some time in the future the East Fork Lewis River would again flow through this area. Because all of the new ponds to be created are outside of the historical CMZ, it is much less likely that the river would avulse into the expanded excavation area.

Originally, the design of the HCP emphasized preventing the East Fork Lewis River from avulsing into the existing ponds, and thereby, into the new ponds. This was to be accomplished primarily by enhancing the bank stability of the East Fork Lewis River at locations identified as being at risk of avulsing (Figure 3-33). However, the WDFW commented that restricting natural channel migration could result in a loss of opportunity for the river to maintain important ecological functions, such as LWD recruitment. In addition, off-channel habitat has been identified as a limiting factor in the East Fork Lewis River for salmonid recovery (WCC 2000). In conjunction with these concerns, the Services wanted to ensure benefits to recovery of the listed species beyond the term of the ITP. After several discussions, Storedahl agreed to substantially reconfigure the existing Daybreak ponds so that the risk of avulsion would be minimized, but that if the river avulsed into the site, the reclaimed ponds would function more similarly to a relict river channel. To achieve these goals, it will be necessary to:

- resist a potential avulsion into the existing Daybreak ponds during the term of the HCP;
- accommodate a potential future avulsion into the existing Daybreak ponds through reclamation designs which acknowledge that the existing ponds are within the historical channel migration zone; and
- minimize adverse effects of a potential avulsion by reducing the recovery time. For example, reclamation designs should resist headcutting in the upstream reach and minimize sediment trapping that could adversely affect habitat in the downstream reach.

Conservation measure CM-08 (Mining and Reclamation Designs) is designed to reduce the risk of an avulsion and to minimize the negative impacts of potential future avulsions in the unlikely event that an avulsion occurs at any point in the future. At the same time, CM-09 (Contingency Plan) will also help reduce the risk of avulsions into the Daybreak site during the life of the ITP or the continued processing of aggregate on-site, whichever comes first, in order to allow sufficient time to achieve the goals of CM-08 (Mining and Reclamation Designs). Ideally, the components of CM-09 could be continued even after the term of the ITP is expired and until the vegetation along the recontoured ponds reaches maturity.

Implementation of CM-05 (Endowment) will provide funding that could be used to fund this conservation measure into the future, if to do so would enhance or protect recovery of the covered species.

Under CM-08 (Mining and Reclamation Designs), the proposed areas in the southeast portion of the Daybreak site that will be excavated under Phases 1C, 1D, and 2 are closest to, and in some cases surrounded by, the 100-year floodplain and they are within the historical CMZ (Figure 3-34). These areas are small and following excavation will be partially filled and graded to create forested and emergent wetlands. Original excavation and reclamation plans for the Phase 1C, 1D, and 2 areas have been extensively modified to minimize the risk of avulsion and to reduce the ecological recovery time in the event an avulsion were to occur into this area. The original design included a small excavation site, which is situated outside the 100-year floodplain, but within the pre-settlement CMZ on the riverward side of Bennett Road, a county-maintained road (Figures 3-30). This excavation site was deleted from the proposed mining area because its location within the historical CMZ and its lack of protection from any hardened buffer (e.g., the road) presented an unacceptable avulsion risk. The Phase 1C, 1D, and 2 excavations have a reduced risk of avulsion because they are located behind Bennett Road or the Storedahl Pit Road, which limit the extent of the existing CMZ (Figures 3-30 and 3-34). Nonetheless, consultation with the Services resulted in revising the reclamation plans for these areas to further reduce the risk of avulsion and to minimize the effects and recovery time in the event an avulsion were to occur. This revision entails a commitment by Storedahl to fill the Phase 1C, 1D, and 2 excavations so that the reclaimed bottom elevations will be approximately equal to the thalweg elevation of the main East Fork Lewis River channel. Reducing the elevation gradient between the bottom of the reclaimed excavations and the river thalweg will reduce the potential for the formation of a headcut and will reduce the extent of a headcut that could form during erosive flow events. This revision effectively eliminates the risk of pond capture at this location by eliminating the ponds. In addition, as discussed in CM-06 (Valley-Bottom Forest), the restoration of native vegetation communities in locations that may be periodically flooded can be beneficial to the maintenance and recovery of salmonids by providing a source of increased productivity and littoral habitat that can provide protection and refuge during high-flow events (Bayley 2001).

The larger areas to be excavated in Phases 3 through 7 are located further away from the existing river channel and further away from the 100-year floodplain. Therefore they have an inherently lower risk of avulsion. Nonetheless, under CM-08 (Mining and Reclamation Designs) these ponds will be reclaimed with several features common to off-channel or periodically flooded habitats, and the risk of avulsion into the new ponds will be further reduced by increasing the buffer width between the new ponds and the existing ponds. Areas of shallow emergent wetlands will be created in each pond, and at least 50 percent of the sideslopes will be contoured to a slope more gradual than or equal to 5:1, reducing the total volume of the new Phase 3 to 7 ponds by 4 to 17 percent and increasing the amount of littoral habitat. A combination of deep and shallow water in off-channel ponds can benefit fish by providing deep water for overwintering habitat and shallow water for rearing habitat. In the unlikely event that the channel avulses into the northeastern portion of the Daybreak site, the emergent wetlands will provide potential shallow water habitat similar to that in off-channel areas in abandoned or relict channels, and because these areas would be shallow, the amount of time required to refill the ponds with gravel, sand, and finer sediment would be reduced. The orientation of the created ponds will be roughly parallel to the East Fork Lewis River, which will result in a shape similar to relict channels (USFWS 1980). In addition, and as discussed below, the buffer width between the new ponds (Phases 3 through 7) and the existing ponds will be increased as a consequence of narrowing and reshaping the existing Ponds 1 through 4. This vegetated buffer will reduce the risk of avulsion into the new ponds and it should reduce the recovery time if an avulsion were to occur.

A major component of CM-08 is the reclamation design for the existing Daybreak ponds, which will reduce the risk of an avulsion and which will avoid and/or minimize potential adverse impacts and the anticipated recovery time in the event of an avulsion. The existing bottom elevations of Daybreak Ponds 1, 2, 3, and 4 will be increased substantially and reconfigured beginning in the first year of the HCP. As fill becomes available, it will first be placed to reduce the risk of an avulsion by increasing the buffer widths between the existing ponds and the river. It is anticipated that the fill used in this reclamation will be obtained primarily as clean imported overburden from local construction projects. The increased buffer widths will not only increase the resistance to a potential avulsion but it will create a geographic pattern within the ponds that is similar to the historical channel and which would direct flood flow and any potential avulsion through the existing pond system and return the flow to the East Fork Lewis River (Figure 4-4; Technical Appendix C, Addendum 1). By incorporating imported fill with the wash water fines accumulating in Pond 1, the difference in elevation between the bottom of Pond 1 and the river thalweg will also be diminished. Pond 1 was identified as the most likely location for an avulsion, if one were to occur in the future. Reducing the difference in elevation between the bottom of this pond and the river thalweg will reduce the potential for the formation of a headcut and consequently will reduce the potential magnitude of its effects on the upstream river channel. The reduced cross-sectional area and volume of the ponds would limit the sediment trapping capability of the

Figure 4-4. Illustration of the existing Daybreak ponds following narrowing of the pond area and reclamation.

ponds following an avulsion. This would limit the potential downstream impacts and would decrease the time for geomorphic recovery of the river channel. In this way, the reclamation of the existing ponds will: 1) increase the resistance to a potential avulsion by increasing the buffer width; 2) accommodate a potential future avulsion by providing a preferred flow path; and 3) minimize adverse effects such as upstream headcutting and downstream sediment trapping.

Hydraulic calculations (Technical Appendix C, Addendum 1) show that during an avulsion event, erosion and transport of finer-grained materials would be limited. If fines in the reclaimed ponds are 'washed out' they would be transported downstream until they reach the zone of tidal influence (RM-6). Some fine sand-sized material could be deposited above the tidal zone, but these materials would be quickly transported down river once the overbank flows recede and the river returns to its narrower and higher-velocity main channel. In addition, the narrowed ponds created under CM-08 will result in wider, vegetated buffers between the river and the existing and new ponds, which will increase the resistance to erosive forces that can cause an avulsion in the first place. Another component of CM-08 is the mining and reclamation sequence (Section 3.5.4 and Figure 3-34) that was designed, in part, to reduce the risk of avulsion. As discussed earlier, the buffers on the existing Ponds 1 through 4 will be increased during the first years of the HCP so that these areas can be revegetated as soon as possible. Concurrently, all areas that will not be mined will also be revegetated, and Storedahl has already initiated reforestation on 20 acres just south of Bennett Road. Additional work under CM-09 (Contingency Plan), and as discussed in the following section, are designed to further reduce the risk of an avulsion until all processing on the site has ceased and the reclamation work under CM-08 is completed.

4.3.5 CM-09 – Contingency Plan for Potential Avulsion of the East Fork Lewis River into the Existing or Proposed Gravel Ponds

CONTINGENCY PLAN FOR POTENTIAL AVULSION OF THE EAST FORK LEWIS RIVER INTO THE EXISTING OR PROPOSED GRAVEL PONDS
CM-09

A contingency plan will be implemented to prevent and mitigate for a potential avulsion of the East Fork Lewis River into the gravel ponds on the Daybreak site. Three sites have been identified that represent the most probable future avulsion paths (Sites G, H, and J on Figure 3-33). As a proactive measure to reduce the likelihood of the river shifting to the relict channel adjacent to Site G:

CM-09 (continued on next page)

CM-09 (continued)

® Storedahl will place LWD in rows or debris jams within the floodplain between Site C and the Storedahl Pit Road.

In addition, Sites G, H, and J will be monitored for bank stability conditions, as described in Section 5.3.8 (MEM-08). If target bank stability conditions are exceeded, Storedahl will implement preventative solutions. Solutions may include biotechnical techniques, hydraulic techniques, and/or structural controls. The specific techniques employed will depend on the nature and location of the identified avulsion threat. Preventative solutions will be designed in consultation with Clark County, WDFW, and all appropriate permitting agencies and approved by the Services prior to construction. Construction activities will be initiated prior to the high flow season (dependent on receipt of all appropriate permits) after the bank stability target conditions are exceeded.

In the event that avulsion of the East Fork Lewis River into the existing or proposed gravel ponds does occur despite preventive actions, mitigation measures will be implemented as part of this conservation measure. These measures include rapid response to:

® assess the potential of direct take of covered fish species that may be stranded in isolated or shallow water, and coordinate efforts with the Services, WDFW, and the LCFRB to transfer stranded fish back into the main channel, as appropriate;

® assess the potential of redirecting flow back into the pre-avulsion channel and the associated benefits to the covered species of this action based on the observed conditions and the results of the Ridgefield Pit Study (CM-10); if the benefits of redirecting the flow are sufficient, engineering solutions will be implemented in consultation with the Services, LCFRB, and other appropriate agencies;

® assess the potential of enhancing or restoring lost steelhead and Chinook salmon spawning habitat based on the observed conditions and the results of the Ridgefield Pit Study (CM-10), and if appropriate, implement enhancement or restoration of spawning habitat in consultation with the Services, LCFRB, and other appropriate agencies; potential actions could include development of a spawning channel in the abandoned reach (if feasible); and

® modify conservation and monitoring measures that are affected by the avulsion, as appropriate; if avulsion negates or modifies the need for conservation or monitoring measures, then funds for these measures will be redirected to restoration efforts associated with the avulsion event.

Rationale

Erosion of channel banks is a natural process that is fundamental to ecologically functioning stream systems. As a channel migrates, aquatic habitat complexity can be created and maintained through, for example, the recruitment of large wood and spawning gravel from the eroding banks and the creation of off-channel habitat in relict channels. Actions that restrict channel migration, such as bank hardening, may remove the potential for a river to create and maintain habitats. This diminished potential is referred to as "lost opportunity" and is considered to be perpetual, for at least as long as bank erosion is halted (Bates and Horn 1998).

The historical and recent migration pattern of the East Fork Lewis River near the Daybreak site is discussed in Section 3.3.2 and Technical Appendix C, Section 7-3. Although the proposed areas for mining on the site are outside of the current channel migration zone (Figure 3-30), the existing ponds are within the historical CMZ (Figure 3-5). If the East Fork Lewis River were to migrate towards the existing ponds, the channel could avulse. Although the long term effects of avulsions are not necessarily detrimental to fish, the short-term effects can include loss of habitat, such as spawning areas, and increased risk of predation on juvenile salmonids by warm water species, such as largemouth bass. A geomorphic analysis of the risk of avulsion (Technical Appendix C) indicates that the East Fork Lewis River would be much more likely to avulse into the existing ponds than into the proposed ponds (although the risk of an avulsion into the existing ponds is considered low and on the scale of decades).

Until the existing Daybreak ponds are fully reclaimed under CM-08 (Mining and Reclamation Designs), the potential negative effects on salmonid fish and habitat from avulsion of the East Fork Lewis River into the Daybreak ponds is undesirable. At the same time, preventing the river from migrating towards the ponds and increasing the threat of avulsion would result in lost opportunity for creating habitat complexity. Consequently, there are trade-offs between reducing the risk of erosion by promoting bank stability and losing the opportunity for creating diverse aquatic and riparian habitats. Roads (e.g., Storedahl Pit Road and Bennett Road), other infrastructure, and the existing Daybreak ponds have already resulted in lost opportunities for creating habitat complexity, compared to conditions present 150 years ago (Figure 3-5).

As emphasized under CM-08 (Mining and Reclamation Designs), several elements of the HCP were designed to: 1) resist a potential avulsion into the existing Daybreak pond during the term of the HCP; 2) accommodate a potential future avulsion into the existing Daybreak ponds through reclamation designs which acknowledge that the existing ponds are within the historical channel migration zone; and 3) minimize adverse effects of a potential avulsion by reducing the recovery time. For example, reclamation designs should resist headcutting in the upstream reach and minimize sediment trapping that could adversely affect habitat in the downstream reach. CM-09 (Contingency Plan) is designed to prevent potential avulsion into the Daybreak ponds in the short-term, while at the same time increase the opportunity to improve ecological functions and habitat forming processes. CM-09 is also designed to assess and mitigate for the potential detrimental effects of an avulsion on the covered species.

Preventing rivers from migrating into undesirable locations is a common goal and practice. For most of its length, the East Fork Lewis River is relatively unconfined by hardened banks or levees, but the movement of the river is controlled at specific locations (WCC 2000) in order to protect private property and public infrastructure. Upstream of the Daybreak site, from the Daybreak Bridge (RM 10) to the mouth of North Mill Creek (RM 9.2), migration of the river could destroy existing residential development and county roads. Measures to prevent channel migration have already been installed around the Daybreak Bridge to protect the county bridge and it's footings from erosion. Structural reinforcements at this site consist primarily of large rock, or riprap. Preventive measures have not been installed downstream of the bridge, but it is expected that the county would reinforce any banks where erosion threatens adjacent homes, and particularly public roads, such as county arterials, and the Clark County Department of Public Works facility. Further downstream, between the mouth of Dean Creek and Mason Creek, the banks along several outer bends are hardened with riprap. These bank protection efforts appear to have been installed to protect agricultural fields.

Evaluation of the potential for the East Fork Lewis River to avulse into the existing and proposed Daybreak ponds (Technical Appendix C) indicated that if an avulsion were to happen in the future, it would likely occur into the existing ponds at one of three locations (Figure 3-33). CM-09 includes components to annually assess the bank stability at those locations. The probability of an avulsion occurring at those sites will be determined based on risk criteria established for bank stability and channel migration. The criteria are detailed in Section 5.3.7 (MEM-07). Actions will be taken to prevent avulsion if the target criteria are exceeded. This plan substantially reduces the threat of avulsion, but retains existing opportunity for habitat forming processes to continue in two ways. One, it initiates bank stability actions only if an avulsion threat is determined to be relatively high, thus avoiding a reduction in channel migration until it is considered necessary. Two, it utilizes a number of techniques that do not harden banks and prevent channel movement, but which allow channel migration to continue within most of the current channel migration zone.

In the unlikely event that an avulsion did occur, this contingency plan also includes measures to restore aquatic habitat adversely affected by the avulsion. These restoration measures include returning the river to its pre-avulsion channel, if considered appropriate, and restoring or enhancing spawning habitat. Although these restoration measures do not include the narrowing of the existing Daybreak ponds implemented under CM-08 (Mining and Reclamation Designs), work under both conservation measures have the same goal of minimizing the potential adverse effects of an avulsion on the protection and recovery of the covered species.

Techniques to Prevent or Control Avulsion and Restore Channel Conditions

Potential preventative and restoration actions include: biotechnical techniques, hydraulic techniques, structural techniques, and channel restoration. A general description of potential solutions and the location of their use are summarized below. Many of these techniques are suggested by WDFW (Bates and Horn 1998). A conceptual drawing of the proposed techniques is shown in Figure 4-5, and details of some specific techniques are shown in Figures 4-6 through 4-10. Potential avulsion sites where each technique might be implemented are shown in parentheses (refer to Figure 3-33 for location of sites).

Biotechnical Techniques. Biotechnical techniques use vegetation, wood, and riparian buffers that mimic or reproduce the natural system to provide structural and surface erosion protection. Biotechnical techniques are typically considered to be “soft” bank protection measures. Vegetation and debris offer hydraulic resistance that reduces flow velocities and dissipates energy. This will help promote deposition of sediment in overbank areas and concentrate flow into the main channel. Biotechnical techniques and the sites to which they may be applicable include:

- ***Live Stakes*** (Sites G, H, and J) (Figure 4-6). Live staking involves the installation of live, rootable woody vegetative cuttings into the ground.
- ***Live Trees*** (Sites G, H, and J). Lives trees planted along the bankline and in the floodplain provide long-term vegetative structure to cover and stabilize the floodplain and streambanks.

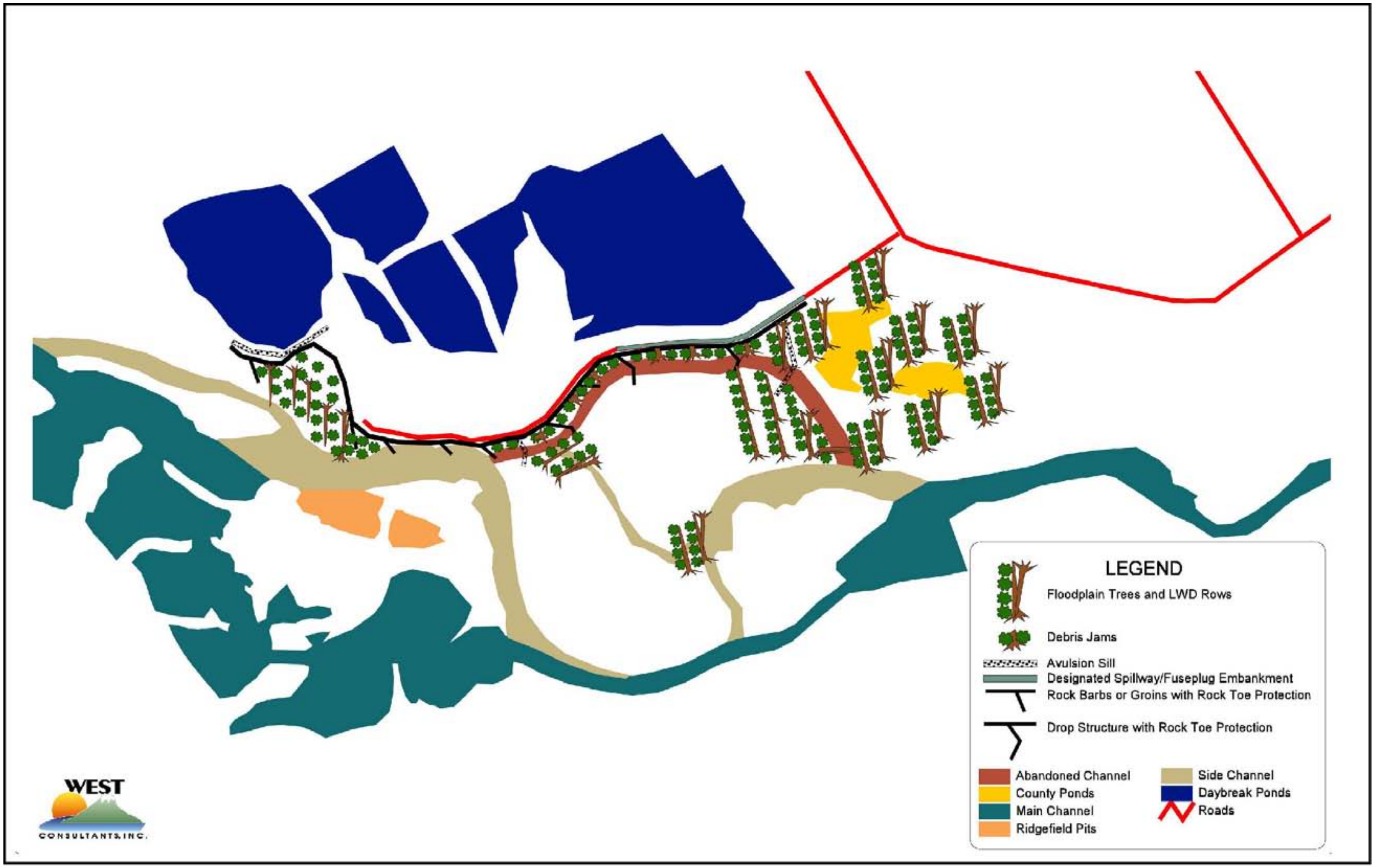


Figure 4-5. Conceptual drawing for typical avulsion prevention techniques.

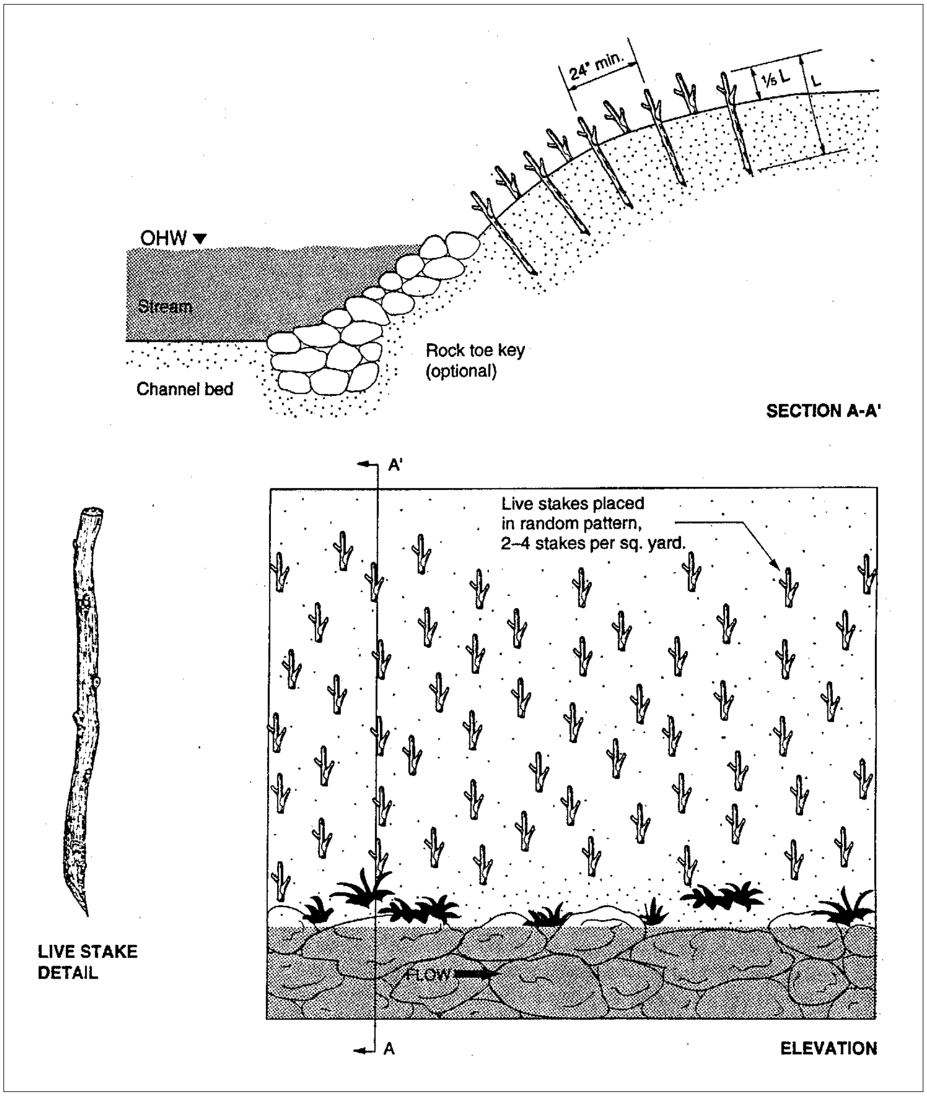


Figure 4-6. Use of willow stakes and rock toe for bank stabilization and revegetation (from Johnson and Stypula 1993).

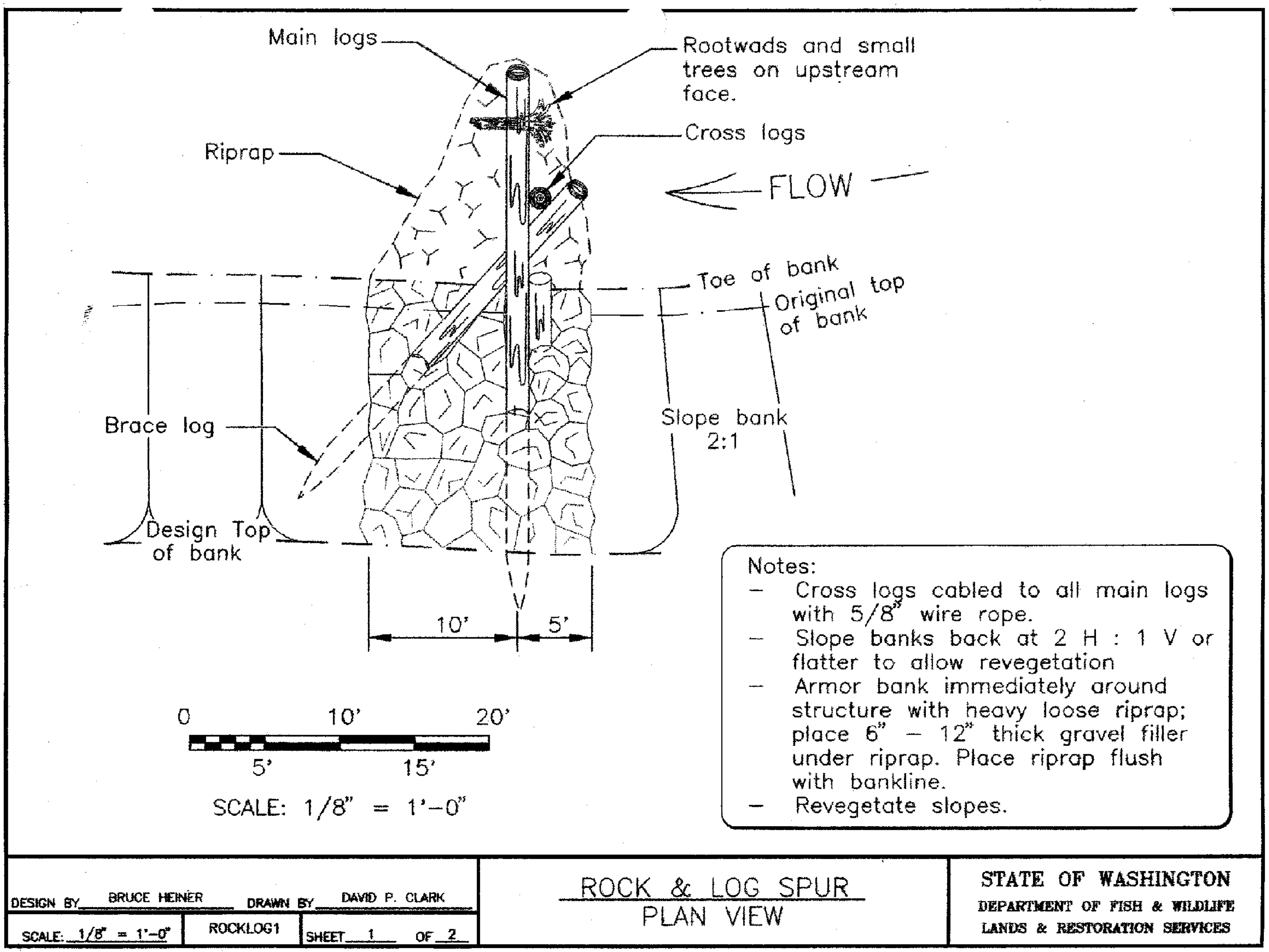
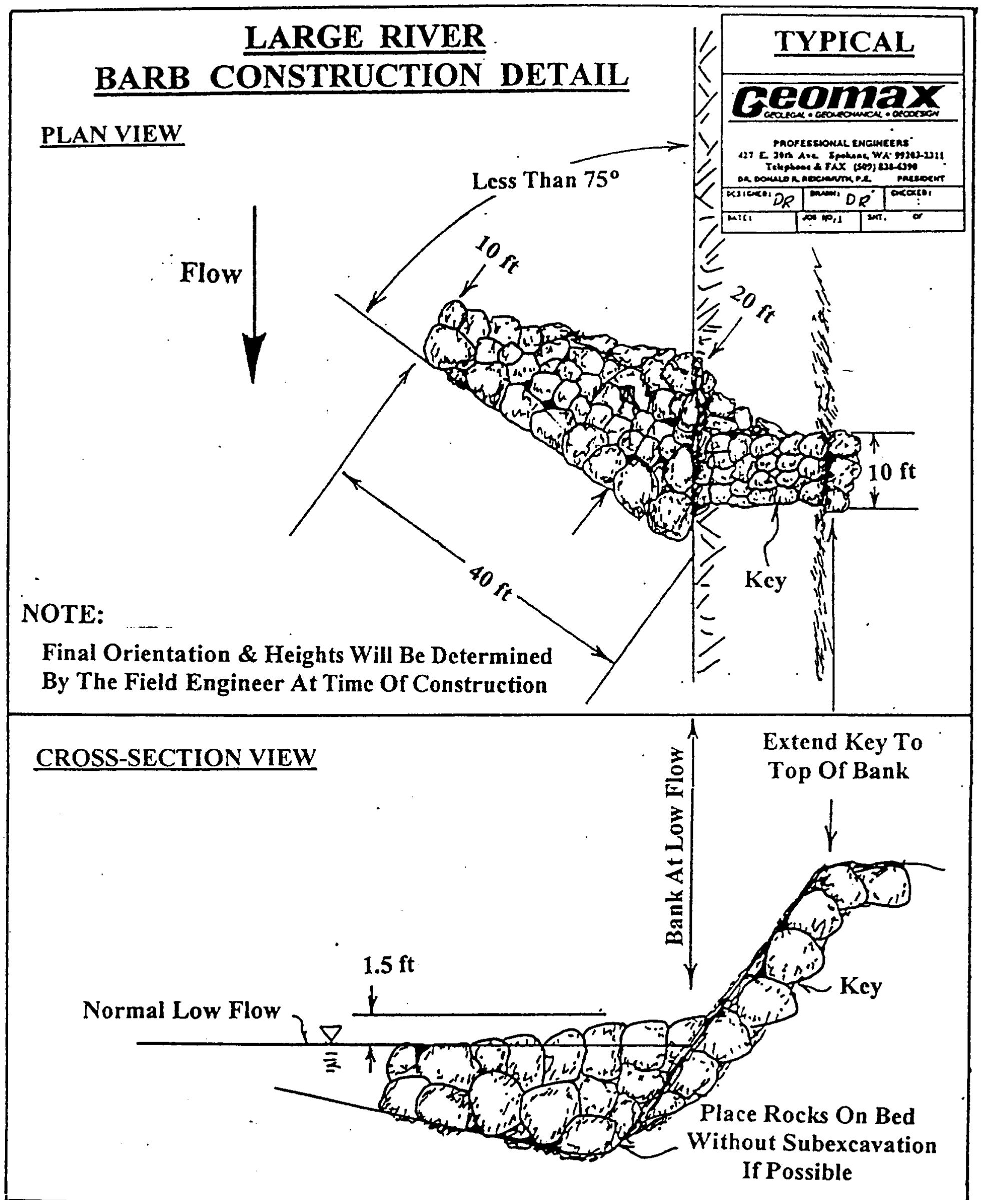


Figure 4-7. Typical design (plan view) of groin using rock and logs (from Bates and Horn 1998).



ROCK SPECIFICATIONS %Larger Than	Effective Diameter	Weight
15%	4 ft	5000 lb
50%	3 ft	2000 lb
85%	2 ft	600 lb
95%	1 ft	80 lb

ROCK VOLUME
Per Structure
170 cu. yds.

NOTE: Willow cuttings to be planted in keys during construction.

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Figure 4-8. Typical design of flow diverter, or barb (from Bates and Horn 1998).

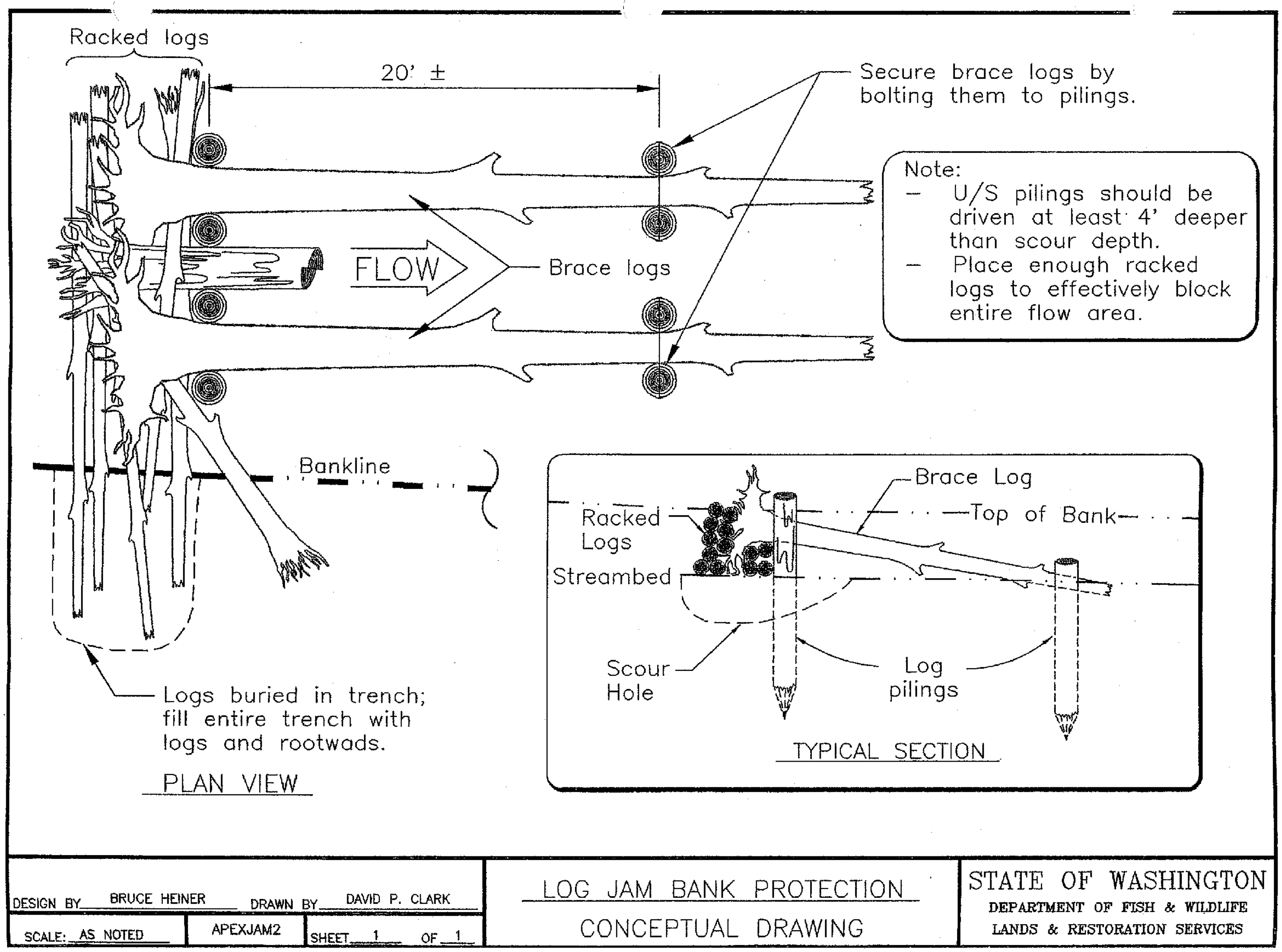


Figure 4-9. Debris jam for log protection (from Bates and Horn 1998).

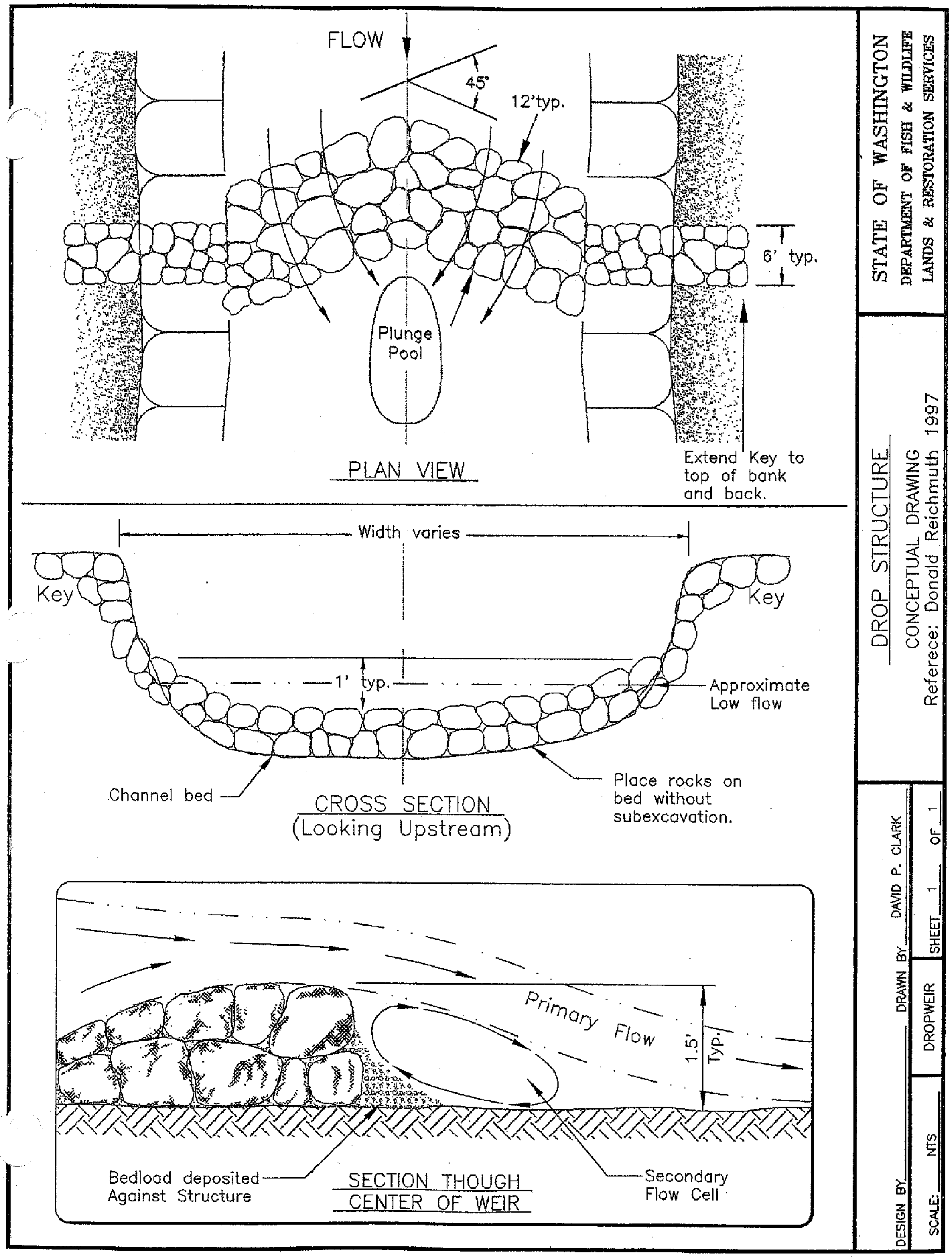


Figure 4-10. Typical design of avulsion sill (from Bates and Horn 1998).

- ***Large Woody Debris*** (Sites G, H and J). Large woody debris (particularly if placed in rows) helps dissipate energy and distribute overland flow across the floodplain. They also promote deposition of sediment in the overbank areas and concentrate flow in the main channel.

- ***Riparian Buffer***. The entire extent of the channel migration zone (CMZ) in the vicinity of the proposed project will be left undisturbed or planted as a riparian buffer (CM-06, Valley-Bottom Forest).

Hydraulic Techniques. Hydraulic techniques influence flow near the bank or in the reach to reduce shear stress. The changes in hydraulics redistribute flow in the channel, change the velocities in the cross section, and/or change the location where energy is dissipated. Potential hydraulic techniques and the sites to which they may be applicable include:

- ***Groins*** (Sites G, H, and J) (Figure 4-7). The primary function of groins is to provide roughness, dissipate energy, and reduce velocities near the bank. Groins may be oriented upstream, perpendicular, or downstream to the flow. The top elevation is typically about bankfull.

- ***Barbs*** (Sites G, H, and J) (Figure 4-8). Barbs are small weirs near the toe of a bank angled upstream to turn the flow away from the bank. Barbs create roughness, which dissipate energy and reduce velocity near the bank. They are typically overtopped by moderate stream flows.

- ***Debris Jam*** (Sites G, H, and J) (Figure 4-9). A debris jam is a collection of large woody debris that intercepts flow and provides bank protection.

- ***Drop Structure*** (Sites G, H, and J). A drop structure is a solid cross channel weir that redirects flow away from the bank to the center of the channel. Drop structures concentrate energy dissipation and reduce erosion along the bank.

- ***Porous Weir*** (Sites G, H, and J). A porous weir is a low profile structure consisting of loosely consolidated boulders that span the entire width of the channel. The structure concentrates energy dissipation and reduces erosion along the bank.

Structural Techniques. Since flood events far in excess of the standard regulatory 100-year flood may occur along the East Fork Lewis River, structural measures to prevent or control the development of potential avulsion flow paths could be instituted. Structural techniques to be considered and the sites to which they may be applicable include:

- ***Overtopping Erosion Protection*** (Site G). Asphalt or concrete road surfaces would help protect Storedahl Pit Road from erosion by flow exceeding the top of road elevation.

- ***Designated Spillways*** (Site G). A designated spillway composed of non-erodible materials could be incorporated into Storedahl Pit Road. This would allow a controlled overtopping of the road during extreme floods that exceed the spillway elevation.

- ***Fuse Plug Embankment Section*** (Site G). This is a modification to a designated spillway. A designated spillway section of Storedahl Pit Road would be filled with easily eroded material. As flows exceed the spillway elevation, the fuse plug would be eroded and allow controlled overflow of water into the Daybreak ponds.

- ***Avulsion Sill*** (Site G and J) (Figure 4-10). A sill composed of large rock or other non-erodible material could be placed at key locations to effectively prevent downcutting and shifting of the river.

- ***Rock Toe or Rock Revetment*** (Site G, H, and J). A rock revetment protecting either the entire bank or the toe of the bank could be used to provide erosion protection.

Implementation of Avulsion Prevention Techniques

The specific technique and method for either preventing an avulsion from occurring or restoration of the river channel in the case of an avulsion are dependent on the specific location and expected benefit to the riparian environment. Results of the proposed Ridgefield Pits Study (CM-10) will be used to refine proposed avulsion control and channel restoration measures, as appropriate.

Site G is considered to have the highest potential for future avulsion. The majority of the existing Daybreak ponds are down gradient from this location. Control of the avulsion potential at this location requires protection of the Storedahl Pit Road. The proportion of the total East Fork Lewis River flow and bank stability conditions along the relict channel adjacent to Site G will be monitored, as described in Section 5.3.7 (MEM-07). Reoccupation of overflow channels is a natural process that maintains complexity in meandering, low gradient rivers and benefits fish habitat over the long-term. However, if the majority of flow shifts to the location of the relict channel, the potential for avulsion or gradual migration into the existing Daybreak ponds will increase. As a proactive measure to reduce the likelihood of the river shifting to the relict channel in the foreseeable future, Storedahl will place LWD in rows or debris jams within the floodplain between Site C and the Storedahl Pit Road. The LWD placement will be coordinated with valley-bottom forest revegetation (CM-06), which has targeted this area for planting due to previous timber harvest and disturbance from off-road vehicle usage. If the river reoccupies the relict channel and conditions in the vicinity of Site G exceed targets identified in MEM-07, preventative solutions as previously described will be implemented. Specific engineered solutions and final designs will be developed in consultation with the Services, WDFW, and Clark County in consideration of all appropriate permitting requirements.

As described above, a combination of biotechnical, hydraulic, and structural techniques could be used to divert the majority of the flow away from the road, distributing it across the floodplain or back into the main channel. Overflow control measures along the road could be implemented to protect the ponds from breaching in the event of catastrophic flood events far in excess of the 100-year flood. Overflow sections would allow the river to overtop the road while controlling the potential for breaching the road section. In combination, the identified avulsion control measures can effectively prevent shifting of the channel into the Daybreak ponds along the Storedahl Pit Road.

Although bank erosion was observed at Site H prior to the avulsion into the Ridgefield site (Bradley 1996), Site H is currently considered to have only a slight potential for migration or avulsion into the Daybreak ponds. An avulsion into the Daybreak ponds at Site H would require the channel to shift out of the Ridgefield Pits and erode through almost 500 feet of existing high ground on which the Daybreak gravel processing facility is currently located. Monitoring of the bank erosion conditions at Site H will be conducted as described in Section 5.3.7 (MEM-07). Appropriate preventative solutions, as previously described, will be implemented as dictated by the observed conditions. Specific engineering solutions and final designs will be developed in consultation with the Services, WDFW, and Clark County in consideration of all appropriate permitting requirements.

An avulsion at Site J is considered possible given the low topography and existing interconnectivity between Pond 5 and the river during extreme high flow events. An avulsion at Site J would only be expected to influence the existing Pond 5 as it is down gradient of all other ponds. Bank erosion conditions at Site J will be monitored as described in Section 5.3.7 (MEM-07). Engineered solutions as previously described will be implemented as dictated by the observed conditions. Specific preventative solutions and final designs will be developed in consultation with the Services, WDFW, and Clark County in consideration of all appropriate permitting requirements.

Implementation of Avulsion Restoration Techniques

The contingency plan for avulsion of the East Fork Lewis River into the existing or proposed ponds also includes measures to respond to an avulsion, if one were to occur. This scenario is unlikely to occur within the term of the HCP given the annual monitoring of bank stability; Storedahl's commitment to implement preventative measures; and the analysis of avulsion potential in Technical Appendix C. However, it is possible that during an extreme flood the river could avulse into one or more of the ponds before reclamation has been completed. If an avulsion were to occur, four actions would be triggered.

First, an assessment would be made to determine if covered species have become stranded or unable to access the main channel after floodwaters recede. Preliminary observations of the Ridgefield Pit reach indicate that this is unlikely. In the Ridgefield Pit reach, even though flow in the river becomes quite low each summer, none of the off-channel areas have been observed to become cut off from the main channel. Instead it appears that groundwater and/or hyporheic flow into the upstream edges of each off-channel area keeps water flowing out of these areas and maintains egress connections to the main channel. This natural adjustment of channel configuration in the Ridgefield Pit reach provides guidance for minimizing and recognizing self-sustaining off-channel connections in the event an avulsion were to occur into the Daybreak site. It is anticipated that if salmonids have become stranded in shallows or isolated waters following an avulsion, professional biologists, in coordination with the Services, LCFRB, and the WDFW, will assess the likelihood of the isolated areas to remain isolated. If it appears that stranded fish would not be able to access the main river to complete their life cycle, options will be explored to reconnect these waters or to transfer the stranded fish back into the main channel using non-lethal trap and haul methods.

Second, the potential long-term ecological benefits and engineering ability to redirect the flow back into the pre-avulsion channel will be evaluated. The potential ecological benefits to be assessed include alterations to amount and type of habitat, sediment transport regime, biological interactions, and impacts on each of the covered species by life stage. This assessment will rely on state-of-the-art science and ecological theory, as well as the information gained from observations of natural processes through the Ridgefield Pit Study (CM-10). Measures that could be used for the restoration of channel conditions following an avulsion would include the hydraulic, biotechnical, and structural techniques previously defined, as well as channel closing structures (Site G) and/or levees (Sites G, H, and J). All decisions and engineering designs will be implemented in consultation with the Services, LCFRB, WDFW, and other appropriate agencies.

Third, the contingency plan includes a commitment to assess the potential of enhancing or restoring spawning habitat that is lost as a result of avulsion and to implement restoration or enhancement, if appropriate. As discussed in Chapter 6, one of the largest potential net negative effects on the covered species from an avulsion into the Daybreak ponds is the loss of spawning habitat for steelhead and Chinook salmon. Both of these large-bodied salmonid species spawn in riffle habitat within mainstem channels, and both species are known to spawn in the vicinity of the Daybreak site.

The assessment of spawning habitat impacts will include an evaluation of opportunities to rectify spawning habitat losses through natural processes or restoration and enhancement. This assessment will rely on information gained from the Ridgefield Pit Study (CM-10) and will be completed in cooperation with the Services, LCFRB, and other appropriate agencies.

The contingency plan also includes a fourth component that commits Storedahl and the Services to modify conservation and monitoring measures that are affected by an avulsion. If avulsion negates or modifies the need for specific conservation or monitoring measures, funds and efforts will be shifted to the actions associated with assessing and minimizing the impacts of the avulsion on the covered species.

4.3.6 CM-10 – Study of the Ridgefield Pits and East Fork Lewis River

STUDY OF THE RIDGEFIELD PITS AND EAST FORK LEWIS RIVER
CM-10

A study will be initiated to assess the conditions within a recent channel avulsion through the Ridgefield Pits (located south of the Daybreak site) on salmonid habitat in the East Fork Lewis River. Study components will include:

- fish habitat surveys of the East Fork Lewis River between RM 6 and RM 13;
- observations of fish use in the East Fork Lewis River between RM 6 and RM 13;
- monitoring of temperature and DO in the avulsed reach;
- assessment of channel shape, pool volume, and sediment infill rates; and
- participation in and assessment of planned habitat restoration efforts.

Rationale

The types of habitat present in a river are a function of depth, velocity, substrate, cover, and water quality. Changes in channel morphology that affect any of these components may alter the type of habitat provided. Changes in habitat commonly associated with pond capture include bed and bank erosion, conversion of spawning habitat to deep pool habitat, loss of hiding cover, introduction of exotic species, reduced velocity, and changes in temperature and dissolved oxygen (Norman 1998; Woodward-Clyde Consultants 1980). Depending on factors limiting salmonid populations prior to the avulsion event, the effects of such changes on salmonid populations may be negative or positive.

Existing evaluations of the effect of pond capture on riverine habitat and fish assemblages are generally qualitative (Woodward-Clyde Consultants 1980) or conceptual, based on observed changes in habitat (Norman et al. 1998). The presence of a recent avulsion in the vicinity of the Daybreak site provides an opportunity to quantitatively document the site-specific conditions of the existing habitat in the East Fork Lewis River within the avulsed reach and upstream and downstream of this reach. Additionally, a conceptual restoration plan has been developed for the Ridgefield Pit site (Technical Appendix B). This plan included recommendations for placement of LWD, bank contouring, revegetation, and control of invasive non-native plants. Pacific Rock Environmental Group, with voluntary assistance from Storedahl, began implementation of this restoration plan in the fall of 2002. A component of this conservation measure is to evaluate the effectiveness of these efforts to provide valuable information on the most appropriate restoration options for avulsed gravel ponds. The study components to be investigated in this conservation measure are included as recommendations for addressing limiting factors in the East Fork Lewis River (WCC 2000). This conservation measure will provide general and specific information that will be valuable to recovery efforts in the East Fork Lewis River, as well as other river systems.

Fish habitat surveys in the East Fork Lewis River and the avulsed reach will be conducted using protocols modified from the USFS stream inventory handbook (USFS 1998). Surveys will be conducted during the low-flow season, and they will include sequential identification of habitat units, such as pools and riffles, between RM 6 and RM 13. The area and volume of each habitat unit will also be quantified. The habitat survey also will assess streambed substrate, large woody debris, bank condition, and riparian composition. Because avulsion into gravel ponds can result in upstream headcutting and reduced downstream transport of sediments, observations of streambed substrate and bank conditions will focus on assessing the extent of these effects.

Observations of fish use in the East Fork Lewis River, including the Ridgefield Pit reach, will focus on comparing presence/absence of fish in the avulsed reach with fish communities upstream and downstream of the site. Determination of habitat use within the river by juvenile salmonids and their predators during spring and early summer will depend on nighttime and daytime underwater observations. Initial nighttime observations during May through June of 2000, indicate that juvenile Chinook and coho salmon are more abundant along the shorelines of the avulsed pits than along the shoreline of the main channel (R2 Resource Consultants, unpublished data). The juvenile fish were observed in shallow (less than 1 foot deep), low-velocity water, regardless of substrate type. The June observations indicated that steelhead fry were also common in shallow backwater areas (less than 3 inches deep) found along the Ridgefield Pit shoreline. During these initial observations, no non-native predators were observed, although native predators, such as sculpin and northern pike-minnow were observed. Expanded observations under this conservation measure will quantify underwater observations by reach, habitat unit, and cover and substrate type. Determination of adult steelhead use between RM 6 and RM 13 will depend on combining the habitat surveys, described above, with WDFW's annual spawning surveys. If possible, the use of available holding habitat by adult salmon and steelhead between RM 6 and RM 13 will be quantified through underwater observations. This may be limited, however, by poor visibility in the deepwater areas.

Temperature and DO will be measured upstream and downstream of the Ridgefield Pits, as well as throughout the avulsed reach to determine the potential effects of the avulsed reach on water quality adjacent to and downstream of the HCP site. A Hydrolab or other suitable device that is capable of recording temperature and DO at different depths within the pools will be used. If vandalism is determined to not be a problem, the use of continuous recorders will be considered. The study schedule will be designed to capture maximum temperatures and minimum DO levels typically associated with late summer low flows.

Geomorphic surveys will be conducted in conjunction with the bank stability monitoring (MEM-07). Cross-section surveys of the channel and floodplain will be conducted from RM 6 and RM 13 to assess potential changes in channel shape and floodplain interactions during the term of the HCP. Pool volumes and sediment infill rates will be estimated using data collected from bathymetric surveys conducted at periodic intervals. Information collected during these surveys will be used to verify or alter the predicted recovery rates (Technical Appendix C). This information will also help guide the avulsion contingency plan (CM-09) by providing information on the rate of pond filling and the risk of the channel shifting out of the Ridgefield site.

The results of the studies will be used to refine the avulsion contingency plan (CM-09) that would be implemented in the unlikely event that the East Fork Lewis River should avulse into the existing or planned gravel ponds at the Daybreak site. Data gathered at the Ridgefield site may help identify minor adaptations to the site development design that would help avoid or mitigate for future impacts. In addition, the information will be used to develop restoration options that would be most beneficial to salmonids in the East Fork Lewis River basin.

4.4 SPECIES AND HABITAT CONSERVATION MEASURES

Eight conservation measures will be implemented to rehabilitate or protect habitat on or adjacent to the Daybreak site or within the lower East Fork Lewis River floodplain that may be used by the covered species and other native species. These measures incorporate a broad array of actions that when implemented together will contribute to the healthy ecosystem functioning of the larger East Fork Lewis River watershed. Included are measures to: 1) protect and enhance water quality and fish habitat in Dean Creek; 2) create diverse and complex wetland and open water habitat; 3) control non-native, predaceous fish populations; 4) guide and control public access; 5) protect potential breeding populations of Oregon spotted frogs; and 6) provide immediate resources for enhancement of off-site areas to benefit covered species in the East Fork Lewis River floodplain.

4.4.1 CM-11 – Off-Site Floodplain Enhancement

OFF-SITE FLOODPLAIN ENHANCEMENT

CM-11

Labor, equipment, and/or materials will be provided to public and private non-profit groups chosen by the LCFRB and Storedahl to enhance floodplain functions related to protection and recovery of the covered species within the East Fork Lewis River basin in locations outside of Storedahl's Daybreak Mine property boundaries.

Storedahl will donate in-kind services (materials, equipment, and/or labor) up to $25,000 per year beginning in the third year of the ITP through year 12 of the ITP for a total value of $250,000. This is in addition to the $1,000,000 conservation endowment (CM-05). The donated services must be used each or every other year, so that total value of services

CM-11 (continued on next page)

CM-11 (continued)

provided in any year does not exceed $50,000. The timely use of the labor and/or services will be guaranteed by providing the services to projects that are nominated to Storedahl by the Lower Columbian Fish Recovery Board for use on projects benefiting ongoing recovery in the East Fork Lewis River basin. All projects will be implemented in accordance with ESA and the Section 4(d) rule. Project sponsors will be responsible for permitting, and access and easement agreements.

Rationale

Several of the species covered by this HCP and ITP are listed or proposed for listing under the ESA due to declining population numbers and continued threats to their recovery. Although all of the conservation measures that will be implemented through this HCP are designed to reduce potential negative project effects, immediate off-site efforts are needed to help protect the ESA-listed salmonid species in the East Fork Lewis River basin. Although implementation of the HCP is designed to minimize and mitigate impacts of the proposed project (including avulsion), many of the covered species would benefit from efforts to enhance existing habitat conditions in the East Fork Lewis River. Of greatest concern was the need to “jumpstart” the enhancement of floodplain functions and habitat in the lower East Fork Lewis River.

To jumpstart the enhancement of floodplain functions and habitat in the lower East Fork Lewis River, material, equipment, and/or labor valued at equal to or greater than $25,000 will be provided annually for 10 years, from the third year of the issuance of the ITP through year 12. This value of materials and/or labor must be used annually or biannually. The labor and services will be provided to nonprofit and/or private conservation groups for projects nominated to Storedahl by the LCFRB, the lead entity for regional recovery planning for the East Fork Lewis River.

Examples of appropriate uses of this expenditure include efforts Storedahl has already supported in the lower East Fork Lewis River watershed including: 1) restoration of overbank flow frequency and improvement of riparian function along lower Lockwood Creek by reducing the elevation of the floodplain through excavation; and 2) development of enhancement designs for the Ridgefield Pits area to increase the rate of recovery following the 1996 avulsion. Additional potential uses of this commitment include removal of berms and dikes to reconnect the East Fork Lewis River with floodplain areas, site preparation for riparian revegetation, and spawning gravel supplementation.

4.4.2 CM-12 – Conservation Easement and Fee-Simple Transfer

CONSERVATION EASEMENT AND FEE-SIMPLE TRANSFER

CM-12

Following issuance of the ITP and prior to the commencement of any active mining (removal of raw sand and gravel) on the Daybreak Mine Lands, Storedahl will grant a perpetual conservation easement for a portion of the Daybreak Mine Lands to a conservation organization or a government entity approved by the Services. The conservation easement will be in a form acceptable to the Services, and will apply to the portions of the Daybreak property not proposed for mining, comprising approximately 19 acres, as more fully described in Technical Appendix H. The easement will prohibit subdivision, commercial or industrial activity, motorized recreation, and any other activities that are inconsistent with protection and recovery of the covered species.

Within 60 days following completion of reclamation on the remainder of the Daybreak property as set forth in this HCP, Storedahl will, without further consideration, convey fee title to the property to one or more conservation organizations or government entities approved by the Services. Such conveyance may be made in one or more transactions and will encompass the entire Daybreak property (comprising approximately 300 acres as described in Addendum 1 of the Implementing Agreement) following completion of all reclamation, or in a series of transactions involving smaller parcels, as reclamation is completed on such parcels, provided that the entire Daybreak property ultimately is so conveyed. Storedahl will ensure, at the time of such conveyance, that the property will be preserved as fish and wildlife habitat in perpetuity, either by means of a conservation easement acceptable to the Services, as described above, or through such other means as the Services may approve at that time. Following fee-simple transfer of the property and granting of the endowment, but no later than the completion of the 25-year term of the ITP, the Conservation and Habitat Enhancement Endowment provided for in CM-05 will be available for management of the property conveyed under this measure. However, if Storedahl, for reasons beyond its control, is unable to conduct mining activity as anticipated under this HCP, Storedahl will not convey a conservation easement with respect to such lands nor will such lands be conveyed in fee title as noted above.

Rationale

A conservation easement is a legal agreement recorded in a deed to restrict uses or development on a parcel of property. The agreements in a conservation easement are perpetual and will remain with the property even if ownership changes. Fee-simple transfer is conveyance of all rights to and interests in real property from the party holding the rights and interest to another party.

If possible, the property will be transferred with a conservation easement and the associated endowment to one conservation or public group. However, it is possible that the land would be divided between two groups. If so, the same deed restrictions will apply to both properties. In any event, the Services will be consulted prior to such conveyance. Deed restrictions that will be included in the conservation easement(s) and generally limit the use, management, and maintenance of the property to those activities that would achieve the overall goals of the HCP. In general, these goals are the conservation and enhancement of fish and wildlife habitat. Prohibited uses include, but are not limited to, logging and forestry activity, construction activity, and development and road building unless necessary to accomplish the goals and objectives of the HCP.

The value of transferring the Daybreak site property with a conservation easement is enhanced by the property's location within a proposed greenbelt adjacent to the East Fork Lewis River.

4.4.3 CM-13 – Riparian Management Zone on Dean Creek

RIPARIAN MANAGEMENT ZONE ON DEAN CREEK
CM-13

A two-zone, 200-foot management area along the left bank (facing downstream) of Dean Creek will be established. The inner zone will be a minimum of 75 feet in width. No excavation for mineral resources will occur in the inner zone. The inner zone will be regraded to create a series of low terraces upwards from the OHWM to reduce or eliminate the likelihood that Dean Creek would avulse into the Daybreak ponds (CM-07). Existing native shrubs and trees in the inner zone will be retained, where appropriate and the entire 75-foot inner zone will be revegetated as native valley-bottom forest (CM-06) or streambank vegetation (CM-14). The inner management zone is designed primarily to enhance channel habitat and protect Dean Creek during Phase 1 mining impacts. Following Phase 1A and 1B mining in the area adjacent to the inner management zone, the outer management zone of a minimum 125 feet will be filled with imported and/or processing by-product material and then revegetated as native valley-bottom vegetation (as per CM-06) within 5 years of implementation of the ITP. Upon revegetation of both the inner and outer zone, no disturbance or heavy equipment operation will be allowed in the entire 200-foot riparian management zone along the left bank of Dean Creek. The two-zone riparian management area will protect Dean Creek from short-term impacts and will provide a wide array of long-term riparian functions that will contribute to improved salmonid habitat in Dean Creek.

Rationale

The riparian zone is the area along water bodies where terrestrial vegetation, hydrology, and substrates interact directly with the aquatic ecosystem (Kauffman et al. 1997). Vegetation growing in the riparian zone relies on the available water, and in turn the plants create a link between the aquatic and terrestrial ecosystems. Streambank vegetation and riparian forests help maintain bank stability and provide large woody debris to the channel. Streambank vegetation also acts to increase inputs of food sources for aquatic organisms, moderate water temperatures, and provide cover and food for wildlife. Leaves, which fall into the water, provide nutrients to support the base of the food chain (Meyer et al. 1988), while the plants along streams alter inputs of agricultural nutrients through nutrient uptake (Lowrance et al. 1984). Dense canopy creates a microclimate that moderates air and water temperatures (FEMAT 1993), and vegetative cover provides valuable wildlife nesting, foraging, and dispersal habitat (Brown 1985). Vegetated riparian zones are recommended on all streams to help protect and recover salmonid species (Spence et al. 1996).

Local climate, the water source, volume and flow pattern, and amount of shade naturally affect stream water temperatures. Water temperatures in healthy cold-water streams on the west slope of the Cascades exhibit natural fluctuations over daily, seasonal, annual, and spatial scales. Each of the species covered by this HCP is dependent on clean, cold-water habitat. As a result of elevated water temperatures, this habitat is limiting in the East Fork Lewis River basin (WCC 2000), and temperature-related water quality impairment in the basin is correlated with decreased forest cover (Hutton 1995a). Streamside vegetation along Dean Creek is clearly important to providing habitat suitable for the salmonid species covered in this HCP.

Current Conditions in Dean Creek Riparian Zone

As described in Chapter 3 (Section 3.2.3.2), existing riparian habitat along Dean Creek is degraded. In the upper approximately 1,350-foot reach of Dean Creek between J. A. Moore Road and where the creek bends sharply west, the right bank (looking downstream) of the creek is bordered by dense blackberry and severely grazed land and the left bank is bordered by blackberry and some willow. There are also scattered black cottonwood, red alder, and Oregon ash in this north-south reach of Dean Creek. Downstream, from the west bend to the existing Daybreak Pond 5, the stream runs through pasture and an open stand of Oregon ash, Pacific willow, and red alder, although the understory is severely grazed in places. The expansive pasture and hay field that characterizes most of the Daybreak site begins within approximately 50 feet of the stream's left bank.

Dean Creek flows south across an alluvial fan as it enters the valley from the uplands to the north. Historically, the channel likely shifted position on the fan, and the present channel position is the result of constructing the bridge at J. A. Moore Road and actions to prevent the stream from flooding the adjacent dairy farm. The stream reach adjacent to the Daybreak site receives considerable gravel from upstream and has been dredged by the county on a regular basis to maintain the present channel and to protect the bridge. The stream is perched above the surrounding land in its upper reach, and it periodically overflows its right bank into a ditch on the Woodside property and is routed away from the dairy operation into the pasture below.

Functions Provided by Existing Riparian Conditions

The existing riparian zone provides sparse to moderate shade over 20 to 30 percent of the stream between J. A. Moore Road and where Dean Creek begins to run parallel to existing Pond 5. There are a few moderate to large deciduous trees and no coniferous trees available for large woody debris recruitment. The shrubs and deciduous trees in the riparian zone likely provide some input of organic matter, but much below potential input levels. There is likely to be little to no retention or filtration of nutrients and sediment from the pasture on the right bank. The topography of the land east from the left bank does not contain the stream during high-flow events. In general, the existing vegetation along the stream has little functional value normally ascribed to riparian areas.

Riparian Characteristics Needed to Protect Dean Creek During Mining

Short-term functions of the Dean Creek riparian management zone include protecting the stream from potential mining impacts. Potential impacts of gravel mining to Dean Creek could include inputs of pollutants (primarily leaks of petroleum products from heavy equipment), increased inputs of sediment, depleted flow regimes, and disturbance to soils and vegetation.

To protect Dean Creek from potential inputs of contaminants, a detailed spill prevention and emergency clean-up plan has been developed that is described in CM-02 (Storm Water and Pollution Plan) and Technical Appendix D. This plan will minimize the probability of contaminants from a potential spill reaching Dean Creek. In addition to this level of protection, the inner riparian management zone along Dean Creek where no heavy equipment is allowed to operate (except that necessary for restoration actions) would further reduce the likelihood of a potential spill reaching Dean Creek. Additionally, a barrier to movement of a spill toward the creek (such as temporary hay bales or more permanent earthen barriers) would virtually eliminate any surface movement of spilled contaminants toward the creek.

Sediment input from mining activities into Dean Creek is not likely to occur because the topographic gradient from the outer edge of the inner riparian management zone (75 feet away from the OHWM) slopes away from the stream and towards the mining area. Eliminating ground disturbance in the inner portion of the riparian zone that slopes toward the stream during excavation of Phase 1A and 1B should prevent increased sediment input to Dean Creek.

Depletions of surface flow in Dean Creek are not likely to occur as a result of implementing this HCP. Water in the upper north-south reach of Dean Creek between the road crossing at J. A. Moore Road and the sharp bend in the stream channel towards the west is maintained by runoff. The stream in this location flows across an alluvial fan for approximately 1,350 feet. This reach is underlain by very coarse textured material that has high hydraulic conductivity making it a “losing stream.” The stream is perched, and therefore the groundwater table is not expressed in the stream at this location. This portion of the stream contains water only when there is more runoff than percolation, which typically occurs during the winter. During the dryer months, the amount of runoff is less than percolation and the stream is dry with only subterranean flow. Further downstream, just past the sharp bend where the stream channel flows towards the west, the stream is in contact with the groundwater table. The water elevation in the stream at this location is similar to the water elevations in Ponds 3 and 5. Groundwater lost from the creek in the upper reach likely moves almost vertically to the underlying water table and has little lateral movement until it reaches the water table. No dewatering of the mining excavations is proposed. Therefore, excavation of a pond some distance from the creek (e.g., outside of the inner riparian management zone or 75 feet) is not likely to change the gradient from the creek channel to the groundwater table. Indirect reduction in flow via increased groundwater loss in losing portions of the stream is not likely, because mining should not result in an increase in either the hydraulic conductivity or the groundwater gradient in the vicinity of the creek. Since excavation of new ponds should not have a substantial effect on the groundwater table at the downgradient end of the ponds where Dean Creek is located, the surface water to groundwater gradient should not be affected by mining. Consequently, excavation should not result in a significant loss of groundwater from Dean Creek.

Riparian Characteristics Needed to Provide Long-Term Benefits to Dean Creek

In contrast to the specific riparian characteristics needed to protect Dean Creek from short-term mining impacts, riparian characteristics over the long-term should provide the array of functions normally associated with healthy riparian areas that are important for maintaining high quality, in-channel salmonid habitat. These long-term functions include shade, large woody debris input, organic matter input, nutrient and sediment retention, bank stabilization, channel migration, and wildlife habitat.

The characteristics for healthy, well-functioning riparian buffers along salmonid-bearing streams in western Washington and Oregon are reviewed and summarized in Spence et al. (1996). Riparian buffers need to have a tree canopy sufficient to provide shade, which moderates summer air temperatures near the stream. Buffers need to provide long-term delivery of coniferous large woody debris and vegetation (trees, shrubs, and herbaceous plants) that contributes substantial fine organic litter to the stream. Riparian vegetation also needs to stabilize banks and extend sufficiently away from the stream to control sediment delivery resulting from erosion and retain nutrients and pollutants from surface runoff. In general, Spence et al. (1996) recommend that buffer widths that are 0.75 of site potential tree height be maintained to provide these varied functions. A 0.75 site potential tree height at Dean Creek would be 150 feet, assuming a site-potential tree height of 200 feet (i.e., the site potential tree height for Type I forest lands in western Washington). Spence et al. (1996) also notes that adequate buffer widths for some functions are either not well known or highly variable. These functions include maintenance of riparian microclimate and productivity, protection from windthrow, and wildlife habitat. Clark County's Habitat Conservation Ordinance regulates a 200-foot riparian zone on streams to substantially maintain habitat functions and values.

To protect Dean Creek during excavation and provide long-term riparian functions, a 200-foot wide riparian management zone comprised of an inner and an outer zone will be implemented. The inner zone would be at least 75 feet in width (Figure 3-36). No excavation, except that necessary for recontouring floodplain terraces as part of CM-07 and preparation for planting under CM-07 would occur within the minimum 75 feet inner zone. The outer portion of the riparian management zone will extend from the edge of the inner zone to a minimum 200 feet distance away from the OHWM of Dean Creek. Gravel excavation will take place as Phase 1A and Phase 1B in the outer portion of the riparian management zone during the first 1 to 2 years following the issuance of the ITP and other required permits.

Immediately following this initial excavation, the area will be backfilled with material consisting of imported fill, processing by-product, and/or stockpiled overburden. The backfill will be capped with at least 18 inches of topsoil overlying at least 24 inches of coarse-textured sand, which will provide soil characteristics similar to the native soils in the area (Puyallup fine sandy loam and Washougal gravelly loam). The ground surface elevation will be raised to a level appropriate to support valley-bottom forest. The outer zone will be backfilled and revegetated as per CM-06 within 5 years of implementation of the ITP and other permits required for the proposed mining, expansions, and implementation of the HCP. Backfilling will be conducted in a manner to minimize any compaction and to provide a good growth medium for reforestation. Upon completion of revegetation actions in both the inner and outer zones, the entire 200-foot management zone will remain undisturbed for the remainder of the ITP, except for needed monitoring and maintenance to ensure vegetative growth and species composition. As shrub and tree vegetation develops and matures in the riparian management zone, it will provide riparian functions over the long-term that are considerably better than the present riparian conditions along Dean Creek.

The inner riparian management zone is designed to protect Dean Creek from impacts specific to short-term mining impacts, while the entire 200-foot riparian management zone (inner and outer zones combined) will provide long-term riparian functions and values to Dean Creek. Riparian functions needed to protect the stream from short-term mining impacts differ from those needed to provide long-term habitat benefits (whether long-term use is pasture/hay fields, aquatic habitat, or housing development). A minimum 75-foot inner zone that consists of restored floodplain terraces and riparian vegetation is expected to be adequate to protect Dean Creek from short-term mining impacts. In contrast, a 200-foot enhanced riparian management zone will provide a wide-array of riparian functions over the remainder of the ITP, and those functions should increase as the planted vegetation in the riparian zone matures over the long-term. Many of the short-term and most of the long-term functions of the riparian management zone will result from enhancement measures included in CM-06 (Native Valley-Bottom Forest), CM-07 (Floodplain Terraces), and CM-13 (Riparian Management Zone). Compared to the existing level of riparian functions along Dean Creek, these conditions should result in significant improvement to fish habitat within and downstream of this reach of the creek.

4.4.4 CM-14 – In-Channel Habitat Enhancement in Select Reaches of Dean Creek

IN-CHANNEL HABITAT ENHANCEMENT
IN SELECT REACHES OF DEAN CREEK
CM-14

Following reestablishment of floodplain terraces on the east bank under CM-07, habitat in Dean Creek will be re-surveyed and LWD will be added to the pool-riffle reach downstream of the J. A. Moore Road and upstream of the palustrine channel in the downstream reach. Designs for site-specific log placements will be developed by year 6 following issuance of the ITP and other required permits (5 years after reestablishment of the floodplain terraces), which will allow riparian vegetation sufficient time to develop root systems that will resist lateral scour. Site-specific designs will be developed to improve low-flow habitat quality by enhancing pool scour and to improve winter rearing habitat by increasing cover in pools. In-channel log structures will consist of key pieces of conifer logs that are at least 88 ft^3 in volume (e.g., 22-inches diameter and 30-feet long) at a frequency of > 1 piece per 72 feet of channel. A plan with details on site-specific log placements will be submitted to the Services and WDFW for review and approval prior to implementation.

Rationale

Neither the existing operation or the planned mine expansion are likely to have any effect on the in-channel structure of Dean Creek. Nonetheless, enhancement of the structural integrity and habitat complexity in Dean Creek are important components of this HCP, because Dean Creek is directly connected to the lower East Fork Lewis River. Efforts to restore some of the properly functioning conditions to this stream should benefit not only Dean Creek, but also the lower river ecosystem including several of the covered species. Conservation measures CM-06 (Native Valley-Bottom Forest), CM-07 (Floodplain Terraces), and CM-13 (Riparian Management Zone) will reestablish riparian vegetation communities, which will eventually provide important structural components and future sources of large woody debris to help maintain and enhance the banks and instream habitat of Dean Creek. Until the riparian vegetation communities mature, conservation measure CM-14 (In-Channel Enhancement) will provide direct benefits to the stream by increasing complexity, creating overhanging cover, and promoting pool habitat.

As described in detail in Technical Appendix C and summarized in Chapter 3, Dean Creek flows across an alluvial fan where it enters the East Fork Lewis River valley. The alluvial fan is a natural sediment deposition zone at the transition from steep valley walls to the valley floor. Prior to construction of J. A. Moore Road and land-use changes associated with farming, the stream channel likely migrated across the alluvial fan in response to sediment deposition. From an analysis of aerial photographs dating to 1962, it is evident the Dean Creek channel has been in its present location for at least 38 years. The stream has a large amount of annual bedload transport from the reach upstream of the J. A. Moore Road crossing, which results in continued deposition of gravel both above and below the road. Periodic dredging of the channel above and below J. A. Moore Road by Clark County and discontinuous small levees likely have been instrumental in keeping the Dean Creek channel in its current location. In addition, a parallel ditch has been dug to the west of the channel below J. A. Moore Road, which routes overbank flows away from the existing home and dairy farm on the Woodside property.

Currently, in-channel structure in Dean Creek is scarce, and habitat complexity is likely diminished from historical conditions. In many places the channel is wider than expected, and within the approximately 1,350 feet of channel downstream of the J. A. Moore Road, pool habitat occupies only 15 percent of the channel area (7.7 channel widths per pool). This reach also contains only 0.08 pieces of LWD per channel width (1 piece per 260 feet of channel), which is only one-fourth the amount of wood typically found in an undisturbed stream (NMFS 1996). In addition, the relative lack of trees along the riparian corridor results in a low potential for LWD to be recruited to the channel in the future. The channel banks are eroding in places downstream of J. A. Moore Road, primarily as a result of past livestock trampling on the west side of Dean Creek, although recent fencing now prevents cattle from having access to the streambanks. Habitat characteristics in this reach correspond to “poor” habitat conditions using the criteria specified by the Washington Watershed Analysis assessment methodology (WFPB 1997) and "not properly functioning" using the NMFS Matrix of Pathways and Indicators (NMFS 1996).

The channel morphology of Dean Creek is pool-riffle with gravel-cobble substrate from the J. A. Moore Road crossing downstream approximately 1,350 feet where the stream channel bends sharply to the west. Flow in this reach is intermittent and is consistently subsurface during the summer. This is consistent with the high permeability of sand, gravel, and cobble deposits typical of alluvial fans.

From the sharp bend to the west downstream to the outlet of Pond 5, the channel morphology is dune-ripple or palustrine (a channel type formerly designated as “regime” by Montgomery and Buffington 1993). This reach has a sand-silt bed and is predominantly pool (65 percent by length). Wood is scarce, but there is abundant cover provided by undercut banks and a dense mix of grass, shrubs, and trees adjacent to the stream. During the August 1999 survey, the channel became continuously wetted near a location adjacent to the east edge of Pond 5.

At this location, there was no obvious flow, and the water was most likely impounded from downstream beaver dams.

Downstream of Pond 5, the reach is braided and often ponded behind beaver dams. A private access road on a property to the west of the project area fords the stream causing the stream to back up and eventually overtop the road. Habitat in this reach has also been adversely impacted by the removal of the riparian forest and subsequent encroachment of non-native weeds, such as Himalayan blackberry and reed canary grass.

The original condition of Dean Creek prior to EuroAmerican settlement is unknown. However, numerous remnant channels are evident on aerial photographs, some of which appear to have merged with Mason Creek to the west. The surrounding forest likely transitioned from somewhat drier conditions on the well-drained alluvial fan to wetland conditions on the valley floor. The distinct break in slope from the alluvial fan about 500 feet below J. A. Moore marks where this forest-wetland transition would likely have occurred. Numerous beaver dams were likely present within these lower reaches of Dean Creek prior to settlement by EuroAmericans, which would have promoted the development of wetlands and impounded water. Improvements in the riparian condition throughout the stream length, combined with enhancement of bank stability, increased aquatic cover, and increased pool area in the upper pool-riffle reach will enhance the potential for Dean Creek to support rearing habitat for fish species such as coho salmon, steelhead, cutthroat trout, and the two lamprey species.

Stream enhancement designs for Dean Creek should take into account a number of constraints. The channel is now in a fixed position and is not free to move across the alluvial fan as it would naturally in response to ongoing sediment deposition. Reestablishment of low floodplain terraces on the east side of the creek (CM-07, Floodplain Terraces) will enhance the potential for the channel to overflow its bank and/or develop a meandering pattern. Sediment deposition will likely continue in the channel below J. A. Moore Road due to the natural break in topography at this location. However, deposition in this location threatens the bridge at J. A. Moore Road. Consequently, periodic removal of sediments by Clark County is assumed to continue both up- and downstream of J. A. Moore Road to maintain the bridge’s capacity to convey high flows and to decrease flooding. The bridge contains both the lateral and the vertical movement of Dean Creek at this location.

Property ownership is another significant constraint on actions Storedahl can take as part of CM-14 (In-Channel Enhancement). Dean Creek generally follows the boundary between the

Storedahl and Woodside properties, with the Woodside property to the west. Rehabilitation of the west and north banks of the creek by Storedahl would require some form of conservation easement by the owner of the Woodside property. Although Storedahl has discussed the possibility of a conservation easement with Woodside, with the intent of extending the enhancement measures included in CM-14 to both banks of the creek from J. A. Moore Road to the western edge of Pond 5, such an easement has not been executed, and consequently, commitment to enhancement measures by Storedahl on the west and north banks of Dean Creek can not be made.

The goals of stream rehabilitation for Dean Creek under CM-14 include: 1) increase habitat complexity in the channel and therefore in the lower East Fork Lewis River basin; 2) improve low-flow habitat quality; and 3) allow channel meandering while minimizing the potential for channel migration or avulsion into the proposed mining and reclamation site. The emphasis is on improving fish rearing habitat, but a healthy aquatic ecosystem in Dean Creek could also provide spawning habitat for cutthroat trout and coho salmon. There are several components in CM-14 to accomplish these goals: 1) removal of non-native plant species along channel banks; 2) enhancement of eroding banks using bio-stabilization techniques; and 3) placement of LWD. In addition, actions taken as part of CM-07 (Floodplain Terraces), and CM-13 (Riparian Management Zone), should also be instrumental in enhancing both short- and long-term habitat quality in Dean Creek. Stream rehabilitation designs presented here are based on published guidelines (i.e., Johnson and Stypula 1993; Slaney and Zaldokas 1997) and will be finalized in consultation with the Services and WDFW.

Removal of exotic plants, especially blackberry, will be conducted in conjunction with CM-07 (Floodplain Terraces), which will include some modification of the floodplain surface to increase flood conveyance capacity. Where the floodplain source is modified, exotic plants will be removed mechanically; in other areas they will be removed manually. Care will be taken not to disturb existing stable banks and native shrubs and trees, where practical, during removal of exotic plants.

Bank stabilization will be accomplished primarily by planting native shrubs, especially willows. Cuttings of willow or red-osier dogwood will be planted using live-stakes or whips with a density of two to four live stakes/whips per square yard of channel bank (Table 4-4). Once mature, these shrubs will also contribute significantly to overhanging vegetation, which will provide shade and organic matter to the stream.

Table 4-4. Specifications and design considerations for Dean Creek channel enhancement actions.

Channel Enhancement Action	Specifications and Design Considerations
Exotic plant removal	• mechanical methods where floodplain modification is also occurring; otherwise use manual removal • ground disturbance will take place during summer
Live stake plantings	• 2-4 cuttings / yd^2 • minimum diameter 0.5 in, optimum diameter 2-3 in • minimum length 1.5 ft, optimum length 3-4 ft • plant in fall or early spring
Herbaceous erosion control cover	• restricted to channel bank • seed mix of grasses and legumes (e.g., *Festuca arundinaceae*, *F. rubra*, and *Trifolium repens*) • seed in early fall after ground disturbance • irrigate as needed during establishment
In-Channel LWD	• minimum volume 88 ft^3 (e.g., 22 in diameter and 30 ft length) • average > 1 piece per 72 feet of channel • angled orientation relative to channel • keyed into bank or against boulders if needed for stability

Until cuttings develop and roots bind the soils on the bank, an herbaceous ground cover will be established on the channel bank for erosion control. However, because herbaceous cover can result in competition with woody species being reestablished and provide cover for rodents that can damage woody species, the areal use of herbaceous erosion control cover will be minimized. In areas with more severe erosion potential, geo-textile fabric will also be used to better stabilize exposed bank soils.

In-channel work will emphasize the placement of LWD in the pool-riffle reach upstream of where the channel bends sharply to the west (approximately 1,350 feet below J. A. Moore Road). Pool-riffle channels form pools via lateral flow oscillations and scour around LWD or obstructions; therefore, banks must be stabilized prior to placement of LWD to prevent further degradation. Placement of LWD will begin 5 years after bank treatment to allow banks to stabilize and resist lateral scour associated with in-channel wood structures.

In-channel LWD will primarily consist of "key pieces," which are LWD pieces large enough to be independently stable in a stream of a given bankfull width and can retain other pieces of organic debris (WFPB 1997). Placement of key pieces will function to trap natural organic debris in the stream, which will be augmented by appropriately sized organic debris salvaged from the mining operations. For Dean Creek, with an average bankfull width of 21 feet, key pieces will have a minimum volume of 88 ft^3 (e.g., a log averaging 22 inches in diameter and 30-feet long) following guidelines of the WFPB (1997) (Table 4-4). Frequency of LWD to be placed in the channel will average > 0.3 pieces per channel length or at least 1 piece per 72 feet of channel length, which is considered to be characteristic of good habitat quality for western Washington streams.

This frequency is comparable to a frequency of > 80 pieces of > 24-inch diameter and > 50 feet-long wood that is used to define "properly functioning conditions" in old-growth coastal rivers (NMFS 1996). The combination of placed and replanted valley-bottom forest along the riparian corridor to provide future inputs of wood will greatly improve the habitat complexity of Dean Creek. The key pieces placed in the channel should be independently stable due to their size, although if necessary, LWD key pieces will be keyed into the bank or against boulders to keep them in place. Placement of boulders in the channel will only be used where they are needed to stabilize placed LWD. The geomorphic setting of Dean Creek indicates that boulders were likely of minor importance compared to LWD in maintaining channel complexity prior to disturbance.

Placed wood will generally be slightly angled with respect to the channel, depending on channel characteristics and enhancement needs at specific locations. Large woody debris will be placed in configurations that avoid backing up water and sediments, and that reduce the proclivity toward further channel migration or widening. A hydraulic analysis will be conducted to ensure that placement of LWD in Dean Creek does not increase the frequency or magnitude of flooding to the Woodside property or exceed the capacity of the setback levee to contain floods. The structural designs will be approved and constructed under a WDFW Hydraulic Project Approval permit and presented to the Services for review prior to implementation.

Conservation measure CM-14 (In-Channel Enhancement) will help improve the habitat complexity within Dean Creek by reducing the rate of input of fines from bank erosion and by providing structural elements to help maintain pools and cover. Implementation of this conservation measure will improve winter rearing habitat for resident and anadromous species, improve low-flow habitat quality by supporting a narrower, deeper channel, and help prevent potential channel migration into the proposed mining and reclamation site.

4.4.5 CM-15 – Shallow Water and Wetland Habitat Creation

SHALLOW WATER AND WETLAND HABITAT CREATION
CM-15

Approximately 84 acres of wetlands, including forested wetland (52 acres) and emergent wetlands (32 acres) will be created and preserved on the Daybreak site. Along the wetted edges and in the shallow water, structural elements will be incorporated into the ponds to provide substrate and cover for a variety of organisms, including invertebrates, amphibians, and fish. The structural elements will consist of submerged tree crowns that are 20- to 30-feet long placed along the submerged sloping perimeter of the ponds. The tree crowns will be anchored with rocks to keep them in place and prevent flotation to the surface. Average frequency of placement will be approximately one per 100 feet of shoreline, although the spacing will be irregular.

Rationale

Complex wetland habitat is an important ecosystem component in the lower reaches of the East Fork Lewis, Lewis, and Columbia rivers. As the East Fork Lewis River enters the Willamette-Puget Lowlands from the foothills of the Cascade Mountains in the vicinity of the Daybreak site, its gradient decreases and the valley widens, allowing the stream to become more meandering. Channel migrations and natural avulsions result in the creation of new channels and the abandonment of old channels. The old channels often become oxbow ponds that remain connected to the current main channel and have extensive wetlands along their margins.

Historic analysis indicates that, prior to alterations following EuroAmerican settlement, there was considerable channel complexity in the reach of the East Fork Lewis River adjacent to the Daybreak site (Collins 1997). The river was braided and associated with a substantial amount of wetland habitat, in contrast to the present condition, which is described by a single channel and valley bottom that is dominated by pasture of primarily upland plant communities. Immediately downstream of the Daybreak site, the river becomes wider and more meandering as the gradient of the river decreases; numerous natural oxbow ponds also remain along this section of the river.

The wetland conditions created by these geomorphic processes in the vicinity of the Daybreak site historically provided important habitat elements for a wide variety of plant and animal species, including those covered in this HCP. The reduction in the extent of these wetlands has diminished the ability of this area to support as diverse and productive an ecosystem as occurred prior to EuroAmerican settlement. The creation of wetland habitat around the existing and proposed ponds will be a substantial contribution to the restoration of this important habitat type in the East Fork Lewis River valley.

The existing Daybreak ponds consist of approximately 64 acres of open water habitat and small amounts of emergent wetland habitat along shorelines. There has been little directed habitat enhancement in these existing, man-made open water and wetland areas; consequently, they provide substantial opportunity for habitat modifications that will directly benefit the overall ecosystem health of this area of the East Fork Lewis River. The narrowing of the existing Daybreak ponds and the creation of forested and emergent wetland along the shorelines will be accomplished under CM-08 (Mining and Reclamation Designs).

The created wetlands throughout the Daybreak site will provide shallow water habitat suitable for Oregon spotted frogs, complex habitat that could support a variety of juvenile fish, habitat for emergent vegetation communities, and increased trophic complexity. Preferred habitat of Oregon spotted frog consists of marshes dominated by sedges, rushes and grasses located along the edges of lakes, ponds, or slow streams (Corkran and Thoms 1996). The created wetlands along the margins of the existing and proposed Daybreak ponds will provide this kind of habitat.

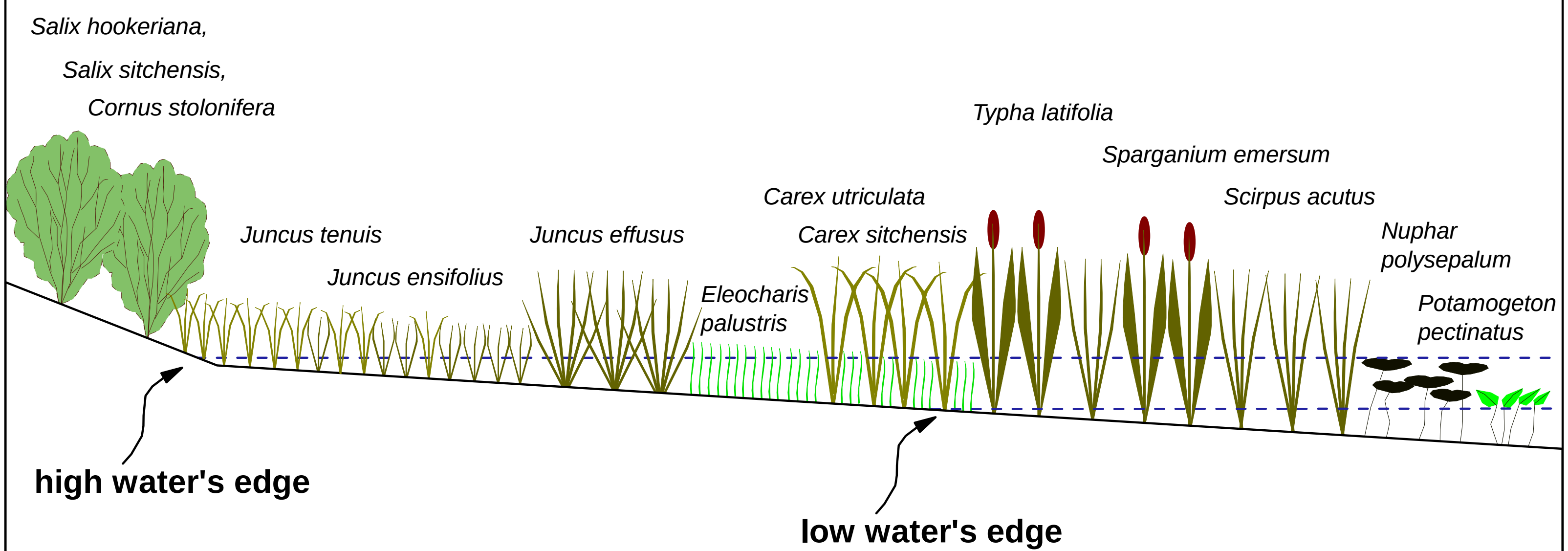
The creation of structurally complex ponds with a mixture of open water and emergent wetlands will also offer a possibility of using one or more of the ponds as off-channel rearing habitat for anadromous fish. Off-channel habitat has been identified as a limiting factor in the East Fork Lewis River for salmonid recovery (WCC 2000). However, as discussed in CM-16 (Control of Non-Natives), Storedahl is committed to restricting the frequency of events that would allow anadromous fish to swim into the ponds, as a way of reducing potential take as a result of predation. However, if the limnological conditions and fish community in the ponds are determined to be suitable for rearing and over-winter habitat, the future possibility exists that the ponds could be made accessible to juvenile salmonids. Following the expiration of this HCP, one or more of the ponds could provide protected aquatic habitat for juvenile salmonids, similar to that of natural oxbow ponds. The typically high productivity of these aquatic areas, combined with other features that benefit young fish (such as shallow water areas, wetlands, and a variety of structural features that will be installed in the ponds) could potentially provide excellent rearing habitat for juvenile salmon and steelhead. Structural features will add substantially to the habitat value of the ponds for fish, providing thermal cover, refuge from predators, and substrate for invertebrates. These features should effectively result in an increase in the carrying capacity of the ponds for fish, as they increase availability of food resources and refugia.

Restoration Plan

The land proposed for mining on the Daybreak site is currently dominated by pasture and hay fields and the existing site is primarily open water or processing areas (Figure 3-29). Mining and reclamation on the 300-acre site will result in approximately 102 acres of open water habitat, 114 acres of valley-bottom forest, 52 acres of forested wetland, and 32 acres of emergent wetlands (Section 3.5.3). Shallow emergent wetlands will be created in embayments, along the pond shorelines, and in smaller excavated areas (Figure 3-35). Several smaller excavated areas (Phase 1C, 1D, and 2) will be reclaimed entirely as forested wetland and emergent wetlands. The width of the wetland zone within the embayments of the larger excavations in the expanded mining area will be up to 200 feet, but will be as narrow as 20 feet in smaller patches.

Water levels in the ponds are now being monitored to provide a more accurate measure of the annual fluctuation, but annual fluctuation is currently estimated to be 2 to 3 feet. The narrower wetlands will have zonation determined by the gradual decrease in water depth shoreward (Figures 4-11 and 4-12, and Table 4-5). Species will be planted at depths approximating their occurrence in natural wetlands. The larger wetland areas will have approximately 50:50 interspersion of emergent vegetation and water created by variability in grading (e.g., deeper and shallower areas).

In deeper areas, sago pondweed (*Potamogeton pectinatus*), a species highly favored by waterfowl for food, will be introduced. Also in deeper, protected areas, rhizomes of yellow pond-lily (*Nuphar polysepalum*) will be planted to develop a floating-leaved component to the wetland vegetation. The deepest emergent plants to be established included hardstem bulrush (*Scirpus acutus*), burreed (*Sparganium emersum* or *S. eurycarpum*), and common cattail. These areas provide cover and nesting habitat for a variety of wetland bird species, such as yellow-headed and red-winged blackbirds, marsh wrens, and some waterfowl species. The mid- to upper portions of the shoreline wetlands will be planted with several species of sedge (*Carex utriculata, C. sitchensis*), spikerush (*Eleocharis palustris*), and rush. There should also be some natural colonization of wetland species from nearby seed sources, such as the existing Daybreak ponds or wetlands in abandoned oxbows.



- Planting density : 3 foot centers
- Plantings using rhizomes or bare-root plants as appropriate
- *Typha latifolia* and *Juncus effusus* in lower proportions

Figure 4-11. Profile of planting scheme in emergent wetland community, at the Daybreak site.

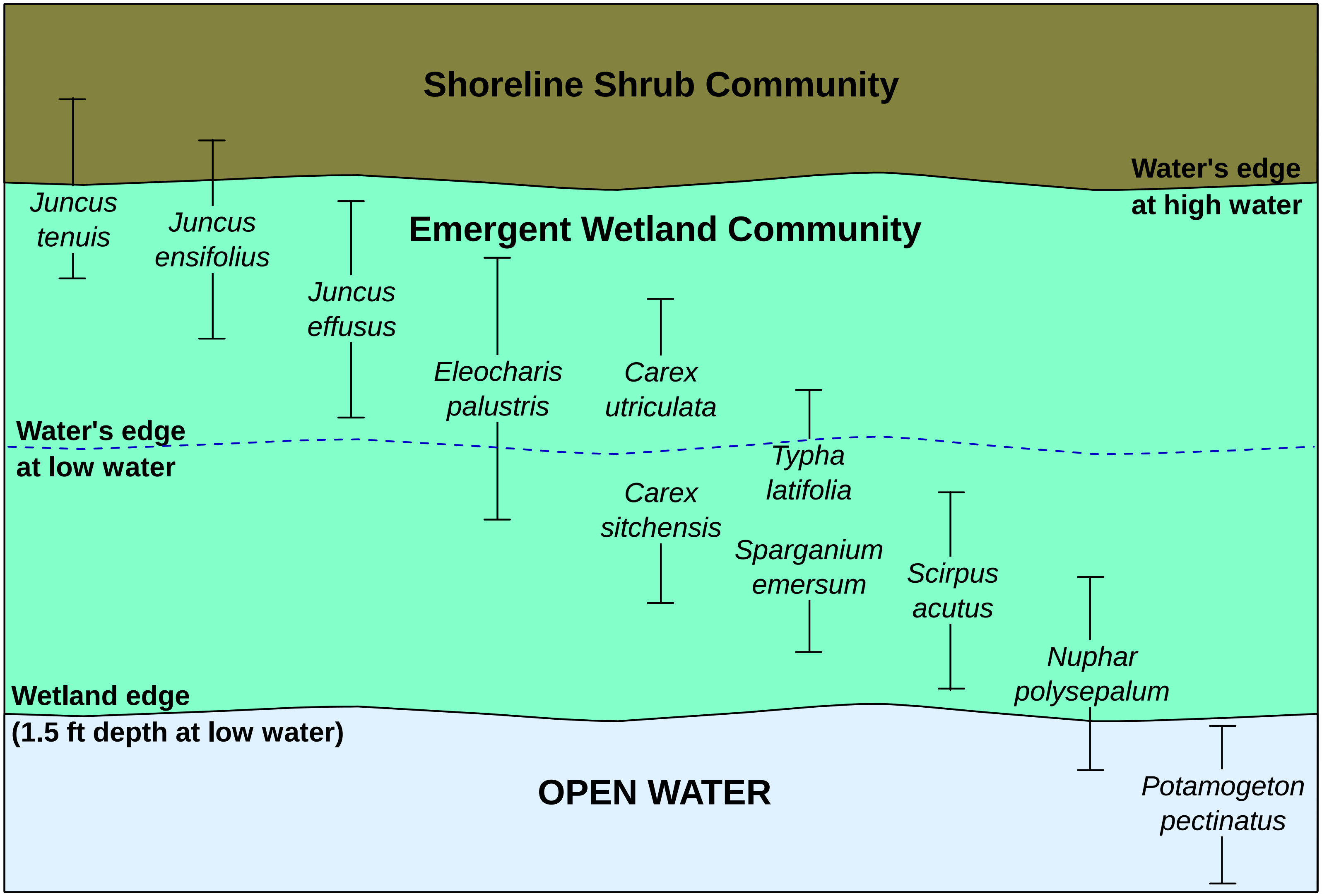


Figure 4-12. Zonation of plantings and natural colonization in emergent wetland community at the Daybreak site.

Table 4-5. Specifications for plantings in wetland areas on the Daybreak site.

Species	Depth Range[1] (feet)	Average Spacing (feet)	Planting Material
Potamogeton pectinatus (sago pondweed)	4.0 – 6.0		rhizome
Nuphar polysepalum (yellow pond lily)	3.0 – 4.0	3	rhizome
Scirpus acutus (hardstem bulrush)	2.0 – 4.0	3	rhizome
Sparganium emersum, S eurycarpum (burreed)	2.0 - 4.0		rhizome
Typha latifolia (common cattail)	2.0 – 3.0	3	rhizome, natural seeding
Carex utriculata (=*C. rostrata*, beaked sedge)	1.5 – 2.5	3	rhizome
Eleocharis palustris (common spikerush)	1.0 - 2.0	3	rhizome
Carex sitchensis (Sitka sedge)	1.0 – 2.0	3	bare-root
Juncus effusus (soft rush)	0.5 – 1.5	3	rhizome, natural seeding
Juncus ensifolius (daggerleaf rush)	0.5 – 1.5	3	rhizome
Juncus tenuis (slender rush)	+0.5 – 0.5	3	rhizome

[1] Depth is relative to high water and assumes a 2 to 3 feet decline in water through the growing season.

Specifications for Site Preparation, Plantings, and Maintenance

The pond shorelines for the wetland areas will have a grade of greater than or equal to 5:1 to create a relatively broad gradient of water depths (Figure 3-35 for elevation contours of wetland areas and Figure 3-36 for profile of typical wetland creation area). The shallow areas will generally be created by backfilling with imported or material excavated but not exported from the site or with sediment separated from gravels. Stored topsoil from the excavated areas will be placed as the topmost layer in the backfilled wetland areas to a depth of at least 12 inches.

Plantings in the lower portions of the wetland areas will be in the fall during low water conditions. Middle and upper portions of the wetlands will be planted in the spring as declining water levels expose portions of the shoreline. Plantings will primarily utilize bare-root plants or rhizomes and will be anchored with staples (Table 4-5). Spacing will be at 3-foot centers. Species will be planted in patches rather than interspersed as individuals. Cattail and soft rush will be planted sparingly, since they will likely colonize naturally and can spread more aggressively than other species.

4.4.6 CM-16 – Control of Non-Native Predatory Fishes

CONTROL OF NON-NATIVE PREDATORY FISHES
CM-16

The frequency of backwater flood flows from the East Fork Lewis River into Pond 5 will be reduced by reconfiguring the southern and western berms around Pond 5 and by installing a single outlet point from Pond 5 for surface water (CM-04, Water Management Plan). Concurrently, the quantity of existing and potential habitat available to non-native predatory fishes in the existing Daybreak ponds will be reduced by significantly narrowing Ponds 1, 2, 3, and 4 (CM-08, Mining and Reclamation Designs). Targeted harvests of non-native predatory fishes to reduce their numbers in the existing ponds will occur under the direction of WDFW warmwater fish biologists in years 5, 10, and 15 following implementation of covered activities and the issuance of any other required permits. Rock barriers will be installed to restrict movement of fish between the existing and created ponds. Educational signs will be installed to warn the public about the dangers of releasing non-native fish species to the ponds and the adjacent stream and river.

Rationale

Non-native fish species, including the predaceous largemouth bass, are known to exist in Pond 5. It is probable that non-native fish species also occur in the other four ponds. Non-native fish are typically released into ponds throughout the United States, either purposefully or in ignorance of fishery regulations designed to prevent these introductions. In the lower Columbia River basin, a mix of non-native and native fish species has been similarly observed in gravel mine ponds adjacent to the Willamette River in Oregon (Bayley and Baker 2002). Non-native predaceous fish, such as largemouth bass, also exist in the mainstem East Fork Lewis River, although these fish typically are associated with lake-like environments, as they depend on relatively warm, low-velocity water, and gravel substrates for nesting (Stuber and Gebhart 1982).

Largemouth bass are highly predaceous, and they commonly feed on fish, crawfish, frogs, large insects, and other small animals. During the feeding months, when water temperatures are warm, largemouth bass generally occur near cover such as vegetation, logs, docks, points, or rocks. Largemouth bass have been observed in the East Fork Lewis River from Lewisville Park all the way down to the mouth (Weinheimer 1999). In addition, largemouth bass are believed to exist in all suitable habitats in southwest Washington, or if not present, they will move into or be transplanted (illegally) to all suitable habitat in the near future (Weinheimer

1999). Gravel ponds and naturally occurring deep, off-channel habitats, such as oxbows, beaver ponds, and wetlands generally provide suitable habitat for largemouth bass. This is also productive habitat for several native fish including longnose dace, stickleback, northern pikeminnow, juvenile lamprey, steelhead, cutthroat trout, and juvenile Chinook and coho salmon. The use of these off-channel habitats by both native and non-native fishes makes it difficult to manage habitat for the recovery of listed and covered species. Although the existing Daybreak ponds currently provide spawning and rearing habitat for non-native predaceous fish, the reclaimed ponds could also provide accessible and potentially high-quality rearing habitat for most of the covered species.

In other western rivers, isolated ponds have been connected to the rivers to provide off-channel rearing habitat for salmonids (Everest et al. 1987; Reeves et al. 1997; Richards et al. 1992; Reiser et al. 1992), and the potential benefits of these efforts are widely recognized (Williams et al. 1997; Naiman and Bilby 1998). In Oregon, juvenile Chinook salmon attain larger sizes in off-channel ponds than in the river (Bayley and Baker 2002). This study also found that terrestrial floodplain habitats were used predominantly by native species for feeding during high flow events. In Alaska, large numbers of juvenile coho salmon were found to use off-channel ponds created by gravel mining as winter rearing habitat (Bryant 1988). In these ponds, the accessibility between the river and the ponds was the most critical factor determining their use by juvenile coho. In the Pacific Northwest, accessibility is also suspected of being critical in maintaining the productivity of off-channel ponds for salmonid production (Frissell and Ralph 1998). Frissell and Ralph (1998) stressed the potential difference in long-term productivity of ponds reconnected to rivers that required maintenance (i.e., dredging of the inlet channel) versus ponds that were designed with self-maintaining connections to the river.

Even though salmonid access to off-channel habitats can increase salmonid productivity, and off-channel habitat has been identified as a limiting factor for salmon and steelhead in the East Fork Lewis River (WCC 2000), the dichotomy remains that rearing salmon and their non-native predators prefer the same off-channel habitat conditions. Development of the HCP for the Daybreak site weighed the potential "benefits" of maintaining access for rearing salmonids to the Daybreak ponds versus the potential "costs" of increased predation on these same fish if they do access the ponds. Currently, Pond 5 alternatively releases surface water from one of three outlets along its western berm. The active surface water outlet is dependent on beaver dam-building activities in the low spots where the surface water exits or dam building downstream of these outlets, which results in backwatering and release of water at one of the other locations. At the same time, during relatively low-intensity flood events, the East Fork Lewis River overtops its banks and backwaters into Pond 5. This frequent and diffuse connection of Pond 5 with the East Fork Lewis River may increase salmonid use and productivity, similar to the benefits observed in other systems (Bryant 1988; Frissell and Ralph 1998; Bayley and Baker 2002). However, the impacts of predation by largemouth bass residing in the pond increases as accessibility to the ponds increase. In order to manage water use and restrict the potential release of warm surface water, the diffuse outlets from Pond 5 need to be reconfigured so that surface water releases can be controlled at a single outlet (CM-04, Water Management Plan). Implementation of CM-04 will effectively reduce the frequency that the East Fork Lewis River backwaters into Pond 5 to greater than 17-year flood events. A potential benefit is that the frequency of interactions between non-native predators in Pond 5 and covered species carried into or swimming into Pond 5 will be reduced.

Another way to reduce the potential for predation by non-native fish on the covered species is to reduce the abundance of the non-native predators in the Daybreak ponds. The reduction in numbers of largemouth bass in the existing ponds is one of the goals of CM-08 (Mining and Reclamation Designs), which will significantly reduce the amount of available habitat for largemouth bass by narrowing the existing ponds and reducing the amount of open water habitat. In addition, under CM-16 (Control of Non-Natives) Storedahl will coordinate with WDFW warmwater fish biologists to develop and implement a selective harvest plan for largemouth bass. This targeted harvest will occur in years 5, 10 and 15 of the HCP at the Daybreak ponds in an effort to reduce their abundance and potential predation on the covered species. Historically, the most common method for removing undesirable fish from ponds was the use of rotenone or other fish toxicants (Murphy and Willis 1996). However, the Daybreak ponds also contain a variety of native fish species, which would also be affected by toxicants. Selective methods of removing non-native fish species are limited. Targeted angling, seining, or other fish trapping methods selected in consultation with WDFW biologists will be used to reduce the number of largemouth bass in the existing ponds. However, it is unlikely that these methods would be effective in permanently eradicating largemouth bass or other undesirable fish populations from the ponds, due to the widespread occurrence of these species in the watershed and the common practice of illegal sport-fish releases, which could result in reintroductions of these fish.

Currently, the existing ponds are hydraulically connected by overflow channels, culverts, or by porous rock berms. The proposed ponds will also be hydraulically connected to each other and to the existing ponds as part of the SWPPP/ESC (CM-02). These connections are needed to control water flow and pond elevations. To restrict movement of and colonization of the future ponds by non-native fish in the existing ponds, porous rock berms will be placed at all hydraulic connections between the ponds. Although fish movement can occur through interstitial spaces between rock substrates, the use of rock barriers should significantly impede fish movement. In addition, Storedahl will install educational signs near the most popular fishing sites on the property to warn the public about the dangers of non-native fish transfers and introductions. In support of CM-16 (Control of Non-Natives) the extent of non-native fish use in the existing and future ponds on the Daybreak site will be determined before and after targeted removal efforts through monitoring measure MEM-09.

4.4.7 CM-17 – Create Habitat Suitable for Oregon Spotted Frog

CREATE HABITAT SUITABLE FOR OREGON SPOTTED FROG
CM-17

If the presence of this species in Clark County is verified by WDFW, surveys of the Daybreak site for Oregon spotted frogs will be conducted. If this covered species is present on the site, potential take will be minimized by installation of exclusion fences to restrict breeding frogs from entering areas where mining and reclamation activities are taking place, and by seasonally timing the mining and reclamation activities (to the maximum extent possible) to avoid negatively impacting breeding spotted frogs.

Rationale

Oregon spotted frogs are rare in Washington State and have been found in only four locations. Recent surveys for spotted frogs in Clark County have not revealed any occurrences, although Clark County and the Daybreak site are located within the historical range of this species. Breeding spotted frogs use seasonally inundated areas with low vegetation to lay their eggs. After the eggs hatch, the tadpoles seek out more permanent water such as ponds and stream margins.

If WDFW finds evidence that Oregon spotted frogs exist in Clark County, Storedahl will avoid potential take of Oregon spotted frogs by surveying for breeding spotted frogs during February and March. If Oregon spotted frogs are observed, exclusion fences will be placed to restrict frogs from accessing sites scheduled for mining or reclamation (Graniterock Company 1998). All observations of frogs will be coordinated and reported to WDFW and Clark County.

4.4.8 CM-18 – Controlled Public Access

CONTROLLED PUBLIC ACCESS
CM-18

Public access to the site will be controlled by the decommissioning of unnecessary roads, placement of vehicle barriers, and development of foot trails. These actions will minimize destructive or injurious vehicle and foot traffic on riparian habitats and limit access to covered species by potential poachers. During the operational phase of the mining and processing, on-site security agents will be instructed to restrict trespassing in sensitive areas when they are present.

Rationale

Public access to the Daybreak site is restricted during business hours, but recreational use occurs on the site after hours and on the weekends. Some of these recreational activities are relatively passive, such as hiking and bird watching. Other activities, including fishing, hunting, and off-road vehicle use could have potential negative impacts on the covered species. Of particular concern is off-road vehicle access onto the site or to adjacent properties via the Daybreak site. Unrestricted vehicle traffic in the floodplain and along the banks of the East Fork Lewis River and Dean Creek can kill vegetation important to overall restoration, reduce bank stability, and promote erosion. Unrestricted foot traffic can also have similar effects where it is excessive or directed onto sensitive areas.

Once mining and site reclamation have been completed, two small gravel surfaced parking areas will be constructed. The former access road will be gated, and a limited number of trails will be constructed to focus recreational use away from sensitive areas. Decommissioning access roads when they are no longer needed, providing and locating foot trails to direct pedestrian traffic away from sensitive areas, and instructing security personnel to prohibit access to sensitive areas during mining and reclamation will reduce destructive vehicle and foot traffic and discourage use of the site by poachers.

CONTENTS

TABLES

5. MONITORING AND REPORTING

Storedahl recognizes that monitoring and evaluation is integral to the success of the habitat and species-specific conservation strategies described in Chapter 4. The monitoring and evaluation program will serve as the primary means of assessing the success of the HCP measures. The monitoring program will allow Storedahl to document compliance with the terms of the ITP and determine the effectiveness of the conservation strategies. The monitoring and evaluation program will also provide critical information needed to determine appropriate adaptive management responses related to the conservation measures and mining activities.

It is only through a program specifically designed to monitor and evaluate that the success of a given conservation measure can be gauged, problems identified, and necessary modifications made to improve its performance and effectiveness. This chapter describes the Monitoring and Evaluation Measures (MEMs) that Storedahl has agreed to fund as part of this HCP.

5.1 OBJECTIVES

The HCP monitoring and evaluation program is designed to meet the following objectives:

1) Ensure that the HCP conservation measures comply with appropriate design standards.
2) Assess the impacts of the project and associated conservation measures on species covered by the HCP and ensure that measures implemented under this HCP are effective in meeting their goals, as described in Chapter 4.
3) Provide information to guide the adaptive management process during the implementation of the HCP conservation measures.

5.2 ADAPTIVE MANAGEMENT FRAMEWORK

The proposed MEMs were developed within an adaptive management framework that acknowledges uncertainty inherent in the management of biological systems and that, in order to succeed, scientists must proceed on the basis of “best available knowledge” (Lee and Lawrence 1986). Key elements of adaptive management include monitoring, analysis, and modification of specific conservation measures to increase their effectiveness and benefits, while meeting overall project goals. This approach involves a number of components that render the program both dynamic and responsive. These include: 1) phased implementation of many of the conservation measures so that appropriate modifications can be made as information becomes available through monitoring; 2) incorporation of potential changes in project design, management, and operations in response to monitoring results; 3) implementation of changes in the monitoring program structure, if necessary, to meet monitoring objectives; and 4) ongoing coordination with resource agencies and the LCFRB to ensure that management strategies and decision making are consistent with the objectives of this HCP. This iterative approach to implementing the specific monitoring measures is consistent with an overall adaptive management philosophy, and will be practiced throughout the duration of the HCP.

Within the adaptive management framework, monitoring is designed to answer specific questions related to the success and mechanisms of success of the HCP conservation measures. That is, specific questions are formulated that address management needs or uncertainty in management actions, and these questions are used to determine the sampling design for data collection in the monitoring program. The results of each monitoring measure should, therefore, help provide answers to the question "Is the conservation measure successful in meeting its stated objectives?" and, if not, "Why is the conservation measure less than successful?" Informed decisions on changing the design or implementation of the measure can then be made as part of the adaptive management process.

5.3 MONITORING AND EVALUATION MEASURES IMPLEMENTED UNDER THE HCP

The Monitoring and Evaluation Measures developed to achieve the objectives stated in Section 5.1 above include two kinds of monitoring measures, compliance and effectiveness monitoring. Compliance monitoring assesses the proper implementation or Storedahl's compliance with individual conservation measures described in Chapter 4. Effectiveness monitoring includes measures focused on assessing the effects of both the project and the effectiveness of the conservation measures. Monitoring measures in the Storedahl Daybreak Mine HCP include:

- evaluation of effects of conservation measures on water quality;

- documentation that wetlands, ponds, and vegetated areas are constructed, maintained, and reclaimed within the HCP area as stipulated in the HCP;

- assessment of plant survival and vigor and the relative degree of bank stability associated with riparian revegetation and bank stabilization projects;

- monitoring of channel and habitat changes in Dean Creek that result from stream and riparian conservation measures including: substrate composition, streambed and streambank configuration, LWD loading, and canopy cover; and

- monitoring of changes in the East Fork Lewis River channel migration rate, channel location, and bank stability.

This section describes the MEMs that Storedahl is committed to funding and implementing under this HCP. Specific monitoring measures are listed in Table 5-1, followed by a detailed description of each measure, including its rationale, the questions it addresses, and possible adaptive management in response to monitoring results. Specifically, Table 5-1 lists the criteria, which would automatically trigger a management response. For example, if monitoring indicates that turbidity levels at the NPDES compliance monitoring point exceed 25 NTU, the management criteria, then the management response will be to change the flocculant or dose in the existing treatment configuration (during the first three years of operation prior to bringing the closed-loop system online), discontinue the discharge of wash water while the ponds settle and corrective actions are implemented, or immediately initiate the use of the closed-loop clarification system to ensure that management criteria are met.

Table 5-1. Monitoring and Evaluation Measures for the Storedahl Daybreak Mine HCP.

Monitoring/ Evaluation Measure	Title	Monitoring Frequency	Reporting	Management Criteria	Management Response
MEM-01	Clarification Process Monitoring	• Initial WET testing prior to use of specific dose or chemical in existing system • Daily to quarterly depending on parameter and location • Fish bioassay quarterly • Initial toxicity and bioaccumulation testing of sediments and chemicals in closed-loop system • Annual whole sediment toxicity and bioaccumulation testing	• Annual reports submitted to the Services • Quarterly reports to Ecology	<u>Existing System</u> • Non-toxic WET results • pH between 6.0 and 9.0 for surface water and 6.5 to 8.5 for groundwater • Turbidity less than 25 NTU at compliance point • Dosage and input location optimized <u>Closed-loop system</u> • Non-toxic whole sediments results	• Change flocculant or dose • Modify circulation path of water through the ponds • Accelerate implementation of closed-loop clarification system • Halt wet processing operations
MEM-02	NPDES Monitoring	• Monthly for pH • Twice monthly for turbidity • Quarterly for total suspended solids • Weekly during July through September for temperature	• NPDES reports to Ecology quarterly • Summary presented to Services at 5-year reviews	• pH between 6.0 and 9.0 for surface water and 6.5 to 8.5 for groundwater • Turbidity < 25 NTU at Pond 3 outlet to Pond 5 • Total suspended solids < 40 mg/l	• Modify measures to control storm water runoff • Modify circulation path of water through the ponds • Prevent discharge at Pond 5 to Dean Creek • Halt mining and/or wet processing operations

Table 5-1. Monitoring and Evaluation Measures for the Storedahl Daybreak Mine HCP.

Monitoring/ Evaluation Measure	Title	Monitoring Frequency	Reporting	Management Criteria	Management Response
MEM-03	Water Management Plan Monitoring	• Pond levels and temperature, DO, and discharge will be measured daily from May-Sept at the outlet from Pond 5 or Pond 3 and in Dean Creek just upstream of the Pond 5 outlet	• Raw data submitted to Services annually • Summarized data submitted to Services at 5-year reviews	• Water discharged from the ponds during May through September at or below temperature in Dean Creek as measured upstream of the Pond 5 outlet • Water discharged from the ponds during May through September at or above DO in Dean Creek as measured upstream of the Pond 5 outlet • Pond levels and discharge from the ponds follows specifications of Water Management Plan	• Restrict release if outflow temperature exceeds Dean Creek temperature • Aerate water to increase DO • Modify release schedule in consultation with Services
MEM-04	Pond, Shallow Water, and Shoreline Physical Structure Monitoring	• Post construction following reclamation of each pond and after 5 years	• As-built drawings and report to Services at 5-year reviews	• 32 acres of emergent wetland habitat (water depth between 0 and 3 feet at high water level) • Pond shorelines in the wetland areas with a grade of >5H:1V • Tree crowns 20 to 30 feet in length anchored along perimeter of pond approximately one per 100 feet of shoreline • Root wads anchored to the bottom of the pond at a density of 1 per 2 acres • Rock reefs composed of angular rock with diameters ranging from 1 to 3 feet in clusters of approximately 1 reef per 4 acres	• Additional reclamation or stabilization of existing reclamation as needed to achieve criteria

Table 5-1. Monitoring and Evaluation Measures for the Storedahl Daybreak Mine HCP.

Monitoring/ Evaluation Measure	Title	Monitoring Frequency	Reporting	Management Criteria	Management Response
MEM-05	Vegetation Monitoring	• Annually for 3 years post-revegetation; • After 5 and 10 years following revegetation	• Annually for 3 years and then to Services at 5-year review • Consistent with reclamation permit	• 80% survival of rooted stock • 80% canopy cover of trees (cottonwood, alder, conifers) after 15 years • 30% cover of native shrub in forest after 10 years • 90% native shoreline herbaceous cover after 1 year • 50% native shoreline shrub cover after 3 years and 80% after 5 years	• Determine reason for non-effectiveness and then, if appropriate, correct and replant/reseed
MEM-06	Dean Creek Riparian and Channel Condition Monitoring	• Years 1, 2, 5 and following flows ≥10 year recurrence interval after planting and floodplain rehabilitation are completed Years 1, 2, 5 and following flows ≥10 year recurrence interval after habitat enhancement is completed	• Summarized to Services at 5-year reviews	• 80% shade/canopy from native species • Raw eroding banks ≤25% of total reach after 5 years • Increase in pool or slow water habitat	• Determine reason for non-compliance and/or non-effectiveness and correct, as appropriate
MEM-07	East Fork Lewis River Critical Bank Stability Monitoring	• Visual inspection at least once per year • During 1st low flow season of the HCP and then annually following the high flow seasons for 1st 5 years. Thereafter, survey following observed change or once every 5 years	• Submitted to Services within 10 months of monitoring	• Site G: The distance between the bank and the edge of the road is greater than 80 ft and the overflow channel at point G consistently transmits < 40% of the flow during normal high flows • Site H: Flow has not shifted back into former channel between Sites I and J and no active erosion is observed at Site H following normal high flows	• If erosion exceeds criteria at Site G, implement appropriate engineering solutions along access road • If criteria are exceeded at Site H, implement appropriate engineering solutions along adjacent bank

Table 5-1. Monitoring and Evaluation Measures for the Storedahl Daybreak Mine HCP.

Monitoring/ Evaluation Measure	Title	Monitoring Frequency	Reporting	Management Criteria	Management Response
MEM-07 (cont)	East Fork Lewis River Critical Bank Stability Monitoring (cont)			• Site J (a): Flow has not shifted back into former channel between Sites I and J and no active erosion is observed at Site J following normal high flows; • Site J (b): erosion rate indicates no threat of breaching Pond 5 for at least 5 years	• If criteria are exceeded at Site J, increase monitoring frequency • If criterion is exceeded, implement appropriate engineering solutions along adjacent bank
MEM-08	Pond Fish Use and Limnological Monitoring	• Existing ponds: Prior to and following targeted largemouth bass harvest • Created ponds: yearly for 3 years following reclamation	• Annual reports submitted to WDFW and the Services	• Largemouth bass abundance reduced • Limnological conditions (temperature, pH, and DO) suitable for salmonids	• Recommend or dissuade future use of ponds by the covered species
MEM-09	Oregon Spotted Frog Monitoring	• Two surveys in February-March for 3 years following confirmation of species presence in Clark County	• Confirmed sightings reported immediately to Clark County, WDFW, and the Services	• Presence/absence of Oregon spotted frogs	• If found, exclusion fencing and/or mining and reclamation activities delayed
MEM-10	Financial Status of Conservation Endowment	• Annually	• Annual reports submitted to the Services	• Deposits and interest are accruing	• Rescind ITP if sand and gravel moved from the site is sold without placing surcharge revenues in the endowment fund

5.3.1 MEM-01 – Clarification Process Monitoring

CLARIFICATION PROCESS MONITORING
MEM-01

Storedahl will continue to monitor the effects of chemical additives on water quality and aquatic organisms. While the existing process water treatment system is in operation (estimated to be the first one to three years of the ITP), monitoring will occur at the outlet from Pond 1 to Pond 2 and at the outlet from Pond 3 to Pond 5. The results of this monitoring will be thoroughly evaluated one year after the implementation of the ITP to assess the effectiveness of CM-01. During the first year of operation under the ITP, Storedahl will develop a detailed monitoring plan to assess the effectiveness and potential toxicity of a closed-loop clarification system. The outline of this new monitoring plan is provided here, but the details within the monitoring plan will be dependent on the final closed-loop system design. Final elements of the new monitoring plan will be subject to approval by the Services and Ecology prior to implementation of the closed-loop system.

Extensive monitoring during the operation of the current system has been completed regarding the effectiveness and potential toxicity of the existing system. The results of this monitoring have been reported to Ecology (Appendix G). The table below summarizes the environmental monitoring that will be conducted under similar operating conditions following receipt of the ITP, and until a closed-loop system is implemented.

	Sample Frequency		
Parameter	Pond 1 Outlet	Pond 2 Discharge	Pond 3 Outlet
Dissolved Oxygen (ppm)	Weekly	NC	Weekly
Turbidity (NTU)	Weekly	NC	Weekly
pH	Weekly	NC	Weekly
Temperature (°C)	Weekly during June, July, August, and September	NC	Weekly during June, July, August and September
Oil Sheen (visual)	Daily	Daily	Daily
Total Suspended Solids	Monthly	NC	Monthly
Alkalinity	Weekly	NC	NC
WET Bioassay	Quarterly	As needed	NC

NC = Not collected

MEM-01 (continued on the next page)

MEM-01 (continued)

Quarterly reports will be submitted to Ecology and the Services. The reports will contain the types and quantities of additive used and a data summary, which will report values for monitoring parameters. Copies of the test results, sampling logs, chain-of-custody forms, analytical reports, and lab quality assurance and control reports will be maintained by Storedahl for at least five years from the date of sample collection and, upon request, will be made available to the Services.

Following approval and implementation of a closed-loop treatment system, the release of process water to the Daybreak ponds will be substantially reduced or eliminated. Incidental release of water during maintenance or during normal operations will be rerouted back to the closed-loop system for reuse. Wet processing would be halted if repair, maintenance, or replacement of the closed-loop system is needed. Operational monitoring will be performed on the closed-loop system to determine the minimum amount of additives needed to remove suspended solids from the process water. Bioassays to determine potential toxicity and bioaccumulation will be performed on the removed and dewatered solids using standard USEPA methods (USEPA 2000).

As with the current system, quarterly monitoring reports on the closed-loop system will be submitted to Ecology and the Services. The reports will contain the quantities of additive used and a data summary, which will report values for monitoring parameters. Copies of the test results, sampling logs, chain-of-custody forms, analytical reports, and lab quality assurance and control reports will be maintained by Storedahl for at least five years from the date of sample collection and, upon request, will be made available to the Services.

Questions Addressed by MEM-01

- Is the clarification system effective in reducing turbidity to below 25 NTU?
- Is the pH of the discharged water between 6.0 and 9.0 for surface water and 6.5 to 8.5 for groundwater?
- Is the water discharged from the existing clarifier system non-toxic to aquatic organisms?
- Is the sediment recovered from the closed-loop system non-toxic to aquatic organism?

Rationale

Turbidity is one of the major water quality concerns for surface mining. The HCP will reduce turbidity levels by utilizing a wash-water clarification process (CM-01) to remove suspended sediments from the water column through coagulation, flocculation, and an effective storm water and erosion control plan (CM-02) (see Chapter 4).

Turbidity generated from the process wash water will be significantly reduced by implementing clarification process systems. As under the existing system, chemical flocculants will be mixed in with the recycled process water at a rate that will reduce the turbidity of the water discharged from Pond 3 to Pond 5 to less than 25 NTU (Technical Appendix G). Because this process releases treated process water to the ponds, precautions will be taken to ensure that secondary water quality problems are not created. The secondary water quality attributes of concern under this system are pH and toxicity.

The use of chemical flocculants can alter the pH of the discharge by two means. First, the pH of the process water must be in the proper range for the flocculant to be effective. If the pH is too high or too low, the operator must adjust the pH through the addition of acid or base, respectively. Second, flocculants tend to lower the pH of the process water in the absence of sufficient alkalinity. If this occurs, the operator needs to monitor and adjust the pH of the process and discharge water. Monitoring will ensure that the pH of the water discharged from Pond 3 to Pond 5 is within the surface water criterion of 6.0 to 9.0 pH units for Class A waters.

Any time a chemical is introduced to a water body, toxicity is a concern. As discussed in Section 4.1.1, only flocculants that can be used without harm to fish and their food resources will be considered for use in the clarification process systems. Tests using on-site water will continue to be conducted, in consultation with Ecology, prior to use of any flocculant in the existing system to determine the appropriate dosage rate and to characterize the toxicity of the flocculant. Additional quarterly acute toxicity WET tests will be conducted on the process water.

The implementation of the closed-loop system will re-circulate the treated process water within the treatment system instead of recycling the treated water through the ponds. Because the water is re-circulated within the closed-loop system, the water quality and aquatic toxicity monitoring established for the existing system will not be needed. Although treated water will not be released to the ponds in the closed-loop system, the solids that settle out and are removed from the system will be bound with the additives used for flocculation. Monitoring for the closed-loop system will include initial toxicity and bioaccumulation testing of the chemical-dosed sediments prior to the use of any chemical. Toxicity and bioaccumulation testing will be conducted in accordance with the methods established by the USEPA for freshwater organisms (USEPA 2000). Use of any chemical in the closed-loop system will be dependent on non-toxic test results. During implementation of the closed-loop system, whole-sediment toxicity and bioaccumulation testing will be performed annually.

Possible Adaptive Management Responses

- Use alternative chemical flocculant.
- Modify rate and dosage of application.
- Reconfigure the flow of water from Pond 1 to Pond 2 to Pond 3 to modify the settling time of the treated water.
- Halt wet processing and discontinue wash water discharges until the ponds settle and/or corrective actions are implemented.
- Accelerate the implementation of the closed-loop treatment system.

5.3.2 MEM-02 – NPDES Monitoring

NPDES MONITORING
MEM-02

Storedahl will monitor turbidity, total suspended solids, and pH of the water discharged from the Daybreak site. This monitoring is required per a specific schedule for the Daybreak site per the NPDES permit, which is a general permit covering surface mining activities in the state of Washington. Discharge will be monitored at the outlet of Pond 3 to Pond 5. To be in compliance with its NPDES permit, discharge from Pond 3 must have turbidity < 50 NTU, total suspended solids < 40 mg/l, and pH between 6.0 and 9.0. Although the NPDES permit allows the release of water with turbidity near 50 NTU, Storedahl will maintain turbidity at the Pond 3 outlet to Pond 5 to below 25 NTU, as specified under CM-01. The NPDES monitoring results are reported quarterly to Ecology. Copies of the reports will be provided to the Services, and results will be summarized at 5-year reviews. Monitoring for NPDES permit compliance will continue throughout the period of on-site mining or processing.

Questions Addressed by MEM-02

- Is Storedahl in compliance with the Daybreak Mine NPDES permit?

Rationale

To remain in compliance with the NPDES permit, Storedahl must continue to monitor for turbidity, pH, total suspended solids, and seasonally for temperature at the outlet of Pond 3 to Pond 5. The monitoring of Pond 3 discharge is also pertinent to evaluating the effectiveness of the clarification system (CM-01) and allows an assessment of the effectiveness of the conservation measures in reducing turbidity.

The NPDES permit requires that water discharged from Pond 3 to Pond 5 have turbidity levels < 50 NTU, total suspended solids < 40 mg/l, and pH between 6.0 and 9.0. In addition, groundwater discharges are limited to a pH of 6.5 to 8.5. If Ecology modifies the NPDES discharge criteria or monitoring and reporting requirements of the Daybreak site permit in the future, Storedahl will notify the Services and modify MEM-02, as necessary. Although the NPDES permit allows turbidity levels at the discharge of Pond 3 to Pond 5 to approach 50 NTU, Storedahl is committed to maintaining turbidity to less than 25 NTU.

Possible Management Responses

- Modify circulation path of surface water through the ponds.
- Modify or implement additional measures to control storm water runoff into ponds.
- Prevent discharge to Dean Creek from Pond 5.
- Halt mining and/or wet processing operations.

5.3.3 MEM-03 – Water Management Plan Monitoring

WATER MANAGEMENT PLAN MONITORING
MEM-03

Storedahl will monitor temperature and DO of the water discharged at the outlet of Pond 5, from the pumped-intake system, and in Dean Creek just upstream of the Pond 5 outlet. Monitoring will be conducted daily during the months of May through September,

MEM-03 (continued on next page)

MEM-03 (continued)
when high temperatures are most likely to adversely affect fish. Outflow water will be taken from cooler, deeper portions of the ponds if the pond surface temperature exceeds the temperature in Dean Creek. If cooler water is unavailable, discharge at the outlet will be prevented, or discharge from the pumped-intake system will be released for riparian irrigation and it will not be released directly to Dean Creek. Pond levels and discharge will meet flow objectives outlined in the water management plan.

Questions Addressed by MEM-03

- Is the water released from Pond 5 warmer than the receiving water in Dean Creek?
- Does the water released from Pond 5 have DO levels as high as the water in Dean Creek?
- Is water released from the ponds according to the flow-relief schedule developed under the water management plan?

Rationale

Implementation of the water management plan (CM-04) will allow Storedahl to supplement flows and moderate water temperatures in Dean Creek by releasing cool water from the pond system during the warmer months. The release schedule for the proposed water management plan is designed to vary the outflow according to the anticipated precipitation deficit and historical low flows in Dean Creek. The proposed release schedule is included in the water management plan, but as noted therein, the schedule may be adapted during the precipitation deficit season based on actual climatic conditions and the observed discharge in Dean Creek. Discharge temperature and DO of the discharged water will be measured daily during May through September. Temperatures will be compared to water temperatures in Dean Creek where surface water is generally present year-round just upstream of the Pond 5 outlet. Seasonal plots of the release at each site and a summary of the success of the water management plan at maintaining the desired outflow and temperature regime will be reviewed in consultation with the Services and used to refine the seasonal flow release schedule.

Temperature is one of the more important water quality concerns in the East Fork Lewis River and Dean Creek (Section 3.1.5). During the summer, temperatures in both of these waters commonly exceed the state water quality criterion of 18ºC. The cause of these high temperatures is primarily increased solar heating as the streams flow through areas cleared of riparian forest cover (Hutton 1995d). Surface water temperatures are also typically increased where water flow is reduced and the surface area exposed, such as in wetlands, beaver ponds, or the Daybreak site ponds. In 1998, the surface water temperatures in the existing Daybreak site ponds were higher than 18ºC during the period from the first half of June through late September (Section 3.1.5.3).

Implementation of conservation measure CM-13 (Riparian Management Zone) will increase the riparian cover on Dean Creek and potentially reduce the summertime water temperatures in Dean Creek as it flows adjacent to the Daybreak site. To help support and maintain the benefits of this effort, implementation of conservation measure CM-04 (Water Management Plan) will allow Storedahl to release cool water from deeper strata of Pond 3 or 5, or restrict the release of Pond 5 water into Dean Creek if pond temperatures exceed temperatures measured in Dean Creek. This will provide a source of cool water until the long-term benefits of shade from maturing vegetation in the riparian zone (CM-13) can be realized. To ensure benefits to the instream environment, the DO concentration of the pond outflow will be compared with the DO in Dean Creek at each daily sample collection. Monitoring the water temperature and DO in both the pond and in Dean Creek will provide the information needed to refine the release regime to maximize benefits to habitat in Dean Creek.

Possible Adaptive Management Responses

- Restrict or prevent flow of Pond 5 water to Dean Creek.
- Aerate water to increase DO.
- Adapt outflow schedule developed as part of Water Management Plan.

5.3.4 MEM-04 – Pond, Shallow Water, and Shoreline Physical Structure Monitoring

POND, SHALLOW WATER, AND
SHORELINE PHYSICAL STRUCTURE MONITORING
MEM-04

Storedahl will conduct as-built topographic and bathymetric surveys following reclamation of the new ponds and wetlands to document that the conservation measures and project design criteria were met with respect to depth, slope, location, and habitat features. Surveys will be conducted within six months following reclamation of each pond.

MEM-04 (continued on next page)

MEM-04 (continued)

Additionally, wetland areas will be examined five years post-reclamation to evaluate the stability of the wetland substrate material. Criteria to be met include establishing approximately 32 acres of emergent wetland habitat and installation of structural habitat elements within the ponds, as specified in the reclamation plan. Monitoring the success of revegetation is addressed under MEM-06. Monitoring fish use and water quality is described in MEM-08.

Questions Addressed by MEM-04

- Were habitat enhancement and reclamation conservation measures implemented as designed?

Rationale

This monitoring measure will ensure compliance with the conservation design elements that are incorporated into the mining, reclamation, and habitat enhancement plans. The successful reclamation of wetlands and the enhancement of shallow and open-water fish habitat will be dependent on the careful construction and development of appropriate physical conditions. For example, reclamation plans were designed to support emergent, wetland vegetation by providing gently sloping pond shorelines. Where wetlands will be created along the edges of the ponds, the slope of the pond will be contoured according to state BMPs for reclaiming surface mines (Norman et al. 1997). Following reclamation, approximately 32 acres of wetland habitat will be created that support a vegetative community adapted to growing in water between 0 and 3 feet deep. Fish, amphibian, and macroinvertebrate habitat will be enhanced by installing physical structures along the pond margins. These structures will consist of root wads or tree crowns with branches.

Possible Management Responses

- Correct any aspects of reclamation that do not meet criteria specified in the plans.

5.3.5 MEM-05 – Vegetation Monitoring

VEGETATION MONITORING
MEM-05

Storedahl will monitor all revegetated areas to evaluate the success of plant establishment from seeding and planting. Monitoring will evaluate plant cover, canopy closure, vigor, species composition, and levels of herbivory. The presence and extent of non-native plant species will be noted. If successful establishment and growth of desired plants is retarded, soil moisture, nutrient status, and pond water level fluctuations will also be monitored to aid in identifying any physical factors that might be retarding the establishment and growth of desired plants. Monitoring of vegetation characteristics and soil nutrients will take place annually during the growing season for three years following revegetation and every five years thereafter. Soil moisture will be monitored monthly during the growing season (April to September) for three years following revegetation. Results of vegetation monitoring will be evaluated according to criteria listed in Table 5-1. Monitoring of riparian vegetation along Dean Creek is addressed in MEM-07.

Questions Addressed by MEM-05

- Are criteria for the successful establishment of native wetland, riparian, and upland vegetation being met?
- Are site conditions (e.g., soil moisture and nutrients, water regime) suitable for species being seeded and planted?
- Are desirable native species becoming established naturally from local seed sources?
- Are invasive, exotic plant species inhibiting establishment of native species?
- Is herbivory reducing growth and spread of desired species?
- What are the patterns of plant succession within the various community types?

Rationale

Vegetation will be established in reclaimed areas throughout the Daybreak site, including wetlands, pond shorelines, and upland areas. In addition, other areas within the Storedahl property that are unaffected by mining but lack native vegetation will also be restored to more natural conditions. Successful establishment of native wetland, riparian, and upland vegetation is an integral part of this HCP. Vegetative establishment and growth can be hindered by conditions unsuitable for desired species including too much or too little water, inadequate sunlight, low soil nutrients, competition with exotic species, inadequate seed sources, herbivory, and lack of mycorrhizal development. In order that effective corrective actions can be taken, monitoring will identify what areas have poor establishment and growth and the reasons successful revegetation may not be occurring. In addition, the monitoring will document changes in vegetation to determine whether succession toward desired future conditions of the site are occurring.

Possible Management Responses

- Replace species used in seeding and planting plans with more suitable species.
- Modify seeding or planting densities or change means of plant introduction (e.g., seeding to planting).
- Implement measures to repel herbivores.
- Add fertilizer or irrigate.
- Implement measures to control invasive non-native species, such as Eurasian water-milfoil.

5.3.6 MEM-06 – Dean Creek Riparian and Channel Condition Monitoring

DEAN CREEK RIPARIAN AND CHANNEL CONDITION MONITORING
MEM-06

Storedahl will conduct stream channel surveys to monitor conditions in and along Dean Creek from the Pond 5 outlet upstream to J. A. Moore Road. Baseline conditions were documented during a habitat survey in August 1999. Preliminary locations requiring structural treatment to reestablish bank stability were identified, and it was determined that stabilization of banks should be completed prior to rehabilitation of in-channel habitats. Following construction of floodplain terraces, structural treatment of unstable banks, clearing of non-native vegetation, and planting of the riparian buffer, surveys of canopy cover will be conducted to document baseline shade conditions. Canopy cover will be measured at 100-foot intervals using a densiometer. Surveys of canopy cover will be repeated at 5-year intervals for the duration of the ITP, and results will be reported at 5-year reviews.

MEM-06 (continued on next page)

MEM-06 (continued)

Channel condition/habitat surveys will be conducted one, two, and five years after planting and treatments of unstable banks are completed. Surveys will also be conducted following regional flood events with a return interval equal to or greater than 10 years (i.e., flows of 15,000 cfs at the Heisson USGS gage). In the fifth year following completion of bank rehabilitation activities, habitat rehabilitation plans will be developed for the pool-riffle reach downstream of the J. A. Moore Road crossing. Following completion of prescribed habitat restoration activities, a post-construction survey will be conducted to document adherence to site-specific designs. Follow-up surveys of channel conditions/ habitat will be completed one, two, and five years after rehabilitation prescriptions are implemented, and following regional flood events with a return interval equal to or greater than 10 years (i.e., flows of 15,000 cfs at the Heisson USGS gage). LWD that has decayed or moved to a position that no longer contributes to habitat function will be replaced once over the term of ITP.

Questions Addressed by MEM-06

- Have channel and riparian enhancement measures resulted in improved instream habitat for salmonids?
- Do stabilized banks and LWD structures continue to function following major flood events?

Rationale

Salmonid populations may be affected by numerous processes outside of Storedahl's control (e.g., ocean and in-river harvest regimes, predator-prey relationships in the ocean and river, migration barriers downstream of the Daybreak site). For this reason maintenance or recovery of habitat function will be used to evaluate the success of habitat rehabilitation rather than increases in population numbers. Dean Creek currently provides poor habitat for the species covered by this HCP due to migration barriers, sedimentation, destabilization of banks by livestock trampling, and high water temperatures due in part to the absence of shade.

Monitoring will begin with collection of baseline information that will assist in enhancing Dean Creek and restoring natural functions. Following the initial assessment, conservation measures including re-planting of riparian vegetation, placement of LWD, and rehabilitation of eroding banks will be implemented as described in CM-07, CM-13, and CM-14 (Chapter 4). Some of these measures (e.g., LWD placement) are expected to have immediate impacts on channel conditions. Other measures (i.e., restoration of riparian vegetation) will require a relatively long time before significant improvements can be expected. Monitoring will document the success of the conservation measures by tracking trends in habitat conditions and will provide information needed for adaptive management throughout the 25-year project life.

Possible Adaptive Management Responses

- Modify bank stability measures to make them more effective.
- Replace LWD that has decayed or moved to a position that no longer contributes to habitat function.

5.3.7 MEM-07 – East Fork Lewis River Channel Bank Stability Monitoring

EAST FORK LEWIS RIVER CHANNEL BANK STABILITY MONITORING
MEM-07

Bank stability will be monitored at Sites G, H, and J (Figure 3-33). At Site G, the proportion of total flow transmitted by the relict channel south of the Storedahl Pit Road, and erosion associated with flows through that channel, will be measured using a combination of surveyed cross-sections and visual observation during normal winter high flows. If the surveys indicate that the relict channel has migrated or enlarged to the point that the distance between the north bank and the access road is less than or equal to twice the average annual rate of channel migration (2 times 40 feet), or if visual observations indicate that the relict channel consistently transmits more than approximately 40 percent of the East Fork Lewis River discharge, Storedahl will notify the Services. Storedahl will coordinate and consult with the Services, LCFRB, WDFW, Clark County, and all appropriate permitting agencies to develop engineering solutions designed to prevent a breach of the Storedahl Pit Road as described in CM-09 (Avulsion Contingency Plan).

Storedahl will conduct annual monitoring of bank stability at Sites H and J. Should the river reoccupy its former channel, or if visual observations suggest that bank erosion has increased at Site H or J, the monitoring approach and frequency will be modified in consultation with the Services. If the estimated erosion rate observed during normal high flows (approximately 9,000 cfs at the Heisson gage) suggests that a breach into the Daybreak ponds is possible within less than 2 years (i.e., distance between bank and ponds becomes less than 2 times the observed erosion rate), Storedahl will implement preventative solutions to reduce the likelihood of pond capture. Specific engineering solutions and final designs will be developed in consultation with the Services, LCFRB, WDFW, and Clark County in consideration of all appropriate permitting requirements.

Questions Addressed by MEM-07

- Has the potential risk of avulsions into the Daybreak site increased due to changes in channel location or configuration?

Rationale

The geomorphic analysis of the East Fork Lewis River near the Daybreak site suggested that there are three potential sites where future channel migration or avulsion could result in capture of the existing Daybreak ponds (Section 3.3.2 and Technical Appendix C). Although the analysis indicated that an avulsion into the existing ponds is unlikely within the term of the HCP (the next 25 years), an avulsion could occur into the Daybreak site at some point in the future. Because of this risk and because channel migration into this area could provide important ecological functions, such as off-channel habitat, the existing ponds will be narrowed, shallowed, and the shorelines revegetated in a pattern based on the historical East Fork Lewis River's braided channel locations. However, the risk of an avulsion into the site will be reduced at the same time by increasing the buffer width between the river and the pond's open water, by reducing the hydraulic gradient between the river channel bottom and the bottom of Pond 1, and by increasing bank roughness and stability with revegetation (CM-08, Mining and Reclamation Designs). In order for these efforts to be completed and to successfully reduce the risk of an avulsion, the bank stability of the East Fork Lewis River will be monitored at Sites G, H, and J (Figure 3-33) during the term of the HCP/ITP. The risk of avulsion at these three sites was assessed in a quantitative manner based on the location of former channels, the historic rate of bank erosion, and the location of the preferred flow path relative to the vulnerable site.

Although Figure 3-33 also shows an overflow path between Sites A and B, flows occur in this path only during extreme flood events. The overflow between Sites A and B is a result of backwater flooding and the amount and flow of water along this path is relatively minor and does not represent an avulsion pathway. In addition, the presence of numerous residential developments and two sections of county road between sites A and B effectively prevent the potential for an avulsion path to develop along this route. For that reason, Route A-B is assumed to have no risk of generating an avulsion that could result in capture of gravel ponds at the Daybreak site, and no monitoring will occur at this location.

At Site C (Figure 3-33) the channel has migrated to the north approximately 200 feet since 1996. Continued erosion at Site C could result in the East Fork Lewis River re-occupying a relict meander mapped as an active channel braid in 1854. Two partially-filled gravel ponds excavated by the Clark County are present within this former channel. Should the channel capture the county ponds, the most likely path of avulsion is back toward the existing channel at Site F, because the gradient between these sites is relatively steep (Figure 3-33). However, it is also possible that the relict side channel could become a preferred flow path. Should the East Fork Lewis River reoccupy the relict channel, erosion along and through the Storedahl Pit Road in the vicinity of Site G could result in a breach into the existing Daybreak ponds if no preventative measures are taken.

The future potential for pond capture at point G will be evaluated using a combination of surveyed cross-sections and visual observation during winter high flows. Ten cross-sections will be established along the relict channel near the Storedahl Pit Road. These cross-sections will be surveyed annually for the first three years of the ITP to assess the baseline variability. After year five, the cross-sections will be surveyed in the first year following any flood event in which channel conditions are visually observed to have changed, or once every five years, whichever is more frequent. Visual inspections will also be conducted by a trained hydrologist each year during normal winter high flows (approximately 1,500 to 9,000 cfs at USGS gage 14222500 near Heisson, Washington). Surveys will be conducted when the relict channel is safely accessible at low to moderate flows. If the surveys indicate that the relict channel has migrated or enlarged to the point that the distance between the north bank and the Storedahl Pit Road is less than or equal to 80 feet (or 2 times the average annual rate of bank erosion measured within the relict channel), or that the relict channel consistently transmits more than approximately 40 percent of the East Fork Lewis River discharge, Storedahl will notify the Services and will implement appropriate hydraulic and structural techniques (CM-09, Avulsion Contingency Plan). Storedahl will consult with the Services, WDFW, Clark County, and all appropriate permitting agencies to construct preventative solutions designed to prevent a breach of the Storedahl Pit Road during the term of the HCP/ITP and until reclamation of the site is complete. Any structural engineered solutions put in-place during the period of operation and reclamation could be modified or removed if deemed beneficial to habitat enhancement by Clark County, WDFW, LCFRB, and the Services following the operational period at the site.

Prior to 1996, the East Fork Lewis River was actively eroding the north bank adjacent to the Storedahl processing site at Site H. The channel has historically had a relatively high erosion rate along the flow path between points C and J (Technical Appendix C), but capture of the

Ridgefield Pits on the opposite side of the East Fork Lewis River resulted in the channel being diverted to the south, effectively precluding further erosion at Site H. Sediment transport analyses suggest that it may take decades for the Ridgefield Pits to fill and for the channel gradient to return to pre-avulsion levels (Technical Appendix C). For this reason, periodic visual observations and photographs taken during other monitoring activities are believed to be sufficient to monitor the potential for channel migration at Site H. However, if the river shifts back into its former channel during the term of the ITP or if reconnaissance visits indicate that the rate of bank erosion has changed at this site for other reasons, the frequency of monitoring will be increased, in consultation with the Services. If the rate of erosion threatens the operations facilities, or suggests that future channel migration may result in capture of the Daybreak ponds within 5 years, Storedahl will implement structural controls to reduce the rate of further erosion. Specific adaptive management approaches and final designs will be developed in consultation with the Services, WDFW, and Clark County in consideration of all appropriate permitting requirements.

Site J is located downstream of the majority of the existing Daybreak ponds, thus capture of the ponds at this site would simply connect Pond 5 to the river without routing flow through the other ponds. As at Site H, until the Ridgefield Pits fill and the East Fork Lewis River reoccupies its former channel, there is little risk that erosion will result in a breach of the narrow levee between the river and Pond 5 at Site J. For this reason, periodic visual observations and photographs taken during other monitoring activities are believed to be sufficient to monitor the potential for increased bank erosion at Site J. However, should the channel shift back into its former channel during the term of the ITP or if reconnaissance visits indicate that the rate of bank erosion has changed at this site for other reasons, the frequency of monitoring will be increased, in consultation with the Services. If the rate of erosion suggests that future channel migration may result in a breach into Pond 5 within five years, Storedahl will implement appropriate engineering solutions to reduce the rate of further erosion as specified in CM-09 (Avulsion Contingency Plan).

Possible Adaptive Management Responses

- Place additional LWD to direct erosive energy away from vulnerable banks.
- Implement hydraulic techniques (e.g., barbs, groins, drop structures) and/or structural techniques (e.g., avulsion sill) along the south side of the Storedahl Pit Road if management criteria are exceeded for Site G (Table 5-1).

- Hydraulic and/or structural control of bank erosion adjacent to the processing site if the river reoccupies the channel abandoned in 1996 and the observed rate of bank erosion at Site H is consistently higher than average during normal to moderate (2 to 10 year return interval) flood events.
- Install fuse plugs or construct designated spillways to control the path of potential reaches.
- Hydraulic and/or structural control of bank erosion between the East Fork Lewis River and Pond 5 at Site J if the river reoccupies the channel abandoned in 1996 and the observed rate of bank erosion is high.
- Modify or remove engineered structural controls at the close of operations and/or reclamation.

5.3.8 MEM-08 – Pond Fish Use and Limnological Monitoring

POND FISH USE AND LIMNOLOGICAL MONITORING
MEM-08

Storedahl will monitor fish communities and water quality characteristics that control fish use in the created ponds and in the existing Pond 5. Water quality attributes to be measured include transparency, temperature, pH, and DO. Transparency in the ponds will be measured by secchi depth, a standard and rapid measure of light penetration in surface waters. Temperature, pH, and DO will be measured along depth profiles from the surface to the bottom near the deepest point of each pond.

Transparency and depth profiles in Pond 5 will be conducted monthly from April through September for the first three years of the HCP. In the newly excavated ponds, monitoring of transparency and depth profiles will be conducted from April through September during the first three years following reclamation.

The fish community in Pond 5 will be monitored following completion of CM-04 (Water Management Plan), which will reconfigure the western berm and outlet of Pond 5 and prior to and following targeted removal of largemouth bass. A variety of fish sampling techniques will be used, including, but not limited to, underwater observation, minnow traps, gill nets, electrofishing, and angling. Prior to fish sampling, all necessary state and federal permits will be obtained.

Questions Addressed by MEM-08

- Do targeted harvests reduce the abundance of largemouth bass?

- Are the fish assemblages and limnology of the Daybreak ponds suitable for growth and survival of anadromous fish?

Rationale

The monitoring of water quality in the existing Pond 5 will provide a continuation of the baseline sampling begun in 1998. This monitoring indicated that Pond 5 and Pond 3, two of the deeper ponds, stratify during the summer. Beginning in May, the surface waters in these two ponds begin to warm up while the lower waters remain cool. By mid-summer, two distinct thermal layers have formed. Associated with the development of thermal layers, the lower waters become isolated from the wave action and other forces that allow atmospheric oxygen to mix into the water. As this isolation continues, DO levels in the lower strata decrease to zero. The ability of ponds such as these to support a cold-water trout fishery is limited when the upper waters are too warm for the fish and the lower, cooler waters are deficient in DO needed for respiration. Although Storedahl is committed to reducing pond accessibility for the covered species, understanding the ability of the Daybreak ponds to support a cold-water fishery will provide important information needed to assess the potential usefulness of these ponds as future off-channel habitat.

It has been demonstrated that the wash water clarification conservation measure, CM-01, can significantly reduce the turbidity in Ponds 2, 3, and 5 and potentially reduce the amount of dissolved phosphorus released during the aggregate processing. Decreasing the nutrients available for algal growth and increasing the transparency could lead to increased levels of DO in the cooler waters. Depth profiles of water quality parameters collected for three years following implementation of CM-01 will provide information to address these hypotheses.

Fish community investigations on the Daybreak ponds will focus on determining if, and to what extent, the ponds support native and non-native fish that are predaceous on the covered species. Species composition, distribution, and abundance will be assessed in relation to fish community observations in the East Fork Lewis River under CM-10 (Ridgefield Pits Study). Management options for reducing select populations of non-native (and native) fish are limited, as discussed under CM-16 (Control of Non-Natives). Nonetheless, accurate information describing these populations before and following control efforts are necessary to support management decisions.

Possible Adaptive Management Responses

- Recommend or dissuade the future use of the Daybreak ponds as off-channel habitat for the covered fish species following the term of the HCP.

5.3.9 MEM-09 – Oregon Spotted Frog Monitoring

OREGON SPOTTED FROG MONITORING
MEM-09

If WDFW confirms that Oregon spotted frogs have been found in Clark County, Storedahl will monitor for the presence of Oregon spotted frogs at the existing ponds, excavation sites, and ponds scheduled for reclamation. The presence of Oregon spotted frogs will be surveyed using basic survey techniques described by Olson et al. (1997). Two surveys will be conducted for three years following a confirmation of the species presence in Clark County. The first survey will occur in February, preferably following a warm rain event or when air temperatures have exceeded 10°C (50°F). The second survey will occur approximately two weeks, and no more than 4 weeks, later. Surveys will focus on the northern edge of each existing pond and cover the shallow water zone and shoreline within 3 meters of the waterline. If spotted frogs are positively identified at the site, Storedahl will develop an ongoing monitoring plan and implement protection measures for Oregon spotted frogs, in consultation with the Services.

Questions Addressed by MEM-09

- Are Oregon spotted frogs present at the Daybreak site?

Rationale

There is a report of potential Oregon spotted frog eggs being found at the Daybreak site (Bartels 1998). However, further surveys for Oregon spotted frogs have failed to locate any occurrences in Clark County. However, if this species is found in Clark County, surveys will be conducted on the Daybreak site by a biologist trained in amphibian surveys. If the presence of Oregon spotted frogs is confirmed, Storedahl will immediately notify the Services and will work with USFWS to develop appropriate protection measures.

Possible Adaptive Management Responses

- If Oregon spotted frogs are found on-site, develop ongoing monitoring plan.

- Install fence exclosures to prevent Oregon spotted frogs from entering areas with traffic, mining, or reclamation activities.
- If Oregon spotted frogs are present in areas where mining is imminent, delay mining activities until tadpoles have moved into open water.

5.3.10 MEM-10 – Financial Status of Conservation Endowment

FINANCIAL STATUS OF CONSERVATION ENDOWMENT MEM-10
Storedahl will submit annual (year end) financial records from the dedicated interest-bearing, or managed, account established for the Conservation and Habitat Enhancement Endowment (CM-05). A surcharge of seven cents will be added to the cost of the aggregate, and deposited monthly into this account for every ton of sand and gravel mined from the Daybreak site and sold by Storedahl. If monies are not placed in the account from the sale of sand and gravel mined from the site in a timely manner, the Services may rescind the ITP.

Questions Addressed by MEM-10

- Have deposits been made and is income and/or interest accruing?
- What is the current balance in the account?

Rationale

Annual reports on the financial status of the endowment fund are needed to ensure compliance with conservation measure CM-05 (Conservation Endowment). Noncompliance of this conservation measure could be a reason to rescind the ITP.

Possible Adaptive Management Responses

- If monies are not placed in the account from the sale of sand and gravel mined from the site in a timely manner, the Services have the authority to rescind the ITP.

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6. EFFECTS OF PROJECT OPERATIONS AND CONSERVATION MEASURES

Gravel mining and processing near alluvial rivers has the potential to alter physical and ecological processes. This chapter discusses the potential for such alterations at the Daybreak site under this HCP, and the direct and indirect effects these changes could have on the covered species. The potential adverse alterations that could occur as a result of mining near alluvial rivers include the following:

- gravel extraction below the water table may indirectly impact aquatic habitat in nearby streams by altering groundwater flow patterns and converting groundwater to surface water, thereby altering groundwater flow rates;
- the quantity of water released to nearby streams may change as a result of altered groundwater flow paths, infiltration, runoff, direct interception of precipitation by surface waters, and rates of evaporation and evapotranspiration;
- surface water temperature may increase as a result of the increased area of open water exposed to solar radiation;
- excavation of gravel below the groundwater surface and aggregate processing may increase the amount of suspended sediment in the ponds and outflow during active mining periods;
- turbid water within ponds may limit primary productivity by impairing light penetration, precluding the growth of aquatic plants that replenish dissolved oxygen concentrations through photosynthesis;
- deep ponds may stratify, exacerbating surface temperature increases and reducing DO levels in the lower strata (hypolimnion);
- creation of off-channel pond habitat may support the production of non-native species;
- meandering alluvial rivers may avulse through ponds created by mining, altering habitat and interrupting the sediment transport regime; and
- bank protection activities may interrupt the natural functions of gravel recruitment, large woody debris recruitment, and creation of off-channel habitats.

The Daybreak site is located adjacent to an alluvial reach of the lower East Fork Lewis River. There are five existing gravel mine ponds located on the Daybreak site within the 100-year floodplain. Under the HCP, 15 additional excavations, resulting in five ponds and 10 small wetlands will be excavated outside of the 100-year floodplain. Storedahl is proposing a number of conservation measures to provide immediate benefit to covered species in the lower East Fork Lewis River basin, and other measures to address and reduce the risk of impacts to aquatic habitat and biota that could result from existing and future excavations. The conservation measures summarized here are described in more detail in Chapter 4. These measures include:

Habitat Enhancement and Restoration. Approximately 52 acres of forested wetland, 32 acres of emergent wetland, and 102 acres of open water habitat will exist following mining and reclamation. Areas with low sideslopes ranging from 2:1 (horizontal:vertical) to 10:1 (averaging 5:1) and emergent wetlands will be established in each new pond to provide habitat for Oregon spotted frogs and other wildlife species. Riparian vegetation along Dean Creek will be restored, and habitat within Dean Creek will be enhanced by widening its floodplain, allowing channel migration, and placement of LWD. Vegetation typical of native valley-bottom forests will be reestablished at the Daybreak site in conjunction with the mining and reclamation activities resulting in the restoration of approximately 114 acres of mixed conifer-hardwood valley-bottom forest, which will be covered by a conservation easement and endowment to fund management. Exclusion fences, pre-operation surveys, and isolation of gravel extraction and processing activities to specific portions of the site will prevent potential impacts to Oregon spotted frogs should they be found on the site. Enhancement of aquatic habitat and floodplain functions will be supported in areas within the lower East Fork Lewis River basin but outside the property boundaries of the Daybreak site.

If the study of the Ridgefield site indicates that availability of off-channel habitat is limiting salmonid production in the lower East Fork Lewis River, Storedahl may recommend that future use of the Daybreak site include the use of the Daybreak ponds to support rearing salmonids. Development of the ponds as off-channel rearing habitat would be contingent on the availability of the property surrounding the mouth and lower reach of Dean Creek so that migration barriers could be corrected. Potential barriers to migration in the lower reach of Dean Creek include blockages from a beaver dam at the mouth and a road crossing. Fish access to Dean Creek is further complicated by the recent excavation of a drainage channel across the adjacent property and into lower Dean Creek.

Water Quality Protection. An updated Storm Water and Erosion Control Plan and Storm Water Pollution Prevention Plan will be implemented. A closed-loop clarification system will be designed, evaluated, permitted, and constructed to reduce or eliminate turbidity resulting from on-site gravel processing. Release of cool water will moderate temperatures in Dean Creek. Restoration of flat and relatively featureless pastureland to valley-bottom forest is expected to further moderate pond and adjacent stream temperatures and filter sediments carried by overland flow.

Water Management Plan. The outlet of the pond system will be designed to control surface water releases directly to Dean Creek from one controlled outlet. The plan will also provide for controlled seasonal release of water from the pond system to supplement summer flows in Dean Creek. In addition, existing water rights for 330 afy will be transferred to the State Trust for instream flow enhancement of the East Fork Lewis River and Dean Creek.

Channel Avulsion. Reclamation of the existing Daybreak ponds will reduce the risk of an avulsion and minimize adverse impacts in the event of an avulsion. However, potential avulsion paths of the East Fork Lewis River will be monitored and, if the likelihood of avulsion into the Daybreak ponds increases prior to completion of reclamation activities, Storedahl will implement engineering solutions to prevent such an event. In the unlikely event that avulsion does occur, Storedahl will implement a series of mitigation measures. Expansion of the floodplain and regrading of the riparian zone along the south and east sides of Dean Creek will reduce the likelihood that this stream could avulse into the ponds. The pond layout and reclamation plans have been designed to provide some features of natural off-channel habitats found elsewhere in the lower East Fork Lewis River. Specifically, the reclamation plan will significantly narrow the existing ponds and are designed based on historical channel paths in the floodplain. Storedahl will conduct a study of fish use, habitat availability, water quality, and geomorphic recovery in the East Fork Lewis River and within the Ridgefield Pits site. This study will allow Storedahl to quantify the negative and positive impacts of pond capture on salmonids in the East Fork Lewis River, and to confirm the accuracy of the predicted recovery rates at the Daybreak site, should an avulsion occur. The study will also facilitate an evaluation of the success of restoration activities that may be undertaken at the Ridgefield Pits site. This evaluation will allow Storedahl to refine the mitigation measures in the contingency plan that would be implemented at the Daybreak site in the event that the East Fork Lewis River should capture one or more of the ponds.

Predation and Competition. The amount of habitat available to non-native predatory species, such as largemouth bass, will be reduced by significantly narrowing the existing Daybreak Ponds 1, 2, 3, and 4. The remaining aquatic habitat will be restored with features that support the covered species and other native species. These features include complex emergent wetland littoral edges that provide refuge and feeding areas for rearing juvenile salmonids. Since this habitat can also support non-native species, targeted, periodic harvests of largemouth bass will aim to reduce their abundance in these ponds. The frequency of backwatering events from the East Fork Lewis River into Pond 5 will also be reduced by reconfiguring the southern and western shores of Pond 5 and its outlet. Signs will be installed on the site to educate the public about the danger of introducing non-native species. Access to the site will be monitored to discourage poachers. Monitoring and engineering techniques will be implemented to reduce the likelihood of an avulsion of the East Fork Lewis River and Dean Creek into the ponds. Monitoring results of fish use and habitat in the river system and within the ponds will be used to develop recommendations for or against developing the ponds as off-channel rearing habitat.

6.1 EFFECTS ANALYSIS PROCEDURES

For the purposes of this HCP, the effects on fish and wildlife are defined as those resulting from the mining, processing, reclamation activities, and conservation measures implemented under this HCP. Effects vary depending on the species and lifestage considered, and the following sections in this chapter are organized to discuss specific effects on each covered species by lifestage. The analysis begins with discussions of the effects in terms of the impacts to five major habitat components: 1) groundwater flow, 2) surface water quality and quantity, 3) riverine habitat, 4) wetland habitat, and 5) predation and competition. Where appropriate, the effects on habitat are discussed in relation to NOAA Fisheries and USFWS guidelines on properly functioning conditions (NMFS 1996; USFWS 1998a). General environmental effects are summarized in Table 6-1.

Table 6-1. Summary of the potential impacts of the Storedahl HCP relative to current conditions.

Issue	Potential Biological Effect	Current Conditions	Conservation Measure[1]	Operations with HCP[2]	Net Result as Compared to Current Conditions
HYDROGEOLOGY					
Evapotranspiration	Reduced flows lead to decreased rearing habitat; increased vulnerability to temperature increases	Summer evaporative losses (ponds and irrigation): 1.40 cfs	CM-03: Donation of water rights CM-04: Water management plan CM-15: Shallow water and wetland habitat	Summer evaporative losses (ponds without irrigation): 0.63 cfs	Summer flows in the East Fork Lewis River and Dean Creek could increase as a result of converting irrigated pastureland to open water 330 afy water right will be transferred to instream flow
Altered groundwater flow paths	Reduced flows lead to decreased rearing habitat; increased vulnerability to temperature increases; and impaired upstream migration	Groundwater flow is to the west. Estimated groundwater inflows to ponds in winter = 3.2 cfs and in summer = 1.2 cfs Estimated groundwater seepage out of the ponds = 0.9 cfs	CM-15: Shallow water and wetland habitat	No significant difference	The pond elevations will approximate the current water table elevation and there will be little change in flow direction for groundwater Minor refraction of groundwater flow lines are expected due to placement of relatively finer sized sediments as part of the reclamation of the existing Daybreak Ponds

Table 6-1. Summary of the potential impacts of the Storedahl HCP relative to current conditions.

Issue	Potential Biological Effect	Current Conditions	Conservation Measure[1]	Operations with HCP[2]	Net Result as Compared to Current Conditions
SURFACE WATER QUALITY					
Pond outflow-temperature	Increased stress, avoidance/migration delay at temperatures greater than 19°C	East Fork Lewis River: exceeds 19°C in summer, but no significant difference in temperature up and downstream of Daybreak site Summer pond outflow and Dean Creek temps >19°C in August; pond outflow 1.0 to 1.6°C warmer than Dean Creek (May through September)	CM-04: Water management plan CM-06: Native valley-bottom forest revegetation CM-13: 200-foot riparian management zone on Dean Creek	Outflows warmer than Dean Creek prevented; cool water releases in summer and increased shade	Temperature decreases in Dean Creek resulting from increased riparian shade and the release of cool water from the bottom of Ponds 3 and 5
Pond outflow-turbidity	Gill abrasion, reduced feeding efficiency, migration delay due to avoidance at levels greater than 25 NTU	Permitted turbidity at NPDES discharge 50 NTU Turbidity in East Fork Lewis River is generally less than 5 NTU since 1985 Dean Creek has been measured at 25 to 88 NTU during storm runoff events	CM-01: Wash water clarification process CM-04: Water management plan	Turbidity of Pond 3 outflow at one-half permitted limit (< 25 NTU) Release of process water virtually eliminated	Suspended sediment contributions from pond discharge will be equal to or less than one-half permitted limit (25 NTU) Turbid discharges during storms can be prevented if necessary
Pond outflow-dissolved oxygen	Stress, avoidance, disease at DO levels <8 mg/l; mortality at low concentrations	DO consistently exceeds 8 mg/l at all sites measured in East Fork Lewis River DO less than 8 mg/l in Dean Creek in Aug and Sept 1998; outflow DO was <5 mg/l on the same dates	CM-04: Water management plan	Outflows will be controlled and re-aerated	DO conditions maintained or increased in Dean Creek

Table 6-1. Summary of the potential impacts of the Storedahl HCP relative to current conditions.

Issue	Potential Biological Effect	Current Conditions	Conservation Measure[1]	Operations with HCP[2]	Net Result as Compared to Current Conditions
Site runoff-turbidity/ petroleum	Disease, mortality, gill abrasion, reduced feeding efficiency, migration delay due to avoidance	Existing storm water and erosion control plan and pollution prevention plan are being implemented	CM-02: Storm water and erosion control plan and pollution prevention plan	Updated plan will decrease surface erosion on site and improve spill response	Reduced delivery of sediment and chemicals from on-site erosion
WATER QUANTITY					
Instream flows	Reduced habitat quantity, quality, and accessibility	Winter inflows from Dean Creek into Pond 5 of up to 20 cfs (>10% of estimated 2-year event) Multiple pond outlets distribute flows to wetlands and ditch that bypasses much of Dean Creek	CM-03: Donation of water rights CM-04: Water management plan	Managed summer outflows could increase summer low flows from 0.1 to 0.5 cfs; winter inflows from Dean Creek prevented	Increased surface flow in Dean Creek during late summer, fall, and winter Summer flows in the East Fork Lewis River and Dean Creek could increase as a result of converting irrigated pastureland to open water 330 afy water right will be transferred to instream flow

Table 6-1. Summary of the potential impacts of the Storedahl HCP relative to current conditions.

Issue	Potential Biological Effect	Current Conditions	Conservation Measure[1]	Operations with HCP[2]	Net Result as Compared to Current Conditions
RIVERINE HABITAT					
Bank Stability/ Conversion of Riparian Zone	Sedimentation of spawning gravel; loss of habitat complexity/ cover	Banks of Dean Creek are degraded due to livestock trampling and lack of riparian vegetation. Past conversion of riparian zone to pasture and non-native species has reduced shade and LWD inputs	CM-14: Enhance in-channel habitat in select reaches of Dean Creek	Riparian habitat, bank stability, and in-channel LWD will be improved	Implementation of conservation measures is expected to improve spawning and rearing habitat conditions in the section of Dean Creek immediately adjacent to the Daybreak site
Avulsion potential	Altered habitat; direct impacts to existing redds or overwintering juveniles	East Fork Lewis River: Potential avulsion paths have been identified Dean Creek: Potential for avulsion of the stream into the Daybreak site ponds	CM-06: Native valley-bottom forest revegetation CM-07: Reestablish floodplain between Dean Creek and ponds CM-08: Mining and reclamation designs to ameliorate negative effects of flooding or potential avulsion of the East Fork Lewis River into the Daybreak site CM-09: Avulsion contingency plan	Decreased potential for avulsion of East Fork Lewis River into Daybreak site Decreased potential for avulsion of Dean Creek into Daybreak site	Narrowing of existing ponds increases buffer widths between river and ponds and between existing ponds and proposed ponds Excavation of the proposed ponds does not change the potential paths or risk of avulsion. The avulsion contingency plan will decrease the risk of avulsion into the existing and proposed ponds since high-risk sites will be monitored and treated to prevent pond capture as necessary The recontoured floodplain terraces adjacent to Dean Creek will help prevent avulsion into the ponds. Restoration of floodplain forest will increase roughness and decrease the energy of flood flows

Table 6-1. Summary of the potential impacts of the Storedahl HCP relative to current conditions.

Issue	Potential Biological Effect	Current Conditions	Conservation Measure[1]	Operations with HCP[2]	Net Result as Compared to Current Conditions
WETLAND HABITAT					
Habitat Alteration	Increased wetland area	Less than 2 acres of forested or seasonally flooded emergent wetlands Approximately 64 acres of open water Approximately 149 acres of pasture Approximately 33 acres of road and graveled surface Approximately 52 acres of mixed woodlands	CM-06: Native valley-bottom forest CM-15: Shallow water and wetland habitat	Approximately 32 acres of shallow emergent wetlands Approximately 102 acres of open water Approximately 166 acres of mixed valley-bottom forest and forested wetland	The creation of wetland habitat and valley-bottom forest will restore natural valley-bottom functions such as productivity and LWD recruitment Oregon spotted frogs potentially on the site will benefit by the increase in the extent and quality of wetland habitat at the Daybreak site

Table 6-1. Summary of the potential impacts of the Storedahl HCP relative to current conditions.

Issue	Potential Biological Effect	Current Conditions	Conservation Measure[1]	Operations with HCP[2]	Net Result as Compared to Current Conditions
PREDATION					
Non-native predators	Increased predation, competition	Non-native predator fish are currently present in the ponds, can access the East Fork Lewis River via Dean Creek and can prey on salmonids that enter the pond system	CM-04: Water Management Plan CM-16: Control of non-native fish CM-18: Controlled public access	The frequency of salmonids entering the ponds during flood flows will be reduced Targeted harvest of non-native predaceous fish Public educated about dangers of introducing non-natives Poaching discouraged	The frequency of backwater events from the East Fork Lewis River into the existing ponds will be reduced, resulting in reduced access to productive off-channel habitat, but also resulting in reduced interactions with non-native predaceous fish

[1] See Chapter 4 for a detailed description of each Conservation Measure

[2] Operations with HCP include the mine expansion and implementation of all conservation measures.

6.2 EFFECTS OF PROJECT OPERATIONS AND CONSERVATION MEASURES ON HYDROLOGY AND HABITAT

6.2.1 Pond Water Balance

The existing ponds at the Daybreak site, which constitute a series of floodplain lakes or ponds, are primarily fed by incident precipitation and groundwater. The one exception is Pond 5 with its surface connection to Dean Creek, which seasonally discharges to Dean Creek and receives significant surface water inflow from Dean Creek during the winter months. A water balance analysis was conducted to compare pond inflows and outflows under existing and post-mining conditions (Table 6-2). The analysis indicates that the overall effect of the new ponds on the water balance will be small, with the exception of Pond 5. The implementation of CM-04 will result in restricted inflows from Dean Creek and seasonal augmentation of flows in Dean Creek. The water balance assumes that the flow system is at steady state and does not include the effects of seasonal storage, but considers all of the water that is intercepted by the ponds. Inflows include groundwater, surface water, and incident precipitation. Outflows include groundwater seepage, surface flow, and evaporation. Process wash water is recycled under both existing and future conditions, thus the effect of gravel processing operations on the water balance is negligible and is not included in the water balance.

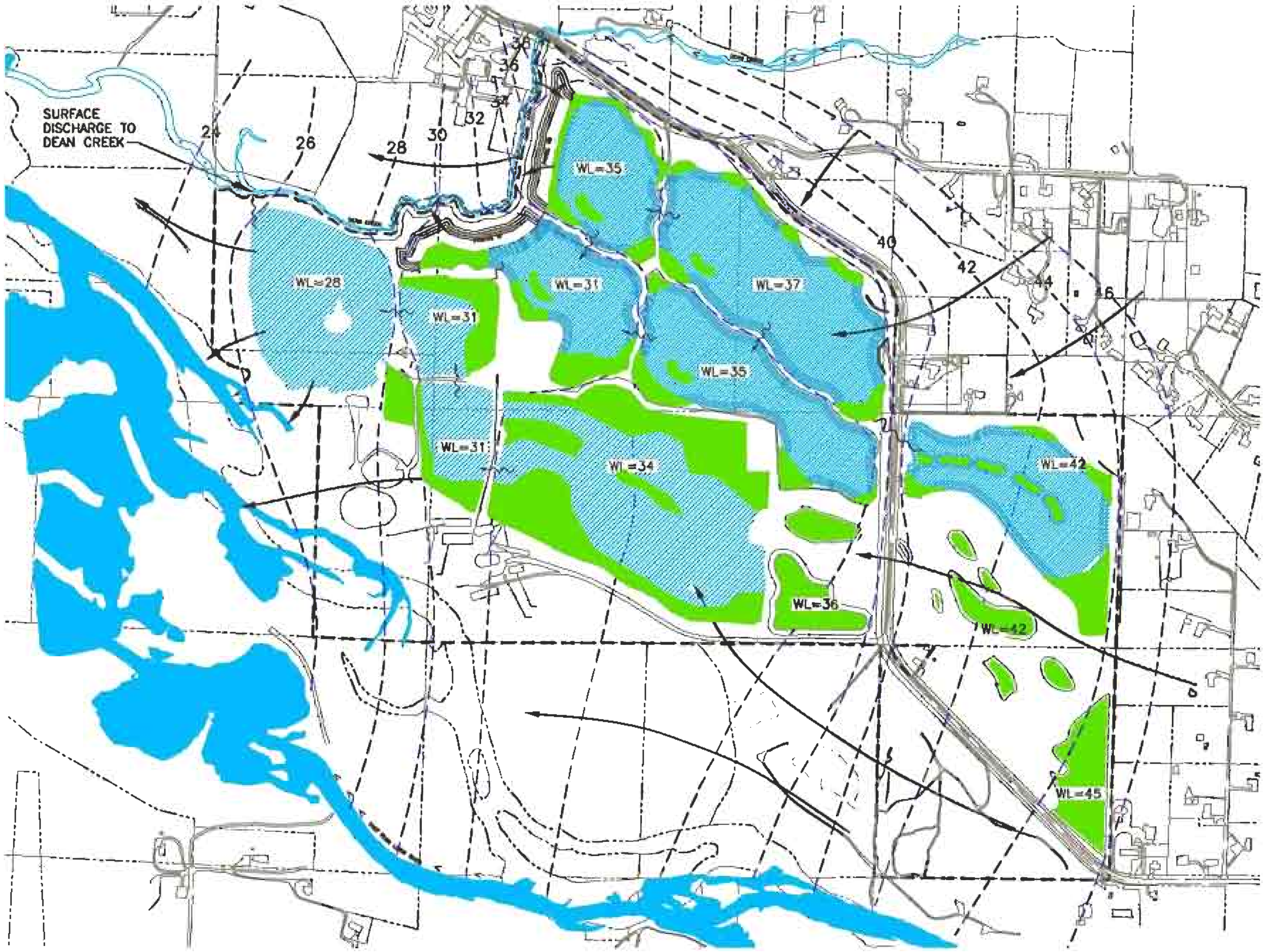
Table 6-2. Daybreak site pond water balance: existing conditions and project completion.

		Existing Conditions		**Project Completion**	
	Flow Component	**Winter (cfs)**	**Summer (cfs)**	**Winter (cfs)**	**Summer (cfs)**
Inflows					
	Groundwater (all ponds)	3.2	1.2	3.2	1.2
	Surface Inflows (Dean Creek) (1)	0 to 20.1	0.0	0.0	0.0
	Incident precipitation (2)	0.5	0.2	0.8	0.4
	Totals	3.7 to 23.8	1.4	4.0	1.6
Outflows					
	Groundwater	0.9	0.9	1.1	0.9
	Surface Outflow (3)	2.9 to 5.1	0 to 0.3	2.9 to 5.1	0.3
	Evaporation (4)	0.0	0.4	0.0	0.6
	Totals	3.8 to 6.0	1.3 to 1.6	4.0 to 6.2	1.8

(1) Based on observation and flow metering 1/24/99.
(2) Battle Ground Station data.
(3) Based on projected controlled discharge to Dean Creek.
(4) Battleground Station data with pan evaporation adjusted per Willamette Experiment Station data.

Current and future groundwater inflow was calculated using Darcy's Law (Q=K*i*A, where Q equals groundwater inflow from areas upgradient of the ponds; K equals the hydraulic conductivity of the alluvial aquifer; *i* equals the average groundwater gradient toward the ponds; and A equals the cross-sectional area of groundwater flow intercepted by the ponds). This calculation is described in detail in Section 3.1.4.1. Figures 3-11 and 3-12 show the water table and groundwater flow paths or flow lines under existing conditions. Figures 6-1 and 6-2 show the water table and groundwater flow paths as they would occur after the completion of mining, reclamation, and implementation of the HCP. Flow lines represent paths along which groundwater can travel (Cedergren 1968) and are constructed based on the water table map for the shallow alluvial aquifer. By definition, the same seepage or flow occurs through a flow channel, i.e., between adjacent pairs of flow lines (Cedergren 1968). Because the final pond elevations will approximate the existing water table elevations, the existing and future flow lines are comparable, bounded by the East Fork Lewis River on the south and the valley wall on the north. One minor exception might be the area to the southeast of Pond 1, where some post-reclamation flow could be refracted to the south and into the active floodplain area of the East Fork Lewis River. Therefore, the future groundwater seepage into the finally reclaimed ponds is projected to be approximately equal to the seepage into the existing ponds, albeit upgradient from the current point of interception (Table 6-2).

Surface-water inflows under existing conditions consist primarily of seasonal inflows from Dean Creek (Table 6-2). Periodic surface-water inflows might also occur from the ephemeral drainage that flows onto the Daybreak site from the north, but contributions from this source are negligible and are not reflected in the overall water balance. The timing and magnitude of surface water contributions from Dean Creek under existing conditions depend on seasonal variations in the pond water level relative to the water level in Dean Creek, which is affected by both discharge and beaver activity downstream of the Daybreak site. Current winter conditions (20.1 cfs inflow) are represented by field data collected at the Daybreak site on 14 January 1999. This was a relatively wet period, as January precipitation was 24 percent above the mean for that month and November through January precipitation was 36 percent above the mean for that period. Surface water was flowing into Pond 5 from Dean Creek on that date, a situation that is common under winter conditions with the existing pond configuration and downstream beaver activity. Surface-water flows to and from Pond 5 were calculated from measurements of the stream velocity and stream cross section. Future inflows from Dean Creek will be limited to 17 year or greater flood events following implementation of the water management plan (CM-04) and reconfiguration of the Pond 5



LEGEND

- PROPERTY BOUNDARY
- DEAN CREEK SETBACK
- PROJECT LIMITS
- —20— GROUNDWATER CONTOUR
- RIVER AND FLOW DIRECTION
- EXISTING POND
- PROPOSED POND
- CREATED WETLANDS
- SURFACE WATER SPILL ZONE
- CONCEPTUAL GROUNDWATER FLOW PATH

N

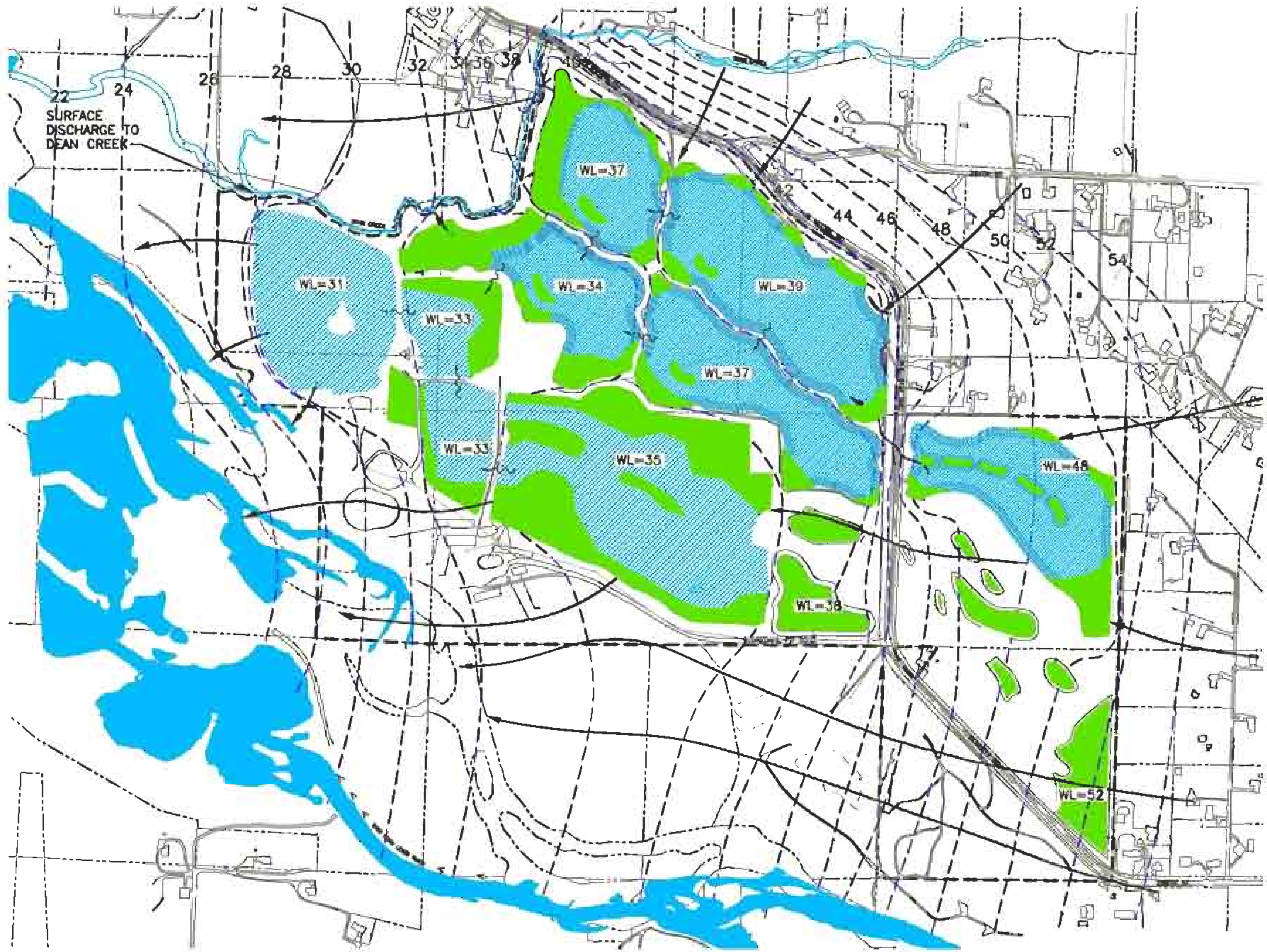
0 600 1200
SCALE IN FEET

NOTE:
ELEVATIONS AND LOCATIONS OF CREATED WETLANDS ARE APPROXIMATE.

IT CORPORATION
15055 SW Sequoia Parkway
Suite 140
Portland, Oregon 97224
(503)624-7200 Fax(503)620-7658

FIGURE 6-1
HABITAT CONSERVATION PLAN
DRY SEASON GROUNDWATER CONTOURS
BUILT CONDITION
J.L. STOREDAHL & SONS INC.
CLARK COUNTY, WASHINGTON

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	PROJECT NUMBER
Portland	J. Clugston 5/22/2001			793584-B6



LEGEND

PROPERTY BOUNDARY
DEAN CREEK SETBACK
PROJECT LIMITS
22 GROUNDWATER CONTOUR
RIVER AND FLOW DIRECTION
EXISTING POND
PROPOSED POND
CREATED FORESTED AND EMERGENT WETLANDS
SURFACE WATER SPILL ZONE
CONCEPTUAL GROUNDWATER FLOW PATH

N

0 600 1200
SCALE IN FEET

NOTE:
ELEVATIONS AND LOCATIONS OF CREATED WETLANDS ARE APPROXIMATE.

PROJECT NUMBER 793584-B7-R2
APPROVED BY
CHECKED BY
DRAWN BY J. Clugston 5/21/2001
OFFICE Portland

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FIGURE 6-2
HABITAT CONSERVATION PLAN
WET SEASON GROUNDWATER CONTOURS
BUILT CONDITION
J.L. STOREDAHL & SONS INC.
CLARK COUNTY, WASHINGTON

outlet. Thus, it is assumed that surface water inputs to the ponds will be minimal during future mining and after final reclamation.

Precipitation also contributes water directly to the ponds. In the water balance, rain falling directly on the pond surfaces (incident precipitation) is assumed to have an instantaneous contribution to outflow, and the effects of storage are not considered. Winter and summer incident precipitation is represented by the recorded precipitation at the Battleground climate station (Table 6-2). Incident precipitation under current conditions is for the existing 64 acres of open water ponds. Incident precipitation under future conditions assumes a 102-acre pond area, an approximately 60 percent increase in the pond surface area with a proportional increase in incident precipitation.

Outflows from the pond system include groundwater seepage to the alluvial aquifer, surface outflows, and evaporation. Groundwater seepage from the ponds to downgradient areas was calculated using the same equations and methods used to calculate groundwater inflow (Section 3.1.4.1). Two downgradient conditions that control seepage (i.e., hydraulic conductivity and saturated thickness of the alluvial aquifer) will not change significantly following mining. However, increased incident precipitation on the larger pond area and restricted surface-water outflow will cause a slight increase in the winter pond elevation, and consequently the gradient, resulting in a slight increase in groundwater seepage from the ponds (Table 6-2). Overall, groundwater seepage from the ponds will not change substantially in the future.

Surface outflows under existing conditions consist of the combined discharge from the three unregulated discharge points on Pond 5 (Figure 3-10), plus evaporation from the surface of the ponds. A current meter was used to measure the outflows from the three outlets on 14 January 1999, and flow rates were calculated from the measured stream cross-sections. The winter combined surface outflow totaled 25.2 cfs. Since calculated inflows from Dean Creek accounted for 20.1 cfs on the same day, the net surface outflow under the winter conditions observed at that time was 5.1 cfs. Future surface outflows assume that inflows from Dean Creek will be prevented and that water will be discharged from the ponds to Dean Creek through a single outlet. Surface outflows are expected to increase during the winter under future conditions as a result of incident precipitation. Accounting for normal precipitation and the slight increase in downgradient seepage, the winter surface outflow could range from 2.9 cfs to 5.1 cfs or more during winter storms (Table 6.2). Data from the North Willamette experiment station indicate that evaporation during the winter is negligible.

Surface outflows from the pond outlets during the summer under existing conditions are minimal and were estimated by visual observation to be 0.2 cfs or less in September 1998. Implementation of the water management plan (CM-04) will facilitate the controlled discharge of water to Dean Creek during critical low flow periods and could be used to increase summer outflows by 0.1 to 0.5 cfs, with a mean value of 0.3 cfs (Section 4.2.2). The summer evaporation rate is based on data from Battleground, corrected for pond evaporation using data from the North Willamette experiment station. Under the water management plan, cool water drawn from the bottom of the ponds will be released to Dean Creek during the summer and early fall. The amount and location of releases will depend on seasonal conditions in Dean Creek and the quality of the discharge water.

The residence time of water in the ponds will change from the existing conditions to the finally reclaimed future conditions. As discussed in Section 3.1.4.2, complete winter recharge of the existing ponds by groundwater inflow and precipitation would occur every 73 days, given the rates of inflow shown on Table 6-2 and assuming a continuous stirred tank reactor, i.e., continuous mixing and uniform flow through all the ponds. During the summer months there is a significant increase in evaporation, reduction in the rate of groundwater recharge, and consequently an increase in the residence time in all of the existing ponds. During the summer, the total recharge or turnover period is estimated to be 279 days.

Following reclamation of the site there will be an approximate 43 percent reduction in the volume of the existing ponds to 306 acre-feet. However, the new deeper Phase 3 to 7 ponds will add approximately 2,493 acre-feet of volume. The total volume of the post reclamation ponds will be approximately 2,799 acre-feet. Following reclamation, there will be effectively no surface inflow into Pond 5 as a result of the water management plan (CM-04) and the modification to the western and southern berms (CM-16). Without the surface inflow and assuming continuous mixing and uniform flow through all the ponds, the time for complete winter recharge or turnover in the new pond complex would be 322 days.

However, closer review of the reclaimed ponds suggests that the existing Ponds 1 through 4 will be significantly changed by their reconfiguration and infill with finer-grained materials after implementation of CM-08. The reduced depth of Pond 1 coupled to the lower hydraulic conductivity of the reclamation materials will result in a large quiescent marsh with only 30 percent of its current volume and relatively little groundwater recharge. In addition, the implementation of CM-01 (Closed-loop System) will eliminate the discharge of recycled water into Pond 1. Similarly, Ponds 2 and 3 will be significantly reduced in volume by 55 percent and 70 percent, respectively. Pond 4 will be transformed into an emergent wetland. The Phase 3, 4, and 7 ponds will be the upgradient groundwater sinks.

Winter recharge or turnover of the Phase 3 pond is wholly dependent on groundwater and incident precipitation and calculated at 255 days. For the Phase 4 pond, calculations result in a winter recharge or turnover period of 171 days, without accounting for surface discharge from Phase 3 into Phase 4. Head differences between the upgradient Phase 3 and 4 ponds and the downgradient Phase 5 and 6 ponds result in a relatively steep gradient conducive to groundwater seepage. This coupled to the overflow should result in similar winter residence times for water in those ponds. Pond 5 will perhaps experience the greatest change. With the elimination of Dean Creek winter inflow, it will have an increased winter residence time.

Summer recharge or turnover times in the new ponds, like the existing ponds, will require a longer period of time due to reduced groundwater gradients and increased evaporation. For example, the Phase 3 pond will have a 352 day recharge or turnover period and the Phase 4 pond will have a calculated turnover period of 270 days. As with the existing ponds, the new ponds will have a recharge or turnover period that is longer than the summer period of increased solar warming. Thus, the surface warming is projected to be cyclical from June through September, and limited to the upper 10 to 15 feet. Beginning in the fall, cooling and mixing will result in pond temperatures cooler than the ambient groundwater during the winter and spring, until the summer warming cycle starts (see Figures 3-15 and 3-23).

6.2.2 Groundwater Flow

Potential Effects of Project Operations on Groundwater Flow. The general direction of groundwater flow at the Daybreak site parallels the direction of flow in the East Fork Lewis River. The new ponds are not expected to have a substantial impact on groundwater flow, as compared to existing conditions. Although the perimeter of the ponds will increase in the future, the new ponds will not intercept a significantly different volume of groundwater from upgradient.

Flow nets constructed to describe groundwater inflow to the ponds were bounded by groundwater flow lines that were intercepted by the ponds, and the boundaries of groundwater flow to the ponds were Dean Creek, the north valley wall, and the East Fork Lewis River. The post-mining groundwater contour maps show that the future flow patterns (Figures 6-1 and 6-2) will not be substantially altered from existing conditions (Figures 3-11 and 3-12). In general, groundwater will continue to flow towards and parallel to the East Fork Lewis River. Groundwater inflow into the ponds is expected to be essentially the same for existing and future conditions. One slight variation might be the refraction of some flow to the south at the southeast corner of Pond 1, due to the placement of relatively fine-grained materials during the reconfiguration of that pond. Since the ponds will not be dewatered to excavate gravel, the groundwater elevation will not drop substantially during mining. Completed ponds will fill with water to the approximate level of the groundwater table (at the downgradient end of each pond) associated with the shallow alluvial aquifer.

The seasonal variation in the hydraulic gradient from the ponds to the aquifer is small relative to the hydraulic gradient between the ponds and the East Fork Lewis River (Figures 6-1 and 6-2). Therefore, seasonal variations in seepage from the ponds to the alluvial aquifer are small. The future seepage rate from the ponds and the surface-water discharge from Pond 5 may differ somewhat from the estimated water balance, depending on the intensity of incident precipitation, local variations in the hydraulic conductivity of material on the downgradient (western) edge of the ponds, the elevation of the outlet control-structure, and hydraulic conditions in Dean Creek downstream of the outlet (e.g., location and height of the beaver dams). These changes will be dependent on implementation and adaptation of the water management plan and the controlled seasonal release of pond water to Dean Creek. However, the water balance demonstrates that, in general, development of additional ponds will not measurably affect groundwater contributions to the East Fork Lewis River. Groundwater seepage rates from the alluvial aquifer into the East Fork Lewis River at RM 10.6 and RM 6.5 were 0.58 and 1.59 cfs per mile, respectively, based on field data collected during a relatively low-flow period in October 1987 (McFarland and Morgan 1996). Additional incident precipitation to the new ponds may increase groundwater outflows in the winter, depending on the amount of water being held for later programmed release to Dean Creek.

Groundwater exchange between Dean Creek and the ponds will continue to occur after mining is complete. While the water balance indicates that development of the new ponds will not influence the overall hydrology of the site, there are expected to be local differences in the groundwater flow path between Dean Creek and the mine ponds with distance along the creek. The upper north-south reach of Dean Creek is perched above the shallow groundwater table and is a losing stream for approximately 1,350 feet after it passes beneath J. A. Moore Road. This reach contains water only when runoff from its upper basin exceeds percolation through the stream bottom and sides. In contrast, the downstream reach that flows towards the west is in contact with the groundwater table. Adjacent to this transition zone, the Pond 5 water surface is essentially flat, but along the north edge of Pond 5, Dean Creek has a relatively steep water surface gradient relative to the pond surface. For this reason, the hydraulic gradient can be toward the pond along the upstream reach that borders the pond, and away from the pond along the downstream reach. Therefore, the ponds that border the creek might gain water along one reach of the creek, and simultaneously lose water to the creek along another reach. In either case, the rate of flow is projected to be relatively low due to the perched nature of the upper portion of Dean Creek and the fine-grained bottom sediments in lower Dean Creek, where the hydraulic conductivity is orders of magnitude less than the alluvial aquifer. This is illustrated by Figures 6-1 and 6-2, which show that the hydraulic gradient along Pond 5 and the Phase 6 and 7 ponds will be alternately toward or away from Dean Creek depending on the relative elevation of the creek and the pond water surface.

Effects of the Conservation Measures on Groundwater Flow. A 75-foot unmined inner riparian management zone will be left along Dean Creek. Groundwater elevation data suggests that perched surface flows will continue to seep from Dean Creek to the underlying shallow alluvial aquifer, and then westward following a relatively steep gradient. There is also potential for some seepage toward the Phase 6 and Phase 7 ponds at their north end, and from the ponds to Dean Creek at their south end, albeit under a lesser gradient and via a less permeable medium. The created forested wetlands and emergent wetlands to be developed in the outer 125-foot riparian zone will be underlain with material that has a lower hydraulic conductivity than the surrounding alluvial gravel, and they will be located parallel to Dean Creek so that they effectively control movement of water into and out of the ponds. The objective will be to maintain flows into Dean Creek via groundwater as well as through controlled surface discharge under the water management plan (CM-04).

Implementation of CM-03 (Donation of Water Rights) will result in 330 afy currently used for irrigation being transferred to the State Trust for instream flow enhancement. This transfer will increase the amount of local groundwater discharge that flows into Dean Creek and the East Fork Lewis River by an estimated 1.1 cfs during the May through September irrigation season. Because irrigation water is used during the summer, the transfer of this water right will enhance flows in the streams during the period of low flow. Dean Creek dries up in the summer in the approximately 1,350 feet downstream of J. A. Moore Road. Discharge from the mouth of Dean Creek, when it is flowing in the summer, was measured as 0.10 cfs (Section 4.2.2) and the implementation of CM-04 (Water Management Plan) will result in the addition of 0.3 cfs. Therefore, the donation of water rights under CM-03, could result in a significant increase in flow to Dean Creek. The addition of 1.1 cfs to the East Fork Lewis River will not be as significant, since low flows in the river average about 50 cfs (Section 3.10.1 in Technical Appendix C). Increased water flow will increase the quantity of summer stream habitat for several of the covered species. Increased flows can also help increase the quality of the habitat by decreasing warm water temperatures through the input of cooler groundwater.

6.2.3 Hyporheic Flow

Potential Effects of Project Operations on Hyporheic Flow. Post-project hyporheic flow, as a component of sub-surface flow, will follow patterns described above for groundwater (Figures 6-1 and 6-2). Since post-project groundwater flow patterns will remain essentially the same as pre-project (Figures 3-11 and 3-12), the only newly excavated area expected to intercept hyporheic flow would be the shallow emergent wetland areas east of existing Pond 1 (Phases 1C, 1D and 2). As described in Section 3.1.4.1, groundwater that will be intercepted by the other proposed ponds will primarily flow from the upgradient alluvial aquifer and upland sources and thus would not be hyporheic. Based on the predicted groundwater flow paths, hyporheic flow intercepted in the eastern portion of the mine expansion area would continue to flow primarily toward the existing ponds. However, uncertainty exists regarding predicted flow paths, since groundwater or hyporheic flow is not uniform. Specifically, the additional amounts of fine-grained materials in the reclaimed ponds may alter the relative permeability or hydraulic conductivity. It is possible that as Ponds 1, 2, and 3 are filled with relatively finer-grained materials, hyporheic flow may be refracted away from the ponds and towards the river.

The new excavated ponds potentially could also affect the water temperature in the downgradient hyporheic water, or the hyporheic area typically considered to be "downstream" of the site (Figures 3-11 and 3-12) as a result of increasing the surface area of the ponds from approximately 64 acres to 102 acres. Additionally, late-summer water temperatures in the ponds could increase due to increased residence time in the ponds and thereby increase hyporheic water temperature.

However, although the final reclaimed ponds will have an increased surface area compared to existing conditions, the surface water area relative to their total volume will be reduced as a result of the reconfiguration of the existing ponds and the increased depth of the new ponds. The existing ponds have a surface area of approximately 64 acres and a volume of 535 acre-feet, while the final reclamation surface area will be 102 acres with a volume of approximately 2,800 acre-feet. This is more than a threefold increase in the surface area to volume ratio. Although Ponds 1, 2 and 3 will decrease significantly in average depth, the new Phase 3 through 7 ponds will be up to 30 feet deep.

Under existing conditions, Ponds 1 and 2 are subject to mixing and relatively short turnover periods due to the recycling of process washwater. This mixing has resulted in relatively uniform seasonal temperature increases with depth in these two ponds (Figure 3-23). On the other hand, mixing in Ponds 3 and 5 is dependent on groundwater recharge, minor summer surface overflow between ponds, and wind generated wave action. Monitoring in the existing Ponds 3 and 5 has shown that late summer solar warming has affected temperatures to a depth of 10 to 15 feet (Figure 3-23). Pond water temperatures below those depths generally remained at 12ºC or less. This lower water temperature in the deeper pond water is within the range of temperatures observed in the upgradient groundwater (Figure 3-15). Because the new Phase 3 through 7 ponds will be up to 30 feet deep, it is anticipated that 50 percent, or more of the new pond volume will remain at the cooler ambient groundwater temperatures, even during the late summer months. Monitoring at the site has shown that the temperatures of the existing pond water cools rapidly with the arrival of fall, and by March water temperatures are at or below the ambient groundwater temperature (Figure 3-23).

Water temperatures downgradient of the ponds also are moderated as groundwater flows through the alluvial aquifer. Temperature data from a piezometer (PZ-3) below Pond 5 indicate that late-summer temperatures in groundwater (which is likely hyporheic in this location) were substantially lower (16°C) than in either the East Fork Lewis River or Pond 5 (> 19°C). Figure 3-15 shows how water temperatures of the groundwater monitored in an irrigation well on the Daybreak site remain essentially constant. In contrast, the water temperature in the East Fork Lewis River exhibits daily fluctuations. Data from hyporheic wells indicate that as water travels from the river or ponds into the hyporheos, the water temperature is moderated and the fluctuations are dampened. This moderating effect occurs as water flows through the ground and is further moderated by the hyporheic flow path, which is parallel to the river for a distance before discharging to the river. Therefore it is expected that the new ponds would have no net effect on hyporheic water temperature discharged to the East Fork Lewis River.

Interception of hyporheic flow could affect biogeochemical processes and the distribution of interstitial invertebrates downgradient from the new ponds. However, since flow paths indicate that hyporheic flow from the new ponds would flow into the existing ponds, any changes in hyporheic biogeochemical or faunal characteristics from the new ponds would likely be the same as those under existing conditions and have no net effect on the East Fork Lewis River.

Effects of the Conservation Measures on Hyporheic Flow. Because experimental manipulation of the hyporheic zone is still in its infancy and hyporheic processes have been studied in relatively few streams (Palmer 1993), prediction of the effects of the proposed ponds on the hyporheic zone is very difficult. Studies of hyporheic processes are inherently constrained by the inaccessibility and highly dynamic nature of the three-dimensional hyporheic zone. Consequently, the Daybreak HCP is limited to developing reasonable hypotheses about these effects based on the general relationship of hyporheic processes to physical and chemical characteristics of the East Fork Lewis River and Dean Creek, the terraces, fluvial plains, and the near-channel sediments.

Finer textured sediments used to backfill the ponds for wetland creation could reduce localized exchange between hyporheic and surface waters (Triska et al. 1989). This could result in a reduced amount of organic matter flowing into the hyporheic zone and a resultant decrease in organic matter decomposition and oxygen consumption by benthic microbes in the hyporheic waters. As a result, levels of subsurface dissolved oxygen would probably be lower, which in turn could result in higher denitrification rates (removal of nitrogen from the ecosystem in gaseous form as opposed to being converted to a form useable by algal production). However, this localized reduction in nutrient inputs due to fine sediments, would likely be offset by an overall increased input of nitrogen and carbon from the created wetlands and replanted native-valley bottom forest. Specifically, nitrogen, which limits primary production in many Pacific coastal streams, can be fixed (converted to a useable form) by a bacterium growing in the roots of red alder in excess of the tree’s growth needs (Edwards 1998). The increased amount of land that will be planted in native-valley bottom forest, which includes red alder, can act as a source of nitrogen for the hyporheos and ultimately the East Fork Lewis River. Wetland ecosystems are also highly productive, and support plant growth as well as insects, amphibians, and fish. The created wetlands on the Daybreak site will maintain a connection with the East Fork Lewis River through hyporheic exchange and also through the surface water outlet at Dean Creek.

Although currently there is often no surface flow in summer in the north-south flowing upper reach of Dean Creek, additional discharge into the creek as part of CM-04 would augment any summer hyporheic flow in that stream. This additional hyporheic flow would benefit riparian plants along Dean Creek and may contribute to surface flow downstream. In turn, enhanced riparian vegetation (CM-13) and increase acreage of valley-bottom forest (CM-06) may increase the supply of dissolved organic matter (DOM) to the hyporheic zone. Concurrently the expanded area of reclaimed gravel ponds would generate higher levels of primary production and DOM. DOM is often a limiting factor in the rates of microbial processes in floodplain aquifers (Clinton and Coe 2002). The supply of DOM and microbial processes ultimately supports the base of the food web for invertebrates and fish.

6.2.4 Surface Water Quantity

Potential Effects of Project Operations and Conservation Measures on Surface Water Quantity. Potential effects of project operations and conservation measures are combined in this section, because their effects on surface water components of the Daybreak site water balance cannot easily be separated. The surface area of the ponds will increase from the existing 64 acres to 102 acres. The water balance shows that the future ponds will not substantially impact the net surface-water flows in Dean Creek or the East Fork Lewis River (Table 6-2). Future net surface-water outflows (i.e., the difference between outflow and inflow) from the ponds will increase slightly during the winter due to increased incident precipitation over a larger pond area. However, this rate will be partially dependent on the increase in pond water levels deemed beneficial for the water management plan (CM-04) to facilitate summer discharge to Dean Creek. Groundwater seepage from the ponds could also contribute to flows in Dean Creek during the summer, again somewhat dependent on the implementation of the water management plan (CM-04). Implementation of CM-03 (Donation of Water Rights) will result in 330 afy currently used in the summer for irrigation being transferred to the State Trust for instream flow enhancement (Section 6.2.2).

The larger pond area will result in a greater water loss from the ponds by evaporation during the summer. However, the increased water loss by open-water evaporation from the future ponds will be offset by eliminating evaporation losses that currently occur during irrigation on the existing pastureland. Under existing conditions during the summer, water is lost by evaporation from approximately 64 acres of open-water ponds and associated wetlands, 149 acres of irrigated pasture and 20 acres of active restoration, and approximately 34 acres of valley-bottom forest, as well as 33 acres of paved road and the graveled operations area. Irrigation currently occurs during the growing season (May through September).

Evapotranspiration from the existing pastureland during the irrigation season was calculated using the Thornwaite-Mather method and data from the North Willamette experiment station. The calculated evapotranspiration rate of 1.6 feet over the period of May to September is similar to published estimates of consumptive-use and net irrigation requirements for hay crops in the region (AgriMet 2000; USDA 1973).

For weather conditions typical of the site and for common irrigation equipment, the irrigation efficiency is conservatively estimated at 80 percent. Thus, approximately 20 percent of irrigation water that is pumped through the sprinklers is lost to evaporation before it hits the ground or enters the root zone (Irrigation Association 1983; Israelson and Hansen 1965). Assuming two feet of irrigation per season and 20 percent efficiency loss to evaporation, the calculated water loss to evaporation is 0.4 feet, or 68 acre-feet per year over the 169 acres of irrigated pasture, crops and active restoration that is currently owned by Storedahl.

Evaporation from the site will gradually increase as the mine ponds are excavated and reclamation is completed. The pond area will increase from the current 64 acres to 102 acres when mining and reclamation is complete (an increase of 38 acres of open-water). The remainder of the site will consist primarily of near-shore wetland and mixed native valley-bottom forest vegetation, which will not require irrigation. The processing area will be planted with valley-bottom vegetation, including a mixture of cottonwood, alder, and conifers following completion of mining.

Table 6-3 compares evaporation losses from the site under existing and future conditions. Based on this analysis, it is estimated that approximately 547 acre-feet of water is lost from the Daybreak site annually as a result of evapotranspiration under existing conditions. Under the HCP, irrigated pasturelands will be converted to open water, wetlands, and mixed valley-bottom forest. The analysis indicates that net losses under future conditions will not change substantially following development of the additional ponds (Table 6-3) and cessation of irrigation. Reconfiguration of the Pond 5 outlet, and adoption of the water management plan (CM-04) will be used to control the seasonal availability of water for release. This will allow Storedahl to increase the amount of water delivered to Dean Creek during the summer in the future. In addition, the transfer of the 330 afy water right will increase the amount of groundwater discharged to Dean Creek and the East Fork Lewis River.

The properly functioning condition of the surface water movement and timing is generally assessed in relation to conditions in an undisturbed watershed (NMFS 1996; USFWS 1998a). At the extreme end are systems that are not properly functioning, where there are typically pronounced changes in peak flow, base flow, and flow timing. The potential effects of this HCP are not expected to have pronounced changes on water flows except for the potential improvement to the low flow conditions in the lower reaches of Dean Creek.

Table 6-3. Evaporation losses from the Daybreak site under existing and future conditions.

Evaporative Loss	Area[1] (acres)	Seasonal[2] Evaporation (ft)	Total Loss (acre-ft)	Total Loss (cfs)
Existing Conditions				
Evaporation from pond surface[3]	64	1.9	122	0.40
Evapotranspiration from valley-bottom forest[4]	34	1.9	65	0.21
Evapotranspiration from pastureland	149	1.6	239	0.78
Irrigation loss[5]	169[5]	0.4	68	0.22
Processing site	33	NA	53	0.21
Total Loss			547	1.81
Future Conditions				
Evaporation from pond surface[3]	102	1.9	194	0.63
Evapotranspiration from valley-bottom forest[4]	198	1.9	376	1.23
Irrigation loss[5]	0	0	0	0
Processing site	0	0	0	0
Total Loss			570	1.86

1 Pasture area includes existing irrigated area within site boundary (Figure 3-29). Pond surface is open-water pond area. Some existing pastureland will be converted to valley-bottom forest.

2 Irrigation season is May 1 to October 1 (154 days).

3 Pond evaporation rate calculated for season average.

4 Calculated evaporation for valley-bottom forest includes existing mixed woodlands and riparian zones (Dorrenbos and Pruitt 1977).

5 Irrigation loss occurs from pasture, crop, and active restoration.

6 Processing site includes process water conveyance, fugitive, pile evaporation, and haul-off losses.

6.2.5 Surface Water Quality

6.2.5.1 Temperature

Potential Effects of Project Operations on Temperature. The East Fork Lewis River is a naturally wide, low elevation alluvial channel and is thus particularly vulnerable to temperature impacts. It is currently listed (State 303(d) list) as water quality impaired due to elevated water temperatures. Summer water temperatures sometimes exceed 22°C at Daybreak Park, just upstream of the HCP area. Salmonids do not usually experience any detrimental effects until temperatures exceed approximately 20°C; lethal temperatures for adult salmonids vary with acclimation temperatures and the duration of the increase, but generally start to occur around 24°C (Bjornn and Reiser 1991).

Water temperatures at the pond surface and in the East Fork Lewis River were generally similar, and the late summer surface water discharge rates from the ponds are low. Surface water temperatures at the Pond 5 outlet were 1°C to 1.6°C higher than temperatures in Dean Creek that were measured just upstream at the Dean Creek Pond 5 station. No temperature data are available for Dean Creek downstream of the Pond 5 station, but temperatures are believed to be even higher there, as downstream of Pond 5 the creek enters a series of low-velocity beaver ponds that decrease the flow velocity and increase the area of surface water exposed to solar radiation. Continuous temperature monitors installed in the East Fork Lewis River upstream and downstream of the confluence with Dean Creek in 1998 revealed no statistically significant differences in temperature (Section 3.1.5.1).

The existing ponds become thermally stratified in the summer, with temperatures that may exceed 20°C in the upper layer (epilimnion). Temperatures in the hypolimnion, or lower layer, are cooler and are adequate for salmonids, but dissolved oxygen measurements taken during the summer of 1998 and in August 1999 were generally low, with some concentrations below 2.0 mg/l. Temperature conditions in the new ponds are expected to be similar to those observed in the deeper existing ponds. The existing Pond 5 currently has three surface outlet locations (Figure 3-16). Flows in Dean Creek generally become subsurface during the summer, and water quality conditions in the ponds and in the beaver complex on lower Dean Creek may be inadequate to support salmonids. Without modifications to the outflow configuration, increased discharge of water that is warmer than Dean Creek at the outlet could increase the potential for adverse impacts resulting from high temperatures.

Effects of Conservation Measures on Temperature. The new upgradient ponds will be significantly deeper than the existing ponds and have a much larger volume of cooler bottom water during the late summer months. Implementation of the closed-loop clarifier system (CM-01) will eliminate the mixing in Ponds 1 and 2 due to the recycling of process washwater. The creation of valley-bottom forest (CM-06) surrounding all the ponds may result in increased shade and less wind-generated mixing in the ponds. The net effect of the conservation measures should be a larger volume of cold bottom water and a more readily available supply of late summer cold water for implementation of the water management plan (CM-04).

Under the water management plan (CM-04), release of water from Pond 5 to Dean Creek will be controlled by restricting outflows to a single location at the northwest corner of Pond 5

(Figure 3-10) and installation of a control valve that can be used to shut off outflows. Water temperatures of the pond outflow and in Dean Creek will be monitored weekly during April through September. No water would be released from the ponds to Dean Creek when outflow temperatures exceed ambient temperatures at the Dean Creek Pond 5 station. The gravity-fed pond outlet structure will allow colder, bottom water to be released to Dean Creek, which could be beneficial to salmonids in lower Dean Creek. During the warm summer months, a pump-intake in Pond 3 or 5 would release colder bottom water to the upper reach of Dean Creek. Reestablishment of native riparian vegetation (CM-13) will provide some additional shade to the East Fork Lewis River and will substantially increase shade to Dean Creek, further moderating water temperatures there.

Groundwater seepage from Pond 5 is projected to be similar to that under existing conditions (Section 3.1.4.2). Groundwater seepage velocities are expected to remain at 4.5 to 12 feet/day and consequently travel time of any seasonally warmer water leaving the pond via groundwater seepage to the East Fork Lewis River is calculated at 70 to 200 days. Note, temperature monitoring in Pond 5, the river, and a piezometer located downgradient from Pond 5 has shown travel time and the dampening effects of the alluvial aquifer result in groundwater flow cooler than the pond or the river during the late summer. Furthermore, the discharge of groundwater from the ponds is calculated at 0.9 cfs under current and future conditions, or less than 1 percent of the mean monthly low flow in the East Fork Lewis River. Therefore, there is not projected change to temperature in the East Fork Lewis River as a result of this project.

The combined effect of the conservation measures will be to reduce water temperatures in Dean Creek. The measures are expected to have little effect on temperatures in the East Fork Lewis River, due to dampening effects of the alluvial aquifer matrix, time of arrival of groundwater seepage, and because the volume of flow contributed by the ponds and Dean Creek is low relative to mainstem flows. The measures are also expected to have little effect on temperatures in Dean Creek downstream of the Pond 5 outlet. In this reach, the stream passes through a beaver pond complex, which are areas that have naturally warmer water temperatures as a result of low velocities and increased open water.

6.2.5.2 Dissolved Oxygen

Potential Effects of Project Operations on Dissolved Oxygen. The deeper existing ponds on the Daybreak site thermally stratify in the summer. In association with increased turbidity from the process wash water, this can lead to dramatic decreases in DO at depth. Dissolved oxygen concentrations at the Pond 5 outlet station and in Dean Creek at the Pond 5 station were both less than 8 mg/l in September 1998. Concentrations of DO in Dean Creek are not believed to affect DO concentrations in the East Fork Lewis River because turbulence at the confluence re-aerates the inflow. DO concentrations exceeded 12 mg/l in the East Fork Lewis River less than 50 feet downstream of Dean Creek during all sample visits (Section 3.1.5.1).

Effects of Conservation Measures on Dissolved Oxygen. The use of an additive-enhanced process water system during the period May 1999 through May 2001 demonstrated a significant reduction in turbidity and consequent increase in transparency of the pond water. Future use of a closed-loop clarification system to treat the recirculated process wash water should result in no release of wash water into the Daybreak pond system. This measure should result in ever greater increases in the transparency of pond water. Although it is not a direct relationship, it is possible that increased water transparency could increase the photosynthesis/respiration quotient, which could result in increased DO levels within the ponds and pond outflow. In addition, the pond outlet and pumped release will be designed to use turbulence to re-oxygenate the water that is discharged to Dean Creek. This may increase DO concentrations in the upstream reach of Dean Creek, but is not expected to affect DO concentrations in the East Fork Lewis River.

6.2.5.3 Turbidity

Potential Effects of Project Operations on Turbidity. The ability of salmonids to find and capture food is impaired when turbidity levels approach the range of 25 to 70 NTU (Lloyd et al. 1987). Additionally, growth may be impaired and gill tissue may be damaged after 5 to 10 days of exposure to turbidity levels that exceed 25 NTU (Sigler et al. 1984). Nonetheless, Storedahl’s current general NPDES and Wastewater Discharge permit allows turbidity in the pond outflow to be as high as 50 NTU. Prior to the development of this HCP, gravel processing at the Daybreak Mine relied on passive settling of fine sediments as water flowed from Pond 1 to Pond 2 and eventually to Pond 5 to control turbidity. This system was generally effective in controlling turbidity levels to below 50 NTU. When the ability of the ponds to passively settle turbidity was no longer effective, operations would be curtailed until turbidity levels decreased. Implementation of an improved water treatment system between May 1999 and May 2001, that actively flocculated fine sediments, resulted in dramatically reduced levels of turbidity in Ponds 3 and 5 and in the outflow from Pond 5 (Figures 3-26 and 3-27). Although the current wet processing system has reduced turbidity levels significantly below the NPDES mandated levels, gravel extraction and processing could release water, if otherwise untreated under the existing NPDES permit, with turbidity levels of 50 NTU until development of the site is completed.

The water balance indicates that surface water outflows from Pond 5 vary from approximately 0.3 cfs in the summer to as high as 5.1 cfs during the winter under existing conditions (Table 6-2), and winter outflows are expected to increase slightly following completion of the Daybreak Mine expansion. Existing summer pond discharges are small, but may be substantial relative to the low or non-existent flows observed in Dean Creek at the same time. Flows of 5 cfs account for approximately 13 percent of the estimated winter baseflows (approximately 40 cfs) in Dean Creek. Thus, if turbid pond outflows were to occur, they could influence the turbidity of Dean Creek during all seasons.

During late summer, flows in Dean Creek are generally less than 1 cfs (McFarland and Morgan 1996), and thus contribute less than 1 percent of the surface flow in the East Fork Lewis River. Visual observations made prior to implementation of the current flocculation water treatment system indicate that flow from Dean Creek completely mixes with flow in the East Fork Lewis River over a distance of less than 50 feet. Thus potential turbidity impacts to the East Fork Lewis River associated with the existing ponds and wet processing under the current NPDES permit are believed to be minimal. Turbidity impacts with the current water treatment system are even less. Fine sediment inputs to the lower river are believed to be currently dominated by material eroded from mass wasting of the high bluffs just upstream of the Ridgefield site and near the Daybreak Bridge.

The sediments suspended in the water column as a result of processing and mining operations can be generally divided into two classes: fines (particles smaller than 50 μm or 0.05 mm) that remain in suspension for hours to days, and silts and sands that settle out of suspension within minutes to hours (OWRRI 1995). Deposition of suspended solids could detrimentally impact salmonid spawning and incubation success. Correlations have been found between increased percentages of sediments < 0.84 mm in spawning gravels and decreased incubation success by smothering incubating eggs or trapping alevins (Reiser 1998; Reiser and White 1988). Although there is no well-defined relationship between turbidity and suspended sediment, a 5 NTU increase in turbidity may be associated with an increase in suspended sediment concentration of approximately 5-25 mg/l (Bell 1991).

Sediment that remains in suspension through the ponds and lower reaches of Dean Creek is generally the finest fraction. Since flows in the East Fork Lewis River have a much greater transport capacity than Dean Creek, most of these fines likely remain in suspension until they are carried into the tidal influence zone. However, sediments that settle out above the tidal influence zone and in the first 1.25 miles downstream of the mouth of Dean Creek could detrimentally impact salmonid spawning habitat.

Effects of Conservation Measures on Turbidity. During the use of the additive-enhanced clarification system, turbidity of water released from Pond 5 averaged less than 10 NTU. However, upon approval of all permitting to initiate mining, a closed-loop clarification system (CM-01) will be implemented within three years that should virtually eliminate the discharge of process wash water to the ponds. As a result, turbidity of water delivered to Dean Creek via the Pond 5 outlet and to the East Fork Lewis River via Dean Creek will be significantly less than the level allowed through the general NPDES permit and less than the levels achieved with the additive-enhanced system. Other land-use activities also contribute to turbidity in Dean Creek and the East Fork Lewis River, including aggregate mining adjacent to Dean Creek upstream of the Daybreak site. In addition, the high rate of sediment input to the river from the eroding upstream bluff may mask improvements resulting from implementation of this HCP.

Implementation of the updated Storm Water and Erosion Control Plan (CM-02) will reduce surface erosion within the HCP area by requiring revegetation of bare soils, maintenance of asphalt or gravel surfaces on active roads, and decommissioning of abandoned haul roads. Runoff generated on the Daybreak site, or entering the site as overland flow from upslope areas will be contained in the ponds to allow sediment to settle out.

Turbid water resulting from mining and reclamation activities will be prevented from reaching Dean Creek and the East Fork Lewis River through implementation of the Storm Water and Erosion Control Plan (CM-02). All sites being actively mined or disturbed by reclamation will be isolated so surface water does not flow from the site to the other ponds, or the activities will occur during May through September when surface water flow from Pond 5 is controlled or shut off.

Water quality in Dean Creek will also be improved by reestablishing a 200-foot wide vegetated riparian zone (CM-07) and by revegetating and stabilizing eroding banks (CM-13 and CM-14). The combined effect of these measures will be to reduce turbidity and delivery of fine sediment from the Daybreak site to Dean Creek and the East Fork Lewis River.

The relatively fine-sized sediments to be placed in the existing Daybreak ponds as part of their reclamation could also be considered as a potential source of turbidity to the East Fork

Lewis River should an avulsion into the ponds occur. A detailed evaluation of the potential for an avulsion into the ponds and the potential impacts of increased supplies of fine sediments to the river is presented in Technical Appendix C and Addendum 1 to Technical Appendix C. The sediment transport evaluation demonstrated that the capacity of the river to transport silt-sized and finer sediments is limited only by the supply of sediment provided to it; the river's transport capacity is sediment supply-limited. Similarly, for fine sand-sized material, the river has a large but finite transport capacity. However, it was determined that the river has the ability to transport all sand-sized sediments downstream to tidally influenced portions of the river in less than four days, even at average annual flow conditions. Consequently, the any potential impact of the fine-grained sediments would be short lived.

It is also noted that any potential influence of fine-sized sediments in the Daybreak ponds on turbidity would be similar to the impacts on turbidity of any overbank-flooding event along the East Fork Lewis River. The supply of fine sediments to the river comes from many sources within the watershed and floodplain. Fine-grained sediments are supplied to the river from processes such as hillslope erosion, rill and gully erosion, river bank erosion, mass wasting, and the failure of natural hydraulic controls such as beaver dams and log jams. The natural supply of fine sediments to the river varies from large-scale short-term introductions to long-term chronic supplies. Deposition of fine sediments in the floodplain is a natural and on-going riparian function. Consequently, sources of fine sediments in the floodplain are widespread and the potential impacts of fine grained sediments placed in the Daybreak ponds on turbidity characteristics of the East Fork Lewis River is not significant.

6.2.6 Riverine Habitat

Riverine habitat in and near the Daybreak site currently reflects impacts of previous management activities. Early this century, the East Fork Lewis River was transformed from an anastomosing system with multiple channels, abundant off-channel habitat, and extensive riparian wetlands, to a single-thread meandering channel (Collins 1997). Riparian forests have largely been replaced by pasture land and introduced herbaceous vegetation. The loss of mature trees that would have naturally fallen into the channels occurred during the same time that LWD was commonly removed from the rivers. The resulting reduction in LWD is believed to have simplified aquatic habitat by reducing cover as well as the frequency of deep pools that provide holding habitat for upstream migrating salmonids (e.g., McIntosh et al. 1994). More recently, the East Fork Lewis River avulsed through the Ridgefield Pits, a series of floodplain gravel ponds immediately south of the Daybreak site. This avulsion transformed approximately 3,200 linear feet of shallow pool-riffle habitat into habitat dominated by deep, low-velocity pools. Since the avulsion, the pools have filled significantly with sand and the upstream approximately 900 feet of the avulsed reach have accumulated enough gravel that it is now shallow riffle habitat.

Both NOAA Fisheries and the USFWS generally recognize that properly functioning watersheds contain abundant off-channel habitat, such as ponds, oxbows, backwaters, and low-velocity side channels (NMFS 1996; USFWS 1998a). Logging and development of the land for agriculture resulted in a loss of channel complexity for the lower East Fork Lewis River, which has reduced its ecological ability to support listed, anadromous salmonids.

Potential Effects of Project Operations on Riverine Habitat. Future aggregate mining operations at the Daybreak site will be conducted on a low terrace outside of the 100-year floodplain of both the East Fork Lewis River and Dean Creek and will have no direct physical impact on channel morphology or riverine habitat. The new ponds will be separated from the existing channel and all potential avulsion paths by the existing Daybreak ponds. In much of the area, the existing and new ponds are further protected from avulsion by county and private roads. Thus, expansion of mining activities at the Daybreak site is not likely to increase the risk of future avulsion (see Section 3.3.2 and Technical Appendix C, Section 8 for a detailed discussion of avulsion risk). However, channel migration studies conducted by Collins (1997) and Bradley (1996) and empirical evidence provided by the 1996 avulsion through the Ridgefield Pits suggest that future avulsion and capture of the existing ponds at the Daybreak site, while improbable in terms of years or decades, must be considered possible over a geologic time scale. On the other hand, the new ponds could become incorporated into the East Fork Lewis River channel system only if the river avulses through local housing, utility corridors, and roads, or through the existing ponds, and from there into the new ponds.

No new mining will occur in the existing five ponds although Ponds 1, 2, 3, and 4 will be significantly reconfigured. If the river were to avulse into one or more of these ponds, the current or even the reclaimed open pond configuration would result in lost opportunity for restoration of side and flood channels that mimic historic conditions. The proposed ponds do not result in lost opportunity for restoration or creation of side and flood channels that mimic historic conditions because the proposed mine expansion area is outside of the area historically known to contain side channels.

Impacts from an avulsion of the river into a floodplain gravel pit can be characterized as short-term or long-term. Short-term impacts are those changes to the morphology of the river that take place during and shortly after the avulsion. Long-term impacts are those that continue to affect the morphology of the river well into the future. Additionally, these impacts can be described by their location in relation to the avulsion site: upstream, local, or downstream (Table 6-4).

Table 6-4. Summary of the possible physical effects of East Fork Lewis River avulsing into the new or existing ponds on the Daybreak site.

Element of Avulsion	**Nature of Impact**		
	Upstream	**Local**	**Downstream**
Geomorphic Characteristics	• Incision of channel • Increased gradient • Coarsening of bed • Undercutting and erosion of banks • +/- lateral migration rates	• Alluvial fan development • Reshaping of ponds • Abandonment of former channel • Loss of natural channel geometry	• Increased lateral migration • Increased channel width
Sediment Transport	• Increased sediment transport capacity • Reduction in bed load deposition	• Deposition of sediment in ponds • Short-term increase in turbidity • Erosion of gravel pit banks	• Reduced sediment supply • Erosion of bed • Coarsening of bed • Increased bank erosion • Short-term increase in turbidity
Hydraulics	• Increased slope • Increased velocities • Decreased normal depth • Increased bed roughness	• Decreased slope • Increased channel depth • Increased channel width • Reduced bed roughness	• Increased bed roughness
Hydrology	• No effect	• Increased evaporation	• Changes of summer low-flows
Water Quality	• No effect	• Increased temperature	• Increased temperature • Short-term increase in turbidity

Upstream Impacts. Short-term impacts upstream of an avulsion into a pond formed by gravel mining may include head cutting (which erodes the bed and increases the channel slope), channel armoring, and/or an increase in the channel armor size (bed coarsening). When a pond is breached and the elevation of the river is higher than the elevation of the pond, a localized difference occurs in the energy between the higher elevation flow in the river and the lower elevation water in the pond, causing a steep energy gradient to form. The increased energy gradient increases the sediment transport capacity of the river, creating a demand for sediment. If the material forming the armor layer on the channel bed is too small to resist the forces created by the energy imbalance, the channel bed material will erode and be transported downstream. This erosion will then propagate (head cut) upstream until the channel bed has formed a stable slope and armor layer that will resist the forces of the flow. The upstream extent of head cutting is controlled by the size characteristics of the bed sediment, the hydraulics associated with the flow, and the existence of any channel grade controls such as a geologic outcrop or man-made structure.

Long-term upstream impacts may include continued head cutting, bed coarsening, channel incision, bank failure due to increased bank heights and slopes caused by the incision, and reduced sediment deposition due to the increased channel slope. During subsequent high flow events, the channel bed may continue to adjust to the changes in hydraulics. Higher flow events may cause additional disruption of the armor layer, increasing degradation and coarsening the bed. The down cutting of the bed could cause an increase in channel bank height and degradation along tributaries. All of these processes would lead to changes in channel cross-section. As the river erodes the banks, an increase in the amount of material input to the stream will occur for the same amount of lateral erosion. This will help satisfy the transport capacity of the river and cause a reduction in the rate of lateral migration. At the same time, excessive bank heights can cause instability and increase the chance of slope failure. The increased slope associated with the head cutting will increase the sediment transport capacity of the river and reduce the amount of material that would otherwise deposit in this reach. Upstream channel degradation can also affect the stability of hydraulic structures such as levees or bridges by undermining support structures (Collins and Dunne 1990).

Incision of the river could result in impacts to riparian vegetation because of a lowering of the water table and decreased frequency of overbank flood events. In addition, floodplain function, such as organic matter input to the stream, flooding of side channels, and nutrient exchange between water and floodplain sediments, would be reduced if channel incision were to occur as a result of avulsion (Spence et al. 1996).

When the East Fork Lewis River avulsed into the Ridgefield Pits in 1996, the river changed course and began flowing through a series of six mined and reclaimed gravel ponds. At the entrance to the ponds, the channel bottom degraded by approximately 5 feet (Technical Appendix C). Later observations by Norman et al. (1998) estimated 10 feet of degradation at the entrance. This decrease in bed elevation resulted in the channel bottom head cutting upstream. Although the extent of the migration is unknown, field observations suggest that head cutting has extended up to at least the Mile 9 Pit. This active downcutting of the stream channel has likely ceased to migrate upstream now that the bottom elevations of the Ridgefield Pits have filled in substantially with deposited bedload. The historic slide area along the high bank on the south side of the river upstream of the Ridgefield site, however, continues to actively erode.

Local Impacts. An avulsion into a floodplain gravel pond has many potential localized impacts. The specific impacts are dependent on the characteristics of the river and pond at the avulsion site. Typically, short-term impacts in the immediate vicinity of an avulsion can include an immediate change in hydraulic conditions from a high-velocity shallow river to a low-velocity, deep and wide lake-like system. A delta will typically develop at the entrance to the ponds, which is formed from bank material that formerly divided the pond from the river and from material removed from the upstream channel by head cutting. Typically, the former pond will act as a deposition zone for sediment, capturing a large portion of the sediment load that might otherwise deposit within or be transported through the reach.

Additionally, a section of river channel may be abandoned as the river changes course and flows through the former pond. The abandoned channel may go dry during average flows if the elevation differential between the avulsion point and the exit from the newly formed pool is large enough. The downstream portion of the abandoned channel may develop into a backwater slough during moderate or low flows or the area can continue to flow with intercepted groundwater or hyporheic water. During higher flows, the river may use the abandoned channel as a secondary conveyance. This channel may act as a deposition zone for finer material such as sands and silts that are carried as suspended load during high flows.

In the long-term, the former pond will continue to flow as a wide and deep channel with very low velocities until substantial filling with sediment has occurred. As the delta continues to form and grow at the entrance to the pits, flow conveyance and sediment transport into the newly formed pool will decrease. Velocities will increase and depth will decrease at the entrance to the pool, while further downstream, the velocities will continue to be slow in the wide and deep channel.

Additional impacts of avulsion into gravel ponds may include impacts to water quality and ground water levels. During summer low flow periods, the wide channel that formed in the former gravel pond may cause an increase in surface water temperature. The magnitude of the temperature increase will depend on the surface area of the channel, exposure to solar radiation, residence time, and discharge. Portions of the newly formed pools may provide deeper and cooler water than some of the shallower reaches of the river.

An avulsion could also disrupt water quantity and water quality conservation measures implemented as part of this HCP. If an avulsion resulted in the East Fork Lewis River entering Pond 5, then a new outlet from Pond 5 would likely be created, making the controlled outlet to Dean Creek ineffective. An avulsion might require a change in the pumped release system into Dean Creek.

The localized impacts of the East Fork Lewis River avulsion into the Ridgefield Pits in 1996, included an increase in channel depth, increased channel width, reduced river velocities, formation of deltic sediment deposit, and the movement of approximately 3,200 feet of channel into a new location. The new channel is of approximate equal length and is comprised of primarily deep pools with slow moving water. The mined and reclaimed gravel ponds had a maximum depth of approximately 30 feet. The channel width changed from a maximum of approximately 200 feet to a maximum of approximately 800 feet. In the embayments and backwaters of the former ponds, river velocities are low. During a field visit in August 1999, temperatures increased moving downstream through the pools, from 18.9ºC in Pit 2 to 20.6ºC in Pit 6. During a 2-year event, the average velocity in the main thread of flow through the former ponds is estimated to be approximately 2.5 feet per second, while velocities at cross sections upstream of the former ponds average approximately 4 to 7 feet per second (Technical Appendix C). Recent field observations suggest that the abandoned channel, created when the avulsion occurred, has started to fill with medium sands during subsequent high flow events, and wetland/riparian vegetation has begun to colonize the pond margins. Observations also indicate that the delta at the entrance to the pools has increased in size, resulting in the creation of approximately 900 lineal feet of riffle habitat through the historical Pits 1 and 2 (Figures 3-31 and 3-32). The remaining pools are 3 to 10 feet deep, with bottoms composed of fine sediments. Between RM 7 and RM 9 aquatic habitat in the river channel is dominated by rearing habitat due to the area that flows through the Ridgefield Pits. It is estimated that within this two-mile reach of river, there is 149,890 yd^2 of rearing area and 68,690 yd^2 of spawning area (Figure 6-3 and Table 6-5).

Table 6-5. Estimated amounts of existing and projected (in the event of an avulsion) spawning and rearing habitat in the East Fork Lewis River near the Daybreak site.

Channel Location	River Mile	Spawning (yd^2)	Rearing (yd^2)
Existing	RM 6 - RM 7	52,719	2,729
	RM 7 – RM 9	68,690	149,890
	RM 9 – RM 10	46,000	2,092
total		**167,409**	**154,711**
Avulsion Path 1	RM 6 - RM 7	52,719	2,729
	RM 7 – RM 9	53,670	337,750
	RM 9 – RM 10	46,000	2,092
total		**152,389**	**342,571**
Avulsion Path 2	RM 6 - RM 7	52,719	2,729
	RM 7 – RM 9	90,818	220,198
	RM 9 – RM 10	46,000	2,092
total		**189,537**	**225,019**
Avulsion Path 3	RM 6 - RM 7	52,719	2,729
	RM 7 – RM 9	94,371	215,794
	RM 9 – RM 10	46,000	2,092
total		**193,090**	**220,615**

Downstream Impacts. An immediate short-term impact, as well as an ongoing long-term impact of an avulsion would be reduced sediment supply to the downstream channel until the ponds fill with sediment. As the pool formed by the former gravel pond traps sediment, the supply of sediment to the downstream channel is curtailed. Until the pond fills and sediment transport re-equilibrates, bed degradation, bed coarsening, and increased bank erosion along the downstream channel may occur. With a reduced supply of sediment to the downstream reaches, the river will increase its sediment transport capacity. The increased transport capacity will erode the channel bed and/or banks. The erosion will transport finer sediments downstream and leave behind the coarser material, causing the bed material to coarsen. Currently, large cobbles, indicative of bed coarsening, dominate the substrate in the East Fork Lewis River for approximately 50 feet downstream of the Ridgefield Pits, although abundant smaller-sized gravels downstream of this area provide suitable substrate for spawning salmon (Figure 3-18). Reduced upstream sediment supply to the downstream reach may cause the downstream channel bed elevation to lower. To accommodate the sediment supply deficit, bank erosion may occur resulting in channel widening or migration. Although measurements of pre-and post avulsion downstream channel widths and elevations are not available, concerns have been expressed that channel incision and accelerated channel bank erosion are occurring downstream of the Ridgefield Pits as a consequence of the 1996 avulsion. However, bank erosion downstream of the mouth of Dean Creek may be exacerbated as a consequence of limited riparian cover, since agriculture fields have been cleared to the river's edge, and riprap has been placed in several areas.

An avulsion into a gravel pond may also cause a short-term increase in the supply of fine sediment to downstream reaches. A detailed analysis was completed to determine the potential movement of fines from the ponds into the river during an avulsion (Technical Appendix C, Addendum 1, and Section 3.1.5.1). During gravel processing operations, fine sediments are typically washed from the sands and aggregate and then deposited in the ponds. During reclamation, additional fines will be added to the ponds to create shallow water and wetland habitats. Turbulence induced by the river flowing through the avulsed pond can entrain material previously deposited in the pond. In general, the magnitude of such an impact in the East Fork Lewis River near the Daybreak site is anticipated to be small since: 1) the avulsion and subsequent transport of fine sediment downstream would likely occur during high flows when large quantities of fine material are already being transported; 2) the transport capacity of the river for fine material is relatively unlimited through this portion of the East Fork Lewis River downstream to the tidal influence zone; 3) fine materials are carried through the reach as wash load; and 4) only a part of the pool will be affected by high velocities. Furthermore, such an event is typically short lived and would not provide a long-term supply of fine sediment to the downstream reaches.

The potential for an avulsion to release and transport the fine sediments in the existing ponds, which exist from historical aggregate processing and which will occur following narrowing of the ponds, was assessed using several conservative calculations (Technical Appendix C, Addendum 1). Using the most conservative calculation, an avulsion through the existing ponds could result in approximately 120,300 tons of fine sand-sized and larger particles depositing within the 1.25 miles of spawning habitat downstream of Dean Creek. However, because the transport capacity of the East Fork Lewis River is so large, deposition of these released sediments would happen only if an avulsion occurred during a relatively low-flow event, which is highly unlikely. It is more likely that an avulsion would occur during a flood event. During a relatively small event flood, such as the 2-year flood, the river has the capacity to transport the entire volume of released fine sediments downstream of the spawning reach within approximately 1.1 days.

Another potential, but negligible, impact to reaches located downstream of the avulsed pond is reduced flood levels. The increased width and depth associated with the geometry of the former gravel pond creates additional channel storage. The amount of reduction in flood levels provided by the changed geometry is related to the volume of additional storage and the magnitude and duration of the flood event. Estimates of potential flood peak reduction induced by increased in-channel storage for the East Fork Lewis River are provided in Technical Appendix C, Table 3-8. These estimates indicate that reduction in flood peaks as a result of the new ponds would be relatively small (< 1 percent), and therefore negligible.

Effects of Conservation Measures on Riverine Habitat. Significantly shallowing and narrowing the existing Ponds 1 through 4 and increasing the buffer widths (CM-08) coupled with the avulsion contingency plan (CM-09) will reduce the risk of future avulsion into the existing and planned pond system as compared to existing conditions. These conservation measures will also accommodate a potential avulsion, while ensuring that negative impacts are minimized. The most likely locations of future avulsions into the existing ponds have been identified and will be monitored for the duration of the ITP. In addition, after conveyance of the land to an appropriate non-profit entity that will manage the Daybreak site under a conservation easement (CM-12), a substantial financial endowment (CM-05) will be provided to allow monitoring of potential avulsion, and response actions as necessary, in perpetuity (i.e., into the post-ITP period). If conditions at one or more of those sites during the ITP suggest that the risk of avulsion has increased and the potential affects on the covered species would be negative, engineering solutions designed to prevent pond capture will be implemented. Following the completion of the ITP, funds from the one million dollar endowment fund would be available for responding to an avulsion risk. Proactive identification of sites vulnerable to avulsion and continuous monitoring will reduce the risk that ponds on the Daybreak site will be captured. Over time, restoration of riparian forests will increase bank stabilization and provide roughness that will act to dissipate the energy of overbank flows, further reducing the risk of avulsion.

Despite rigorous monitoring and implementation of preventative solutions designed to prevent gravel pond capture, there is a remote possibility that an unexpected avulsion could occur within the term of the ITP. Extensive reconfiguration of the existing ponds will result in narrowed open water areas that are aligned within the path of historical channel migrations. These narrowed ponds would accommodate an avulsion by directing the water through a more natural flow path back to the river, while providing an increased buffer width to resist an additional avulsion into the new ponds. Orienting the new ponds roughly parallel to the river and creating shallow wetlands in the existing and new ponds will result in habitat that is more similar to natural side channels or oxbow lakes. Upland areas between the ponds will be planted with native trees and shrubs to provide shade and reduce temperature increases. Incorporation of such design elements into the Daybreak Mining and Habitat Enhancement Project increases the likelihood that if a pond is captured, it will function more effectively as off-channel habitat should they become connected to a river (Norman 1998). Specifically, because the most likely locations of future avulsions are directed into the existing ponds, CM-08 (Mining and Reclamation Designs) will result in significant narrowing, shallowing, and revegetating of the existing ponds.

Based on the identification of the three most likely locations for an avulsion to occur, potential avulsion paths through the reclaimed Daybreak ponds were mapped and are shown in Figure 6-4. If the East Fork Lewis River were to avulse into the Daybreak ponds the most likely location would be into Pond 1. This avulsion location is identified as Site G (Figure 3-33) and is called Avulsion Path 1 on Figure 6-4. An avulsion into Pond 1 would be expected to result in the largest potential adverse impacts as compared to existing conditions, because of the relatively large amount of channel area that would be affected. An avulsion through Avulsion Path 1 would essentially switch the river out of its current channel through the Ridgefield Pits and instead channel the river through the four largest existing Daybreak ponds. As shown in Figure 6-4 and Table 6-5, it is projected that the change in spawning (riffle) and rearing (pool) habitat from current conditions resulting from an avulsion into Pond 1 could result in a doubling of the rearing habitat area between RM 7 and RM 9, as the river would likely remain connected to the Ridgefield Pits through a downstream connection. The amount of spawning habitat, however, is projected to decrease by only 22 percent (from 68,690 yd^2 to 53,670 yd^2 of riffle habitat as approximately 1,582 lineal feet of current riffle habitat is converted to pool habitat), as a result of the channel flowing through Site G and into Pond 1.

These estimates reflect the immediate condition of habitat that is likely following an avulsion in Pond 1. However, two uncertainties exist with these calculations. First, prior to a potential avulsion along this path, the habitat quantity and quality would be different than it is currently. Specifically, a potential avulsion would only be likely to occur after the channel had migrated over years or decades. The amount and quality of habitat within the river between the current condition and the avulsed condition is unknown. Second, because Pond 1 will be significantly shallower following reclamation (CM-08, Mining and

Reclamation Designs), it is likely that gravel will quickly deposit within Pond 1 following an avulsion, similar to what was observed in the upper portion of the avulsed Ridgefield Pit reach. This deposition of gravels over the finer sediments in Pond 1 could result in the creation of shallow riffle (spawning) habitat in the Pond 1 reach within five or more years following an avulsion. In addition, because Pond 1 will be significantly shallower following reclamation, the potential for upstream incision will be reduced (Kondolf et al. 2002).

Two other locations were identified as potential sites that an avulsion could occur into the Daybreak site. These locations are Site H, which would direct the river into Pond 4, and Site J, which would result in the river breaching into Pond 5 (Figure 3-33). Figures 6-5 and 6-6 show the projected channel locations and habitat conditions following a potential avulsion into either Pond 4 (Avulsion Path 2) or Pond 5 (Avulsion Path 3). Table 6-5 gives the estimated amount of spawning and rearing habitat that could occur following an avulsion into these sites. If the East Fork Lewis River were to avulse into either Pond 4 or Pond 5, the flow is likely to exit through the western berm of Pond 5 and the main channel would not capture Ponds 1, 2, or 3. This would result in a reduced area of pool (rearing) habitat in the reach between RM 7 and RM 9 compared to an avulsion into Pond 1. However, the net effect would be an increase of 32 to 37 percent in pool habitat compared to existing conditions (Table 6-5). On the other hand, prior to an avulsion into these sites, the river would have to first migrate out of the Ridgefield Pit reach. If this happened, the most likely path for the river to occupy is the old channel that it occupied prior to the avulsion. As shown in Figures 6-5 and 6-6, the amount of shallow riffle (spawning) habitat would therefore be greater than existing conditions even if the river did avulse into Pond 4 or 5 (Table 6-5). However, as discussed previously, because the river would have to first migrate out of its current location, the differences between the avulsed condition and the condition just prior to an avulsion is unknown and is not quantified in Table 6-5.

The results of the Ridgefield Pits study will provide valuable information for modification and implementation of the contingency plan mitigation actions that would be implemented in the unlikely event that the Daybreak ponds are captured during an avulsion.

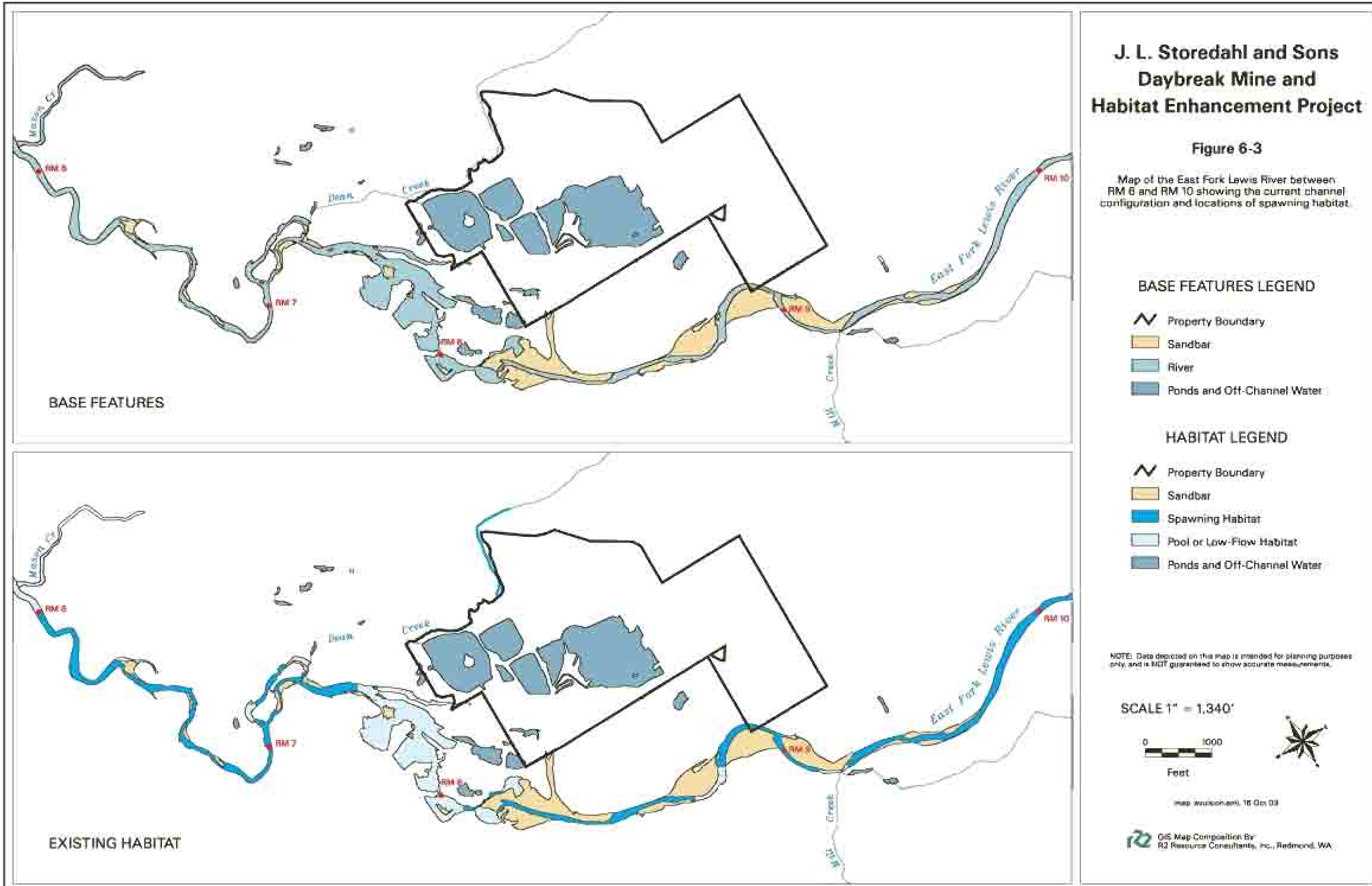
It is anticipated that some lifestages, such as upstream migrating adult fish, may benefit from pond capture and the increase in pool holding habitat, while other species or life stages may be detrimentally impacted by an alteration in the amount and location of habitat types. The study will be used to identify the nature and magnitude of impacts of pond capture by species and lifestages. Restoration plans and adaptive management decisions can then be designed to focus on improving or optimizing habitat conditions for those species and lifestages or certain suites of species. The overall effect of the HCP will be to reduce the risk of future avulsion through the Daybreak site, while increasing the likelihood that the ponds would provide high-quality rearing and adult holding habitat in the event that an unavoidable avulsion does occur.

Conservation measures should have minimal effects on lost opportunity for the creation of side and flood channels resulting from natural channel migration processes. First, preventative solutions will only be implemented if there is a real threat of avulsion prior to completion of reclamation and revegetation of the existing ponds. This could avoid the potential of lost opportunity altogether, and would reduce the time period of lost opportunity should the engineering solutions be necessary. Second, within the present CMZ (which is a reasonable representation of where habitat creation by natural channel migration would occur), engineering solutions that would be applied are largely “soft” techniques that slow or redirect channel migration but do not eliminate it. If needed during the ITP, hardening of banks adjacent to the existing Daybreak ponds or roads to prevent an avulsion would represent lost opportunity for habitat creation. However, because the ponds already exist in this location, channel migration into this site before the ponds are fully reclaimed does not provide the opportunity to create quality habitat.

Downstream adverse impacts of the preventative solutions would likely be limited to reduction in fine sediment supply, if toe hardening along the Storedahl Pit Road were to be implemented. If the river were prevented from eroding into the land on which the road is located, the sediment released from the eroding bank would no longer be available for transport. This would represent a very small fraction of the total sediment supply to downstream reaches.

Preventing the East Fork Lewis River from migrating and potentially avulsing into the Daybreak site could also result in reduced amounts of LWD being recruited into the river. However, implementation of the HCP will significantly increase the amount of forested land along the river and thus the potential for LWD recruitment.

Implementation of the HCP will also improve habitat in Dean Creek. Dean Creek currently lacks shade and habitat complexity due to the absence of riparian vegetation and recruitable LWD. The banks are severely eroded in places due to the lack of vegetation and livestock trampling, and in some reaches flows are subsurface during the summer. Restoration of riparian forests, bank stabilization using bioengineering, and placement of in-channel LWD will help enhance habitat quality in Dean Creek by reducing temperatures and increasing



J. L. Storedahl and Sons
Daybreak Mine and
Habitat Enhancement Project
Figure 6-3
Map of the East Fork Lewis River between RM 6 and RM 10 showing the current channel configuration and locations of spawning habitat.
BASE FEATURES LEGEND
Property Boundary
Sandbar
River
Ponds and Off-Channel Water
HABITAT LEGEND
Property Boundary
Sandbar
Spawning Habitat
Pool or Low-Flow Habitat
Ponds and Off-Channel Water
NOTE: Data depicted on this map is intended for planning purposes only, and is NOT guaranteed to show accurate measurements.
SCALE 1" = 1,340'
0
1000
Feet
GIS Map Composition By
R2 Resource Consultants, Inc., Redmond, WA
BASE FEATURES
EXISTING HABITAT
Mason Cr
Dean
Creek
East Fork Lewis River
Mill
Creek
RM 6
RM 7
RM 8
RM 9
RM 10

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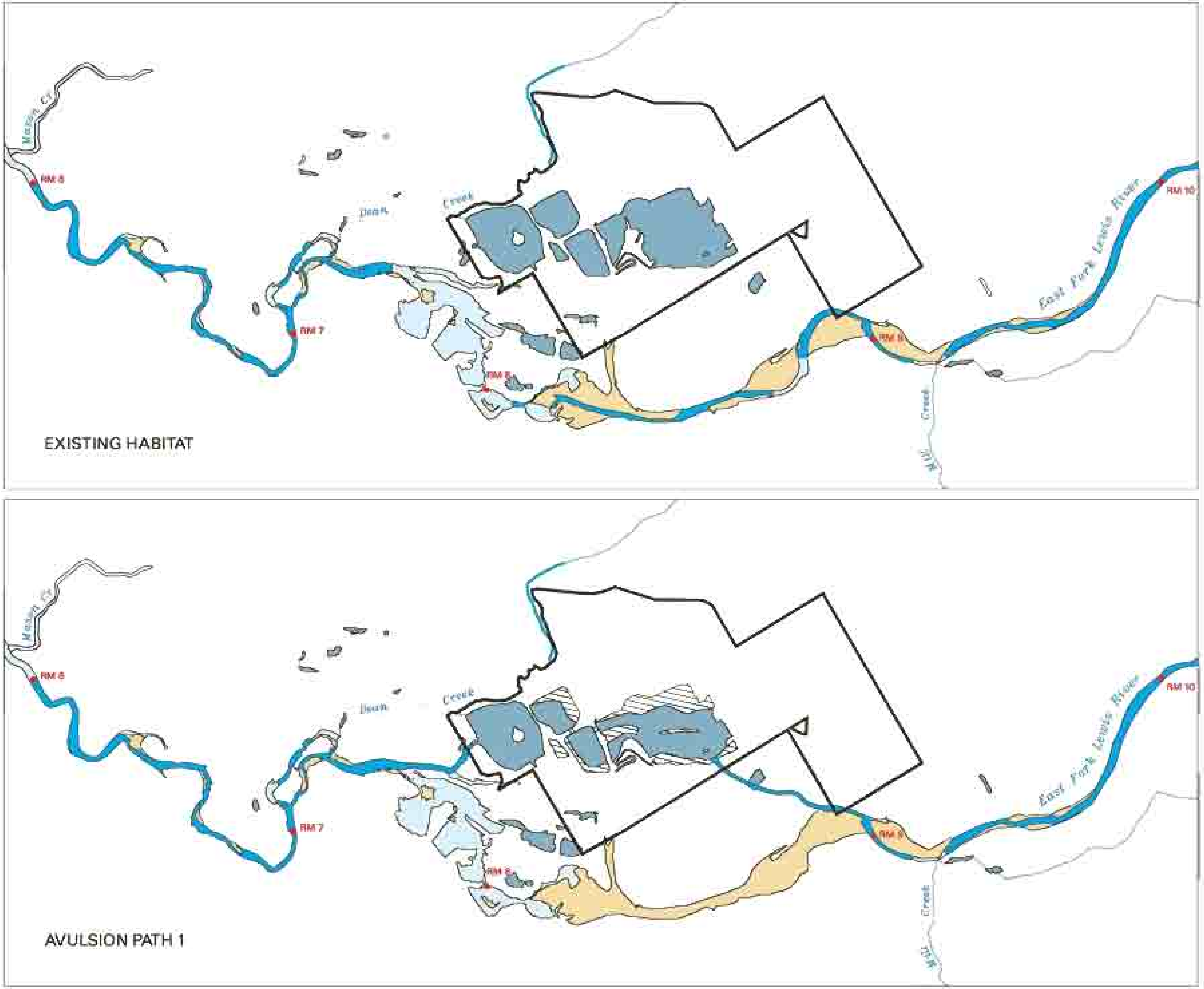
Figure 6-4

Map of the East Fork Lewis River between RM 6 and RM 10 showing the potential channel configuration and habitat conditions following an avulsion into Pond 1.



LEGEND

- Property Boundary
- Fill
- Sandbar
- Spawning Habitat
- Pool or Low-Flow Habitat
- Ponds and Off-Channel Water

NOTE: Data depicted on this map is intended for planning purposes only, and is NOT guaranteed to show accurate measurements.

SCALE 1" = 1,340'

0 1000

Feet

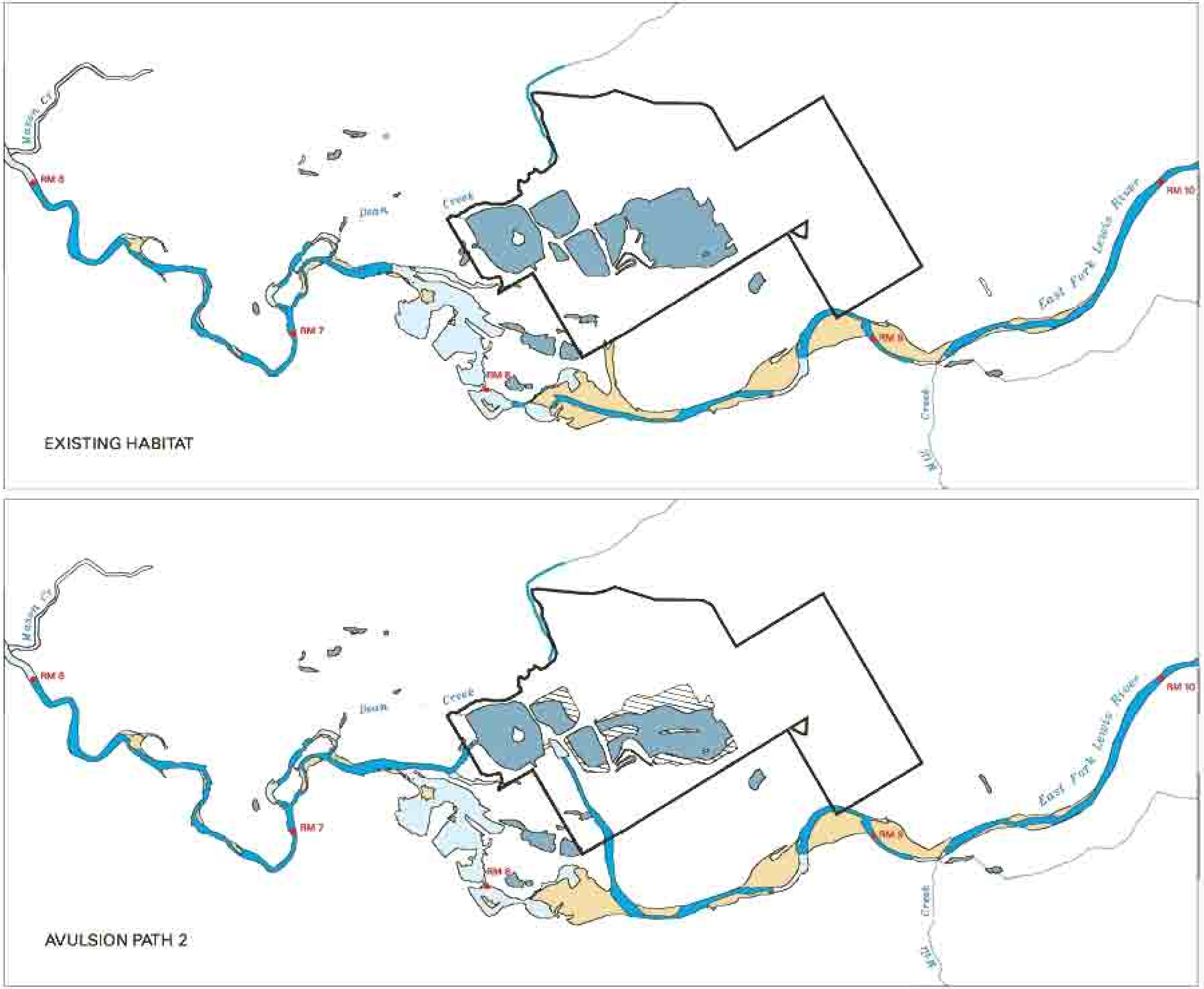
(map avulsion.aml, 16 Oct 03)

GIS Map Composition By: R2 Resource Consultants, Inc., Redmond, WA

J. L. Storedahl and Sons Daybreak Mine and Habitat Enhancement Project

Figure 6-5

Map of the East Fork Lewis River between RM 6 and RM 10 showing the potential channel configuration and habitat conditions following an avulsion into Pond 4.



LEGEND

- Property Boundary
- Fill
- Sandbar
- Spawning Habitat
- Pool or Low-Flow Habitat
- Ponds and Off-Channel Water

NOTE: Data depicted on this map is intended for planning purposes only, and is NOT guaranteed to show accurate measurements.

SCALE 1" = 1,340'

0 1000

Feet

map avulsion.aml, 16 Oct 03

GIS Map Composition By: R2 Resource Consultants, Inc., Redmond, WA

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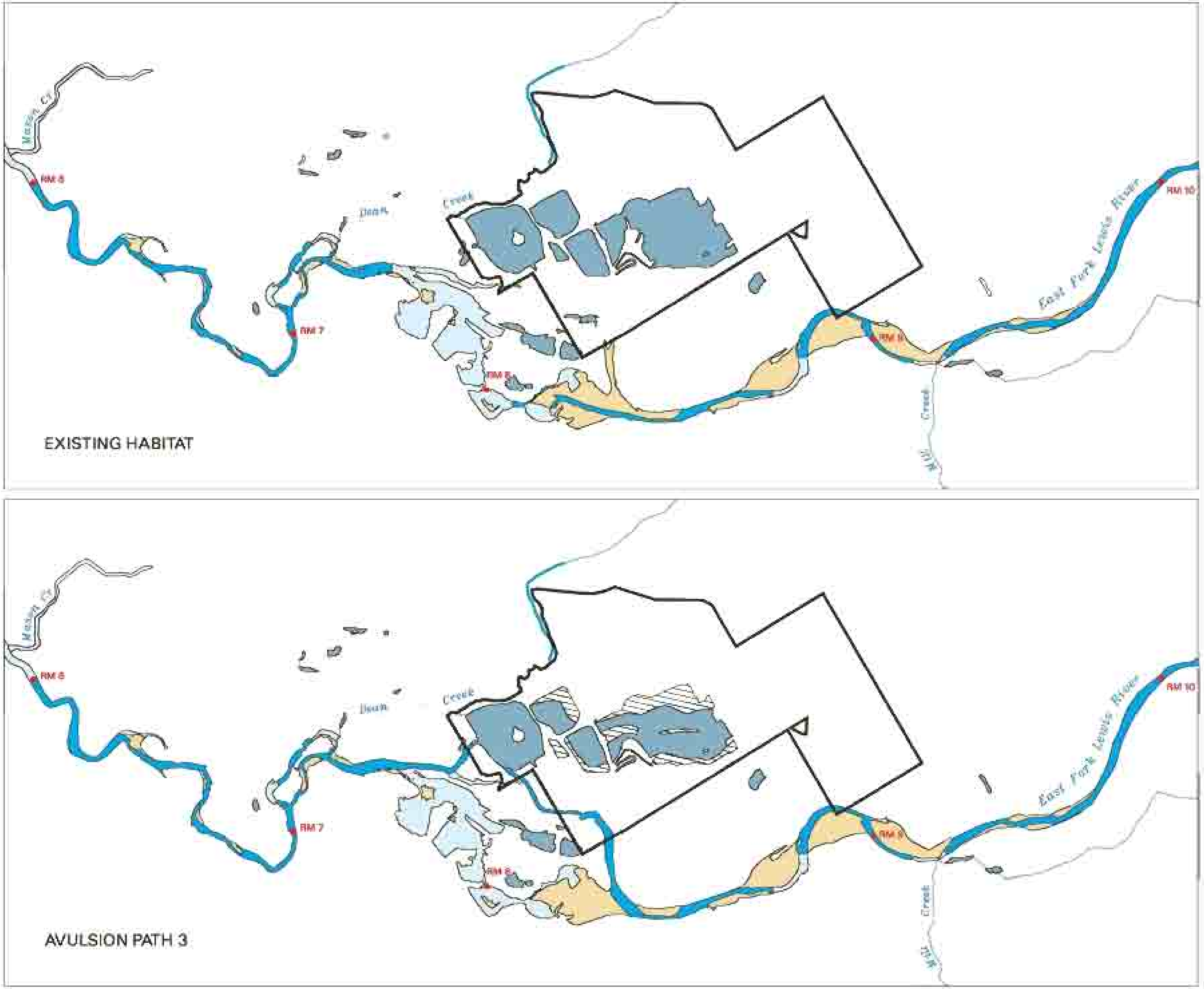
Figure 6-6

Map of the East Fork Lewis River between RM 6 and RM 10 showing the potential channel configuration and habitat conditions following an avulsion into Pond 5



LEGEND

- Property Boundary
- Fill
- Sandbar
- Spawning Habitat
- Pool or Low-Flow Habitat
- Ponds and Off-Channel Water

NOTE: Data depicted on this map is intended for planning purposes only, and is NOT guaranteed to show accurate measurements.

SCALE 1" = 1,340'

0 1000

Feet

map avulsion.aml, 16 Oct 03

GIS Map Composition By: R2 Resource Consultants, Inc., Redmond, WA

channel complexity. Stabilized banks and increased vertical scour around obstructions will create deeper pools and may help maintain surface flows and possible refugia through the summer when flows are low.

6.2.7 Wetland Habitat

As described in Section 3.2.3, wetland habitat area on the Daybreak site is currently limited. A 1998 jurisdictional wetland delineation identified three individual wetlands, which total 0.63 acres within the Daybreak site and one wetland (<0.1 acre), which is immediately adjacent to the site (Ecological Landscape Services 1998). In addition, Dean Creek and an unnamed seasonal drainage south of J. A. Moore Road are considered wetlands under the Clark County Wetlands Protection Ordinance. Other potential wetlands beyond the project area include low-lying lands west of the site, where beaver dams have affected flows in Dean Creek, and portions of the 100-year floodplain near the East Fork Lewis River. Some shoreline areas of the existing Daybreak ponds also have wetland characteristics, but were not identified as jurisdictional wetlands in the 1998 survey.

Prior to changes at the Daybreak site and East Fork Lewis River from historical land-use activities, most of the Daybreak site was likely wetland habitat. From examination of historical information, Collins (1997) concluded that the Daybreak site was an area that historically included extensive wetlands.

Potential Effects of Project Operations on Wetland Habitat. Expanded gravel mining is expected to result in the loss of one of the three on-site wetlands (Wetland “B,” 0.25 acres). In contrast, expansion of gravel mining will convert approximately 137 acres of flat and featureless pastureland to a complex mosaic of open water, shallow emergent wetland, and valley-bottom forest.

Effects of Conservation Measures on Wetland Habitat. Wetland creation and enhancement within the Daybreak site will be achieved through the implementation of several conservation measures. Within the excavated areas, wetland habitat will be created by backfilling areas to achieve shallow water depths that will support floating-leaf and emergent wetland vegetation. The project will result in the creation of approximately 32 acres of emergent wetland habitat. These areas of wetland vegetation will be interspersed with shallow open-water areas. In addition, wetland habitat complexity will be further increased by the creation of shoreline riparian habitat around the margins of the ponds and native valley-bottom forest in the intervening areas between the ponds. The riparian zone along Dean Creek will also be enhanced considerably relative to present conditions. Since the post-excavation depth to the water table around the ponds is not known with certainty at this time, the total area of riparian and forested wetland habitat that will meet jurisdictional criteria in the future cannot be quantified. However, it is estimated that there will be 52 acres of forested wetland and 114 acres of native valley-bottom forest, which will be a substantial contribution to the amount and quality of wetland habitat at the Daybreak site and near the lower East Fork Lewis River, as defined by the USFWS (Cowardin et al. 1979). The creation of approximately 32 acres of emergent wetland habitat and approximately 166 forested acres far exceeds the 0.5 acres of existing wetland that will be altered by the gravel extraction.

Creation of shallow emergent wetlands within the ponds is expected to increase productivity. Wetlands are generally the world's most productive ecosystems (Etherington 1983). Reestablishing riparian vegetation adjacent to the ponds, Dean Creek, and East Fork Lewis River will also increase contributions of fine particulate organic matter and terrestrial invertebrate prey items that are typically important components of the aquatic food web in mid-size rivers (Vannote et al. 1980). The biomass of the available food is anticipated to increase through the creation of additional open water and wetland associated communities. Fish commonly congregate at the outlet of ponds and wetlands where they feed on abundant zooplankton and other invertebrates that are released by these systems.

This mosaic of wetland vegetation species and structural types will be more similar to natural valley-bottom conditions along the East Fork Lewis River than the present flat and homogeneous pastureland. In terms of both the amount and quality of wetland habitat, the creation and restoration of wetlands will be a net positive effect of the HCP.

6.2.8 Predation and Competition

Potential Effects of Project Operations on Predation and Competition. Observations of Pond 5 indicate that the existing ponds contain native and non-native fish and amphibian species that could prey on juvenile salmonids, lamprey, or Oregon spotted frogs. Native predators of juvenile fish known to be present in the ponds include northern pikeminnow (formerly known as northern squawfish) and sculpin. Non-native predators observed in Pond 5 include largemouth bass, black crappie, yellow perch, and bullfrogs. It is unknown if or how many of these non-native species also occur in the beaver pond complex near the mouth of Dean Creek, or are present in the East Fork Lewis River. Mining, processing, and reclamation activities at the Daybreak site will add approximately 96 acres of pond and wetland habitat, and could therefore increase the total number of potential predators supported at the site.

As discussed in Section 6.2.6, if the East Fork Lewis River were to avulse, the most likely location would be into the existing Daybreak ponds. An avulsion into the existing ponds could result in an increase in the amount of predation on juvenile salmonids from both native (e.g., northern pikeminnow) and non-native (e.g., largemouth bass) fish. In addition, an avulsion could result in the release of predatory fish into the East Fork Lewis River from the ponds and it could also expose juvenile salmonids in the avulsed reach to increased predation. Nighttime snorkel surveys for largemouth bass in the Ridgefield Pits during 2000 did not find bass present in the spring when juvenile salmonids were migrating downstream and water temperatures were still cold, although native northern pikeminnow were observed in the avulsed reach (R2 Resource Consultants, unpublished data). These data indicate that the risk of predation on juvenile salmonids in avulsed pits from non-native fish may be relatively low because juvenile salmonids are migrating when water temperatures are still relatively cool and bass are in their winter feeding dormancy.

Currently flooding of the East Fork Lewis River potentially exposes the covered species to predation from fish in Pond 5, because the river backs up into Pond 5 during relatively low-flow flood events. Although the extent of this baseline predation is unknown, the western berm of Pond 5 has three low spots where surface water from Pond 5 can exit, depending on the pond surface elevation and dam building by beavers. During approximately a two-year flood event or greater, water in the East Fork Lewis River spreads out over the floodplain and overtops the outlets of Pond 5. This natural flooding can result in predation on salmonids that move with the flood water out of the high velocity areas and into the lower velocity backwaters, including Pond 5, which contain native and non-native predators.

Effects of Habitat Conservation Measures on Predation and Competition. The primary goal of reconfiguring the existing ponds to be narrower and shallower through conservation measure CM-08 (Mining and Reclamation Designs) is to reduce the risk and potential adverse effects of an avulsion into these ponds. A second benefit of this conservation measure will be to reduce the total amount of the existing pond habitat. The amount of habitat suitable for non-native predators will be reduced in the existing Daybreak ponds as a consequence of narrowing and shallowing the ponds. Non-native predators in the ponds, such as largemouth bass, are essentially lake-dwelling species. Reducing the amount of pond habitat will reduce the carrying capacity of the Daybreak site to support these species. This should result in fewer non-native predators in the existing ponds.

The implementation of CM-09 (Avulsion Contingency Plan) will also result in a reduced risk of the East Fork Lewis River avulsing into the existing or new ponds prior to the ponds being reclaimed by being narrowed and revegetated. Reducing the risk of an avulsion into the unreclaimed ponds will reduce the risk of the East Fork Lewis River capturing additional slow velocity, wide pool habitat that is potential habitat for predaceous fish including non-native species. The net effect of implementing CM-08 and CM-09 will be to reduce the risk of potential predation by reducing the risk of avulsion and by reducing the amount of habitat available to predators in the event an avulsion does occur in the future.

Conservation measure CM-04 (Water Management Plan) will also reduce the amount of predation on the covered species by reducing the frequency that flood waters of the East Fork Lewis River backflood into Pond 5. Implementation of CM-04 will result in reconfiguring and increasing the elevation of the western berm so that surface water releases are controlled at a single outlet. A secondary benefit of this conservation measure is that the East Fork Lewis River will be able to overtop and backwater into Pond 5 only during a 17-year or greater flood event. Over a 25-year time period, the net effect will be more than an 80 percent reduction in the potential frequency of events conducive to predation by non-native fish in the ponds on the covered salmonids in the river.

Implementation of CM-16 (Control of Non-Natives) will also reduce the numbers of largemouth bass in the Daybreak ponds through targeted harvest. Selectively removing largemouth bass by angling, seining, and other fish trapping methods will effectively reduce the number of largemouth bass and therefore reduce the potential amount of predation on the covered species. Because fish populations and movements are difficult to control, selective harvest is expected to reduce largemouth bass numbers only within the short period of time following intensive harvest events. These intensive harvest events will occur three times during the term of the ITP and under the direction of warmwater fish biologists in WDFW. To prevent the reintroduction and recolonization of largemouth bass into the existing ponds, and especially into Pond 5, rock barriers will be installed to restrict the movement of fish between the existing ponds and the created ponds. These barriers will be constructed during mining of the new ponds and these structures will remain following reclamation and revegetation. Since local anglers frequent the ponds, educational signs will be installed to warn the public about the dangers of transferring or releasing non-native fish species into or between the ponds and into the East Fork Lewis River and Dean Creek. The net effect of selective harvesting (CM-16) will be a reduction in the number of largemouth bass in the

Daybreak ponds over the short-term. Longer-term benefits may be achieved through the implementation of rock barriers between the ponds and educational signs.

At the same time that potential impacts of predation will be minimized, the competitive advantage of salmonids potentially entering the Daybreak ponds will be enhanced. However, as discussed in Section 4.4.6, off-channel habitat can provide prime rearing habitat for several of the salmonid species, as well as their non-native predators. The creation of emergent and forested wetland habitat around each pond and the reestablishment of native valley-bottom forest in the uplands will provide prime feeding areas for many fish species during flood events (Bayley and Baker 2002). During flood flows, riverine fish seek out areas of lower velocity, such as along the edges of the river. If these areas are vegetated, terrestrial insects living on and among the plants can become a valuable food source for fish. In addition, the reclaimed ponds will contain vegetated edges and woody structure so that they can function as off-channel habitat for rearing salmonids. For example, off-channel pond areas are known to support higher densities of rearing coho salmon (Beechie et al. 1994). It is unknown how an enhanced competitive advantage for juvenile salmonids rearing in off-channel areas compares with a potentially increased risk of predation within the same habitat. Although the frequency of salmon entering the Daybreak ponds during flood events will be minimized by restructuring the berm along Pond 5 and therefore the risk of predation will be reduced, fish that do enter the ponds may be able to feed, rear, and return to the river via the outlet to Dean Creek with an increased competitive advantage over other fish in their cohort, which had been unable to access off-channel rearing habitat.

6.3 EFFECTS OF PROJECT OPERATIONS AND CONSERVATION MEASURES ON STEELHEAD (*ONCORHYNCHUS MYKISS*)

The following analysis is limited to steelhead, a species that is listed as threatened under the ESA in the Columbia River (63 *Fed. Reg.* 13347-11809). Separate analyses are presented for each major life history stage of steelhead, including upstream migration, spawning and incubation, juvenile rearing, and downstream migration. Detailed information concerning specific life history characteristics and habitat requirements is presented in Technical Appendix A. Other species for which coverage is being sought under this HCP/ITP will be similarly analyzed and described in subsequent sections.

6.3.1 Steelhead Upstream Migration

Summer and winter races of steelhead are present in the East Fork Lewis River. Winter-run steelhead return to the river between December and April, and summer-run fish return between May and November. Both populations spawn in the spring. Therefore adult steelhead are potentially in the river at all times of the year. Upstream migrating steelhead primarily utilize habitat in the mainstem and large tributaries, moving into smaller tributaries only to spawn. The potential for Storedahl's mining activities to affect upstream migrating steelhead is generally greatest in the late summer when water temperatures are highest, dissolved oxygen would generally be the lowest, and low-flow conditions may restrict the amount of available holding habitat and make the fish most vulnerable to turbidity increases.

6.3.1.1 Groundwater

Expanded mining and reclamation under the HCP will not impact groundwater contributions to the East Fork Lewis River (Section 6.2.2). However, the transfer of 330 afy currently used for irrigation to the State Trust for instream flow enhancement could increase flows and have a positive effect on upstream migrating steelhead.

6.3.1.2 Surface Water Quantity and Quality

Implementation of the water management plan could increase surface outflows from the ponds during the late summer. Increased flows would be most notable in Dean Creek, where total discharge in the late summer is generally less than 1 cfs (McFarland and Morgan 1996), and stream sections go subsurface during the summer. However, flow increases are expected to be less than 0.5 cfs, thus there will be no effect on upstream migrating steelhead in the East Fork Lewis River.

High water temperatures are most likely to detrimentally impact adult steelhead migrating upstream or holding in the mainstem during the summer low-flow period. Implementation of this HCP is expected to maintain or reduce water temperatures in Dean Creek adjacent to the Daybreak site. Downstream of this reach, Dean Creek flows through a large beaver complex with low velocities and a large area of shallow water exposed to solar radiation. Therefore, any temperature reductions resulting from the HCP will likely be localized, and would have little effect on water temperatures in the East Fork Lewis River unless or until restoration activities are completed on the lower reach of Dean Creek. For this reason, temperature reductions that occur as a result of this HCP will not affect steelhead migrating upstream or holding in the East Fork Lewis River.

Dissolved oxygen is not currently considered a limiting factor in the East Fork Lewis River. Implementation of the HCP may increase the DO concentrations in Dean Creek as a result of increased DO in the Pond 5 outflow and pumped discharge to Dean Creek. However, downstream of the Daybreak site Dean Creek flows through a large beaver pond complex where low velocities and naturally high temperatures are likely to result in reduced DO. Since increasing the DO of the pond outflow is not expected to influence DO levels in the East Fork Lewis River, increases in DO that occur as a result of this HCP will not affect upstream migrating steelhead.

Turbidity is expected to be significantly reduced under the HCP. However, even under existing conditions, turbidity associated with activities at the Daybreak site has little impact on water quality in the mainstem East Fork Lewis River. Therefore, the reduction in turbidity expected to occur under this HCP is expected to have no effect on steelhead migrating upstream or holding in the East Fork Lewis River.

6.3.1.3 Riverine Habitat

Increasing the buffer width and reforesting the area between the East Fork Lewis River and the Daybreak ponds will reduce the risk of an avulsion through the Daybreak site. Monitoring and implementation of the avulsion contingency plan will further reduce the risk of an avulsion during the term of the ITP. However, as described in Technical Appendix C, future avulsions, while improbable, must be considered possible. If such an event did occur, observations of the Ridgefield site suggest that the result would be formation of a series of pools and an increase in the complexity of the channel and shoreline. Deep, thermally stratified pools provide refuge habitat for adult steelhead when stream temperatures elsewhere in the river reach incipient lethal levels (Nielsen and Lisle 1994). The lower East Fork Lewis River is currently on the Washington State 303(d) listing due to temperature exceedance. Prior to the 1996 avulsion, only three pools deeper than six feet were identified between RM 10.2 and RM 7.0 during a survey conducted in 1991 (EnviroScience 1996a). Therefore, an increase in the number of deep, coldwater refugia as a result of avulsion through the Daybreak site could have a positive effect on upstream migrating steelhead. However, pool depths at the Ridgefield site in 1999, three years after the avulsion, were generally less than 10 feet, so positive thermal effects for upstream migrating steelhead may be short-lived. Migrating adult steelhead could be stranded in avulsed ponds after high flow events if the ponds become isolated due to sediment deposition and receding water levels. However, observations of the Ridgefield Pits indicate that following winter high flows the off-channel pools remain connected to the river, most likely due to significant hyporheic flow.

6.3.1.4. Wetland Habitat

The creation of approximately 32 acres of emergent wetland habitat will not directly influence migrating steelhead, primarily because fish passage into the ponds and wetlands will be restricted as a result of reconfiguring the surface water outlet and the western berm on Pond 5.

6.3.1.5 Predation and Competition

Implementation of the HCP will not alter the current species assemblage in the East Fork Lewis River or Dean Creek. While the existing ponds contain native and non-native fish species that may colonize the created ponds, none of the species present would be expected to prey upon or compete with adult steelhead. Therefore, implementation of this HCP will not affect predation on or competition with adult steelhead trout.

6.3.2 Steelhead Spawning and Incubation

Both summer- and winter-run steelhead spawn from March through late May or early June. Steelhead are able to spawn throughout the river, and summer-run steelhead spawn from the end of the tidal influence zone at RM 6.0 to upstream of Sunset Falls at RM 32.7. Winter-run steelhead can use spawning habitat in the river up to Lucia Falls at RM 21.3. The total length of stream available for spawning, including the mainstem and tributaries, is approximately 54 miles (WDF and WDW 1993). Steelhead are not believed to have utilized Dean Creek for spawning either historically (Bryant 1949) or recently (WDF and WDW 1993), although the pool-riffle segment of Dean Creek could provide some marginal steelhead spawning habitat.

6.3.2.1 Groundwater

Increased flows entering the East Fork Lewis River and Dean Creek as a result of the transfer of water rights to the State Trust will not affect steelhead spawning and incubation since the increased flows would occur in the summer and early fall.

6.3.2.2 Surface Water Quantity and Quality

Reconfiguring the pond outlet to prevent inflow from Dean Creek and implementing a water management plan could increase flows in Dean Creek during the spring, but flow increases would only affect the reach downstream of suitable spawning sites. The potential flow increase in Dean Creek is small compared to the average flows in the East Fork Lewis River during the spring, and is therefore not expected to affect steelhead spawning and incubation.

Steelhead prefer temperatures lower than 10ºC for spawning and incubation (Bell 1991; USEPA 2001). Temperatures in the East Fork Lewis River during the spawning period are generally suitable for steelhead spawning. However, data collected at Daybreak Park from 1976 to 1992 indicate that temperatures in the East Fork Lewis River sometimes exceed 10ºC during the latter part of the steelhead spawning and incubation season (Hutton 1995d). Restoration of riparian forest will increase shade, thereby reducing water temperatures in Dean Creek adjacent to the Daybreak site, which could have a positive effect on steelhead spawning and incubation in Dean Creek. Downstream of this reach, Dean Creek flows through a large beaver complex with low velocities and a higher exposure to solar radiation. Any temperature reductions resulting from the HCP will be localized and are expected to have little effect on water temperatures in the East Fork Lewis River. Temperature reductions resulting from implementation of this HCP are therefore not expected to affect steelhead spawning and incubation in the East Fork Lewis River.

Salmonid eggs and alevins require DO levels greater than 7 mg/l in order to develop properly (Bell 1991). In general, the DO concentration is typically lower within the streambed than in the surface flow. Thus, assuming a difference of 3 mg/l between intergravel and instream DO concentrations, instream values greater than 10 mg/l should adequately maintain DO levels at around 7 mg/l within the gravel (MacDonald et al. 1991). Implementation of the HCP is expected to maintain or increase DO in the pond outflow as a result of turbulent discharge. However, since DO levels measured in both Dean Creek and the East Fork Lewis River downstream of the Daybreak site exceeded 10 mg/l for all samples collected during the steelhead spawning and incubation period, increased DO is not expected to affect steelhead spawning and incubation.

The 1.25 mile segment of potential spawning habitat in the East Fork Lewis River from the Daybreak ponds to the tidal influence zone could be impacted by sediment generated from Storedahl's operations, although spawning conditions in this reach are also influenced by sediments eroding from the high bluffs above the Ridgefield Pits and the Daybreak Bridge. This reach represents 2 percent of the approximately 54 miles of available steelhead spawning habitat. Use of a clarification system has significantly reduced turbidity of the pond outflows and will therefore continue to reduce sediment inputs as a result of operations at the Daybreak site. Further, implementation of a closed-loop clarification system should substantially reduce or eliminate turbidity contributions from the processing operations. The net result will be a reduction in the amount of fine sediment delivered to the East Fork Lewis River, which could have a positive effect on steelhead spawning downstream of the Daybreak site, provided contributions from other sediment sources do not overwhelm minor reductions from the Daybreak site.

6.3.2.3 Riverine Habitat

There are currently an estimated 54 miles of suitable steelhead spawning habitat in the East Fork Lewis River watershed. Since avulsion is most likely to occur during fall and winter high flows and since steelhead spawn in the spring, direct impacts to steelhead spawning and incubation by dewatering of redds in the abandoned channel segments and scour of redds up or downstream of the site are considered to be unlikely. Avulsion into the Daybreak site could affect steelhead spawning over the long term by replacing spawning habitats in the channel that would have existed prior to an avulsion with deep, slow pool habitat. If an avulsion were to occur into Pond 1 (Figure 6-4), it could result in a decrease of 22 percent of the available spawning habitat that currently exists in the river between RM 7 and RM 9 (Table 6-5). The amount of spawning habitat that could be potentially impacted between RM 7 and RM 9 (1,582 lineal feet) amounts to less than 1 percent of the available steelhead spawning area (54 miles) in the East Fork Lewis River. This effect could persist for decades, although during this time there would be a gradual increase in spawning habitat as gravel is deposited in the pools and the channel continues to meander. Sediments released downstream during a potential avulsion could also impact the 1.25 miles of riffle habitat immediately upstream of the tidal zone or 2 percent of the available steelhead spawning area in the East Fork Lewis River. A potential avulsion would be expected to have only minor impacts on steelhead spawning and incubation, because a) the implementation of the HCP will reduce the overall risk of avulsion into the existing ponds, b) direct impacts are unlikely and c) the area that could be impacted represents a small fraction of the total available steelhead spawning habitat.

6.3.2.4 Wetland Habitat

Steelhead do not spawn in wetland habitat. Therefore the creation of approximately 32 acres of emergent wetland is expected to have no effect on steelhead spawning and incubation.

6.3.2.5 Predation and Competition

The existing ponds do not contain native or non-native fish species that are expected to compete with adult steelhead for spawning sites, although several of the species are known to prey on salmonid eggs. These fish are also found in the East Fork Lewis River where steelhead spawning occurs. The HCP is not expected to affect predation on or competition with steelhead spawning and incubation.

6.3.3 Steelhead Juvenile Rearing and Downstream Migration

Juvenile steelhead in the East Fork Lewis River system generally emerge from the gravels between April and July and rear in freshwater for two years before migrating downstream to the ocean (Technical Appendix A). During their first summer, steelhead fry prefer habitat along the stream margin, where velocity and depth are low. As they grow, the young fish move into deeper, swifter water. Steelhead over-winter in the interstitial spaces of the substrate or in pools with cover provided by LWD. Juvenile steelhead utilize rearing habitats in the East Fork Lewis River and possibly within certain small tributaries, such as Mason Creek and perhaps Dean Creek.

6.3.3.1 Groundwater

Expanded mining and reclamation under the HCP will not impact groundwater contributions to the East Fork Lewis River (Section 6.2.2). However, the transfer of 330 afy currently used for irrigation to the State Trust for instream flow enhancement could increase the amount and quality of rearing habitat and have a positive effect on steelhead rearing.

6.3.3.2 Surface Water Quantity and Quality

Implementation of the water management plan could increase surface flows in Dean Creek during the late summer, fall, and winter. This would increase the amount of low velocity habitat available to juvenile steelhead. However, steelhead are less likely to utilize this type of habitat than other salmonid species such as coho, thus benefits to this species would be minimal. Implementation of the HCP will have no effect on steelhead rearing in the East Fork Lewis River.

Detrimental effects from high temperatures are most likely to impact juvenile steelhead during the late summer. Water quality within several of the existing ponds meets the water quality criteria required for steelhead rearing during the winter, but could pose a thermal risk to fish that remain throughout the summer months. Reconfiguration of the Pond 5 outlet will restrict juvenile steelhead during most flows from entering the ponds and becoming exposed to high temperatures. Implementation of the HCP could decrease temperatures in Dean Creek, although it is not expected to change temperatures in the East Fork Lewis River. The overall effect of these measures on juvenile steelhead rearing is expected to be positive.

Reducing turbidity in the ponds and reconfiguring the Pond 5 outlet will likely increase DO levels in the ponds and pond outflow. Increased DO would have a net positive effect on juvenile steelhead rearing in Dean Creek through the summer. However, downstream of the Pond 5 outlet, Dean Creek flows through a low-velocity beaver pond complex prior to entering the East Fork Lewis River. Consequently, the increases are not expected to persist in the East Fork Lewis River, and there will be no effect on rearing juvenile steelhead.

Use of a closed-loop clarification system to treat the wash water will substantially reduce or eliminate the turbidity contributions from wash water to the ponds, and implementation of the Storm Water and Erosion Control Plan will further reduce turbidity during winter storms. As a result, turbidity of water delivered to Dean Creek and the East Fork Lewis River is expected to decrease. Because surface outflow from the pond can represent a substantial portion of the flow in Dean Creek, turbidity of the outflow can have a substantial impact on habitat conditions in the creek. Implementation of the HCP is expected to result in a substantial reduction in the outflow turbidity, and will therefore have a positive effect on juvenile steelhead rearing in Dean Creek. Discharge from Dean Creek contributes only a fraction of the East Fork Lewis River flows, and therefore the reduced turbidity will not affect juvenile steelhead rearing in the mainstem.

6.3.3.3 Riverine Habitat

Expanded mining and gravel processing at the Daybreak site under this HCP will not directly affect physical habitat in the East Fork Lewis River or Dean Creek. However, HCP conservation measures will restore riparian forests and convert the existing pasture to a complex mosaic of open water ponds and wetlands. These measures are expected to increase the amount of food available to juvenile steelhead in Dean Creek and the East Fork Lewis River downstream of the confluence with Dean Creek. Restoration of stream banks and placement of LWD in Dean Creek, in concert with restoration of the riparian zone, is expected to result in an overall improvement of stream habitat. The net effect of these actions on juvenile steelhead in Dean Creek and the East Fork Lewis River will be positive.

The potential net effect of avulsion through the Daybreak ponds on juvenile steelhead is unknown. Conversion of the predominantly riffle-type habitat of the existing natural channel to a series of deep, slow pools that contain structure and created wetlands will create conditions that share some features with rivers that avulse into natural off-channel habitats, such as oxbows. Newly emerged steelhead fry were observed in June 2000 congregating in the shallow slackwater edge habitat that is abundant in the avulsed reach through the Ridgefield Pits (R2 Resource Consultants, unpublished data). Steelhead prefer deep pools with cover for winter rearing (Campbell and Nuener 1986), and they use deep pools with cool groundwater inflows during the summer as refugia when stream temperatures elsewhere in the river reach incipient lethal levels (Nielsen and Lisle 1994). Therefore, increasing the amount of low-velocity edges and deep pools are expected to have a positive effect on juvenile steelhead.

Conversely, studies show that downstream migrating smolts generally move at rates that are a function of the local current velocity (Raymond 1979; Moser et al. 1991). An avulsion through the Daybreak site could increase the travel time of downstream migrating fish, and slightly increase the time smolts are exposed to predators. Predatory fishes such as the native northern pikeminnow prefer slower moving waters (Faler et al. 1988). An avulsion into the Daybreak site may release non-native fish to the East Fork Lewis River, slightly increase downstream travel time, and increase the area of deep, low-velocity habitat favored by predators, all of which could negatively affect juvenile steelhead. In addition, juvenile steelhead could be stranded in avulsed ponds after high flow events, if the ponds become isolated by sediment deposition and receding water levels.

6.3.3.4 Wetland Habitat

Although juvenile steelhead use off-channel habitat during high flows, the reconfigured outlet of Pond 5 would restrict juvenile steelhead from accessing the wetland habitat on the Daybreak site during most flows. Creation of approximately 32 acres of emergent wetlands is expected to increase the overall productivity of aquatic habitat on the site. Increased productivity will release more food items to Dean Creek, benefiting juvenile fish, which could be present in the stream. Therefore the increase in wetland habitat could have a positive effect on rearing juvenile steelhead in Dean Creek.

6.3.3.5 Predation and Competition

Dean Creek and the Daybreak ponds currently provide off-channel habitat that may be attractive to juvenile steelhead during winter high flows. However, the reconfigured Pond 5 outlet will restrict juvenile steelhead during most flows from entering the ponds. Pond 5 contains a variety of native and non-native fish species that could prey on juvenile steelhead. Restricting outflows to a single site and reconfiguring the western berm to prevent backflooding from the East Fork Lewis River during floods with a magnitude less than a 17-year event will restrict steelhead from entering the ponds during most flows. Reducing the available habitat by narrowing the existing ponds and targeted harvest of largemouth bass in the Daybreak ponds will reduce the number of predators. Restricting access and reducing the numbers of predators are anticipated to result in a positive effect on juvenile steelhead.

6.4 EFFECTS OF PROJECT OPERATIONS AND CONSERVATION MEASURES ON CHINOOK SALMON (*ONCORHYNCHUS TSHAWYTSCHA*)

The following analysis is limited to Chinook salmon, a species that is listed as threatened under the ESA in the Columbia River (64 *Fed. Reg*. 14307-14328). However, the fall-run of Chinook salmon in the East Fork and mainstem Lewis River is considered to be healthy (Myers et al. 1998). Few, if any spring Chinook return to the East Fork Lewis River today, and there is a possibility that the native run of spring Chinook is extinct (Myers et al. 1998). Separate analyses are presented for each of the major life history stages of Chinook salmon, including upstream migration, spawning and incubation, juvenile rearing, and downstream migration. Detailed information concerning specific life history characteristics and habitat requirements is presented in Technical Appendix A.

6.4.1 Chinook Salmon Upstream Migration

The East Fork Lewis River may support populations of both spring- and fall-run Chinook salmon, although spring-run fish are believed to be strays from the North Fork Lewis River (WDF and WDW 1993). The East Fork Lewis River was historically used primarily by fall Chinook (Fulton 1968). Spring Chinook return to the river between May and July, and hold in deep pools in the mainstem through the summer. Fall-run fish return during September and October. Upstream migrating Chinook are the largest of all Pacific salmon and generally only utilize habitat in the mainstem and larger tributaries. The potential for the Daybreak Mining and Habitat Enhancement Project to affect upstream migrating fish is greatest for spring Chinook that may hold in the river throughout the summer when water temperatures are highest, dissolved oxygen is generally the lowest, and low-flow conditions restrict the amount of available holding habitat and make the fish most vulnerable to turbidity increases.

6.4.1.1 Groundwater

Expanded mining and reclamation under the HCP will not impact groundwater contributions to the East Fork Lewis River (Section 6.2.2). However, the transfer of 330 afy currently used for irrigation to the State Trust for instream flow enhancement could increase flows and have a positive effect on upstream migrating Chinook salmon.

6.4.1.2 Surface Water Quantity and Quality

Implementation of the water management plan is expected to result in flow increases of 0.1 to 0.5 cfs in lower Dean Creek during the late summer. Adult Chinook salmon would be unlikely to utilize habitat in Dean Creek, and flow increases are not of a sufficient magnitude to measurably affect flows in the East Fork Lewis River. Therefore, this HCP is not expected to have an effect on upstream migrating Chinook in the East Fork Lewis River.

High water temperatures are most likely to impact adult Chinook salmon migrating upstream or holding in the mainstem during the summer. Implementation of this HCP is expected to maintain or reduce water temperatures in Dean Creek. However, downstream of the Daybreak site, Dean Creek flows through a large beaver complex with low velocities and a large area of water exposed to solar radiation, temperature reductions are not expected to persist, and will have little effect on water temperatures in the East Fork Lewis River. For this reason, temperature reductions resulting from implementation of this HCP are not expected to affect upstream migrating Chinook salmon.

Implementation of the HCP may increase the DO concentration in Dean Creek as a result of increased shading along the creek and turbulent discharges from Pond 5. However, since Dean Creek flows through a large beaver pond complex with low velocities and naturally high temperatures, increases in DO would not persist. Since DO is not currently considered a limiting factor in the East Fork Lewis River and DO concentrations in the East Fork Lewis River are not expected to change as a result of this HCP, there will be no effect on upstream migrating Chinook salmon.

Turbidity is expected to be significantly reduced under the HCP. However, even under existing conditions, turbidity associated with activities at the Daybreak site has little impact on water quality in the mainstem East Fork Lewis River during the time when adult Chinook are migrating upstream. Therefore, turbidity reductions that occur as a result of this HCP are expected to have no effect on upstream migrating Chinook salmon.

6.4.1.3 Riverine Habitat

Increasing the buffer width and reforesting the area between the East Fork Lewis River and the Daybreak ponds will reduce the risk of an avulsion through the Daybreak site. Monitoring and implementation of the avulsion contingency plan are expected to reduce further the risk of an avulsion during the term of the ITP. However, as described in Technical Appendix C, future avulsions, while improbable, must be considered. If such an event should occur, observations of the Ridgefield site suggest that the result would be the formation of a series of deep pools. Deep, thermally stratified pools could provide refuge habitat for adult Chinook salmon when stream temperatures elsewhere in the river reach incipient lethal levels (Nielsen and Lisle 1994). The lower East Fork Lewis River is currently on the Washington State 303(d) listing due to temperature concerns, and prior to the 1996 avulsion only 3 pools deeper than 6 feet were identified between RM 10.2 and 7.0 during a survey conducted in 1991 (EnviroScience 1996a). Therefore, an increase in the number of deep, coldwater refugia could have a positive effect on upstream migrating Chinook. However, pool depths at the Ridgefield site in 1999, three years after the avulsion, were generally less than 10 feet so positive effects for upstream migrating Chinook may be short-lived. Adult, migrating Chinook salmon could be stranded in avulsed ponds after high flow events, if the ponds become isolated by sediment deposition and receding water levels. However, observations of the Ridgefield Pits indicate that following winter high flows the off-channel pools remain connected to the river, most likely due to significant groundwater flow.

6.4.1.4 Wetland Habitat

The creation of approximately 32 acres of emergent wetland habitat will not directly affect upstream migrating Chinook salmon. Chinook salmon are not expected to migrate into Dean Creek, and fish passage into the ponds and wetlands will be restricted as a result of reconfiguring the surface water outlet and western berm on Pond 5.

6.4.1.5 Predation and Competition

The existing ponds contain a variety of native and non-native fish species. However, none of the species present are expected to prey upon or compete with adult Chinook during upstream migration. Therefore, changes in predation and competition from implementation of this HCP will have no effect on adult Chinook salmon.

6.4.2 Chinook Salmon Spawning and Incubation

Spring-run Chinook salmon in the East Fork Lewis River spawn during August and September, and the more abundant fall-run Chinook spawn predominantly during October and November. Chinook spawning is limited to the mainstem and extends from Mason Creek upstream to Lucia Falls, a total distance of approximately 15 miles.

6.4.2.1 Groundwater

Increased flows entering the East Fork Lewis River and Dean Creek as a result of the transfer of water rights to the State Trust could benefit spring Chinook salmon and possibly fall Chinook salmon that begin spawning in summer and early fall.

6.4.2.2 Surface Water Quantity and Quality

Development of additional gravel ponds on the Daybreak site and implementation of the water management plan is not expected to measurably alter surface flows in the East Fork Lewis River. Implementation of the HCP is therefore not expected to affect Chinook salmon spawning and incubation in the East Fork Lewis River.

Preferred temperatures for Chinook salmon spawning and incubation is lower than 11°C (Bell 1991) or lower than 10°C (USEPA 2001). Temperatures in the East Fork Lewis River during the fall Chinook spawning period are generally suitable for spawning. However, data collected at Daybreak Park from 1976 to 1992 indicate that temperatures in the East Fork Lewis River often exceed 11°C during August and September (Hutton 1995d) when spring-run Chinook would be spawning if they stray into the river.

Implementation of this HCP is expected to maintain or reduce water temperatures in Dean Creek. However, since Dean Creek flows through a large beaver complex with low velocities and a large area of water exposed to solar radiation, temperature reductions will be localized and are therefore not expected to influence water temperatures in the East Fork Lewis River. For this reason, reductions of water temperature in Dean Creek are not expected to affect Chinook salmon spawning and incubation.

Salmonid eggs and alevins require DO levels greater than 7 mg/l in order to develop properly (Bell 1991). In general, the DO concentration is typically lower within the streambed than in the surface flow. Thus, assuming a difference of 3 mg/l between intergravel and instream DO concentrations, instream values greater than 10 mg/l should adequately maintain DO levels at around 7 mg/l within the gravel (MacDonald et al. 1991). DO levels measured in the East Fork Lewis River downstream of the Daybreak site exceeded 10 mg/l for all samples collected during the Chinook spawning and incubation period. Implementation of the HCP could increase DO in the water delivered to Dean Creek during the late summer but is not expected to influence DO levels in the East Fork Lewis River. For this reason, increased DO concentrations in the ponds and Dean Creek achieved under this HCP are not expected to affect Chinook spawning and incubation

The portion of the East Fork Lewis River that could potentially be influenced by sediment generated from Storedahl's operations (1.25 miles downstream to the tidally-influenced zone) represents approximately 8 percent of the 15 miles of available Chinook spawning habitat. Use of a clarification system has significantly reduced turbidity in the ponds and will continue to reduce the amount of suspended sediment released from the Daybreak site. Further, implementation of a closed-loop clarification system should substantially reduce or eliminate turbidity contributions from the processing operations. The net result will be a reduction in the amount of fine sediment delivered to the East Fork Lewis River. However, the affected reach is also influenced by erosion of fine sediments from the high bluffs upstream of the Ridgefield Pits and the Daybreak Bridge. Reducing fine sediment delivery from the Daybreak site will have a positive effect on Chinook spawning downstream of the Daybreak site, but that positive impact could be masked by continued high inputs from erosion of the bluffs upstream of the site.

6.4.2.3 Riverine Habitat

There is currently potentially 15 miles of suitable Chinook salmon spawning habitat in the East Fork Lewis River between Lucia Falls and the limit of tidal influence at Mason Creek. Since Chinook spawn in the late summer and fall, eggs are in the gravel during the fall and winter high flow period, when avulsion would be most likely to occur. Chinook spawning and incubation could therefore be directly impacted by scour and dewatering of redds in the unlikely event that an avulsion into the Daybreak site occurs. A reforested and expanded buffer width in addition to monitoring and implementation of the avulsion contingency plan will reduce the risk of avulsion as compared to existing conditions. However, if an avulsion into Pond 1 and through the Daybreak site should occur, the amount of potential spawning habitat that could be converted to deep pool habitat is approximately 1,582 lineal feet, based on the current length of riffle habitat minus the projected length of remaining riffle habitat following an avulsion. This is a decrease of 22 percent of the riffle area (Table 6-5). This would result in the loss of approximately 2 percent of the available spawning habitat (15 miles) in the East Fork Lewis River. These effects could persist for decades, although during this time there would be a gradual increase in spawning habitat as gravel is deposited in the pools and the channel continues to meander. Sediments released downstream during a potential avulsion could also impact the 1.25 miles of riffle habitat immediately upstream of the tidal zone, or 8 percent of the available Chinook spawning area. Thus, while implementation of this HCP is expected to reduce the risk of future avulsions through the Daybreak site, if an avulsion did capture ponds at the Daybreak site, the increased time required for recovery resulting from the expanded mining could negatively affect Chinook spawning.

6.4.2.4 Wetland Habitat

Chinook salmon do not spawn in wetland habitat. Therefore the creation of approximately 32 acres of emergent wetland is expected to have no effect on Chinook salmon spawning and incubation.

6.4.2.5 Predation and Competition

The existing ponds do not contain any native or non-native fish species that would be expected to compete with adult Chinook salmon for spawning sites, although several of the native species are known to prey on salmonid eggs. These fish are also found in the East Fork Lewis River where Chinook salmon spawning occurs. The HCP is not expected to affect predation on or competition with Chinook spawning and incubation.

6.4.3 Chinook Salmon Juvenile Rearing and Downstream Migration

Juvenile Chinook salmon in the East Fork Lewis River system generally emerge from the gravels between December and May. Some juvenile fish may move to the ocean quickly, while others rear in streams and estuaries for up to a year (Healey 1991). During their first summer, Chinook fry prefer habitat along the stream margin, where velocity and depth are low. As they grow, the young fish move into deeper, swifter water. Chinook salmon that over-winter in freshwater tend to be found in deep pools in the mainstem and interstitial spaces of the substrate (Healey 1991). However, little is known about Chinook salmon rearing behavior in the East Fork Lewis River.

6.4.3.1 Groundwater

Expanded mining and reclamation under the HCP will not impact groundwater contributions to the East Fork Lewis River (Section 6.2.2). However, the transfer of 330 afy currently used for irrigation to the State Trust for instream flow enhancement could increase the amount and quality of rearing habitat and have a positive effect on Chinook salmon rearing.

6.4.3.2 Surface Water Quantity and Quality

Implementation of the water management plan will increase flows in lower Dean Creek by restricting inflow to the ponds during the winter and supplementing flows during the summer. This will benefit juvenile Chinook salmon rearing in Dean Creek by increasing available summer and winter rearing habitat.

Increased temperature and turbidity and decreased DO are most likely to detrimentally impact juvenile Chinook salmon during the late summer. Implementation of the HCP is unlikely to influence temperature, turbidity, or DO in the East Fork Lewis River, because water quality improvements achieved as a result of this HCP are not expected to affect the East Fork Lewis River or juvenile Chinook salmon rearing in the river. If Chinook use habitat in Dean Creek for summer or winter rearing, water quality improvements achieved as a result of this HCP would have a positive effect on juvenile Chinook salmon rearing.

6.4.3.3 Riverine Habitat

Expanded mining and gravel processing at the Daybreak site under this HCP will not directly affect physical habitat in the East Fork Lewis River or Dean Creek. Restoration of habitat in Dean Creek, in concert with restoration of the riparian zone, is expected to result in an overall improvement of the habitat there. If juvenile Chinook use the enhanced habitat in Dean Creek, these actions will have a positive effect on juvenile Chinook salmon. Restoration of riparian forests and conversion of pasture to a complex of open water ponds and wetlands are additionally expected to increase inputs of both fine particulate organic materials and the productivity of ponds, thereby increasing the amount of food delivered to juvenile Chinook rearing in the East Fork Lewis River downstream of the Daybreak site.

The potential net effect of avulsion through the Daybreak ponds on juvenile Chinook salmon is unknown. However, nighttime snorkel observations during the spring of 2000 indicate that relatively high numbers of juvenile Chinook are found in the abundant low-velocity, shallow edge habitat within the avulsed Ridgefield Pit reach (R2 Resource Consultants, unpublished data). Conversion of the predominantly riffle-type habitat of the existing natural channel to a series of deep, slow pools that contain structure and extensive wetlands will create conditions that share some features with channels that avulse into natural off-channel habitats. Chinook salmon prefer pools for winter rearing and will use off-channel habitats, especially during high-flow conditions. Therefore, increasing this type of habitat is expected to have a positive effect on juvenile Chinook salmon.

Conversely, studies show that downstream migrating smolts generally move at rates that are a function of the local current velocity (Raymond 1979; Moser et al. 1991). An avulsion through the Daybreak site could increase the travel time of downstream migrating fish, and slightly increase the time smolts are exposed to predators. Predatory fishes such as northern pikeminnow prefer slower moving waters (Faler et al. 1988). An avulsion into the Daybreak site may release non-native fish to the East Fork Lewis River, slightly increase downstream travel time, and increase the area of deep, low-velocity habitat favored by predators, all of which could negatively affect juvenile Chinook salmon. In addition, juvenile Chinook salmon could be stranded in avulsed ponds after high flow events if the ponds become isolated by sediment deposition and receding water levels.

6.4.3.4 Wetland Habitat

Although juvenile Chinook salmon use off-channel habitat during high flows, the reconfigured outlet of Pond 5 would restrict juvenile Chinook salmon from accessing the wetland habitat on the Daybreak site during most flows. However, increased productivity from the creation of approximately 32 acres of emergent wetland habitat could increase the release of food items to Dean Creek and eventually to the East Fork Lewis River. Therefore, the creation of wetland habitat is expected to have a positive effect on juvenile Chinook salmon.

6.4.3.5 Predation and Competition

Dean Creek and the Daybreak ponds currently provide off-channel habitat that may be attractive to juvenile Chinook salmon during winter high flows. However, the reconfigured Pond 5 outlet will restrict juvenile Chinook salmon during most flows from entering the ponds. Pond 5 contains a variety of native and non-native fish species that could prey on juvenile Chinook salmon. Restricting outflows to a single site and reconfiguring the western berm to prevent backflooding from the East Fork Lewis River during floods with a magnitude less than a 17-year event will restrict Chinook salmon from entering the ponds during most flows. Reducing the available habitat by narrowing the existing ponds and targeted harvest of largemouth bass in the Daybreak ponds will reduce the number of predators. Restricting access and reducing the numbers of predators will result in a positive effect on juvenile Chinook salmon.

6.5 EFFECTS OF PROJECT OPERATIONS AND CONSERVATION MEASURES ON COHO SALMON (*ONCORHYNCHUS KISUTCH)*

The following analysis is limited to coho salmon, a candidate species for listing under the ESA. Separate analyses are presented for each of the major life history stages of coho, including upstream migration, spawning and incubation, juvenile rearing, and downstream migration. Detailed information concerning specific life history characteristics and habitat requirements is presented in Technical Appendix A.

6.5.1 Coho Upstream Migration

Coho salmon are native to and were historically abundant in the Lewis River basin (Bryant 1949). However coho salmon that presently return to the East Fork Lewis River are believed to be primarily the progeny of hatchery fish (Johnson et al. 1997). Coho return to the Lewis River system between August and December. Like Chinook and steelhead, coho require deep pools with cover for resting and sufficient flow for upstream movement. The potential for Storedahl's mining activities to affect coho during their upstream migration is generally greatest in the late summer when water temperatures are highest, dissolved oxygen is generally the lowest, and low-flow conditions may restrict the amount of available holding habitat and make the fish most vulnerable to turbidity increases.

6.5.1.1 Groundwater

Expanded mining and reclamation under the HCP will not impact groundwater contributions to the East Fork Lewis River (Section 6.2.2). However, the transfer of 330 afy currently used for irrigation to the State Trust for instream flow enhancement could increase flows and have a positive effect on upstream migrating coho.

6.5.1.2 Surface Water Quantity and Quality

Restricting inflow from Dean Creek to the ponds will increase stream flows during the fall and winter, and implementation of the water management plan will increase late summer flows by 0.1 and 0.5 cfs. Increased instream flows in Dean Creek during the fall and winter could facilitate migration through the beaver ponds and increase attraction of adult coho to spawning habitat in Dean Creek. Flow increases that occur with the implementation of this HCP are expected to have a positive effect on upstream migrating coho.

Detrimental impacts from high water temperatures are most likely to affect adult coho migrating upstream or holding in the mainstem during the summer low flow period. High temperatures can cause adult fish to delay entering spawning streams. Implementation of this HCP is expected to maintain or reduce water temperatures in Dean Creek. However, downstream of the Pond 5 outlet Dean Creek flows through a large beaver complex with low velocities and a large area of water exposed to solar radiation. Therefore, temperature reductions in Dean Creek resulting from the HCP will likely be localized, and would most likely not affect temperatures at the mouth of the stream or prevent delayed entry into Dean Creek. However, if temperatures in Dean Creek downstream of the Daybreak site are sufficient to attract adult coho, implementation of the water management plan to facilitate temperature reductions in the outflow coupled with increased riparian shade could have a positive effect on upstream migrating coho.

Dissolved oxygen is not currently considered a limiting factor in the East Fork Lewis River. Implementation of the HCP may increase the DO concentration in Dean Creek as a result of increased DO in the Pond 5 discharge. Increasing the DO of the pond discharge would have a positive effect on coho migrating upstream in Dean Creek.

Turbidity is expected to be significantly reduced under the HCP. Since high turbidity may cause adult fish to avoid spawning areas, reduced turbidity in Dean Creek may attract upstream migrating coho, and could have a positive effect on this species and lifestage.

6.5.1.3 Riverine Habitat

Expanded mining and gravel processing at the Daybreak site under this HCP will not directly affect physical habitat in the East Fork Lewis River or Dean Creek. However, if the channel should avulse through the Daybreak site, observations of the Ridgefield site suggest that the result would be formation of a series of deep pools. Only 3 pools deeper than 6 feet were identified in the East Fork Lewis River between RM 10.2 and RM 7.0 during a survey conducted in 1991 (EnviroScience 1996a), although the subsequent avulsion through the Ridgefield Pits has increased the amount of pool habitat. An increase in the number of deep pools as a result of avulsion through the Daybreak site could have a positive effect on upstream migrating coho, although positive effects are expected to be less beneficial for coho than for Chinook or steelhead, since coho tend to enter rivers later in the season and hold for shorter periods of time before spawning. Adult, migrating coho could be stranded in avulsed ponds after high flow events if the ponds become isolated by sediment deposition and receding water levels. However, observations of the Ridgefield Pits indicate that following winter high flows the off-channel pools remain connected to the river, most likely due to significant hyporheic flow.

6.5.1.4 Wetland Habitat

The creation of approximately 32 acres of emergent wetland habitat will not directly influence migrating coho. Coho will be restricted from accessing this habitat by the reconfiguration of the Pond 5 outlet during most flows. Therefore there will be no effect of wetlands on migrating coho.

6.5.1.5 Predation and Competition

While the existing ponds contain native and non-native fish species, none of the species present would be expected to prey upon or compete with adult coho during upstream migration. Therefore, implementation of this HCP will not affect predation or competition with adult coho.

6.5.2 Coho Spawning and Incubation

Coho salmon spawn in mainstem habitats, but this species prefers to spawn in small tributaries, such as Mason Creek and Dean Creek in reaches with gradients less than 3 percent. Coho spawning occurs from October through December in the Lewis River system. There is approximately 41 miles of potential coho spawning habitat in the East Fork Lewis River basin, including 15 miles of mainstem downstream of Lucia Falls, and 26 miles of tributary habitat. Coho have been stocked in Dean Creek, and redds have been observed during WDFW spawning surveys (EnviroScience 1996a). However, the recent excavation of a channel across the downstream property adjacent to the Daybreak site may limit areas of suitable spawning habitat as well as access to Dean Creek.

6.5.2.1 Groundwater

Increased flows entering the East Fork Lewis River and Dean Creek as a result of the transfer of water rights to the State Trust will not affect coho spawning and incubation since the increased flows would occur in the summer and early fall prior to spawning.

6.5.2.2 Surface Water Quantity and Quality

Restricting inflows from Dean Creek to the ponds should result in higher fall and winter flows in Dean Creek. Increased flows in Dean Creek during the fall and winter will only affect the lower portion of Dean Creek, which is downstream of the reach that provides suitable coho spawning habitat. Therefore, increased fall and winter flows will not increase the amount or quantity of available spawning habitat in Dean Creek. Implementation of the HCP will also not result in net increase to flows in the mainstem during the fall and winter. Therefore, implementation of this HCP is not expected to affect surface water flows for coho spawning and incubation.

Coho prefer temperatures lower than 10°C for spawning and incubation (USEPA 2001), and require DO concentrations greater than 10 mg/l (Bell 1991). Temperatures and DO in both the East Fork Lewis River and Dean Creek during the fall and winter are generally suitable for coho spawning. Implementation of this HCP is expected to maintain or reduce water temperatures and increase DO concentrations in Dean Creek. However, since temperatures and DO are already generally suitable, changes resulting from implementation of this HCP are not expected to affect coho spawning and incubation.

Adult coho may avoid tributaries or portions of the mainstem with high turbidity. Use of a clarification system has significantly reduced turbidity of the pond outflows and will continue to reduce turbidity in Dean Creek. Further, implementation of a closed-loop clarification system should substantially reduce or eliminate turbidity contributions from the processing operations. Reduced turbidity in Dean Creek will prevent avoidance and delay of adult coho that could migrate into the stream to spawn, resulting in a positive effect on coho spawning.

Reduced turbidity will also reduce the input of fine sediments to Dean Creek, which could improve the condition of spawning habitat downstream of the Pond 5 outlet. However, the amount of spawning in this lower reach of Dean Creek is limited by the influence of beaver activity in this area, which creates ponded conditions. Therefore, the net result of reduced turbidity and input of fine sediments will have no effect or a slight positive effect on coho spawning in Dean Creek.

The 1.25 mile segment of potential mainstem spawning habitat in the East Fork Lewis River from the Daybreak ponds to the tidal influence zone could be impacted by sediment generated from Storedahl's operations, although spawning conditions in this reach are also influenced by sediments eroding from the high bluffs above the Ridgefield Pits and the Daybreak Bridge. This reach represents 3 percent of the approximately 41 miles of available coho salmon spawning habitat. Use of a clarification system has significantly reduced turbidity of the pond outflows and will therefore continue to reduce sediment inputs as a result of operations at the Daybreak site. Further, implementation of a closed-loop clarification system should substantially reduce or eliminate turbidity contributions from the processing operations. The net result will be a reduction in the amount of fine sediment delivered to the East Fork Lewis River, which could have a positive effect on coho salmon spawning downstream of the Daybreak site, provided contributions from other sediment sources do not overwhelm minor reductions from the Daybreak site.

6.5.2.3 Riverine Habitat

There are currently an estimated 41 miles of coho spawning habitat in the East Fork Lewis River watershed. Since potential avulsion into the Daybreak site would be most likely to occur during fall and winter high flows, and coho are fall spawners, direct impacts to coho spawning and incubation by dewatering of redds in the abandoned river channel and scour of redds up or downstream of the site could occur. Over the long term, avulsion could affect coho spawning by replacing spawning habitats in the channel that existed prior to an avulsion with deep, slow pool habitat. If an avulsion were to occur into Pond 1 (Figure 6-4), it could result in a decrease of 22 percent of the available spawning habitat that currently exists in the river between RM 7 and RM 9 (Table 6-5), which is less than 1 percent of the available coho spawning area (41 miles) in the East Fork Lewis River watershed. This lost habitat consists of mainstem channel, which is not preferred coho spawning habitat, in comparison to tributary habitat. Additional adverse impacts could result from sediments released and deposited on the 1.25 miles of riffle habitat downstream of the site. This area represents 3 percent of coho spawning habitat in the watershed. Because the implementation of the HCP will reduce the overall risk of avulsion, and because the area that could be impacted represents a small and suboptimal fraction of the total available coho spawning habitat, a potential avulsion into the Daybreak site would not be expected to affect coho spawning and incubation.

6.5.2.4 Wetland Habitat

Coho salmon do not spawn in wetland habitat. Therefore the creation of approximately 32 acres of emergent wetland is expected to have no effect on coho spawning and incubation.

6.5.2.5 Predation and Competition

The existing ponds do not contain fish species that are expected to compete with adult coho for spawning sites, although several of the native species are known to prey on salmonid eggs. These fish are also found in the East Fork Lewis River where coho spawning occurs. The HCP is not expected to affect predation on or competition with coho spawning and incubation.

6.5.3 Coho Juvenile Rearing and Downstream Migration

Juvenile coho salmon emerge from the gravels in the late winter and early spring and rear in freshwater for up to two years before migrating downstream (Technical Appendix A). Juvenile coho prefer to rear in pools that have abundant cover. Coho over-winter in side channels and off-channel sloughs and in deep pools with cover provided by LWD. Juvenile coho currently use rearing habitat in the East Fork Lewis River and presumably in Dean Creek.

6.5.3.1 Groundwater

Expanded mining and reclamation under the HCP will not impact groundwater contributions to the East Fork Lewis River (Section 6.2.2). However, the transfer of 330 afy currently used for irrigation to the State Trust for instream flow enhancement could increase the amount and quality of rearing habitat and have a positive effect on coho rearing.

6.5.3.2 Surface Water Quantity and Quality

Implementation of the water management plan will increase flows in Dean Creek during the late summer, fall, and winter. Preventing inflows from Dean Creek to the ponds will result in higher flows in lower Dean Creek during the fall and winter, which could facilitate access to the beaver complex downstream of the existing ponds. This type of habitat is particularly productive for coho. In addition, increasing summer low flows by 0.1 to 0.5 cfs could substantially increase the amount and quality of summer rearing habitat in Dean Creek.

Detrimental impacts from high water temperatures are most likely to affect juvenile coho during the late summer. Water quality within several of the existing ponds meets the water quality criteria required for coho rearing during the winter, but would pose a thermal risk to fish that remain throughout the summer months. Reconfiguring the Pond 5 outlet will restrict juvenile coho during most flows from entering the ponds during the winter and later being exposed to high temperatures during the summer. Implementation of the HCP is expected to maintain or decrease temperatures in Dean Creek, although it is not expected to affect temperatures in the East Fork Lewis River. The overall effect of these measures on juvenile coho rearing is expected to be positive.

Reduced turbidity in the ponds and turbulent aeration at the Pond 5 outlet will increase DO levels of the outflow water. Increased DO concentrations will have a positive effect for juvenile coho rearing in Dean Creek. Dissolved oxygen does not currently limit juvenile rearing in the East Fork Lewis River, and because Dean Creek must pass through a low-velocity beaver pond complex prior to entering the East Fork Lewis River, the increased levels of DO are not expected to persist to the East Fork Lewis River. This measure will therefore not affect juvenile coho rearing in the East Fork Lewis River.

Use of a clarification system to treat wash water has dramatically reduced the turbidity in the pond outflow. Further, implementation of a closed-loop clarification system should substantially reduce or eliminate turbidity contributions from the processing operations. Finally, implementation of the Storm Water and Erosion Control Plan will further reduce turbidity during winter storms. As a result, turbidity of water delivered to Dean Creek and the East Fork Lewis River is expected to decrease. Because surface outflows from the pond can represent a substantial portion of the late summer flow in Dean Creek, turbidity of the outflows can have a considerable impact on stream habitat conditions. Implementation of the HCP will result in a substantial reduction in the outflow turbidity and will therefore have a positive effect on juvenile coho rearing in Dean Creek. Discharge from Dean Creek contributes only a fraction of the East Fork Lewis River flows, and therefore juvenile coho rearing in the mainstem are not expected to benefit from reduced turbidity.

If the Ridgefield study indicates that coho over-winter rearing habitat is limited, and the water quality monitoring confirms that the Daybreak ponds could provide suitable habitat, one or more of the ponds could be developed as off-channel rearing habitat under the proposed adaptive management program. This action would benefit all salmonids, but particularly coho.

6.5.3.3 Riverine Habitat

Expanded mining and gravel processing at the Daybreak site under this HCP will not directly affect physical habitat in the East Fork Lewis River or Dean Creek. Restoration of stream banks and placement of LWD in Dean Creek, in concert with restoration of the riparian zone and increased flows, will result in an overall improvement of the stream habitat. The net effect of these actions on juvenile coho in the East Fork Lewis River will be smaller, but also positive.

The potential net effect of avulsion through the Daybreak ponds on juvenile coho is unknown. However, nighttime snorkel observations during the spring of 2000 indicate that relatively high numbers of juvenile coho are found in the abundant low-velocity, shallow edge habitat within the avulsed Ridgefield site reach (R2 Resource Consultants, unpublished data). Conversion of the predominantly riffle-type habitat of the existing natural channel to a series of deep, complex pools that contain structure and created wetlands would create conditions that share many features with channels that avulse into natural off-channel habitats. Winter rearing coho prefer pools and embayments, such as those that would be formed by an avulsion into the ponds. Therefore, increasing this type of habitat is expected to have a positive effect on juvenile coho.

Conversely, studies show that downstream migrating smolts generally move at rates that are a function of the local current velocity (Raymond 1979; Moser et al. 1991). Increasing the travel time of downstream migrating coho through the Daybreak site would slightly increase the time they are exposed to predators. Predatory fishes such as northern pikeminnow prefer slower moving waters (Faler et al. 1988). An avulsion into the Daybreak site would connect predatory fish with the East Fork Lewis River, slightly reduce downstream travel time, and dramatically increase the area of deep, low velocity habitat favored by predators, all of which could negatively affect juvenile coho. In addition, juvenile coho could be stranded in avulsed ponds after high flow events if the ponds become isolated by sediment deposition and receding water levels.

6.5.3.4 Wetland Habitat

Although juvenile coho use off-channel habitat for rearing and during high flows, the reconfigured outlet of Pond 5 would restrict juvenile coho salmon from accessing the wetland habitat on the Daybreak site during most flows. Creation of approximately 32 acres of emergent wetlands is expected to increase the overall productivity of aquatic habitat on the site. Increased productivity will release more food items to Dean Creek, benefiting juvenile coho, which could be present in the stream. Therefore the increase in wetland habitat will have a positive effect on juvenile coho.

6.5.3.5 Predation and Competition

Dean Creek and the Daybreak ponds currently provide off-channel habitat that may be attractive to juvenile coho salmon during winter high flows. However, the reconfigured Pond 5 outlet will restrict juvenile coho salmon during most flows from entering the ponds. Pond 5 contains a variety of native and non-native fish species that could prey on juvenile coho salmon. Restricting outflows to a single site and reconfiguring the western berm to prevent backflooding from the East Fork Lewis River during floods with a magnitude less than a 17-year event will restrict coho salmon from entering the ponds during most flows. Reducing the available habitat by narrowing the existing ponds and targeted harvest of largemouth bass in the Daybreak ponds will reduce the number of predators. Restricting access and reducing the numbers of predators will result in a positive effect on juvenile coho salmon.

6.6 EFFECTS OF PROJECT OPERATIONS AND CONSERVATION MEASURES ON CHUM SALMON (*ONCORHYNCHUS KETA)*

The following analysis has been limited to chum salmon, a species in the Columbia River that is listed as threatened under the ESA (64 *Fed. Reg.* 14508-14517). Separate analyses are presented for each of the major life history stages of chum, including upstream migration, spawning and incubation, juvenile rearing, and downstream migration. Detailed information concerning specific life history characteristics and habitat requirements is presented in Technical Appendix A.

6.6.1 Chum Upstream Migration

Chum salmon were once widespread in the lower Columbia River system and are believed to have historically used the East Fork Lewis River (Rawding 1999). Early hatchery production in the Lewis River basin included chum salmon up until 1940. However, today chum salmon are a rarity in the Lewis River system, including the East Fork Lewis River. Chum salmon reportedly move into the Lewis River in October and November (Salo 1991). Unlike steelhead or Chinook, adult chum spend little time holding in the mainstem. The potential for Storedahl's mining activities to affect upstream migrating chum is greatest in the early fall during years when the fall rains are late and temperatures in the mainstem may be high, dissolved oxygen low, and low-flow conditions restrict accessibility to spawning habitat and make the fish most vulnerable to turbidity increases.

6.6.1.1 Groundwater

Expanded mining and reclamation under the HCP will not impact groundwater contributions to the East Fork Lewis River (Section 6.2.2). However, the transfer of 330 afy currently used for irrigation to the State Trust for instream flow enhancement could have a positive effect on chum salmon potentially migrating upstream in the East Fork Lewis River or Dean Creek in the early fall.

6.6.1.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflows from Dean Creek to the pond system will increase instream flows in Dean Creek during the late summer, fall, and winter. Winter flow increases could improve access for adult chum through the beaver pond system, thus increasing the amount of available spawning habitat. Increased stream flows that occur as a result of this HCP will therefore have a positive effect on chum salmon potentially migrating upstream.

Detrimental impacts from high water temperatures are most likely to affect adult chum migrating upstream or holding in the mainstem during the early fall when flows are low. High temperatures may cause adult fish to delay entering spawning streams. Implementation of this HCP is expected to maintain or reduce water temperatures in Dean Creek adjacent to the Daybreak site. However, downstream of the Pond 5 outlet Dean Creek flows through a large beaver complex with low velocities and a large area of water exposed to solar radiation.

Therefore, temperature reductions in Dean Creek resulting from the HCP will likely be localized, and would most likely not affect temperatures at the mouth of the stream or prevent delayed entry into Dean Creek. However, if temperatures in Dean Creek downstream of the Daybreak site are sufficient to attract adult chum potentially present in the East Fork Lewis River, temperature reductions due to outflow control or increased riparian shade would have a positive effect on upstream migrating chum.

Dissolved oxygen is not currently considered a limiting factor in the East Fork Lewis River. Implementation of the HCP may increase the DO concentration in Dean Creek as a result of increased DO in the Pond 5 discharge. Increasing the DO of the pond discharge will have a positive effect upstream migrating chum that are potentially in Dean Creek.

Turbidity is expected to be significantly reduced under the HCP. Since high turbidity may cause adult fish to avoid or delay entering spawning areas, reducing turbidity in Dean Creek may attract chum potentially migrating upstream and would have a positive effect on upstream migration.

6.6.1.3 Riverine Habitat

Expanded mining and gravel processing at the Daybreak site under this HCP will not directly affect physical habitat in the East Fork Lewis River or Dean Creek. However, if the channel should avulse through the Daybreak site, observations of the Ridgefield site suggest that the result would be formation of a series of deep pools fed by river flow and groundwater. Only 3 pools deeper than 6 feet were identified between RM 10.2 and RM 7.0 during a survey conducted in 1991 (EnviroScience 1996a), although the subsequent avulsion through the Ridgefield Pits has increased this type of habitat. Avulsions through the Daybreak site would also be expected to increase the amount of salmonid holding habitat. However, since chum spend little time holding in mainstem rivers, a potential avulsion through the Daybreak site would be unlikely to affect adult migrating chum.

6.6.1.4 Wetland Habitat

The creation of approximately 32 acres of emergent wetland habitat will not directly affect chum in the East Fork Lewis River or Dean Creek if present, primarily because fish passage into the ponds and wetlands will be restricted as a result of reconfiguring the surface water outlet and the western berm on Pond 5.

6.6.1.5 Predation and Competition

While the existing ponds contain native and non-native fish species, none of the species present would be expected to prey upon or compete with adult chum during upstream migration. Therefore, implementation of this HCP will not affect predation or competition with adult chum.

6.6.2 Chum Spawning and Incubation

Chum salmon spawning occurs during November and December in the Lewis River system. Chum may spawn at the heads of riffles in the mainstem, but prefer side channels and small groundwater fed tributaries such as Dean Creek. Historical conversion of the East Fork Lewis River from an anastomosing system with multiple channels to a single thread mainstem may have dramatically reduced the amount of preferred chum spawning habitat in the lower East Fork Lewis River. The Ridgefield Pit reach currently contains some potential chum spawning habitat, notably in the recently formed egress channel that flows from the former Pit 1. However, chum spawning surveys conducted by WDFW in 1999 and 2000 have not located any spawning activity in the lower East Fork Lewis River. Assuming chum were present, they could utilize spawning habitats as far upstream as Lucia Falls. There are currently approximately 41 miles of potential chum spawning habitat available in the East Fork Lewis basin, including 15 miles of mainstem downstream of Lucia Falls and 26 miles of tributary habitat. However, chum spawning is believed to have been concentrated historically in side channels in the reach between RM 6 and RM 10.

6.6.2.1 Groundwater

Increased flows entering the East Fork Lewis River and Dean Creek as a result of the transfer of water rights to the State Trust will not affect chum spawning and incubation since the increased flows would occur prior to spawning.

6.6.2.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflows from Dean Creek to the ponds will increase instream flows in Dean Creek during the late summer, fall, and winter. Flow increases would range from 0.1 to 0.5 cfs in the summer to more than 20 cfs in the winter as a result of preventing inflows from Dean Creek to the ponds. Increased flows in Dean Creek during the fall and winter could have a positive effect on potential chum spawning. Implementation of this HCP is not expected to affect potential chum spawning and incubation in the East Fork Lewis River.

Chum prefer temperatures lower than 10ºC for spawning and incubation, and require DO concentrations greater than 10 mg/l (Bell 1991). Temperatures and DO in both the East Fork Lewis River and Dean Creek during the fall and winter are generally suitable for chum spawning. Implementation of this HCP is expected to maintain or reduce water temperatures and increase DO concentrations in Dean Creek. However, since temperatures and DO are already generally suitable, changes resulting from implementation of this HCP are not expected to affect potential chum spawning and incubation.

Adult chum may avoid tributaries or portions of the mainstem with high turbidity. Use of a clarification system has significantly reduced turbidity of the pond outflow and turbidity contributing to Dean Creek. Further, implementation of a closed-loop clarification system should substantially reduce or eliminate turbidity contributions from the processing operations. Reducing turbidity in Dean Creek will reduce avoidance and delay of adult chum that could potentially spawn there, resulting in a positive effect on chum spawning.

Reduced turbidity will also reduce the input of fine sediments to Dean Creek, which could improve the condition of spawning habitat downstream of the Pond 5 outlet. However, the amount of spawning in this lower reach of Dean Creek is limited by the influence of beaver activity, which creates ponded conditions. Additionally, the recently excavated channel across the adjacent property downstream from the Daybreak site could adversely affect the availability of suitable spawning habitat and access to Dean Creek. Therefore, the net result of reduced turbidity and input of fine sediments may only have a slight positive effect on potential chum spawning in Dean Creek.

The 1.25 mile segment of potential mainstem spawning habitat in the East Fork Lewis River from the Daybreak ponds to the tidal influence zone could be impacted by sediment generated from Storedahl's operations, although spawning conditions in this reach are also influenced by sediments eroding from the high bluffs above the Ridgefield Pits and the Daybreak Bridge. This reach represents 3 percent of the approximately 41 miles of available chum salmon spawning habitat, although chum prefer to spawn in side channels and tributaries as opposed to mainstem habitats. Use of a clarification system has significantly reduced turbidity of the pond outflows and will therefore continue to reduce sediment inputs as a result of operations at the Daybreak site. Further, implementation of a closed-loop clarification system should substantially reduce or eliminate turbidity contributions from the processing operations. The net result will be a reduction in the amount of fine sediment delivered to the East Fork Lewis River, which could have a positive effect on chum salmon spawning downstream of the Daybreak site, provided contributions from other sediment sources do not overwhelm minor reductions from the Daybreak site.

6.6.2.3 Riverine Habitat

There are currently an estimated 41 miles of East Fork Lewis River habitat suitable for spawning chum. Natural avulsions benefit chum by maintaining a network of side channels and abandoned channels fed by groundwater during the fall and winter. However, because avulsion would most likely occur during fall and winter high flows, and chum are fall spawners, an avulsion through the Daybreak site could, in the short-term, directly impact chum spawning and incubation by dewatering redds in the abandoned river channel and by scour of redds upstream of the site. Over the long term, avulsion could affect potential chum spawning by replacing spawning habitats in the channel that existed prior to an avulsion with deep, slow pool habitat. If an avulsion were to occur into Pond 1 (Figure 6-4), it could result in a decrease of 22 percent of the available spawning habitat that currently exists in the river between RM 7 and RM 9 (Table 6-5) or less than 1 percent of the available potential chum spawning area in the East Fork Lewis River watershed (41 miles). Because implementation of the HCP will reduce the risk of avulsion, and because the area that could be impacted represents only a small fraction of the total available chum spawning habitat, future avulsions are not expected to affect chum spawning and incubation. If impacts to chum spawning are identified through monitoring, chum spawning habitat could be replaced by developing groundwater fed spawning channels in the abandoned mainstem and/or rehabilitation of lower Dean Creek.

6.6.2.4 Wetland Habitat

Chum salmon do not use wetland habitat for spawning. Therefore creation of additional wetland area will have no effect on chum potentially spawning in the East Fork Lewis River or Dean Creek.

6.6.2.5 Predation and Competition

The existing ponds do not contain any fish species that are expected to compete with adult chum for spawning sites, although several of the species are known to prey on salmonid eggs. These fish are also found in the East Fork Lewis River where chum spawning could occur. The HCP is not expected to affect predation on or competition with chum spawning and incubation.

6.6.3 Chum Juvenile Rearing and Downstream Migration

Juvenile chum salmon emerge from the gravels between January and April and migrate downstream to estuarine environments within a few days to weeks (Technical Appendix A). While present in the riverine environment, juvenile chum are predominately found in side channels and slow pool and backwater habitats in the mainstem.

6.6.3.1 Groundwater

Juvenile chum salmon would not be in the river during the summer and early fall when flows could be increased as a result of the transfer of water rights to the State Trust. Therefore there will be no effect on juvenile chum.

6.6.3.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflow from Dean Creek to the Daybreak ponds will increase flows in Dean Creek by up to 0.5 cfs during the late summer, and up to 20 cfs during the fall and winter. However, implementation of this HCP is not expected to affect juvenile chum, since they are present only in the late winter and spring and spend little time rearing in riverine environments.

High temperatures and low DO generally occur only during the summer in the East Fork Lewis River. Water quality in Dean Creek and the mainstem East Fork Lewis River is suitable for chum rearing during the time the young fish would be present. Reconfiguring the Pond 5 outlet will restrict juvenile chum from entering the ponds, becoming stranded as outflows decrease, and exposing them to warm water temperatures during the summer. The overall effect of these measures on juvenile chum potentially rearing in Dean Creek is expected to be minor, but positive.

Use of a clarification system to treat wash water has substantially reduced the turbidity in the pond outflow. Further, implementation of a closed-loop clarification system should substantially reduce or eliminate turbidity contributions from the processing operations. Finally, implementation of the Storm Water and Erosion Control Plan will further reduce turbidity during winter storms. As a result, turbidity of water delivered to Dean Creek and the East Fork Lewis River is expected to decrease substantially. Because surface outflows from Pond 5 can represent a substantial portion of the flow in Dean Creek, turbidity of the outflows can have a substantial impact on habitat conditions there. Implementation of the HCP is expected to result in a substantial reduction in the outflow turbidity and will therefore have a positive effect on juvenile chum in the stream. Discharge from Dean Creek contributes only a fraction of the East Fork Lewis River flows, and delivery of fine sediments is dominated by erosion of two high bluffs upstream of the Ridgefield Pits and the Daybreak Bridge. Therefore juvenile chum present in the mainstem are not expected to be affected by reduced turbidity.

6.6.3.3 Riverine Habitat

Expanded mining and gravel processing at the Daybreak site under this HCP will not directly affect physical habitat in the East Fork Lewis River or Dean Creek. Restoration of stream banks and placement of LWD in Dean Creek, in concert with the water management plan and restoration of the riparian zone, will result in an overall improvement of the stream habitat. The net effect of these actions on juvenile chum potentially present in Dean Creek and the East Fork Lewis River will be positive.

Monitoring and implementation of the avulsion contingency plan are expected to reduce the likelihood for an avulsion through the Daybreak site. However, as described in Technical Appendix C, future avulsions, while improbable, must be considered possible. Based on existing data, the potential net effect of avulsion through the Daybreak ponds on juvenile chum is unknown. Conversion of the predominantly riffle-type habitat of the existing natural channel to a series of deep, slow pools that contain structure and created wetlands will create conditions that share many features with channels that avulse into natural off-channel habitats. Juvenile chum use pools and embayments such as those formed by captured ponds as they move downstream, but overall they spend little time in the riverine environment. Therefore, increasing this type of habitat is not expected to affect juvenile chum.

Studies show that fish moving downstream generally move at rates that are a function of the local current velocity (Raymond 1979; Moser et al. 1991). Increasing the travel time of downstream migrating chum through the Daybreak site would increase the time they are exposed to predators. Predatory fishes such as northern pikeminnow prefer slower moving waters (Faler et al. 1988). An avulsion into the Daybreak site would connect predatory fish in the ponds to the East Fork Lewis River, slightly increase downstream travel time, and dramatically increase the area of deep, low velocity habitat favored by predators, all of which would negatively affect juvenile chum. In addition, juvenile chum could be stranded in avulsed ponds after high flow events if the ponds become isolated by sediment deposition and receding water levels.

6.6.3.4 Wetland Habitat

Juvenile chum will be restricted from entering the ponds and wetland habitat at the Pond 5 outlet. However, the creation of approximately 32 acres of emergent wetland habitat in the ponds will increase productivity and thus could increase the release of food items to Dean Creek and eventually the East Fork Lewis River. Therefore, the creation of wetland habitat is expected to have a positive effect on juvenile chum.

6.6.3.5 Predation and Competition

Dean Creek and the Daybreak ponds currently provide off-channel habitat that may be attractive to juvenile chum salmon during high flows. However, the reconfigured Pond 5 outlet will restrict juvenile chum salmon during most flows from entering the ponds. Pond 5 contains a variety of native and non-native fish species that could prey on juvenile chum salmon. Restricting outflows to a single site and reconfiguring the western berm to prevent backflooding from the East Fork Lewis River during floods with a magnitude less than a 17-year event will restrict chum salmon from entering the ponds during most flows. Reducing the available habitat by narrowing the existing ponds and targeted harvest of largemouth bass in the Daybreak ponds will reduce the number of predators. Restricting access and reducing the numbers of predators will result in a positive effect on juvenile chum salmon.

6.7 EFFECTS OF PROJECT OPERATIONS AND CONSERVATION MEASURES ON BULL TROUT (*SALVELINUS CONFLUENTUS)*

The following analysis is limited to bull trout, a species that is listed as threatened under the ESA in the Columbia River (63 *Fed. Reg*. 31647-31674). Separate analyses are presented for each of the major life history stages of bull trout, including upstream migration, spawning and incubation, and juvenile rearing and downstream migration. Detailed information concerning specific life history characteristics and habitat requirements is presented in Technical Appendix A.

6.7.1 Bull Trout Upstream Migration

Isolated populations of bull trout exist in the North Fork and the mainstem Lewis River (WDW 1992). These populations are located upstream of hydroelectric dams that restrict anadromous access as well as upstream movement among each of the populations. Cold water temperature is a critical habitat requirement for bull trout (Rieman and McIntyre 1993), and this also likely confines bull trout to the upper watershed streams. Temperatures that are >15°C limit bull trout distributions (Bjornn 1961, Fraley and Shepard 1989, Brown 1992). Bull trout can also use the lower sections of rivers on an opportunistic basis (e.g., winter months when water temperatures are suitable), as migration corridors, and during movements along coastal areas from one river outlet to another. While occasional straying may occur, the East Fork Lewis River and its headwaters are not believed to support bull trout (Weinheimer 1998; Rawding 1999).

Bull trout often stage at the mouth of their natal streams and rivers prior to spawning. In the North Fork and the mainstem Lewis River, bull trout typically spawn in the tributary streams in late August through mid-September. Although bull trout could potentially migrate into the East Fork Lewis River and through the HCP area, they are not believed to use this system for spawning or rearing. High water temperatures are likely the greatest limitation to bull trout becoming established in the East Fork Lewis River. If bull trout were present in the system, the potential for Storedahl's mining activities to affect bull trout during their upstream migration would be greatest in the late summer when water temperatures are highest, dissolved oxygen is lowest, and low flow conditions may restrict the amount of available holding habitat or make the fish most vulnerable to turbidity increases.

6.7.1.1 Groundwater

Expanded mining and reclamation under the HCP will not impact the groundwater contributions to the East Fork Lewis River (Section 6.2.2). Although the transfer of 330 afy water rights to the State Trust will enhance instream flows, bull trout are not expected to be in the East Fork Lewis River and therefore there will be no effect on upstream migrating or holding bull trout.

6.7.1.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflow from Dean Creek to the ponds will increase flow in Dean Creek during the late summer fall and winter. Because bull trout are not expected to utilize low elevation tributaries that typically have high temperatures, it is unlikely increased flows in Dean Creek would affect upstream migrating bull trout.

Detrimental impacts from high water temperatures are most likely to affect adult bull trout migrating upstream or holding in the mainstem during the summer low-flow period. High water temperatures can cause adult fish to delay entering spawning streams. Implementation of this HCP is expected to maintain or reduce water temperatures in Dean Creek. However, downstream of the Pond 5 outlet Dean Creek flows through a large beaver complex with low velocities and a large area of water exposed to solar radiation. Therefore, temperature reductions in Dean Creek resulting from the HCP will likely be localized and would most likely not affect temperatures at the mouth of the stream or prevent delayed entry into Dean Creek. If adult bull trout were to enter Dean Creek, temperature reductions due to outflow control and increased riparian shade would have a positive effect.

Dissolved oxygen is not currently considered a limiting factor in the East Fork Lewis River. Implementation of the HCP may increase the DO concentration in Dean Creek as a result of increased DO in the Pond 5 discharge. Increasing the DO of the pond outflow would have a positive effect on bull trout potentially migrating upstream in Dean Creek.

Turbidity is expected to be significantly reduced under the HCP. Since high turbidity may cause adult fish to avoid spawning areas, reduced turbidity could make Dean Creek more attractive to bull trout that are potentially migrating upstream. However, since temperatures are expected to remain in excess of those preferred by bull trout, reduced turbidity is not expected to affect upstream migrating adults.

6.7.1.3 Riverine Habitat

Expanded mining and gravel processing at the Daybreak site under this HCP will not directly affect physical habitat in the East Fork Lewis River or Dean Creek. However, if the channel should avulse through the Daybreak site, observations of the Ridgefield site suggest that the result would be formation of a series of deep pools. Deep, thermally stratified pools provide refuge habitat for adult salmonids when stream temperatures elsewhere in the river reach incipient lethal levels (Nielsen and Lisle 1994). The lower East Fork Lewis River is currently on the Washington State 303(d) listing due to temperature concerns, and only three pools deeper than six feet were identified between RM 10.2 and RM 7.0 during a survey conducted in 1991 prior to the Ridgefield Pit avulsion (EnviroScience 1996a). Therefore, an increase in the number of deep, cold-water refugia as a result of avulsion through the Daybreak site could have a positive effect on upstream migrating bull trout. However, pool depths at the Ridgefield site in 1999, three years after the avulsion, were generally less than 10 feet, and temperatures were not markedly cooler at depth. Thus, positive effects for upstream migrating bull trout would be short-lived. If adult, migrating bull trout were present, they could be stranded in avulsed ponds after high flow events if the ponds become isolated by sediment deposition and receding water levels. However, observations of the Ridgefield Pits indicate that following winter high flows the off-channel pools remain connected to the river, most likely due to significant groundwater flow.

6.7.1.4 Wetland Habitat

The creation of approximately 32 acres of emergent wetland habitat will not directly influence bull trout that are potentially migrating upstream in the East Fork Lewis River system. Bull trout will be restricted as a result of reconfiguring the surface water outlet and the western berm on Pond 5, and therefore there will be no effect on migrating bull trout.

6.7.1.5 Predation and Competition

While the existing ponds contain native and non-native fish species, none of the species present would be expected to prey upon or compete with adult bull trout during upstream migration. Therefore, implementation of this HCP will not affect predation or competition with adult bull trout.

6.7.2 Bull Trout Spawning and Incubation

Bull trout are not believed to occur in the East Fork Lewis River system. If they did occur, they could spawn in the mainstem or in low gradient reaches of small tributaries. This spawning habitat is similar to the areas used by steelhead, which is estimated to occur over approximately 54 miles in the East Fork Lewis River system (WDF and WDW 1993). Bull trout require cold temperatures for spawning (between 5 and 9°C) (McPhail and Baxter 1996). Optimum temperatures for incubation are between 2 and 4°C (Rieman and McIntyre 1993). Optimum DO concentrations for spawning and incubation are assumed to be similar to other salmonids, or near 10 mg/l. Bull trout spawning occurs from late August through mid-September in the Lewis River and North Fork Lewis River.

6.7.2.1 Groundwater

Bull trout are not expected to spawn in the East Fork Lewis River or Dean Creek. Thus, there will be no effect from hydrogeology on bull trout spawning.

6.7.2.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflows from Dean Creek to the ponds should result in higher late summer, fall, and winter instream flows. Because bull trout are not expected to spawn in Dean Creek, which is a low elevation tributary prone to high temperatures, flow increases that occur as a result of implementation of this HCP are expected to have no effect on bull trout spawning and incubating. Since there will be no measurable change in flows in the mainstem during the fall and winter, implementation of this HCP is also not expected to affect bull trout spawning and incubation that could occur in the East Fork Lewis River.

Temperatures in both the East Fork Lewis River and Dean Creek are too warm for bull trout spawning. Although implementation of this HCP is expected to maintain or reduce water temperatures in Dean Creek, temperatures are unlikely to be low enough to support bull trout spawning because of the low elevation. Additionally, because the East Fork Lewis River system is not known to support a bull trout population, changes resulting from implementation of this HCP are not expected to affect bull trout spawning and incubation.

Adult bull trout may avoid tributaries or portions of the mainstem with high turbidity. Use of a closed-loop clarification system as part of this HCP is expected to significantly reduce turbidity of the pond outflows, and will therefore reduce turbidity in Dean Creek. Reduced turbidity in Dean Creek would reduce avoidance and delay of potential bull trout that could spawn in the stream, resulting in a potential positive effect on bull trout spawning. However, because of temperature limitations, this measure is not expected to affect potential bull trout spawning.

Reduced turbidity will also reduce the input of fine sediments to Dean Creek, which could improve the condition of spawning habitat downstream of the Pond 5 outlet. However, the lower reach of Dean Creek has ponded conditions, which are unlikely to maintain sorted gravel substrates or to sustain temperatures cold enough for bull trout spawning. Therefore, the net result of reduced turbidity and input of fine sediments will have little or no effect on bull trout spawning.

6.7.2.3 Riverine Habitat

Bull trout require water temperatures for spawning and incubation that are colder than those in the East Fork Lewis River adjacent to the Daybreak site. Therefore a potential avulsion into the Daybreak site is unlikely to affect bull trout spawning habitat.

6.7.2.4 Wetland Habitat

Bull trout do not spawn in wetland habitat. Therefore the creation of approximately 32 acres of emergent wetland is expected to have no effect on potential bull trout spawning and incubation.

6.7.2.5 Predation and Competition

The existing ponds do not contain fish species that are expected to compete with bull trout for spawning sites, although several of the species are known to prey on salmonid eggs. These fish are also found in the East Fork Lewis River where bull trout spawning could occur if they occurred in the vicinity of the Daybreak site. The HCP is not expected to affect predation on or competition with bull trout spawning and incubation.

6.7.3 Bull Trout Juvenile Rearing and Downstream Migration

Juvenile bull trout emerge from the stream gravel in early spring. Although some life forms are known to migrate to the ocean, most bull trout rear in freshwater their entire life in water that is colder than 15°C (Bjornn 1961, Fraley and Shepard 1989, Brown 1992). Bull trout typically spawn for the first time at age 5 or 6. Juvenile and/or adult bull trout are not believed to be currently present in the East Fork Lewis River or it tributaries, which include Dean Creek.

6.7.3.1 Groundwater

Bull trout are not expected to rear in the East Fork Lewis River or Dean Creek. Thus, there will be no effect from hydrogeology on bull trout rearing.

6.7.3.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflow from Dean Creek to the ponds will increase flows in lower Dean Creek during the late summer, fall, and winter. However, bull trout are not expected to utilize Dean Creek, and net flow increases in the East Fork Lewis River will be small; thus, increased flows are not expected to affect bull trout rearing. There will be no net change in surface flows in the East Fork Lewis River.

Water temperatures in the East Fork Lewis River and Dean Creek are too high to support bull trout throughout the year. Implementation of the HCP is expected to maintain or decrease temperatures in Dean Creek, although it is not expected to affect temperatures in the East Fork Lewis River. Nonetheless, the potential temperature decreases in Dean Creek are not expected to be sufficient to support bull trout. Therefore, implementation of the HCP would have no effect on bull trout potentially rearing in the East Fork Lewis River or Dean Creek.

Reduced turbidity in the ponds and turbulent aeration at the Pond 5 outlet will increase DO levels of the outflow water. Increased DO concentrations could have a positive effect on bull trout potentially rearing in Dean Creek. However, use of Dean Creek by bull trout is unlikely because of temperature limitations. Therefore, this measure is not expected to affect potential bull trout rearing.

Use of a clarification system to treat wash water has dramatically reduced the turbidity in the pond outflow. Further, implementation of a closed-loop clarification system should substantially reduce or eliminate turbidity contributions from the processing operations. Finally, implementation of the Storm Water and Erosion Control Plan will further reduce sediment delivery from the Daybreak site during winter storms. As a result, turbidity of water delivered to Dean Creek and the East Fork Lewis River is expected to decrease. Because surface outflows from the pond can represent a substantial portion of the flow in Dean Creek, turbidity of the outflows can have a substantial impact on stream habitat conditions. Implementation of the HCP is expected to result in a substantial reduction in the outflow turbidity. However, use of Dean Creek by bull trout is unlikely because of temperature limitations. Therefore, this measure is not expected to affect potential bull trout rearing.

6.7.3.3 Riverine Habitat

Expanded mining and gravel processing at the Daybreak site under this HCP will not directly affect physical habitat in the East Fork Lewis River or Dean Creek. Restoration of riparian forests and conversion of pasture to a complex of open water ponds and wetlands are expected to increase the amount of food available to juvenile fish in Dean Creek and the East Fork Lewis River downstream of the confluence with Dean Creek. Restoration of stream banks and placement of LWD in Dean Creek, in concert with restoration of the riparian zone, is expected to result in an overall improvement of the stream habitat. However, use of Dean Creek by bull trout is unlikely because of temperature limitations. Therefore, this measure is not expected to affect potential bull trout rearing.

The potential net effect of avulsion through the Daybreak ponds on bull trout potentially present in the East Fork Lewis River is unknown. Conversion of the predominantly riffle-type habitat of the existing natural channel to a series of deep, slow pools that contain structure and created wetlands will create conditions that share many features with channels that have avulsed into natural off-channel habitats. Salmonids have been observed to use deep pools with cool groundwater inflows during the summer as refugia when stream temperatures elsewhere in the river reach incipient lethal levels (Nielsen and Lisle 1994). Many species of juvenile salmonids also rely on low velocity pool and backwater habitat for winter rearing. Therefore, increasing this type of habitat is expected to have a positive effect on bull trout potentially rearing in the East Fork Lewis River.

Conversely, studies show that downstream migrating smolts generally move at rates that are a function of the local current velocity (Raymond 1979; Moser et al. 1991). Increasing the travel time of bull trout that could be migrating downstream through the Daybreak site could increase the time they are exposed to predators. Predatory fishes such as northern pikeminnow prefer slower moving waters (Faler et al. 1988). An avulsion into the Daybreak site would connect predatory fish with the East Fork Lewis River, slightly reduce downstream travel time, and dramatically increase the area of deep, low velocity habitat favored by predators, all of which would negatively affect juvenile bull trout that are potentially migrating downstream. In addition, juvenile bull trout could be stranded in avulsed ponds after high flow events if the ponds become isolated by sediment deposition and receding water levels.

6.7.3.4 Wetland Habitat

Creation of approximately 32 acres of emergent wetlands is expected to increase the export of food items to Dean Creek and to juvenile fish residing in the stream. However, use of Dean Creek by bull trout is unlikely because of temperature limitations. Therefore, this measure is not expected to affect potential bull trout rearing.

6.7.3.5 Predation and Competition

Pond 5 contains a variety of native and non-native fish species that could prey on juvenile bull trout. However Dean Creek and the East Fork Lewis River in the vicinity of the Daybreak site are not believed to support juvenile bull trout because of temperature limitations. Therefore, reducing the risk of predation is not expected to affect bull trout.

6.8 EFFECTS OF PROJECT OPERATIONS AND CONSERVATION MEASURES ON COASTAL CUTTHROAT TROUT (*ONCORHYNCHUS CLARKI CLARKI*)

The following analysis is limited to coastal cutthroat trout, a Southwest Washington/ Columbia River population. The analysis is focused on the anadromous, sea-run form of the species. Separate analyses are presented for each of the major life history stages of coastal cutthroat trout, including upstream migration, spawning and incubation, juvenile rearing, and downstream migration. Detailed information concerning specific life history characteristics and habitat requirements is presented in Technical Appendix A.

6.8.1 Coastal Cutthroat Trout Upstream Migration

Freshwater and anadromous coastal cutthroat trout are present in the East Fork Lewis River, although their abundance is depressed from its historical population size. Anadromous coastal cutthroat trout generally remain close to shore while in the ocean and return to freshwater in the late summer, fall, or winter of the year they go to sea (Trotter 1997). Similar to steelhead, coastal cutthroat trout over-winter in freshwater and then spawn in the spring. Cutthroat trout spawn in clean gravels in low gradient areas of small streams. Returning adult fish may be first time or repeat spawners or they may not spawn at all after their first or second migration back into freshwater. Upstream migrating and over-wintering cutthroat trout are likely to be in the East Fork Lewis River mainstem, as well as in small tributary streams such as Dean Creek. The potential for Storedahl’s mining activities to affect cutthroat trout that are migrating or over-wintering is generally greatest in the late summer when water temperatures are highest, DO is lowest, and low-flow conditions can restrict access to spawning streams and holding habitat and make the fish most vulnerable to turbidity increases.

6.8.1.1 Groundwater

Expanded mining and reclamation under the HCP will not impact groundwater contributions to the East Fork Lewis River (Section 6.2.2). However, the transfer of 330 afy currently used for irrigation to the State Trust for instream flow enhancement could have a positive effect on upstream migrating and holding cutthroat trout.

6.8.1.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflows from Dean Creek to the Daybreak ponds will increase flows in lower Dean Creek during late summer, fall, and winter. This may facilitate upstream migration and will therefore have a positive effect on upstream migrating and over-wintering anadromous coastal cutthroat trout.

Warm water temperatures are most likely to detrimentally impact adult cutthroat trout migrating or holding in the river and tributaries during the summer low-flow period. Implementation of this HCP is expected to maintain or reduce water temperatures in Dean Creek, and this is expected to have a positive effect on adult cutthroat trout migrating or holding in Dean Creek. Because Dean Creek flows through a large beaver complex with low velocities and a large area of water exposed to solar radiation, any temperature reductions in Dean Creek resulting from the HCP will likely be localized to the stream area adjacent to the Daybreak site and are not expected to affect water temperatures in the East Fork Lewis River. For these reasons, influences on water temperature will have no effect on coastal cutthroat trout migrating or holding in the East Fork Lewis River.

Dissolved oxygen is not currently considered a limiting factor in the East Fork Lewis River although it is potentially a limiting factor in Dean Creek during the summer. Implementation of the HCP may increase the DO concentration in Dean Creek as a result of increased shading along the creek and releases of turbulent, aerated water from Pond 5. Therefore there is an expected positive effect on coastal cutthroat trout migrating or holding in Dean Creek. However, downstream of the Daybreak site, Dean Creek flows through a large beaver complex with low velocities and naturally high temperatures that may result in reduced DO. Therefore, beneficial DO concentrations in Dean Creek resulting from the HCP will likely be localized to the stream area adjacent to the Daybreak site and are not expected to affect DO concentrations in the East Fork Lewis River. Impacts on DO in the East Fork Lewis River from implementation of the HCP will have no effect on upstream migrating or holding coastal cutthroat trout.

Turbidity in the outlet of Pond 5, due to the implementation of a closed-loop clarification system and storm water controls, is expected to be significantly reduced under the HCP, and is expected to have a positive effect on coastal cutthroat trout that could seek out and/or migrate up into Dean Creek. Under existing conditions, turbidity associated with activities at the Daybreak site has little impact on water quality in the mainstem East Fork Lewis River, and therefore implementation of the HCP is expected to have no effect on upstream migrating cutthroat trout in the East Fork Lewis River.

6.8.1.3 Riverine Habitat

Current operations at the Daybreak site do not affect the physical riverine habitat. Implementation of the HCP is also not expected to affect physical habitat in the East Fork Lewis River. However, if the channel should avulse through the Daybreak site, observations at the Ridgefield Pit site suggest that the result would be the formation of a series of deep pools fed by river flow and groundwater. It is unknown if anadromous coastal cutthroat trout use deep pools for refuge during migration, but deep pools do provide flow and thermal refuge for adult steelhead. Pool depths at the Ridgefield site in 1999, three years after the avulsion, were generally less than 10 feet. Thus, thermal benefits to upstream migrating coastal cutthroat may expected to be short-lived, but increased velocity refugia may persist for decades. Adult, migrating coastal cutthroat trout could be stranded in avulsed ponds after high flow events if the ponds become isolated by sediment deposition and receding water levels. However, observations of the Ridgefield Pits indicate that following winter high flows the off-channel pools remain connected to the river, most likely due to significant groundwater flow.

6.8.1.4 Wetland Habitat

Migrating anadromous coastal cutthroat trout will be restricted to accessing created wetland habitat as a result of reconfiguring the surface water outlet and the western berm on Pond 5. Therefore there will be no effect on migrating cutthroat trout.

6.8.1.5 Predation and Competition

Coastal cutthroat trout are less dominant than steelhead, coho, or other salmonids and tend to move further upstream in response to competition. Enhancements to Dean Creek through implementation of the HCP may increase use of the stream by the more dominant steelhead and coho salmon. However, these species have co-evolved, and competitive pressures on migrating and holding cutthroat trout from other salmonids are a natural condition.

While the existing ponds contain native and non-native fish species, none of the species present would be expected to prey upon or compete with adult cutthroat trout during upstream migration. Therefore, implementation of this HCP will not affect predation or competition with adult coastal cutthroat trout.

6.8.2 Coastal Cutthroat Trout Spawning and Incubation

Coastal cutthroat trout spawn from February through mid-May. Coastal cutthroat trout typically spawn in the tails of pools within small tributaries. Although their distribution and habitat use in the East Fork Lewis River have not been studied or documented, it is reasonable to assume that because of the relatively large size of the East Fork Lewis River, cutthroat trout do not spawn in the mainstem channel. It is likely, however, that coastal cutthroat trout historically spawned in Dean Creek, and it is possible that the creek continues to support a limited spawning population. One cutthroat trout, approximately 10 inches long, was observed in Dean Creek downstream of Pond 5 during the spring of 1998 by R2 biologists. Current access to Dean Creek may be limited by the recent excavation of a drainage channel on the adjacent property downstream of the Daybreak site.

6.8.2.1 Groundwater

Increased flows entering the East Fork Lewis River and Dean Creek as a result of the transfer of water rights to the State Trust will not affect cutthroat trout spawning and incubation since the increased flows would occur in the summer and early fall prior to spawning.

6.8.2.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflows from Dean Creek to the ponds will increase flows in Dean Creek during the late summer, fall, and winter instream flows. However, habitat downstream of the Pond 5 outlet is predominantly beaver pond complexes and the amount of clean gravel available for spawning is limited. Therefore, effects of increased surface flows from implementation of the HCP are expected to have no effect on potential coastal cutthroat trout spawning and incubation in Dean Creek.

Cutthroat trout have been observed to initiate spawning when water temperatures approach 10°C (Stolz and Schnell 1991), but may spawn throughout a range of approximately 6°C to 17°C (Bell 1986). Temperatures recorded in Dean Creek during 1998 indicate that May temperatures are within the temperature range preferred by cutthroat trout.

Implementation of this HCP is expected to maintain or reduce water temperatures in Dean Creek. Because Dean Creek flows through a large beaver complex with low velocities and a large area of water exposed to solar radiation, any temperature reductions in Dean Creek resulting from the HCP will be localized to the stream area adjacent to the Daybreak site. Reduced water temperatures in Dean Creek adjacent to the Daybreak site will have a positive effect on potential coastal cutthroat trout spawning and incubation.

Cutthroat trout embryos require sufficient intergravel DO for proper development. Salmonid eggs and alevins typically require intergravel DO levels greater than 7 mg/l (Bell 1991). The DO concentration is typically lower within the streambed than in the surface flow. Thus, assuming a difference of 3 mg/l between intergravel and instream DO concentrations, instream values greater than 10 mg/l would adequately maintain DO levels at around 7 mg/l within the gravel (MacDonald et al. 1991). Currently summertime DO concentrations in Dean Creek and the Pond 5 outlet are sometimes lower than 10 mg/l. Implementation of the HCP will increase riparian canopy over Dean Creek, which is expected to reduce water temperatures and primary productivity in the stream. These effects will potentially increase summertime DO concentrations in the reach of Dean Creek adjacent to the Daybreak site, and would result in a positive effect on cutthroat trout embryos incubating in Dean Creek.

Implementation of a clarification system has significantly reduced turbidity in the Pond 5 discharge. Further, implementation of a closed-loop clarification system should substantially reduce or eliminate turbidity contributions from the processing operations. Finally, implementation of a Storm Water and Erosion Control Plan should continue to reduce fine sediment inputs to Dean Creek and the East Fork Lewis River. Because spawning habitat is limited downstream of the Pond 5 outlet, implementation of this conservation measure may have only a slight positive net effect on cutthroat trout embryo incubation downstream of the Daybreak site.

6.8.2.3 Riverine Habitat

Implementation of the HCP is expected to not affect physical habitat in the East Fork Lewis River or Dean Creek. However, if avulsion occurs into the existing and/or created gravel ponds, it would result in the replacement of predominantly riffle habitat in the channel that existed prior to an avulsion with deep, slow pool habitat. Because coastal cutthroat trout spawn in tributaries smaller than the East Fork Lewis River, a potential avulsion is expected to have no effect on spawning and incubating cutthroat trout.

6.8.2.4 Wetland Habitat

Coastal cutthroat trout do not use wetland habitat for spawning. Therefore the creation of approximately 32 acres of emergent wetland will have no effect on spawning cutthroat.

6.8.2.5 Predation and Competition

The existing ponds do not contain any fish species that are expected to compete with adult cutthroat for spawning sites, although several of the species are known to prey on salmonid eggs. These fish are also found in Dean Creek where coastal cutthroat spawning could occur. The HCP is not expected to affect predation on or competition with coastal cutthroat spawning and incubation.

6.8.3 Coastal Cutthroat Trout Juvenile Rearing and Downstream Migration

Juvenile anadromous coastal cutthroat trout in the East Fork Lewis River system generally emerge from the gravels between April and July and rear in freshwater for two to four years before migrating downstream. Juvenile cutthroat trout prefer to rear in low-velocity habitats, such as isolated pools and backwaters, and could be distributed both within the mainstem East Fork Lewis River and in the smaller tributaries and off-channel habitats. In some systems, beaver ponds support the highest abundance of rearing juvenile cutthroat trout (Solazzi et al. 1997). Juvenile trout over-winter in interstitial spaces of the substrate or in pools with cover provided by LWD. Under existing conditions, juvenile cutthroat trout rearing in Dean Creek can access the Daybreak ponds during winter high flows.

6.8.3.1 Groundwater

Expanded mining and reclamation under the HCP will not impact groundwater contributions to the East Fork Lewis River (Section 6.2.2). However, the transfer of 330 afy currently used for irrigation to the State Trust for instream flow enhancement could increase the amount and quality of rearing habitat and have a positive effect on cutthroat trout rearing.

6.8.3.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflows from Dean Creek to the ponds will result in increased instream flows in Dean Creek downstream of Pond 5 during the late summer, fall, and winter. Increasing flows in Dean Creek will increase the amount of rearing habitat available to rearing cutthroat trout and is therefore expected to have a positive effect. Net flow increases will be small, relative to flows in the mainstem, thus implementation of this HCP will not affect rearing habitat in the East Fork Lewis River.

Detrimental effects of warm water temperatures on rearing cutthroat trout are most likely to occur during the late summer. Establishing a riparian canopy over Dean Creek and preventing warm water discharges from Pond 5 will prevent management related temperature impacts to cutthroat trout rearing in the stream. These actions are anticipated to have a positive effect on rearing cutthroat trout.

Dissolved oxygen is not currently considered a limiting factor in the East Fork Lewis River although it is potentially a limiting factor in Dean Creek during the summer. Implementation of the HCP will likely increase the DO concentration in Dean Creek as a result of increased shading along the creek and releases of aerated, turbulent water from Pond 5. Therefore there is an expected positive effect on cutthroat trout rearing in Dean Creek. Downstream of the Daybreak site, Dean Creek flows through a large beaver complex with low velocities and naturally high temperatures that are believed to result in reduced DO. Therefore, beneficial DO concentrations in Dean Creek resulting from the HCP will likely be localized to the stream area adjacent to the Daybreak site and are not expected to affect DO concentrations or rearing coastal cutthroat trout in the East Fork Lewis River.

Use of a clarification system to treat the wash water has significantly reduced the turbidity in the Pond 5 discharge. Further, implementation of a closed-loop clarification system should substantially reduce or eliminate turbidity contributions from the processing operations. Finally, implementation of the Storm Water and Erosion Control Plan will further reduce turbidity during winter storms. As a result, turbidity of water delivered to Dean Creek and the East Fork Lewis River is expected to decrease. The net effect of implementing this HCP will be positive for cutthroat trout rearing in Dean Creek, but will have little or no effect on cutthroat trout rearing in the East Fork Lewis River.

6.8.3.3 Riverine Habitat

Current operations at the Daybreak site do not affect the riverine habitat. Implementation of the HCP is also not expected to affect physical habitat in the East Fork Lewis River. However, an avulsion into the existing and/or created gravel ponds would result in the replacement of predominantly riffle habitat in the abandoned natural channel with deep, slow pool habitats. Slow moving pools and embayments may provide rearing habitat for juvenile cutthroat trout. Large woody debris placed on the pond margins would enhance the value of the ponds for rearing if they were connected to the river by an avulsion. However, cutthroat trout rear predominantly in tributaries smaller than the East Fork Lewis River. Therefore, a potential avulsion would be expected to have little or no effect on rearing cutthroat trout.

Studies show that fish moving downstream generally move at rates that are a function of the local current velocity (Raymond 1979; Moser et al. 1991). Increasing the travel time of downstream migrating cutthroat trout through the Daybreak site would increase the time they are exposed to predators. Predatory fishes such as northern pikeminnow prefer slower moving waters (Faler et al. 1988). An avulsion into the Daybreak site would connect predatory fish in the ponds to the East Fork Lewis River, slightly increase downstream travel time, and dramatically increase the area of deep, low velocity habitat favored by predators, all of which would negatively affect juvenile cutthroat trout. In addition, juvenile cutthroat trout could be stranded in avulsed ponds after high flow events if the ponds become isolated by sediment deposition and receding water levels.

6.8.3.4 Wetland Habitat

Although juvenile cutthroat trout use off-channel habitat for rearing and during high flows, the reconfigured outlet of Pond 5 would restrict juvenile cutthroat trout from accessing the wetland habitat on the Daybreak site during most flows. However, the creation of approximately 32 acres of wetland habitat will increase the productivity of the system and could increase the release of food items to Dean Creek. This is expected to have a positive effect on rearing cutthroat trout.

6.8.3.5 Predation and Competition

Dean Creek and the Daybreak ponds currently provide off-channel habitat that may be attractive to juvenile coastal cutthroat trout for rearing and during winter high flows. However, the reconfigured Pond 5 outlet will restrict juvenile cutthroat trout during most flows from entering the ponds. Pond 5 contains a variety of native and non-native fish species that are likely to prey on juvenile coastal cutthroat trout. Restricting outflows to a single site and reconfiguring the western berm to prevent backflooding from the East Fork Lewis River during floods with a magnitude less than a 17-year event will restrict cutthroat trout from entering the ponds during most flows. Reducing the available habitat by narrowing the existing ponds and targeted harvest of largemouth bass in the Daybreak ponds will reduce the number of predators. Restricting access and reducing the numbers of predators will result in a positive effect on juvenile cutthroat trout.

Cutthroat trout are less dominant than steelhead, coho, or other salmonids and tend to be distributed further upstream or to use less preferable habitat in response to competition. Enhancements to Dean Creek through implementation of the HCP may increase use of the stream by these more dominant salmonids. However, these species have co-evolved together and competitive pressures from other salmonids on rearing cutthroat trout are a natural condition.

6.9 EFFECTS OF PROJECT OPERATIONS AND CONSERVATION MEASURES ON PACIFIC LAMPREY (*LAMPETRA TRIDENTA)*

The following analysis is limited to Pacific lamprey. Pacific lamprey have been petitioned to be reviewed by the USFWS for listing under the ESA. Current lamprey populations in the Pacific Northwest are depressed. Because they required spawning habitat similar to Pacific salmon, their status is affected by many of the same habitat conditions that affect salmonid abundance and distribution (Close et al. 1995). In this section, separate analyses are presented for each of the major freshwater life-history stages of Pacific lamprey, including upstream migration, spawning and incubation, and larval (ammocoete) rearing. Detailed information concerning specific life history characteristics and habitat requirements is presented in Technical Appendix A.

6.9.1 Pacific Lamprey Upstream Migration

Pacific lamprey are present in the East Fork Lewis River, but their abundance and distribution are unknown. Pacific lamprey leave the ocean and return to coastal rivers during July through October, and similar to steelhead, they over-winter in freshwater prior to spawning in the spring. Pacific lamprey can migrate up into the small headwaters to spawn (Beamish 1980), and it is possible that adults migrate up into Dean Creek. The potential for Storedahl's mining activities to affect Pacific lamprey that are migrating or over-wintering is generally greatest in the late summer when water temperatures are highest, dissolved oxygen is lowest, and low-flow conditions can restrict access to spawning streams and holding habitat and make them more vulnerable to turbidity increases.

6.9.1.1 Groundwater

Increased flows resulting from the transfer of water right could have a positive effect on upstream migrating and holding Pacific lamprey.

6.9.1.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflows from Dean Creek to the ponds will increase instream flows in Dean Creek downstream of Pond 5 during the late summer, fall, and winter, which could have a positive effect on upstream migrating Pacific lamprey.

Warm water temperatures are most likely to detrimentally impact adult Pacific lamprey that are migrating or holding in the river and tributaries during the summer low-flow period. Implementation of this HCP is expected to maintain or reduce water temperatures in Dean Creek, which will have a positive effect on adult Pacific lamprey migrating or holding in Dean Creek. Because Dean Creek flows through a large beaver complex with low velocities and a large area of water exposed to solar radiation, any temperature reductions in Dean Creek resulting from the HCP will likely be localized to the stream area adjacent to the Daybreak site, and are not expected to affect water temperatures in the East Fork Lewis River. For these reasons, influences on water temperature will likely have no effect on adult Pacific lamprey migrating or holding in the East Fork Lewis River.

Dissolved oxygen is not currently considered a limiting factor in the East Fork Lewis River, although DO is potentially a limiting factor in Dean Creek during the summer.

Implementation of the HCP may increase the DO concentration in Dean Creek as a result of increased shading along the creek and turbulent discharges from Pond 5, and will therefore have a positive effect on adult Pacific lamprey migrating or holding in Dean Creek. Downstream of the Daybreak site, Dean Creek flows through a large beaver complex with low velocities and naturally high temperatures that are believed to result in reduced DO. Therefore, beneficial DO concentrations in Dean Creek resulting from the HCP will likely be localized to the stream area adjacent to the Daybreak site and are not expected to affect DO concentrations in the East Fork Lewis River. Thus, there would be no effect on upstream migrating Pacific lamprey in the East Fork Lewis River.

Turbidity in the outlet of Pond 5 is expected to be significantly reduced under the HCP, and is expected to have a positive effect on adult Pacific lamprey that could migrate up into Dean Creek. However, even under existing conditions, turbidity associated with activities at the Daybreak site has little impact on water quality in the mainstem East Fork Lewis River. Therefore, implementation of the HCP is expected to have no effect on upstream migrating Pacific lamprey in the East Fork Lewis River.

6.9.1.3 Riverine Habitat

Continued mining and implementation of the HCP will not directly affect physical habitat in Dean Creek or the East Fork Lewis River. However, if the channel should avulse through the Daybreak site, observations at the Ridgefield Pit site suggest that the result would be formation of a series of deep pools fed by river flow and groundwater. It is unknown if Pacific lamprey use deep pools for refuge during migration, but such pools do provide refugia for adult steelhead. An increase in the number of refugia could have a potentially positive effect on upstream migrating Pacific lamprey. However, pool depths at the Ridgefield site in 1999, three years after the avulsion, were generally less than 10 feet, so positive effects for upstream migrating lamprey may be short-lived. Adult migrating Pacific lamprey could be stranded in avulsed ponds after high flow events if the ponds become isolated by sediment deposition and receding water levels. However, observations of the Ridgefield Pits indicate that following winter high flows the off-channel pools remain connected to the river, most likely due to significant groundwater flow.

6.9.1.4 Wetlands Habitat

Upstream migrating Pacific lamprey are not believed to use wetland habitat. Therefore the creation of additional wetland areas will have no effect on Pacific upstream migrating lamprey.

6.9.1.5 Predation and Competition

The existing ponds contain a variety of native and non-native fish species. However, none of the species present are expected to prey upon or compete with adult Pacific lamprey during their upstream migration. Therefore, implementation of this HCP will not affect predation or competition with adult Pacific lamprey.

6.9.2 Pacific Lamprey Spawning and Incubation

Pacific lamprey spawn in the spring, typically in the month of May. Spawning Pacific lamprey have been observed during steelhead spawning surveys, and they appear to use similar spawning habitat as steelhead (Jackson et al. 1996; Foley 1998). It is assumed that Pacific lamprey in the East Fork Lewis River are able to spawn in suitable sites from the end of the tidal influence zone at RM 6.0 to upstream of Sunset Falls at RM 31.5. Based on estimates of steelhead spawning habitat, the total length of stream available for spawning, including the mainstem and tributaries, potentially occurs over 54 miles. Incubation is relatively short, and the fish hatch and emerge from the gravel after 4 or 5 weeks (Close et al. 1995). If Pacific lamprey use Dean Creek for spawning and incubation, it would likely occur upstream of the low-velocity beaver complex area that is downstream of the Pond 5 outlet.

6.9.2.1 Groundwater

Increased flows from the transfer of water rights would occur in the summer or early fall and there will be no effect on Pacific lamprey spawning in the spring.

6.9.2.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflows from Dean Creek to the ponds will increase instream flows in Dean Creek downstream at Pond 5 during the late summer, fall, and winter. Because spawning habitat downstream of the Pond 5 outlet is limited, flow increases are expected to have no effect on potential Pacific lamprey spawning and incubation in Dean Creek. Because net flow increases will be small relative to flow in the mainstem, and are unlikely to occur during the spring, implementation of this HCP is expected to have no effect on Pacific lamprey spawning and incubation in the East Fork Lewis River.

Pacific lamprey initiate spawning when water temperatures are between 10°C to 15°C (Close et al. 1995). Temperatures in the East Fork Lewis River during the spawning period are generally suitable for spawning. Data collected at Daybreak Park from 1976 to 1992 indicate that temperatures in the East Fork Lewis River during May are typically between 10°C and 15°C (Hutton 1995d). Temperatures recorded in Dean Creek during 1998 also indicate that May temperatures are within the range preferred by Pacific lamprey.

Implementation of this HCP is expected to maintain or reduce water temperatures in Dean Creek. Because Dean Creek flows through a large beaver complex with a large area of low-velocity water exposed to solar radiation, any temperature reductions in Dean Creek resulting from the HCP will likely be localized to the stream area adjacent to the Daybreak site and are not expected to affect water temperatures in the East Fork Lewis River. Reduced water temperatures in Dean Creek adjacent to the Daybreak site will likely have a positive effect on Pacific lamprey spawning. However, there would likely be no effect on Pacific lamprey spawning and incubation in the East Fork Lewis River.

The DO requirements of developing Pacific lamprey embryos are unknown, but are assumed to be similar to requirements for salmonid development. Salmonid eggs and alevins typically require DO levels greater than 7 mg/l (Bell 1991). The DO concentration is typically lower within the streambed than in the surface flow, thus, assuming a difference of 3 mg/l between intergravel and instream DO concentrations, instream values greater than 10 mg/l would adequately maintain DO levels at around 7 mg/l within the gravel (MacDonald et al. 1991). DO levels measured in the East Fork Lewis River downstream of the Daybreak site exceeded 10 mg/l for all samples collected during the Pacific lamprey spawning and incubation period. Currently summertime DO concentrations in Dean Creek and the Pond 5 outlet are sometimes lower than 10 mg/l. Reduced water temperatures in Dean Creek and controlled discharges from Pond 5 will potentially increase summertime DO concentrations in the reach of Dean Creek adjacent to the Daybreak site. Implementation of the HCP is not expected to change DO levels in the beaver complex area of Dean Creek or the East Fork Lewis River. For these reasons there will be no effect on Pacific lamprey spawning and incubation in the East Fork Lewis River and a potential positive effect in Dean Creek.

The portion of the of the East Fork Lewis River that could potentially be influenced by fine sediment generated by Storedahl's operations represents 2 percent of the approximately 54 miles of assumed Pacific lamprey spawning habitat. Implementation of a closed-loop clarification system and a controlled outlet are expected to significantly reduce turbidity in the Pond 5 discharge, and will therefore reduce fine sediment inputs to Dean Creek and the East Fork Lewis River. Implementation of the HCP will therefore have a positive effect on Pacific lamprey that spawn downstream of the Daybreak site.

6.9.2.3 Riverine Habitat

Since avulsion would be most likely to occur during the fall and winter high flows, and Pacific lamprey spawn in the spring, direct impacts to spawning and incubation are unlikely. However, avulsion into the Daybreak site could affect Pacific lamprey spawning and incubation over the long term by replacing spawning habitats in the channel that existed prior to the avulsion with deep, slow pool habitats (Table 6-5). If Pacific lamprey spawning habitat is considered similar to steelhead spawning habitat, a potential reduction in spawning habitat as a result of an avulsion amounts to less than 1 percent of the available spawning area in the East Fork Lewis River watershed. This effect could persist for decades, although during this time there would be a gradual increase in spawning habitat as gravel is deposited in the pools and the channel continues to meander. Because the implementation of the HCP will reduce the overall risk of avulsion into the existing ponds, and because direct impacts are unlikely and the area that could be impacted represents a small fraction of the total available habitat, a potential avulsion is not expected to affect Pacific lamprey spawning and incubation.

6.9.2.4 Wetland Habitat

Pacific lamprey do not use wetland habitat for spawning. Therefore the creation of additional wetland areas will have no effect on spawning Pacific lamprey.

6.9.2.5 Predation and Competition

The existing ponds do not contain native or non-native fish species that are expected to prey on adult Pacific lamprey or compete with them for spawning sites. Thus, there will be no effect on Pacific lamprey spawning and incubation from predation or competition.

6.9.3 Pacific Lamprey Ammocoetes Rearing and Downstream Migration

Larval Pacific lamprey, or ammocoetes, rear in silty substrates for five or six years before metamorphosing into a parasitic life form, which then migrates to the ocean (see Technical Appendix A). The ammocoetes feed by filtering organic matter and algae suspended above and within the substrate. Although there are no documented observations of Pacific lamprey ammocoetes in or near the HCP area, adults have been observed actively building spawning nests in a recently expanded riffle area in the Ridgefield Pit reach (R2 Resource Consultants, unpublished data). It is likely that ammocoetes would be most abundant in backwater areas of the East Fork Lewis River, in the beaver pond complex, and in the dune-ripple segment of Dean Creek. Access to these areas in Dean Creek may be limited by the recent excavation of a drainage ditch through the adjacent property downstream of the Daybreak site. If Pacific lamprey can access Dean Creek, ammocoetes could also access the Daybreak ponds during flood events greater than a 17-year flood.

6.9.3.1 Groundwater

Increased flows from the transfer of water rights could result in a positive effect on rearing Pacific lamprey ammocoetes.

6.9.3.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflows from Dean Creek to the pond system will increase instream flows in Dean Creek downstream of Pond 5 during the late summer, fall, and winter. Increasing flows in Dean Creek will increase the amount of available rearing habitat available to Pacific lamprey ammocoetes and is therefore an expected positive effect.

Detrimental effects of warm water temperatures on Pacific lamprey ammocoetes are most likely to occur during the late summer. Establishing a riparian canopy over Dean Creek and releasing cool water from Pond 3 or 5 under the water management plan could benefit ammocoetes rearing in the beaver complex downstream. These actions are anticipated to have a positive effect on Pacific lamprey.

Reduced water temperatures in Dean Creek and controlled discharges from Pond 5 will potentially increase summertime DO concentrations in the reach of Dean Creek adjacent to the Daybreak site. Implementation of the HCP is not expected to change DO levels in the beaver complex area of Dean Creek or the East Fork Lewis River. Increased DO could potentially have a positive effect for ammocoetes rearing in the substrates of Dean Creek. However, no effect on ammocoetes rearing in the East Fork Lewis River is expected from increased DO concentration upstream of the slow-water beaver pond complex in Dean Creek.

Use of a clarification system to treat wash water has substantially reduced the turbidity in the Pond 5 discharge. Further, implementation of a closed-loop clarification system should substantially reduce or eliminate turbidity contributions from the processing operations. Finally, implementation of the Storm Water and Erosion Control Plan will further reduce turbidity during winter storms. As a result, turbidity of water delivered to Dean Creek and the East Fork Lewis River is expected to decrease. The net effect of expanded mining and implementation of this HCP will have a positive effect on ammocoetes rearing in Dean Creek and little or no effect on ammocoetes rearing in the East Fork Lewis River.

6.9.3.3 Riverine Habitat

The Daybreak ponds currently provide off-channel habitat that may be used by rearing Pacific lamprey ammocoetes. However, no ammocoetes have been collected from the ponds (R2 Resource Consultants, unpublished data), so their present use is unknown. If ammocoetes are present, reconfiguration of the Pond 5 outlet could restrict lamprey currently rearing in the ponds and that have metamorphosed from ammocoetes to juveniles from leaving the ponds on their migration to the ocean. Additionally, the controlled outlet could restrict movement of ammocoetes from Dean Creek into the ponds to rear. These potentially negative effects from implementation of the HCP are considered to be an acceptable trade-off with positive effects to salmonids. Allowing unrestricted access and relatively uncontrolled discharges would continue to subject covered salmonid fish species to high temperatures and low DO concentrations in the ponds, as well as unmanaged temperature, DO, and turbidity impacts in Dean Creek.

Studies show that fish moving downstream generally move at rates that are a function of the local current velocity (Raymond 1979; Moser et al. 1991). Increasing the travel time of downstream migrating Pacific lamprey through the Daybreak site would increase the time they are exposed to predators. Predatory fishes such as northern pikeminnow prefer slower moving waters (Faler et al. 1988). An avulsion into the Daybreak site would connect predatory fish in the ponds to the East Fork Lewis River, slightly increase downstream travel time, and dramatically increase the area of deep, low velocity habitat favored by predators, all of which would negatively affect juvenile Pacific lamprey. In addition, maturing Pacific lamprey could be stranded in avulsed ponds after high flow events if the ponds become isolated by sediment deposition and receding water levels.

6.9.3.4 Wetland Habitat

The reconfigured western berm and Pond 5 outlet will restrict Pacific lamprey ammocoetes from drifting into the ponds and created wetland habitat during most flows. However, the creation of approximately 32 acres of emergent wetlands is expected to increase the overall productivity of aquatic habitat on the site. Increased productivity will release more food items to Dean Creek, benefiting rearing Pacific lamprey, which could be present in the stream. Therefore the increase in wetland habitat will have a positive effect on Pacific lamprey ammocoetes.

6.9.3.5 Predation and Competition

Larval and juvenile Pacific lamprey are preyed upon by a large number of fish and bird species including native and non-native species (Close et al. 1995). Distribution of ammocoetes into rearing habitat is presumed to be through passive drifting. Reconfiguration of the Pond 5 outlet to restrict flow of Dean Creek water into the pond will most likely prevent ammocoetes from entering the Daybreak ponds under most flow conditions. Therefore the HCP will have a positive effect on larval Pacific lamprey rearing in Dean Creek or the East Fork Lewis River by reducing their exposure to predation.

6.10 EFFECTS OF PROJECT OPERATIONS AND CONSERVATION MEASURES ON RIVER LAMPREY (*LAMPETRA AYRESI)*

The following analysis is limited to river lamprey. River lamprey have been petitioned to be reviewed by the USFWS for listing under the ESA. Current lamprey populations in the Northwest are depressed. Because they have spawning habitat requirements that are similar to Pacific salmon, their status is affected by many of the same habitat conditions that affect salmonid abundance and distribution (Close et al. 1995). In this section, separate analyses are presented for each of the major freshwater life-history stages of river lamprey, including upstream migration, spawning and incubation, and larval (ammocoete) rearing. Detailed information concerning specific life history characteristics and habitat requirements is presented in Technical Appendix A.

6.10.1 River Lamprey Upstream Migration

River lamprey are assumed to be present in the East Fork Lewis River, but their abundance and distribution is unknown. River lamprey leave the ocean and return to coastal rivers to spawn, but little is known about the biology or habitats of this species. Much of their biology and habitat are assumed to be similar to those of the Pacific lamprey, although they have a shorter life span and a smaller body size. It is believed that river lamprey return to freshwater in the fall and then over-winter before spawning in the spring (Beamish 1980). It is possible that adults migrate up into Dean Creek. The potential for Storedahl's mining activities to affect river lamprey that are migrating or over-wintering is generally greatest in the late summer when water temperatures are highest, dissolved oxygen is lowest, and low-flow conditions can restrict access to spawning streams and holding habitat and make lamprey more vulnerable to turbidity increases.

6.10.1.1 Groundwater

Expanded mining and reclamation under the HCP will not impact groundwater contributions to the East Fork Lewis River (Section 6.2.2). However, the transfer of 330 afy currently used for irrigation to the State Trust for instream flow enhancement could have a positive effect on upstream migrating and holding river lamprey.

6.10.1.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflows from Dean Creek to the pond system will increase instream flows of Pond 5 during the late summer, fall, and winter. This is expected to have no effect or a positive effect on upstream migrating river lamprey.

Warm water temperatures are likely to detrimentally impact adult river lamprey migrating or holding in the river and tributaries during the summer low-flow period. Implementation of this HCP is expected to maintain or reduce water temperatures in Dean Creek, which will have a positive effect on adult river lamprey migrating or holding in Dean Creek. Because Dean Creek flows through a large beaver complex with low velocities and a large area of water exposed to solar radiation, any temperature reductions in Dean Creek resulting from the HCP will likely be localized to the stream area adjacent to the Daybreak site and are not expected to effect water temperatures in the East Fork Lewis River. For these reasons, influences on water temperature will have no effect on adult river lamprey migrating or holding in the East Fork Lewis River.

Dissolved oxygen is not currently considered a limiting factor in the East Fork Lewis River although it is potentially a limiting factor in Dean Creek during the summer. Implementation of the HCP may increase the DO concentration in Dean Creek as a result of increased shading along the creek and turbulent discharges from Pond 5, and therefore there is an expected positive effect on adult river lamprey migrating or holding in Dean Creek. Downstream of the Daybreak site, Dean Creek flows through a large beaver complex with low velocities and naturally high temperatures may result in reduced DO. Therefore, beneficial DO concentrations in Dean Creek resulting from the HCP will be localized to the stream area adjacent to the Daybreak site and are not expected to affect DO concentrations in the East Fork Lewis River. Thus, there will be no effect on upstream migrating river lamprey in the East Fork Lewis River.

Turbidity in the outlet of Pond 5 is expected to be significantly reduced under the HCP, and is expected to have a positive effect on adult river lamprey that could migrate into Dean Creek. However, even under existing conditions, turbidity associated with activities at the Daybreak site has little impact on water quality in the mainstem East Fork Lewis River. Therefore, implementation of the HCP is expected to have no effect on upstream migrating river lamprey in the East Fork Lewis River.

6.10.1.3 Riverine Habitat

Continued mining and implementation of the HCP will not directly affect the physical habitat in Dean Creek or the East Fork Lewis River. However, if the channel should avulse through the Daybreak site, observations at the Ridgefield Pit site suggest that the result would be formation of a series of deep pools fed by river flow and groundwater. It is unknown if river lamprey use deep pools for refuge during migration, but such pools do provide refugia for adult steelhead. An increase in the number of refugia would have a potentially positive effect on upstream migrating river lamprey. However, pool depths at the Ridgefield site in 1999, three years after the avulsion, were generally less than 10 feet, so positive effects for upstream migrating river lamprey would be short-lived. Adult, migrating river lamprey could be stranded in avulsed ponds after high flow events if the ponds become isolated by sediment deposition and receding water levels. However, observations of the Ridgefield Pits indicate that following winter high flows the off-channel pools remain connected to the river, most likely due to significant groundwater flow.

6.10.1.4 Wetland Habitat

Upstream migrating river lamprey are not believed to use wetland habitat. Therefore the creation of additional wetland areas will have no effect on river lamprey.

6.10.1.5 Predation and Competition

The existing ponds contain a variety of native and non-native fish species, such as largemouth bass, that could prey on adult river lamprey during upstream migration. However, migrating river lamprey are not believed to use wetland habitat. Restricting access to Pond 5 by reconfiguring the outlet and the western berm and controlling largemouth bass populations by reducing the existing habitat and controlled harvest are expected to have a positive effect on adult river lamprey.

6.10.2 River Lamprey Spawning and Incubation

River lamprey are believed to spawn in May, but spawning could extend from April to June. River lamprey construct nests in gravel, where they lay their fertilized eggs (Beamish 1980). They rely on cold water habitat similar to the Pacific salmon species covered by this HCP. It is assumed that river lamprey in the East Fork Lewis River basin are able to spawn in suitable sites from the end of the tidal influence zone at RM 6.0 to upstream of Sunset Falls at RM 31.5. Based on estimates of steelhead spawning habitat, the total length of stream potentially available for spawning, including the mainstem and tributaries, is approximately 54 miles. Following a short incubation in the gravel, the larval fish emerge and distribute into silty substrates in slow water areas. If river lamprey use Dean Creek for spawning and incubation, it would likely occur upstream of the low-velocity beaver complex area that is downstream of the Pond 5 outlet.

6.10.2.1 Groundwater

Increased flows entering the East Fork Lewis River and Dean Creek as a result of the transfer of water rights to the State Trust will not affect river lamprey spawning and incubation since the increased flows would occur in the summer and early fall prior to spring spawning.

6.10.2.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflows from Dean Creek to the pond system will increase instream flows in Dean Creek during the late summer, fall, and winter. Because spawning habitat downstream of the Pond 5 outlet is limited, the HCP is expected to have no effect on potential river lamprey spawning and incubation in Dean Creek. Because net flow increases will be small relative to flow in the mainstem, and are unlikely to occur during the spring, implementation of this HCP is expected to have no effect on river lamprey spawning and incubation in the East Fork Lewis River.

River lamprey are spring spawners and likely require water temperatures between 10°C to 15°C, similar to the Pacific lamprey. Temperatures in the East Fork Lewis River during the spawning period are generally suitable for spawning. Data collected at Daybreak Park from 1976 to 1992 indicate that temperatures in the East Fork Lewis River during May are typically between 10°C and 15°C (Hutton 1995d). Temperatures recorded in Dean Creek during 1998 also indicate that May temperatures are within range presumed to be preferred by river lamprey.

Implementation of this HCP is expected to maintain or reduce water temperatures in Dean Creek. Because Dean Creek flows through a large beaver complex with low velocities and a large area of water exposed to solar radiation, any temperature reductions in Dean Creek resulting from the HCP will likely be localized to the stream area adjacent to the Daybreak site and are not expected to affect water temperatures in the East Fork Lewis River. Reduced water temperatures in Dean Creek above this area and adjacent to the Daybreak site will have a positive effect on river lamprey spawning. There will be no effect on river lamprey spawning and incubation in the East Fork Lewis River.

The DO requirements of developing river lamprey embryos are unknown, but are assumed to be similar to requirements for salmonid development. Salmonid eggs and alevins typically require DO levels greater than 7 mg/l (Bell 1991). The DO concentration is typically lower within the streambed than in the surface flow. Thus, assuming a difference of 3 mg/l between intergravel and instream DO concentrations, instream values greater than 10 mg/l would adequately maintain DO levels at around 7 mg/l within the gravel (MacDonald et al. 1991). DO levels measured in the East Fork Lewis River downstream of the Daybreak site exceeded 10 mg/l for all samples collected during the river lamprey spawning and incubation period. Currently summertime DO concentrations in Dean Creek and the Pond 5 outlet are sometimes lower than 10 mg/l. Reduced water temperatures in Dean Creek and controlled discharges from Pond 5 will potentially increase summertime DO concentrations in the reach of Dean Creek adjacent to the Daybreak site. Implementation of the HCP is not expected to change DO levels in the beaver complex area of Dean Creek or the East Fork Lewis River. For these reasons there will be no effect on river lamprey spawning and incubation in the East Fork Lewis River and a potential positive effect in Dean Creek.

The portion of the of the East Fork Lewis River that could potentially be influenced by fine sediment generated by Storedahl's operations represents 2 percent of the approximately 54 miles of assumed river lamprey spawning habitat. Implementation of a closed-loop clarification system and a controlled outlet are expected to significantly reduce turbidity in the Pond 5 discharge, and will therefore reduce fine sediment inputs to Dean Creek and the East Fork Lewis River. Implementation of the HCP will therefore have a positive effect on river lamprey that spawn downstream of the Daybreak site.

6.10.2.3 Riverine Habitat

Since avulsion would be most likely to occur during fall or winter high flows, and river lamprey spawn in the spring, direct impacts to river lamprey spawning and incubation are unlikely. However, avulsion into the Daybreak site could affect river lamprey spawning and incubation over the long term by replacing spawning habitats in the abandoned natural channel with deep, slow pool habitats. If river lamprey spawning habitat is considered similar to steelhead spawning habitat, the reach that could be influenced (Table 6-5) amounts to less than 1 percent of the available spawning area in the East Fork Lewis River watershed. This effect could persist for decades, although during this time there would be a gradual increase in spawning habitat as gravel is deposited in the pools and the channel continues to meander. Because implementation of the HCP will reduce the overall risk of avulsion into the existing ponds, and because direct impacts are unlikely and the area that could be impacted represents a small fraction of the total available habitat, a potential avulsion is not expected to affect river lamprey spawning and incubation.

6.10.2.4 Wetland Habitat

River lamprey do not use wetland habitat for spawning. Therefore the creation of additional wetland areas will have no effect on spawning river lamprey.

6.10.2.5 Predation and Competition

Adult river lamprey are not expected to seek out wetland and pond habitat during their upstream migration. However, the existing ponds contain a variety of native and non-native fish species, such as largemouth bass, that are likely to prey upon adult river lamprey during spawning. Reconfiguration of the Pond 5 outlet to restrict flow of Dean Creek water into the pond will most likely prevent adult river lamprey from entering the Daybreak ponds under most flow conditions. Therefore, influences on predation and competition from implementation of this HCP are expected to have a positive effect on adult river lamprey reproduction.

6.10.3 River Lamprey Ammocoetes Rearing and Downstream Migration

Larval river lamprey, or ammocoetes, rear in silty substrates for a number years before metamorphosing into a parasitic life form, which then migrates to the ocean (see Technical Appendix A). The ammocoetes feed by filtering organic matter and algae suspended above and within the substrate. Although there are no documented observations of river lamprey ammocoetes in or near the HCP area it is likely that they would be most abundant in backwater areas of the East Fork Lewis River, in the beaver pond complex, and in off-channel habitat in Dean Creek. If there is adequate access under current conditions, ammocoetes rearing in Dean Creek could access the Daybreak ponds during flooding greater than a 5-year event.

6.10.3.1 Groundwater

Increased flows from the transfer of water rights could result in a positive effect on rearing river lamprey ammocoetes.

6.10.3.2 Surface Water Quantity and Quality

Implementation of the water management plan and restricting inflows from Dean Creek to the pond system will increase instream flows in Dean Creek during the late summer, fall, and winter. Higher flows will increase the amount of available rearing habitat available to river lamprey ammocoetes and is therefore expected to have a positive effect. Since net flow increases will be small relative to flows in the mainstem, implementation of this HCP will not affect river lamprey rearing in the East Fork Lewis River.

Detrimental effects of warm water temperatures on river lamprey ammocoetes are most likely to occur during the late summer. Establishing a riparian canopy over Dean Creek and releasing cool water from Pond 3 or 5 could benefit ammocoetes rearing in the beaver complex downstream. These actions are anticipated to have a positive effect on river lamprey.

Reduced water temperatures in Dean Creek and controlled discharges from Pond 5 will potentially increase summertime DO concentrations in the reach of Dean Creek adjacent to the Daybreak site. Implementation of the HCP is not expected to change DO levels in the beaver complex area of Dean Creek or the East Fork Lewis River. Increased DO could potentially have a positive effect for ammocoetes rearing in the substrates of Dean Creek. However, no effect on ammocoetes rearing in the East Fork Lewis River is expected from these measures due to increased DO concentration upstream of the slow-water beaver pond complex in Dean Creek.

Use of a clarification system to treat the wash water has significantly reduced the turbidity in the Pond 5 discharge. Further, implementation of a closed-loop clarification system should substantially reduce or eliminate turbidity contributions from the processing operations. Finally, implementation of the Storm Water and Erosion Control Plan will further reduce turbidity during winter storms. As a result, turbidity of water delivered to Dean Creek and the East Fork Lewis River is expected to decrease. The net effect of expanded mining and implementation of this HCP will be positive for ammocoetes rearing in Dean Creek. There will be little or no effect on ammocoetes rearing in the East Fork Lewis River.

6.10.3.3 Riverine Habitat

The Daybreak ponds currently provide off-channel habitat that may be used by rearing river lamprey ammocoetes. However, no ammocoetes have been collected from the ponds (R2 Resource Consultants, unpublished data), so their present use is unknown. If ammocoetes are present, then reconfiguration of the Pond 5 outlet could restrict lamprey currently rearing in the ponds and that have metamorphosed from ammocoetes to juveniles from leaving the ponds on their migration to the ocean. Additionally, the controlled outlet will restrict movement of ammocoetes from Dean Creek into the ponds to rear. These potentially negative effects from implementation of the HCP are considered to be an acceptable trade-off with positive effects to salmonids. Allowing unrestricted access and relatively uncontrolled discharges would continue to subject covered salmonid fish species to lethal temperatures and low DO concentrations in the ponds, as well as unmanaged temperature, DO, and turbidity impacts in Dean Creek.

6.10.3.4 Wetland Habitat

Although juvenile river lamprey use off-channel habitat for rearing, the reconfigured outlet of Pond 5 would restrict juvenile river lamprey from accessing the wetland habitat on the Daybreak site during most flows. Creation of approximately 32 acres of emergent wetlands is expected to increase the overall productivity of aquatic habitat on the site. Increased productivity will release more food items to Dean Creek, benefiting river lamprey ammocoetes, which could be present in the stream. Therefore the increase in wetland habitat will have a positive effect on river lamprey ammocoetes.

6.10.3.5 Predation and Competition

Larval and juvenile river lamprey are believed to be preyed upon by a large number of fish and bird species. Distribution of ammocoetes into rearing habitat is presumed to be through passive drifting. Installation of a control structure on Pond 5 to restrict flow of Dean Creek water into the pond will likely restrict ammocoetes from entering the Daybreak ponds. Therefore the HCP will have a positive effect on larval river lamprey rearing in Dean Creek or the East Fork Lewis River by reducing their exposure to predation by non-native species.

6.11 EFFECTS OF PROJECT OPERATIONS AND CONSERVATION MEASURES ON OREGON SPOTTED FROG (*RANA PRETIOSA)*

The following analysis is limited to Oregon spotted frog. The Oregon spotted frog is a federal candidate for listing under the ESA and a state endangered species. Oregon spotted frogs have not been observed within the HCP area or anywhere else in Clark County, but the Daybreak site is within the historical distribution of this species. Although not known to be present on the site there is a potential for this species to occur or to re-colonize this area. In this section, separate analyses are presented for the major life-history stages of egg-laying/incubation, and larval/adult rearing. Detailed information concerning specific life history characteristics and habitat requirements is presented in Technical Appendix A.

6.11.1 Oregon Spotted Frog Egg-Laying and Incubation

Oregon spotted frogs are not believed to be present in the HCP area. In other areas of Washington State where they are present, they are found in ponds, stream edges, and adjacent flooded fields. This species breeds during February or March. Oregon spotted frogs breed in areas with low-growing vegetation and shallow water. Eggs are laid in clusters near the surface of the water. These breeding areas are often flooded only seasonally and the eggs are thus most susceptible to desiccation and freezing (McAllister 1999). Steep banks and forested habitat could restrict access to preferred spawning sites. The larval frogs, or tadpoles, hatch within 2 to 4 weeks, and they then congregate in the warmest parts of the water where they feed on algae, detritus, and bacteria. Tadpoles are preyed upon by a variety of fish species, great-blue herons, garter snakes, and non-native bullfrogs.

6.11.1.1 Groundwater

Because Oregon spotted frogs lay their eggs near the water surface (in contrast to salmon, which lay their eggs in gravel), incubation is not especially dependent on groundwater flow. Nonetheless the hydrogeologic analysis indicates that implementation of the HCP will not significantly impact groundwater flows, and no effects on breeding and incubating Oregon spotted frogs are anticipated.

6.11.1.2 Water Quantity and Quality

Implementation of the water management plan and restricting inflows from Dean Creek to the pond system will increase instream flows in Dean Creek during the fall and winter. This is expected to have no effect on potential breeding and incubating Oregon spotted frogs.

Although implementation of this HCP is expected to maintain or reduce summer water temperatures in Dean Creek, it is not expected to affect winter water temperatures that would be experienced by breeding and incubating frogs. Therefore there will be no effect on potential breeding and incubating Oregon spotted frogs.

Because adult Oregon spotted frogs primarily breathe atmospheric oxygen, DO is not considered to be a limiting factor. However, eggs and tadpoles rely on DO in the water. Because incubation occurs during a relatively cold period of the year when DO concentrations are typically at saturation, DO is also not considered to be a limiting factor for incubation. Implementation of the HCP and impacts to DO levels will have no effect on potentially breeding or incubating Oregon spotted frogs.

Turbidity in the Daybreak ponds and in the outlet of Pond 5 is expected to be significantly reduced under the HCP. This is expected to have a positive effect on breeding or incubating Oregon spotted frogs potentially located along the edges of the ponds or in Dean Creek downstream of the Pond 5 outlet.

6.11.1.3 Wetland Habitat

Implementation of the HCP will create approximately 32 acres of emergent wetlands. This will increase the amount of habitat suitable for Oregon spotted frogs at the Daybreak site.

6.11.1.4 Predation and Competition

The existing ponds contain a variety of native and non-native predators, including the non-native bullfrog, which is a known predator of Oregon spotted frog. Expansion of shoreline and wetland habitat within the Daybreak site will provide more habitat and better cover for this predator, which could have a negative effect if Oregon spotted frogs are present on the site.

6.11.2 Oregon Spotted Frog Larval and Adult Rearing

Oregon spotted frogs typically hatch during March or early April. The tadpoles seek out warm water and eventually move out of the seasonally inundated breeding areas and into more permanent edge habitat. Tadpoles typically metamorphose during mid-August of their first summer and begin to breed at age three (Nussbaum et al. 1983). Tadpoles are primarily herbivorous, whereas adults feed on invertebrates near the water's edge. During the winter, adult frogs hibernate in muddy substrates.

6.11.2.1 Groundwater

Rearing Oregon spotted frogs are not directly dependent on groundwater flows and expanded mining and implementation of this HCP will not significantly impact groundwater flows. Thus, there will be no effect from hydrogeology on rearing Oregon spotted frogs.

6.11.2.2 Surface Water Quantity and Quality

Development of additional gravel ponds on the Daybreak site will increase surface outflows from the pond system to Dean Creek. Since frog habitat is not dependent on flow levels, this is expected to have no effect on rearing Oregon spotted frogs potentially present in Dean Creek.

Implementation of this HCP will maintain or reduce water temperatures in the existing ponds. Increased canopy cover over Dean Creek and controlled discharges from Pond 5 are expected to maintain or reduce water temperatures in Dean Creek in the reach adjacent to the Daybreak site. Reduced water temperature as a result of implementation of the HCP will have a positive effect on Oregon spotted frogs that are potentially present in the existing or created ponds or in Dean Creek.

Adult Oregon spotted frogs primarily use atmospheric oxygen, and the larval frogs “breathe” DO through their mouths and internal gill structures. Both life stages also uptake a portion of their oxygen requirement through the skin surface. The upper layers in the ponds maintain DO concentrations at or near saturation throughout the year. Implementation of the HCP will not affect this and therefore will not affect Oregon spotted frogs that are potentially rearing in the ponds and Dean Creek.

Historically, the high levels of suspended sediments in the ponds may have potentially impaired tadpole rearing and respiration, or affected adult rearing by abrading their skin’s protective mucus layer. Implementation of a clarification system has significantly reduced turbidity in the ponds and in the Pond 5 discharge. Further, implementation of a closed-loop clarification system as proposed under this HCP should substantially reduce or eliminate the discharge of turbid water from the processing operations. Finally, a Storm Water and Erosion Control Plan and Storm Water Pollution Prevention Plan will be implemented. As a result, turbidity should be substantially reduced in the discharge of water from Pond 5. As a result of these measures, there will be a positive effect on Oregon spotted frogs that are potentially rearing in the ponds and Dean Creek.

6.11.2.3 Wetland Habitat

Implementation of the HCP will create approximately 32 acres of emergent wetland. This will increase the amount of habitat suitable for Oregon spotted frogs rearing at the Daybreak site.

6.11.2.4 Predation and Competition

The existing ponds contain non-native predators such as largemouth bass and bullfrog that would be expected to prey on rearing larval and adult Oregon spotted frogs. The current species assemblage will not be altered by excavation and reclamation of the new ponds, but the addition of approximately 32 acres of wetlands and 38 acres of ponds could increase the number of predators, which would detrimentally affect Oregon spotted frogs potentially rearing within the Daybreak site.

6.12 QUANTIFICATION OF TAKE

This section identifies and discusses the mechanisms by which “take” may occur under the covered activities and provides estimates of the amount of take that may occur. For a more detailed description of the ESA of 1973, as amended, please refer to Section 2.1.1.

6.12.1 Definition of Take

Take as defined by the ESA means, “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct” 16 U.S.C. § 1532(19).

6.12.2 Definition of Harm

The USFWS, by rule, has defined “harm” to mean, “an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering” 50 C.F.R. § 17.3. Similarly, NOAA Fisheries has defined “harm” by regulation as, “an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, *spawning*, *rearing*, *migrating*, feeding or sheltering” (emphasis added).

6.12.3 Definition of Harass

The USFWS has defined by regulation the term “harass” as, “harass in the definition of ‘take’ in the Act means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" 50 CFR § 17.3.

6.12.4 Estimation of Take

The HCP is designed to avoid take that might otherwise result from Storedahl's activities covered by the ITP. No take is expected to result from Storedahl's day-to-day mining and processing activities, or from most of the reclamation and habitat enhancement activities. One exception is the potential take of Oregon spotted frogs, should they recolonize the area. The likelihood of salmonid or lamprey take is low, but is possible in the event of an avulsion and/or flooding into the existing ponds. Implementation of the HCP's conservation measures is expected to generally result in fewer impacts to covered species than under the existing, baseline conditions.

Although conservation measure CM-17 in the HCP includes methods (e.g., exclusionary fences) designed specifically to avoid take of Oregon spotted frogs, if this species recolonizes the site, take could occur as a result of vehicular injury or mortality, excavation of eggs and/or suitable habitat during expansion of the mining area, and burial of eggs and/or rearing habitat during infill and creation of wetlands. If Oregon spotted frogs recolonize the Daybreak site, predation by non-native species could also result in potential take of Oregon spotted frogs.

The risk of an avulsion into the existing ponds and adverse effects on covered species is part of the existing, baseline conditions. The existing ponds will be subject to continued use for storm water detention and reclamation activities, including the incorporation of fine sediments recovered during aggregate processing and the importation of fill to reconfigure Ponds 1 through 4 for reclamation purposes. In the long term, reclamation of the existing ponds will make the ponds more avulsion resistant, and reduce the time needed for geomorphic recovery from an avulsion, should it occur. Reclamation activities will also reduce habitat for non-native predatory fishes, and are expected to produce a significant increase in wetland acreage, all of which will benefit the covered species. However, since an avulsion is, by definition, "a sudden and unexpected" event, if an avulsion occurred prior to stabilization and establishment of vegetation in and around the existing ponds, the extent of headcutting and the amount of sediment carried downstream from the existing ponds could equal or exceed that expected under the existing, baseline conditions. The dynamic nature of geomorphic recovery in the nearby Ridgefield Pits and the relatively unpredictable timing of an avulsion make the estimation of take under future conditions difficult.

The negative effects of an avulsion would be greatest under the existing, baseline conditions, that is, without implementation of the HCP's conservation measures. For example, infill and reconfiguration of existing Ponds 1 through 4 under CM-08 will significantly reduce the possibility and/or extent of a headcut, and consequently the potential impact to listed species and habitat, should an avulsion occur. Under the HCP, monitoring and mitigation measure MEM-08 will evaluate movement of the river towards the ponds and will allow timely implementation of measures to prevent an avulsion under CM-09, should an avulsion threat develop. Under the existing, baseline conditions, an avulsion through the existing Daybreak ponds could result in habitat modifications and consequently in impaired behavioral patterns that injure or cause mortality to covered species and could result in stranding of covered species. Following an avulsion, the ability of the covered species to use the area for spawning, foraging, or as a source of cover, or refuge, could be diminished by: 1) the extent to which an avulsion alters the amount of spawning (riffle) and rearing (pool) habitat; 2) the extent of a headcut and upstream channel alteration resulting from an avulsion; 3) the extent to which downstream spawning habitat is affected by released fine sediment; 4) the extent of increased surface water (pool) influence on water temperature; 5) the extent that increased slow water (pool) habitat increases exposure to predation on migrating smolts; and 6) the number of fishes stranded in wetlands and ponds following an avulsion. Again, as noted, the covered activities would include continued use of the ponds, deposition of sediments in the ponds, and infill and reconfiguration of the ponds to make them more avulsion ready and reduce the recovery time if an avulsion took place. Some these activities could result in take, but the net result will be that the adverse effects on covered species will be much less under the HCP. Because of the complex relationships between fish use and habitat values, it is difficult, if not impossible, to accurately quantify the numbers of individuals that would be taken during a future avulsion event, despite the use of best available scientific and commercial data. When the number of individual animals to be taken cannot be reasonably estimated, the Services can use habitat as a surrogate to assess the extent of take. The surrogate provides a threshold of anticipated take, which if exceeded, provides a basis for reinitiating consultation.

Potential take of Oregon spotted frogs during ongoing operation, or as a result of predation by non-native species includes the following:

1) Vehicular Mortality

Should Oregon spotted frogs recolonize the Daybreak site, there is the potential for take due to vehicular traffic on Storedahl Pit Road, in the processing area, and on secondary haul roads (approximately 23 acres). However, the HCP includes a conservation measure to survey for the species and to place exclusionary fencing to minimize this avenue of take. In the event that Oregon spotted frogs recolonize the site, potential take is therefore expected to be low, but at unknown numbers of individuals.

2) Excavation of New Ponds

During the excavation of the new ponds at the site (101 acres), there is the potential for take of Oregon spotted frogs, should they recolonize the Daybreak site, as a result of heavy equipment removing topsoil and aggregate. However, if surveys show that the frogs are present, the HCP will require the use of exclusion fences in areas scheduled for mining and reclamation, and seasonally timing these activities to avoid negatively affecting breeding frogs. Therefore, take caused by excavation is expected to be low, but at an unknown number of individuals.

3) Filling and Reconfiguration

The HCP includes infill for reconfiguration of the existing Daybreak ponds, as well as the creation of emergent wetlands in the new ponds (59 acres). If Oregon spotted frogs recolonize the Daybreak site and area of infilling, these activities could result in take through burial of eggs and habitat during reclamation and habitat enhancement activities. However, the exclusionary fencing and timing of activities included in the HCP conservation measures should result in low levels of take, but at an unknown number of individuals. In addition, the creation of emergent wetland habitat will benefit the frogs in the long term, should they recolonize the Daybreak site.

4) Non-Native Predation

Should Oregon spotted frogs recolonize the area, there is the potential for take in the existing and new ponds (102 acres) and the emergent wetlands (32 acres) through predation by non-native species in the ponds. The HCP includes conservation measures to minimize this predation including: a reduction in habitat (e.g., the volume of water in the existing ponds that could support largemouth bass) for non-native predators, restricting access from Dean Creek into Pond 5, targeted harvests of non-native predatory fishes in the Daybreak ponds, and installing signs warning against the dangers of releasing non-native fishes into the ponds. Therefore, the potential for predatory take of Oregon spotted frogs is low, but at unknown numbers of individuals.

Potential take of covered fish species due to activities covered under the ITP are primarily those effects related to an avulsion of the East Fork Lewis River into the existing Daybreak ponds. The effects that could result in take include the following:

1) Spawning and Rearing Habitat from Channel Abandonment

   An avulsion of the East Fork Lewis River into the existing Daybreak ponds under existing, baseline conditions could result in the channel abandonment of 167,409 yd^2 of existing spawning habitat and dewatering of salmonid redds and/or lamprey nests if they are present in the abandoned channel. In addition, there is the potential for the abandonment of 154,711 yd^2 of existing rearing habitat, potentially affecting rearing and/or migratory habitat for any of the HCP covered salmonids that are present, as well as lampreys. Under the HCP/ITP, infilling and reconfiguration of the ponds, and monitoring and preventative actions would decrease the likelihood of an avulsion into the ponds and reduce the adverse effects of an avulsion, relative to existing, baseline conditions.

   Based on WDFW steelhead spawning surveys conducted between 1987 and 2002 during the months of February through June, as many as 53 redds have been counted in the lower East Fork Lewis River downstream of the Daybreak Bridge during a single month. The LCFRB is currently developing a recovery plan for listed salmonids and their data provides additional insight regarding the recent 4-year average return of adults to the East Fork Lewis River (LCFRB 2003). They report the average adult returns (current conditions) to the East Fork Lewis River as 235 fall Chinook salmon, 75 winter steelhead, and 96 summer steelhead. Although chum salmon have been observed only occasionally in the East Fork Lewis River since the 1950s (Section 3.2.1.2), the LCFRB recovery planning process is using a default value of 150 chum salmon for the total Lewis River basin, including the East Fork Lewis River (LCFRB 2003).

To estimate the numbers of fish that the East Fork Lewis River could support under restored or degraded conditions, the LCFRB has contracted with the WDFW and S.P. Cramer and Associates to complete Ecosystem Diagnosis and Treatment (EDT) modeling of the East Fork Lewis River. One of the model outputs is an estimate of the decline in abundance of adult returns to the spawning grounds under degraded conditions in the East Fork Lewis River. The EDT model uses more than 40 reach-specific attributes of habitat conditions, such as flow characteristics, habitat complexity, temperature, and other biotic and abiotic characteristics to predict relative population abundance of adults returning to the spawning grounds under historical, current and degraded conditions. Although an avulsion of the East Fork Lewis River into the Daybreak ponds is not specifically modeled, the EDT model does provide an estimate of relative adult population abundance under severe degradation through the incorporation of hypothetical degradation values for each river reach in the model, including the 1.25 miles of spawning habitat in the East Fork Lewis River between Dean Creek and Mason Creek. Assuming an avulsion results in severe degradation, the model output can be used to project the relative decline, or take, in overall population abundance of adult returns. EDT model results under degraded conditions in the 1.25 mile reach downstream of the Daybreak ponds were provided by Johnston (2003), and the model estimated relative declines in population abundances as follows: fall Chinook salmon at 14.8 percent, winter steelhead at 1.9 percent, summer steelhead at 0.4 percent, and chum at 17.4 percent. Although EDT model results are provided as a percent decline in populations, applying these relative declines to the recent average returns of adults would result in the loss of 35 adult fall Chinook salmon, one adult winter steelhead, one adult summer steelhead, and 20 adult chum salmon (assuming 75 percent of the reported Lewis River chum salmon population is in the East Fork Lewis River). The actual decline in numbers of adults would differ depending on the escapement in any given year. Note however, this potential degradation could occur under existing, baseline conditions. Implementation of the conservation measures included in the HCP will result in a reduction in the potential level of degradation, and therefore a reduced potential for adverse effects on the covered species.

An avulsion under existing, baseline conditions could also negatively affect populations of coho salmon and lamprey species, but at unknown numbers. Although coastal cutthroat trout and bull trout (if present) are not expected to spawn in the mainstem East Fork Lewis River, implementation of the HCP's conservation measures is expected to reduce the overall negative impacts on coho salmon, lamprey, coastal cutthroat trout, and bull trout (if present) in the East Fork Lewis River between Dean Creek and Mason Creek. For this reason, issuance of the ITP is not expected to result in take of such species. Effects of an avulsion through the Daybreak ponds on the lower reach of Dean Creek are not addressed in this section, because the reach is comprised of ponded habitat and does not currently provide habitat suitable for spawning.

2) Headcutting

An avulsion of the East Fork Lewis River into Pond 1 could result in an upstream headcut, and attendant channel destabilization, of up to 4,500 feet (6,667 yd^2) of spawning habitat. If salmonid redds or lamprey nests are present in this reach affected by headcutting, it could result in harm or mortality to those eggs, alevins or juvenile lamprey. These effects from headcutting could occur under the existing, baseline conditions, if an avulsion were to occur. Under the HCP, fill would be placed in the existing ponds to an elevation approximating the thalweg in the East Fork Lewis River, which would reduce the potential for a headcut, magnitude of headcutting, and the potential for adverse impacts to covered species relative to existing, baseline conditions, should an avulsion into the existing Daybreak ponds occur.

The EDT model was used to provide an estimate of the relative decline in abundance under degraded conditions in the East Fork Lewis River between Manley Creek, just upstream of the Daybreak Bridge, to Dean Creek. Approximately one-third of this reach could be subjected to headcutting if an avulsion occurs. The EDT model estimated relative declines in population abundance, or take, under degraded conditions in the entire reach from Manley Creek to Dean Creek as: fall Chinook salmon at 7.9 percent, winter steelhead at 0.3 percent, summer steelhead at 0.1 percent, and chum at 2.6 percent. Although EDT model results are provided as a percentage decline in populations, applying these relative declines to the recent average returns of adults would result in the loss of 19 adult fall Chinook salmon, one adult winter steelhead, one adult summer steelhead, and 3 adult chum salmon (assuming 75 percent of the reported chum salmon population in the Lewis River is in the East Fork Lewis River). The actual decline in numbers of adults would differ depending on the escapement in any given year. Note however, this potential degradation could occur under existing, baseline conditions. Implementation of the conservation measures included in the HCP will result in a reduction in the potential level of degradation and, therefore, a reduced potential for adverse effects on the covered species. Because issuance of the ITP and implementation of covered activities would reduce such impacts, no take is expected.

Headcutting resulting from an avulsion under existing, baseline conditions could also negatively affect populations of coho salmon and lamprey species, but at an unknown number. Although coastal cutthroat trout and bull trout are not expected to spawn in the mainstem of the lower East Fork Lewis River, implementation of the HCP conservation measures is expected to reduce the overall negative impacts associated with a potential headcut on coho, lamprey, coastal cutthroat trout, and bull trout (if present) in this reach of the East Fork Lewis River.

3) Fine Sediments and Channel Stability

Under the HCP/ITP, covered activities would result in the infilling of the existing ponds with approximately 300,000 yd^3 of materials. If an avulsion occurred before these activities were complete and rooted vegetation was established, then some of these materials could be washed into the East Fork Lewis River, and could result in increased adverse effects above the baseline and "take" of covered species. An avulsion of the East Fork Lewis River into the existing Daybreak ponds could result in the short term (i.e., days) deposition of up to 120,300 tons of sand-sized and larger particles (an unknown fraction of which would be from the HCP infill materials) within the 1.25 miles of spawning habitat (52,719 yd^2) in the East Fork Lewis River downstream of Dean Creek, potentially smothering an unknown number of redds, if they are present. Depending on the timing of the avulsion, this could adversely affect Chinook salmon, steelhead, coho salmon, and chum salmon redds and/or lamprey nests and result in take of eggs, alevins and/or juvenile lamprey. The number of fishes, and relative population abundance decline of adult returns would be incorporated into the estimated numbers provided in 1) Spawning and Rearing, above.

Sediment capture in the avulsed ponds could result in a reduced supply of bed material to the downstream reach, increasing channel instability and habitat degradation downstream from the avulsed ponds, and potentially negatively affecting spawning, rearing and migration habitat of Chinook salmon, steelhead, coho salmon, chum salmon, and lamprey. Channel instability could also negatively affect the migration of adult coastal cutthroat trout and straying adult bull trout (if present).

These degradation effects could continue for 3 decades under the existing, baseline conditions, should an avulsion occur (Technical Appendix C, Addendum 1). Following implementation of the HCP's conservation measures, the recovery estimate for the avulsed ponds is 5 years; hence, the HCP will reduce the potential for long-term adverse effects of an avulsion on the covered species.

4) Temperature

Based on monitoring of the Ridgefield Pits, an increase in surface water area could result in locally increased surface water temperatures. Increased summertime water temperatures in the avulsed reach and the area immediately downstream of the open water area may result in adverse effects as a consequence of delayed upstream migration of adult salmonids and lamprey and reduced cool water habitat available for holding adults, which could harm the covered salmonids and lamprey.

An avulsion of the East Fork Lewis River into the existing Daybreak ponds could result in as much as 64 acres of open water (pools) subject to solar warming that are directly connected to the East Fork Lewis River. Following implementation of the HCP conservation measures, the total open water area subject to solar warming at the Daybreak site will be increased to 102 acres. As noted elsewhere, it is highly unlikely that the area of expanded mining would be subject to an avulsion, since to avulse into this area the East Fork Lewis River would have to first avulse through local housing, utility corridors, and roads, or through the existing ponds and from there into the new ponds. However, the area of the existing ponds that would be in direct connection to the East Fork Lewis River (if an avulsion were to occur) will be reduced under the HCP from 64 acres to 38 acres, and is expected to reduce the potential for future adverse effects, relative to existing, baseline conditions. The potential effects resulting from increased temperatures is incorporated into the previously estimated population declines in the downstream reach discussed in 1) Spawning and Rearing, and in the reach from Manley Creek to Dean Creek discussed in 2) Headcutting. However, because these effects on temperatures would be reduced from the existing baseline conditions, issuance of the ITP is not expected to result in take of the covered species.

5) Predation

An avulsion of the East Fork Lewis River into the existing Daybreak ponds could increase the amount of favorable habitat in the river for native and non-native predatory fishes, resulting in increased predation on smolts and juvenile lampreys as they migrate through captured pool habitat (approximately 64 acres under existing conditions), albeit at unknown numbers. Under the HCP/ITP, the area available to predatory fishes in the existing ponds would be reduced to a total of 38 acres. Because these effects would be reduced from the existing, baseline conditions, no "take" from predation is expected following an avulsion as a result of issuance of the ITP.

Although an avulsion could also result in the release of an unknown number of native and non-native predatory fish residing in the ponds into the East Fork Lewis River, available habitat for these fishes in the river is expected to already be fully occupied by the same predatory species. Predation is also one of the attributes incorporated into the EDT model and, therefore, resulting impacts from increased predation is incorporated into 1) Spawning and Rearing and 2) Headcutting for the avulsed reaches. Again, because the HCP's conservation measures would reduce predation relative to the existing baseline condition, issuance of the ITP is not expected to result in take of the covered species.

6) Stranding, Collection and Capture

An avulsion of the East Fork Lewis River into the existing Daybreak ponds could result in stranding of fishes in the abandoned river channel, the wetlands associated with mining, reclamation and habitat enhancement, and possibly within the avulsed ponds, albeit at unknown numbers. Under the HCP/ITP, the risk of an avulsion into the existing ponds would be reduced. Further, should an avulsion occur, the period during which the ponds are filled, and recover to function as channel area, would be reduced from 3 decades under the existing, baseline conditions to 5 years under fully reclaimed conditions. However, under the HCP/ITP the capture, collection and transfer of stranded fishes to the main channel would be considered take even though the goal would be to return collected fishes to the main channel, and the impact of the take would likely be beneficial in comparison to the existing condition. The number of covered fishes subject to take due to stranding, capture, collection and transfer, is unknown, but stranding could occur in 167,409 yd^2 of spawning and 154,711 yd^2 of existing pool habitat, as well as the 64 acres existing ponds and wetlands to be created. Further, as noted, stranding would likely occur under existing, baseline conditions and the impact of the take identified would improve conditions in comparison to the existing baseline conditions.

Potential take related to flooding includes:

1) Predation

Under existing, baseline conditions, flooding in the East Fork Lewis River at a 2 to 5-year return flow provides fish access to Pond 5 as the river water spreads out and backs into the pond. Juvenile fish that enter Pond 5 have the potential to be preyed on by native and non-native predaceous fishes resident in Pond 5, as well as the potential for escapement of the predatory fishes from the pond to Dean Creek and the East Fork Lewis River. Implementation of HCP conservation measures will reduce the potential for covered species to enter Pond 5 to flood events greater than the estimated 17-year return flow. Because the HCP/ITP improves conditions in comparison to the baseline conditions, no take would occur.

2) Stranding

During flooding events in the East Fork Lewis River greater than the 10-year return flow, there is the potential for covered fish species to be stranded in the existing Daybreak ponds, depressions in the cultivated fields, and in the wetlands outside the CMZ. Although most fishes are expected to leave the site as the river begins to recede, some fishes may remain trapped in the existing ponds, depressions, and wetlands. Once trapped, these fish may be subject to predation, turbidity effects, and increasing water temperatures during the following summer, and attendant physiological stress, harm, injury, or death. It is anticipated that most if not all of these fish trapped in the ponds would leave the ponds during a 17-year return flow event (or greater), but at lesser flows such fishes may be subject to mortality. The estimated habitat units include the existing ponds (64 acres), the Phase 1C, 1D, and 2 wetlands (approximately 27 acres), and depressions in the existing on-site cultivated fields. However, the potential for covered species to enter the existing ponds and become stranded where they could be subject to mortality would decrease under the HCP. Under the HCP, the total area and volume of the existing ponds would be reduced and Pond 5 berm heights would be increased thereby reducing the likelihood of covered species entering the existing Ponds and becoming stranded. Because the adverse effects associated with stranding under the HCP would be reduced, no take is anticipated as a result of covered activities under the HCP.

The effects noted above primarily relate to existing conditions. The potential for and magnitude of adverse effects that may occur under the existing, baseline conditions would be significantly reduced, but not necessarily eliminated, following implementation of the HCP's conservation measures. As noted above, the conservation measures are designed either to (i) ameliorate or minimize potential adverse effects arising from existing, baseline site conditions, or (ii) avoid take, or minimize and mitigate the impact of take to the maximum extent practicable, that may arise from covered activities. HCP Sections 6.2 through 6.11 provide detailed information regarding the potential effects of the HCP activities on each of the covered species, at each of their major life stages.

CONTENTS

TABLES

7. COSTS AND FUNDING OF THE CONSERVATION, MONITORING, AND RESEARCH MEASURES

7.1 INTRODUCTION

Under Section 10(a)(2)(A) of the ESA and regulations promulgated thereunder (50 C.F.R. §§17.22[b][1], 17.32[b][1], and 222.22), an HCP submitted in support of an incidental take permit must establish "the funding that will be available to implement such steps (the applicant will take to monitor minimize, and mitigate the impacts from the proposed taking)." The USFWS and NMFS HCP Handbook states that "whatever the proposed funding mechanism is, failure to demonstrate the requisite level of funding prior to permit approval . . . [is] grounds for denying a permit application."

In view of the recent listing of Pacific Northwest species such as the steelhead trout and Chinook salmon, and the potential for future listings under the ESA, Storedahl re-evaluated its aggregate mining and gravel processing activities. Storedahl prepared this HCP to memorialize its voluntary commitments to conserve and enhance fish and wildlife habitat and to support its application for an Incidental Take Permit. These actions will assist Storedahl in gaining certainty over its ability to meet the current and future demand of its customers. In many cases, existing practices, regulations, and mitigation efforts developed through other authority and proceedings served to satisfy requirements of the ESA. In other cases, new conservation measures were developed to ensure that Storedahl's activities are in compliance with the ESA.

The conservation measures identified by Storedahl in Chapter 4 are intended to avoid take and to minimize, or otherwise mitigate to the maximum extent practicable the impacts of take associated with aggregate mining and gravel processing activities.

Storedahl will provide such funds as may be necessary to carry out its obligations under the HCP and the Implementing Agreements. Storedahl will notify the USFWS and NOAA Fisheries if Storedahl's funding sources, revenue streams, or financial well being has materially changed. Such notification will include a discussion of the nature of the change from the information provided herein.

7.2 ESTIMATED COSTS OF THE HABITAT CONSERVATION MEASURES

The estimated cost of the conservation measures, including measures developed to meet state and local requirements as well as conservation measures developed specifically as part of this HCP will total over 11.5 million dollars depending on the results of monitoring and the need for adaptive management (Tables 7-1 and 7-3). The two major costs of the habitat conservation measures are a one million dollar endowment fund and extensive improvements to the wash water treatment process. The endowment will provide funding for monitoring and management of the site following the completion of mining and reclamation. The installation of a closed-loop clarification system will enable Storedahl to achieve water quality levels beyond those required by existing state and local permits and reclamation activities. Further, the level of commitment set forth in the HCP will leave the property in a condition that creates and enhances fish and wildlife habitat and supports efforts by Clark County to establish a greenbelt along the East Fork Lewis River. Approximately two million dollars of the total estimated costs represent monies to implement engineering solutions to reduce or prevent the probability of avulsion, as well as provide a source of monies to respond to any unexpected avulsion event. The actual occurrence of such events is believed to be unlikely over the term of the HCP (Technical Appendix C). As discussed in Chapter 4 (CM-05), the endowment will be generated by a surcharge on the aggregate mined and the interest accrued on that surcharge, and is expected to reach one million dollars by the end of the eleventh year of the ITP. The total endowment, including accrued interest could reach more than two million dollars by the twenty-fifth year. This money could be used to prevent or respond to an avulsion or as the interest accrues, used for other ecological needs as discussed in Chapter 4 and stipulated in the IA and ITP.

The costs of this HCP represent Storedahl’s commitment to manage its Daybreak operations in a manner that supplies the construction needs of the Portland-Vancouver Metropolitan Area while, at the same time, provides substantial conservation and enhancement of fish and wildlife habitat in the East Fork Lewis River basin.

7.3 ESTIMATED COSTS OF THE MONITORING PROGRAM

As described in Chapter 5, Storedahl will implement a compliance monitoring program to ensure that conservation measures are implemented according to specified standards. Effectiveness monitoring will provide information to improve the performance of measures where Storedahl is responsible for ensuring results.

In most cases, monitoring consists of verification that the conservation measures have been funded or implemented as specified (Tables 7-2 and 7-3). Project completion reports or periodic summaries of activities conducted specific to each measure will be prepared and submitted as described in Chapter 5. Changes to conservation measures as a result of monitoring efforts may increase Storedahl's operational costs. It is difficult to predict the extent of changes to the conservation measures that may be necessary; however, acceptable alternative approaches with known costs have been specified in the measures where possible. Estimated monitoring costs over the term of the HCP will total almost $600,000.

7.4 PROPOSED FUNDING TO IMPLEMENT HCP

Storedahl conservatively estimates that the wholesale value of the minerals (sand and gravel) at the Daybreak Site, less the costs of extracting and processing the sand and gravel at the Daybreak site, exceeds the conservation, habitat enhancement, and monitoring commitments set forth in the HCP. The mining process itself will be used to create various habitat features set forth in the HCP. Further, the Washington Surface Mining Act, RCW 78.44.087, requires that an acceptable performance security be posted in favor of the Washington DNR before a mining reclamation permit may be issued. This security may include secured interests in real property, letters of credit, deposits, surety bonds, and the like.

Several circumstances ensure that Storedahl will have funding available to implement the HCP. First, mining will take place sequentially; secondly, conservation activity will generally take place sequentially following mining activity (Table 7-3); third, financial assurance to undertake mining reclamation activity must be filed by Storedahl in favor of the DNR to account for land disturbance activity anticipated to take place within the next 12 to 24 months (as required by the Washington Surface Mining Act); and fourth, anticipated revenue streams far exceed the costs of implementing the HCP. Funding will clearly be available to conduct all proposed conservation, enhancement, preservation, and monitoring activity during the term of the HCP.

With regard to long-term habitat enhancement, once mining is substantially completed as set forth in mining plans and the HCP, and the necessary conservation, enhancement and reclamation activities are implemented, Storedahl will convey a perpetual conservation easement(s) to one or two appropriate not-for-profit entity(s) whose primary purpose is the preservation, conservation, and management of fish and wildlife habitat. The conveyance of the conservation easement(s) may occur sequentially, as the property is reclaimed. However, the final conservation easement will not be conveyed unless and until all mining and the habitat enhancement and reclamation are completed. Once the conservation easement(s) for all of the various parcels has been conveyed, Storedahl will grant the property, in fee, to an appropriate conservation organization(s), and preferentially to the entity that holds and implements the conservation easement(s). A dedicated conservation endowment fund will then be transferred to the entity(s) holding the conservation easement or title in fee.

The endowment fund will be used to conduct all monitoring and contingent activity once mining is completed. Storedahl will provide one million dollars as principle to this endowment fund to ensure that all activities are covered after mining is completed, currently anticipated to be year 15 of the HCP. Principle and interest in this fund should be available to undertake conservation activity well after the full term of the HCP is complete.

Table 7-1. Total costs of and cost assumptions of conservation measures to be implemented under the J.L. Storedahl & Sons HCP.

Measure #	Description	Assumptions	Total Cost
CM-01	Wash Water Clarification Process	In-pond treatment system alternative Operational cost = $388,000 per year (2 years) Closed-loop treatment system alternative Capital cost = $500,000 Operational cost = $220,000 per year (13 years)	$776,000 $3,360,000
CM-02	Storm Water and Erosion Control Plan and Storm Water Pollution Prevention Plan	Costs are over and above costs required by current mining and reclamation plans $31,000 per year (through year 15)	$465,000
CM-03	Donation of Water Rights	Total value of water rights donated to the State Trust for instream flow at $1,500/acre ft.	$495,000
CM-04	Water Management Plan	Cost are for construction of outlet control structure, spillway, reconfiguration of shoreline, and pump/conveyance system for release of water to Dean Creek Capital cost =$45,000 Operational cost =$500 per year (25 years)	$57,500
CM-05	Conservation and Habitat Enhancement Endowment	Funds will be generated by a surcharge leveed on each ton of sand and gravel	$1,000,000 plus any accrued interest
CM-06	Native Valley-Bottom Forest Revegetation	Assumes 45 acres will be planted using paid labor	$145,000
CM-07	Floodplain reestablishment between Dean Creek and the Phase 6 and 7 Ponds	Includes cost of backfilling to create a 200-foot wide vegetated buffer zone	$77,000
CM-08	Mining and Reclamation Designs to Ameliorate Negative Effects of Potential Avulsions of the East Fork Lewis River into the Existing or Proposed Gravel Ponds	Includes the cost of substantially narrowing the existing ponds, import place and surcharge 300,000 cubic yards of fill, placement of fines for emergent wetlands, creation of islands and grading 40 acres at $1.50/cubic yard plus planting using paid labor at $130,000	$580,000

Table 7-1. Total costs of and cost assumptions of conservation measures to be implemented under the J.L. Storedahl & Sons HCP.

Measure #	Description	Assumptions	Total Cost
CM-09	Contingency Plan for Potential Avulsion of the East Fork Lewis River into the Existing or Proposed Gravel Pond	Implement avulsion prevention (potential cost unlikely to be incurred) • 40 stacks of logs placed on the floodplain • Plant trees and woody shrubs at sites G, H, and J • Rip-rap 2,600 feet of bank from Site G to H: 2:1 sideslope, 10 foot tall, 42" thick • Two trapezoidal avulsion sills in abandoned channel from Site G to H • Five trapezoidal rock barbs from Site G to H • Engineering designs and contingency = 20% of materials	$465,000
		Respond to unexpected breach at Site G (potential cost, unlikely to be incurred) • 300 foot wide by 15 foot high break in Storedahl Pit Road (30 foot roadway with 2:1 sideslopes) • Fill material $325,200 • Engineering design and contingency = 20% of materials • Evaluation and response to stranded fish = $20,000 • Evaluation of redirecting flow and pre-avulsion channel = $15,000 • Modify conservation/monitoring measures = $7,000	$440,000

Table 7-1. Total costs of and cost assumptions of conservation measures to be implemented under the J.L. Storedahl & Sons HCP.

Measure #	Description	Assumptions	Total Cost
CM-10	Study of the Ridgefield Pits and East Fork Lewis River	Study components include: • Habitat survey of East Fork Lewis River RM 5.9 to RM 10 in years 1, 5 and 10 = $9,500/yr • Underwater surveys of fish species and distribution during 1, 2, 5 and 10 = $6,500/yr • Monitoring of temperature and DO in years 2, 5 and 10 = $5,000/yr • Repeat bathymetry surveys to assess pool volume and infill rate in years 5 and 10 = $10,000/yr • Preparation of detailed study plan, and annual reports/presentations to Services in years 1, 2, 5 and 10 = $18,000/yr	$161,500
CM-11	Off-Site Floodplain Enhancement	Materials and/or in-kind services to be provided for lower East Fork Lewis River enhancement projects = $25,000 per year (10 years)	$250,000
CM-12	Conservation Easement and Fee-Simple Transfer	Estimated value of property to be gifted	$3,000,000
CM-13	Riparian Management Zone on Dean Creek	Cost represents revenue lost by expanding buffer (inner zone) from 50 to 75 feet (80,000 tons @$2.00/ton)	$160,000
CM-14	In-Channel Habitat Enhancement in Select Reaches of Dean Creek	Bank Stabilization • Planting costs included in CM-05 • Bank stabilization requires placement of 4 logs ($400 per log) at 2 sites. • Transport/Placement conducted by Storedahl personnel • Biologist planning, oversight and permit application • Contingency/Coordination with Services $1,200	$6,000

Table 7-1. Total costs of and cost assumptions of conservation measures to be implemented under the J.L. Storedahl & Sons HCP.

Measure #	Description	Assumptions	Total Cost
CM-14 (cont)		LWD Placement in year 5 • Assume 20 logs @$400 per log • Biologist planning, oversight and permit application • Transport/Placement conducted by Storedahl personnel • Contingency/Coordination with Services $2,000	$13,000
CM-15	Shallow Water and Wetland Habitat	Wetland Planting • Grading/clearing done as part of CM-08 • Plant 56 acres (2/3 of 84 total) at cost of $6,000/acre • Plantings at 3 foot centers requires 4960 plants per acre at $1.00 each • Worker @ $10.00 per hour plants 20 plants per hour	$346,000
		Structural Habitat Elements • 20 pieces of LWD per pond x 5 ponds=100 pieces at $250.00 per piece • Anchoring materials/equipment $50/piece • Biologist 40 hours for planning, oversight and permit application	$33,000
CM-16	Control of Non-Native Predatory Fishes	• Targeted harvest in years 5, 10, and 15	$15,000
CM-17	Create Habitat Suitable for Oregon Spotted Frog	Habitat creation included in costs for CM-08	NA
CM-18	Controlled Public Access	• Year 1, signs $1,000 • Year 10, parking lots and gravel road $5,000 • Year 15, gates, road rails, re-surface parking lots and roads $15,000	$21,000
TOTAL COST OVER 25 YEARS			$11,866,000 $10,961,000 [1]

[1] Does not include costs of CM-09.

Table 7-2. Total costs of and cost assumptions of monitoring and evaluation measures to be implemented under the J.L. Storedahl & Sons HCP.

MEM		Duration/Frequency		
		HCP Years	**Assumptions**	**Total Cost**
MEM-01	Clarification Process Monitoring	1 through 15 (duration is dependent on operation of processing equipment)	Includes ongoing monitoring of treatment system $16,000 per year for 15 years	$240,000
MEM-02	NPDES Monitoring	1 through 15 (duration is dependent on operation of processing equipment)	$9000 per year for 15 years	$135,000
MEM-03	Water Management Plan Monitoring	1 through 25	Weekly measurement of temperature and discharge by Storedahl personnel $1,000 per year for 25 years	$25,000
MEM-04	Pond, Shallow Water, and Shoreline Physical Structure Monitoring	Following completion of each mining phase and in year 20	$10,000 for post-mining bathymetry in year 15 $1,500 per year for 8 years	$22,000
MEM-05	Vegetation Monitoring	2-10, 15, 20, 25	Mixed forest: 134 acres, 1 transect/5 acres = 24 transects; 6 transects per person/day Wetland: 32 acres, 1 transect/3 acres=10 transects; 5 transects per person/day Total 7 days per year for 12 years $4,600/year	$55,200
MEM-06	Dean Creek Riparian and Channel Condition Monitoring	Years 3, 4 and following high-flow events with a 10-year or larger return interval (assume 3 over 25 year permit)	$2,500 per year for 5 years	$12,500

Table 7-2. Total costs of and cost assumptions of monitoring and evaluation measures to be implemented under the J.L. Storedahl & Sons HCP.

		Duration/Frequency		
MEM		**HCP Years**	**Assumptions**	**Total Cost**
MEM-07	East Fork Lewis River Bank Stability Monitoring	1-25	Prepare detailed study design, install monitoring stations	$5,000
			3 person crew 3 days/year for 24 years	$52,800
MEM-08	Pond Fish Use and Limnological Monitoring	Monthly from May to September for three years total	Measure depth, DO, temp, transparency, fish species $8,000 per year for 3 years	$24,000
MEM-09	Oregon Spotted Frog Monitoring	After confirmation of species in Clark County	$1,300 per year for 3 years	$3,900
MEM-10	Financial Status of Conservation Endowment Monitoring	1-15	$1,000 per year for 15 years	$15,000
TOTAL COST OVER 25 YEARS				$590,400

Table 7-3. Allocation of costs for Daybreak HCP conservation and monitoring measures.

Measure No.	**Description**	**Years 0-25 Capital Costs***	**Years 0-25 Annual Costs**	**Year 0–2 Costs****	**Year 3-15 Costs****	**Year 16-25 Costs****	**Years 0-25 Total Costs**
CM-01***	Wash Water Clarification Process						
	In-pond treatment system	$0	$388,000	$776,000	$0	$0	$776,000
	Closed-loop treatment system	$500,000	$220,000	$500,000	$2,860,000	$0	$3,360,000
CM-02	Storm Water/Erosion Control Plan and Storm Water Pollution Prevention Plan	$0	$31,000	$62,000	$403,000	$0	$465,000
CM-03	Donation of Water Rights	$495,000	$0	$355,500	$72,000	$67,500	$495,000
CM-04	Water Management Plan	$57,500	$500	$46,000	$6,500	$5,000	$57,500
CM-05	Endowment Fund	$0	$66,667 [1]	$140,200	$859,800	$0	$1,000,000
CM-06	Native Valley-Bottom Forest	$145,000	$0	$135,000	$10,000	$0	$145,000
CM-07	Dean Creek Floodplain	$77,000	$0	$77,000	$0	$0	$77,000
CM-08	Avulsion Effects Amelioration	$580,000	$0	$390,000	$190,000	$0	$580,000
CM-09****	Avulsion Contingency Plan						
	Avulsion Protection	$465,000	$0	$0	$0	$0	$0
	Avulsion Response	$440,000	$0	$0	$0	$0	$0
CM-10	Ridgefield Pits Study	$0	differs/year	$63,500	$98,000	$0	$161,500
CM-11	Off-Site Floodplain Enhancement	$0	$25,000	$0	$250,000	$0	$250,000
CM-12	Conservation Easement	$3,000,000	$0	$200,000	$2,800,000	$0	$3,000,000
CM-13	Dean Creek Riparian Management Zone	$160,000	$0	$160,000	$0	$0	$160,000
CM-14	Dean Creek Channel Enhancement	$19,000	$0	$6,000	$13,000	$0	$19,000
CM-15	Shallow Water and Wetland Habitat	$379,000	$0	$180,000	$189,000	$10,000	$379,000
CM-16	Control of Non- Native Fish	$0	differs/yr	$0	$15,000	$0	$15,000
CM-17	Habitat for Oregon Spotted Frog	(MEM-09)	(MEM-09)	$0	$0	$0	$0
CM-18	Control Public Access	$21,000	$0	$1,000	$5,000	$15,000	$21,000
Subtotal Conservation Measures		**$6,338,500**		**$3,092,200**	**$7,771,300**	**$97,500**	**$10,961,000**

Table 7-3. Allocation of costs for Daybreak HCP conservation and monitoring measures.

Measure No.	Description	Years 0-25 Capital Costs*	Years 0-25 Annual Costs	Year 0–2 Costs**	Year 3-15 Costs**	Year 16-25 Costs**	Years 0-25 Total Costs
MEM-01	Clarification Process Monitoring	$0	$16,000	$32,000	$208,000	$0	$240,000
MEM-02	NPDES Monitoring	$0	$9,000	$18,000	$117,000	$0	$135,000
MEM-03	Water Management Plan Monitoring	$0	$1,000	$2,000	$13,000	$10,000	$25,000
MEM-04	Pond, Shallow Water, Shoreline, Physical Structure Monitoring	$0	$1,500	$0	$22,000	$0	$22,000
MEM-05	Vegetation Monitoring	$0	$4,600	$4,600	$41,400	$9,200	$55,200
MEM-06	Dean Creek Riparian and Channel Monitoring	$0	$2,500	$0	$7,500	$5,000	$12,500
MEM-07	EF Lewis River Critical Bank Stability Monitoring	$5,000	$2,200	$7,200	$28,600	$22,000	$57,800
MEM-08	Pond Fish Use and Limnological Monitoring	$0	$8,000	$16,000	$8,000	$0	$24,000
MEM-09	Oregon Spotted Frog Monitoring	$0	$1,300	$2,600	$1,300	$0	$3,900
MEM-10	Financial Status of Conservation Endowment Monitoring	$0	$1,000	$2,000	$13,000	$0	$15,000
Subtotal Monitoring		**$5,000**	**$47,100**	**$84,400**	**$459,800**	**$46,200**	**$590,400**
Total		**$6,343,500**		**$3,176,600**	**$8,231,000**	**$143,700**	**$11,551,400**

* Capital costs are variously allocated through the HCP period. Costs in this column are not included in total for years 0-25, but are allocated into 0-2, 3-15, or 16-25 year periods.

** Costs for years 0-2, 3-15, and 16-25 include capital costs borne during the respective period plus annual costs.

*** Assumes that in-pond treatment will be used for years 0-2 and closed-loop system for years 3-15.

**** Costs are only in case there is threat or occurrence of avulsion.

[1] = year 1 to year 11.

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8. ALTERNATIVES TO THE PROPOSED INCIDENTAL TAKE

8.1 INTRODUCTION

As required under Section 10 of the Endangered Species Act, Storedahl has considered alternatives for avoiding the incidental take that could result from further aggregate mining at the Daybreak Project Site. In addition to this HCP/ITP, three alternatives were identified and are analyzed in detail in the accompanying Environmental Impact Statement (EIS) prepared under the direction of NOAA Fisheries and USFWS. All four alternatives are described below.

8.2 CONTINUED MINING AND IMPLEMENTATION OF THE HCP/ITP FOLLOWED BY TRANSFER OF THE DAYBREAK SITE TO A PRIVATE NON-PROFIT LAND CONSERVATION ORGANIZATION (PREFFERED ALTERNATIVE)

The proposed design of Daybreak Mining and Habitat Enhancement project is based on the goal of extracting a natural resource of great value to the regional community and concomitantly reclaiming the subject property to re-establish historical and enhance existing habitat functions and values of the site. Because of the complexity of the project and multiplicity of interests involved, the proposed design evolved from input and consideration from public regulatory and service agencies and special interest groups. These included the National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Natural Resources, the Washington Department of Ecology, the Washington Department of Fish and Wildlife, Clark County Department of Community Development, Vancouver-Clark Parks and Recreation Department, Friends of the East Fork, Fish First, Pacific Rock Environmental Enhancement Group, and the Daybreak Neighborhood Association.

Mining or processing or both have occurred on the subject property as well as on surrounding properties for at least 30 years. The quality of the gravel resources extracted from the subject and surrounding properties has continuously met or exceeded standards and specifications for public works and private construction projects. Tests and investigations at the subject property indicate that a substantial quantity of the resource exists at the same level of quality sufficient to make extraction efficient and economical. Further, the site is located such that the processed rock material can be conveniently distributed to final use locations throughout the regional market area.

A series of preliminary designs preceded the proposal. These included varying configurations of mining and reclaimed ponds and enhancement of undisturbed areas of the site. These designs ranged from one large lake to a series of large and small ponds of different shapes and sizes. The final design, described in detail in Sections 3.4 and 3.5, reflects Storedahl's intent to: 1) conduct mining on the site in an economical manner; 2) meet or exceed the WDNR's regulatory requirements and standards of mine design reclamation criteria in a manner that will also be conducive to productive on- and off-site aquatic, wetland and terrestrial habitat; and 3) be compatible with the surrounding land uses. It is also designed to connect and expand the open space and greenbelt scheme along the East Fork Lewis River that is being implemented by the Vancouver-Clark Parks and Recreation Department.

Under the proposed alternative, Storedahl will expand the Daybreak mine in an area comprising 178 acres, extracting gravel from approximately 101 acres of that area which is exclusively located outside of the 100-year floodplain. Reclamation activities designed to create and enhance habitat for the covered species, as well as other native species utilizing the site, will be instituted concurrently with the mining activities.

Ongoing public involvement and consultation with the Services will help guide development of the final-use plans. A number of ponds and wetlands, surrounded by re-established native valley-bottom forest habitats will be established. These areas will include the development of amenities (i.e., trails and parking areas) designed to support limited passive recreational features at the Daybreak site and linked to a greenbelt comprised of land acquired by Vancouver-Clark Parks and Recreation and others along the East Fork Lewis River. The reclaimed property would be conveyed in fee to an appropriate private not-for-profit conservation corporation(s), together with a $1 million endowment to cover management and insure its preservation in the reclaimed condition in perpetuity.

8.3 CONTINUED MINING AND IMPLEMENTATION OF A LESS AGGRESSIVE HCP/ITP (ALTERNATIVE 2)

This alternative mining and habitat enhancement plan is also based on the goal of extracting mineral resources at the site and concomitantly reclaiming the subject property to re-establish historical and enhance existing habitat functions and values. Similar to the preferred alternative, this alternative design evolved from input and consideration from public regulatory and service agencies and special interest groups. Under this alternative, Storedahl would extract aggregate resources (i.e., sand and gravel) while concurrently reclaiming, rehabilitating, and enhancing the project site area similar to the preferred alternative, but with fewer and earlier versions of several conservation measures. Open-water ponds, wetlands, and valley-bottom forest would be created to restore native riparian plant communities, and to create fish and wildlife habitat at the project site.

Somewhat different from the submitted proposal, a total of 114 mined acres within the 178-acre expansion area would be sequentially mined reclaimed, rehabilitated, and enhanced. Processing would continue in the 80 acres historically used for processing (assuming approval of pending permits from Clark County), which would be reclaimed when aggregate is no longer available. The enhanced habitat would result from the open water and emergent wetlands created by reclaiming gravel mining areas and natural features of the project site as well as extensive planting of riparian plant communities. The reclamation proposed with this alternative would create and enhance habitat for fish and wildlife and would be designed to provide limited public access to open space for passive recreation. In general, reclamation would involve creating final pond contours, constructing and planting wetland areas on the pond perimeters, placing structural elements such as tree roots, boulders and other large items in the deeper water, and contouring and planting areas that will be revegetated with near-shore wetland and riparian and valley-bottom upland vegetation.

However, a variety of conservation measures in the preferred alternative would be deleted under Alternative 2 and some conservation measures would not be as intensive or extensive as under the preferred alternative. These differences include:

- 14 conservation measures would be implemented under this alternative as compared to the 18 conservation measures associated with the preferred alternative;

- The existing water rights would not be transferred to the State Trust for enhancement of in-stream flow as described in CM-03. Instead these water rights would likely be transferred to another user in the drainage basin;

- Mining would take place to within 50 feet of Dean Creek and a setback levee would be constructed 75 feet distant from the creek to restrict migration of the stream;

- The existing ponds would not be substantially narrowed and reclaimed to resist, accommodate, and minimize a potential avulsion. CM-08 would focus more on reducing the risk of an avulsion by limiting potential channel migration;

- Only about 25 acres of wetlands would be created rather than the 32 acres of emergent wetlands under the preferred alternative;

- Mining would occur on a small parcel southwest of Bennett Road that is outside the 100-year floodplain, but within the area of the channel migration zone.

- This alternative does not include a specific commitment to convey a conservation easement to the site, which would restrict the use of the site and preserve the property as fish and wildlife habitat in perpetuity. Future use of the site would be managed by the receiving entity with the limitations of the ITP expiring at the end of its term;

- Storedahl would not participate in any off-site floodplain enhancement projects related to the protection or recovery of covered species in the drainage basin; and

- Measures to control non-native species would be limited to the construction of a fish access barrier between Pond 5 and Dean Creek and posting signs warning the public of the ecological risks of introducing non-native fish, such as largemouth bass and other species, into the ponds.

8.4 CONTINUED MINING WITHOUT THE HCP/ITP FOLLOWED BY PARTITION OF THE DAYBREAK SITE INTO SEVEN TO TEN PARCELS (ALTERNATIVE 3)

This alternative would include expanded mining operations at the Daybreak site using the current design as described in Sections 3.4 and 3.5. Take of listed species would be avoided without obtaining an ITP and implementing the associated HCP. Concurrent reclamation activities and design features included in this alternative are limited to the subject property and are intended to meet the standards of the Washington Surface Mining Act, the requirements of the NPDES permit issued by the Washington Department of Ecology, and various land development standards of Clark County. This alternative would also include mitigation measures required to offset the environmental effects identified in the state environmental impact statement and for activities not otherwise specifically regulated.

Portions of the property could be partitioned and sold as specific mining phases are completed. Nevertheless, at the completion of mining, or when aggregate is no longer available for processing, the reclaimed site would be partitioned into 7 to 10 water front parcels and sold. This would potentially result in 7 to 10 single-family dwellings on the site.

Many of the conservation measures described in detail in Chapter 4 exceed the requirements of the applicable state and local regulations. The following is a brief discussion of those measures that would not be implemented under this alternative.

- The closed-loop wash water clarification equipment and process described in CM-01 would be eliminated from the proposed development. Instead, process water would continue to be treated as at present with the introduction of additives to maintain turbid water discharges at less than half the level of turbidity allowed under the current NPDES permit.

- Rather than donate water rights to the State Trust for in-stream flow augmentation, as described in CM-03, these rights would be maintained with the property ownership or sold to another user in the drainage basin.

- The Water Management Plan would not be implemented as described in CM-04. Facilities to increase the outflow to Dean Creek during the summer months with cool water from the bottoms of Ponds 3 and 5 would not be installed, and flows in Dean Creek would continue in volumes and at temperatures similar to those observed under existing conditions.

- The $1 million endowment to fund property management, habitat enhancement, and other lower East Fork Lewis River basin enhancement projects would not occur.

- A conservation easement to limit the use of the Daybreak site for conservation and enhancement of fish and wildlife habitat would not be granted to a conservation organization or government entity.

- Conservation measures designed to improve habitat in Dean Creek would not be implemented, including CM-07 and CM-13, and CM-14. While Clark County generally requires a 200-foot separation buffer between disturbance and the creek it would not require any stream, floodplain, or buffer enhancement.

- Although it is likely that Storedahl would implement measures to prevent avulsion if future channel migration resulted in conditions that posed an immediate threat to the property or equipment before mining was completed, no additional avulsion contingency planning or monitoring would occur.

- Studies would not be funded to assess the conditions and fish use in the Ridgefield Pits and East Fork Lewis River.

- Efforts to control the non-native fish in the ponds would not occur, including activities to narrow the existing ponds to reduce habitat area; reduce the frequency of backwater flood flows; harvest of predatory fishes; create barriers between the ponds to restrict fish movement; and install educational signs.

- Finally, because the presence of Oregon spotted frogs on the subject property has not been verified, Storedahl would not conduct breeding surveys if their presence within Clark County were confirmed (CM-16). Exclusion fences designed to restrict the frogs from moving into the mining and reclamation areas would not be installed if the species were found unless such protective measures were required under state or federal law.

8.5 DEVELOPMENT OF THE SUBJECT PROPERTY FOR 20-ACRE RESIDENTIAL/AGRICULTURAL TRACTS (NO MINING, ALTERNATIVE 4)

Under the no mining alternative, Storedahl would not implement the proposed HCP and would not expand mining operations at the Daybreak site. Processing of sand and gravel would continue at the current operation until adequate supplies of raw materials were no longer available for import within an economical haul area, assuming shoreline permits, which are pending, are granted for the existing processing equipment. Subsequent development and uses of the subject property would be guided by the land use regulations assigned to the site by Clark County. Presently, the *Clark County 20 Year Comprehensive Growth Management Plan* designates the property as agricultural lands. The county implements this designation through the Agriculture (AG-20) base zone.

The AG-20 zoning district has a minimum lot size of 20 acres. Permitted uses include a variety of natural resource based activities such as silviculture and agricultural activities, including crop production, feed lot operations, small saw mills with log storage, sorting and chipping facilities, and single family residences.

In Washington State, the division of land into parcels smaller than five acres must be reviewed and approved by the applicable local government. Local governments are authorized to raise that threshold if they deem it appropriate. Clark County regulates the division of land when any parcel resulting from the division would be smaller than 20 acres.

Under this alternative, the subject property would be developed immediately for use consistent with the county zoning. The 300-acre site would be partitioned into 20-acre lots for use as ultra-low density rural residential activities with specialty or limited agricultural activities, or “hobby farms” while a portion of the site would continue to be used to process imported raw mineral resources. Because of the poor soil capability for growing crops other than pasture grasses, the most likely agricultural activity on these farms would be pasture for livestock (e.g., horses or other species).

When the supply of raw materials is exhausted or becomes uneconomical to import, the processing equipment and support buildings would be dismantled and removed from the site. The processing area would be prepared for subsequent use consistent and compatible with the other partitioned tracts as the existing ponds are reclaimed consistent with a reclamation plan approved by the Washington Department of Natural Resources.

This alternative development pattern would be above the threshold for local, state, or federal regulatory review for the entire site. For that reason, there would be no opportunity to guide, shape, or otherwise influence the resulting development patterns other than those items directly related to public health, safety and access. Because of the rural nature of the subject property and vicinity, and the county’s planning efforts to continue that type of land use pattern, public water and sewerage facilities are not and will not be available. Consequently, future residential and agricultural development under this alternative scenario will be dependent on on-site wells for water supply and on-site wastewater disposal systems. Notably, the water rights attendant to the property would most likely be sold or transferred on a pro-rata basis with the land. Public agency regulatory purview would be limited to individual on-site utility systems, private road development, and applicable building permits, with the attendant review for locally regulated critical areas such as wetlands or habitat.

There would be no opportunity to direct the development to include any habitat enhancement activities. Several effects generally adverse to fish and wildlife habitat would result from this alternative development plan. Runoff would increase from the increased impervious surfaces of structures and roads. The livestock manure loading in the pastures and the septic systems would potentially have negative impacts on both ground- and surface water quality. Vegetation would continue to be dominated by pasture grasses or crops with the addition of lawns and other ornamental shrubs around the homes on the property. Pesticides and fertilizers to maintain this ornamental vegetation and potential crops could be transported to streams in storm runoff and would contribute to lower water quality in both Dean Creek and the East Fork Lewis River. Development of these large tracts would remove the subject property from the open space/greenbelt system along the East Fork Lewis River being pursued by the parks department and others. In sum, any opportunities for improving the habitat value of the site would be eliminated, or at least significantly reduced; and in fact, what value the site offers currently would likely be further reduced.

8.6 SUMMARY

The preferred alternative would provide the most net environmental benefits, provide a supply of aggregate materials and achieve the overall project objectives. Alternative 2 would provide considerable environmental benefits and would also provide significant quantities of aggregate resources. However, the environmental benefits under this alternative would not be as great as under the preferred alternative. Alternative 3 would provide significant quantities of aggregate resources and mining would be conducted so as to avoid take of listed species. However, fish and wildlife habitat at the site would not be protected or conserved in perpetuity. Alternative 4 would not achieve the overall project objectives as aggregate would not be mined. Further, fish and wildlife habitat would likely be diminished over the long-term as the property would be developed for residential uses.

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Appendix A

Life Histories for the Species of Concern

APPENDIX A

FIGURES

APPENDIX A
Life Histories for the Species of Concern

A. INTRODUCTION

This appendix provides a description of life history traits, habitat requirements, range and abundance of all species proposed for coverage under the Habitat Conservation Plan.

FISH SPECIES

Salmonids

There are at least five species of anadromous salmonids present in the East Fork Lewis River today. The East Fork Lewis River supports populations of coho (O*ncorhynchus kisutch*), Chinook (*O. tshawytscha*), and chum (*O. keta*) salmon, and steelhead (*O. mykiss*) and coastal cutthroat (*O. clarki clarki*) trout.

The life history of these Pacific salmon species involves constructing nests in the stream in which the eggs are fertilized and incubated. After two to four months of incubation, and up to a year of rearing in freshwater, the juvenile fish migrate to the ocean for feeding and maturation, and then return to the natal streams for spawning and completion of the life cycle. There are many variations on the timing and duration of these life cycles among species, and from year to year for the same species. Figure A-1 provides a summary of the timing of the freshwater life phases of the salmonid species in the Lewis River basin.

Historically, prior to dam construction, anadromous and fluvial bull trout (*Salvelinus confluentus*) populations were present in the Lewis River (WDF and WDW 1993). Bull trout and the closely related Dolly Varden (*S. malma*) are currently only present in the mainstem Lewis River in the reservoirs above Merwin, Yale and Swift dams. However, straying into the East Fork Lewis River may occur. Pacific (*Lampetra tridentata*) and river (*L. ayresi*) lamprey are present in the East Fork Lewis River system, but little information is available on their current status.

The Pacific salmonid species, including bull trout have each been either listed, proposed, or are candidates for listing under the Endangered Species Act (ESA). In order to determine the benefit of protection measures and the effect of activities proposed for coverage under the ESA, an understanding of the life history traits and habitat requirements are needed.

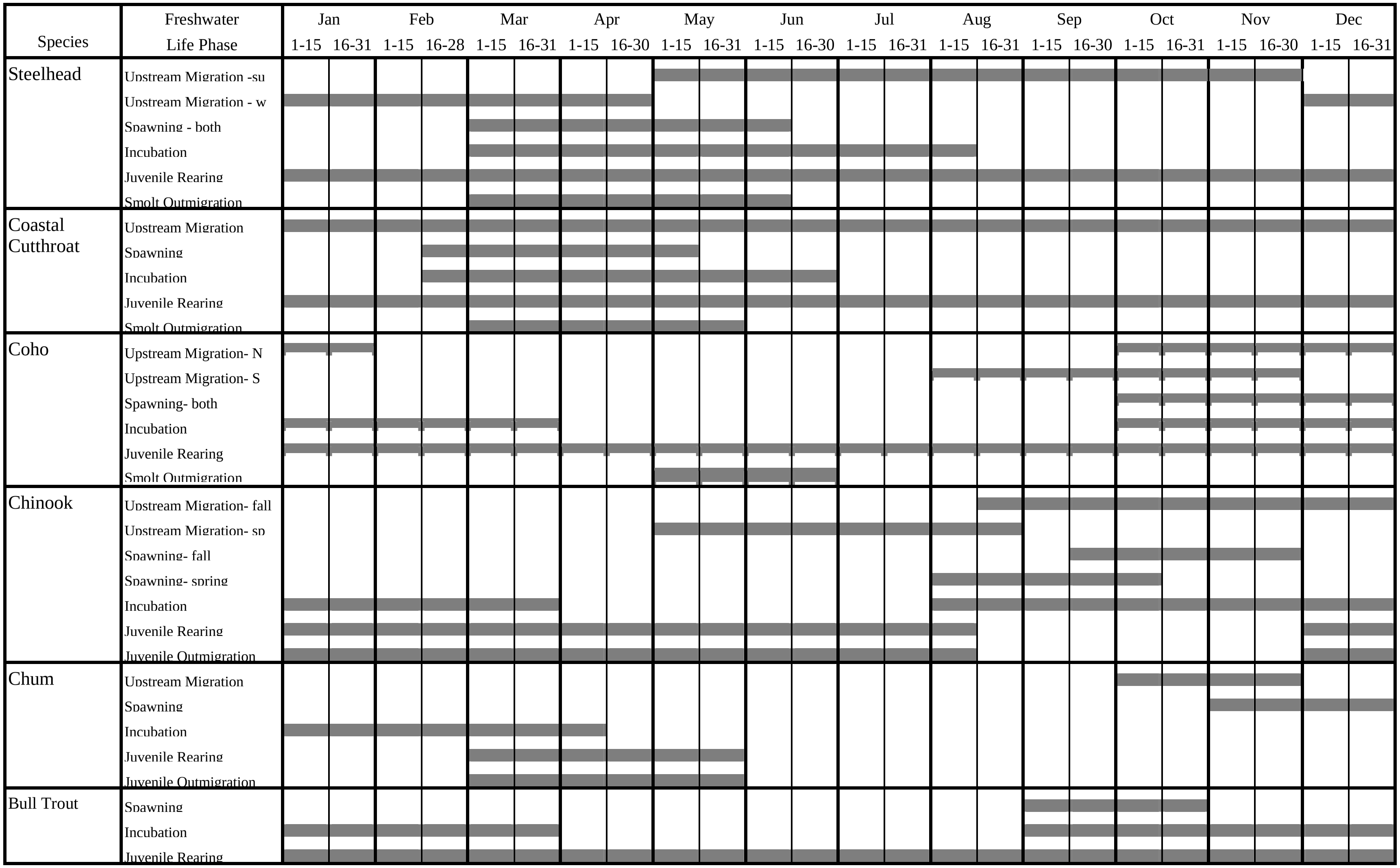

Figure A-1. Temporal distribution of adult and juvenile salmonid habitat utilization in the Lewis River basin, Washington.

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Steelhead (Oncorhynchus mykiss)

Life History and Habitat Requirements

Summer and winter races of steelhead, the anadromous form of rainbow trout, are present in the East Fork Lewis River (Figures A-2, A-3). The two runs are differentiated by the timing of adult returns to natal spawning streams. The juveniles of each run share common behavior patterns (Stolz and Schnell 1991). Winter-run steelhead adults return to the East Fork Lewis River from December through April, and exhibit late stages of maturity upon entering. Summer-run adults generally return to the East Fork Lewis River as immature fish during the period from May through November (WDF and WDW 1993). Native winter- and summer-run steelhead spawning occurs from early March to late May or June.

Adult steelhead, like other anadromous salmon, require holding or resting sites during upstream migration (Spence et al. 1996). Summer-run steelhead are known to arrive at spawning sites months before spawning, or they hold in mainstem rivers for weeks to months before moving into smaller tributaries to spawn (Bjornn and Reiser 1991). Large wood, instream boulders, and other structures create the necessary slow water and pool habitat needed for resting and cover during migration (Spence et al. 1996). The use of cold-water pools for resting could also potentially conserve energy needed for subsequent spawning by lowering the metabolic expenditures of the fish (Spence et al. 1996). This can be especially important for summer-run fish, because they can enter the river up to ten months prior to the spawning season. Steelhead, unlike other salmonids, also need suitable habitat for feeding during their adult freshwater phase. Preferred feeding areas are slower velocity water adjacent to faster water. These areas carry food items to the fish with little need for energy expenditure by the fish (Spence et al. 1996).

Spawning steelhead generally prefer higher gradient locations than Chinook salmon, with fast, relatively shallow water in mainstem or tributary streams (Everest and Chapman 1972). Preferred spawning substrate consists of predominantly large gravel, with some small cobble (Caldwell and Hirschey 1989). Pauley et al. (1986) found steelhead spawning in gravel ranging from 1.3 to 11.4 centimeters in diameter. Adult fish waiting to spawn or in the process of spawning are vulnerable to disturbance and predation in areas without suitable cover that could be provided by undercut banks, submerged vegetation, deep water or turbulence.

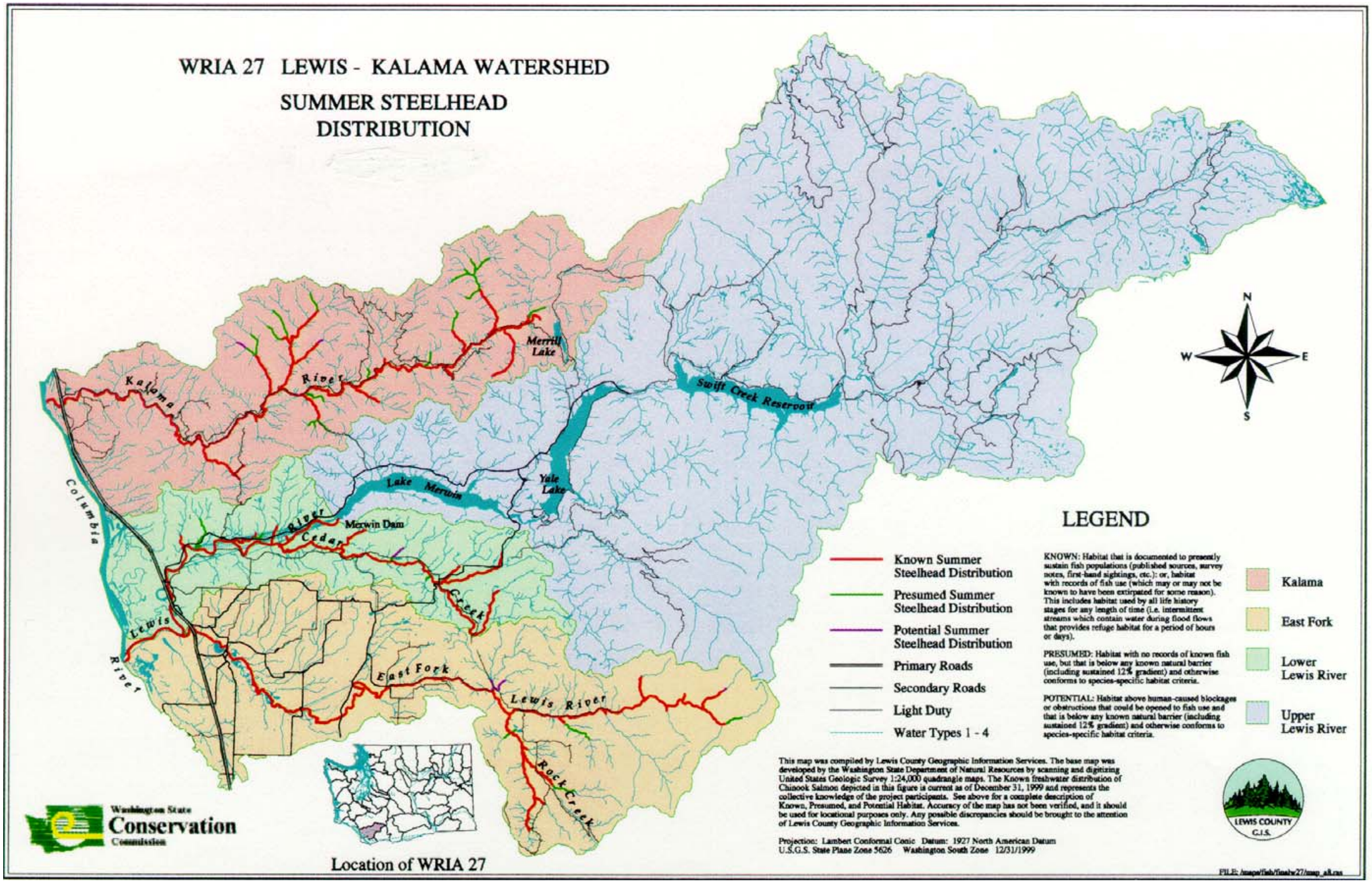

Figure A-2. Summer steelhead distribution in the Lewis-Kalama watershed (WCC 2000).

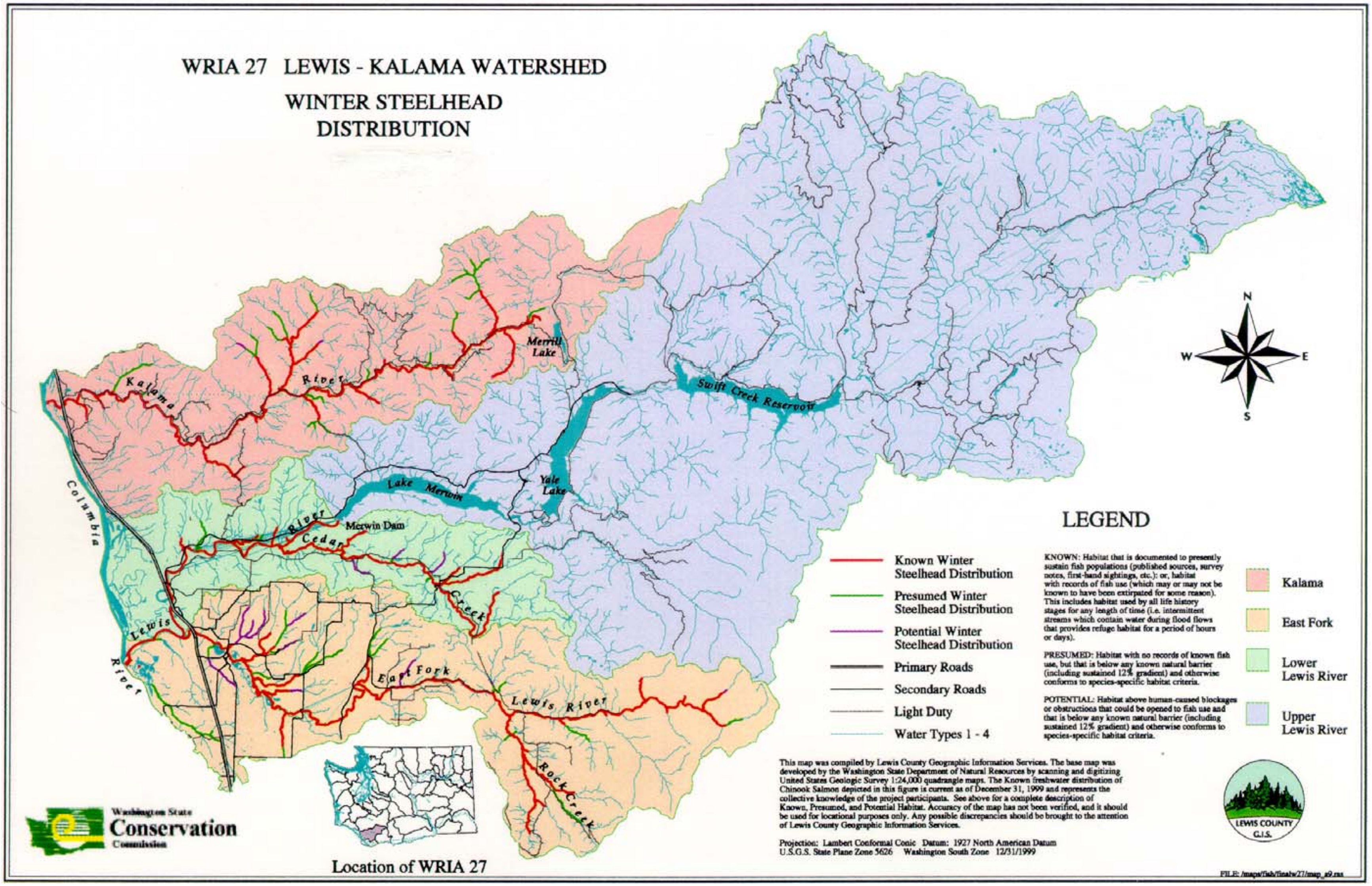

Figure A-3. Winter steelhead distribution in the Lewis-Kalama watershed (WCC 2000).

Incubation rates vary with water temperature, but typically fry emerge 40 to 80 days after spawning. Dissolved oxygen levels at or near saturation with no temporary reductions in concentration below 5 parts per million are most suitable for incubation (Stolz and Schnell 1991). Everest and Chapman (1972) found age-0 steelhead residing over cobbles in water velocities of <0.5 fps and depths of 15 to 30 centimeters. Juvenile steelhead also utilize stream margins and submerged rootwads, debris and logs for shelter and cover while rearing (Bustard and Narver 1975).

At the watershed level, steelhead stock abundance is limited by rearing conditions in fresh water. Factors affecting the abundance of juveniles include quantity and quality of suitable habitat, abundance of food resources and ecological interactions with other fish and animals (State of Washington 1998). Both winter- and summer-run juvenile steelhead rear in freshwater for one or more years before undergoing a physiological change to become smolts and migrating to the ocean (Stolz and Schnell 1991). In the Lewis River specifically, most juvenile steelhead migrate after 2 years of rearing in freshwater (WDF 1990). Juvenile downstream migration for steelhead smolts occurs from April through June, with peak migration, in general, occurring in mid-April (Wydoski and Whitney 1979).

Estuaries provide important nursery and schooling environments for juvenile salmon. This transition zone allows outmigrant salmonids to physiologically adapt to the seawater conditions (Seattle Regional Water Authority 1998). Most steelhead in Washington streams remain at sea for 22 months (after two years of rearing in freshwater) prior to returning to freshwater to spawn (Meigs and Patzke 1941). A significant difference between the life history of steelhead and Pacific salmon is that not all steelhead adults die after spawning. Steelhead are capable of repeat spawning (iteroparous), although the incidence is relatively low and specific to individual streams. Steelhead will rarely spawn more than twice before dying. Repeat spawning in Washington ranges from 4.4 to 14.0 percent of total spawning runs (Wydoski and Whitney 1979).

Known Occurrences in the Project Vicinity

The Washington Department of Fish and Wildlife (WDFW) manages the East Fork Lewis River for both hatchery and native runs of winter- and summer-run steelhead (WDF and WDW 1993). The hatchery winter-run steelhead have been planted since 1954, and summer-run stocks have been planted in the river since 1964. The hatchery brood stocks originate from Elochoman, Chambers Creek, Cowlitz, and Skamania stocks (WDF and WDW 1993). During the 1980s, an average of 89,000 winter and 90,000 summer-run steelhead smolts were released annually into the East Fork Lewis River. Currently, WDFW plants approximately 40,000 summer and 100,000 winter-run fish (Rawding 1999). Returning hatchery steelhead have been selected to spawn earlier than the wild steelhead in an effort to minimize interactions on the spawning beds. Typically, the hatchery fish spawn in early to mid-January prior to spawning activities by the wild runs (Rawding 1999).

The downstream extent of steelhead spawning in the mainstem East Fork Lewis River is a stretch of approximately 5 miles between the confluences of Mason, Lockwood, and Mill creeks (Rawding 1999). Spawning habitat downstream of these locations is limited due to the predominantly silty substrates that occur in the tidally influenced areas (Rawding 1999). In 1982, Sunset Falls was notched to increase steelhead access to the upstream reaches and tributaries, such as Rock Creek. However, winter steelhead are unable to migrate pass Lucia Falls, most likely due to temperature induced energy expenditures (Rawding 1997). Only summer-run steelhead can navigate past these falls. Furthermore, numerous small falls in the mainstem are barriers to steelhead migration during periods of low flow (WDF 1990).

The escapement goal for the East Fork Lewis River summer-run steelhead is 814 wild adults, and 204 wild winter-run adults (WDF and WDW 1993). Summer-run escapement is difficult to quantify due to the spawning time overlap with winter steelhead (WDF and WDW 1993). However, a July snorkel survey of summer-run steelhead conducted by the WDFW in 1998, prior to returns of winter-run fish, indicated wild fish accounted for two-thirds of steelhead sightings, with marked hatchery fish accounting for only one-third of the observations (Hale 1998). Although the snorkel survey originated near the Daybreak Mine site, steelhead were only observed upstream of the Daybreak Bridge. Escapements of wild winter-run steelhead have ranged from 72 to 140 fish, which is well below the escapement goal of 204 fish (WDF and WDW 1993). Spawned out salmon provide vital nutrients to the stream ecosystem, including nitrogen and phosphorus. In an effort to supplement the natural return of these nutrients to the East Fork Lewis River watershed, approximately 200 surplus hatchery carcasses were placed in the watershed in 1997. This effort will continue in future years (State of Washington 1998).

There has been no commercial harvest of steelhead below Bonneville Dam (on the Columbia River) since 1975, with the exception of incidental harvest during the spring Chinook fishery (WDF 1990). However, the East Fork Lewis River is a popular sport-fishing stream, known for the large size of its fish. Average yearly sport harvest in the 1980s was 2,730 steelhead in the mainstem East Fork Lewis River alone, not including tributaries and the North Fork Lewis River (WDF 1990). The current management goal is to maximize harvest of hatchery fish and allow escapement of wild fish. There have been catch-and-release restrictions on wild summer-run steelhead since 1986, and wild winter-run fish since 1991 (Rawding 1999). Fishing for hatchery-reared steelhead occurs in the river from mid-April through May with a limit of two fish per day (WDFW 2000). The current harvest rate of hatchery fish is estimated to be 40 percent of the total hatchery fish entering the East Fork Lewis River system (WDF 1990). Popular fishing locations for steelhead within the project location include the pool underneath the bridge at Daybreak Park (approximately RM 10) and the pools at the Ridgefield Pits area (approximately RM 8).

Population Status and Status under the ESA

Steelhead in the East Fork Lewis River were listed by NMFS as threatened under the ESA on 19 March 1998 (63 *Fed. Reg*. 13347-13371). East Fork Lewis River steelhead are classified as part of the Lower Columbia River Evolutionarily Significant Unit (ESU), which is 1 of 15 West Coast steelhead ESUs. Natural fish stocks (wild runs) are the focus of ESU determinations. Both the summer and winter wild runs of steelhead in the East Fork Lewis River are identified as “depressed” by the WDFW (State of Washington 1998). Winter-run steelhead escapement numbers dropped an average of 15.7 percent a year between 1986 and 1994 (Busby et al. 1996). Additionally, Busby et al. (1996) indicated that summer-run steelhead in this ESU, in general, appear to have substantial spawning overlap between hatchery and natural fish, which leads to concerns about genetic introgression (Busby et al. 1996). However, as mentioned previously, hatchery stocks on the Lewis River are selected to spawn earlier than the native steelhead in an effort to minimize interactions on the spawning beds (Rawding 1999). Many factors have contributed to the decline of Lower Columbia River steelhead. In particular, the National Marine Fisheries Service (NMFS) has listed the following five major causes of decline: 1) universal and often dramatic population declines since mid-1980s, 2) nineteen of 21 Washington populations are depressed, 3) Wind River stock has declined from “depressed” to “critical,” 4) hatchery transplants are compromising local populations, and 5) a high percentage of hatchery fish present on spawning grounds. Future conservation planning efforts by the states of Washington and Oregon, along with those of industry may reduce the risks faced by this ESU, but these plans are only in the formative stages (Busby et al. 1996).

Chum Salmon (Oncorhynchus keta)

Life History and Habitat Requirements

Chum salmon distribution in the Columbia River basin is limited to the mainstem river and tributaries below the Bonneville Dam. Chum salmon were reported by Salo (1991) to migrate up the Lewis River during October and November. Upstream chum migration, in general, can be very fast, with rates of 30 miles per day. The spawning season is November through December (WDF and WDW 1993). Preferred spawning areas are in groundwater-fed streams or at the head of riffles (Grette and Salo 1986). Chum salmon spawn in shallower, low-velocity streams and side channels more frequently than other salmon species (Johnson et al. 1997).

The length of embryo incubation is influenced primarily by water temperature. For example, eggs at 15°C hatch approximately 100 days before eggs incubated at 4°C. Health of the emergent chum fry, as with the other salmonid species, is also dependent on dissolved oxygen, gravel composition, spawner density, stream discharge, and genetic characteristics (Salo 1991).

Juvenile chum salmon rear in freshwater for only a few days to weeks before migrating downstream to saltwater (Grette and Salo 1986). In Washington, downstream chum salmon migration occurs from late January to May (Johnson et al. 1997). Chum outmigration is associated with increasing day length and warming of estuarine waters. Juvenile chum have longer rearing times in estuaries than most salmon, and estuarine survival appears to play a major role in determining subsequent adult return to freshwater (Johnson et al. 1997). Simenstad et al. (1982) reported that eelgrass (*Zostera* spp.) habitats might be particularly preferred. Simenstad et al. (1982) found chum salmon generally moved offshore at a size of 50-160 mm fork length. Chum salmon mature at 2 to 6 years of age (Salo 1991).

Known Occurrences in the Project Vicinity

Early hatchery production in the Lewis River basin included chum salmon up until 1940, which resulted in a large hatchery population. However, today chum salmon are a rarity in the Lewis River system including the East Fork Lewis River (WDF 1990) (Figure A-4). Factors that contributed to this population decline include predation by hatchery Chinook and coho salmon, habitat alteration and destruction, and lack of hatchery input (WDF 1990). Furthermore, the Columbia River is the maximum usual southerly range of the chum salmon, and therefore is probably less capable of retaining a large population.

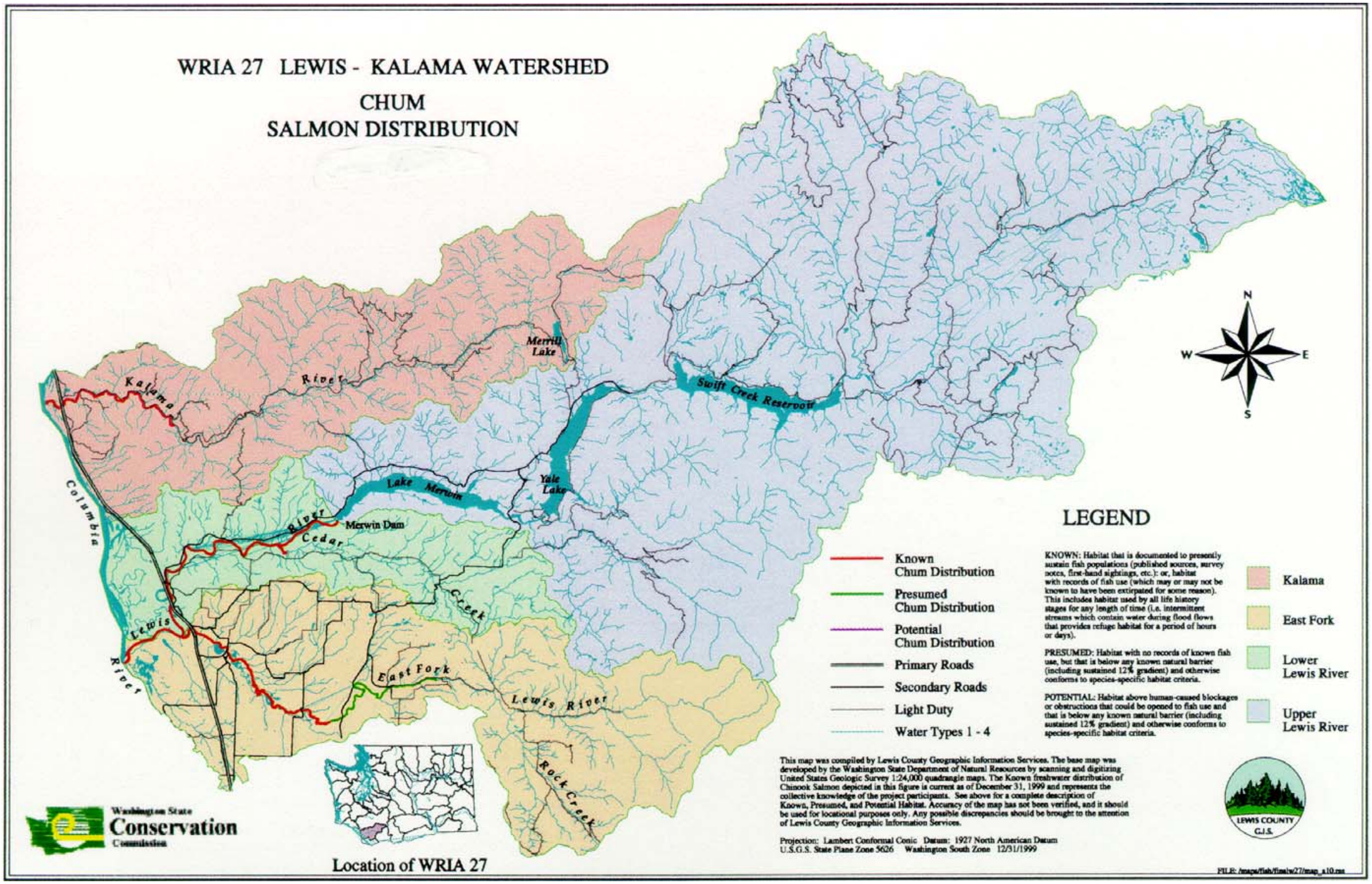

Figure A-4. Chum salmon distribution in the Lewis-Kalama watershed (WCC 2000).

In the mainstem Columbia River, commercial and sport fisheries do not target chum salmon. However, chum salmon are incidentally harvested during the late coho salmon gill-net fishery (WDF and WDW 1993). There are no WDFW escapement goals for Columbia River stocks of chum salmon. Recent escapements of chum salmon in the Columbia River was in the range of "a few thousand up to ten thousand" (Johnson et al. 1997). Chum have only been observed in the East Fork Lewis River occasionally since the 1950s (Rawding 1999). However, 78 chum fry were captured in a smolt trap just upstream of Mason Creek near RM 6 in the spring of 2001 (Rawding 2000). This indicates that at least some successful chum spawning occurred in the East Fork Lewis River the previous fall.

Population Status and Status under the ESA

East Fork Lewis River chum salmon are included in the Columbia River ESU and this population was listed by NMFS as threatened under the ESA on 25 March 1999 (64 *Fed. Reg.* 14508-14517). The current abundance of this ESU is estimated to be only 1 percent of historic levels. At this population level, genetic diversity is undoubtedly decreased. Only three chum populations are recognized in the Columbia River drainage (Grays River, Hardy and Hamilton creeks). Chum are not adept at surmounting migration obstacles and the Bonneville Dam prevents chum salmon from accessing habitat further upstream. This barrier combined with loss of habitat in the estuary and associated areas, and with population declines, prompted NMFS to conclude that this ESU is at risk of becoming endangered.

Chinook Salmon (Oncorhynchus tshawytscha)

Life History and Habitat Requirements

The Lewis River basin supports populations of both spring- and fall-run Chinook salmon (Figures A-5, A-6). The populations are separated into the different runs based on the timing of river entry by returning adults. Spring-run Chinook salmon enter the Lewis River between May and July, and fall Chinook salmon entry peaks in September and October. The variations in entry run and spawning times are in response to the local temperature and water flow regimes (Myers et al. 1998). Fall-run populations are the most predominant Chinook salmon stock in the Lewis River.

Chinook salmon are the largest of all Pacific salmon, and can achieve weights of over 100 pounds, the average being closer to 22 pounds. Owing to their large body size the presence of deep holding water and sufficient discharge are vital for upstream migration. Larger body

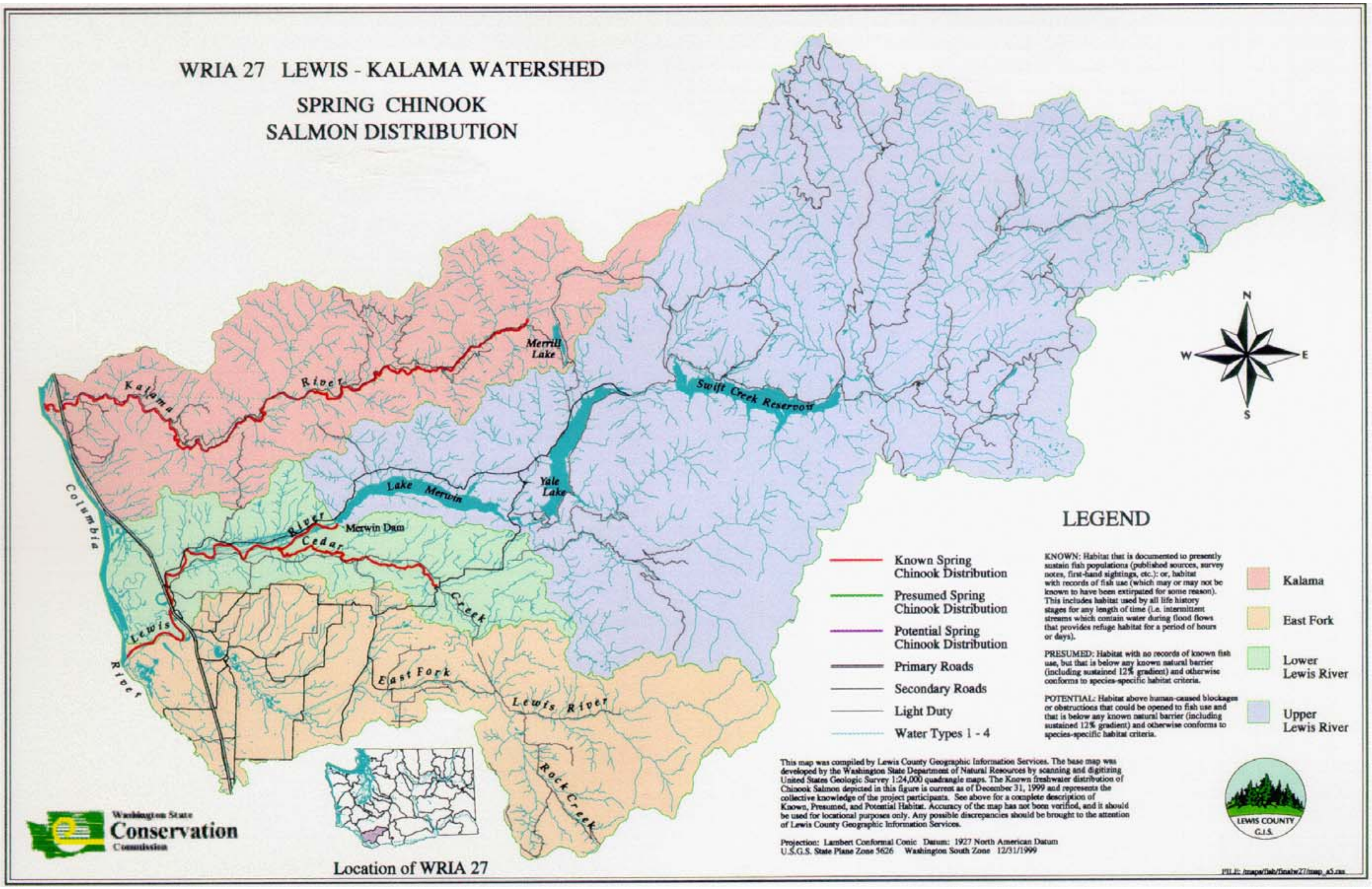

Figure A-5. Spring-run Chinook salmon distribution in the Lewis-Kalama watershed (WCC 2000).

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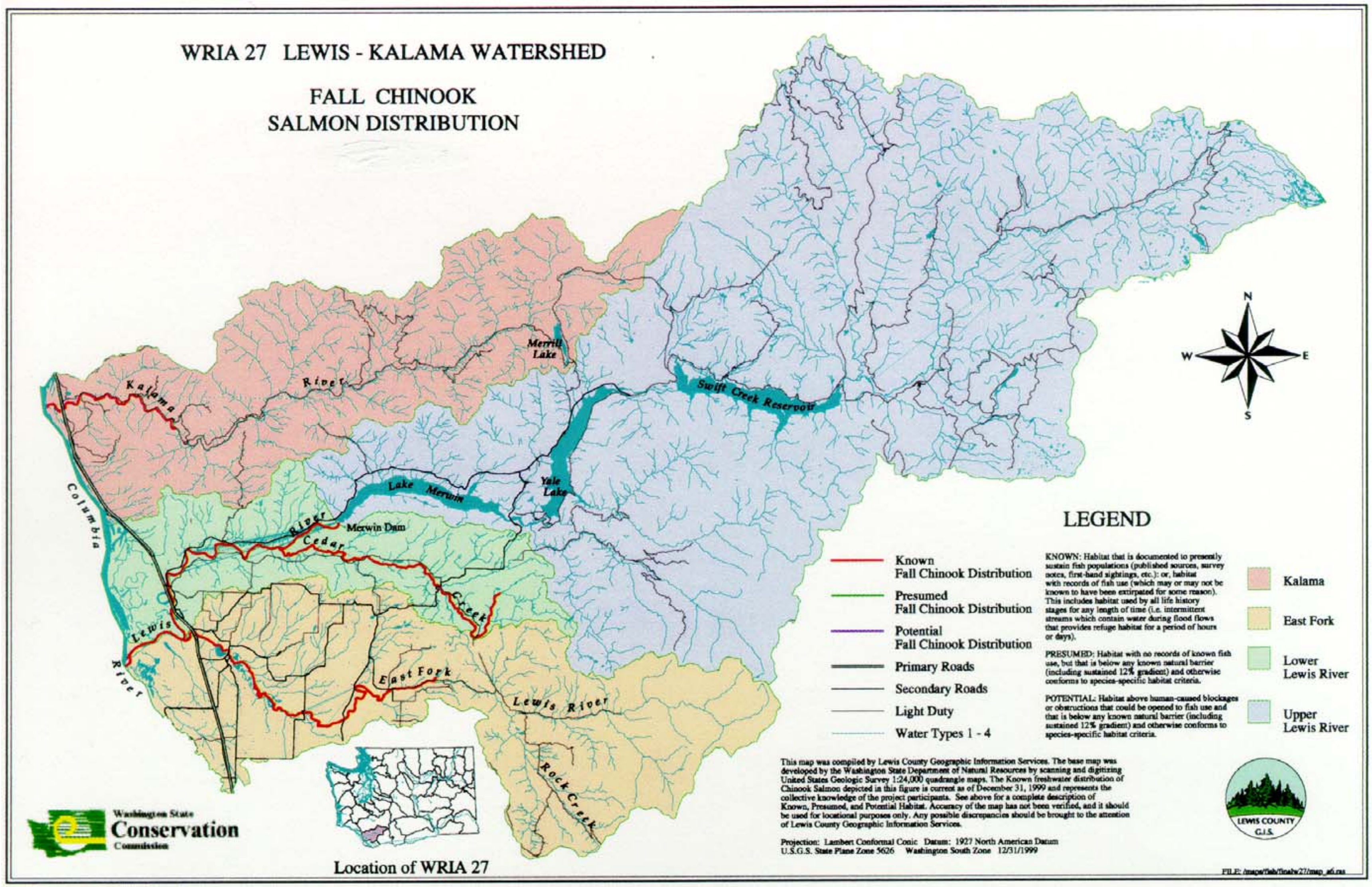

Figure A-6. Fall-run Chinook salmon distribution in the Lewis-Kalama watershed (WCC 2000).

size also allows the fish to utilize larger spawning gravel and cobble substrates (Raleigh et al. 1986). Spring-run Chinook salmon spawn in the East Fork Lewis River during August and September, and fall-run Chinook salmon spawn predominately during October and November, but late spawning may occur into January. Approximately 22 miles of the East Fork Lewis River are available for spawning by Chinook salmon. In particular, fall Chinook salmon spawn in a 4.2-mile section of the East Fork Lewis River from Daybreak Park (RM 10.2) upstream to Lewisville Park (RM 14.4) (EnviroScience 1996). The upstream barrier to Chinook salmon migration is Lucia Falls (Rawding 1999).

Similar to all salmon, Chinook salmon egg incubation varies with temperature. Chinook salmon eggs hatch in about 159 days at 3°C, and in 32 days at 16°C (Healey 1991). Prior to emerging, the young remain in the gravel for two to three weeks after hatching (Wydoski and Whitney 1979). Many variations in juvenile life history are possible within the fall run alone. Some juvenile fish may move into the ocean quickly, while others depend on extended rearing in the streams or estuaries (Reimers 1973). Environmental cues such as streamflow reductions, food supply, changes in photo-period, and temperature increases are all factors that lead to the evolution and expression of particular juvenile outmigration timing (Myers et al. 1998).

Chinook salmon in the Lewis River mature, on average, at ages 3 and 4, which is somewhat younger than other populations in Washington (Myers et al. 1998). In the Pacific Northwest, Chinook salmon is the least abundant of the Pacific salmon species, nevertheless, this species is important economically for commercial and sport harvest (Wydoski and Whitney 1979).

Known Occurrences in the Project Vicinity

The East Fork Lewis River fall Chinook salmon are a native stock of wild production. The are no hatcheries, or hatchery releases of fall Chinook salmon (Rawding 1999) on the East Fork Lewis River. However, some straying of Chinook salmon that originated from hatcheries further downstream have been observed (WDF and WDW 1993). The native fall run consists of two distinct spawning segments, early and late. The early segment spawns in October, while the late segment spawns in November through January. The early run fish are often referred to as "tules" distinguished by their dark skin coloration and advance state of maturation at the time of river entry (Myers et al. 1998). The late fall run fish are much less mature, and are referred to as "brights." These fish are the more desirable sport catch.

A run of native spring Chinook salmon existed at one time in the mainstem Lewis River, but dam construction has drastically reduced the population. Few if any spring Chinook salmon return to the East Fork Lewis River specifically, and there have only been occasional hatchery releases into the East Fork Lewis River from a variety of stock sources (WDF and WDW 1993). The naturally spawning spring Chinook salmon population in the Lewis River basin on a whole is healthy, based on escapement trends that averaged 2,194 fish between 1980 and 1991 (WDF and WDW 1993). However, Myers et al. (1998) indicate the possibility that the native Lewis River spring stock is extinct, and the observed stock has undergone substantial hybridization. Harvest of the Lewis River spring-run Chinook salmon is estimated to be 50 percent of the total population, based on data from 1982 to 1989 (Myers et al. 1998).

Population Status and Status under the ESA

Fall Chinook salmon escapements in the East Fork Lewis River averaged 598 between 1967 and 1991 and, together with fish in the mainstem Lewis River, is considered the only healthy native run in the Lower Columbia ESU (WDF and WDW 1993). However, the abundance of Chinook salmon in the entire ESU has declined substantially; both long- and short-term abundance trends are predominantly downward. On 24 March 1999, NMFS listed the Lower Columbia Chinook salmon ESU as threatened under the ESA (64 *Fed. Reg.* 14307-14328). This listing includes both fall and spring Chinook salmon in the East Fork Lewis River.

Coho Salmon (Oncorhynchus kisutch)

Life History and Habitat Requirements

Two coho salmon stocks are present in the East Fork Lewis River, north-turning (N-Type) and south-turning (S-Type) stocks. Because of the direction the fish turn after entering the ocean, N-Type contribute more heavily to the northern ocean fisheries, and the S-Type contribute primarily to the southern ocean fisheries. Adult S-Type coho return to the Lewis River system between August and November, slightly earlier than N-Type coho, which return between October and January. Fry emergence of S-Type is also slightly earlier than the N-Type fish. Similar to Chinook salmon, adult coho salmon require deep holding cover for resting during migration and sufficient discharge for upstream movement. However, Laufle et al. (1986) reported minimum depths of 18 centimeters are needed for upstream migration, which is much less than is necessary for the larger Chinook salmon.

The coho spawning season in the Lewis River is October through December (WDF and WDW 1993). There is approximately 22 miles of habitat available for coho spawning in the mainstem East Fork Lewis River, and an additional 25.6 miles of tributaries (EnviroScience 1996) (Figure A-7). The length of incubation for coho salmon ranges from 35 to 101 days (Laufle et al. 1986). Egg mortality occurs at stream temperatures above 13.3 °C (Spence et al. 1996). After hatching, larval fish typically spend two to three weeks in the gravel before they emerge in early March to mid-May (Laufle et al. 1986; McMahon 1983).

Juvenile coho salmon rear in freshwater for approximately 15 months prior to migrating downstream to the ocean, but some rear in freshwater up to two years (Sandercock 1991). Newly emerged fry usually congregate in pools in their natal stream. As juveniles grow, they disperse and aggressively defend their territory, which results in displacement of excess juveniles downstream to potentially less favorable habitat (Wydoski and Whitney 1979). This aggressive behavior may be an important factor that maintains the numbers of juveniles within the carrying capacity of the stream. Once territories are established, individuals typically rear in selected areas of the stream, feeding on drifting benthic organisms and terrestrial insects until the following spring (Hart 1973). Complex woody debris structures and side channels are important habitats for coho salmon, particularly during the summer low-flow period, and during the winter (Grette and Salo 1986). In the winter, this complex habitat can provide low velocity refuge from high flows. These studies suggest that the abundance of juvenile coho is often determined by the combination of limited space, food, and temperature interactions in the freshwater environment.

Outmigrating yearling coho tend to move quickly through the estuary compared to other salmonid species (Emmett et al. 1991). Adult coho generally return to their natal streams to spawn at age 3, after spending 18 to 24 months (up to three years) in the marine environment. However, many males will also return early as two-year old jacks (WDF and WDW 1993).

Coho salmon are an important commercial and recreational species. There is a high harvest rate of Columbia River coho from gill netting in late September and early November and the Buoy 10 fishery located near the city of Astoria at the mouth of the Columbia River. A small sport fishery is also present on the East Fork Lewis River, which averages 40 fish annually (WDF and WDW 1993).

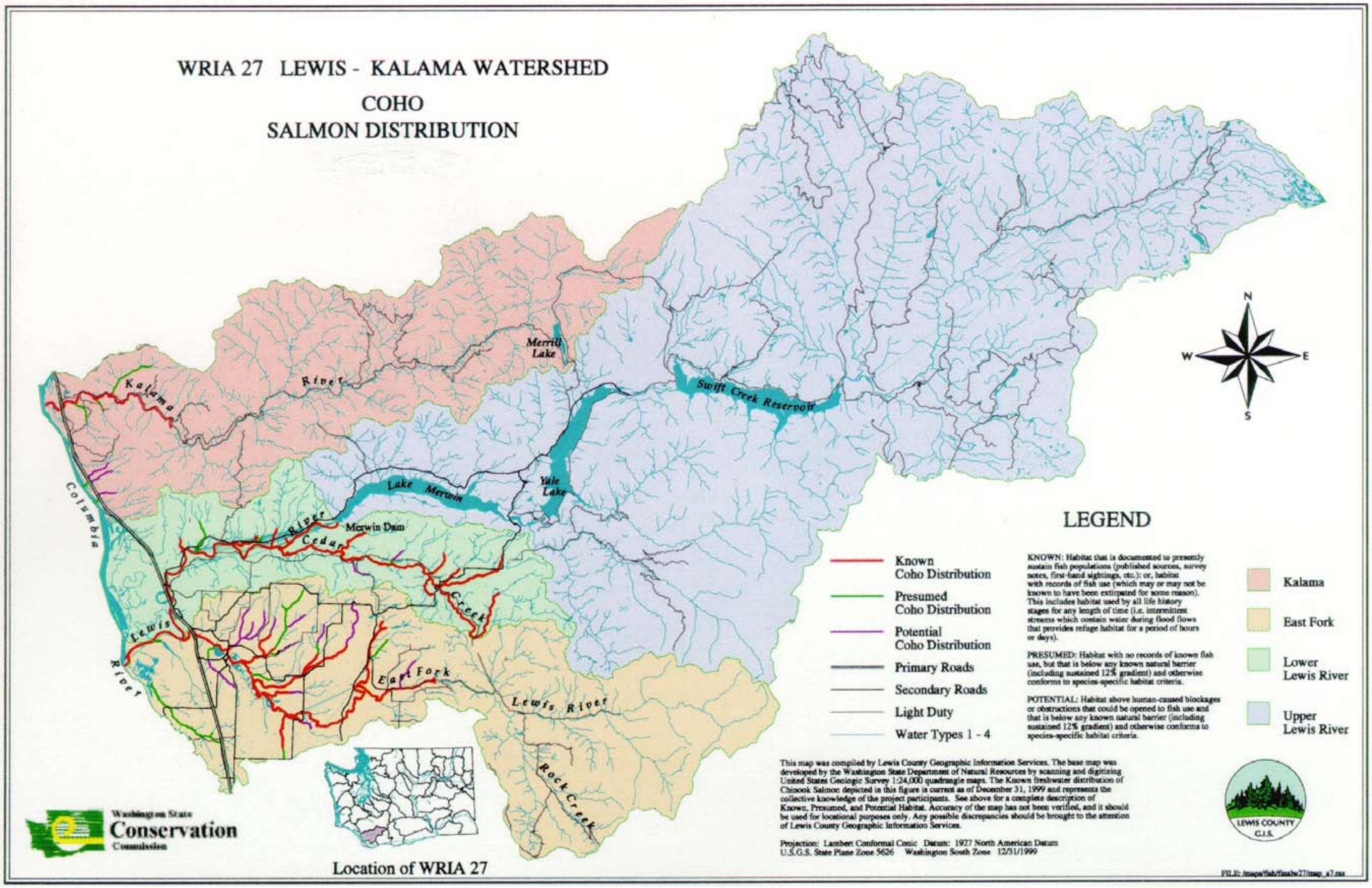

Figure A-7. Coho salmon distribution in the Lewis-Kalama watershed (WCC 2000).

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Known Occurrences in the Project Vicinity

In 1949, Bryant described the Lewis River as one of the most important producers of coho in the Columbia River Basin (WDF 1990). Currently, S-Type and N-Type stocks are both managed as hatchery stocks in the Lewis River system, with over a million hatchery juveniles released into the East Fork Lewis River alone (WDF and WDW 1993). Type-N escapements averaged around 18,000 during 1982 through 1986. S-Type annual returns average around 5,000 fish.

Native coho populations were historically present in the Lewis River, but their status is unknown today, and hatchery straying and natural spawning in the East Fork Lewis River may occur. One estimate of East Fork Lewis River production is 2,000 naturally spawning coho (Johnson et al. 1997). If natural spawning populations are present, they probably spawn before or after the influx of hatchery fish, and their relationship to historically native coho is uncertain (Johnson et al. 1997).

Population Status and Status under the ESA

East Fork Lewis River coho are part of the Southwest Washington Coast/Lower Columbia River ESU. NMFS was unable to identify any remaining natural populations in this ESU that warranted protection under the ESA. However, there is sufficient concern regarding the overall health of this ESU (especially if native fish are found to exist). Therefore, this ESU was added to the candidate list until further information is available and the native population issue can be resolved (Johnson et al. 1997).

Coastal Cutthroat Trout (Oncorhynchus clarki clarki)

Life History and Habitat Requirements

The East Fork Lewis River supports both resident and anadromous (sea-run) coastal cutthroat trout populations. Both life history forms belong to the subspecies *O. clarki clarki*. The discussion in this section focuses primarily on the less abundant, anadromous form. Coastal cutthroat trout in the Lewis River basin exhibit early life history characteristics similar to steelhead. Additionally, similar to steelhead, coastal cutthroat spawn in the spring.

The anadromous coastal cutthroat trout spawning season occurs from mid-March through early May. Stolz and Schnell (1991) indicate the start of spawning is prompted by 10°C water temperature. Coastal cutthroat trout spawn in low gradient reaches of small tributaries, or in the lower regions of streams (Trotter 1997). Use of this spawning habitat is likely an adaptation to reduce competition from other, more competitive species such as steelhead (Stolz and Schnell 1991). The preferred spawning substrate is pea- to walnut-sized gravel, in 15-45 cm of water, with pools nearby for escape cover. Spawning by individual females may extend over a period of two to three days (Trotter 1997). Eggs require approximately 300 temperature units for incubation and an additional 150 to 200 units for emergence to occur (Stolz and Schnell 1991). This is comparable to embryos incubating for 30 days at 10°C, with emergence occurring 15 to 20 days later. Peak emergence occurs in mid-April although emergence may extend through June (Trotter 1997).

Emergence of juvenile cutthroat trout occurs from March to mid-July, depending on the spawning date and water temperature (Wydoski and Whitney 1979). Juvenile coastal cutthroat will generally rear in streams for two or more years, where they prefer pools and other slow-water habitats that have root wads and large wood for cover (Trotter 1997). Often coho fry prefer the same habitat, and if present, the larger coho force the smaller cutthroat trout into less preferable riffle habitat (Stolz and Schnell 1991). Seaward migration of cutthroat smolts peaks in May at 2 years of age, coinciding with steelhead smolt emigration (Grette and Salo 1986). Average length of smolts is 160 mm (Johnson 1982). During the marine phase of their life cycle, coastal cutthroat trout use waters near the shore, usually in areas relatively close to their natal streams (Moyle 1976). Both gravel beaches with upland vegetation, and nearshore areas containing large logs and other large woody debris are used during the marine residency phase.

Similar to steelhead, adult coastal cutthroat trout are repeat spawners, but unlike steelhead, cutthroat trout typically recover quickly to their pre-spawning condition (Trotter 1997). They may live to an age of 7 or 8 years, spawning three, four, or even as many as five times during their life (Trotter 1997). Although true anadromy exists, there is evidence that this trait is not strongly developed. Coastal cutthroat trout generally remain close to shore or in areas of reduced salinity (Trotter 1997). They will rarely if ever, overwinter in saltwater, which indicates that some of the returning fish may not spawn during their first or second migrations back into freshwater. Spawning fish home to their natal tributary, while non-mature fish do not always return to their home stream to feed or to over-winter (Trotter 1997). Coastal cutthroat trout are usually smaller than other anadromous salmonids, and rarely exceed 50 cm in length. This smaller size is adaptive for entering smaller tributaries where interspecific competition for habitat with other, larger salmonids is reduced (Pearcy 1997).

Known Occurrences in the Project Vicinity

An anadromous coastal cutthroat trout population is believed to be present although not abundant in the East Fork Lewis River. This is based on angling reports, occasional sightings, and fish trapped on the Cedar River, a tributary to the North Fork Lewis River (Rawding 1999). They are also known to utilize Mason and Mill creeks, which are tributaries to the East Fork Lewis River (Rawding 1997). It is possible that Dean Creek could support anadromous cutthroat trout, however cutthroat trout observed in this stream may be resident fish, and not anadromous (EnviroScience 1996).

Population Status and Status under the ESA

On 5 April 1999, NMFS and USFWS jointly proposed to list the Southwestern Washington/ Columbia River ESU of coastal cutthroat trout as threatened under the ESA (64 *Fed. Reg.* 16397-16414). Subsequently, the USFWS assumed jurisdiction over coastal cutthroat trout, and on 26 June 2002 announced that the species did not warrant listing under the ESA.

Bull Trout (Salvelinus confluentus)

Life History and Habitat Requirements

The taxonomic status of bull trout has been historically confused with that of Dolly Varden (*S. malma*). Both species are native Pacific coast salmonids and members of the char sub-family. The two species are similar in coloration, morphology, and life history, which makes distinction between the two species difficult without the use of electrophoretic samples or exact measurements of specific external characteristics (Beak 1996). Furthermore, morphological and genetic samples taken from populations in Washington show a degree of overlap and genetic introgression. The state of Washington has indicated that protective measures and management for the two species are identical (WDW 1992, WDF and WDW 1993). Therefore, the following description of status and life history for the two species has been combined, and discussions in this section refer to native char where information is summarized from studies that did not differentiate between these two species or where conditions are similar for both species.

Spawning in most native char populations occurs in September and October, although spawning may occur as early as August at elevations above 4,000 feet in the Cascades and as late as November in coastal streams (Beak 1996). Most anadromous populations spawn only every second year while resident stream fish spawn every year (Morrow 1976). Spawning sites are characterized by low gradient, uniform flow, and a gravel substrate between 0.6 and 5 centimeters in diameter (Wydoski and Whitney 1979; Fraley and Shepard 1989). Groundwater influence and proximity to cover are also important factors in spawning site selection (Fraley and Shepard 1989). Studies conducted throughout the species range indicate that spawning occurs in water from 20 to 60 cm deep (Wydoski and Whitney 1979, Fraley and Shepard 1989) and often occurs in reaches fed by springs or near other sources of cold groundwater (Pratt 1992).

Embryos incubate for approximately 100-145 days, and hatch in late winter or early spring (Weaver and White 1985). Rieman and McIntyre (1993) indicate that optimum incubation temperatures are between 2 and 4ºC. Alevins remain in the streambed and absorb the yolk sac for an additional 65-90 days (Pratt 1992). Emergence from the streambed occurs in late winter/early spring (Pratt 1992). High fine sediment levels in spawning substrates reduce embryo survival, but the extent to which they affect bull trout populations is not entirely known (Rieman and McIntyre 1993).

Native char in coastal streams and Puget Sound may include anadromous populations. Anadromous Dolly Varden migrate to sea in the spring and return to freshwater in late summer and early fall (Wydoski and Whitney 1979). Little is known about their habits or distribution while in the marine environment. Most bull trout spend their entire lives in freshwater (Rieman and McIntyre 1993). The existence of anadromous bull trout populations is possible, but because bull trout populations often occur in the same habitats as Dolly Varden, and with the difficulties of distinguishing the two species, the presence of anadromous bull trout is uncertain (McPhail and Baxter 1996).

Bull trout fry are usually found in shallow, slow backwater side channels and eddies (Elliott 1986). Juveniles (less than 100 millimeters in length) are primarily bottom dwellers and are found among coarse substrate (Fraley and Shepard 1989; Pratt 1992). Young-of-the-year bull trout rear primarily in side channel areas and along stream margins (Fraley and Shepard 1989). Older, larger individuals utilize habitats consisting of stream pools or lakes with deeper water and temperatures less than 15°C (Pratt 1992).

Long overwinter incubation periods for bull trout embryos and alevins can make them particularly susceptible to increases in fine sediments. The period from deposition to emergence can be longer than seven months. The WDFW lists the following as the limiting factors for the species: stream temperatures which exceed the normal spawning and incubation temperature range; lack of spawning and rearing habitat; and a high percentage of fine sediment in spawning gravels (State of Washington 1998). Bull trout populations are also negatively impacted by the presence of brook trout *(Salvelinus fontinalis)*. Bull trout readily interbreed with non-native brook trout, and brook trout competitively exclude bull trout (Buckman et al. 1992; Dambacher et al. 1992). A small population of brook trout is present in Moon and Pemi lakes in the upper East Fork Lewis River watershed (USFS 1995). Finally, native char are easily caught and are highly susceptible to fishing pressure (Fraley and Shepard 1989). Any increase in the accessibility of a population to fishing pressure could negatively impact a population.

Known Occurrences in the Project Vicinity

A wild, naturally reproducing stock of bull trout/Dolly Varden is present in the North Fork and mainstem Lewis River (WDW 1992). These populations are believed to be strictly adfluvial, with three power dams restricting upstream movement among the three predominately isolated bull trout/Dolly Varden populations (Figure A-8). Spawning areas are primarily tributaries to the mainstem Lewis River and North Fork Lewis River, including Cougar, Rush, and Pink creeks. While occasional straying may occur, bull trout are not known to exist in the East Fork Lewis River (Weinheimer 1998). The USFS has conducted surveys in the headwaters, and many snorkel and electrofishing surveys have occurred with no bull trout ever being sighted in the East Fork Lewis River (Rawding 1999).

Population Status and Status under the ESA

Lewis River bull trout are part of the Columbia River bull trout distinct population segment (DPS). This DPS is a geographically isolated segment, encompassing the entire Columbia River basin and its tributaries, and the Lewis River watershed supports a sub-population of this distinct population segment. Due to several detrimental factors, which include forest management and road building, mining, increased stream temperatures and loss of habitat, this DPS was listed as threatened on 10 June 1998 by the USFWS under the ESA (63 *Fed. Reg*. 31647-31674). Fishing for bull trout/Dolly Varden has been closed in the Lewis River since 1992. The WDFW Enforcement Program has been very active in protecting bull trout and Dolly Varden in the reservoirs and tributaries of the Lewis River.

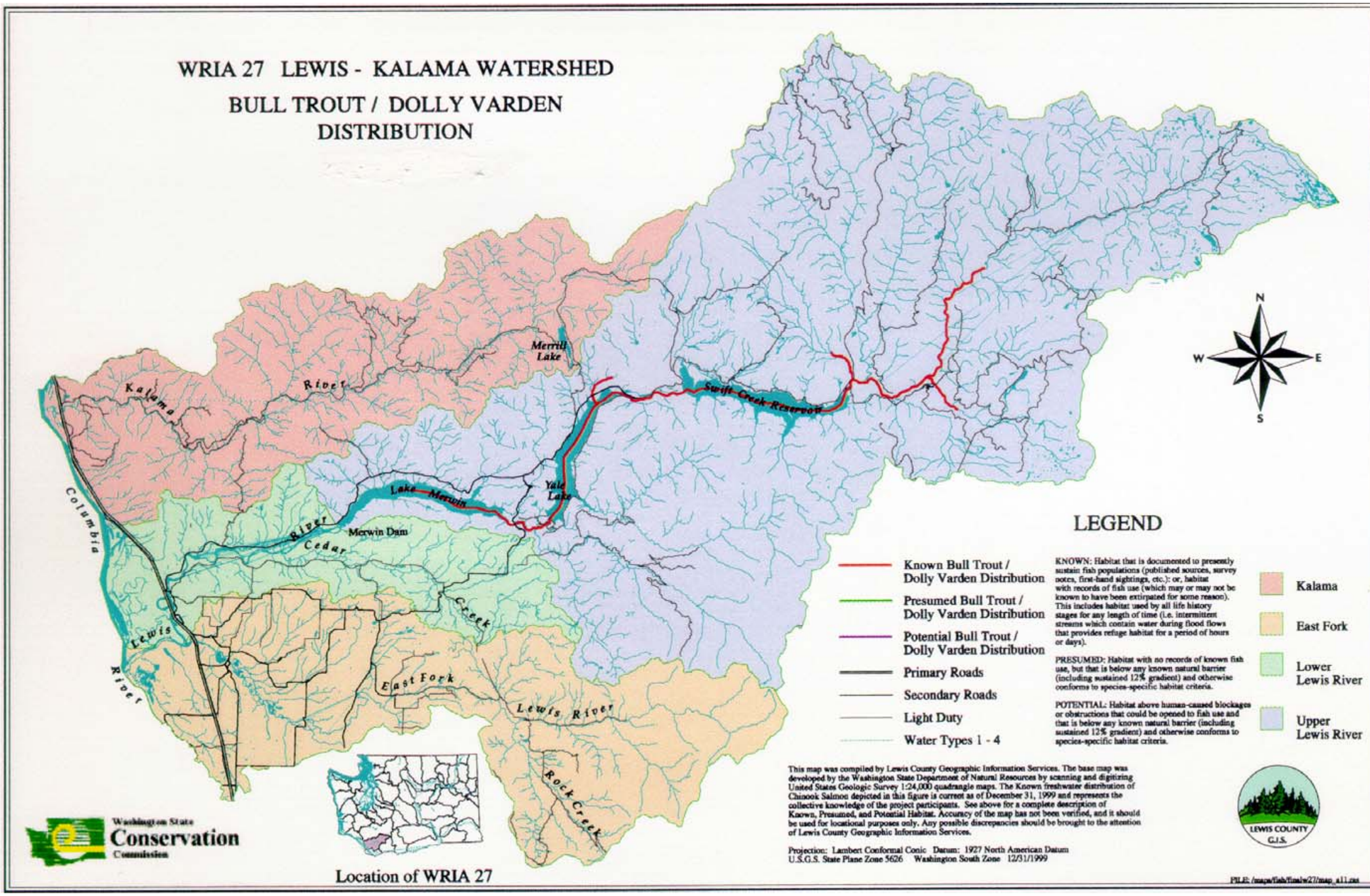

Figure A-8. Bull trout/Dolly Varden distribution in the Lewis-Kalama watershed (WCC 2000).

Other Fish Species

Pacific Lamprey (Lampetra tridentata)

Life History and Habitat Requirements

The Pacific lamprey is one of the most primitive fishes found in the Lewis River basin. Pacific lamprey are often mislabeled as pest species due to the problems associated with the Atlantic sea lamprey *(Petromyzon marinus)* that invaded the Great Lakes (Close et al. 1995). Their snake-like appearance has also led to further misconceptions. Lamprey species are often commonly referred to as "eels" (Jackson et al. 1996), although taxonomically, they belong to a separate family, the Petromyzontidae. The Pacific lamprey is native to the Lewis River system and has cultural, utilitarian, and ecological significance (Close et al. 1995).

Pacific lamprey are anadromous fish, which spawn and rear in freshwater streams (Wydoski and Whitney 1979). Adult Pacific lamprey migrate upstream in July to October. They overwinter in freshwater and spawn in May when water temperatures are between 10°C and 15°C (Close et al. 1995). Both sexes construct a shallow nest in the stream gravel (Morrow 1976). Flowing water (1.6-3.3 fps) in low gradient sections is preferred for spawning (Close et al. 1995). After preparation of the nest, the female attaches herself to a rock with her oral sucker while the male attaches to the head of the female. The male and female coil together while the eggs and sperm are released. The fertilized eggs adhere to the downstream portion of the nest (Moyle 1976). The adults then cover the eggs with gravel. The process is repeated several times in the same nest site, and the adults die shortly after spawning (Moyle 1976). Spawning Pacific lamprey are often observed during steelhead spawning surveys and they often spawn in similar habitat (Jackson et al. 1996; Foley 1998).

Juvenile Pacific lamprey, termed ammocoetes, swim up from the nest and are washed downstream where they burrow into mud or sand to feed by filtering organic matter and algae (Moyle 1976). The ammocoetes generally remain buried in the substrate for five or six years, moving from site to site (Wydoski and Whitney 1979). Such an extended freshwater residence makes them especially vulnerable to degraded stream and water quality conditions, including bedload disturbances. Larval lamprey transform to juveniles from July through October (Close et al. 1995). It is during this transition that they become ready for a parasitic lifestyle, developing teeth, tongue, eyes and the ability to adapt to saltwater. After metamorphosis, juvenile lamprey may remain in fresh water up to 10 months before passively migrating with the current downstream to the ocean in late winter or early spring (Wydoski and Whitney 1979).

After reaching the ocean Pacific lamprey attach themselves to and parasitically feed upon other fish (Moyle 1976). They may remain in saltwater for up to three and a half years (Close et al. 1995). Pacific lamprey return to freshwater in the fall, overwinter, and then spawn in the spring (Close et al. 1995). They do not feed during the spawning migration, and they die shortly after spawning. The spawned out carcasses provide important nutrients to the stream system, as well as dietary items for other fish (Close et al. 1995). Pacific lamprey may reach a size of approximately 70 centimeters, or over 2 feet long, at maturity (Hart 1973).

Known Occurrences in the Project Vicinity

The Pacific lamprey can be found in coastal streams from California to Alaska (Morrow 1976). They are native to the Columbia River basin (Jackson et al. 1996), and were historically abundant (Jackson et al. 1996). No information was discovered for this HCP regarding the status of Pacific lamprey in the Lewis River basin. However, the Lewis River and the East Fork Lewis River are within the known range of Pacific lamprey, furthermore, preferred freshwater habitat for this species exists near the project site. It is assumed that the East Fork Lewis River system supports spawning, rearing, and migrating Pacific lamprey.

Population Status and Status under the ESA

Although historical population sizes of the Pacific lamprey are not known, it is clear that these fish were once abundant and a significant source for tribal subsistence, ceremonial, and medicinal purposes. Current Pacific lamprey populations in the Pacific Northwest are depressed (Close et al. 1995). Pacific lamprey have similar spawning habitat requirements as Pacific salmon, and therefore, face the same habitat problems affecting salmonid abundance and distribution. In particular, elevated water temperatures (greater than 20°C) and increased sediment in spawning gravels are two major habitat factors attributed to lamprey population decline (Close et al. 1995). Juvenile rearing habitat for Pacific lamprey has also been negatively impacted by the decrease in abundance of off-channel habitats, such as beaver ponds and oxbows, due to widespread channel straightening and floodplain development.

Migration barriers at dams and fishways have also negatively impacted Pacific lamprey abundance and access to historical habitats. In particular, one fishway on the Columbia River at Ice Harbor Dam was modified in the early 1970s to specifically eliminate upstream lamprey passage (Jackson et al. 1996). Additionally, the historical lack of interest by agency biologists regarding monitoring lamprey populations, and assessments of impacts on lamprey has hindered the status of lamprey populations (Jackson et al. 1996). The USFWS was petitioned in February 2003 to list Pacific lamprey under the ESA. The USFWS has not yet initiated a review of this species due to budgetary constraints.

River Lamprey (Lampetra ayresi)

Life History and Habitat Requirements

River lamprey occur from northern California to southeastern Alaska, including most major rivers in Washington (Wydoski and Whitney 1979). Like Pacific lamprey, adult river lamprey are parasitic on fish. Primary food items for the river lamprey include herring and young salmon (Beamish 1980). River lamprey migrate to freshwater during September through late winter to spawn. Spawning occurs in the spring, from April to June.

The larval form, ammocoetes, are similar to other lamprey in that they are blind and toothless, feeding on algae and microscopic organisms. River lamprey ammocoetes are morphologically similar to Pacific lamprey, making positive distinction between the two difficult (Wang 1986). River lamprey ammocoetes begin to transform into the adult stage in July, when they are as small as 11.7 centimeters (less than 5 inches) in total length (Wydoski and Whitney 1979). They become parasitic soon after this transformation, even in freshwater, and it is at this phase during their life history that they can become predatory on juvenile salmon. It can be concluded that lamprey predation has an impact on juvenile salmonids, but wound and mortality rates need further study to quantify the extent of this impact (Beamish 1980). During the extended period of December through June, river lamprey migrate out of freshwater habitat and into saltwater (Beamish 1980).

The adult river lamprey is smaller than the Pacific lamprey, with a body length of only 30 cm, or slightly less than 1 foot (Hart 1973). Beamish (1980) indicated the possibility of a new life history form that exists only in lakes and feeds on resident salmonids. Upstream migration of river lamprey often takes place through rapids, and over waterfalls, which indicates that dams may not necessarily pose a migration barrier (Beamish 1980). The life span of river lamprey from metamorphosis to death after spawning is two years (Beamish 1980).

Known Occurrence in the Project Vicinity

Little information exists on the occurrence of river lamprey in the Lewis River basin or the East Fork Lewis River. However, the Lewis River and the East Fork Lewis River is within the known range of the river lamprey, and preferred freshwater habitat for this species exists near the project site. It is assumed that the East Fork Lewis River system supports spawning, rearing, and migrating river lamprey.

Population Status and Status under the ESA

River lamprey are of no sport or commercial value (Wang 1986) and, similar to the Pacific lamprey, little effort has been made to monitor or document their distribution and population status. The USFWS was petitioned in February 2003 to list river lamprey under the ESA. The USFWS has not yet initiated a status review of this species due to budgetary constraints.

WILDLIFE SPECIES

Oregon Spotted Frog (Rana pretiosa)

Life History and Habitat Requirements

The Oregon spotted frog is a highly aquatic amphibian, and is usually associated with marshes or the edges of lakes, ponds, and slow streams (Corkran and Thoms 1996). In these aquatic settings, the spotted frog prefers non-woody wetland plant communities including sedges, rushes, grasses (Leonard et al. 1993). Adults feed on invertebrates, usually within 60 centimeters of the water's edge on dry days, but during, or after rain, they may travel to feed in wet vegetation and ephemeral puddles. Spotted frogs do not usually occupy habitats within mature forested areas. Early-successional habitats up to the closed sapling-pole stage are primary feeding and resting habitat for the species. Adult spotted frogs are active from February through October. The cold winter months are spent in hibernation in muddy bottoms of ponds near breeding sites, however, some activity does occur during this time (Leonard et al. 1993).

The egg laying season is usually during February or March (Leonard et al. 1993). Eggs are laid in shallow water, in association with low vegetation, and often in seasonal wetlands (Corkran and Thoms 1996). Eggs in these habitats are highly susceptible to desiccation and freezing. Hatching can occur in as little as 14 days, but 18-30 days is more typical (Leonard et al. 1993). Tadpoles utilize the warmest parts of the water (Corkran and Thoms 1996), where they graze on algae, detritus, and bacteria (Leonard et al. 1993). The tadpoles typically metamorphose during mid-August of their first summer at lower elevations, and begin to breed at age three (Nussbaum et al. 1983). Garter snakes, bull frogs and great blue herons are some of the many predators of post-metamorphic spotted frogs (Leonard et al. 1993).

Known Occurrence in the Project Vicinity

Historically, the Oregon spotted frog ranged from southwestern British Columbia to the northeast corner of California, including the Puget Sound Lowlands, Willamette Valley, and Cascade Mountains of south-central Oregon (McAllister and Leonard 1997). This species has been extirpated from much of its historic range in Washington, which was west of the Cascades in the Puget Trough. Four extant populations in Thurston and Klickitat counties are known to be present today (McAllister 1999). Habitat in Washington State that supports spotted frogs is usually shallow emergent wetlands associated with prairie or sparse grasslands that become inundated during high water (McAllister 1999).

An amphibian survey in Clark County conducted in February 1998 indicated that potential Oregon spotted frog egg masses were located at several sites within the county including one egg mass found at the Daybreak site (Corkran 2000). During this survey, a total of five eggs were collected for rearing and identification from the Storedahl site. Unfortunately a positive species confirmation could not be made. A subsequent survey for tadpoles and adults by county and WDFW staff failed to observe any Oregon spotted frogs within Clark County (McAllister 1999). On a follow-up survey in March 1999, potential Oregon spotted frog eggs were collected from a site approximately 2 miles south of the Daybreak site. However, DNA testing revealed the eggs to be those of the common red-legged frog (Corkran 2000). At this time, the presence of Oregon spotted frogs at the project site or within Clark County remains unknown. The project site contains potential habitat that could support the frogs, although the rarity of the species within the state, and the presence of highly predatory bullfrogs and largemouth bass in the existing ponds makes it doubtful that a self-sustaining population of Oregon spotted frogs is supported at this site.

Population Status and Status under the ESA

The Oregon spotted frog (Pacific Coast population) is a federal candidate for listing and a state endangered species. During recent surveys to expand the known distribution of this frog in western Washington, approximately 60 locations containing potential habitat were searched, revealing an additional single spotted frog (McAllister and Leonard 1997). Currently, Washington State is known to contain only four populations of spotted frogs (McAllister 1999). The reason for the depressed population status of the Oregon spotted frog in Washington State is not known, but degradation of wetlands combined with introductions of the non-native bullfrog (*Rana catesbeiana*) and warm-water predacious fish species are suspected to have contributed to population declines (Corkran and Thoms 1996).

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Appendix B

Conceptual Restoration Plan for Ridgefield Pits

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Memorandum

Date:	February 9, 1999	*Project Number:*	**1115.01**
To:	Jack Kaeding, Fish First		
From:	David Chapin		
Subject:	Conceptual Restoration Plan for Ridgefield Pits		
cc:	Kimball Storedahl, Randy Sweet, Dudley Reiser		

This technical memo presents a conceptual plan for restoring ecosystem components within the Ridgefield Pits area. In light of current interest and funding opportunities for enhancing fish and wildlife habitat at the site, this plan is intended to lay the groundwork for developing specifications in a more detailed plan. If you should have any questions about the conceptual plan described here, feel free to give me a call at 425-556-1288.

CONCEPTUAL RESTORATION PLAN FOR RIDGEFIELD PITS

The Ridgefield Pits represent an excellent opportunity to restore components of the East Fork (EF) Lewis River floodplain ecosystem. The site has undergone major changes over the past 30 years, beginning with the excavation of numerous pits for extraction of sand and gravel. In 1996 the EF Lewis River avulsed into these pits, abandoning the channel that lies immediately north. The pits are now part of a very dynamic fluvial system that will likely continue to change for some time as the pits fill with sediment and as the river modifies the pond shorelines.

The area of the Ridgefield Pits can be categorized into several distinct features: the active channel, off-channel ponds, channel and pond shorelines, and floodplain. The first two of these features are aquatic, and the latter two are wetland or terrestrial. They are defined as follows:

- ***Active Channel:*** the portion of the ponds through which the main flow of the river runs.
- ***Off-Channel Ponds:*** mostly embayments off the active channel formed from the pre-avulsion pits that retain surface water connections to the active channel; one pond remains unconnected by surface water with the active channel.
- ***Channel and Pond Shorelines:*** the sides of the pre-avulsion pits consisting of a typically steep upper portion (slopes estimated 1V:1H to1V:1.5H) and a shallower sloped lower portion that includes colluvial material from upslope and recent fluvially deposited sediments occurring since avulsion
- ***Abandoned Floodplain Surface:*** the relatively flat terrestrial areas around the pits that remained unexcavated and that were likely used for processing and transportation purposes when mining was active.

The opportunities and constraints for restoration presented by each of these features will be dealt with in turn. As will be shown, the most promising opportunities for active restoration are on the abandoned floodplain surface, which is the area that will be emphasized in the plan. In other areas, a passive restoration approach is recommended, allowing natural processes to proceed with little intervention.

ACTIVE CHANNEL

The EF Lewis River now flows through the series of ponds that previously comprised the Ridgefield pits. The river cut through several narrow strips of land separating the ponds. Although the channel presently has a shape that is largely determined by the original pond configurations, there is a distinct "thalweg" that is characterized by higher velocity flow that threads through the ponds. Presumably this path of flow through the ponds varies in depth, depending on the original pond depth and how deep it has cut through the inter-pond strips of land. The pond depths are likely changing, as sediment accumulates in them.

RECOMMENDED RESTORATION ACTIONS

Given the dynamic nature of this feature of the Ridgefield pits, no active restoration measures are recommended. The pits will continue to fill in, and it is possible the flow path through the ponds will change.

OFF-CHANNEL PONDS

The gravel ponds, all but one of which have surface water connections to the path of the active channel, are relatively quiet water at lower river discharges. At higher river discharges, however, they likely have higher velocities from eddies and side currents off the main channel. In some cases, the strips of land still separating the ponds are breached at high flow (as was observed by debris in January 1999 from a high flow event earlier this winter). The water in the pond that has no surface connection to the river is primarily fed by groundwater, although during very high flow events (e.g. February 1996), it likely has surface water input from the river.

During the January 1999 field visit, when the EF Lewis River discharge was 625 to 875 cfs, extensive deposits of sand were visible in many of these ponds, particularly those at the upstream end. Some of these sand deposits had young willow already established on them. The rapidly eroding valley wall just upstream of the Ridgefield pits, composed largely of sands that fall as large blocks of material into the river, is a source for much of this sediment. Towards the upstream end of the ponds, there were also numerous pieces of large woody debris (LWD) that were lying on the exposed sand deposits. Like the active channel, these off-channel pond areas are also very dynamic and will likely continue to change for some time to come.

I predict that many of these areas will be good examples of passive restoration as they continue to accumulate sediment and develop vegetation. The establishment of willows should increase sediment accumulation rates, and the new surfaces should provide excellent substrate for the development of floodplain vegetation. Willows, alders, and cottonwoods are likely colonizing species at relatively higher surfaces, and emergent wetland species, such as sedges, rushes, and cattails, should colonize relatively lower surfaces that are wet through the growing season and not subject to high velocity flows. Deposition of LWD should also contribute to the passive restoration of these areas, encouraging the accumulation of sediment and creating a more heterogeneous floodplain surface.

RECOMMENDED RESTORATION ACTIONS

Due to their dynamic nature, little active restoration is recommended for the off-channel ponds connected by surface water to the river. Artificially moving sediments and soil within the ponds would require an HPA, and the outcome would likely be modified by riverine processes anyway. The changes occurring there now are largely positive and represent a valuable case-study in how avulsed ponds can change naturally.

Intentional placement of LWD into the ponds is one active restoration measure that is recommended. This would provide immediate habitat structure for fish, as well as the same long term benefits of naturally deposited LWD. Since LWD is being deposited naturally at the upstream end of the avulsed ponds, placement of LWD would be most beneficial in downstream ponds.

CHANNEL AND POND SHORELINES

The steep slopes of the channel and pond shorelines support some willow and alder, but also include unvegetated, actively eroding banks. It should be noted that steep banks occur along relatively natural active and abandoned channels just upstream of the pits, although these are generally not as high as those in the ponds. Consequently, a steep shoreline is not necessarily undesirable, but is within the range of naturally occurring channel bank profiles in the area.

There are also some shorelines with a bench between the ponds and the higher unexcavated area used for processing and transportation (i.e., the abandoned floodplain surface described below). One of these areas examined in January 1999 had deposits of sediment from recent high flows, but was also well vegetated with willows, alders, sedges, and other plants. Such benches are in some way similar to the sediment deposits that are accumulating in the shallower portions of the ponds, but they already have established vegetation and are presently slightly higher in vegetation.

RECOMMENDED RESTORATION ACTIONS

The lower portions of the shorelines, including the benches intermediate in elevation should be left alone for the most part. These areas are also dynamic, in the sense that they are inundated periodically and tend to be acquiring sediment. It is desirable to let these natural processes continue and let vegetation become established on its own.

One intervention that would be of use is implementing some control measure for reed canarygrass (*Phalaris arundinaceae*) invasion that is taking place. The infestations are not now extensive, and manual removal together with planting highly competitive, desirable species would help retard the spread of this very invasive species

In the one off-channel pond that remains unconnected to the river (Pond 9), some active restoration is recommended. This would include modifying the banks from their presently steep shape to much more gradual slope (1H:5V or shallower) to allow the development of an emergent wetland zone. This would be an excellent opportunity for a pilot project to test methods for creating emergent wetlands along reclaimed pond shorelines in the Daybreak area. These could involve trials to test species for suitability to plant at the site and evaluation of the potential for natural colonization of wetland areas.

Restoration of the upper portions of the shorelines ties in directly with any restoration actions taking place on the floodplain surface. The upper portions of the steep shoreline banks also tend to be the steepest and least vegetated. Grading these sharp bank edges back to reduce potential for erosion and revegetating them with species such as red alder and cottonwood would help to stabilize the bank tops, contribute to shade of the water surface below, and provide a future source of LWD.

ABANDONED FLOODPLAIN SURFACE

Much of the floodplain area in the vicinity of the Ridgefield pits and Daybreak ponds is characterized by dense forests of cottonwoods and alder with conifers such as Douglas fir and western red cedar invading in somewhat older stands. Establishing this kind of native forest community should be the goal for the flat higher surfaces around the ponds, referred to here as the abandoned floodplain surface. Now that the river has avulsed into the gravel ponds, these areas are above the 100-year floodplain, but historically were likely within the active floodplain along a reach that was once characterized by braided channels. Reintroduction of a floodplain/valley bottom forest will provide habitat for a variety of wildlife, will stabilize the land surface, eventually be a source of LWD to the river, and provide shade along the water's edge.

The surface appears now to be highly compacted as a result of activities associated with gravel processing and transportation of mined materials. The surface is now mostly vegetated by grasses, with the exotic shrub Scots broom (*Cytisus scoparius*) in the process of invading and forming open to dense stands in some areas. There are also scattered individuals or patches of young red alder. Red alder is mostly present along the edges in slight depressional areas.

RECOMMENDED RESTORATION ACTIONS

Restoration of this area will likely require extensive scarification to reduce or eliminate the compaction and remove the Scots broom. It would also be desirable to create some topographic heterogeneity to introduce some drainage and create microsites for a more diverse vegetation. Judging from the successful natural colonization of red alder in places on the present land surface, creation of an alder dominated forest would seem most readily attainable. Cottonwood, Douglas fir, and western red cedar could also be incorporated in lesser amounts. Successful establishment of cottonwood, and to some extent alder, will depend on adequate levels of soil moisture. Because the avulsion of the river into the pits has lowered its surface elevation, the water table in this abandoned floodplain area has also likely dropped, which may make establishment of some desired species more difficult.

To create dense swards of alder simulating the development of a natural stand and to eliminate competition from invasive species, seeding rather than planting would be preferred. Seed and planting trials should be conducted to determine the most effective method of establishing as quickly as possible the desired species mix. If dense stands of these species can be established, no understory plantings will be necessary. The understory, as well as other tree species, can be introduced later either by natural colonization or by plantings as the stand opens up by self-thinning.

Control of Scots broom will likely be needed until the stand can be established. The existing plants have likely created a relatively large seed bank that will continue as a source of new plants for several years to come.

Table 1. Summary of conceptual restoration plan for Ridgefield Pits, East Fork Lewis River.

Geomorphic Feature	Restoration Goal	Active/Passive Restoration	Restoration Elements
Active channel	• fill in ponds with sediment and eventually restore spawning gravels	passive	• allow river to move in sediment and gravel naturally
Off-channel ponds	• develop wetlands and off-channel rearing habitat	passive, some active	• allow river to move sediment into ponds • allow vegetation to establish naturally • move some LWD into ponds to provide habitat structure in interim
Channel and pond shorelines	• create emergent wetland in shoreline elevation locations • create cottonwood-alder dominated riparian vegetation at higher shoreline elevations	passive/active	• allow sediment deposition and natural emergent wetland development in lower shoreline elevations • remove reed canarygrass and plant with fast-growing native species • cut back top of bank to create smoother slope to abandoned floodplain • plant alder and cottonwood along top of bank
Abandoned floodplain surface	• establish cottonwood-alder and mixed forest	active	• scarify surface and create more heterogeneous topography • seed with alder • plant cottonwood and conifers at lower densities in selected locations

Photo 1. Aerial photograph of Ridgefield Pits showing area included in conceptual restoration plan. Boundary of area on left bank of river (top of photograph) intended for revegetation as cottonwood-alder forest is arbitrary, actual boundary would depend on topography, ownership and scope of project.

Photo 2. Large woody debris and gravel deposits at upper end of Ridgefield Pits exemplifying active fluvial processes within areas seasonally inundated by EF Lewis River.

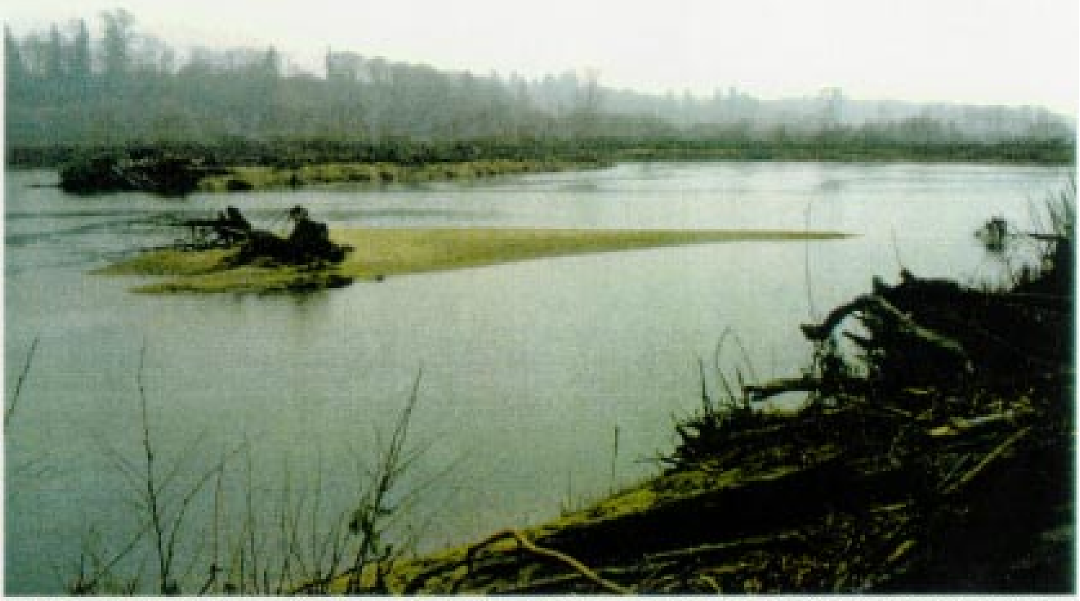

Photo 3. Path of EF Lewis River (i.e., "active channel") through Pond 5 within Ridgefield Pits showing LWD and sediment deposits. Active restoration envisioned for this area includes grading back the top of steep shorelines and establishing cottonwood-alder forest on prior floodplain surface.

Photo 4. Off-channel pond area in portion of Pond 3 north of flow path. Active restoration in this pond would also include grading back the tops of steep shorelines and establishing cottonwood-alder forest on abandoned floodplain surface.

Photo 5. Deposition of sediment in Pond 1 of Ridgefield Pits. Young willow is present in foreground. Passive restoration by natural processes should take place in this area. Steep bank in background would be graded back.

Photo 6 Shoreline bench with naturally establishing wetland and riparian vegetation. This area has recent sediment deposits and will likely continue to be affected by fluvial processes. No active restoration planned for this area, other than possible reed canarygrass control.

Photo 7. Abandoned floodplain surface with grass and Scots broom vegetation. This is a compacted surface that needs to be scarified before revegetation with cottonwood-alder floodplain forest.

Photo 8. Edge of abandoned floodplain surface showing natural colonization by alders. Seeding of alders on scarified surface is possible way to extend this natural revegetation process to rest of abandoned floodplain surface.

Photo 9. Example of natural floodplain surface just upstream of Ridgefield Pits. Larger deciduous trees are cottonwood and smaller deciduous trees are alder. Small Douglas-fir is colonizing in foreground. This is reasonable reference site for restoration of abandoned floodplain surface in Ridgefield Pits.

Appendix C

Geomorphic Analysis of the East Fork Lewis River

Geomorphic Analysis of the East Fork Lewis River in the Vicinity of the Daybreak Mine Expansion and Habitat Enhancement Project

May 18, 2001

Prepared for:

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1 Introduction

J. L. Storedahl and Sons, Inc. owns a gravel extraction operation and processing plant, known as the Daybreak Mine, in rural Clark County, Washington, near the confluence of Dean Creek with the East Fork Lewis River. The Daybreak Mine is located approximately 15 miles north of Vancouver, 4 miles southeast of La Center, and approximately 1 mile downstream of Clark County's Daybreak Park (Figure 1-1). The plant is currently operated for processing and distributing sands and gravels that are imported from offsite. The gravel pits located on-site have been mined out, one has been reclaimed and the others are planned for reclamation. Located just north and east of the processing plant is an important source of high quality sand and gravel, which forms a terrace above the 100-year floodplain. This area has been proposed as an expansion to the existing Daybreak Mine and is referred to as the Proposed Project throughout this report. A detailed description of the mining, reclamation, mitigation and conservation activities proposed for the site is given in the Site Plan, Daybreak Mine: Mine Expansion and Habitat Enhancement (EMCON, 1998).

This report was prepared as part of a Habitat Conservation Plan (HCP) and an Environmental Impact Statement (EIS) for the proposed expansion of the Daybreak Mine. In the following sections, the affected environment is described and analyses are presented of hydrology, hydraulics, sediment transport, channel profile, channel planform and channel avulsion. Each section contains its own summary with discussion of impacts to the East Fork Lewis River and Dean Creek from the Proposed Project.

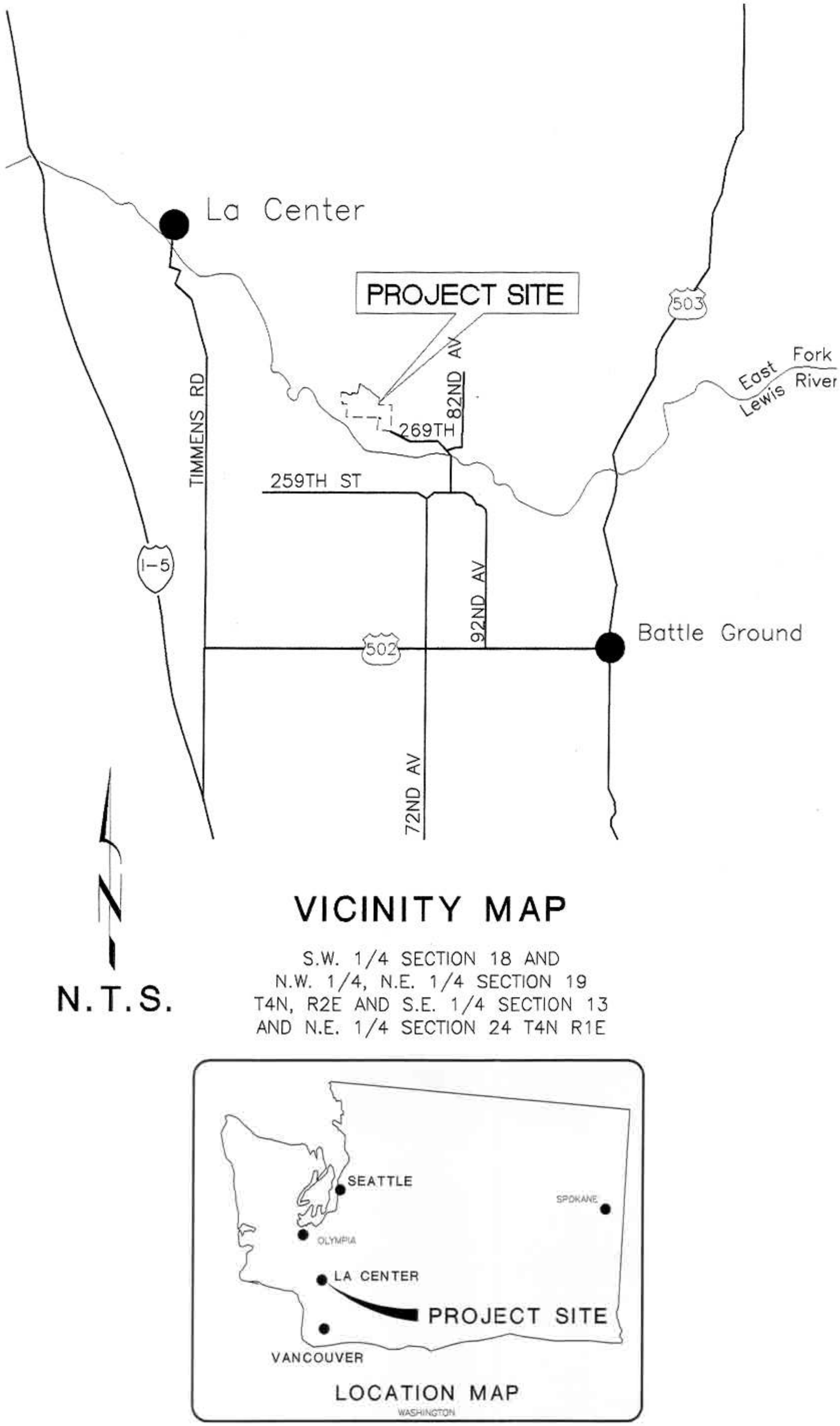


Figure 1-1. Project Location Map

2 Characterization of Affected Environment

2.1 Introduction

In the following sections the location and the physical characteristics of the basin and study area are described.

2.2 Basin Location and Size

The East Fork Lewis River basin is located in southwestern Washington State (Figure 2-1). Seventy-nine percent of the basin is within Clark County while the remaining twenty-one percent of the upper basin is in Skamania County. The outlet of the basin is approximately fifteen miles north of the Portland, OR – Vancouver, WA metropolitan area. The 212 square mile basin extends from the Western Cascade Mountains to the Willamette-Puget Trough (S.C.S., 1972). The basin is bordered on the east by the Cascade Mountains, the north by the Lewis River basin divide, and to the south by the Washougal River basin divide and Salmon Creek basin divide. The basin is approximately 31 miles long and ranges from 4 miles to 12 miles in width.

The East Fork Lewis River headwaters are in the western foothills of the Cascade Mountains on the west slopes of Cougar Rock and Lookout Mountain in the Gifford Pinchot National Forest. From this location the river flows west to its confluence with the Lewis River near La Center, WA. Basin elevations range from 4,442 feet at Green Lookout Mountain to approximately mean sea level at the confluence with the Lewis River. The main stem of the East Fork flows for approximately 11 miles in Skamania County and the National Forest before entering Clark County. The river continues for another 32 miles to its confluence with the Lewis River. From the confluence, the Lewis River flows southwesterly for approximately 3 miles to its confluence with the Columbia River at river mile 87. A profile plot of the lower and middle portions of the East Fork Lewis River is shown in Figure 2-2.

The basin can be subdivided into three main sections based on similar geomorphic characteristics. The upper or mountainous section is characterized by steep forested terrain with tributary gradients that average 130 feet per mile. The middle section is characterized by a transition from steep to flat gradients with slopes averaging 20 feet per mile. The lower section is characterized by very flat and broad terrain with slopes averaging 2 feet per mile.

2.3 Floodplain / Channel Characteristics

In the following sections, a general description of the channel and floodplain characteristics associated with the East Fork Lewis River and Dean Creek are described. These characteristics include the channel slope, channel confinement, sinuosity and approximate floodplain width.

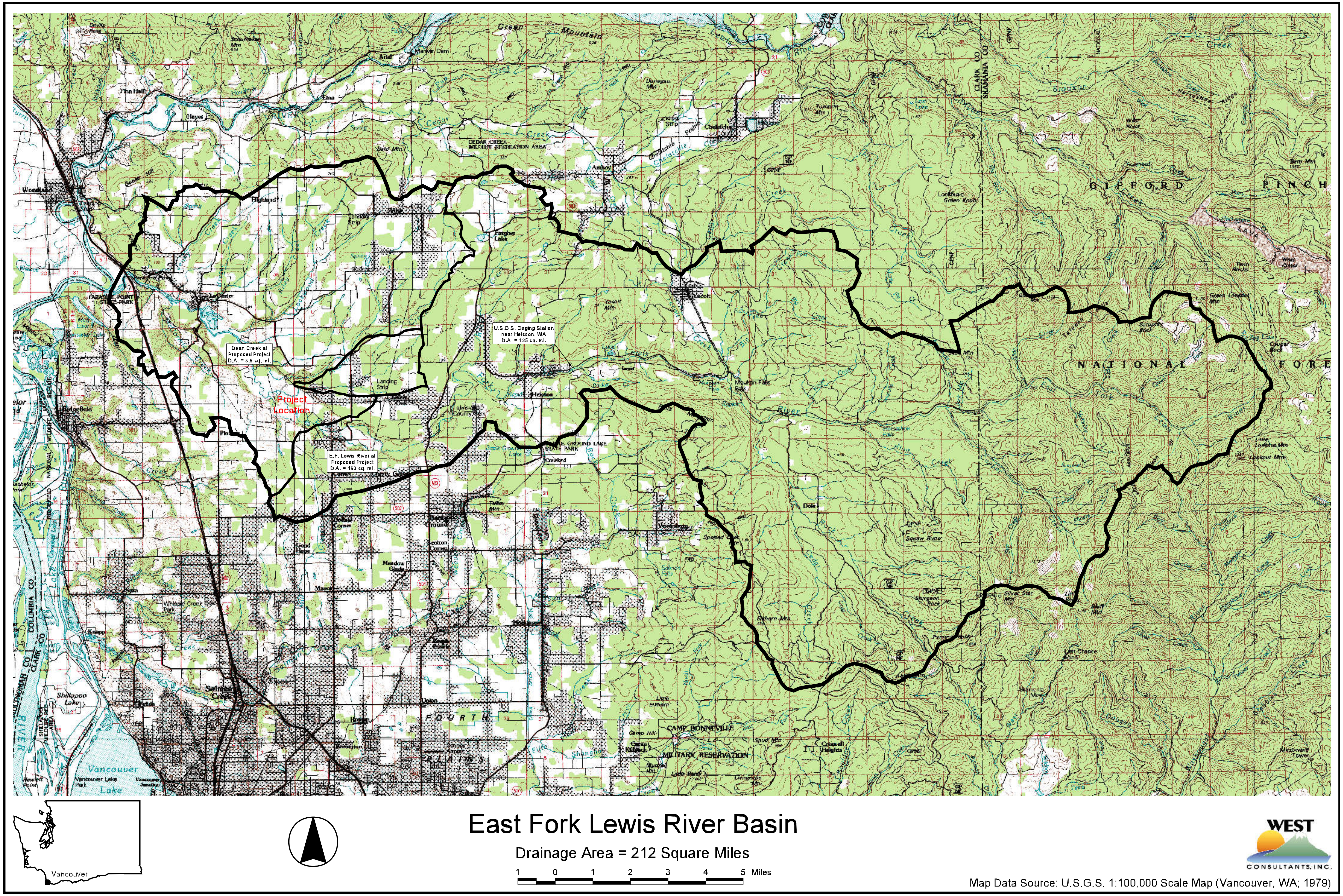


Figure 2-1. East Fork Lewis River Basin Map

2.3.1 East Fork Lewis River Characteristics

Field reconnaissance observations and examination of a series of USGS 7.5-minute series topographic maps were used to define floodplain and channel characteristics of the East Fork Lewis River. The upper portion of the East Fork (headwater to RM 23.1) has a mean gradient of approximately 2.5 percent. The river is typically confined to a narrow v-shaped valley that includes several falls and rapids. From RM 23.1 to RM 19.0 the river travels through a narrow valley with a discontinuous floodplain. The mean gradient of the river in this reach is approximately 0.74 percent. From RM 19.0 to RM 16.8 the river is confined to a narrow gorge adjacent to a small terrace. The mean gradient in this reach is approximately 0.69 percent. From RM 16.8 to RM 10.2 the river is confined to a narrow meander belt that is approximately one-eighth to one-quarter of a mile in width. The river in this reach is very sinuous and includes island and bar deposits with a mean gradient of approximately 0.42 percent.

From RM 10.2 to RM 7.0 the river transitions to a much lower gradient system. This reach represents a depositional zone that is the focus of this study. The valley bottom in this section of river is approximately one-half to three-quarters of a mile in width. Several alluvial terrace deposits have been mapped (Mundorff, 1964) in the vicinity of the Daybreak site. The terraces are the result of sediment deposition that occurred at different river elevations from the mid-Pleistocene to the present. The Proposed Project will be located on existing ground that is 10 to 15 feet in elevation above the existing channel. However, after mining, the minimum elevation of Proposed Pits will be below the existing thalweg elevation of the channel. The channel is generally located along the southern edge of the valley throughout this reach.

The East Fork Lewis River channel typically ranges from 100 to 350 feet in width and averages approximately 4 to 6 feet in depth at bank full stage. The banks are typically comprised of non-cohesive materials similar to the sediments found in the channel bed (sand, gravel and cobble). The rapid reduction in river gradient through the reach correspondingly reduces the sediment transport capacity of the river. The reduction in sediment transport capacity results in the deposition of sediments transported from upstream sources. The natural trend for sediment deposition along the river in this area results in a relatively high lateral migration rate. Additionally, lateral migration tends to rework materials that have been deposited in the past.

Three tributaries join the East Fork in the vicinity of the Proposed Project. The confluence with Mill Creek is located at about RM 9.2, Dean Creek joins the river at about RM 7.3, and Mason Creek enters at RM 5.9. All three tributaries issue from the steep valley walls surrounding the East Fork Lewis River and have much smaller drainage areas. Of these tributaries, Dean Creek is considered to be an important stream due to its proximity to the Proposed Project and its use by salmonids. A summary of drainage areas for the East Fork Lewis River and its tributaries in the vicinity of the Proposed Project is shown in Table 2-1.

Table 2-1. Drainage area of East Fork Lewis River and major tributaries in vicinity of Proposed Project.

Stream	Location	Drainage Area (mi^2)
East Fork Lewis River	At entrance to Ridgefield Pits	163
Mill Creek	At confluence with East Fork Lewis River	3.79
Dean Creek	At confluence with East Fork Lewis River	4.02
Mason Creek	At confluence with East Fork Lewis River	10.8

During a field reconnaissance conducted on January 18, 1999, the East Fork Lewis River was seen to be actively eroding the high banks of the south valley wall in several locations between RM 10.2 and RM 7.0. The eroding banks are approximately 75 to 100 feet in height and are situated in an exposure of the Lower Troutdale geologic formation that consists of sands with some clays and silts. The high banks were observed to be eroding due to a combination of undercutting and overland runoff. In both locations, the river was seen to be impinging on the toe of the slope. At RM 7.0, runoff from upland areas was flowing down and eroding the bank slope. Runoff was also seen to be flowing from the boundaries between different soil horizons in the bank. Large blocks of the high bank had been recently eroded and the river was transporting the eroded materials away from the toe of the slope.

From RM 7.0 to RM 2.4 the river valley broadens further and the river continues its sinuous pattern at an approximate slope of 0.05 percent. Tidal effects from the Columbia are normally present up through this reach to approximately RM 5.9 (Hutton, 1995), but can extend as far as RM 7.3 when flooding coincides with high tide (FEMA, 1991). Field observations indicate that the median sediment size decreases rapidly in a downstream direction. Gravel bars are absent and river banks are comprised of sands and silt. Bank heights are typically 5 to 8 feet above the river surface.

From RM 2.4 to RM 0.8 the river channel widens but is confined by steep hill slopes and the I-5 freeway bridge. The mean gradient in this section is approximately 0.02 percent. From the I-5 bridge at RM 0.8 to its confluence with the Lewis River the gradient is approximately 0.01 percent. Downstream of the I-5 Bridge the river turns to the south and then to the west flowing around a bar that has formed at the confluence of the East Fork Lewis and Lewis Rivers.

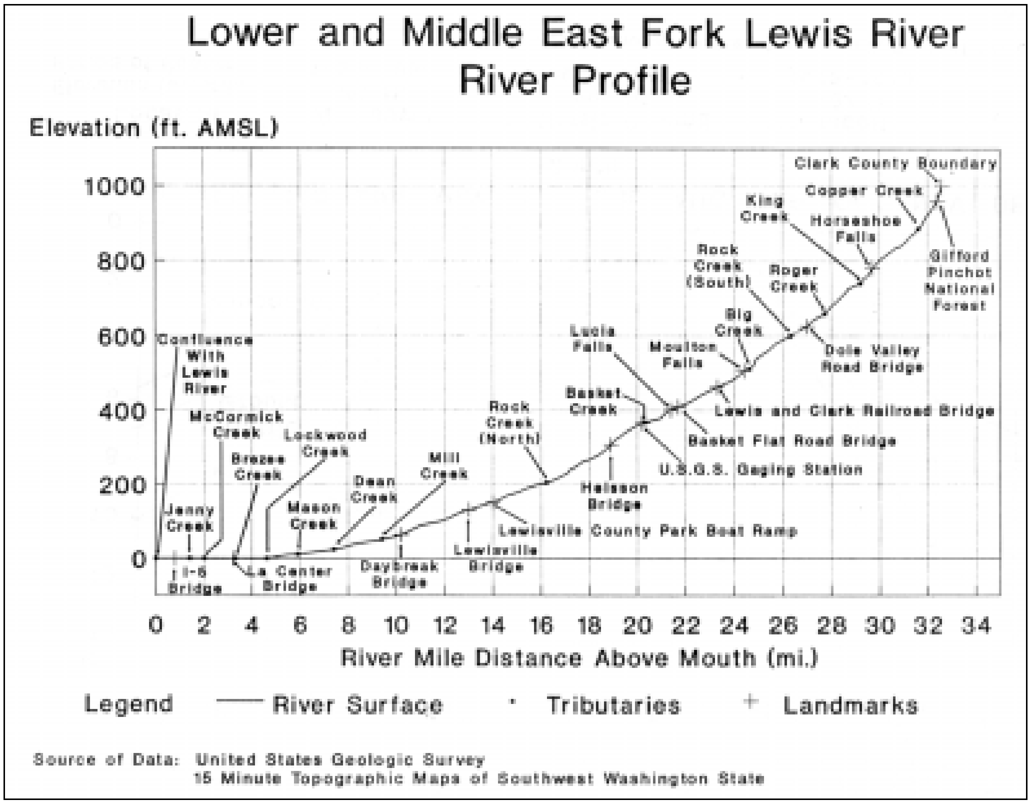


Figure 2-2. Profile of lower and middle East Fork Lewis River (Hutton, 1995).

2.3.2 Dean Creek Characteristics

Field reconnaissance observations and examination of a series of USGS 7.5-minute series topographic maps were used to define channel characteristics of Dean Creek. The headwaters of Dean Creek (headwater to NE 112th Avenue) have a mean gradient that ranges form 5 to 6 percent. The creek is typically confined to a shallow v-shaped valley. Below this section (from NE 112th Avenue to NE 82nd Avenue) Dean Creek has a channel gradient of approximately 1 percent where it flows along the high terrace above the East Fork Lewis River valley. From NE 82nd Avenue the channel gradient increases to approximately 2.5 percent as it descends through a narrow canyon into the East Fork Lewis River valley. Below J. A. Moore Road, the gradient is reduced to approximately 0.5 percent and the creek becomes slightly sinuous as it descends a small alluvial fan down to the East Fork Lewis River. Bed material is typically deposited in the vicinity of the J.A. Moore Road crossing due to the rapid reduction in channel slope at this location. Deposited sediments are periodically removed by county maintenance crews to maintain conveyance through the crossing. Additionally, discontinuous small levees exist on both sides of the creek that help maintain flow in the channel. However, these levees are composed of erodible native soils that would not be expected to prevent channel migration. A plan view of Dean Creek is shown in Figure 2-3.

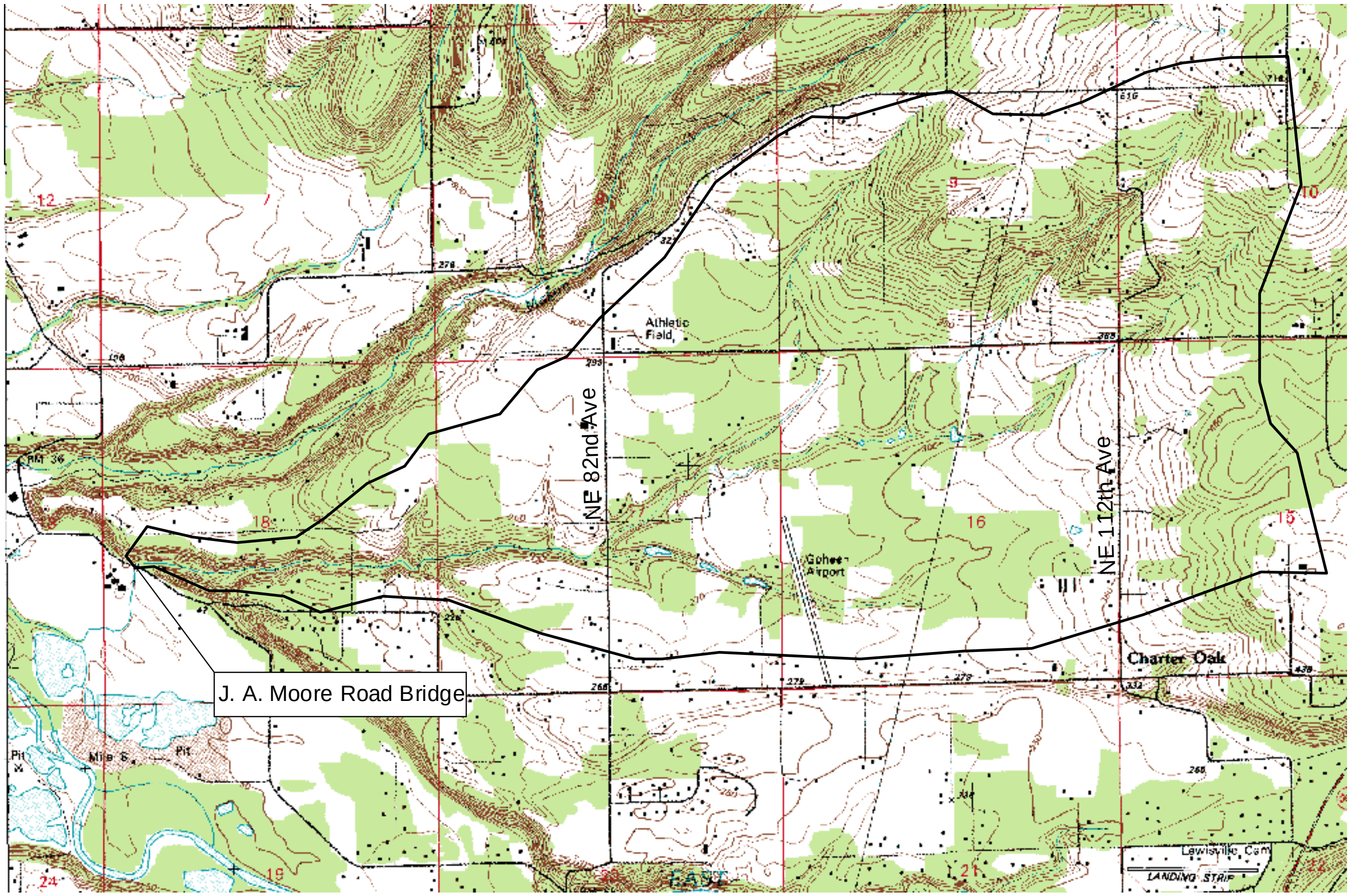


Figure 2-3. Plan view of Dean Creek Basin above J.A. Moore Rd.

2.4 Bed Material Characteristics

The following sections describe the bed material size characteristics for the East Fork Lewis River and Dean Creek in the vicinity of the Proposed Project.

2.4.1 East Fork Lewis River Bed Material Characteristics

Sediments found in appreciable quantities within the bed of the river are called bed material. The size characteristics of bed material along the East Fork Lewis River vary with stream gradient. They range from sand to medium cobbles in size. The portions of the channel bed observed during field reconnaissance activities displayed armoring characteristics typical of gravel-bed rivers. The low gradient sections of the channel were armored with smaller 1- to 2-inch diameter gravel while the steeper sections were armored with 4- to 6-inch diameter cobbles. Abandoned channels, with the lowest gradients, were observed to have significant deposits of medium to coarse sand building on top of gravel and cobble armor developed under former flow conditions. Subsurface sediment sizes were observed to be relatively consistent along the river in the vicinity of the project. The median sediment size (D_{50}) of material underlying the armor layer was estimated to be gravel of approximately 1.5 inches in diameter. The largest sediment size observed was about 8 inches in diameter. Detailed bed material size gradation information is provided in Section 5, “Sediment Transport”.

2.4.2 Dean Creek Bed Material Characteristics

Field observations of bed material in Dean Creek near J. A. Moore Road show it to have size characteristics similar to the bed material of the East Fork Lewis River. In the steeper portions of the creek the channel is seen to be armored with large gravel- and cobble-sized material. Subsurface sediments range from sand to gravel in size.

2.5 Geology

The geology of the East Fork Lewis River basin was mapped and described by Phillips (1987). The East Fork Lewis River basin contains 3 major types of geological deposits: volcaniclastic rocks forming the Cascade Mountains, sedimentary deposits of the Troutdale formation, and periglacial deposits from the Lake Missoula Glacial Outburst Floods. Minor inclusions include intrusive granitics of the Silver Star pluton and basalt flows of the Boring lavas. Alluvium dating from the Pleistocene to the present occupies the valley formed by the lower East Fork Lewis River.

Sedimentary deposits of the Troutdale formation dating from the Pliocene are located along the western foothills of the Cascades, trending northwest to southeast across the East Fork Lewis River basin. The older, Lower Troutdale is composed primarily of clay, silt, and fine sand (Mundorff, 1964). The lower Troutdale crops out along the East Fork Lewis River valley and is visible on the north side of the valley above the Daybreak Bridge as well as the south bank across from the Daybreak site and in the mining operation east of Dean Creek. Mundorff (1964) mapped the upper surface of the lower Troutdale formation in Clark County. Information in Mundorff (1964) and from site observations indicate that the top of the lower Troutdale formation is at an elevation of approximately 100 to 115 feet along the south bank of the East Fork Lewis River near the Daybreak site. The fine-grained lower Troutdale is exposed along a steep cut-bank directly south of the site. The Pliocene-age Upper Troutdale Formation consists of cemented gravel and conglomerates, with lenses of sand and claystone. The formation occurs as a wedge of sediments throughout the Portland Basin.

The Lower Troutdale formation exposed along the south side of the East Fork Lewis River near the Ridgefield Pits is overlain by a Pleistocene alluvial terrace deposit. There is an erosional unconformity between the Lower Troutdale and alluvial deposits which is visible along the riverbank. The alluvial terrace deposit consists of very coarse gravel in a sandy matrix and is known to be unstable. The deposits include quartzite and granitic pebbles, which were reworked from the Upper Troutdale formation and periglacial deposits. Recent observations suggest this to be a significant source of local sediment input to the river.

Periglacial deposits from the Lake Missoula glacial outburst floods were left along the Columbia River between about 12,700 to 15,300 years ago. The material was deposited as a great delta or fan at the mouth of the gorge (Mundorff, 1964). Within the East Fork Lewis River basin, these deposits are predominantly sand-sized. The Columbia River cut down through this formation, leaving a series of wide benches and terraces to the south.

The river valley formed by the lower East Fork Lewis River is filled with alluvium dating from the Pleistocene to the present. The alluvium consists of gravel, cobbles, sand, and silt, and ranges from several feet to 50 feet thick at and near the Proposed Project site. Gravels and cobbles are exposed in cut banks and on the river bottom in the vicinity of the site. Gravel bars are common in the river reaches above and along the Daybreak site but are absent downstream in the tidally influenced reach, where fine sands, silts, and clays predominate.

2.6 Soils

Soils in the upper East Fork Lewis River basin are generally deep, well-drained silt loams (McGee, 1972). Soils formed on periglacial deposits adjacent to the lower river are deep, well to poorly drained silt and sandy loams. Soils formed on alluvium deposited by the East Fork Lewis River are generally excessively drained sandy loams underlain by gravelly sand or loamy sand at a depth of 16 to 40 inches (McGee, 1972).

The soil types identified at the Daybreak site, as mapped by the Soil Conservation Survey (SCS) (McGee, 1972) include the Washougal loam (WaA), Washougal gravelly loam (WgB, WgE), Puyallup fine sandy loam (PuA), and Pilchuck fine sand (PhB). Descriptions of each soil type are as follows:

Washougal Loam and Washougal Gravelly Loam

The Washougal loam and Washougal gravelly loam consist of well-drained soils on top of sands and gravels. The water-holding capacity of the loam is slightly higher than that of the gravelly loam. Permeability in the units is rapid in the substratum and the surface runoff potential is low, making the erosion hazard slight to none. The Daybreak site contains about 50 acres of Washougal loam, 50 acres of Washougal gravelly loam with 0 to 8 percent slopes, and 0.4 acre of Washougal gravelly loam with 8 to 30 percent slopes. The soils are classified as Capability unit IIIe-3 (low fertility).

Puyallup Fine Sandy Loam

Puyallup soils are excessively well drained and overly sands and gravel of moderately rapid permeability. Surface runoff is low, making the erosion hazard slight to none. About 125.5 acres of Puyallup fine sandy loam occur on the Daybreak site. The soil is classified as Capability unit IIIs-1 (moderate fertility).

Pilchuck Fine Sand

Pilchuck fine sand consists mostly of sand, with some cobbles and gravel. The Daybreak site contains about 40 acres of Pilchuck fine sand. The soil is classified as Capability unit VIIIw-1 (not suited for cultivation).

2.7 Human Influences

The East Fork Lewis River basin is subject to a variety of human activities that may influence the morphology of the river. These activities include conversion of land use due to rapidly expanding residential developments, mining, road and bridge construction, and forestry practices. Brief descriptions of these human influences follow.

2.7.1 Population

Population data for the entire East Fork Lewis River basin is not available; however, historic population information for the Clark County portion of the basin can be used as an indicator of population trends. The population within Clark County's portion of the basin has increased from approximately 17,900 in 1981 to 20,500 in 1991, approximately a 15 percent increase (Hutton, 1995). The majority of the population lives in the western two-thirds of Clark County's portion of the basin (Hutton, 1995). Higher population densities are found along the State Route 503 corridor near the three incorporated areas of Battle Ground, La Center, and Yacolt as well as adjacent to the mainstem East Fork Lewis River (Hutton, 1995). In recent years, there has been a substantial increase in the number of homes built and seasonal cottages renovated adjacent to the East Fork (Hutton, 1995).

2.7.2 Land Use

The pattern of land use within the East Fork Lewis River basin changes over the three general topographic subdivisions (lower, middle, upper) of the watershed. Generally, forestland increases and farming and residential land use decreases from west to east. The predominant land uses in the basin are forestland and agriculture. The character of the basin remains mostly rural. In recent years, residential development has increased in the lower section of the basin (Hutton, 1995).

In the vicinity of the Proposed Project, residential developments are significant along NE 269th Street. The roads and residential developments in this area are in close proximity to and may be influenced by flooding along the East Fork Lewis River. Effectively, the developments in this area constrain the potential migration range of the East Fork Lewis River.

From field reconnaissance observations, it is noted that urbanization is rapidly increasing in the watershed areas of tributaries to the East Fork Lewis River including the Dean Creek basin. The increasing urbanization would be expected to increase runoff volumes and flood peaks along the tributary streams. Channel adjustments along the tributaries would be expected to accommodate the altered hydrologic conditions. Channel adjustments may include channel downcutting and bank erosion.

2.7.3 Mining

Copper and gold associated with the Silver Star Pluton were discovered near the headwaters of the East Fork Lewis River in the late 1890’s (USFS, 1995). Several hundred mining claims were staked, and small mining communities such as Copper City and Texas Gulch were established (USFS, 1995). The Yacolt Burn forest fire of 1902, and subsequent fires brought an abrupt end to mining activities, destroying mine structures and the timber that provided a source of construction materials (USFS, 1995). There are currently approximately 300 active mining claims within the basin (USFS, 1995).

The aggregate resources of the East Fork Lewis River are valuable due to their high quality and close proximity to the Vancouver - Portland metropolitan area. Aggregate from mines along the East Fork Lewis River has been incorporated into a substantial portion of the asphalt and concrete paving of Clark County as well as many public and private projects in the county. It is not known when gravel mining first began in the lower East Fork Lewis River basin. However, it is known that numerous operators have historically conducted gravel mining along the lower East Fork for many years. Mining at the Daybreak site began sometime prior to 1968. A composite aerial photograph identifying the location of various currently operating and abandoned gravel pits along the lower East Fork is shown in Figure 2-4.

Figure 2-3. Composite Aerial Photo of East Fork Lewis River near Daybreak Mine

The gravel mining along the East Fork Lewis River has numerous potential hydrologic, hydraulic, water quality, and geomorphic impacts. Geomorphic impacts include creation of floodplain lakes and their associated potential for channel avulsion. A channel avulsion is a rapid and unexpected shift in channel position that causes a portion of the existing channel to be abandoned. An avulsion of the river into a gravel pit can dramatically alter the location of the watercourse resulting in the abandonment of sections of the existing channel system. The hydraulic and sediment transport characteristics of the river may be affected upstream, within, and downstream of the pit location. A potential for upstream and downstream degradation of the channel bed and other channel adjustments is associated with the avulsion of the river into a gravel pit.

The historic gravel mining activities in the vicinity of the Proposed Project have already influenced the morphology of the river (see Figure 2-4). In 1995, the river avulsed in to an abandoned gravel pit (RM 9 Pit) located near RM 9.0. This event caused the abandonment of a large meander bend. During the February 1996 flood, the river broke into the southeast corner of Ridgefield Pit No. 7, flowing back into the channel at its northwestern most point (Miller, 1996). This caused the abandonment of approximately 1,500 feet of channel located southwest of Daybreak Pit No. 5. In November 1996, the river migrated into the Ridgefield Pit No. 1, flowing back into the channel from Pit No. 7 again relocating a section of the main channel of the river. The avulsions into abandoned gravel pits have altered the hydraulic and sediment transport characteristics of the river. Other abandoned or mined out gravel pits exist along the river in the vicinity of the Proposed Project including the Daybreak Pits, County 1 Pit and County 2 Pit, and the remaining Ridgefield Pit No. 9 (see Figure 2-4) and may influence the river in the future. The most significant of these pits are the Daybreak Pits. Consequently, an evaluation of geomorphic impacts must consider both the effects of the Proposed Project individually and cumulatively with other historic gravel mining operations in the area.

2.7.4 Roads

As seen in Figure 2-4, numerous roads are located in the East Fork Lewis River valley in the vicinity of the project. The roads influence the morphology of the river by confining its potential migration boundaries and restraining its main channel location at bridge crossings. At RM 10.2, the Daybreak Bridge holds the East Fork Lewis River main channel against the north valley wall. However, the piers of the Daybreak Bridge direct downstream flow toward the south valley wall. Between RM 10.2 and 8.9, the river valley is crossed by several roads. These roads, and the developments bordering them, present practical barriers to the potential migration boundaries of the river. Erosion control measures would most likely be employed if migration of the river threatened the roads or surrounding developments, preventing permanent relocation of the channel to this portion of the valley.

Numerous forest roads are also located in the upper watershed of the East Fork Lewis River. Construction of the roads in the upper basin began in the 1940’s, primarily to support recreation and timber harvest (USFS, 1995). The construction and operation of forest roads can alter runoff characteristics by increasing drainage density, runoff volumes, and flood peaks. The alteration of hydrologic conditions and slope failures associated with forest roads can increase sediment supplies to stream channels. It is assumed that hydrologic alterations associated with forest roads in the upper basin are insignificant in the lower basin in the vicinity of the Proposed Project due to the large increase in drainage area. Furthermore, it is assumed that any increase in the sediment supply to the river attributed to forest roads will continue in the future.

2.7.5 Logging

Extensive forest fires in the early 1900's and the late 1920's reduced the amount of mature timber in the East Fork Lewis River watershed. This likely increased the amount of sediment input to the stream system at that time. Vegetation in the upper basin is composed primarily of early- to mid-successional conifer stands, and hardwoods (USFS, 1995). As timber harvesting increases in the upper watershed, sediment input to the streams may potentially increase.

2.8 Summary

The morphology of the East Fork Lewis River is affected by both natural and human influences. The Proposed Project is located in a transition zone between a steep, narrow transport reach and tidally influenced lowlands. It is a natural zone of sediment deposition. As the gradient of the stream reduces, the velocity of flow reduces, and the sediment transport capacity of the river is decreased. The reduction in sediment transport capacity causes the deposition of sediments supplied from upper watershed areas. The deposition of sediments results in relatively large lateral migration rates.

A similar process of sediment deposition occurs along Dean Creek where it transitions from a relatively steep system above J. A. Moore Road to a shallow gradient alluvial fan where it meets the East Fork Lewis River valley bottom. Sediment has been routinely removed from the Dean Creek channel in the vicinity of the J. A. Moore Road Bridge by Clark County to maintain channel conveyance. The removal of sediment may be contributing to the relative long-term stability of the Dean Creek channel in its present location. As described in Section 7, "Planform Analysis", Dean Creek has remained in the same location for at least the last 38 years.

The project area is influenced by a variety of human influences. These include land use changes, urbanization, mining, roads, and forestry practices. Urbanization of the watershed is expected to increase runoff volumes, flood peaks and sediment supply. The altered hydrologic characteristics of the basin may also alter sediment transport characteristics of the East Fork Lewis River. The urban development, roads and bridges along the river and throughout the river valley present practical limits to future river migration.

Gravel mining has been occurring along the East Fork Lewis River in the vicinity of the Daybreak site since at least the 1960's. Several abandoned or mined out gravel pits exist along the East Fork in the vicinity of the Proposed Project. Avulsion of the river into abandoned or unused pits has affected the hydraulics, sediment transport, and morphology of the watercourse. Avulsions of the river into abandoned pits occurred once 1995 (RM 9.0 pit) and twice in 1996 (Ridgefield Pits). Future avulsions of the river into existing and proposed gravel pits are possible. Both individual and cumulative impacts of such avulsions into gravel pits are evaluated in Section 8, “Channel Avulsion”.

3 Hydrology

3.1 Introduction

In the following sections, the hydrologic characteristics of the East Fork Lewis River and its tributary Dean Creek are described.

3.2 Climate

Western Washington's regional climate is maritime, influenced by mountainous barriers that inhibit the passage of both the moist marine air masses arriving from the west and the hot, dry continental air masses from the east. This region is characterized by mild temperatures with prolonged fair and cloudy periods, muted extremes, and narrow diurnal fluctuations (Hutton, 1995). Summers are relatively dry and warm, while winters are typically mild, wet, and cool. The majority of the precipitation occurs as rain caused by low-pressure systems that move in off the Pacific Ocean.

In Battleground, WA, located approximately 4 miles southeast of the Proposed Project site, average annual temperatures range from a mean monthly minimum of 31.4 °F in January to a mean monthly maximum of 78.1 °F in July (WRCC, 1998). Local climate varies substantially with elevation and season. Rainfall and snowfall increase and temperatures decrease rapidly with increasing elevation. The East Fork basin's local climate is heavily influenced by elevation increases in the Cascade foothills just east of Battle Ground (Hutton, 1995). As elevation rises over a relatively short distance, precipitation increases significantly and temperature decreases rapidly.

3.3 Precipitation

Average annual precipitation varies from 52.3 inches in Battleground, WA to over 100 inches in the upper East Fork Lewis River basin. Generally, precipitation is the lowest in the southwestern lower elevation areas and the highest in the northeast high elevations areas. Figure 3-1 shows the average monthly precipitation for representative stations in the basin. In general, the highest precipitation occurs during the months of November through February while the lowest precipitation occurs during the months of July and August.

3.4 Gage Records

The East Fork Lewis River contains only one long-term gaging station (East Fork Lewis River near Heisson, WA, USGS Gage No. 14222500). The record from this gage was used to describe the flow statistics along the East Fork Lewis River in the vicinity of the Proposed Project site. This included a flood-frequency analysis, average-flow conditions analysis, flow-duration analysis, and low-flow conditions analysis.

The gage (USGS gage no. 14222500) is located on the right bank, 60 feet downstream from Basket Creek, 1.5 miles northeast of Heisson and 3.4 miles southwest of Yacolt at river mile 20.2. The drainage area at this gage is 125 square miles. The period of record is from September 1929 to present. There is no regulation or diversion of flow upstream of the gage. The gage datum is 356.8 ft above sea level. Gage data were obtained from the USGS world wide web site (USGS, 1998)

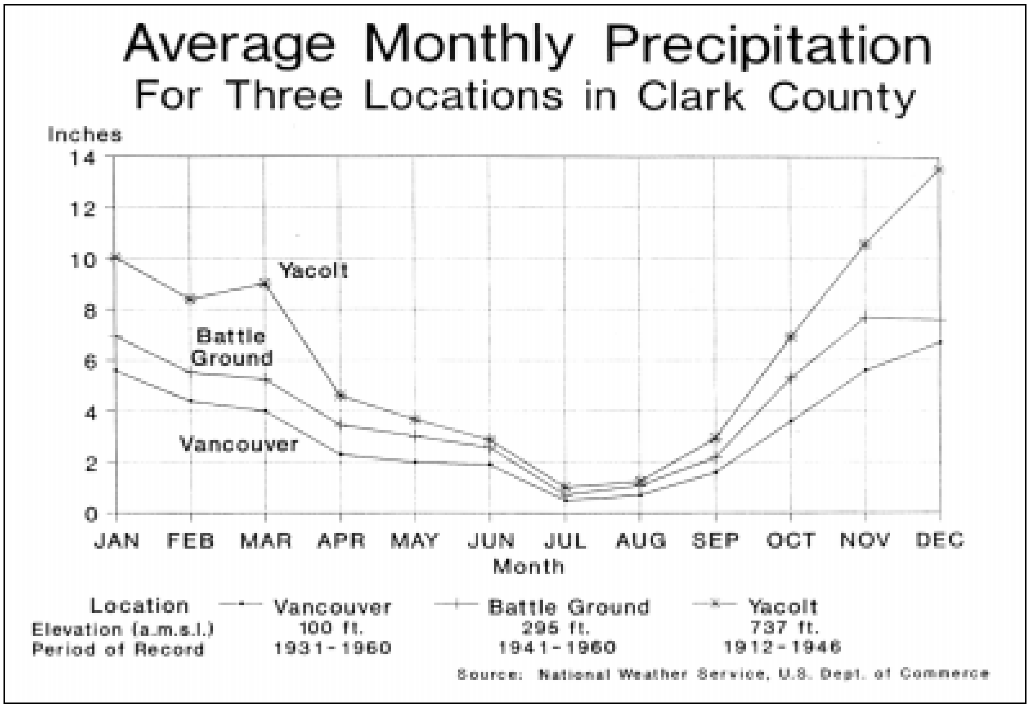


Figure 3-1. Average monthly precipitation (Hutton, 1995)

3.5 Flood History

The maximum discharge for the period of record for the gage near Heisson, WA was estimated to be 28,600 cfs and occurred on February 8, 1996 (Kresch, 1996). The ten largest floods measured at the gage are shown in Table 3-1. The smallest annual peak discharge of 3,390 cfs occurred on March 7, 1977. Figure 3-2 shows the peak flood events by water year for the period of record through 1996.

Table 3-1. Ten highest annual flood peaks for the East Fork Lewis River near Heisson, WA (1930 –1996).

Rank	Date	Discharge (cfs)
1	2/8/96	28,600
2	12/2/78	19,300
3	1/20/72	19,200
4	12/22/33	15,600
5	3/31/31	15,500
6	2/23/86	15,200
7	1/24/82	14,400
8	2/17/49	14,000
9	12/22/64	13,500
10	1/25/64	13,400

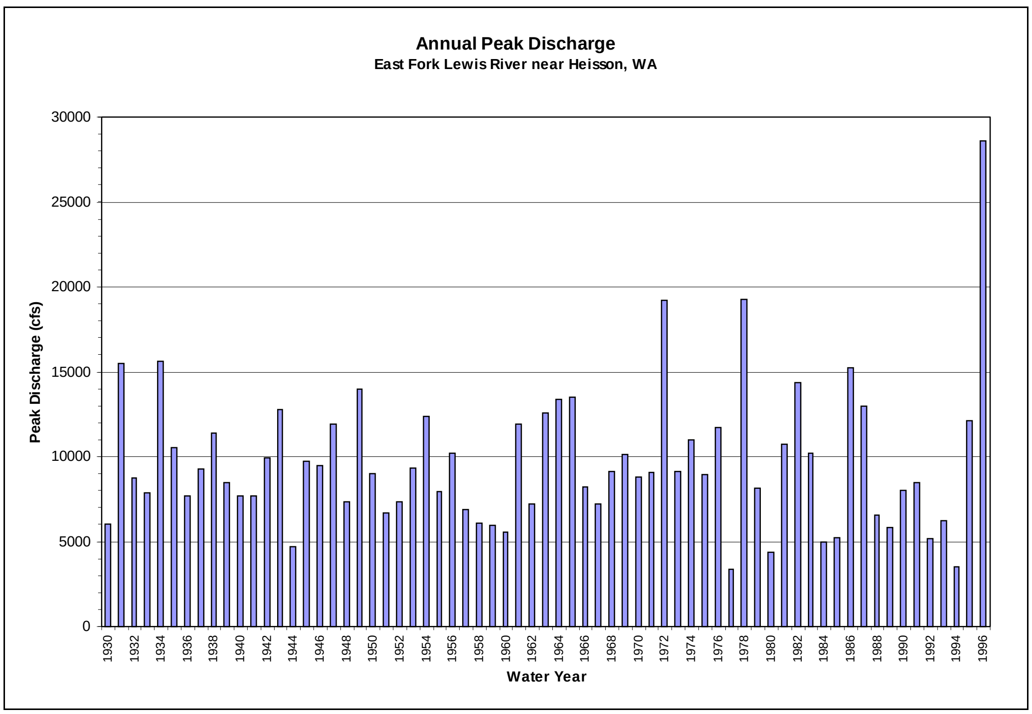


Figure 3-2. Annual peak flows for the East Fork Lewis River near Heisson, WA.

3.6 Flood Frequency Analysis

A flood frequency analysis was prepared for use in hydraulic and sediment transport analyses. The following sections describe the analyses conducted for the East Fork Lewis River and Dean Creek.

3.6.1 East Fork Lewis River Flood Frequency

A flood frequency analysis was prepared based on the East Fork Lewis River near Heisson, WA gage record. A Log-Pearson Type III analysis was performed using the Army Corps of Engineers HEC-FFA flood frequency analysis program (USACE, 1992). The analysis used data for the period from water year 1930 to water year 1996. The flood-frequency values for the USGS gage near Heisson, WA are given in Table 3-2.

Table 3-2. Flood-frequency values for the East Fork Lewis River gage near Heisson, WA.

Probability of Exceedance (%)	Recurrence Interval (yrs)	Discharge (cfs)
50	2	8,930
20	5	12,600
10	10	15,000
4.0	25	18,200
2.0	50	20,700
1.0	100	23,300
0.5	200	25,900
0.2	500	29,600

Based on the results of the flood-frequency analysis, the flood of record that occurred on February 8, 1996 had a recurrence interval of 500 years (USGS, 1997). The flood-frequency curve is shown in Figure 3-3.

In order to estimate the flood-frequency values for the East Fork Lewis River at the Proposed Project site, the values determined for the gaged site were transferred to the ungaged study site by a drainage area ratio transfer procedure. This was done using the following equation:

$$Qp_{\text{ungaged}} = Qp_{\text{gage}} * (D.A._{\text{ungaged}}/D.A._{\text{gage}})^{b}$$

Where:

Qp_{ungaged} is the peak discharge calculated for the location of interest downstream for a given recurrence interval.

Qp_{gaged} is the peak discharge for the USGS gage near Heisson, WA for a same recurrence interval.

$D.A._{\text{ungaged}}$ is the drainage area of the location of interest.

D.A. $_{gaged}$ is the drainage area at the USGS gage (in this case, 125 mi^2).

b is the exponent for drainage area parameter from the regional regression equation published by the USGS (USGS, 1974).

- For 2-year frequency, b=0.86
- For 5-year frequency, b=0.86
- For 10-year frequency, b=0.85
- For 25-year frequency, b=0.85
- For 50-year frequency, b=0.86
- For 100-year frequency, b=0.86
- For 500-year frequency, b=0.86 (assumed)

The drainage area for the East Fork Lewis River at the Proposed Project site is 163 square miles. Using the drainage area ratio transfer procedure, the calculated flood recurrence intervals are given in Table 3-3.

Table 3-3. Flood-frequency values determined for E.F. Lewis River at Proposed Project site.

Probability of Exceedance (%)	Recurrence Interval (yrs)	Discharge (cfs)
50	2	11,200
20	5	15,800
10	10	18,800
4	25	22,800
2	50	26,000
1	100	29,300
0.2	500	37,200

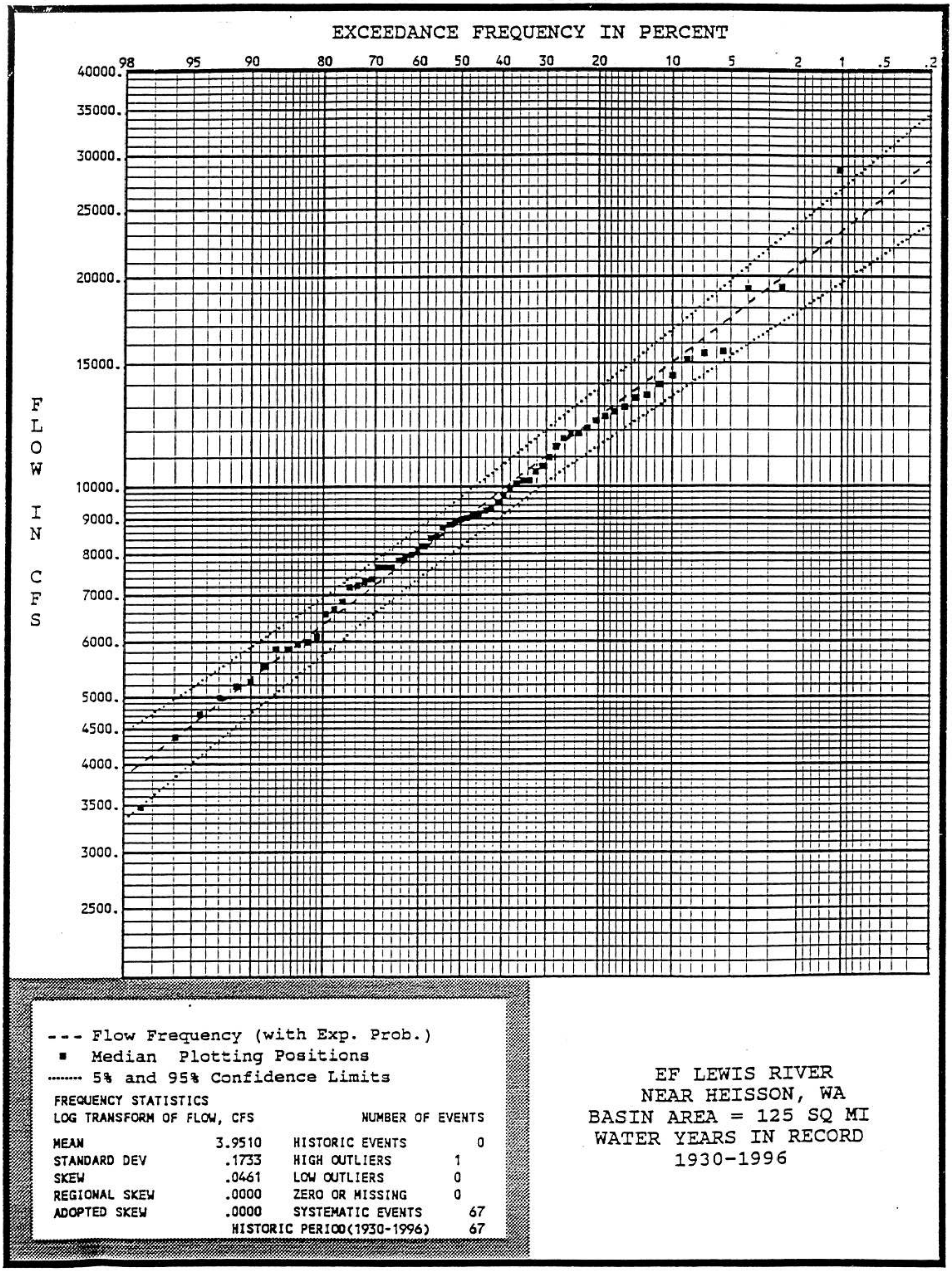


Figure 3-3. Flood-frequency curve for the East Fork Lewis River near Heisson, WA.

3.6.2 Dean Creek Flood Frequency

Dean Creek is an intermittent stream that flows along the northwest border of the project site. In order to determine peak flows for Dean Creek, regional regression equations (USGS, 1998) were used. The regional regression equation for Region 3, which includes Dean Creek, is shown below:

$$Q=aA^bP^c$$

Where:

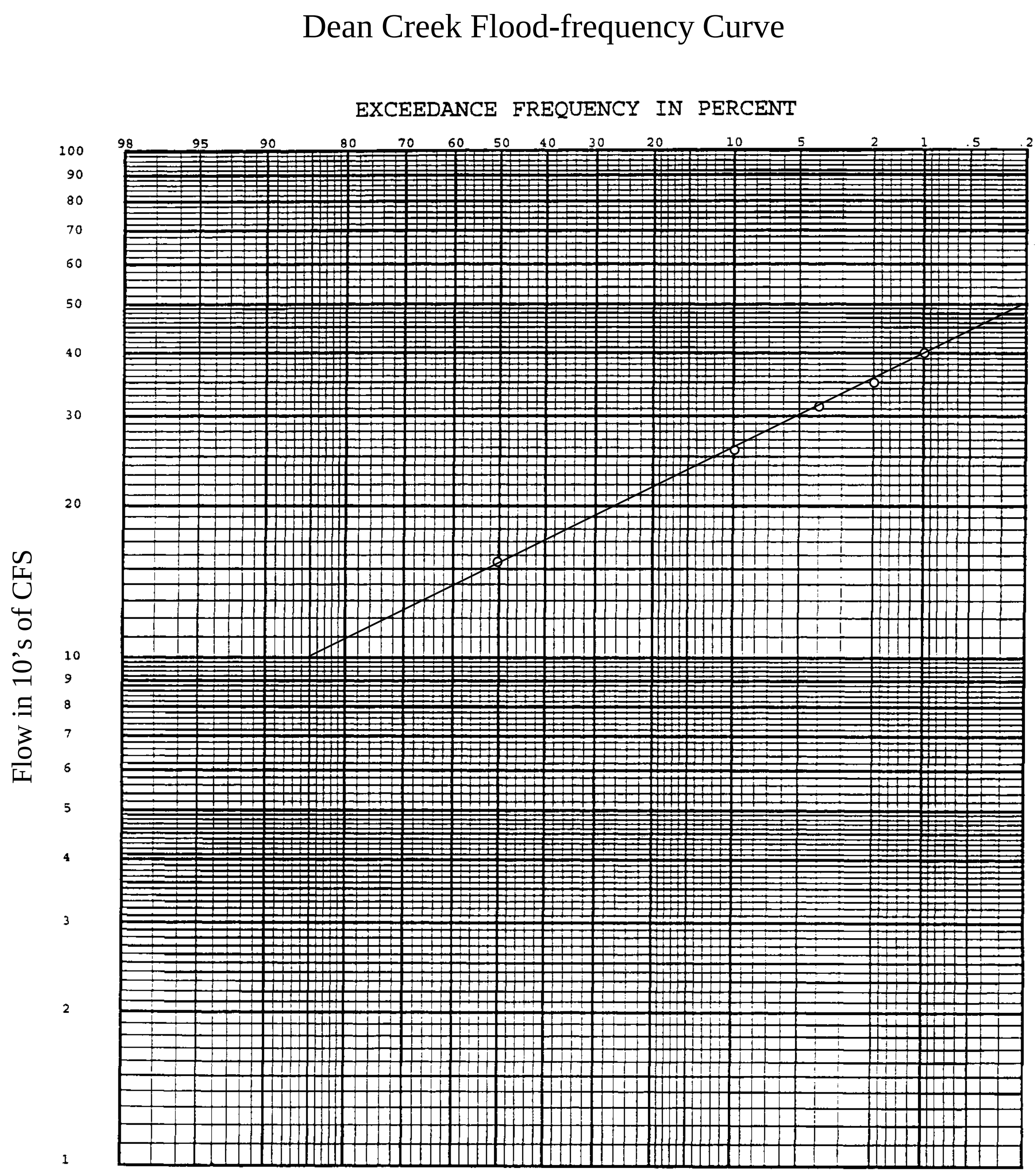
Q is the flood magnitude in cubic feet per second.
A is the drainage area of the basin in square miles.
P is the mean annual precipitation in inches.
a,b,c are regression coefficients.

Values used for Dean Creek are given in Table 3-4.

Table 3-4. Values used in regional regression equation (USGS,1998).

Probability of Exceedance (%)	Return Period (yrs)	a	b	c
50	2	0.817	0.877	1.02
10	10	0.845	0.875	1.14
4	25	0.912	0.874	1.17
2	50	0.808	0.872	1.23
1	100	0.801	0.871	1.26

The drainage area of Dean Creek at the Proposed Project site is 3.6 square miles. The mean annual precipitation is 60 inches (USGS, 1998). The developed flood peak estimates for Dean Creek are given in Table 3-5. The flood-frequency relation is shown graphically in Figure 3-4.



Event		Exceedance Frequency
500-Year	=	0.2%
100-Year	=	1.0%
50-Year	=	2.0%
10-Year	=	10.0%

Figure 3-4. Flood-frequency curve for Dean Creek.

Table 3-5. Flood-frequency values determined for Dean Creek at the Proposed Project site.

Probability of Exceedance (%)	Return Period (yrs)	Peak Discharge (cfs)
50	2	164
10	10	276
4	25	336
2	50	380
1	100	425

3.7 Average Flow Characteristics

In the following sections, average flow characteristics for the East Fork Lewis River and Dean Creek are presented.

3.7.1 East Fork Lewis River Average Flow Characteristics

Figure 3-5 shows the mean annual and mean monthly discharge determined for the East Fork Lewis River at the project site for water years 1930 through 1996. The pattern of average monthly stream flows is very similar to the pattern of precipitation shown in Figure 3-1. This is indicative of a rain-dominated system.

The average monthly flow values were determined by direct scaling of measurements at the Heisson gage. Scaling was done based on the ratio of drainage areas. The mean annual discharge of the East Fork Lewis River at the Proposed Project site was estimated to be 967 cfs. Monthly average discharges for the months of November through April exceed the mean annual discharge while the monthly average discharges for the months of May through October are less than the mean annual discharge. December has the highest mean monthly discharge of 1,909 cfs or 198% of the mean annual discharge while August has the lowest mean monthly discharge of 108 cfs or 11% of the mean annual discharge. December had the largest mean monthly discharge of 5,160 cfs, which is 534% of the mean annual discharge. August had the lowest monthly discharge of 48 cfs, which is 5% of the mean annual discharge.

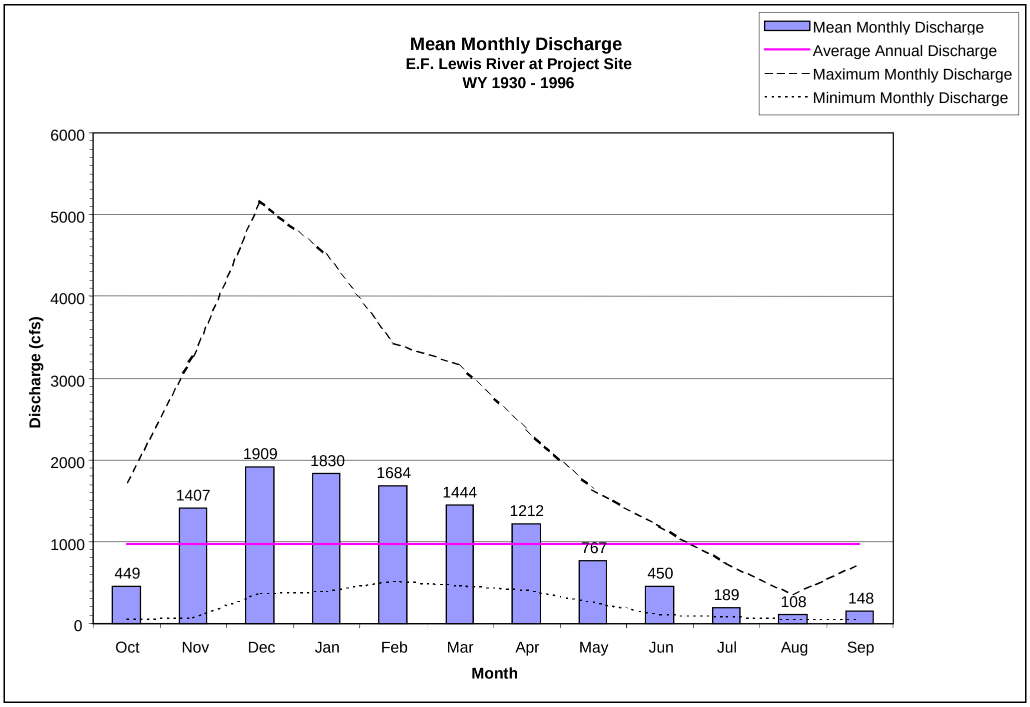


Figure 3-5. Estimated annual and monthly flow characteristics – E. F. Lewis River at the Proposed Project site.

3.7.2 Dean Creek Average Flow Characteristics

There is no continuous flow data available for Dean Creek. Additionally, there are no gaged streams of similar hydrologic characteristics within the basin on which to base a similar gage analysis. Thus, only a qualitative description of the flow characteristics can be given.

Dean Creek is an intermittent stream with an average monthly streamflow pattern that is assumed to be similar to that of the East Fork Lewis River. High flows occur during the winter months of November through February while low flows are fed by groundwater during the late summer months of July through September.

The flow characteristics of Dean Creek may change over time as urbanization of its watershed increases. Peak flows during winter runoff events will likely increase as urbanization increases impermeable areas and reduces the amount of vegetative cover. Urbanization will likely increase the magnitude of peak flows, increase winter runoff and increase the amount of sediment input to Dean Creek. Summer low flows may also be reduced as water that would otherwise infiltrate into soils becomes surface runoff. Reduced infiltration can lower the amount of water stored in the soils that supply water for late summer base flows.

3.8 Average Daily Discharge – East Fork Lewis River

Mean daily discharge for the East Fork Lewis River near Heisson, WA during water years 1995 and 1996 are shown in Figure 3-6. The individual high flow events are easily distinguished from one another. Both the rising and falling limbs of individual storm events are very steep. The stream system responds rapidly to rainfall events with increased discharge and drops off rapidly when the rains cease. High-flow events typically last less than two weeks. Extreme high flows, such as the February 1996 event, typically last a few days. Given sufficient time between storm events, the river discharge can drop off dramatically to well below the mean annual discharge. This is likely due to the shallow well-drained soils and steeps slopes in the middle and upper portions of the basin. Such soils rapidly transmit water as subsurface flow to the stream channel (Whipkey, 1965). The rapid response of the river from the storm event is reflected in the steep rising and falling limbs of the runoff hydrograph.

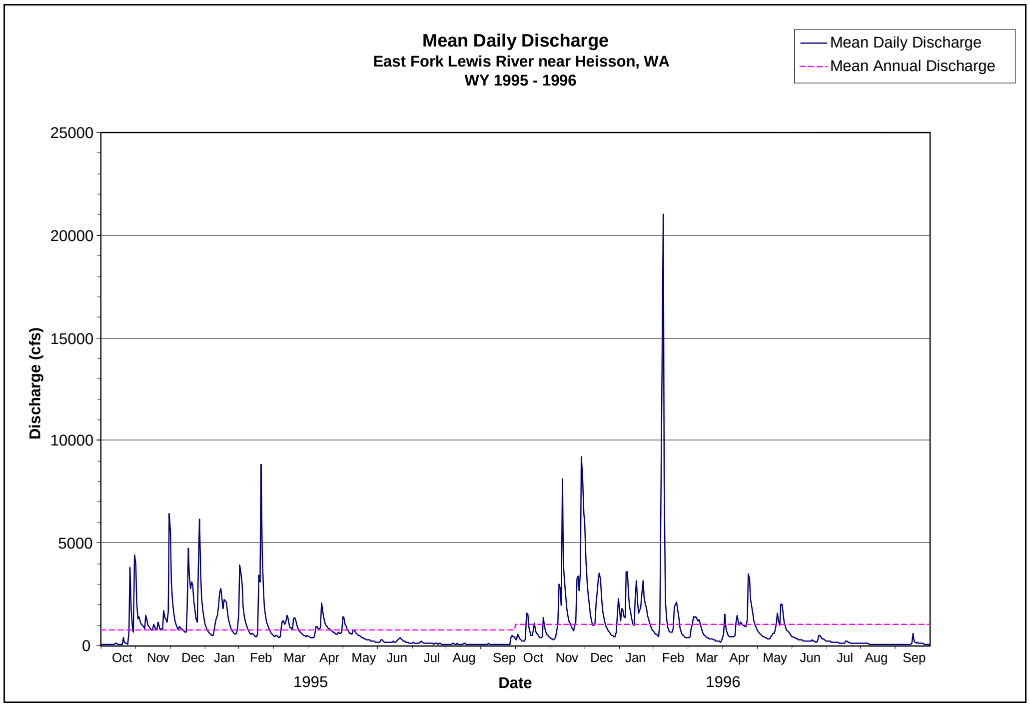


Figure 3-6. Mean daily discharge for the East Fork Lewis River near Heisson, WA (water years 1995 and 1996).

3.9 Flow-Duration Analysis – East Fork Lewis River at the Proposed Project Site

Figure 3-7 shows a flow-duration curve developed for the East Fork Lewis River at the Proposed Project site based on average daily flows. Values for this curve were obtained by scaling the flow duration curve for the USGS gage near Heisson, WA. The mean annual discharge is equaled or exceeded approximately 33 percent of the time. Table 3-6 summarizes the values for the flow-duration curve. Appendix 1 shows monthly flow-duration curves, based on average daily values, for the East Fork Lewis River at the Proposed Project site.

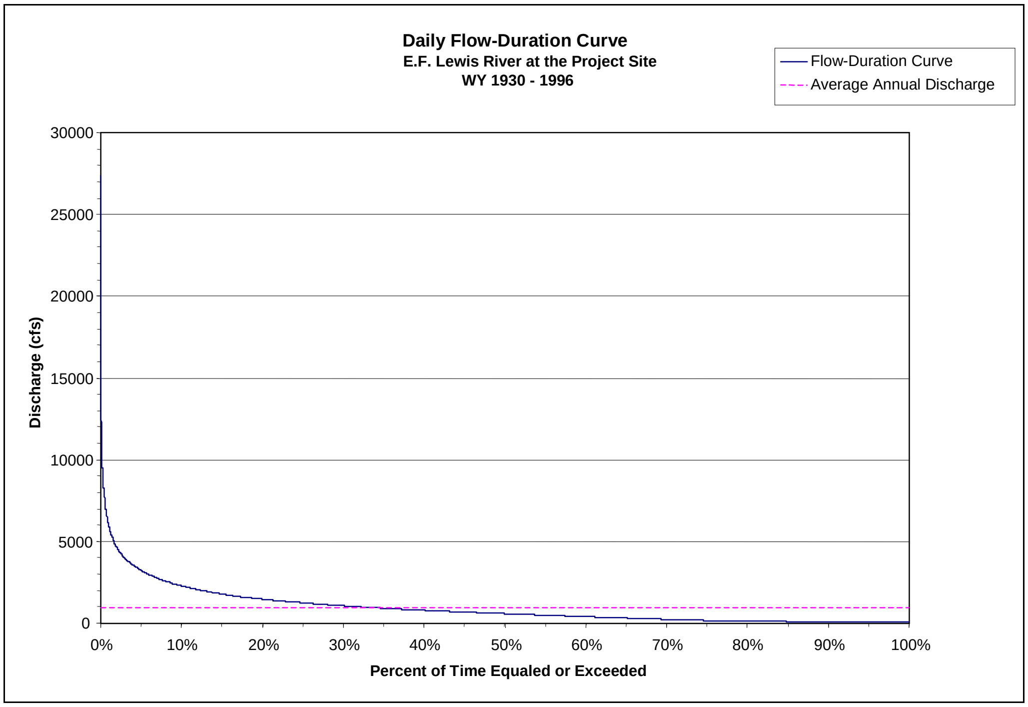


Figure 3-7. Estimated flow-duration curve for the East Fork Lewis River at the Proposed Project site.

Table 3-6. Estimated flow-duration values for East Fork Lewis River at the Proposed Project site.

Percent of Time Equaled or Exceeded	Discharge (cfs)
5	3,221
10	2,282
15	1,786
20	1,460
25	1,249
30	1,063
35	913
40	789
45	678
50	579
55	488
60	398
65	310
70	230
75	166
80	126
85	102
90	83
95	68

3.10 Low-Flow Characteristics

Low-flow characteristics are important for understanding the ability of the basin to deliver groundwater to the stream system. This can have a direct impact on the aquatic ecology of a stream. In the following sections, the low-flow characteristics of the East Fork Lewis River and Dean Creek are presented.

3.10.1 East Fork Lewis River Low-Flow Characteristics

Figure 3-8 shows the low-flow frequency distribution determined for the East Fork Lewis River at the Proposed Project site. The distribution is based on average daily flows obtained from the USGS gage near Heisson, WA. The flows at the project site were estimated based on drainage area ratios. Average 1-day, 3-day, 7-day, 14-day, 30-day, 60-day and 90-day flows were determined for each water year from 1930 to 1996. The lowest average daily flows from each category were then used for each water year. The flows were then ranked from smallest to largest with the smallest flow ranked number one. The Weibull plotting position formula was used to determine the recurrence interval for each annual low-flow event. Low flow frequency curves were visually fitted to the data plotted on the graph (Figure 3-8).

The lowest estimated average 1-day discharge of 37 cfs has a recurrence interval of 68 years. A summary of low-flow frequency distribution values determined for the East Fork Lewis River at the Proposed Project site is given in Table 3-7.

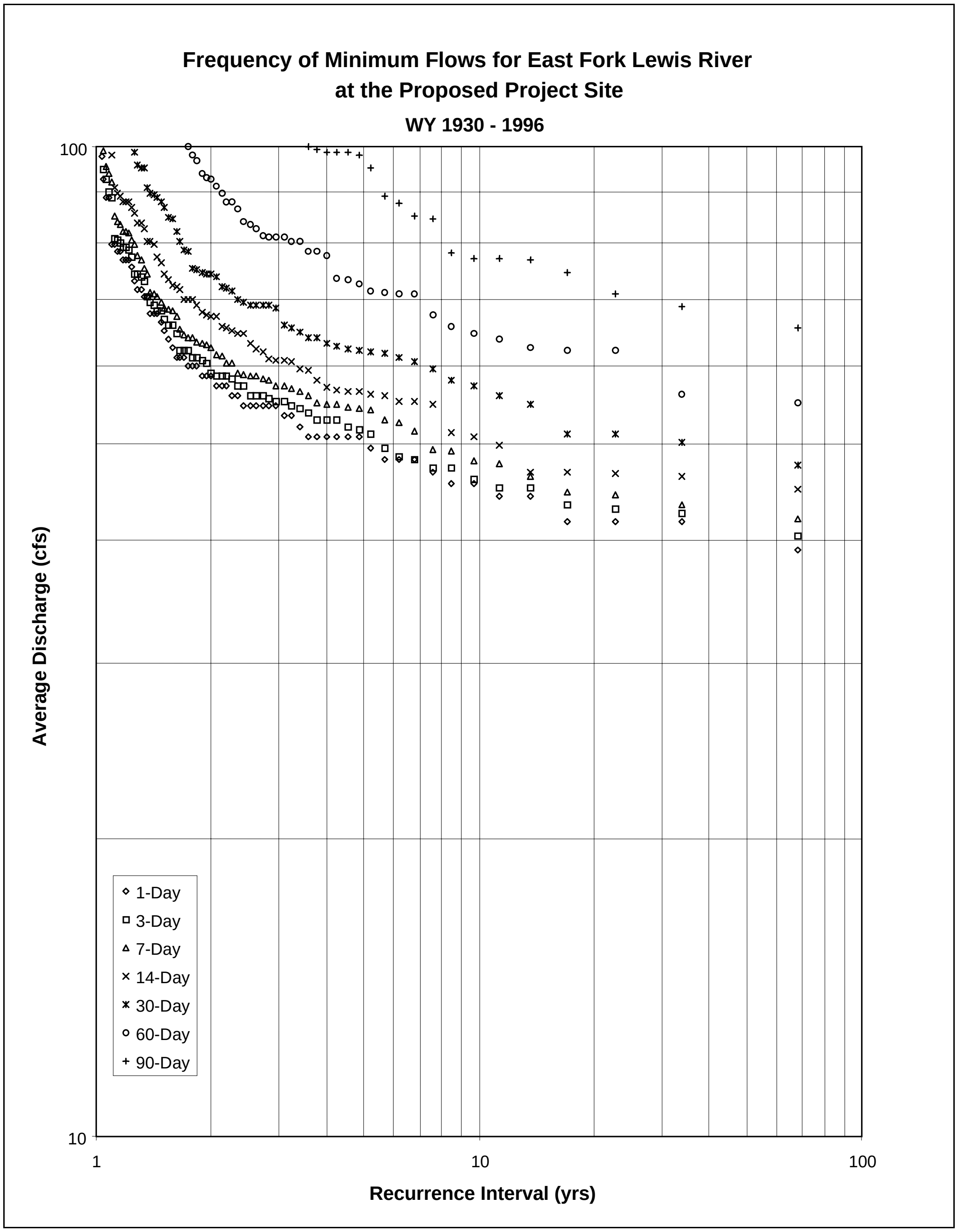


Figure 3-8. Low-flow frequency distribution for the East Fork Lewis River at the Proposed Project site.

Table 3-7. Summary of low-flow frequency distribution – East Fork Lewis River at the Proposed Project site.

Time Period (days)	2-Year (cfs)	5-Year (cfs)	10-Year (cfs)	50-Year (cfs)	100-Year (cfs)
1	58	48	45	40	37
3	60	51	46	41	40
7	61	54	47	42	41
14	66	56	51	46	45
30	75	61	56	48	46
60	91	71	66	52	51
90	130	81	79	64	61

3.10.2 Dean Creek Low-Flow Characteristics

Two separate streamflow measurements on Dean Creek made by McFarland and Morgan (1996) in October 1987 and October 1988 measured 0.10 and 0.15 cfs, respectively. These flows were approximately 0.25 percent of the flows measured in the East Fork Lewis River above Mason Creek. October is at the end of the dry season and likely represents the magnitude of typical low flows in Dean Creek. However, Dean Creek is known to go dry or become subterranean flow in the summer in some locations near J.A. Moore Road bridge (EMCON, 1998). The gradient of the stream changes rapidly at this location as the stream enters the relatively flat East Fork Lewis River valley bottom. Coarse gravel and cobble are deposited in this location providing a highly porous and permeable medium for water to flow through.

Groundwater-surface waters interactions of Dean Creek and the Proposed Pits are presented in the Project HCP. As discussed in the HCP, there does not appear to be a direct connection between the groundwater and surface flows in Dean Creek. Nearer the confluence with the East Fork Lewis River, beaver dams are known to exist that help maintain water levels in the lower portion of the stream during the summer months.

3.11 Evaporation

Evaporation from gravel pit ponds could cause a decrease in water resources available to the East Fork Lewis River. The net evaporation is the difference between the evaporation due to the ponds and the evapotranspiration that would normally exist due to native vegetation. A detailed analysis of the net evaporation is presented in the project HCP. As described in the HCP, the net evaporation loss from the Proposed Project is less than the existing irrigation water right.

3.12 Flood Storage

Gravel mining has occurred along the East Fork Lewis River in the vicinity of the Daybreak site since at least the 1960’s. Previous mining has resulted in several abandoned or unused gravel pits in the valley floor surrounding the East Fork Lewis River. The Proposed Project will construct additional pits. The volume of material removed from these pits will create additional volume that could be utilized for flood storage if the pits became connected with the river.

The Ridgefield Pits are estimated to have a total volume of 2 million yd^3 (Norman et al., 1998). The Daybreak pits have an approximate volume of 1.6 million yd^3 (EMCON, 1999). The

Proposed Pits will have an approximate final volume of 5 million yd^3 (EMCON, 1999). The total volume of the existing and proposed pits is about 8.6 million yd^3 (5,330 acre-ft). The volume of other pits (County1 and County 2) are unknown but estimated to be minor compared to the Ridgefield, Daybreak, and Proposed Pits volumes. Increased flood storage could reduce flood levels adjacent to and downstream of the project site.

The actual volume of storage available for flood storage depends upon the interconnectivity of the pits with the river and the pre-flood water surface in the pits. If the pits are completely disconnected from the low-flow channel, flood storage does not become available until overtopping of the high ground between the channel and the pit occurs. Available flood storage would be calculated as the total volume of the pit above the pit water surface. In the case of low magnitude events, that are unable to overtop the high ground, the additional flood storage provided by the pit would not be utilized by the river. However, the pit may capture localized runoff. If the pits were completely connected to the river, such as the Ridgefield Pits, the entire volume of the pits above the pre-flood water surface would be available for flood storage.

It is not possible to determine the future connectivity of the Existing and Proposed Daybreak Pits with the East Fork Lewis River, the pre-flood water surface elevations in the pits, or the exact amount of storage that would be utilized. Thus, a simplified approach was used to estimate the potential reduction in flood peaks related to the additional storage provided by the pits. The simplified approach estimates the maximum flood peak reduction assuming complete interconnectivity of the pits with the river. The available flood storage volume was estimated by determining the difference between the average annual discharge water surface elevation and the peak flood elevations determined from hydraulic modeling and multiplying it by the surface area of the ponds. It is recognized that connection between the existing and proposed ponds and the main channel of the East Fork Lewis River would change the geometry of the channel and therefore could change the hydraulics for both the average flow and flood flow conditions.

To provide a quantitative measure of flood storage created by the Ridgefield, Existing Daybreak and Proposed Daybreak Pits, the volume of flood storage was estimated for the 10-, 50-, 100-, and 500-year floods. The analysis was performed assuming different cases of interconnectivity between the pits with the river. Results of the analysis are summarized in Table 3-8. Synthetic flood hydrographs with a flood-duration of 4 days were used in the analysis.

The estimated reduction of the peak discharge for the 500-year event was found to range from 0.2 to 1.0 percent depending upon the interconnectivity between the different pits with the river. This would likely cause only a minor reduction in the peak stage of the river for an event of this magnitude. However, for more frequent events, the additional flood storage may play a slightly more significant role in reducing the magnitude of the peak discharge. As seen in Table 3-8, the peak discharge of the 10-year event is estimated to be reduced by 1.6 percent.

Table 3-8. Maximum flood peak reduction due to flood storage provided by pits.

Flood Event Return Period (yrs)	Pit Name	Flood Storage Volume (acre-ft)	Percent Reduction of Flood Peak
10	Ridgefield	349	0.5
	Daybreak	289	0.4
	Proposed	559	0.8
	Ridgefield + Daybreak	638	0.7
	Daybreak + Proposed	848	1.1
	Ridgefield + Daybreak + Proposed	1,197	**1.6**
50	Ridgefield	395	0.4
	Daybreak	327	0.3
	Proposed	632	0.6
	Ridgefield + Daybreak	722	0.7
	Daybreak + Proposed	959	0.9
	Ridgefield + Daybreak + Proposed	1,354	**1.3**
100	Ridgefield	400	0.3
	Daybreak	331	0.3
	Proposed	640	0.6
	Ridgefield + Daybreak	731	0.6
	Daybreak + Proposed	971	0.8
	Ridgefield + Daybreak + Proposed	1,371	**1.2**
500	Ridgefield	434	0.3
	Daybreak	360	0.2
	Proposed	694	0.5
	Ridgefield + Daybreak	794	0.5
	Daybreak + Proposed	1,054	0.7
	Ridgefield + Daybreak + Proposed	1,488	**1.0**

3.13 Summary

The hydrology of the East Fork Lewis River basin is typical of the rain-dominated systems of the Western Cascade Mountains. During the winter months, moist marine air masses move over the higher elevation Cascade Mountains producing rainfall in excess of 100 inches per year at the higher elevations. Winter runoff consists of a series of isolated high water events with periods of lower flow that often is less than the average annual discharge. Flood events are typically caused by large rainstorm events while extremely large flood events are typically caused by rain-on-snow events. Summers are relatively dry and warm with occasional precipitation events producing a short duration and relatively small increase in runoff.

The flood of record occurred on February 8, 1996, when a combination of heavy rainfall and snowmelt produced record setting discharges at many stations in the Pacific Northwest. At the USGS gage near Heisson, WA, this event was estimated to have a maximum discharge of 28,600 cfs and a recurrence interval of 500 years (USGS, 1996).

Summer low flows in the East Fork Lewis River and Dean Creek are fed by groundwater. At the Proposed Project site, estimated flows for the East Fork Lewis River ranged from a low of 37 cfs for a one-day period and a 100-year return interval to a high of 58 cfs for a one-day period and a 2-year return interval. August generally has the lowest flows, typically ranging between 60 cfs and 360 cfs with a 66-year average of approximately 110 cfs at the Proposed Project site. Two separate flow measurements on Dean Creek made by McFarland and Morgan (1996) in October 1987 and October 1988 measured 0.10 and 0.15 cfs, respectively. These flows were approximately 0.25 percent of the flows measured in the East Fork.

The surface area of water exposed by the existing and proposed pits influences the amount of evaporation of East Fork Lewis River water resources. A detailed analysis of the net evaporation associated with the Proposed Pits is presented in the Project EIS. In total, the net evaporation is less than the water volume consumed under the irrigation water right for the property. Accordingly, net evaporation will have no impact to average flow characteristics along the East Fork Lewis River. However, the proximity of the Proposed Project excavations to Dean Creek may impact groundwater inflows and outflows to and from the creek. An analysis of groundwater interconnectivity with Dean Creek is presented in the Project EIS.

The combination of the Existing and Proposed Daybreak Pits and the Ridgefield Pits with combined volumes of approximately 8.6 million cubic yards (5,330 acre-ft) would create an additional volume for flood storage assuming a direct connection with the river. It was demonstrated that the combined flood storage potential of the pits would cause only slight reductions in the magnitudes of the flood peaks in the vicinity and downstream of the Daybreak Site. The flood storage created by the gravel pits would have the least influence on the larger less frequent flood events, such as the 500-year event, while having a progressively greater influence as the magnitude of the flood event decreases.

4 Hydraulics

4.1 Introduction

Hydraulic conditions along watercourses potentially influenced by the proposed project were evaluated. This included the East Fork Lewis River and Dean Creek in the vicinity of the proposed project.

4.2 East Fork Lewis River Hydraulics

A hydraulic analysis of the East Fork Lewis River was conducted using the Army Corps of Engineers River Analysis System (HEC-RAS) standard-step backwater computer program (U.S. Army Corps of Engineers, 1998). The analysis included flows ranging from the 50 percent equaled or exceeded discharge to the 100-year return period event. The analysis extended from river mile 6.78 upstream to river mile 10.01, near the Daybreak Bridge. As described in Section 5, “Sediment Transport”, the results from the hydraulic analysis were used to conduct a quantitative geomorphic assessment of sediment transport and channel stability of the East Fork Lewis River in the vicinity of the Proposed Project.

4.2.1 FEMA Regulated 100-year Floodplain

Flooding in the vicinity of the Daybreak site, caused by the 500-year event that occurred in February 1996, was less extensive than depicted by the 100-year FEMA floodplain. The FEMA regulated 100-year floodplain in the vicinity of the Proposed Project was revised by WEST Consultants (1997) and presented as a letter of map revision (LOMR). The revised map has been accepted by FEMA and adopted by Clark County. The revised map is presented in the Project EIS.

4.2.2 Hydraulic Analysis Methods

The analysis utilized an existing HEC-RAS hydraulic model developed previously for delineation of the East Fork Lewis River floodplain (WEST Consultants, 1997). Topography for the study was based on topographic maps developed from aerial photography dated December 1996 and field surveys. The topographic elevations are based on the National Geodetic Vertical Datum (NGVD) of 1929.

The conditions modeled assume that existing high ground that separates the pits from the river remains in place. This would presumably yield the greatest flow depths and velocities and therefore the most conservative results.

The system was divided into a number of reaches as shown in Figure 4-1. The division of flow at the junction of any two reaches was determined by balancing energy between the upstream most cross-sections of each respective reach. Four locations were identified where flow splits away from the mainstem “EF Lewis” flow path and two locations where flow escapes form the “EF Split” and then returns to the main channel. Initially, water splits from the main channel (flow path “EF Lewis”) along flow path “EF Split”.

Figure 4-1. Flow Paths of Hydraulic Model.

Water escapes from the “EF Split” flow path and returns to the main channel through flow paths “Spill 1” and “Spill 2.” A second flow split from the main channel to the “EF Split” occurs along flow path “South Split.” The third and fourth split from the main channel occurs along flow paths “Path 1” and “Path 3.” Both of these splits return to the main channel. The split of flow between the various flow paths was determined by balancing the energy grade line at cross-sections located at the upstream limit of the two diverging flow paths.

4.2.3 Hydraulic Roughness

Hydraulic roughness (Manning’s *n*) values utilized in the hydraulic model were chosen based on field reconnaissance observations, review of recent color aerial photographs of the study area, published descriptions of Manning’s *n* values (Barnes, 1987 and Chow, 1959), and professional judgement.

4.2.4 Starting Water Surface Elevations

The boundary condition at the downstream end of the hydraulic model was determined from a normal depth calculation. The downstream most cross-section in the model corresponds with a cross-section from the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FEMA, 1991). The water surface slope at this FEMA cross-section was used as the downstream boundary condition in the hydraulic analysis. The FEMA study had water surface slopes for the 10-, 50-, 100-, 500-year events. For the 100-year and 50-year flows in the hydraulic analysis an estimated FEMA water surface slope of 0.00018 and 0.0004, respectively, was used. For the 20-year flow and all smaller volume flows, the 10-year estimated FEMA water surface slope of 0.0007 was used for the downstream boundary condition. The 500-year event was not evaluated as part of this study. The flow data as discussed in Section 3, “Hydrology”, were used in the analysis. Table 4-1 summarizes the nine flows used in the hydraulic model.

Table 4-1. Discharges used in hydraulic model.

Event	Exceedance Frequency	Flow (cfs)
50% Equaled or Exceeded Daily	N/A	579
Average Annual Flow	N/A	967
2-Year	0.50	11,200
5-Year	0.20	15,800
10-Year	0.10	18,800
20-Year	0.05	22,800
50-Year	0.02	26,000
100-Year	0.01	29,300

4.2.5 HEC-RAS Analysis

Figure 4-2 and Figure 4-3 are profile plots of water surface elevation and average channel velocity for the East Fork Lewis River mainstem for selected flows. A large spike in the average cross section velocity is seen near RM 8 in Figure 4-3. This spike is due to a constriction of the channel in the Ridgefield Pit complex. It would be expected that this constriction would be rapidly eroded by the high velocities caused by the channel geometry. Figure 4-4 shows the flow volume in each for the various events. The river is contained within the mainstem for both the 50% equaled or exceeded flow and the average annual flow. For the 2- and 5-year events overtopping occurs into "Path 1" and "Path 2." For the 10-year event and greater flows there is some portion of the river flow in nearly all of the flow paths.

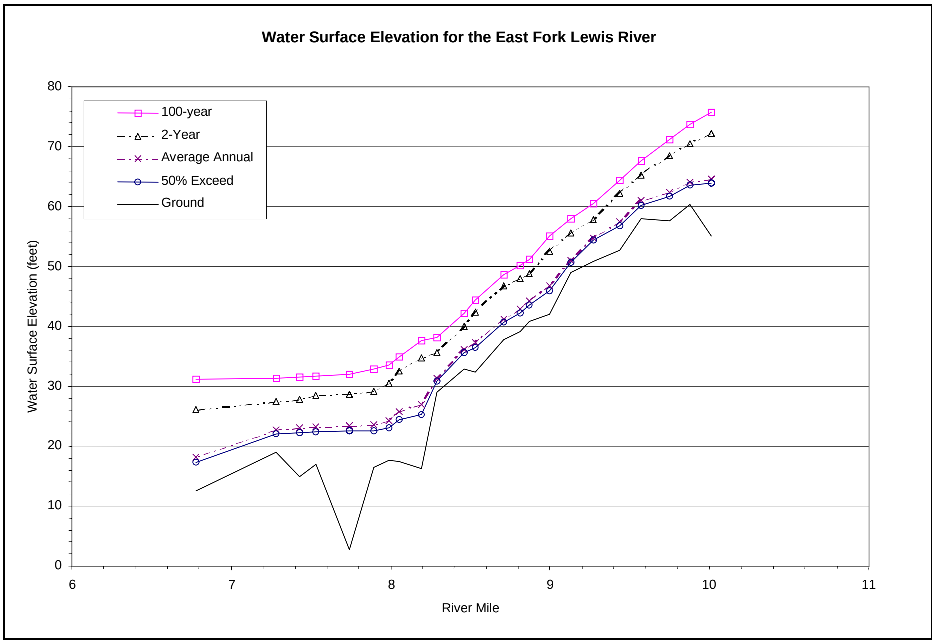


Figure 4-2. Estimated water surface elevations of the East Fork Lewis River for selected flows.

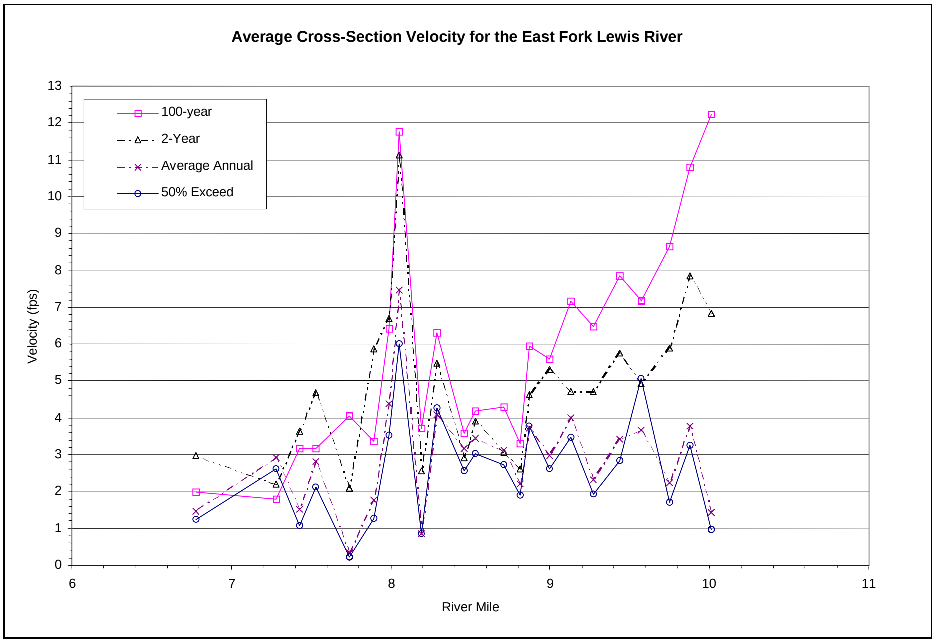


Figure 4-3. Estimated average velocities of the East Fork Lewis River for selected flows.

4.2.6 Hydraulic Analysis Results

Table 4-2 summarizes selected hydraulic values estimated for the 2- and 100-year recurrence interval flood. Average channel velocities range from 2.2 to 7.8 and 1.8 to 12.2 feet per second for the 2- and 100-year recurrence interval events, respectively. Average depths ranged from 1.5 to 10.3 and 3.5 to 14.7 feet for the 2- and 100-year recurrence interval events, respectively. Locations within the Ridgefield Pits were excluded from the table, as hydraulic conditions were not considered typical of the main channel of the East Fork Lewis River for the purpose of developing sediment transport estimates.

Table 4-3 summarizes maximum channel velocities and channel bank velocities for the average annual discharge and 2- and 100-year return period flood events at selected cross sections. Maximum channel velocities ranged from 1.1 to 14.6 feet per second for the average annual discharge and 100-year return period flood event, respectively. Main channel bank velocities ranged from near 0 in the Ridgefield Pits to 6.7 feet per second at RM 8.53 for the 2-year return period event. This suggests that velocities in the river are sufficient to erode the bank material during a 2-year (bank-full) flood event.

Table 4-2. Hydraulic values for the for 2- and 100-year flood events for selected main channel locations.

River Mile	2-year event	2-year event	2-year event	2-year event	100-year event	100-year event	100-year event	100-year event
	Top Width (ft)	Avg. Depth (ft)	Energy Gradient	Avg. Velocity (ft/sec)	Top Width (ft)	Avg. Depth (ft)	Energy Gradient	Avg. Velocity (ft/sec)
10.01	159.5	10.28	0.0016	6.8	628.3	13.1	0.0038	12.2
9.88	515.3	7.29	0.0032	7.8	888.4	10.5	0.0038	10.8
9.75	459.6	4.48	0.0035	5.9	770.3	6.8	0.0042	8.6
9.57	1006.6	3.45	0.0034	4.9	1103.1	5.8	0.0036	7.2
9.44	690.2	2.82	0.0061	5.8	832.5	4.4	0.0061	7.9
9.27	774.8	3.08	0.0036	4.7	1329.9	5.6	0.0031	6.5
9.13	660.4	3.61	0.0029	4.7	889.3	6.0	0.0034	7.2
9.00	1135.6	1.94	0.0067	5.3	1377.1	4.2	0.0062	5.6
8.87	950.2	3.02	0.0045	4.6	1382.6	3.5	0.0052	6.0
8.81	1439.4	2.99	0.0017	2.6	2152.8	4.3	0.0021	3.3
8.71	1546.9	2.49	0.0034	3.1	1869.7	4.3	0.0035	4.3
8.53	1928.5	1.49	0.0067	3.9	1938.5	3.5	0.0067	4.2
8.46	1996.7	1.93	0.0056	2.9	2013.2	4.0	0.0054	3.6
7.53	3873.6	5.72	0.0016	4.7	4145.9	8.6	0.0004	3.2
7.43	3865.2	7.97	0.0006	3.6	4126.9	11.7	0.0003	3.2
7.28	3943.2	4.05	0.0007	2.2	4880.1	8.0	0.0002	1.8
6.78	2814.3	9.7	0.0007	3.0	4499.9	14.7	0.0002	2.0

Table 4-3. Hydraulic values for the average annual discharge, 2- and 100-year return period events for selected cross sections.

River Mile	Average Annual Discharge			2-year flood			100-year flood		
	Left Bank Velocity	Right Bank Velocity	Max Velocity	Left Bank Velocity	Right Bank Velocity	Max Velocity	Left Bank Velocity	Right Bank Velocity	Max Velocity
10.01	0.5	0.3	1.7	1	1	8.2	4.1	4.4	14.6
9.00	0.2	2.5	3.7	0.5	5	9.3	2.7	5.9	12.0
8.53	1.1	1.8	4.1	6.7	2.6	9.2	9.5	3.0	11.9
8.19	0	0	1.1	0	0	2.9	0	0	4.1
7.43	0.2	0.4	1.8	1.4	1.4	4.4	2.0	2.3	3.7

4.2.7 Summary of East Fork Lewis River Hydraulic Analysis

In the previous sections, a hydraulic analysis of the East Fork Lewis River was presented. The values of velocity and depth were estimated for a variety of flow conditions ranging from the 50 percent equaled or exceeded flow to the 100-year return period flood. As seen in Table 4-2 average velocities ranged from 2.2 to 7.8 feet per second for the 2-year return period event and 1.8 to 12.2 feet per second for the 100-year return period event. In general, velocities decrease in the downstream direction as the slope decreases, although deviation occurs due to changes in local channel geometry and slope.

As seen in Table 4-3, maximum velocities ranged from 2.9 to 14.6 feet per second for the 2- and 100-year return period events, respectively. Velocities along the channel banks ranged from 0 in the Ridgefield Pits to 6.7 feet per second at RM 8.53 (0.23 miles upstream of entrance to the Ridgefield Pits) for the 2-year return period event. The largest flow velocity along the bank was 9.5 feet per second, also at RM 8.53, for the 100-year return period event.

4.3 Dean Creek Hydraulics

A hydraulic analysis of Dean Creek was conducted using the Army Corps of Engineers River Analysis System (HEC-RAS) standard-step backwater computer program (U.S. Army Corps of Engineers, 1998). The analysis included flow from the 2-year and 100-year return period events. The analysis extended from the J. A. Moore Road Bridge downstream to Daybreak Pond 5.

The analysis was conducted to characterize the hydraulic conditions along Dean Creek in the vicinity of the project. Proposed modifications to Dean Creek are described in the Habitat Conservation Plan. These include removal of the existing discontinuous levees along the channel, grading of the floodplain in the vicinity of the existing levees, and restoration of riparian forest within a 200-foot wide buffer.

4.3.1 Hydraulic Analysis Methods

An existing conditions hydraulic model of Dean Creek was based on 9 cross sections of the Dean Creek channel (labeled 2 –10) (Spurlock & Associates, 1999). The hydraulic model encompasses an approximate 2,100-foot reach of Dean Creek between J. A. Moore Road Bridge and Daybreak Pond 5 (see Figure 4-4). Additional cross sections, delineated from available topographic mapping (WEST, 1996), were used to model the existing overflow channel that parallels Dean Creek to the west (located on the Woodside Property). Geometry in the overbank areas was supplemented with data from a 2-foot contour interval topographic map (WEST, 1996).

4.3.2 Hydraulic Roughness

Hydraulic roughness (Manning's *n*) values utilized in the hydraulic model were chosen based on field reconnaissance observations, review of recent color aerial photographs of the study area, published descriptions of Manning's *n* values (Barnes, 1987 and Chow, 1959), and professional judgement. A Manning's *n* value of 0.035 was used for the main channel. This is a typical value used for gravel and cobble streams (Chow, 1959). A Manning's *n* value of 0.040 was used for the existing overbank areas. This is typical of values used for pastureland (Chow, 1959).

4.3.3 HEC-RAS Analysis Results

The 2-year and 100-year return period flood events (164 and 425 cfs, respectively) were evaluated in the hydraulic model. The 2-year return period event was evaluated to define geomorphic implications of the project. A 2-year return period discharge is considered to approximate the dominant discharge. The 100-year return period event was evaluated to define the flooding characteristics of Dean Creek. The discharge values for these events were estimated from USGS regional regression equations (USGS, 1998) as discussed in Section 3, "Hydrology".

During high flow events, water is seen to split from the main channel of Dean Creek just below the J. A. Moore Road Bridge and flow to the west through an overflow channel that parallels the Creek (see Figure 4-4). The overflow channel transitions into a series of shallow swales within the farm fields to the west. These swales are seen to connect to the lower portion of Dean Creek and Mason Creek, further to the west. The flow split between Dean Creek and the overflow channel was modeled by balancing the energy at the upstream confluence of the two channels. In addition to the split at J. A. Moore Road Bridge, water is seen to overflow from the main Dean Creek channel to the west at approximately cross section 6. As seen in Table 4-4, the discharge in the main channel at and below cross section 6 is reduced to account for this overflow. The excess discharge was added to the overflow channel to maintain continuity

Average cross sectional velocities associated with the 100-year recurrence interval flood range from 2.3 to 6.5 feet per second under existing conditions. Velocities along the left bank levee are typically 3 to 5 feet per second under existing conditions for the 100-year return period event. No change to the channel geometry or hydraulic roughness is planned for locations below the 2-year water surface (OHWM) elevation. Accordingly, no significant impacts to the sediment transport characteristics of Dean Creek are expected as a result of the overbank modifications.

4.3.4 Summary of Dean Creek Hydraulic Analysis

The Dean Creek channel is situated on a small alluvial fan. The apex of the fan is located approximately where J.A. Moore Road crosses the creek. Generally, the topography of the fan is steeper in a westerly direction from the apex. Accordingly, overflows of the channel in the vicinity of the apex would be expected to flow to the west, away from the Proposed Project. In fact, a secondary channel is located to the west of the existing Dean Creek channel. The secondary channel provides flood protection from overflows of the Dean Creek channel. From the apex of the fan downstream to the approximate location of Cross Section 5, high ground and a discontinuous levee exists along the left bank of the stream. The levee prevents overflows to the west along this portion of the channel.

No significant change in the velocities and water surface elevation will occur for the 2-year flood. This is because no modifications are planned for the channel below the OHWM (2-year discharge water surface elevation). Accordingly, no significant impacts to the sediment transport characteristics of Dean Creek are expected. However, it is noted that the significant reduction in gradient naturally occurring along Dean Creek in the vicinity of J.A. Moore Road and further downstream create a depositional environment for sediments transported from upstream areas.

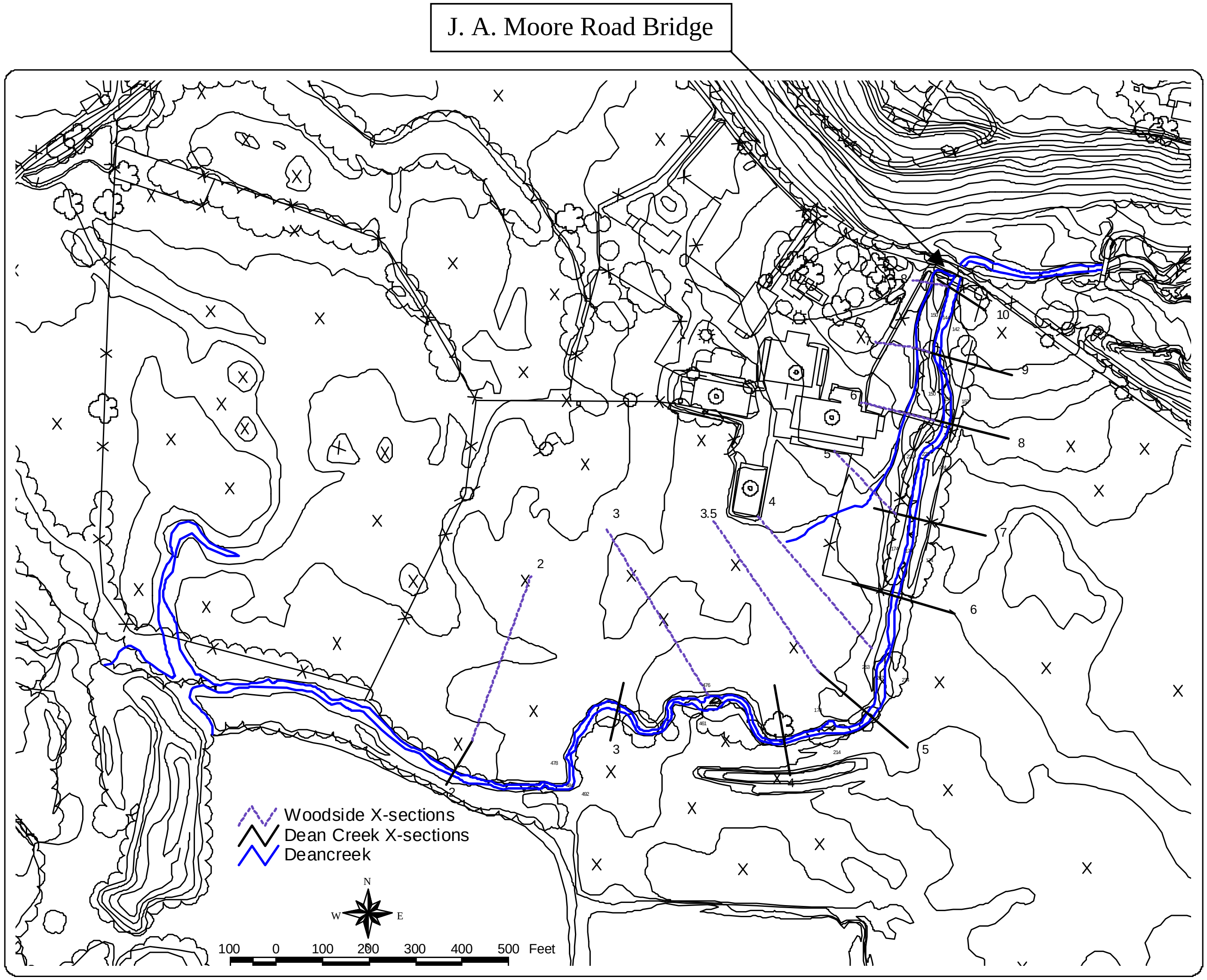


Figure 4-4. Plan view of Dean Creek showing cross section locations.

Table 4-4. Hydraulic analysis results for Dean Creek existing conditions with flow split.

Total 2-year Discharge = 164 cfs			
Cross Section	Channel Discharge (cfs)	WS El. (ft)	Average Velocity (ft/sec)
10	137	46.41	4.54
9	137	45.05	3.51
8	137	43.50	4.96
7	137	40.17	4.71
6	137	38.19	4.29
5	137	35.54	4.28
4	137	34.18	3.57
3	137	32.63	2.81
2	137	31.88	2.48

Total 100-year Discharge = 425 cfs			
Cross Section	Channel Discharge (cfs)	WS El. (ft)	Average Velocity (ft/sec)
10	345	47.16	5.78
9	345	45.87	4.96
8	345	44.22	6.24
7	345	40.87	6.51
6	290	38.84	5.08
5	290	36.30	4.90
4	290	34.94	4.70
3	290	33.56	2.31
2	290	32.51	3.38

5 Sediment Transport

5.1 Introduction

The following sections describe the analysis methods used to evaluate sediment transport conditions along the East Fork Lewis River and Dean Creek near the Proposed Project site. The objective of the sediment transport analysis for the East Fork Lewis River was to estimate its average annual sediment transport capacity. The sediment transport rate was used to estimate the expected rate of morphologic change in the Ridgefield Pits as well as Existing and Proposed Daybreak Pits in the event of an avulsion of the East Fork Lewis River. A qualitative evaluation of the sediment transport characteristics of Dean Creek was made to characterize potential impacts of the Proposed Project.

5.2 Definitions

To facilitate the discussion of sediment transport characteristics of the East Fork Lewis River, concise definitions of the terminology used are warranted. The total sediment load of a river consists of two components, the suspended load and bed load. Within the suspended load is another component called the wash load. Figure 5-1 shows a comparative classification of sediment transport, showing various modes of transport of the total load.

<table>
<tr><td rowspan="4">Total
Sediment
Load</td><td rowspan="3">Suspended
Load</td><td>Wash
Load</td><td rowspan="2">Suspension
Load</td></tr>
<tr><td rowspan="3">Bed
Material
Load</td></tr>
<tr><td>Saltation
Load</td></tr>
<tr><td>Bed
Load</td><td>Contact
Load</td></tr>
<tr><td>Classification</td><td>by mechanism of movement</td><td>by bed composition, source area, or method of calculation</td><td>by manner of movement</td></tr>
</table>

Figure 5-1. Comparative classification of sediment transport.

The definitions of the various components of the total sediment load can be classified based on the mechanism of movement, composition, or on the manner of movement. In general, the suspended load is comprised of fine-grained material that moves in suspension while the bed load consists of coarse-grained material moving on or near the bed. The wash load is part of the suspended sediment load and has particle sizes smaller than those found in appreciable quantities in the stream bed. Typically, the wash load is comprised of silt and clay sized sediment (< 0.0625 mm) while the bed-material load is that part of the total sediment load that is composed of particle sizes found in appreciable quantities in the stream bed. The bed material transport capacity is relevant to the form and stability of the channel.

For this study, we are concerned with that portion of the sediment load that is conveyed into and out of the vicinity of the Proposed Project and that composes the bed of the river (bed material load). However, it must be remembered that the sediment sizes found in the bed at one location within the stream are not necessarily the same as the sizes found in a different location. Thus, the bed material load will differ from one location to another. The transport and deposition of sediment is generally controlled by the channel hydraulics and the size characteristics of the sediment.

5.3 Sediment Transport Characteristics

A qualitative evaluation of the sediment transport characteristics for streams is important for understanding the overall processes the control the morphology of a stream system. In the following sections, the sediment transport characteristics for the East Fork Lewis River and Dean Creek are presented.

5.3.1 East Fork Lewis River

The profile of the East Fork Lewis River, in the vicinity of the Proposed Project, transitions from a steep slope to a flat slope. In this transition zone the transport capacity of the river is reduced causing deposition of the sediment carried into the reach. The size of the deposited bed material transitions from larger material in the upstream reaches to finer material in the flatter downstream section of the river. This is due to the energy required to transport the different sizes of sediment. As the slope of the river decreases, so does the energy of the river and its ability to transport large sediment. In other words, as the slope decreases the size of the sediment being transported also decreases. Downstream of the Proposed Project site the channel is relatively flat and it is influenced by backwater from the Lewis and Columbia Rivers. This causes even finer sediments (sands and silts) to deposit. The wash load (silts and clays) is typically transported through the system or may be deposited in over bank areas during high flows.

It is typical for gravel bed rivers such as the East Fork Lewis River and to form an armor layer of coarse material (gravels and cobbles) that acts to protect the underlying mixture of fine and coarse sediment. When a channel's sediment transport capacity exceeds the rate of sediment supply to the channel, the excess sediment transport capacity will be satisfied by erosion of the channel bed and/or banks. When sediment is eroded from the bed the channel will degrade. The different sizes of sediment that compose the bed of the river will be transported at different rates depending on their size. The finer material will be removed at a faster rate, leaving the coarser material behind. This coarsening process will stop once a layer of coarse material effectively covers the streambed protecting the finer material beneath from being transported downstream. After the process is complete, the streambed is armored. The coarse layer of sediments is referred to as the armor layer.

The armor layer will develop based on the size of bed material that is available, the discharge, and the related local hydraulic conditions. If the discharge and hydraulic conditions change sufficiently to transport the material that forms the existing armor layer, then the underlying bed material will be transported. If sufficient coarse material exists to resist the forces created by the altered hydraulic conditions, then a new armor layer will develop and erosion of the bed will be limited. If sufficient material does not exist to form a new armor layer, the bed material will be transported until the discharge and related hydraulic conditions have moderated sufficiently to form an armor layer.

5.3.2 Dean Creek

The profile of Dean Creek, in the vicinity of the Proposed Project, transitions from a steep slope to a mild slope where it meets the valley floor of the East Fork Lewis River. Over geologic time, this deposition zone has formed an alluvial fan. The apex of the fan is fixed at J. A. Moore Road Bridge, which is located at a break in slope. Bed material in Dean Creek ranges from sands to cobbles in size and are similar to those described for the East Fork Lewis River. Bed material has been removed from the channel in the vicinity of the J.A. Moore Road Bridge on a regular basis by Clark County to maintain conveyance through the structure. The removal of deposited sediments has likely helped Dean Creek to remain relatively stable over the recent past. If sediment removal activities cease, significant aggradation of the Dean Creek channel is expected, resulting in loss of hydraulic conveyance and sediment transport capacity.

5.4 East Fork Lewis River Bed Material Size Characteristics

The average size of the sediments composing the armor layer will transition from large to small as the channel slope decreases. The D_{90} of the armor transitions from approximately 8 inches (200 mm) just upstream of the site near RM 9 to approximately 2.5 inches (60 mm) in the vicinity of the Proposed Project site near RM 8. The armor size will vary locally, depending on the local hydraulics in the channel.

The size distribution of the channel bed material was determined from sieve analysis of floodplain substrate and channel materials sampled in the vicinity of the Proposed Project. The resultant size distribution is shown graphically in Figure 5-2. As seen from the Figure, the bed material sediments are comprised primarily of gravels and cobbles with some sands. The D_{50} values of the samples range from coarse gravel (25 mm) to very coarse gravel (40 to 60 mm). These data were used for estimating sediment transport capacity.

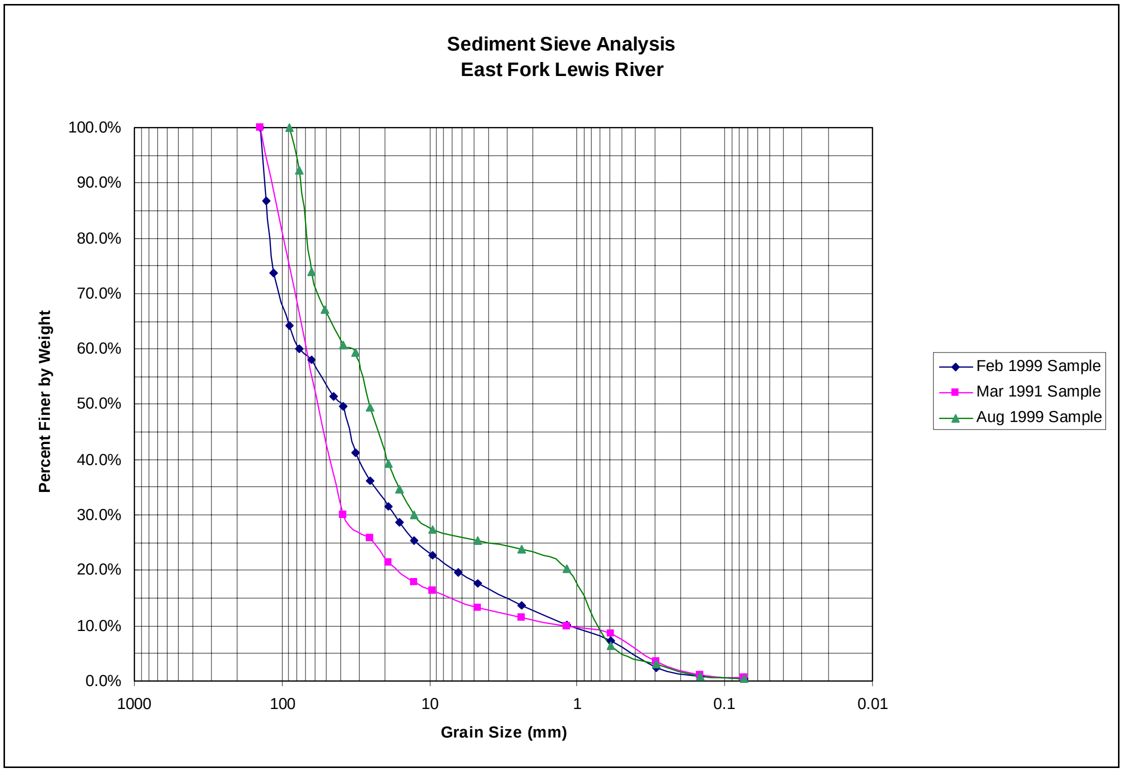


Figure 5-2. Bed material size distributions, East Fork Lewis River near Daybreak.

The avulsion of the East Fork Lewis River into the Ridgefield Pits in 1996 significantly reduced the supply of bed material sediment to reaches downstream of the pits. The flattened slope and modified channel geometry in the abandoned gravel pits has reduced the capacity of the river to transport coarse sediment to reaches downstream of the pits. To satisfy its sediment transport capacity along downstream reaches, the river may recruit material from the bed and/or banks. This may cause the channel bed to erode or coarsen, and cause the channel banks to erode.

5.5 East Fork Lewis River Armoring Characteristics

Armoring sizes were calculated using incipient motion equations from Meyer-Peter and Muller (1948), Mavis and Laushey (1948), Lane (1952), Shields (1936), and Yang (1973) for two locations along the East Fork Lewis River. The analysis was conducted to illustrate differences in sediment transport and armoring characteristics along the river. The differences in the armoring potential are related to the slope of the river, hydraulics of the flow, and the sediment size characteristics. The armoring conditions upstream at RM 10.01 are considered to be characteristic of the steeper river reaches supplying sediment to the Proposed Project area. The armoring conditions at the downstream section RM 7.43 are representative of the flatter channel gradient downstream of the Proposed Project area. Armoring calculations were performed for the estimated 50 percent equaled or exceeded discharge, average annual discharge, and the 2-, 5-, 10-, 20-, 50- and 100-year return period flood events. Table 5-1 summarizes these calculations for RM 10.01 near the Daybreak Bridge and RM 7.43 located just downstream of the Ridgefield Pits. This information helps to characterize the ability of the river to transport bed material along the reach near the Proposed Project site.

Table 5-1. Estimated armor size characteristics for RM 10.01 and 7.43, East Fork Lewis River.

Discharge Event	Average Armor Size (mm)	Armor Thickness (ft)	Percent Coarser by Weight	Depth of Degradation Required to form Armor Layer (ft)
RM 10.01				
50%	2	0.02	89	0.002
AAQ	3	0.03	85	0.006
2-yr	68	0.7	41	1
5-yr	103	1	31	2.3
10-yr	134	1.3	7	-
20-yr	165	1.6	0	-
50-yr	192	1.9	0	-
100-yr	214	2.1	0	-
RM 7.43				
50%	2	0.02	88	0.002
AAQ	4	0.04	84	0.007
2-yr	20	0.19	68	0.09
5-yr	21	0.2	68	0.1
10-yr	21	0.2	68	0.1
20-yr	25	0.2	65	0.1
50-yr	19	0.2	69	0.08
100-yr	14	0.1	74	0.05

* Not computed

The armoring calculations for the cross section at RM 10.01 show that the bed of the East Fork Lewis River can develop an armor layer for flows up to the 5-year return period event. When discharges exceed this amount, bed material of sufficient size is not available to form an armor layer. For discharges greater than the 5-year flood, the entire bed is mobilized.

At RM 7.43 the slope is much flatter and a larger portion of the discharge is conveyed in the overbank areas, reducing the ability of the river to transport coarse material. At high discharges, downstream backwater effects also reduce the sediment transport capacity. The armoring calculations indicate that the channel bed can armor itself over the entire range of flows evaluated. Compared to the upstream section, only much finer-grained sediment can be transported beyond this section of the East Fork Lewis River. At RM 7.43, it was estimated that the river is unable to transport material greater than about 1 inch (25 mm) in diameter. Thus, sediment sizes used for spawning are generally not transportable beyond this location.

5.6 East Fork Lewis River Sediment Transport Estimates

There are two commonly used methods for estimating sediment transport capacity when actual measurements are not available. These methods include 1) extrapolation from historic suspended sediment measurement data and 2) empirical/physical predictive equations. Published measurements of sediment transport are unavailable for the East Fork Lewis River. Consequently, sediment transport equations were used to estimate bed material load transport rates.

The Pacific Northwest River Basin Commission Study (PNRBC, 1970) evaluated sediment data from various sources and published a generalized annual sediment yield map for the Lower Columbia River region, which includes the East Fork Lewis River Basin. This map was developed from a limited number of unpublished suspended sediment measurements for the East Fork Lewis River. The PNRBC sediment yield estimates were used as a comparison to the estimates of sediment transport capacity for the East Fork Lewis River determined using sediment transport equations.

The Corps of Engineers Hydraulic Design Package for Channels (SAM) (USACE, 1998) was used to estimate the sediment transport capacity of the East Fork Lewis River in the vicinity of the Proposed Project. Transport formula by Toffaleti (1966) and Meyer-Peter and Muller (1948) where used. The bed material size distributions in Figure 5-2 were used in the evaluation.

5.7 East Fork Lewis River Sediment Transport Capacity

A typical channel cross section, located near the Daybreak Bridge (RM 10.01), was used to estimate sediment transport capacity in the vicinity of the Proposed Project. This location was chosen as it was judged to best represent a transport reach rather than a depositional reach. A sediment transport rating curve was developed for the cross section. The rating curve was then integrated with flow-duration information to provide an estimate of the average annual sediment transport capacity of the river at this cross section. The sediment transport capacity was estimated to be 145,000 tons per year. In low-gradient gravel- and cobble-bed rivers, bed load is typically 2 to 16 percent of the suspended load, with lower-gradient channels typically having lower values, and steeper rivers having higher values (Collins, 1997). Thus, bed load transport capacity would range from 3,000 to 20,000 tons per year. Using a value of 5 percent to represent the low gradient portion of the East Fork Lewis River, bed load transport would be approximately 7,000 tons/year.

The sediment transport volumes associated with specific flood events were also estimated. Synthetic flood-hydrographs with a base of 4-days were estimated for the 2-, 5-, 10-, 25-, 50-, and 100-year floods and were input into the SAM Model to compute the sediment transported by each of these events. Table 5-2 summarizes these values. As seen from the table, the 100-year flood event has the capacity to transport approximately 2 times the average annual sediment load.

Table 5-2. Sediment transport capacity for floods of various return periods.

Sediment Load	2-Year Flood (tons)	5-Year Flood (tons)	10-Year Flood (tons)	25-Year Flood (tons)	50-Year Flood (tons)	100-Year Flood (tons)
Total Load	24,000	57,000	88,000	140,000	192,000	249,000

Sediment transport capacity results were compared to annual sediment yield estimates for the basin published as part of the PNRBC (1970) study. The PNRBC study estimated the annual sediment yield for the East Fork Lewis River Basin to range from 0.1 to 0.2 acre-ft of sediment per square mile of basin. As seen in Table 5-3, the total transport capacity estimated by the current study is approximately 2 to 4.5 times higher than the values published. This suggests that the East Fork Lewis River may be supply limited. In other words, the capacity of the river to transport sediment exceeds the supply of sediment to the river. This is typically due to the natural tendency of the river to armor itself whereby a coarser sediment layer protects underlying finer sediment. Only during flows high enough to disrupt the armor layer are the finer underlying sediments transported.

Table 5-3. Sediment yield values for the East Fork Lewis River at Daybreak Bridge.

PNRBC Study Values	Total Yield (0.2 acre-ft/mi^2)	Total Yield (0.1 acre-ft/mi^2)
Total Volume (acre-ft/year)	32.6	16.3
Total Yield* (tons/year)	64,000	32,000

* Unit weight of 90 lb/ft^3

Conditions can exist where there is insufficient sediment available to satisfy the transport capacity of the river, causing the actual sediment transport to be less than the equilibrium transport (supply limited). This can occur due to armoring of the bed and bank materials as described in the previous paragraph. As described in Section 5.5, the armoring characteristics along the East Fork Lewis River vary with location. At RM 10.01 the armoring conditions were shown to protect the bed for events with a recurrence interval equal to or less than 5-years while at RM 7.43 the armoring conditions protect the bed for the entire range of flows evaluated. It is noted that the developed sediment transport estimates assume that equilibrium transport conditions exist. Equilibrium transport conditions exist when there is enough transportable sediment to satisfy the transport capacity. In such cases, the long-term average sediment transport rates may be overestimated.

5.8 Estimated Time for Geomorphic Recovery of the Ridgefield Pits

The East Fork Lewis River avulsed into the abandoned Ridgefield Pits in 1996. Because the river has the potential to avulse into other nearby off-channel gravel pits such as the Existing or Proposed Daybreak Pits, it is necessary to estimate the amount of time that is required for its geomorphic recovery. Geomorphic recovery of the East Fork Lewis River channel within the Ridgefield Pits will occur when the geometry and hydraulics of the channel return to conditions similar to those that existed prior to the avulsion in 1996. This is assumed to occur when the channel has returned to an elevation similar to the pre-1996 avulsion channel. The avulsion into the Ridgefield Pits that occurred in 1996 provides an opportunity to estimate this recovery time. The geomorphic recovery of the Ridgefield Pits is also important in the discussion of the potential for avulsion into the Existing and Proposed Daybreak Pits. It was determined that the potential for the river to avulse into the downstream end of the existing Daybreak Pits is greatly reduced due to the river's current location within the Ridgefield Pits (see Section 8 "Channel Aulsion"). Once geomorphic recovery occurs within the reach of the Ridgefield Pits, the river may have an increased potential for migration in the lateral direction. Lateral migration could allow the channel to move back to a location near the Existing Daybreak Pits.

Fill elevations for geomorphic recovery for the Ridgefield Pits were determined from pre-avulsion channel elevation data. These data show a channel elevation of approximately 35 ft at the upstream end (above Pit 1) and an elevation of approximately 24 ft at the downstream end (below Pit 7) of the Ridgefield Pits reach. Average pit elevations required for geomorphic recovery ranged from 33 ft in Pit 1 to 24 ft in Pit 7. Because the active channel of the East Fork Lewis River currently occupies Ridgefield Pits 1 through 7, Pits 8 and 9 were not evaluated as part of this analysis.

The average depths of pre-avulsion pits, below average water levels in the pits, were estimated by a former gravel mine operator at the Ridgefield Pits (Personal Communication with Kimball Storedahl, 1999). The average excavation depths below the water surface of the pre-avulsion pits were estimated to be 12 ft in Pits 1 and 2, 20 ft in Pits 3 through 5, and 30 feet in Pits 6 and 7. It is noted that the depth of Pit 7 was influenced by an avulsion into that pit which occurred prior to the 1996 avulsion. It was estimated that approximately 10 ft of fill occurred, reducing the pre- 1996 avulsion depth to 20 ft.

Average water surface elevations in the Ridgefield pits were estimated based on groundwater contours defined for the Daybreak site and extrapolating them across the valley. Average water surface elevations in the Ridgefield Pits were estimated to range from 35 ft in Pit 1 to 30 ft in Pit 7. This resulted in pre- 1996 avulsion fill requirements ranging from 10 ft in Pit 1 to 24 ft in Pit 7. The total fill volume for geomorphic recovery prior to the 1996 avulsion was estimated to be approximately 1.1 million cubic yards for Pits 1 through 7. Compared to pre-1996 avulsion conditions, recent surveys (Chase Jones, 1999) indicate the Ridgefield Pits have filled significantly. As seen in Table 5-4, average pit elevations have increased between 1 to 13 ft reducing the geomorphic recovery volume to approximately 0.7 million cubic yards. The total volume of Ridgefield Pits 1 through 7 including material removed above the geomorphic recovery elevation, was estimated to be approximately 1.8 million cubic yards. When the volumes of Pits 8 and 9 are included, the total volume of the Ridgefield Pits is similar to the 2 million cubic yards estimated by Norman (1998).

Table 5-4. Estimated changes in geometry of the Ridgefield Pits since the 1996 avulsion.

Pit	Estimated Pre-1996 Avulsion Pit Depth (ft)	Estimated Pre-1996 Avulsion Pit Elevation (ft)	Estimated Pre-1996 Avulsion Pit Volume (yd^3)	Estimated 1999 Pit Depth (ft)	Estimated 1999 Pit Elevation (ft)	Estimated 1999 Pit Volume (yd^3)	Estimated Change in Pit Elevations (ft)	Volume Change (Percent)
1	12	23	157,700	9	26	110,400	+3	-30.0
2	12	22	102,900	11	23	92,600	+1	-10.0
3	20	13	108,500	16	17	82,900	+4	-23.6
4	20	12	143,500	13	19	84,400	+7	-41.2
5	20	11	164,800	15	16	113,300	+5	-31.3
6	30	1	204,900	17	14	93,900	+13	-54.2
7	20	10	186,900	14	16	106,800	+6	-42.9
Total			1,069,200			684,300		-36.0

The volume of sediment deposited in the Ridgefield Pits since the 1996 avulsion is estimated to be approximately 385,000 cubic yards. Sediment samples taken from the Ridgefield Pits were tested to determine the unit weight of the deposited sediments. Sand sized material deposited in portions of Pits 1 and 2 were found to have a unit weight of 90 lbs/ft^3 while fine sand and silt material in Pit 4 had a unit weight of 55 lbs/ft^3. To estimate the weight of sediment deposited within the Ridgefield Pits, a unit weight of 90 lbs/ft^3 was used for Pits 1 and 2 and a unit weight of 55 lbs/ft^3 was used for Pits 3 through 7. Accordingly, an estimated 300,000 tons of sediment have accumulated in the Ridgefield Pits since the 1996 avulsion. This is equivalent to an average rate of 100,000 tons/year. However, it is noted that this rate was high initially and has likely reduced since the avulsion occurred.

Sediment supplies to the Ridgefield Pits since the 1996 avulsion have included long-term average supplies from upstream watershed areas and short-term locally increased supplies caused by avulsion related erosion. Locally increased short-term sediment supplies would include material from the breached levees, erosion of the upstream channel bed, and locations of upstream bank erosion. The contribution to the pits from short-term locally increased sediment supplies was estimated to be 85,000 tons over the last three years, of which approximately 60,000 tons was likely deposited during and immediately following the avulsion in 1996. These estimates are based on field observations, aerial photography, and survey data. Compared to the volume of sediment accumulated in the pits since the 1996 avulsion, the supply of sediment from upstream watershed areas is approximately 215,000 tons or an average of 72,000 tons per year. The sediment transport capacity of the East Fork Lewis River upstream of the Ridgefield Pits was estimated to be 145,000 tons per year based on the application of the Toffaleti (1966) and Meyer-Peter and Muller (1948) sediment transport functions. Assuming that the stream is not sediment supply limited, the trap efficiency of the pits can be estimated to be about 50 percent since the avulsion in 1996.

If the Ridgefield Pits continue to fill at a rate equivalent to the upstream supply of 72,000 tons per year and the trap efficiency remains at 50 percent, it will take approximately 10 years (average unit weight of 70 lbs/ft^3) to complete the filling of the pits to an elevation similar to the river channel prior to the 1996 avulsion. However, it is recognized that the trap efficiency of the pits will diminish over time and the unit weight of the deposited sediments will increase. As the channel through the pits becomes more defined it will be more capable of transporting material through the pits and the trap efficiency will be reduced. Similarly, the unit weight of the deposited material will increase over time as coarse delta deposits migrate downstream and consolidation of deposited sediments occurs. Assuming an average trap efficiency of 20 percent, and an average unit weight of 80 lbs/ft^3, the time required to fill the pits would be approximately 25 years. If the geomorphic recovery of the Ridgefield Pits were to be judged against deposition of the approximate 2 million cubic yard volume estimated by Norman (1998), the time required to fill the pits would be approximately 75 years.

To further evaluate the rate of filling in the pits, an analysis of the growth rate of the gravel and cobble delta forming in Pits 1 and 2 was conducted. The purpose of this analysis was to characterize the rate and manner in which these pits are filling. As observed in the field, the delta forming in Pits 1 and 2 is composed of coarse gravel and cobble, while finer material (sands and silts) was observed in the backwater portions of the downstream pits. Using the downstream growth rate (approximately 100 ft/year) of the gravel delta formed since 1996, it is estimated that it will take approximately 30 years for it to reach the downstream end of the Ridgefield Pits. This time frame is consistent with the estimates described above for geomorphic recovery of the Ridgefield Pits. It is noted that the growth rate of the delta was high initially and has likely reduced since the avulsion occurred.

5.9 Estimated Time Required for Geomorphic Recovery of the Existing and Proposed Daybreak Pits

To evaluate the impacts of a potential avulsion of the river into the Existing and Proposed Daybreak Pits, an analysis of the time required for geomorphic recovery of the pits was conducted. This analysis assumes that the river is flowing through the entire series of pits, and that the entire pit volume below the pre-1996 avulsion channel elevation must be filled for geomorphic recovery to occur. It is also assumed that the regional hydrologic and sediment transport characteristics will remain the same during the filling process. Because the exact nature of a potential avulsion can not be predicted, the amount of sediment supplied to the pits by local sources such as levee, bank, and bed erosion can not be predicted. Therefore, the total pit volumes may be overestimated. Table 5-5 summarizes the estimated time required for geomorphic recovery of the Existing and Proposed Daybreak Pits.

Table 5-5. Estimated time for geomorphic recovery of the Existing and Proposed Daybreak Pits.

Daybreak Gravel Pits	Estimated Geomorphic Recovery Volume (yd^3)	100% of Total Load 70 lb/ft^3 (years)	50% of Total Load 70 lb/ft^3 (years)	20% of Total Load 80 lb/ft^3 (years)	100% of Bed load* 80 lb/ft^3 (years)	PNRBC 100% of Total Load 80 lb/ft^3 (years)
Existing	720,000	5	10	30	40-260	10-20
Proposed	4,200,000	30	55	160	230-1500	70-140
Total	4,920,000	35	65	190	270-1760	80-160

*Bed load ranges from 2 to 16 percent of the suspended load.

As seen from the table, the expected time required to fill the pits varies widely with the volume of the pits and the proportion of the total bed material sediment load that is assumed will deposit in the pits. Assuming an average trap efficiency of 20 percent and unit weight of 80 lb/ft^3, it is expected to take approximately 30 and 160 years for geomorphic recovery of the Existing and Proposed Daybreak Pits, respectively. It must be noted that projections that exceed approximately 50 years require qualification. The sediment transport calculation methods employed are based on hydrologic data collected since 1930 (66-years). Extrapolation for periods outside of the observed record is less reliable. For predictions that are several times longer than the observed record, significant deviations from the presented estimates could be expected.

Furthermore, the time required for geomorphic recovery is directly related to the specific hydrologic conditions experienced. If low flows occur, the rate of filling would be less than that estimated for average conditions. If larger flows occur, the rate of filling would be greater than average. As seen from Table 5-2, the estimated amount of sediment transported in a 100-year return period flood would fill about 30 percent of the Ridgefield Pits during a single event.

5.10 Summary

Bed material of the East Fork Lewis River is composed of coarse sands, gravels, and cobbles. Fine sands, silts, and clays are carried as wash load and are typically transported downstream of the area of the Proposed Project to flatter gradient, low energy reaches. As described previously in Section 2, "Characterization of Affected Environment", the bed and banks downstream at RM 6 are typically composed of sands and silts. The changes in channel geometry and hydraulics associated with the avulsion of the Ridgefield Pits have reduced the transport capacity of the river in the pits. The Ridgefield Pits effectively capture the bed load and a portion of the suspended load that might otherwise be transported downstream. However, it is recognized that due to the natural reduction in channel gradient in this reach, a large portion of the bed material load from upstream areas would be expected to deposit in this section of river even if the avulsion into the Ridgefield Pits had not occurred.

Dean Creek, in the vicinity of the Proposed Project, transitions from a steep slope to a mild slope where it meets the valley floor of the East Fork Lewis River. Over geologic time, this natural deposition zone has formed an alluvial fan. The apex of the fan is fixed at J. A. Moore Road Bridge, which is located at a break in slope. Historically, bed material has been removed from the channel in the vicinity of the bridge on a regular basis by Clark County to maintain conveyance. This action has likely helped maintain the stability of Dean Creek over the recent past. If deposited sediments are not periodically removed from the channel in the vicinity of the bridge, the hydraulic conveyance and sediment transport capacity of the channel will diminish. This will cause an increase in overflows from the channel that may cross J.A. Moore Road. This will generally increase the potential for channel instability. The Proposed Project will reduce any potential for migration of the channel to the east. The proposed channel improvements and removal of the existing discontinuous levee will enlarge the floodplain area available to the watercourse, dissipate flow in the left overbank, and reduce sediment transport capacity.

The gravels and cobbles that form the bed of the East Fork Lewis River in the vicinity of the Proposed Project can form an armor layer that protects the underlying mixture of bed sediment from erosion. The armor layer is disrupted by hydraulic conditions that exceed the incipient motion conditions for the armor material. The presence of the armor layer and the size of the particles vary with location, but usually will decrease in size in the downstream direction.

The average annual sediment transport capacity of the East Fork Lewis River was estimated by application of the Toffaleti (1966) and Meyer-Peter and Muller (1948) sediment transport formulas. Average transport capacity was estimated to be 145,000 tons per year. Measurements of the bed load transport in other gravel bed rivers indicated the bed load to suspended load ratio is 2 to 16 percent (Collins, 1997). Thus, for the East Fork Lewis River, bed load transport capacity would range from 3,000 to 20,000 tons per year. In the vicinity of the Proposed Project, it is estimated that the bed load transport capacity is approximately 7,000 tons/year or 5 percent of the total transport capacity.

The time required for existing and proposed gravel pits to fill was estimated based on various sediment deposition scenarios. It is most likely that the amount of sediment trapped by pits will reduce over time. As the channel through the pits becomes more defined it will be more capable of transporting material through the pits and the trap efficiency will be reduced. Similarly, the unit weight of the deposited material will increase over time as coarse delta deposits migrate downstream and consolidation of deposited sediments occurs. If we assume an average trap efficiency of 20 percent, and an average unit weight of 80 lbs/ft^3, the time required for geomorphic recovery of the Ridgefield Pits would be approximately 25 years. Similarly, the time required for geomorphic recovery of the Existing and Proposed Daybreak Pits would be 30 and 160 years, respectively. Combined geomorphic recovery of these pits will take approximately 200 years under current hydrologic and sediment transport conditions. It should be noted that sediment transport calculation methods are based on existing conditions and only 66 years of hydrologic data. Significant deviation in the hydrologic, hydraulic, and sediment transport conditions in the East Fork Lewis River watershed could occur over time periods in excess of the period of record.

6 Channel Profile

6.1 Introduction

An analysis of historic East Fork Lewis River profile data was conducted to understand the physical characteristics of the river channel. An evaluation of available cross section data was made to characterize slopes along the river and understand the sediment transport characteristics along the channel. The influence of historic river avulsions into abandoned gravel pits on the profile of the channel was investigated. The potential impacts of the Proposed Project on the channel profile were characterized. No historic data was available for the profile of Dean Creek, however a discussion of the current profile is presented.

6.2 Channel Profile

In the following sections, a general description of the channel profiles for the East Fork Lewis River and Dean Creek are given.

6.2.1 East Fork Lewis River Profile

As seen in Figure 6-1, the profile of the East Fork Lewis River channel in the vicinity of the Proposed Project can be divided into three reaches. Reach 1 is from the confluence with the Lewis River at RM 0 to RM 4. This reach has a channel slope of less than 1 foot per mile and is influenced by backwater from the Columbia and Lewis Rivers. Reach 2 is from RM 4 to RM 7.5 and has a slightly steeper channel slope of approximately 7 feet per mile. Tidal influences occur within the lower portion of this reach. Reach 3 is from RM 7.5 to RM 12.7 and has an even steeper channel slope of approximately 18 feet per mile. The transition zone between the steeper slope of Reach 3 and the shallower slope of Reach 2 is the location where coarse sediments (sands, gravels, and cobbles) carried downstream by the East Fork Lewis River are deposited. This is also the location of Existing and Proposed Daybreak Pits. Finer sediments (fine sands, silts and clays) are generally transported further downstream, depositing in Reach 1.

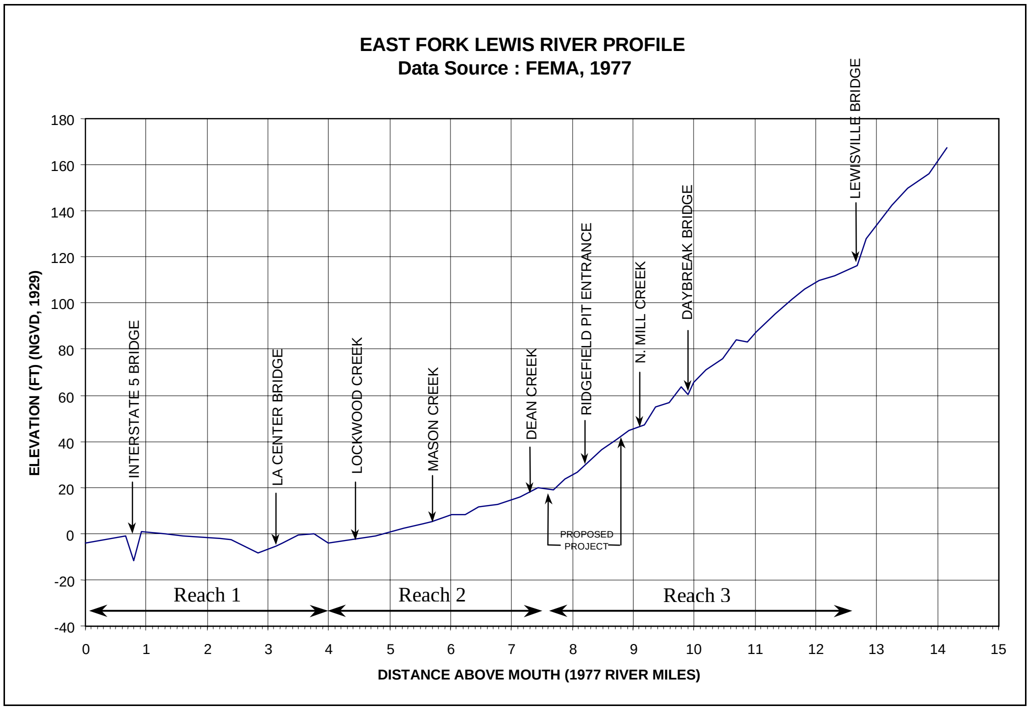


Figure 6-1. Profile of lower East Fork Lewis River.

6.2.2 Dean Creek Channel Profile

As seen in Figure 6-2, the profile of Dean Creek can be divided into four reaches. Reach 1 is from the confluence with the East Fork Lewis River to J. A. Moore Road. This reach has an average channel slope of approximately 25 feet per mile and is partially influenced by backwater during high flows in the East Fork Lewis River. Reach 2 is from J. A. Moore Road Bridge to NE 82nd Avenue. This reach has an average channel slope of 130 feet per mile as it descends the relatively steep wall of the East Fork Lewis River valley. Reach 3 is from NE 82nd Avenue to NE 112th Avenue. This reach has an average slope of approximately 50 feet per mile as it descends through a relatively flat section of land overlooking the East Fork Lewis River valley. This area is occupied by a large number of rural homes and a small airport, which have likely caused increased runoff and sediment supply to Dean Creek. Reach 4 is from NE 112th Avenue to the headwaters and has an average slope of approximately 300 feet per mile.

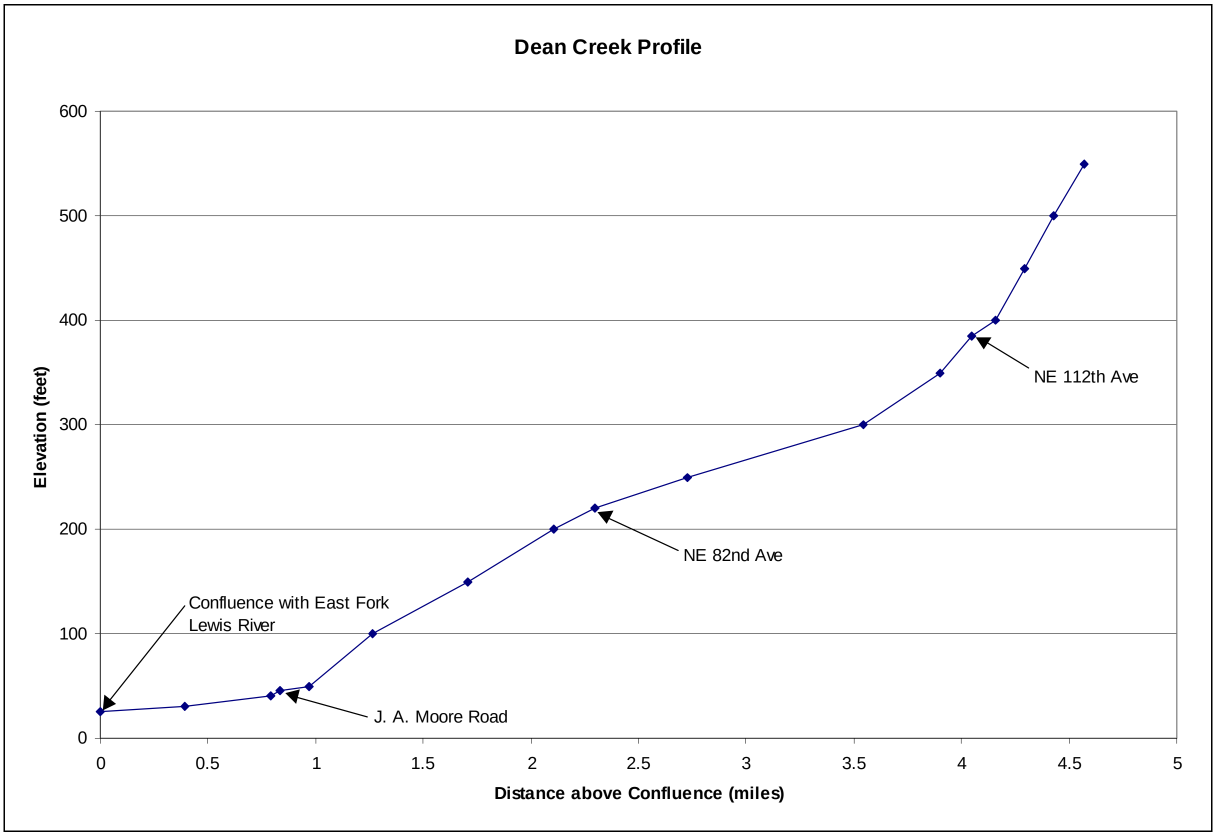


Figure 6-2. Profile of Dean Creek.

6.3 Evaluation of Historic Cross Section Data for the East Fork Lewis River

Two sets of historic cross section data are available for the East Fork Lewis River pertinent to the Proposed Project area. Cross section data for the East Fork Lewis River was collected as part of the FEMA Flood Insurance Study in 1977 (FEMA, 1991). The second data set was collected in December 1996 as part of a reevaluation of the East Fork Lewis River floodplain (WEST Consultants, 1997). The thalweg elevation data of each cross section was plotted against its distance in the upstream direction from the river mouth (Figure 6-3). The slopes of the river were determined from these plots. The section of river covered by this analysis is between RM 7.2 and the Daybreak Bridge (approximately RM 10.2). The average channel thalweg slope in 1977 was 0.327% while the slope in 1996 was 0.398%, a difference of +0.071%. The average slope in 1996 is steeper due to the avulsion of the East Fork Lewis River into the Mile 9 Pit in 1995 and the abandoned Ridgefield Pits in 1996. As seen in the profile (Figure 6-3), the thalweg of the channel in 1996 is at a lower elevation than the thalweg of the channel prior to the avulsions.

One must be careful in evaluating the type of plot shown in Figure 6-3 due to the dynamic nature of the river channel. The channel length is continuously changing as the river meanders and avulses over time. Accordingly, the channel distance measured along the center of the channel upstream from its confluence with the Lewis River also changes. In 1977, the distance from the mouth to the Daybreak Bridge was 9.89 river miles, while the 1990 USGS quad map indicates 10.19 river miles, and 1996 topographic mapping shows 10.04 river miles. From 1977 to 1990 the river channel increased its length by approximately 1,600 feet. From 1990 to 1996 the channel decreased its length by approximately 800 feet. For this reason, the deposition or erosion of sediment at any given location cannot be simply evaluated by comparing the profile plots for different time frames. The physical locations of intermediate points along the two profiles shown in Figure 6-3 are not the same.

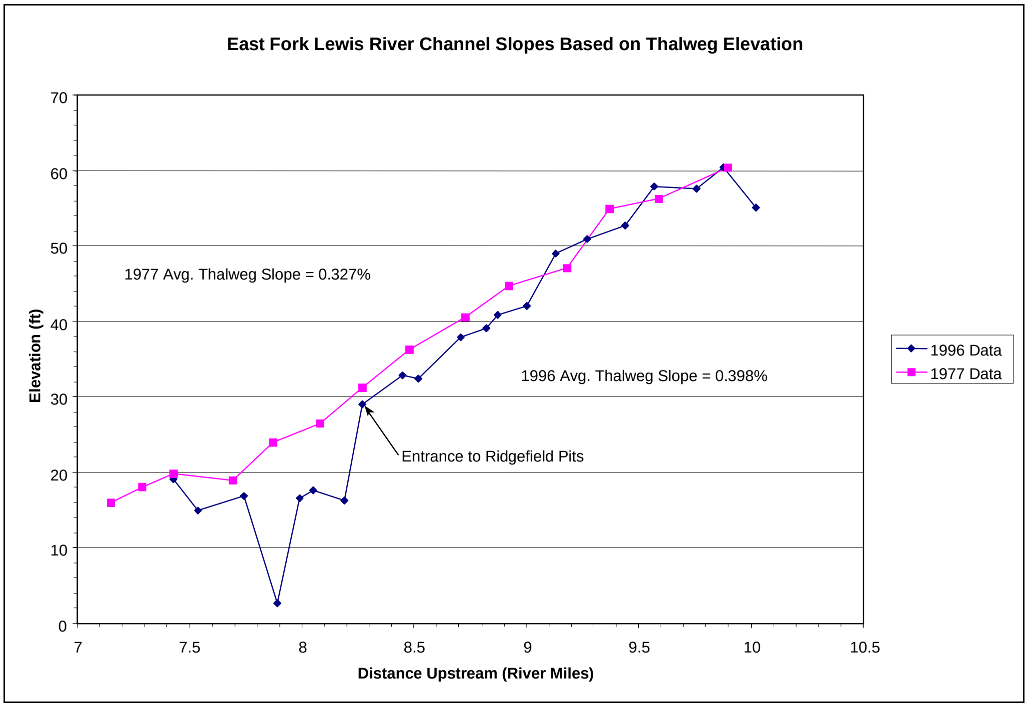


Figure 6-3. Channel slopes from 1977 and 1996.

From examination of the 1996 topographic maps (WEST Consultants, 1996), it is noted that only one month had passed between the time of the breach into the Ridgefield Pits and the collection of the 1996 cross section data. It is also noted that the flood of record had occurred 10 months earlier. Although some head cutting appears to have occurred upstream of the Ridgefield Pit avulsion (from field observations), the exact upstream extent is unknown. From examination of the 1996 topographic maps (WEST Consultants, 1996), the channel was judged to have lowered its base by approximately 5 feet immediately upstream of the pit entrance. Later estimates made by Norman et al. (1998) had estimated degradation of approximately 10 feet at this same location. Channel changes will continue as the river adjusts to the impacts of the 1996 flood and avulsion.

Figure 6-4 shows an evaluation of the historic river slopes in reaches upstream and downstream of the entrance to the Ridgefield Pits. This comparison was made to determine the impacts of the breach on the slope of the river channel upstream of the pits and through the pits. However, it is important to understand that the 1996 data reflects river conditions only one month after the avulsion of the river into the Ridgefield Pits. The 1996 thalweg profile data are compared to the river conditions from nineteen years earlier. No data were available to compare with the channel conditions just prior to the avulsion.

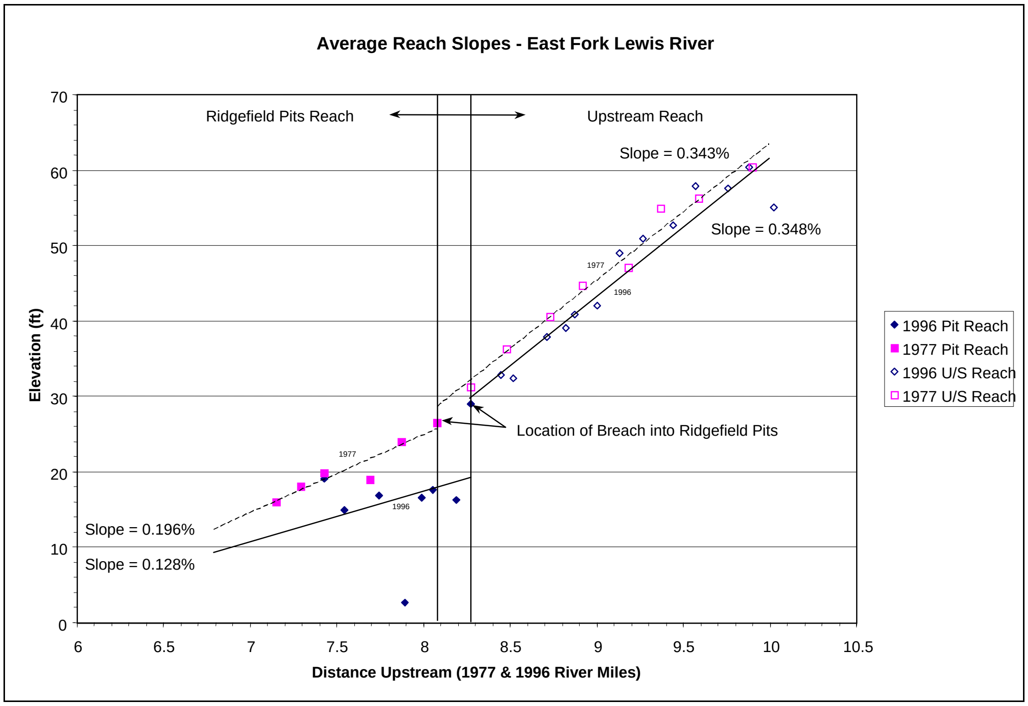


Figure 6-4. Average channel slope by reach.

Average slopes in the reach between the Ridgefield Pits and the Daybreak Bridge (labeled “Upstream Reach” in Figure 6-4) are very similar for 1977 and 1996, 0.343% and 0.348%, respectively. The location of the break point from the steeper slope upstream to the flatter slope downstream is shown in two locations on Figure 6-4. This is due to changes in the river length caused by avulsion and meandering of the river. As measured from the 1977 and 1996 data, the average slope in the reach along the Ridgefield Pits has changed from a slope of 0.196% to a flatter slope of 0.128%. It is noted that tidal backwater influence from the Columbia River occurs at approximately RM 5.9 of the East Fork Lewis River (Hutton, 1995). The tidal influence serves as a downstream hydraulic control that regulates the deposition of material transported out of the steeper portions of the watershed. This tidal influence creates backwater conditions that are similar to that of a river flowing into a reservoir.

In a reservoir, a delta will form as sediment is deposited at the transition from the flowing river to the slack water of the reservoir. Larger sediments deposit further upstream while the finer sediments are transported further downstream, settling out in more quiescent water conditions. Given sufficient time, the delta deposits can become significant, raising the local bed elevation and causing a slow migration of the delta. When the reservoir level drops, the river head cuts through the delta deposits, lowering its bed elevation and abandoning its floodplain. Sediment is transported further downstream and deposits at the new transition location. The zone of accumulation will migrate upstream and downstream as the reservoir level rises and falls. Similarly, backwater influences from the Columbia River act like a reservoir at the lower end of the East Fork Lewis River. Using this analogy one can understand the sequence of deposition and erosion that has taken place within the East Fork Lewis River study area over geologic time.

In order to evaluate historic deposition and erosion patterns, a comparison of elevations at similar locations was made. Figure 6-5 shows a plot of thalweg elevations from 1977 and 1996. The 1977 elevation data were referenced to the 1996 channel profile to allow comparison.

Comparison of the historic thalweg data indicates several significant changes. A large change in bed elevation is noted in the vicinity of the Daybreak Bridge between the two time periods. The 1996 thalweg elevation downstream of the bridge is lower than the 1977 thalweg. The degradation at the bridge may be explained as a localized scour phenomenon caused by the bridge. It is noted that the 1977 cross section is located just upstream of the bridge while the 1996 cross section is located just downstream. The scoured area downstream of the bridge may have been present in 1977 but was not surveyed. Contraction scour and local scour caused by the constriction of the river through the bridge may account for the lower bed elevation downstream of the bridge as seen in the 1996 data.

Between RM 9.9 and RM 9.5 an increase in the channel thalweg elevation is observed between 1977 and 1996. The amount of pre-avulsion aggradation in this reach is unknown. Head cutting caused by the avulsions of the Mile 9 Pit in1995 and the Ridgefield Pits in 1996 may have lowered the elevation at this location. However, the 1996 channel thalweg elevation is still above the elevations measured in1977. It appears that head cutting at this location was not as significant as it was further downstream.

In the vicinity of the confluence of North Mill Creek (RM 9.5 – RM 9.1), the river tends to flatten and widen. This suggests an influx of sediment from the tributary or other localized source such as the high bank of the south valley wall has helped to maintain a lower channel gradient. The thalweg elevation has risen approximately 4 feet at this location between 1977 and 1996. As described above, effects of head cutting due to the breach of the Mile 9 Pit or the breach of the Ridgefield Pits are unknown. The 1996 data suggest that head cutting has occurred downstream between RM 9.1 and the Ridgefield Pits. The exact extent of head cutting upstream of RM 9.1 is unknown

It can be seen from the plot of thalweg elevations that the East Fork Lewis River between RM 9 and the Ridgefield Pits has lowered its base elevation to approximately the same as that which existed in 1977. In other words, the breach into the Ridgefield Pits, and its subsequent head cutting, has eroded approximately nineteen years worth of accumulated channel-sediments. The eroded sediments were likely deposited into the Ridgefield Pits.

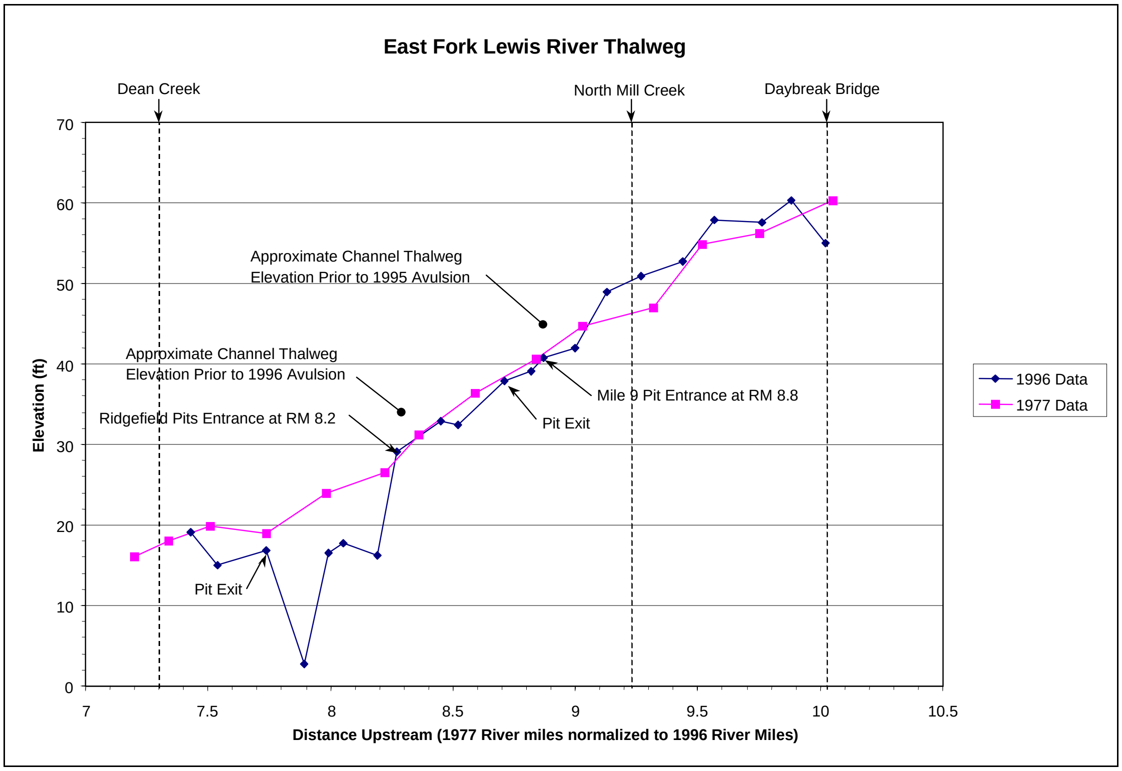


Figure 6-5. Channel thalweg elevations along valley floor.

6.4 Impacts of the Proposed Project on the Channel Profile

The Proposed Project should have no impact on the channel profile of the East Fork Lewis River as long as the river remains separated from the Existing and Proposed Daybreak Pits. The Proposed Project would impact the channel profile only if an avulsion into the pits were to occur. The probability of channel migration and avulsion into these pits is presented in Section 8, "Channel Avulsion". The potential impacts from an avulsion on the channel profile would be similar to the impacts caused by the breach into the Ridgefield Pits in 1996. The observed impacts to the river profile included a local steepening of the slope and incision of the channel upstream of the pits due to head cutting and a flattened slope through the pits.

Specific impacts downstream of the Ridgefield Pits are not quantifiable, although some generalizations can be made. Gravel pits tend to trap sediment similar to a reservoir. The bed material load of the river below the pits will be significantly reduced relative to its transport capacity. The river will attempt to recruit material from the bed and/or banks by erosion to satisfy its sediment transport capacity unless prevented by armoring of the bed or bank sediments. Such erosion could cause deepening of the downstream channel, increased bank heights and erosion, and coarsening of the channel substrate. However, it must be noted that the length of river below the Ridgefield Pits directly impacted by the avulsion and not affected by tidal backwater is relatively short (approximately1.5 miles).

The specific impacts to be expected will depend on the magnitude of the unsatisfied sediment transport capacity and the size characteristics of the bed and bank materials. It is also noted that the gradient of the East Fork Lewis River reduces rapidly downstream of the Proposed Project location. Furthermore, tidal influences substantially reduce the sediment transport capacity of the river in this area. An evaluation of the relative sediment transport characteristics of the various reaches of the East Fork Lewis River is discussed in Section 5, “Sediment Transport”.

6.5 Summary

The profile of the East Fork Lewis River in the vicinity of the Proposed Project can be characterized as a transition zone from a steep slope to a flatter slope. This break in slope creates a transition zone where river sediments tend to deposit. A comparison of the 1977 and 1996 bed elevation data show that changes in the profile are directly related to the avulsions into the Mile 9 Pit in 1995 and the Ridgefield Pits in 1996. As seen in Figure 6-5, the avulsions reduced the thalweg bed elevations between RM 9 and the Ridgefield Pits to a level similar to that in 1977 while causing a significant lowering of the bed elevation in the channel section that occupies the pits.

Impacts from the Proposed Project on the profile of the river will only occur if the river avulses into the existing Daybreak and/or subsequently into the Proposed Pits. If this were to occur in the future, the impacts would likely be similar to those created by the avulsion into the Ridgefield Pits. However, it must be remembered that the impacts on the river profile are cumulative and would be inversely proportional to the time between subsequent avulsions. In other words, the longer the time between pit avulsions the smaller the impact on the channel profile. However, the risk of avulsion would be directly proportional to the time between avulsions. In other words, as the time between subsequent avulsions increases, the risk of avulsion into abandoned channels or other nearby gravel pits within the channel migration zone (CMZ) increases. The CMZ for the East Fork Lewis River is described in Section 8, “Channel Avulsion”.

It is further emphasized that the 1996 profile data used in the comparison of historic profiles was surveyed only about one month after the river avulsed into the Ridgefield Pits. The full impact of the head cutting caused by the avulsion may not be evident in the data available for comparison. The specific impacts of the head cutting due to the avulsion into the Mile 9 Pit and the Ridgefield Pits on the Daybreak Bridge are also not quantified. However, the thalweg plots in Figure 6-5 suggest a net deposition of sediment has occurred between RM 9.1 and 9.9 from 1977 to 1996. The data suggests that head cutting has not adversely affected this section of river or the Daybreak Bridge.

The profile of Dean Creek in the vicinity of the Proposed Project is a transition zone from a steep slope to a flatter slope that is naturally depositional. This area shows typical characteristics of an alluvial fan that forms at the intersection of a small tributary with a larger river valley. The apex of the fan is fixed at J. A. Moore Road Bridge, which is located at a break in slope. Examination of the topography surrounding the Dean Creek channel in the vicinity of the apex shows that the west side of the fan is steeper. Historically, bed material has been removed from the channel in the vicinity of the bridge on a regular basis by Clark County to maintain hydraulic conveyance. This has likely helped the profile of Dean Creek to remain relatively stable over the recent past. It is also noted that an overflow channel parallels Dean Creek to the west. Because the west side of the fan is steeper, overflows from the Dean Creek main channel flow to the west into the existing overflow channel.

7 Channel Planform

7.1 Introduction

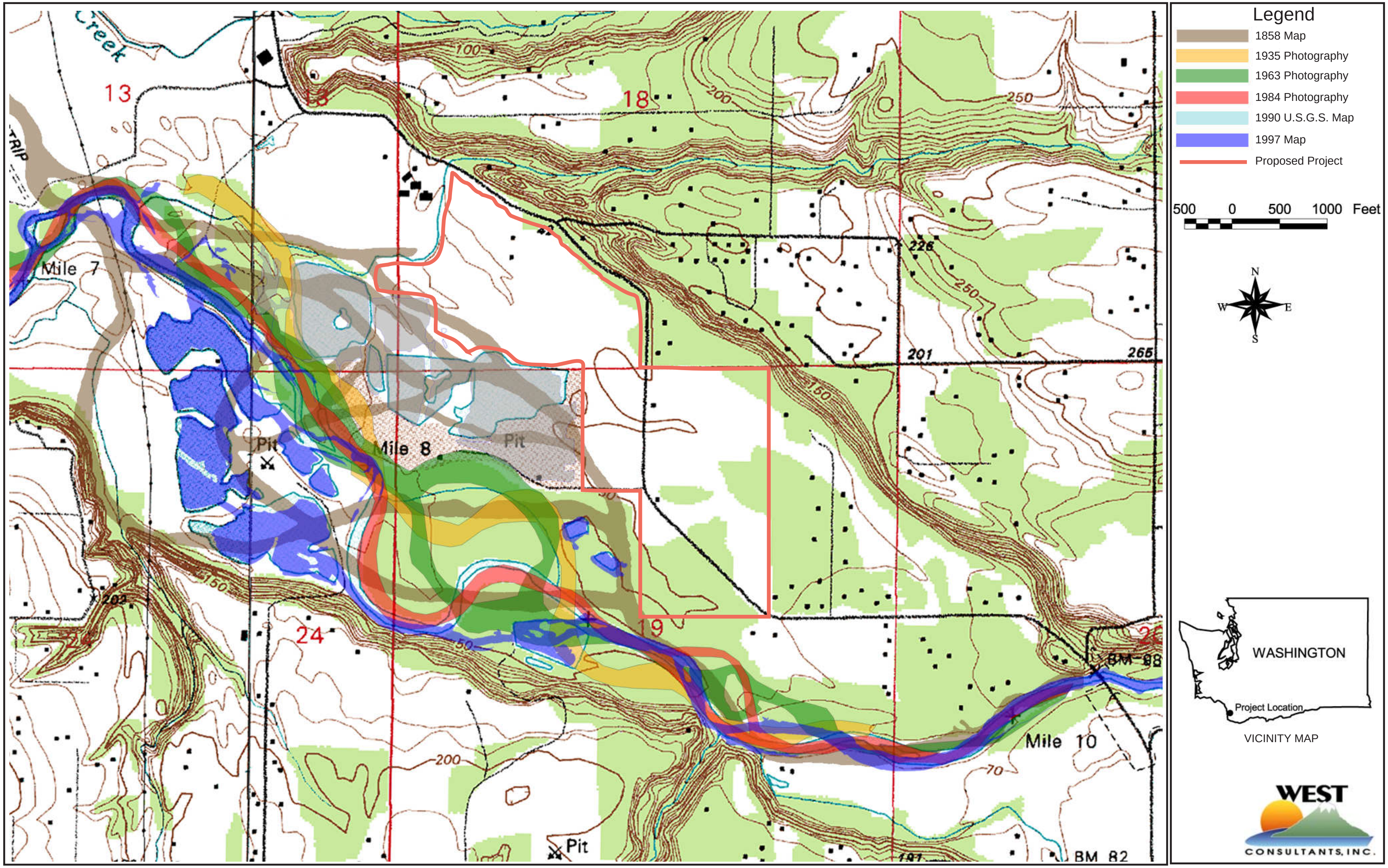
Planform analyses of the East Fork Lewis River and Dean Creek near the project site was conducted to understand the historic movements, or migration of the stream channels, with respect to the surrounding landscape as well as the Proposed Project location. The analysis was used to determine the types of channel movement and the average rates of movement in the lateral and longitudinal directions along the river. The historic trends identified from the analysis can be used to predict expected future locations of the river and is important for evaluating the potential impacts of the Proposed Project on the morphology of the channels.

7.2 Prior Studies

Several prior studies have been conducted on the geomorphology of the East Fork Lewis River. The reports from those prior studies were reviewed to identify available data and information. In the following paragraphs, the general conclusions of the prior studies are described. No prior studies are known to exist for Dean Creek.

Bradley (1996) reviewed historic aerial photography covering a period of 61 years. He showed that the channel position has remained relatively constant along the south valley wall from the Daybreak Bridge site down to the confluence of North Mill Creek at RM 9.5 (Figure 7-1). Bradley contends the Daybreak Bridge fixes the location of the river and helps direct downstream flow from the bridge toward the southern valley wall. He also documented the migration of the large meander bend just upstream of the abandoned Ridgefield Pits. He noted a recent trend for the meander to migrate toward the south valley wall away and from the existing Daybreak Pits. Bradley recognized and warned of the possibility of the channel avulsing into the Ridgefield Pits.

Collins (1997) described a widespread historic transformation in the morphology of the East Fork Lewis River he identified from the mapping and photographic record. Collins presented figures created from survey data, maps, and/or aerial photos depicting channel locations in 1854/1858, 1937, 1951, and 1990 (Figure 7-2). The 1854-era map shows nearly the entire valley bottom as wetlands “subject to inundation”. It is important to note that the location of the Proposed Project was not mapped as wetlands in the 1854-era map. The river planform in the vicinity of the abandoned Ridgefield Pits and Daybreak Pits is shown to be braided (RM 9 to 7). By 1937, a single thread channel, bordered by a system of ephemeral floodplain sloughs had replaced the braided planform. The 1951 and 1990 planform views indicate further concentration of the flow in a single thread channel and successive loss of floodplain sloughs. Collins suggests that river engineering, floodplain land uses, and gravel mining is responsible for the changes in river morphology.



Base Map: U.S.G.S. 1:24,000 Scale Maps (Ridgefield & Battle Ground, WA; 1990)

Figure 7-1. East Fork Lewis River - Approximate Historic Channel Locations

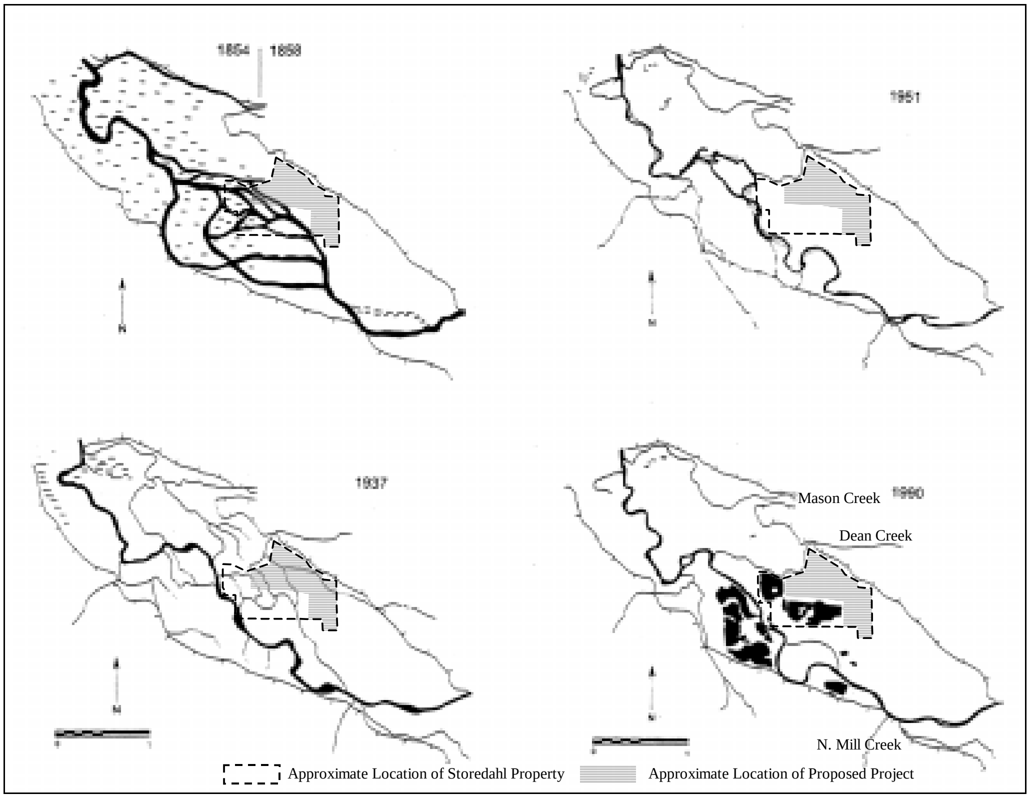


Figure 7-2. Historic Channel Locations (modified from Collins, 1997).

Norman et al. (1998) discusses the impacts of channel avulsions into abandoned gravel pits that occurred in 1995 and 1996. During the November 1995 event, the river avulsed through a gravel pit pond located approximately at RM 9 (Mile 9 Pit) and abandoned approximately 1,700 feet of channel. Observations made subsequent to the avulsions in the Mile 9 Pit showed erosion at the toe of the Pleistocene Terrace/Slide Mass on the south side of the river valley. During the November 1996 event the river avulsed into the Ridgefield Pits. This avulsion abandoned approximately 3,200 feet of channel bordering the southern boundary of the Daybreak Site. According to Norman et al., (1998) the results of the avulsions include approximately 10 feet of channel bed down cutting caused by the upstream migration of a nickpoint, increased erosion along the south bank upstream of the pits, and sluggish flow through the pits. Norman et al., (1998) estimated that it would require more than 2 million cubic yards of sand and gravel to refill the 70-acre pits through which the river now flows. Figure 7-3 is a modified figure from Norman et al. (1998) that shows the historic pattern of the East Fork Lewis River in the vicinity of the Proposed Project along with the avulsion path through the Ridgefield Pits.

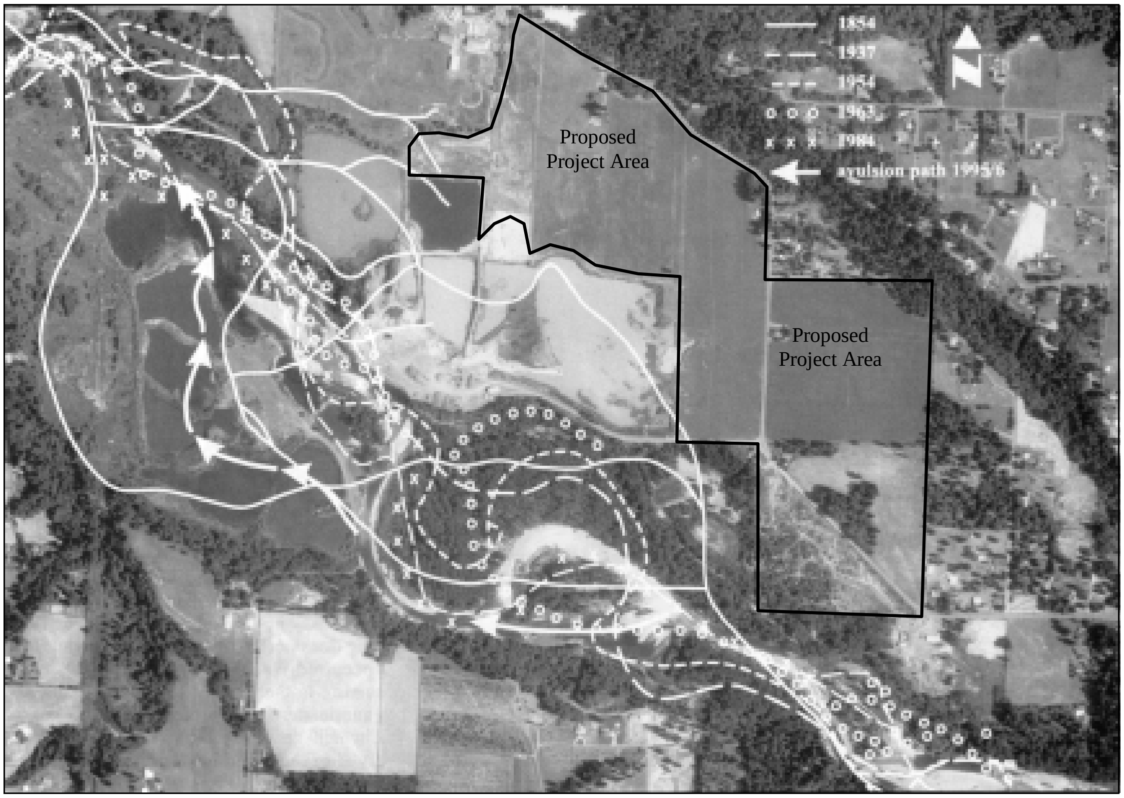


Figure 7-3. Historic channel locations (modified from Norman et al., 1998).

7.3 Historic Channel Locations

In the following sections, a discussion of the historic channel locations for the East Fork Lewis River and Dean Creek are presented.

7.3.1 East Fork Lewis River Historic Channel Locations

Figure 7-1 shows historic channel locations of the East Fork Lewis River near the Proposed Project site. In all time frames evaluated, the course of the river remains relatively constant from the Daybreak Bridge at RM 10.2 to the confluence of North Mill Creek along the south valley wall at RM 9.5. Along this reach, the river has very low sinuosity and shows only minor migration of meanders in the downstream direction. Very little lateral migration of the river has occurred in this reach. The low sinuosity of this reach would suggest that the gradient is steep enough to transport the majority of the bed material load through this reach.

From RM 9.5 to approximately RM 9 the river has shifted laterally back and forth over time in a zone that ranges from 500 to 1,000 feet in width. This zone borders the upper gravel pit (Mile 9 Pit) that was breached in November 1995. The location of the Mile 9 Pit was previously occupied by the main channel in the 1930's and again in the 1960's. The location of the Mile 9 Pit coincides with a break in the channel gradient to a shallower slope. The break in slope causes the river to deposit sediment and migrate laterally. Consequently, the East Fork Lewis River becomes more sinuous in this area.

Maps from the 1850's show that this location was the transition zone from a single thread channel upstream to a braided network of channels downstream.

Between RM 9 and RM 8 the channel has historically formed a large meander bend. The meander has migrated laterally and been cut off several times since the 1930's. The lateral migration zone of the large meander bend is approximately 2,000 feet in width. The wavelength measured from the 1990 map is approximately 2,000 feet with an amplitude of approximately 1,200 feet and an average radius of approximately 800 feet. The 1854-era map depicts this area as having a braided channel pattern rather than the single thread sinuous channel as seen in later time periods.

The transition between the braided pattern shown in the 1854-era map developed by Collins (1997) to the current single thread channel may be attributed to either limitations of the historic data or changes in the geomorphic processes controlling the river morphology. Assuming the historic data are accurate, the change in geomorphic processes may be caused by either natural or human influences. According to Lane (1957), a primary cause for a braided planform is sediment overloading. Sediment overloading can be caused by increased sediment supplies or reduced sediment transport capacity. Changes in the historic woody debris located along the East Fork Lewis River may have also influenced the channel planform. Sedell (1984) has shown that large woody debris within the channel can significantly influence channel patterns. Abbe and Montgomery (1996) discuss the significance of woody debris jams on the geomorphology of rivers in Washington State and how they may influence future channel locations.

The historic braided channel planform was probably produced by the significant reduction in river slope that occurs between RM 9 and 7 and backwater influences of the downstream Lewis and Columbia Rivers. The reduction in slope reduces the sediment transport capacity of the stream, inducing deposition of sediment (sediment overloading). The numerous dams and reservoirs, dredging for navigation, and levees for flood control along the downstream Lewis and Columbia Rivers have altered the influence of their annual flood peaks and hydraulics on the East Fork Lewis River. Effectively, the hydraulic base level of the East Fork Lewis River may have been lowered. These effects could have influenced the location and magnitude of sediment deposition along the East Fork Lewis River. Historic land use changes have also resulted in the draining and filling of sloughs and wetlands.

Remnant alluvial terrace deposits along the stretch of the river in the Daybreak vicinity suggest that the river was at a higher elevation than it is currently. These terrace deposits represent several different higher river elevations from the mid-Pleistocene (0.5 – 1.0 million years ago) to present. The terrace ranges from approximately 4 to 15 feet above the bed of the main channel in a west to east direction. Mine excavations for the Proposed Project will be located on this elevated river terrace and will be limited to areas above the 100-year floodplain.

Below RM 7 the river continues its meandering pattern at a much flatter slope. A similar meander pattern is also seen in the 1854-era map, suggesting the hydraulic and sediment transport characteristics have changed very little in this section since that time. Below RM 5.9 the river is subject to backwater tidal effects from the Columbia River (Hutton, 1995). The East Fork Lewis River has been known to flow in a reverse direction in some sections when low flow in the East Fork coincides with high tide (Hutton, 1995).

7.3.2 Historic Channel Locations for Dean Creek

Dean Creek is situated on a small alluvial fan at the edge of the East Fork Lewis River valley. Over geologic time, Dean Creek has migrated over the extent of the fan. However, analysis of historic aerial photographs suggests that Dean Creek has remained relatively stable for the last 38 years. Figure 7-4 shows a sequence of aerial photographs of Dean Creek dating back to 1962. Dean Creek is a single thread channel that has remained essentially unchanged in position throughout the available period of record. The relative stability of the channel is likely due to the periodic removal of gravel from the channel in the vicinity of the J. A. Moore Road Bridge by Clark County and by past landowner activities within and along the channel.

If sediment removal activities in the vicinity of the J.A. Moore Road crossing cease, the hydraulic capacity of the channel and bridge crossing will decrease, overflows of the channel and road will increase, and instability of the channel may be expected. Ultimately, the sediment deposition would be expected to reduce the hydraulic capacity of the road crossing to low flows. Moderate to high flows will overflow the road and will increase the potential for flooding on all parts of the fan. However, since J.A.Moore Road in the vicinity of the apex slopes to the west, and the topography of the fan is steepest on the western side of the fan, the potential for increased flood impacts would be greatest on the west side of the fan. The potential for migration of the existing channel to the east will be reduced by the proposed removal of the existing levee along the stream and restoration of the riparian forest. The removal of the levee will dissipate flow in the left (east) overbank and the restoration of riparian forest will increase resistance to flow and erosion in the left overbank.

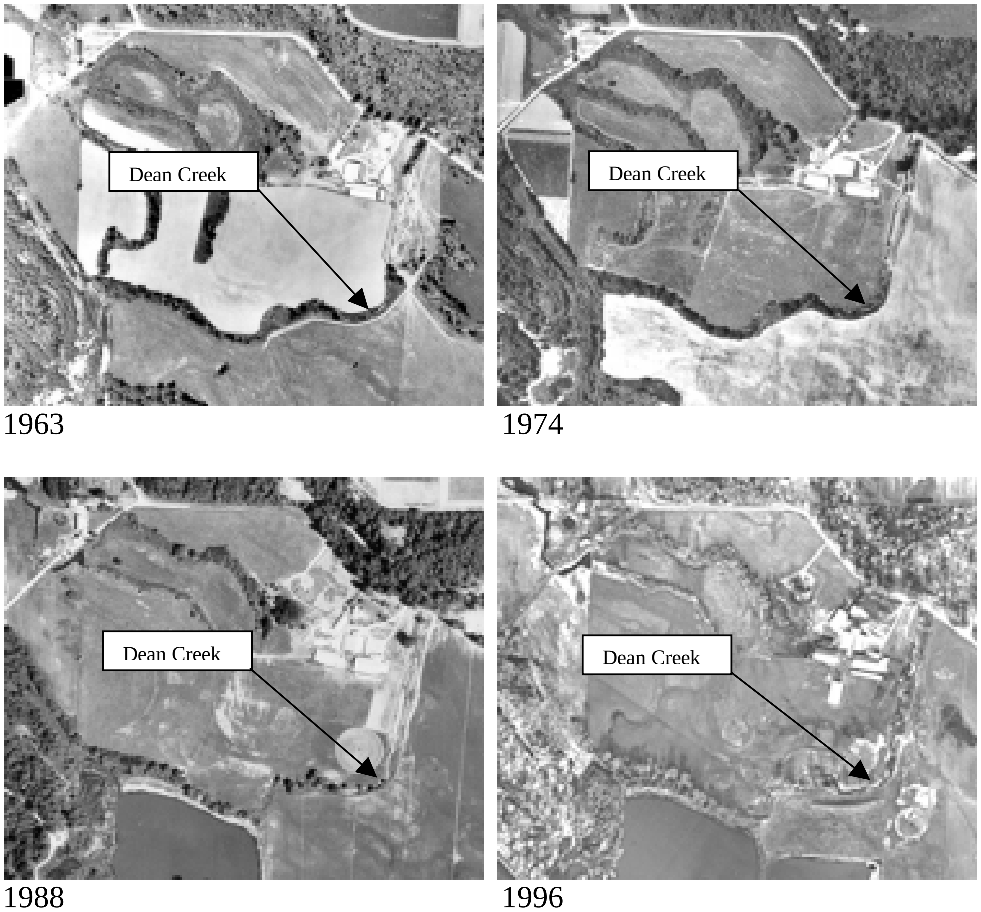


Figure 7-4. Dean Creek historic channel locations.

7.4 Historic Channel Migration Rates

The East Fork Lewis River between RM 10 and RM 9.3 shows evidence of longitudinal migration of meanders in the downstream direction. Between 1984 and 1997 the meander migrated downstream approximately 500 feet. This is an average migration rate of approximately 36 feet per year. Lateral migration was approximately 125 feet between 1963 and 1984, averaging approximately 6 feet per year.

Between RM 9.3 and RM 9.0 the river channel has tended to position itself along the south valley wall at the confluence of North Mill Creek. The 1963 and 1984 data both show a mid channel bar or island formation with the main channel split to the north and south. Lateral migration of the south channel between 1963 and 1984 was approximately 130 feet, averaging approximately 6 feet per year. Longitudinal migration of the north channel averaged approximately 9 feet per year.

Recent field observations at RM 9.0 showed the river to have migrated laterally approximately 200 feet to the north at a site just downstream of North Mill Creek between December 1996 and January 1999. This equates to a 2-year average migration rate of 100 feet per year. Prior to 1996, the river migration averaged 5 feet per year at this location. Figure 7-5 shows the bank erosion associated with the recent northward migration of the channel.

Between RM 9.0 and RM 8 the river changed direction from a north flowing meander to a south flowing meander as a result of a meander cutoff that occurred sometime between 1935 and 1963. The 1963 channel path shows a split around a large island with the northern channel later becoming abandoned by 1984. The large meander at this location had migrated downstream at an average rate of approximately 27 feet per year when it was flowing to the north between 1935 and 1963. Lateral migration averaged 30 feet per year and longitudinal migration averaged 27 feet per year while the meander was flowing to the south between 1963 and 1984. However, this meander has not migrated downstream past RM 8.

Between RM 8 and RM 7.5 the river migrated approximately 250 feet to the southwest between 1984 and 1990. This equates to an average rate of 42 feet per year. As a result of this migration, the river broke into the abandoned Ridgefield Pit No. 8 along the eastern edge of the site.

Between RM 7.5 and RM 7 the main channel was directed to the north through a meander bend from sometime prior to 1935 to sometime after 1954 where it bordered Daybreak Pit No. 5. During the time period between 1935 and 1954 the channel migrated laterally approximately 500 feet. This is an average migration rate of 25 feet per year. A similar rate was noted for downstream migration. Sometime after 1954 the meander was cut off and river flow was directed more in a northwesterly direction closer to Ridgefield Pit No. 6.

Average channel migration rates for various reaches in the vicinity of the Proposed Project site are summarized in Table 7-1. A long-term average lateral channel migration rate in the vicinity of the Proposed Project was estimated to be about 40 feet per year.

Table 7-1. Channel migration rates in the vicinity of the Proposed Project.

Location	Type of Migration	Average Migration (ft/year)
RM 10 - 9.3	Lateral (side to side)	6
	Longitudinal (up/down valley)	36
RM 9.3 – RM 9	Lateral (side to side)	6
	Longitudinal (up/down valley)	9
RM 9	Lateral (side to side)	5 and 100*
	Longitudinal (up/down valley)	-
RM 9 – RM 8	Lateral (side to side)	30
	Longitudinal (up/down valley)	27
RM 8 – RM 7.5	Lateral (side to side)	-
	Longitudinal (up/down valley)	42
RM 7.5 – RM 7.0	Lateral (side to side)	25
	Longitudinal (up/down valley)	25

* Short-term channel migration between 1996 and 1998.

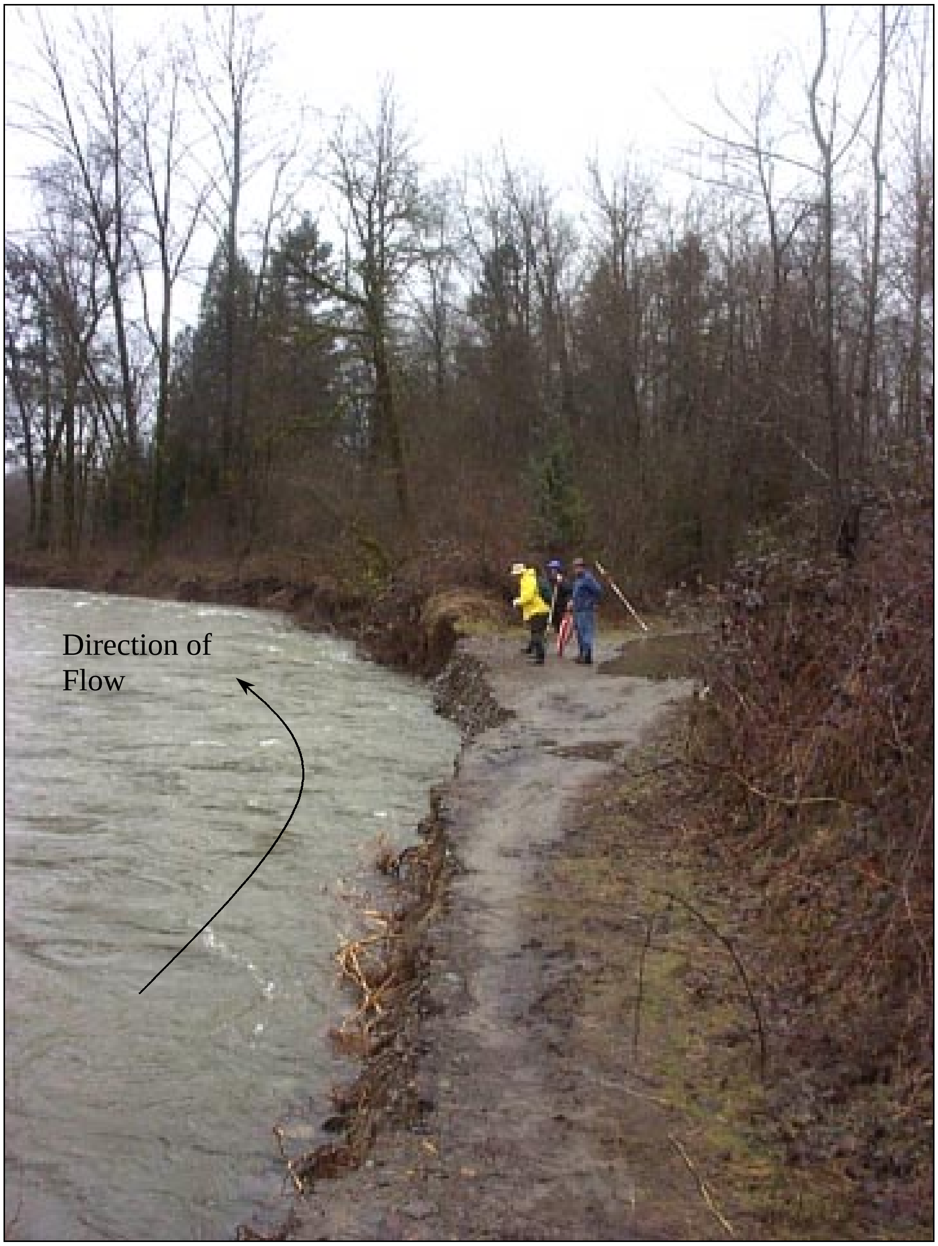


Figure 7-5. Photo of erosion of north bank just downstream of North Mill Creek at RM 9.

7.5 Expected Future Conditions Based on Historic Trends

Aerial photography and maps of the river through the Daybreak reach show that the river has not been within the Proposed Project area within the recent past with one exception. As shown on Figure 7-1, the 1854-era map shows one channel of the braided channel system within the southwestern portion of the Proposed Project area. Since 1935 the river has displayed a meandering planform and has not influenced the location of the Existing or Proposed Daybreak Pits.

In 1854 the planform of the river in the vicinity of the Proposed Project was braided and the riverbed was likely at a higher elevation compared to the present. It is unlikely that the river would revert back to a planform similar to the 1854 channel unless significant changes occurred in the hydrologic and sediment transport characteristics of the river that would cause significant aggradation. The recent capture of the Ridgefield Pits by the river has reduced the chances of significant aggradation of the channel near the Proposed Project. The Ridgefield Pits would have to substantially fill with sediment in order to rebuild the channel bed elevation up to a level that would allow the channel to migrate north toward the abandoned channel that borders the Daybreak site. Sediment infilling is predicted to take approximately 25 to 30 years. If the river were to migrate toward the Proposed Pits at this location, it would have to breach the existing Daybreak Pits before reaching the location of the Proposed Pits. Significant bank erosion and a breach of the Storedahl Pit Road would have to occur to allow the river to breach the Daybreak Pits at this location.

The East Fork Lewis River between RM 10.2 and RM 9.3 was seen to flow in a southwesterly direction along the southern valley wall throughout the period of mapping and photography. For several reasons it is unlikely that the river will substantially migrate from this path in the future. First, the Daybreak Bridge will continue to direct flow through it toward the south valley wall. Second, substantial development has occurred along NE 269th Street. If the channel began migrating to the north toward NE 269th street, it would be expected that measures would be taken to prevent loss of property (i.e. revetments or similar erosion control structures). The development conditions effectively limit the migration of the main channel and preclude the possibility of the Proposed Pits being breached by a split flow channel developing along the east edge of the Proposed Pit locations.

It is recognized that minor flow splits from the main channel have and will occur to the north of the river between RM 10.2 and RM 9.7 during major floods such as the 1996 event. The flow splits would likely enter the Proposed Pits and cause head cutting similar to that which occurred in Daybreak Pit No. 1 during the 1996 flood. However, it is noted that the 1996 flood has been determined to be a 500-year return period flood (USGS, 1997). The head cuts associated with the 1996 flood event were limited in extent. Practically, head cutting caused by flow splits is limited by the magnitude of flow in the overbank and the duration of flooding.

The sharp northward bend at the confluence of North Mill Creek (RM 9.2) has effected the local hydraulics of the channel, causing a portion of the rivers sediment load to deposit on the downstream point bar. Just downstream at RM 9, the channel has shown a tendency to stay to the north of the south valley wall. Recent field investigations have shown that the channel continues to deposit material on the point bar located on the south side of the channel while eroding the north bank (Figure 7-5). The recent acceleration of erosion on the south bank located immediately upstream may have been induced by the Mile 9 Pit capture in 1995 and possibly the Ridgefield Pit capture in 1996. This material may be contributing to the increased rate of deposition on the point bar at RM 9 and thus causing the channel to migrate to the north. Northward migration of the river at this location may continue, although likely not at the same high rate. Historic records indicate that high lateral erosion rates are not typical at this location.

The 1854-era map shows a former channel path that splits to the west and northwest at approximately RM 9. The northwest path is directed toward the abandoned county gravel pits (County 1 and County 2). Near the County Pits the former channel splits again to the west and northwest. The westerly path is directed back toward the former meander bend shown in the 1935 and 1963 photography. The northwesterly path is directed toward Daybreak Pit No. 1. A path similar to this former channel path could develop and cause an avulsion into the abandoned county pits as well as the existing Daybreak Pits. However, it should be noted that grading, levees, and road development now occupy portions of this channel and no topographic features of the 1854-era channels exist in the current topography of the floodplain at this location.

Between the Mile 9 Pit and the Ridgefield Pits, the channel has tended to migrate laterally at a relatively high rate. The meander bend located along this reach switched flow direction from north to the south in the early 1960's. Further sediment deposition in this reach of the river would have a tendency to cause the channel to shift back to the north. However, the recent capture of the Ridgefield Pits has increased the slope of the channel in this reach. Sediment that would formerly have deposited in this section of channel is now transported further downstream and deposited in the pits. The potential for northward migration of the channel in this reach of the East Fork Lewis River has been significantly reduced by the capture of the Ridgefield Pits. The potential for deposition of sediment in the channel immediately upstream of the Ridgefield Pits will be reduced until geomorphic recovery of the pits occurs. This is estimated to take approximately 25 to 30 years.

7.6 Impacts of the Proposed Project on the Planform of River

In the following sections, impacts to the planform of the East Fork Lewis River and Dean Creek from the Proposed Project are presented.

7.6.1 Impacts to East Fork Lewis River Planform

The proposed expansion and reclamation of the Daybreak Mining Site should have no impact on the planform of the East Fork Lewis River if an avulsion of the river into the existing Daybreak pits does not occur. The existing Daybreak Pits occupy portions of the 100-year floodplain next to the former main channel of the river. Any migration of the river to the north, away from the Ridgefield Pits, would need to breach the Existing Daybreak Pits before reaching the Proposed Pits. The location of the Proposed Project (further to the north of the channel and Existing Daybreak Pits and outside the 100-year floodplain) is such that any future channel migration would intercept the Existing Daybreak Pits prior to the Proposed Pits. If the river breached the Existing Daybreak Pits, the hydraulics of flow and conditions of sediment transport along the river would be affected. The affects of breaching the Existing Daybreak Pits would likely be similar to those associated with breaching the Ridgefield Pits. The pits would locally steepen the slope of the river channel and store sediments transported into them. Filling of the pits with sediments would occur over several decades. The exact route the river would take through the Existing Daybreak Pits is unknown. The potential for the river to breach into the Proposed Pits during the same event that breaches the Existing Daybreak Pits would be influenced by the physical characteristics of the breach into the Existing Daybreak Pits and the hydrologic and hydraulic conditions experienced. Breaching of the Proposed Pits during subsequent events would be influenced by the rate at which the Existing Daybreak Pits fill with sediment, the physical characteristics of the delta formed in the Existing Daybreak Pits and the hydrologic conditions experienced. The probability of the Proposed Pits being breached in the future would increase if the river avulsed into the Existing Daybreak Pits.

If the river avulsed into the Proposed Pits, potential impacts on the planform of the river would be similar to the impacts observed to be associated with the recent (1996) avulsion into the Ridgefield Pits. The channel would widen and deepen within the pits. Significant deposition of material would occurred at the entrance to the pits causing a sand, gravel, and cobble delta to form. Over time, the delta of sediment would extend downstream within the pits. Ultimately, the delta would extend through all of the pits. Backwater areas in the pits may become isolated from the main flow path through the pits. Some of the shallow backwaters could evolve into wetland areas, filling with fine sized sediments carried to them in suspension during floods. Deeper backwater areas may evolve into pools or floodplain sloughs. The growth of vegetation and collection of woody debris will influence the deposition of sediment and path of the main flow channel within the pits. The capture of the pits will locally lower the elevation and gradient of the main channel, created a preferential location for sediment deposition, and locally steepen the gradient of the channel into the pits.

7.6.2 Impacts to Dean Creek Planform

Impacts to the planform of Dean Creek from the Proposed Project would be directly related to the proposed removal of the existing discontinuous levee, revegetation of the riparian area and the potential for future avulsions. Assuming that the sediment supply to Dean Creek remains the same and the periodic removal of sediment deposits continues, the planform of the channel will not be impacted by the Proposed Project. The sediment transport characteristics of the bankfull channel of Dean Creek will not be altered by the project. The removal of the existing levee will allow high flows to occupy the newly created floodplain and dissipate flow in the left overbank. The restoration of riparian forest will create woody vegetation and debris that will increase hydraulic resistance to flow in overbank areas. Generally, the woody vegetation or debris on the floodplain would be expected to be resistant to any migration of the main channel.

A naturally occurring depositional environment exists in the vicinity of the J.A. Moore Road crossing. Historically, sediment deposits in the channel have been removed by the County to maintain flow conveyance through the bridge. If those sediment removal activities cease, the hydraulic capacity of the bridge and the channel in the vicinity of the bridge will diminish. Moderate to high flows would be expected to bypass the bridge and overflow J.A. Moore Road. This will increase the potential for flooding everywhere on the fan. However, the flooding potential is expected to increase the greatest on the west side of the fan since J.A. Moore Road slopes to the west in the vicinity of the fan apex. Also, the fan has a steeper gradient on its west side near the apex.

If sediment deposition is unmanaged along Dean Creek in the vicinity of the J.A. Moore Road crossing, a possibility exists for Dean Creek to overflow the road into the Proposed Pits. However, J.A. Moore Road is a rural collector road and a primary transportation route in the area. The possibility of Dean Creek avulsing into one of the Proposed Project Pits is discussed in see Section 8 “Channel Avulsion”.

7.7 Summary

A review of the historic data has shown the East Fork Lewis River to be a dynamic river in the vicinity of the Proposed Project. Measurements of historic lateral migration rates range from 5 to 30 feet per year, while recent rates at one location (RM 9) were estimated at 100 feet/year. A conservative estimate of the average long-term lateral migration rate of the channel in the vicinity of the Proposed Project was determined to be about 40 feet per year.

Available planform data for 1854 indicates that one channel of a braided planform intersected the Proposed Project site at that time. In contrast to the 1854 data, aerial photography data since the 1930’s has shown the East Fork Lewis River channel to have a meandering single thread channel that has not intersected the Proposed Project location. Over the last 65 years, the river has flowed along the south valley wall within a fairly well defined zone of migration ranging from 400 to 2,250 feet in width.

It is recognized that during high flow events, minor overflows splits from the main channel have and will occur to the north of the river between RM 10.2 and RM 9.7. The flow splits would likely enter the Proposed Pits and, if the discharge was large enough and for a significant duration, cause minor head cutting similar to what occurred in Daybreak Pit No. 1 during the 1996 flood. However, it is unlikely the river would change course and flow along these overflow paths. Rural collector road, several local streets, improved private roads, utility corridors, the Clark County Road Operations and Maintenance Shops, and residential development occupy this area. It is expected that measures would be taken to prevent loss of property. The development conditions are assumed to effectively limit the migration of the channel and preclude the possibility of the Proposed Pits being breached by a split flow channel developing along the east edge of the Proposed Pit locations.

Just upstream of the Proposed Project site, between the Mile 9 Pit and the Ridgefield Pits, the large meander bend has actively migrated in both the lateral and longitudinal directions. In 1996, the meander captured the Ridgefield Pits. The subsequent head cutting caused by the pit capture has increased the channel slope and decreased the potential for sediment deposition within this section of river. The capture of the Ridgefield Pits has created a well-defined sink for sediments transported along the river. Until the pits are substantially filled, the likelihood of significant lateral main channel migration in the vicinity of the Proposed Project is limited. Estimates of sediment transport suggest that the Ridgefield Pits could take approximately 25 to 30 years to effectively fill.

Accordingly, the Proposed Project should have no impact on the planform of the river in the short-term. In the long-term, the Ridgefield Pits will continue to fill with sediments. Subsequent to that filling the river channel will again freely migrate. This future migration may put a larger area of developed property, roads, utilities, and buildings at risk from erosion. Before breaching the Proposed Pits, the river must first breach the existing roads and the Existing Daybreak Pits. Based on sediment transport estimates, it would take approximately 30 years to effectively fill the Existing Daybreak Pits. However, due to their proximity, the river could enter the Proposed Pits prior to the complete filling of the Daybreak Pits. The hydraulic and sediment transport characteristics of the river would be significantly affected by breaching the Daybreak Pits. Impacts on the planform of the river from breaching the Daybreak Pits would most likely be similar to those observed to be associated with the recent breaching of the Ridgefield Pits. These impacts would include abandonment of former main channel reaches, significant widening of the flow area within the pits, deposition of sediments in the pits, and local incision of the main channel upstream of the pits.

Dean Creek has shown no evidence of channel migration in the recent past (38 years). The relative stability of the channel during this period may be due to the periodic removal of sediment deposits from the Dean Creek channel in the vicinity of the crossing by the County. If sediment removal activities by the County were to cease, the hydraulic capacity of the channel in the vicinity of the crossing would diminish and overflows from the channel would increase. Ultimately, the hydraulic conveyance capacity of the crossing would be reduced to only low flows and moderate to high flows would overflow J.A. Moore Road. This would create a potential for overflows into the Proposed Pits. However, since the J.A. Moore Road slopes to the west at the crossing, the overflows on the west side of the Dean Creek alluvial fan are more likely. Furthermore, the west side of the alluvial fan has an overall steeper gradient, which should concentrate flows on the west side of the fan. If the overflows enter the Proposed Pits and the discharge is large enough for a significant duration, minor head cutting could occur. However, J.A. Moore Road would be expected to control the upstream limit of potential headcutting.

Deposition of sediment along the existing Dean Creek channel adjacent to the project would reduce its hydraulic conveyance capacity, increase overflows from the channel, and increase the potential for channel migration. The proposed removal of the existing discontinuous levee and restoration of riparian forest along Dean Creek will reduce the potential for migration of the existing channel toward the east. The levee removal will help to dissipate flow while the restoration of woody vegetation and debris will help to resist bank erosion, reduce overbank velocities, promote suspended sediment deposition in overbank areas, and concentrate flow in the main channel.

8 Channel Avulsion

8.1 Introduction

A channel avulsion is a rapid and unexpected shift in channel position that causes a portion of the existing channel to be abandoned. Avulsions are typically caused by an obstruction to the flow such as a log or debris jam or by the breaching of a levee or high ground separating the river channel from a topographic low such as a former channel or gravel pit. The following sections describe the analysis used to characterize the potential for the East Fork Lewis River to avulse into gravel pits within the Proposed Project site.

8.2 Historic Avulsions

In the following sections, a discussion of historic channel avulsions for the East Fork Lewis River and Dean Creek are presented.

8.2.1 Historic Avulsions of the East Fork Lewis River

Historically, the East Fork Lewis River has been an actively migrating channel. Over geologic time the channel is believed to have migrated from valley wall to valley wall in the reach encompassing the Ridgefield Pits, Existing Daybreak Pits, and Proposed Project site. In the recent past, the channel has tended to stay along the south valley wall. Historic maps and photographs show that the channel has migrated and shifted position several times along this reach. Due to the limitations of historic data, for most of the period of record, it is not known where avulsions, if any, took place. However, it is certain that significant channel shifting and abandonment have occurred. These occurrences were probably due to debris jams or meander cutoffs.

In the 1854-era maps, the channel is documented to have had a braided channel pattern. Braided channels are known to be unstable and change alignment rapidly (Simons and Senturk, 1976). This would suggest that natural avulsions in the East Fork Lewis River might have been common during this time period. However, a braided channel pattern has not been observed since the 1854-era maps and is not expected to return under the current hydrologic, sediment transport, and human-influenced conditions. In recent years, three instances of avulsion have been documented. Each of the documented avulsions were associated with the migration of a river meander into abandoned gravel pits that were located in close proximity to the main river channel.

The first documented avulsion involved the Mile 9 Pit in November 1995. The Mile 9 Pit is located approximately one-half mile upstream of the Ridgefield Pits. This event caused the channel to shift to the south, abandoning approximately 1,700 feet of channel (Norman et al., 1998). The second documented avulsion occurred during the February 1996 flood (Miller, 1996). At that time, the river broke into the southeast corner of Ridgefield Pit No. 7, flowing back into the channel at its northwestern most point. This caused the abandonment of approximately 1,500 feet of channel located southwest of Daybreak Pit No. 5. However, the majority of the abandoned channel remained submerged and connected to the main channel. The third documented avulsion again involved the Ridgefield Pits in November 1996. The channel avulsed into the southeastern corner of Ridgefield Pit No. 1. This changed the course of the river, which was formerly flowing to the north along the southern boundary of the Daybreak Site. The channel currently flows through a complex of six gravel pit lakes. Approximately 3,200 feet of channel was abandoned (Norman et al., 1998).

Other minor avulsions or pit breaches were documented from examination of historic maps and aerial photos. Sometime just prior to 1990 the river had migrated into Ridgefield Pits No. 8. This did not cause the channel to change course. However, a connection was created between the pit and the main channel.

By strict definition, neither the avulsion into the Mile 9 Pit or the Ridgefield Pits, was an "unexpected" shift in channel position. In both cases, a meander of the river migrated toward the pits over a period of time. In fact, the river's migration into the Ridgefield Pits was predicted several years in advance. The historic migration path of the river had been documented to be in the direction of the Ridgefield Pits for a period of over 60 years (Bradley, 1996).

8.2.2 Historic Avulsions of Dean Creek

The formation of an alluvial fan relies on the movement of the channel over geologic time. Movement of the channel occurs due to the deposition of sediment along the channel. As sediments are deposited, the channel may shift or avulse to a new location on the fan. Dean Creek has likely avulsed many times through geologic time as it formed the fan it now occupies. However, the planform analysis suggests that the creek has remained relatively stable over the recent past (38 years). The lateral stability of the stream is likely due to the continued removal of bed material from the Dean Creek channel near J. A. Moore Road Bridge by Clark County and the presence of a discontinuous levee system along the margins of the channel.

8.3 Hydrologic Floodplain and Channel Migration Zone

The extent of the Hydrologic Floodplain and Channel Migration Zone (CMZ) are important for determining the relative risk of channel migration/avulsion into existing side channels or gravel pits adjacent to the East Fork Lewis River. The boundaries of the CMZ are also important as the environment contained within the CMZ is at greater risk of potentially negative impacts caused by human activities.

The Hydrologic Floodplain is defined as the land adjacent to the baseflow channel residing below bankfull elevation. The hydrologic floodplain is the portion of the floodplain that the river is frequently acting upon. Potential channel migration or avulsion is considered to be most probable within the boundary of the hydrologic floodplain. It is inundated approximately two years out of three (USDA, 1998).

While at some point in time, rivers have occupied each part of the valley floor, the current channel pattern and migration potential are more closely related to recent climatic and erosional patterns (WFPB, 1999). Thus, on the time scale of decades, rivers typically influence only a portion of the valley floor (WFPB, 1999). In short, the purpose of delineating the CMZ along the East Fork Lewis River is to define land areas that have a significant probability of being affected by the river. That portion of the valley floor influenced by the river is known as the Channel Migration Zone. Several definitions for a CMZ exist in the literature. The following definitions are taken from several Washington Forest Practices Board (WFPB) documents and a Timber Fish Wildlife (TFW) (USFWS et. al, 1999) document.

The Emergency Forest Practice Rules (WFPB, 1999) define the CMZ as "the area where the active channel of a stream is prone to move and this results in a potential near-term loss of riparian habitat adjacent to the stream" and refers to the Forest Practices Board Manual for descriptions and illustration of CMZ's, and delineation guidelines, including modifications to CMZ's by a permanent levee or dike. The Board Manual (WFPB, 1999) defines the CMZ as the lateral extent of likely movement along a stream reach with evidence of active stream channel movement over the past 100 years.

According to the Forests and Fish Report (USFWS et. al, 1999) a channel migration zone means, for each of the types of streams described below, the area where the active channel of such stream is prone to move and where such movement would result in a potential near-term loss of riparian forest adjacent to the stream. As described in the report, stream types associated with channel migration zones include moderately confined streams, unconfined streams, unconfined meandering streams, unconfined braided streams, and unconfined avulsing streams. The methods described for delineating the CMZ differ for each stream type. The East Fork Lewis River in the vicinity of the Daybreak Mine currently has or in the past has had characteristics of the last three stream types, while Dean Creek is considered an unconfined stream. Definitions for these four stream types provided in the Forests and Fish Report (USFWS et. al, 1999) are as follows:

> <u>Unconfined stream</u>
>
> As used in this definition, "unconfined streams" are 2nd to 4th order type F[1] or S[2] waters with bankfull widths of less than 50 feet, which usually have gradients less than 4% (but occasionally have a gradient up to 8%). These streams are often located in broader headwater or tributary valleys or are flowing across the terraces of larger river valleys. They may also occur in areas where a significant change in channel slope or confinement causes high amounts of sediment deposition such as at alluvial fans or the mouth of confined tributary valleys. Channel movement typically occurs during floods when woody debris or large sediment accumulations can cause the stream or portions of the stream to jump or avulse into side channels. These side channels are considered part of the active channel. Localized reaches of meandering or braided streams may also be present.

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[1] Type S waters include "all waters within their ordinary high-water marks, inventoried as shorelines of the state…"

[2] Type F waters include "all segments of natural waters (other than Type S waters) (a) are within the bankfull widths of defined channels or (b) with lakes, ponds, or impoundments have a surface area of 0.5 acres or greater at seasonal low water which, in either case, contain fish habitat…"

Unconfined meandering stream definition

As used in this definition, "unconfined meandering streams" are 5th order and larger Type S waters (Type S waters include all waters within their ordinary high-water marks, inventoried as “shorelines of the state”) with bankfull widths greater than 50 feet and gradients of less than 2% with the following additional characteristics: The waters are sinuous, primarily single-thread channels that have a distinct meandering pattern readily observable on aerial photographs. Remnant side-channels and oxbow lakes often create wetland complexes within the associated channel migration zone. A diverse set of vegetation can grow within the associated channel migration zone including cedar, spruce, hardwoods, and wetland vegetation on wetter sites and Douglas-fir, spruce, hemlock and true firs on drier terraces. "Unconfined meandering streams" do not include any waters that are unconfined braided streams or unconfined avulsing streams.

Unconfined braided stream definition

As used in this definition, "unconfined braided streams" are 5th order or larger Type S waters with bankfull widths greater than 50 feet and gradients of less than 2% with the following additional characteristics: These waters have a high sediment supply and form numerous channels (multi-threaded) that are likely to move within the bankfull width of the stream in even small storm events. The frequent rate of channel movement means that the associated channel migration zone is typically sparsely vegetated with young hardwoods along the channel margins. Glacially fed streams often have large sections of braided channel. "Unconfined braided streams" do not include any waters that are unconfined meandering streams or unconfined avulsing streams.

Unconfined avulsing stream definition

As used in this definition, "unconfined avulsing streams" are 5th order or larger Type S waters with bankfull widths greater than 50 feet and gradients of less than 2% with the following additional characteristics: These waters are usually large dynamic river systems that in some cases have had dikes and levees constructed that may restrict channel movement. Numerous side channels, wall-based channels, oxbow lakes, and wetland complexes may exist within the associated channel migration zone. Sizeable islands with productive forest land may also exist within the zone. Woody debris jams with larger diameter pieces of large woody debris are an important element for creating pools within these waters, as well as redirecting flow to create side channels and islands. Vegetation within the associated channel migration zone can include cedar, spruce, hardwoods, and wetland vegetation on wetter sites and Douglas-fir, spruce, hemlock and true firs on drier terraces or islands. "Unconfined avulsing streams" do not include any waters that are unconfined meandering streams or unconfined braided streams.

8.3.1 East Fork Lewis Hydrologic Floodplain and Channel Migration Zone

For the purposes of this report, the Hydrologic Floodplain is mapped as the area inundated by the 2-year recurrence interval flood (Figure 8-1) or within 80 feet (2 times the average lateral migration rate of approximately 40 feet per year derived from evaluation of historic aerial photography (See Chapter 7) of the existing low-flow channel, which ever is less. The employed definition of the hydrologic floodplain was selected to provide a conservatively large definition of its limits.

The East Fork Lewis River near the Proposed Project makes a transition from a steeper more confined valley to a flatter less confined valley. At this location much of the river's bed load is deposited causing the stream to become more sinuous. According to maps from 1858, the channel at this location showed evidence of braiding and would fit into the unconfined braided stream category. However, evidence of a braided channel planform has not been seen in any subsequent mapping or photography. Since the 1930's, the planform has been that of a mostly single thread meandering channel. Thus, under the current hydrologic and sediment transport regime, the East Fork Lewis River in the vicinity of the Daybreak Mine would be considered either an unconfined meandering stream or an unconfined avulsing stream.

Historic evidence suggests that at least one natural avulsion has taken place sometime prior to the 1960's that caused a large meander to be cut off, temporarily forming an island. The remnant channel from this former meander bend is located along the south side of Storedahl Pit Road. Also, a smaller island located just upstream, at the confluence with North Mill Creek, had existed for many years between the 1960's and the 1980's. For this reason it is concluded that the East Fork Lewis River in the vicinity of the Daybreak Mine more closely fits the definition of an unconfined avulsing stream.

As defined in the Forests and Fish Report (USFWS et. al, 1999), the CMZ for unconfined avulsing channels can include much of the valley bottom and is typically hundreds of feet, but can easily be a few thousand feet, in width. Delineation of the boundaries is often determined based upon a review of the associated vegetation and history of past migration.

Based on the history of past migration (Figure 7-1), the CMZ for the East Fork Lewis River does not include the entire valley bottom. In fact, since the 1858 (approximately 140 years of record) the river has remained almost entirely within the southern portion of the valley. Because no specific method for determining the CMZ of unconfined avulsing channels is given, the methods described for an unconfined braided and unconfined meandering stream were used. The CMZ for an unconfined braided stream is considered to be the bankfull width. However, it is noted that the East Fork Lewis River in the vicinity of the Proposed Project has not had a braided pattern since at least the 1930's. Accordingly, a CMZ associated with an unconfined braided stream type is not representative of the current channel form. The CMZ for an unconfined meandering stream is defined as (1) the area within the amplitude of the meander bends or (2) the area subject to bank erosion over the time required for growing functional large woody debris. A conservative estimate of the time required to grow functional large woody debris is 200 years (200 ft tall, 2-3 ft diameter Douglas Fir). At an average erosion rate of 40 feet per year, the limits of the CMZ would be 8,000 feet. This distance is greater than the boundaries of all documented historic channel locations and the width of the valley floor, which is approximately 3,000 feet wide in the vicinity of the Daybreak Mine. Accordingly, this method was not considered appropriate for determining the CMZ for the East Fork Lewis River. Analysis of historic planform data suggests that the CMZ for the unconfined meandering stream type based on method 1 more closely represents the unconfined limits of channel migration under the current hydrologic regime (Figure 8-2).

Both of the methods previously described were not seen to adequately describe the true limits of the CMZ. Several areas with topographic evidence of past channel movement fell outside of the CMZ as they were not represented in the historic photography and mapping. These areas were seen to be located within the active floodplain below the upper terrace elevation. For this reason, another method (method 3) was used to define the edges of the upper terrace deposits as the limits of the CMZ. Method 3 defines the CMZ as the area inundated by the 20-year recurrence interval flood (Figure 8-1), or within 800 feet (20 times the average lateral migration rate of 40 feet per year) of the existing low-flow channel, which ever is less. A period of 20 years was selected since it represents a period of several decades, consistent with the Forest Practice Board Manual definitions (WFPB, 1999). This method of defining the CMZ was combined with the historic planform analysis (method 1) to determine the most conservative representation of the CMZ.

It is noted that overflow paths of the East Fork Lewis River do exist in the vicinity of the Daybreak Mine in the northern portion of the valley. These overflow paths are excluded from the CMZ because they cross several county roads, are above bankfull elevation and show no evidence typically associated with side channels. Side channels are typically characterized by gravel bottoms (often covered with leaf litter), sparse to no vegetation, or a rectangular cross section (WFPB, 1999). The Board Manual (WFPB, 1999) describes secondary channels with beds above the bankfull elevation that are disconnected from the main channel as overflow channels. Overflow channels (such as the overflow paths of the East Fork Lewis River) do not constitute evidence for a CMZ (WFPB, 1999).

It should be further noted that the portion of the East Fork Lewis River for which a CMZ is being delineated is not a forest practice unit. Historically, land use in the vicinity of the Proposed Project has been for agriculture. However, the valley bottom associated with the East Fork Lewis River can be described as a disturbed/altered floodplain environment as is described in the Board Manual (WFPB, 1999). A disturbed/altered floodplain environment commonly includes human-caused restrictions on streams from roads, railroads, riprap, dikes and levees (WFPB, 1999). According to the Board Manual, the CMZ does not extend beyond the limits of a structure such as a dike or levee if “the structure supports a public right-of-way or conveyance route and receives regular maintenance to maintain structural integrity” and “the structure was constructed pursuant to appropriate federal, state and local requirements”.

According to this definition, all county roads and Storedahl Pit Road would be considered to limit the extent of the CMZ. This definition is similar to King County's description of Mitigated Hazard Zones for channel migration. A Mitigated Hazard Zone is described as the unconstrained natural limits of channel migration scaled back to the boundaries of major roads, developed areas, revetments and levees (Perkins, 1993). Using the definition of CMZ for disturbed/altered floodplains defined by the Board Manual (WFPB, 1999) and King County (Perkins, 1993), the Channel Migration Zone (CMZ) for the East Fork Lewis River in the vicinity of the Daybreak Mine is shown in Figure 8-3.

8.3.2 Dean Creek Hydrologic Floodplain and Channel Migration Zone

Similar to the East Fork Lewis River, the hydrologic floodplain for Dean Creek was chosen as the 2-year floodplain. Except for a small overflow channel to the west, the existing channel contains the 2-year recurrence interval flood. The existing channel banks along the channel were chosen to define the limits of the hydrologic floodplain.

As defined in the Forests and Fish Report (USFWS et. al, 1999), the CMZ for an unconfined stream is determined by reference to the surrounding topography and vegetation. Delineating the boundaries of these zones can be more difficult because of the subtle changes in these features. The extent of the channel migration zone often coincides with the furthest extent of side channels. The entire channel migration zone width is typically on the order of 10's of feet for small streams, but can be a few hundred feet on moderate sized streams. The lack of side channels and the historic photographic evidence suggest that the CMZ for Dean Creek coincides with the bankfull channel edge.

Dean Creek in the vicinity of the Proposed Project flows over an alluvial fan. For modern alluvial fans, channel migration is common and often difficult to predict (WFBP, 1999). Alluvial fans at the confluence of streams (such as Dean Creek) are typically considered modern alluvial fans (WFBP, 1999). The CMZ will typically encompass the entire fan surface because of the difficulty in predicting future channel locations (WFBP, 1999). However, historic evidence suggests that Dean Creek has remained relatively stable for the last 38 years. The lack of side channels, presence of a discontinuous levee system, and general fan topography indicate the potential for future channel movement is low. Additionally, the extraction of bed material by Clark County in the vicinity of the bridge will continue to reduce the likelihood of channel migration. The available evidence suggests that the current CMZ for Dean Creek should be defined as the bankfull channel edge.

If the removal of sediment deposits along Dean Creek by Clark County is not continued, an increased potential for channel migration would exist. The CMZ for Dean Creek could potentially encompass the entire alluvial fan. However, the steeper gradient on the west side of the fan would likely promote channel migration on that side of the fan. The proposed removal of the existing discontinuous levee would define the east boundary of the CMZ. If sediments are not removed periodically, the hydraulic capacity of the J.A. Moore Road Bridge will diminish and overflows of the road would be expected for moderate to high flows. Overflows of the road to the east may occur that may enter the Proposed Pits. A headcut may develop where the overflow enters a pit. The upstream extent of the head cut is expected to be limited by J.A. Moore Road. Such an overflow is not an avulsion path since the location of the Dean Creek channel is fixed at the bridge and the road will prevent formation of a channel in any other direction. The proposed removal of the existing discontinuous levee will define a mitigated boundary for migration of the channel. The restored riparian forest in the left overbank would increase hydraulic roughness, reduce overbank flow velocity, and promote deposition of suspended sediments. This will reduce the potential for channel migration to the east, toward the project.

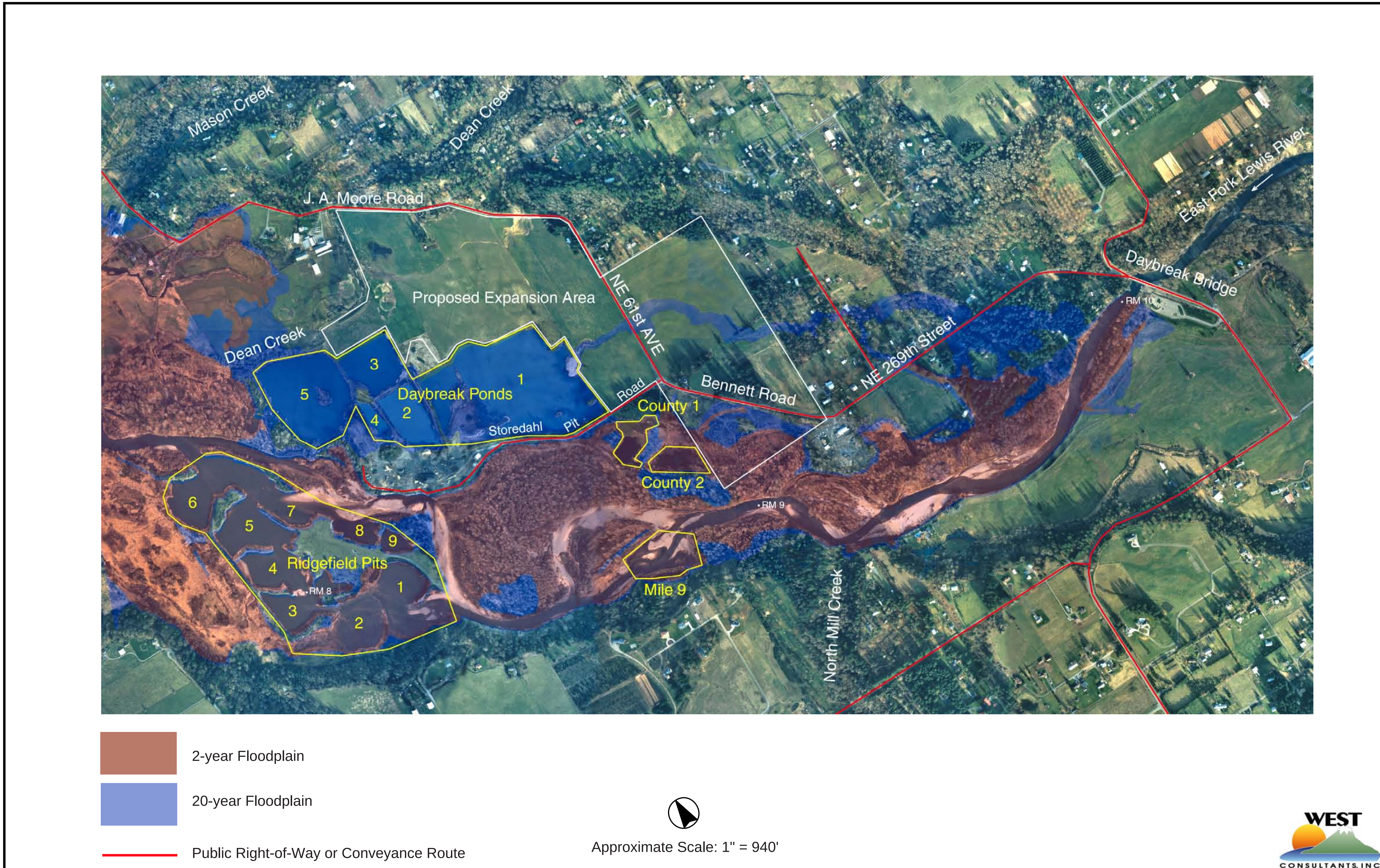

Figure 8-1. 2- and 20-year floodplain used to define the Hydrologic Floodplain and Channel Migration Zone.

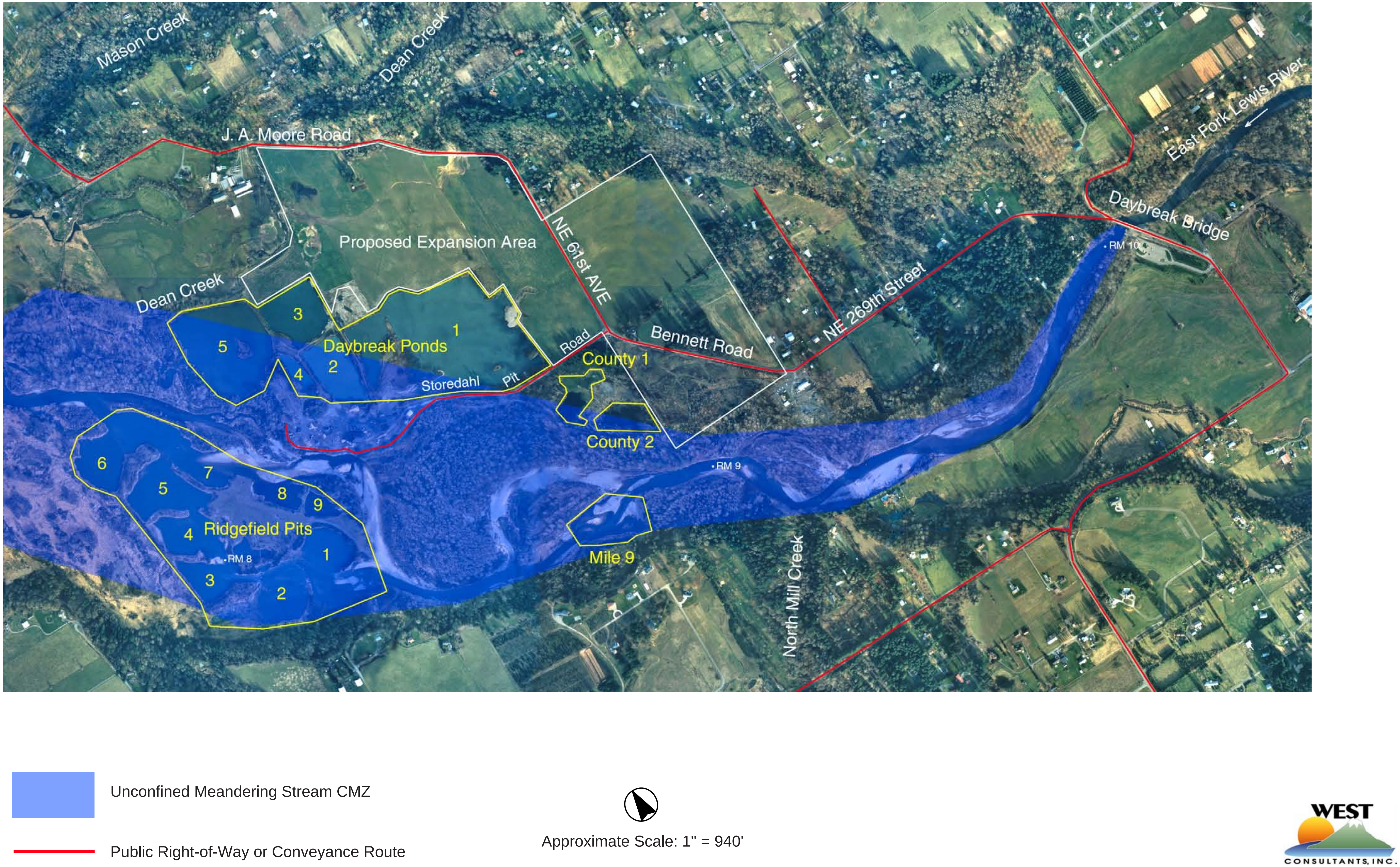

Figure 8-2. Unconfonfined Meandering Stream (method 1) Channel Migration Zone.

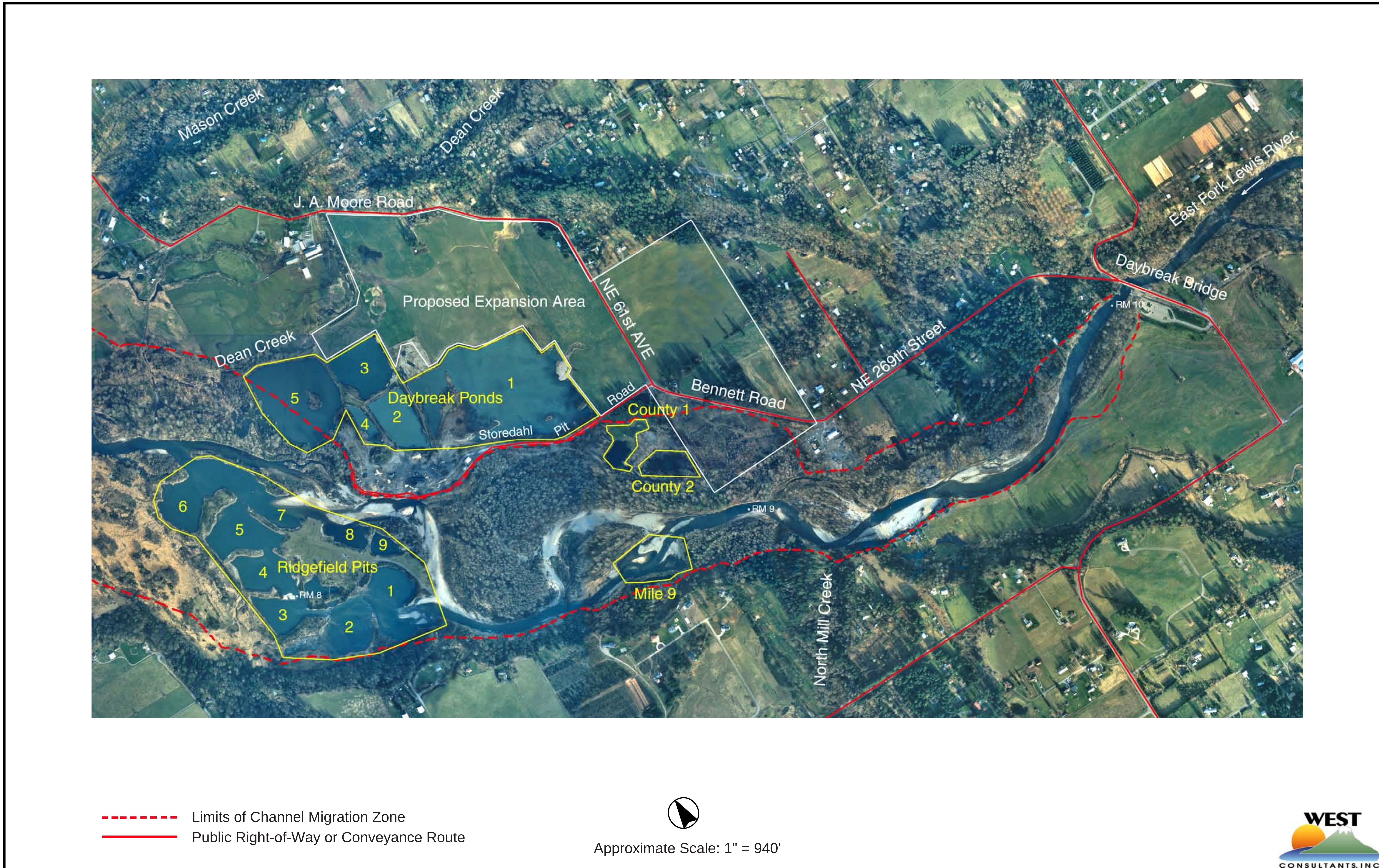

Figure 8-3. East Fork Lewis River Channel Migration Zone.

8.4 Potential for Channel Migration / Avulsion

Avulsions are triggered by unpredictable, random events such as large woody debris jams, landslides, large floods, or upstream changes in river position, therefore it is not possible to predict when or if an avulsion will definitely occur. However, the relative risk of one location along the river versus another can be qualitatively evaluated to determine the potential locations of future avulsions. Accordingly, such an evaluation was made based on available information and historic trends. The analysis does not imply that an avulsion will definitely take place at the indicated locations in the future, rather that if an avulsion were to occur, the identified locations have a greater potential for avulsion than other locations. The following sections describe the potential paths for channel migration/avulsion by reach. The analysis incorporates results described in previous sections of this report.

8.4.1 East Fork Lewis River Avulsion Potential

To help define the potential for channel migration/avulsion into the Proposed Project, each potential migration/avulsion path identified is described as within the Hydrologic Floodplain, within the Channel Migration Zone (CMZ) or outside of the CMZ. Migration/avulsion paths that are located within the Hydrologic Floodplain indicate they have a potential to be occupied within about two years. Migration/avulsion paths located within the CMZ are believed to have a potential to be occupied within about 20 years. Observations of current conditions and historic trends were also used to judge the potential for migration/avulsion. In the following paragraphs, refer to Figure 8-4 to define the locations of potential migration/avulsions paths.

<u>Daybreak Bridge (RM 10) to North Mill Creek (RM 9.2).</u>

The planform analysis demonstrated that the river channel within this reach has moved very little in the 145 years since the survey of 1854/1858. The channel profile is relatively steep and shows only minor changes in bed elevation over the period from 1977 to 1996 except at the confluence with North Mill Creek. Aggradation has occurred at this location that may cause increased lateral migration. However, no obvious alternative flow paths exist that would allow the river channel to make a direct connection to the Proposed Project from this location.

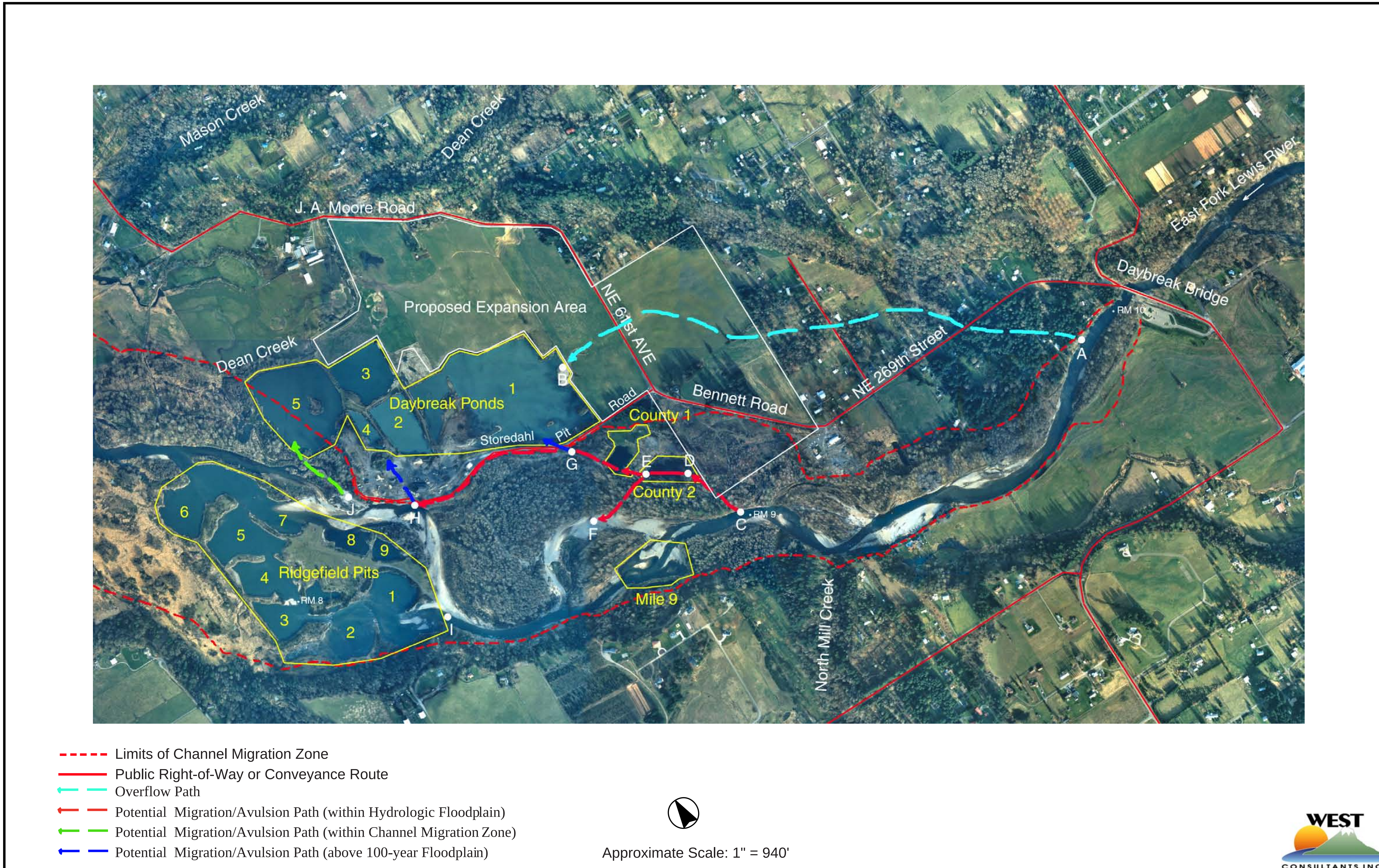

Figure 8-4. Overflow path and potential paths of channel migration and/or avulsion.

It is recognized that minor overflows split from the main channel between Sites A and B have and will occur along this reach during large floods. The flow splits along this route would possibly enter the Proposed Pits and cause head cutting similar to that which occurred in Daybreak Pit No. 1 during the 1996 flood. However, it is noted that the 1996 flood has been determined to be a 500-year return period flood (USGS, 1997). The head cut associated with the 1996 flood event was limited in extent. Practically, head cutting caused by flow splits between Sites A and B is limited by the possible magnitude of flow in overbank areas and the duration of flooding. The discharge values of the split flows for various return periods determined from hydraulic modeling are shown in Table 8-1.

Table 8-1. Split flow magnitudes.

Return Period (years)	Splitflow Q (cfs)
2	0
10	100
20	285
50	475
100	650

The hydraulic model used to define the split flow values was developed to evaluate the flood hazard potential along the East Fork Lewis River. Accordingly, the split flow values identified are considered to be conservatively large and likely overestimate the potential for split flows to affect the proposed development. In fact, an approximate 10-year return period flood occurred on the East Fork Lewis River on November 25, 1999 (Personal communication with USGS, 1999). No split flows were observed in the vicinity of the Proposed Project during this event. (Personal communication with K. Storedahl, 1999).

Split flow paths in the vicinity of Proposed Project showed no signs of erosion or tendency for channel formation due to the 500-year return period flood that occurred in February of 1996. Accordingly, there is no reason to believe that flood events with lesser magnitudes would have a significantly different erosion potential. There appears to be little or no erosion risk to the land separating the Proposed Project from the 100-year floodplain. In the case of floods greater than a 100-year return period event, or if flow paths are obstructed, overflows into the Proposed Project Pits are expected to cause minor head cutting at the pit boundaries. A delta of sand and gravel, similar to the delta that formed in Daybreak Pond No. 1 as a result of the 500-year flood event in February 1996, would be expected to form in the Proposed Project Pits and could disturb some portion of the proposed wetlands associated with the pits.

In addition, the reestablishment of floodplain forests and wetlands in the vicinity of the Proposed Project should further reduce the potential for impacts. Also, the existence of residential development and county roads (NE 269th St., Bennett Rd. and NW 61st Ave.) effectively prohibit the potential for shifting of the channel to the north of its current and historic locations. This will prevent any future channel avulsion into the Proposed Project along this overflow path. This spilt flow path is considered to be an overflow path as defined by the Washington Forest Practices Board Manual (WFPB, 1999) and is effectively outside of the CMZ.

North Mill Creek (RM 9.2) to Ridgefield Pit Entrance (RM 8.3)

The planform analysis has shown the channel in this reach to have a historic southward trend. The slope decreases slightly in this reach causing increased sediment deposition. Recent field investigations have shown that the channel is depositing material on the point bar located on the south side of the main channel, at RM 9, causing erosion along the north bank (see Figure 7-5). From recent field investigations, it was estimated that the river channel has migrated approximately 200 feet to the north in this area since 1996 (halfway between Site C and D). Capture of the Mile 9 Pit in 1995 may have caused the channel to influence erosion along the south valley wall at the confluence of North Mill Creek and increasing the sediment supply to the downstream reach. No obvious evidence of incision was apparent during a recent field investigation; however, this may have been masked by subsequent sediment deposition. Continued northward migration of the river at this location may occur.

The 1854-era map (Collins, 1997) shows a former channel path that splits to the west and northwest at approximately RM 9 (Figure 7-1). The abandoned County Pits (County 1 and County 2) were excavated from within the northwest path of this former channel. In the vicinity of the County Pits, the 1854 channel was seen to split again to the west and northwest. The 1854 westerly path is directed back toward the former meander bend noted in the 1935 and 1963 photography (similar to path from Site E to G). Hydraulic modeling indicates this path to be within the hydrologic floodplain (Figure 8-1). The 1854 northwesterly path was directed toward Daybreak Pit No. 1. The location of this former channel path shows some potential for future avulsion into the abandoned County Pits and possibly the Existing Daybreak Pits if the river breached Storedahl Pit Road.

If the East Fork Lewis River continues to migrate north and capture the abandoned County Pits at site D, the new preferred flow path would most likely be from Site D to F, as the slope between these points is relatively steep. However, it is also possible that a significant proportion of the flow could follow the path from Site E to H along the abandoned meander bend located just to the south of Storedahl Pit Road. Should this abandoned meander bend begin to transmit a large proportion of the channel flow, the risk of the river avulsing into Daybreak Pit No. 1 would increase. However, the potential for an unexpected shift of the channel through the Daybreak Pits is somewhat reduced by the existence of the paved entrance road (Storedahl Pit Road) to the Daybreak processing area. It would be expected that erosion control measures would be instituted if the road became threatened by the river. It is also noted that the road is outside of the CMZ and above the 100-year recurrence interval floodplain. The risk of the river avulsing into the Proposed Pits would increase if the Existing Daybreak Pits were breached along this path.

As seen in Section 7 “Planform Analysis”, the channel between the Mile 9 Pit and the Ridgefield Pits has tended to migrate laterally at a relatively high rate (30 feet/year). The meander bend located along this reach switched flow direction from the north to the south in the early 1960’s. Further sediment deposition in this reach of the river could cause the channel to shift back to the north toward Site F. However, the recent capture of the Ridgefield Pits has increased the slope of the channel in this reach. Sediment that would otherwise deposit in this section of channel is now carried downstream and deposited in the pits. The potential for northward migration of the channel in this reach of the East Fork Lewis River has been significantly reduced by the capture of the Ridgefield Pits. The deposition of sediment in the channel upstream of the Ridgefield Pits will continue at a reduced rate until the pits have been substantially filled. In Section 5 “Sediment Transport”, it was estimated that this may take approximately 25 to 30 years.

Once the Ridgefield Pits become substantially filled, the river will again increase its bed elevation by depositing sediment along this reach. As this occurs, the potential for the channel to migrate will increase. If the channel reoccupied the former northern meander bend that parallels Storedahl Pit Road, the potential for avulsion into the existing Daybreak Pits would be increased. Storedahl Pit Road provides the only access to the gravel processing operation and provides the only separation between the abandoned meander bend and Daybreak Pit No. 1. The risk of the river avulsing into the Proposed Pits would increase if the Existing Daybreak Pits were breached at this location. However, it is expected that measures would be taken to prevent the breach of the Daybreak Pits during the life of the gravel processing operations at this site. It would be expected that erosion of the Storedahl Pit Road embankment would most likely occur over a period of time. As was the case with the Ridgefield Pits, the migration of the channel into the pits was predicted several years prior to occurrence. The avulsion may have been preventable with the installation of suitable bank protection along the road. The installation of erosion control measures along Storedahl Pit Road would be expected if it became threatened by the river and could be planned for.

<u>Ridgefield Pits Entrance (RM 8.3) to Ridgefield Pits Exit (RM 7.6)</u>

The avulsion of the East Fork Lewis River into the Ridgefield pits in 1996 has effectively reduced the risk of avulsion into the existing Daybreak Pits at Sites H and J and the Proposed Pits over the next several decades. The abandoned channel between Sites I and J remains within the CMZ. However, the lowering of the channel elevation by head cutting has caused the low-flow channel to be less connected to this abandoned channel. Also, there is approximately 420 feet of land that is outside of the CMZ and above the 100-year floodplain between the existing Daybreak Pits and Site H. This effectively reduces the risk of the channel avulsing along this path.

The potential migration/avulsion path between Site J and Daybreak Pond 5 is within the CMZ. Although a breach into Pond 5 could occur, the East Fork Lewis River would not be expected to shift its channel position into the Proposed Pits, as this would require up-gradient flow. It is more probable that the river would form a connection with Daybreak Pond 5 similar to its former connection with Ridgefield Pit 8.

8.4.2 Dean Creek Avulsion Potential

The potential for Dean Creek to avulse into the Proposed Project Pits is based on the ability of the Dean Creek channel to migrate over to the location of the pit or overflow its banks and erode a new channel into the pit. The ability of the channel to avulse (change location) into the Proposed Pits will depend on the energy gradient that exists between the energy grade line of the creek and the water surface of the pit at the time the creek breaches or overflows the pit wall. If the energy gradient along the path through the pit is steeper than the one in the existing channel, an avulsion will most likely occur. However, if the gradient in the existing channel is steeper than the path through the pit, a connection will likely occur without the abandonment of the existing channel. The depth of the Proposed Pits will not increase the potential for avulsion unless the water surface elevation in the pit is linked to the pit depth. Water levels in the pits will be close representations of the shallow groundwater table due to the highly permeable sands and gravels on the project site. Mitigation measures to prevent the channel from migrating or forming a channel into the Proposed Pits could be implemented and are described in Section 8.7.

It has been shown that Dean Creek has been stable in the period of available record (38 years). However, the relative stability of the channel may be due to the periodic removal of sediment deposits by Clark County in the vicinity of the J.A. Moore Road crossing of the creek. If sediment deposits along the creek continue to be removed on a periodic basis, the potential for avulsion from the existing channel to proposed pit locations is considered low. The proposed levee removal and restoration of riparian forest would further reduce any potential for avulsion into the Proposed Pits. The removal of the existing levee would dissipate flow in the left (east) overbank by broadening the available floodplain. Grading of the floodplain in the area of the existing levee will present a barrier to flow reaching the pits from the creek. The restored riparian forest and its woody vegetation and debris would slow overbank flow velocities, promote deposition of suspended sediments, increase resistance to bank erosion along the channel, and help concentrate flow in the main channel of the stream.

If the removal of sediment deposits along the channel in the vicinity of the J.A. Moore Road crossing is not continued, the hydraulic capacity of the channel will diminish, overflows from the channel will become more common, and migration or avulsion of the channel may occur. Again, the removal of the existing levee and restoration of riparian forest will serve to mitigate the potential for the channel to migrate to the east. The grading of the floodplain associated with the removal of the existing levee will prevent overflows into the pits and control any eastern migration of the channel. Since the gradient of the fan is steepest on the west side of the fan, overflows of the channel toward the west would be expected. It is noted that an overflow channel parallels the existing Dean Creek channel to the west.

If overflows of J.A. Moore Road occur to the east, the overflows could be expected to flow into the Proposed Pits. Such overflows could cause a headcut to form at the boundary of the pit. The upstream limit of such erosion would be expected to limited by the J.A. Moore Road. Accordingly, the road is expected to prevent the formation of a new channel required for the avulsion of Dean Creek into the Proposed Pits from a point upstream of J.A. Moore Road.

8.5 Ability to Mobilize Existing Bank Sediments

The material forming the lower river banks of the East Fork Lewis River in the vicinity of the project site are composed of sediments that have been previously deposited by the river as it migrated back and forth along the valley bottom. These sediments are non-cohesive and unconsolidated materials that are easily eroded by the river. The bank material is most vulnerable to erosion along the outside bends of the river, as was observed in the avulsion into the Ridgefield Pits. It is noted that the levees associated with the gravel pits in the vicinity of the Proposed Project were not constructed as such, but are remnants of the former land surface prior to the excavation of gravel pits as well as material stockpiles. Therefore, the “levee” sediments are comprised of the same sediments as the bank sediments and as such have the same erosion potential. The developed hydraulic model for the East Fork Lewis River in the vicinity of the Proposed Project indicates bank velocities of approximately 9 feet per second for the 2-year flood event at RM 9. Trees and other vegetation located along the riverbanks would be expected to provide some resistance to erosion, although field observations suggest that the river can effectively undermine trees and transport them downstream. The existence of vegetation could influence the direction and extent of river migration.

8.6 Characterization of Impacts from Avulsion into Gravel Pits

Impacts from the avulsion of the river into a floodplain gravel pit can be characterized as short-term or long-term. Short-term impacts are those changes to the morphology of the river that take place during and shortly after the avulsion. Long-term impacts are those that continue to effect the morphology of the river well into the future. Additionally, these impacts can be described by their location in relation to the avulsion site. Table 8-2 summarizes the impacts from avulsion described in this section.

8.6.1 Upstream Impacts

Short-term impacts upstream of an avulsion into a gravel pit include head cutting, which causes degradation of the bed and increased channel slope, channel armoring, and/or an increase in the channel armor size (bed coarsening). When a gravel pit is breached, a localized difference occurs in the energy between the higher elevation flow in the river and the lower elevation water in the pit causing a steep energy gradient to form. The increased energy gradient will increase the sediment transport capacity of the river, creating a demand for sediment. If the material forming the armor layer on the channel bed is too small to resist the forces created by the energy imbalance, the channel bed material will erode and be transported downstream. This erosion will then propagate (head cut) upstream until the channel bed has formed a stable slope and armor layer that will resist the forces of the flow. The upstream extent of head cutting is controlled by the size characteristics of the bed sediment, the hydraulics associated with the flow, and the existence of any channel grade controls such as a geologic outcrop or man-made structure.

Long-term impacts include continued bed coarsening, channel incision, bank failure due to increased bank heights and slopes caused by the incision, and reduced sediment deposition due to the increased channel slope. During subsequent high flow events, the channel bed may continue to adjust to the changes in hydraulics. Higher flow events could cause additional disruption of the armor layer, increasing degradation and coarsening the bed. The down cutting of the bed could cause an increase in channel bank height and degradation along tributaries. As the river erodes the higher banks, an increase in the amount of material input to the stream will occur for the same amount of lateral erosion. This will help satisfy the transport capacity of the river and cause a reduction in the rate of lateral migration. At the same time, excessive bank heights can cause instability and increase the chance of slope failure. The increased slope associated with head cutting will increase the sediment transport capacity of the river and reduce the amount of material that would otherwise deposit in the degraded channel reach. Upstream channel degradation can also affect the stability of hydraulic structures such as levees or bridges by undermining support structures (Collins and Dunne, 1990).

When the East Fork Lewis River avulsed into the Ridgefield Pits in 1996, the river immediately changed course and began flowing through a series of seven abandoned gravel pits. At the entrance to the pits, the channel degraded by approximately 5 feet. Later observations by Norman et al. (1998) estimated 10 feet of degradation at the entrance. Head cutting associated with the avulsion migrated upstream, however the extent of the migration is unknown. Recent field observations suggest that head cutting has extended up to at least the Mile 9 Pit. Also, the high bank on the south side of the river upstream of the pits is actively eroding.

8.6.2 Local Impacts

An avulsion into a floodplain gravel pit has many potential localized impacts. The specific impacts are dependent on the characteristics of the river and gravel pit at the avulsion site. Typically, short-term impacts in the immediate vicinity of an avulsion can include an immediate change in hydraulic conditions from a high velocity shallow river to a low velocity deep and wide lake-like system. A delta will develop at the entrance to the pits formed from material that composed the high ground that formerly divided it from the river and from material removed from the upstream channel by head cutting. Typically, the former gravel pit will act as a deposition zone for sediment, holding a large portion of the sediment load that might otherwise been deposited within or have been transported through the reach.

Additionally, a section of river channel will be abandoned as the river changes course and flows through the gravel pits. The abandoned channel may go dry during average flows if the elevation differential between the avulsion point and the exit from the pit is large enough. The downstream portion of the abandoned channel may develop into a backwater slough during moderate or low flows. During higher flows, the river may use the abandoned channel as a secondary conveyance. This channel may act as a deposition zone for finer material such as sands and silts that are carried as suspended load during high flows.

In the long-term, the former gravel pit will continue to flow as a wide and deep channel with very low velocities until substantial filling with sediment has occurred. As the delta continues to form and grow at the entrance to the pits, flow conveyance and sediment transport into the pit will decrease. Velocities will increase and depth will decrease at the entrance to the pit while further downstream, the velocities continue to be slow in the wide and deep channel. Additionally, the gravel pits can act as flood storage during high flows, which could slightly reduce downstream flood levels. Although this will decrease over time as the pits fill with sediment.

Additional impacts of avulsion into gravel pits may include impacts to water quality and ground water levels. During summer low flow periods, the wide channel that formed in the former gravel pit may cause an increase in surface water temperature. The magnitude of the temperature increase will depend on the surface area of the channel, exposure to solar radiation, residence time and discharge into the pit. Portions of the avulsed pits may provide deeper and cooler water than some of the shallower reaches of the river. Impacts on water temperature caused by the avulsion into the Ridgefield Pits was not quantitatively evaluated as part of this study. Impacts to groundwater related to the Proposed Project are described in the EIS for the project and are considered negligible.

The localized impacts of the East Fork Lewis River avulsion into the Ridgefield Pits, included an increase in channel depth, increased channel width, reduced river velocities within the pits, formation of delta sediment deposit and the abandonment of approximately 3,200 feet of channel. The new channel is of approximate equal length and is comprised of primarily deep pools with slow moving water. The Ridgefield Pits had a maximum depth of approximately 70 feet during gravel extraction operations (Storedahl, 1999). Average pit depths ranged from 12 to 30 feet (Storedahl, 1999). The width changed from a maximum of approximately 200 feet to a maximum of approximately 800 feet. In the embayments and backwaters of the former pits, river velocities are low. During the 2-year event, the average velocity in the main thread of flow through the former pits is approximately 2.5 feet per second, while velocities at cross sections upstream of the former pits, average 4 to 7 feet per second. Recent field observations showed that the abandoned channels, created when the avulsions occurred, have started to fill with medium sands during subsequent high flow events. Wetland/riparian vegetation has begun to establish in these former channels. Observations also indicate that the gravel and cobble delta at the entrance to the pits has increased in size, filling in a large portion of Pit 1 and beginning to fill the upstream portion of Pit 2.

8.6.3 Downstream Impacts

As the former gravel pit traps sediment, the supply of sediment to the downstream channel is curtailed. Until the sediment transport conditions in the section of the channel within the pits return to pre-avulsion conditions, bed degradation, bed coarsening, and increased bank erosion along the downstream channel may occur. With a reduced supply of sediment to the downstream reaches, the sediment transport capacity will not be fulfilled. This may cause erosion of the channel bed and/or banks. The river will transport the finer sediments downstream leaving behind the coarser material, causing the bed material to coarsen or armor, protecting against subsequent high flow events. Reduced upstream sediment supply may cause the channel bed elevation to lower until it becomes controlled by armoring. To accommodate the sediment supply deficit, bank erosion may occur resulting in channel widening.

An avulsion into a gravel pit may also cause a short-term increase in the supply of fine sediment to downstream reaches. During gravel processing operations, fine sediments are typically washed from the sands and aggregate and deposited in the gravel pits ponds. A layer of fine sediment will form and build on the bottom and edges of the pit. Turbulence induced by the river flowing through the pit can entrain material previously deposited in the pit. The magnitude of such an impact is likely small since: 1) the avulsion and subsequent transport of fine sediment downstream would likely occur during high flows when large quantities of fine material are already being transported; 2) the transport capacity of the river for fine material is nearly unlimited through this portion of the East Fork Lewis River downstream to the tidal influence zone; 3) fine materials are carried as wash load; 4) a portion of the fine material will be buried under the coarse sediments transported into the pits from upstream; 5) only part of the pit will be effected by high velocities; and 6) clays are cohesive which reduces their erodability. Furthermore, such an event is typically short lived and would not provide a long-term supply of fine sediment to the downstream reaches. The magnitude of the affects to the downstream reach will depend on the characteristics of the river below the pits. In the portion of river below the pit that has the capacity to transport the wash load, the sediment will pass through it and/or deposit in the over bank areas.

Another possible impact to reaches located downstream of the avulsed pit is reduced flood levels. The increased width and depth associated with the geometry of the gravel pit creates additional flood storage. The amount of reduction in flood levels provided by the changed geometry is related to the volume of additional storage and the magnitude and duration of the flood event. Estimates of potential flood peak reduction induced by increased flood storage for the East Fork Lewis River is given in Section 3, “Hydrology”.

The downstream impacts of the East Fork Lewis River avulsing into the Ridgefield Pits effects a relatively small reach of the river. The river travels a short distance (approximately 1.5 miles) before it becomes tidally influenced and the channel slope is nearly flat. Impacts on the channel within this reach may include bed degradation, bed coarsening and bank erosion, but have not been documented. Impacts from fine sediments propagated from the Ridgefield Pits are also unknown. It is assumed that a portion of this material was transported downstream to the Lewis and Columbia Rivers while the rest was deposited in the tidally influenced reach and/or over bank areas.

Table 8-2. Summary of the possible effects of a river avulsing into a gravel pit.

Element of Avulsion	Nature of Impact		
	Upstream	**Local**	**Downstream**
Geomorphic Characteristics	• Incision of channel • Increased gradient • Coarsening of bed • Undercutting and erosion of banks • +/- lateral migration rates	• Alluvial fan development • Reshaping of pits • Abandonment of former channel • Loss of natural channel geometry	• Increased lateral migration • Increased channel width
Sediment Transport	• Increased sediment transport capacity • Reduction in bed load deposition	• Deposition of sediment in pits • Short-term increase in turbidity • Erosion of gravel pit banks	• Reduced sediment supply • Erosion of bed • Coarsening of bed • Increased bank erosion • Short-term increase in turbidity
Hydraulics	• Increased slope • Increased velocities • Decreased normal depth • Increased bed roughness	• Decreased slope • Increased channel depth • Increased channel width • Reduced bed roughness	• Increased bed roughness
Hydrology		• Increased flood storage • Increased evaporation	• Reduction of flood levels • Attenuation of flood peaks • Changes of summer low-flows

8.7 Mitigation to Prevent Future Avulsion

To prevent any impacts caused by the avulsion of the river into a gravel pit, various mitigation measures could be developed. The specific mitigation measures necessary to effectively prohibit the river from avulsing into the pit should be chosen based on the relative potential for avulsion and the estimated impacts. If the potential for avulsion is judged to be likely and the impacts of the avulsion are predicted to be severe, mitigation measures should be employed at that location to prevent an avulsion. If the potential for avulsion is less probable or the impacts of avulsion are predicted to be minor, then little or no action may be required. Possible mitigation measures include the use of monitoring programs, planting of native riparian vegetation, and the use of bank stabilization measures to control potential future river migration.

Mitigation measures should be used at locations that would do the most good while at the same time have the least impact on the environment. Vegetation along potential avulsion paths should be planted as soon as possible to allow sufficient time for growth. Channel and bank stabilization measures could be placed at locations that are the most vulnerable to erosion. Construction of these measures could be done prior to the river reaching the threatened location. This would prevent the need for in-channel work.

Mitigation measures, for the existing Daybreak and Proposed Pits should include a long-term monitoring program to track the changes of the river with respect to the site and planting of native riparian vegetation between the river and the Proposed Pits. The long-term monitoring program could be used to help predict future changes in the channel and update the status of potential avulsion locations. Establishment of mature riparian forests in areas surrounding potential avulsion sites should help slow channel migration into these areas.

The placement of channel and bank stabilizing measures along Storedahl Pit Road along with the existence of Bennett Rd. and NE 269th St. would effectively prevent the possibility of future avulsion into the Existing and Proposed Daybreak Pits by removing this area from the Mitigated Hazard Zone. The only potential avulsion location exposed to the possibility of future avulsion is at the downstream end of the Daybreak Site. A potential avulsion path into Daybreak Pond 5 is shown to be within the CMZ. All of the pits associated with the Proposed Project will be located up gradient from Daybreak Pond 5, effectively preventing any impacts to the river from the Proposed Project.

Mitigation measures to prevent an avulsion of Dean Creek include removal of the existing discontinuous levee and restoration of riparian forest along the stream. Removal of the levee restores floodplain area and dissipates flood flows. Replanting the riparian zone with native vegetation will reduce overbank flow velocities, promote deposition of suspended sediment and increase resistance to erosion.

8.8 Response to an Avulsion

The impacts of an avulsion into a gravel pit on the morphology of the East Fork Lewis River are documented in previous sections. Whether these impacts are positive or negative to the local biological communities is not known. Information on this subject may be found in the Project HCP and/or EIS. During the life of the Proposed Project, all necessary measures should be taken to prevent the river from avulsing into the Existing and Proposed Daybreak Pits. This would allow maximum utilization of the gravel resource with minimal impacts on the river. If an avulsion were to occur during this time period, measures should be taken to return the river to its previous location.

If it has been determined that the impacts of the river avulsing into the Proposed Pits are more negative than positive, a plan should be developed to monitor and prevent its occurrence. If preventative measures are not enough, the river should be returned to its previous location. If positive impacts justify the occurrence of a future avulsion into the Proposed Project, a monitoring program should be in place to document the effects. If the Dean Creek avulses into the Proposed Pits, the relative benefits and impacts of returning the channel to its prior location should be assessed. If benefits are judged to out weigh impacts, plans for returning the channel to its former location should be developed and implemented.

8.9 Summary

The East Fork Lewis River is a relatively unconfined meandering stream. Avulsions have occurred along the river due to both natural and human influences. The record of documented historic avulsions is limited. Three events characterized as avulsions have been documented. All of the events involved abandoned gravel pits located in the floodplain directly adjacent to the river channel. Assessment of the potential for future avulsions is limited by the available data and the unpredictability of future channel movements. However, available historic data and current observations allow the potential avulsion sites to be described. The relative risk of avulsion for a given location is determined by its location relative to the Hydrologic Floodplain, Channel Migration Zone (CMZ), Mitigated Hazard Zone and historic information and current observations of channel migration.

Available historic data and current observations have shown the majority of the river’s potential avulsion sites to be within the CMZ. However, the avulsion sites that would cause the river to shift its channel into the Existing Daybreak Pits are outside of the CMZ and the 100-year floodplain. This does not infer that the possibility of avulsion does not exist, rather the likelihood of such an occurrence is low. The recently observed bank erosion resulting in a northward migration of the channel at RM 9 and historic data indicate an increased probability of avulsion into the abandoned County Pits (County 1 and County 2). If an avulsion into the county pits occurred, changes in the channel position are uncertain. Three scenarios exist if the county pits are breached. 1) The main channel may not change course, 2) it could reoccupy the meander abandoned by the avulsion of Mile 9 Pit, or 3) it could reoccupy the large abandoned meander bend that parallels Storedahl Pit Road. If the abandoned county pits are breached in the future, the potential for avulsion into the Existing and Proposed Daybreak Pits may increase. However, the existence of numerous improved roads in the area effectively places the Existing and Proposed Daybreak Pits outside of the Mitigated Hazard Zone. As was noted with the observed avulsion into the Ridgefield Pits, a significant period of time should be available to further mitigate against possible avulsion into the Existing and Proposed Pits Daybreak Pits.

The potential for Dean Creek to avulse into the Proposed Project Pits is based on the ability of the Dean Creek channel to migrate over to the location of the pit or overflow its banks and erode a new channel into the pit. Dean Creek has shown little tendency to migrate over the recent past. Historic evidence suggests that the Dean Creek channel has remained stable for at least the last 38 years. The periodic removal of sediment deposits by Clark County in the vicinity of the J. A. Moore Road Bridge crossing is believed to have contributed to the stability of the channel. If sediment deposits along Dean Creek continue to be removed, the potential for avulsion into Proposed Pits is considered to be low. Proposed measures to remove the existing discontinuous levee along the watercourse and restore riparian forest would reduce the potential for avulsion further.

If the removal of sediment deposits in Dean Creek by the County were to cease, the hydraulic capacity of the channel in the vicinity of the bridge will diminish, overflows from the channel will increase, and the potential for channel migration will increase. The proposed removal of the existing levee and associated grading of the floodplain will prevent overflows from entering the Proposed Pits and dissipate overbank flow. The restoration of riparian forest will slow overbank flow velocities, promote suspended sediment deposition, concentrate flow in the main channel and provide resistance to channel migration.

If sediment deposits in the channel restrict flow through the J.A. Moore Road crossing of Dean Creek, overflows of the road are expected. Since the road slopes to the west, overflows are also expected in that direction. If overflows occur in an easterly direction, flow may enter the Proposed Pits. A headcut may form where overflows enter the pit. The road is expected to limit the upstream extent of any headcut. Since the J.A. Moore Road crossing of Dean Creek is fixed, an avulsion across the road in a new channel location is not expected.

Impacts on streams from an avulsion into a gravel pit are both short-term and long-term. Many of the short-term impacts may continue into the future but usually at a slower or decreasing rate. The impacts may also be reversed given sufficient time for pit recovery. The impacts also vary by location with respect to the avulsion site. Upstream impacts may include head cutting, channel incision, bank erosion, increased armor size, and increased channel slope. Local impacts of avulsion may include changes in channel geometry with associated changes in channel hydraulics, redirection of flow causing the abandonment of a section of river channel, deposition of sediment in a delta deposit at the breach location and changes in water quality. Downstream impacts may include the reduction of sediment supply caused by trapping sediments in the pit, bed degradation, bed coarsening, bank erosion, channel widening, and short-term increases in fine sediments propagated from the pit and entrained as wash load.

The possibility of future impacts of an avulsion of the East Fork Lewis River into the Proposed Project could be effectively prevented by the use of mitigation measures. Monitoring changes in river morphology, establishment of native riparian vegetation in potential avulsion areas, and the installation of suitable erosion protection, such as a revetment or bioengineered structure along Storedahl Pit Road, could all be used to mitigate against potential future avulsion of the East Fork Lewis River into the Proposed Project.

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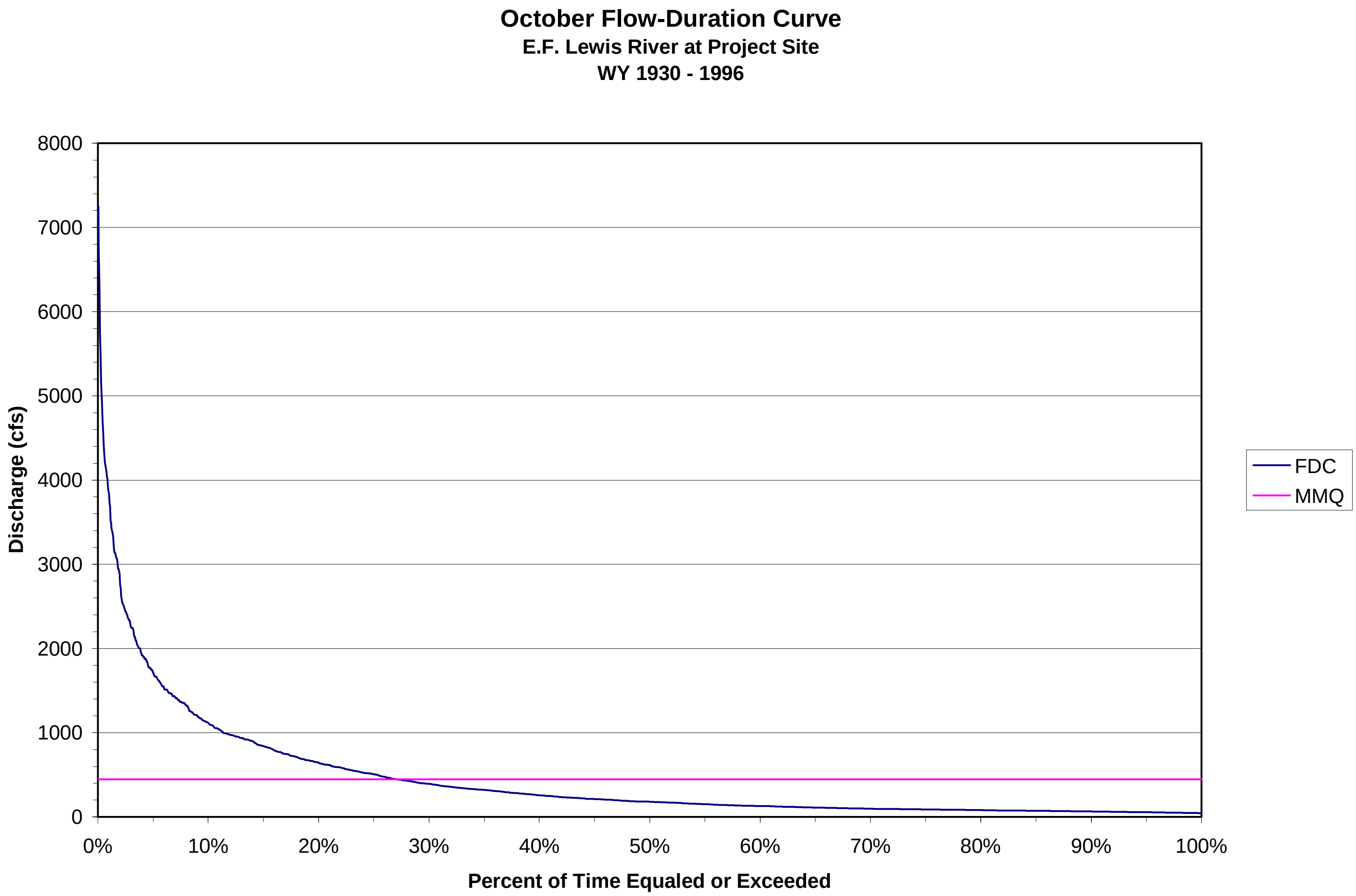
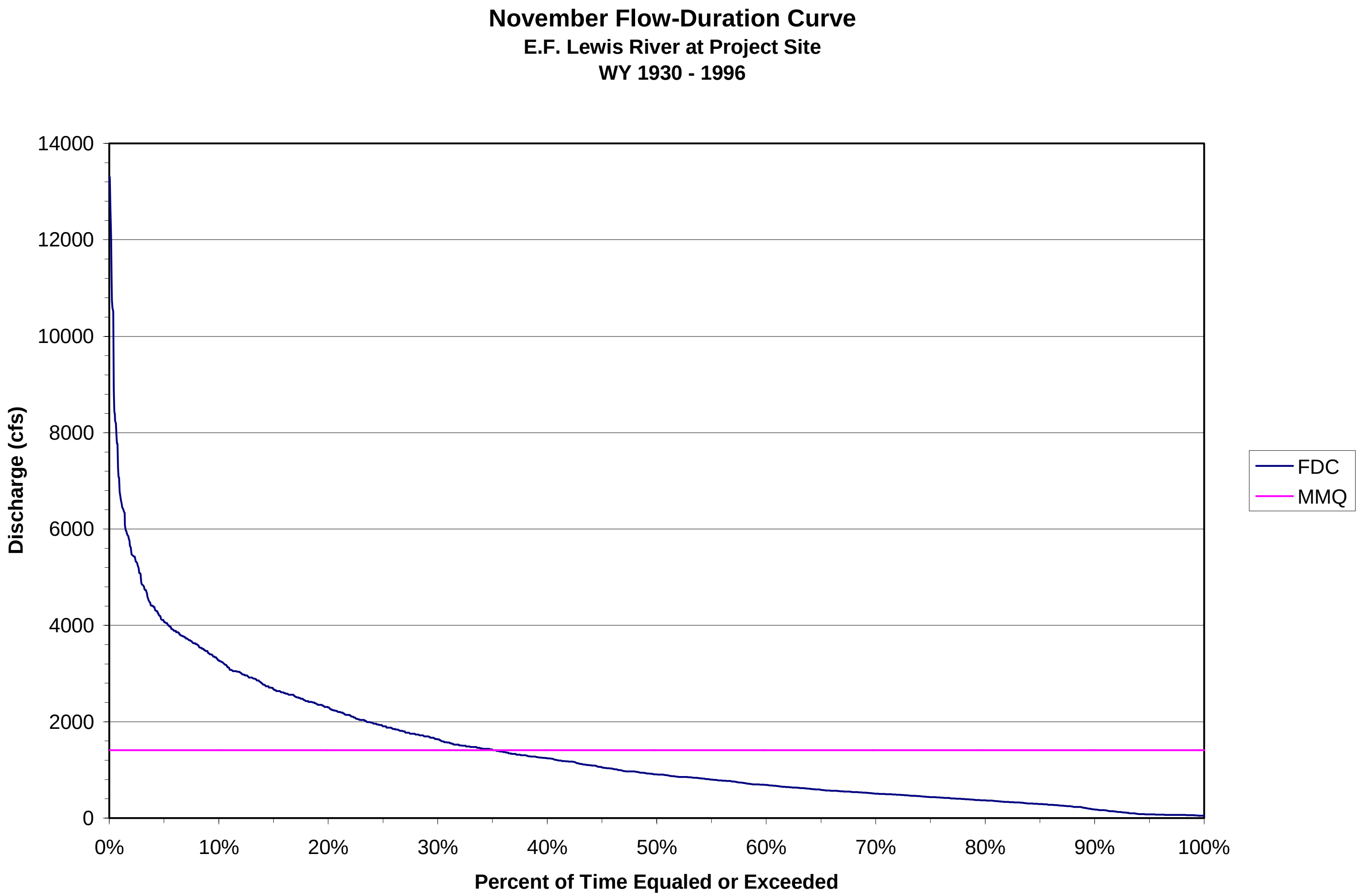
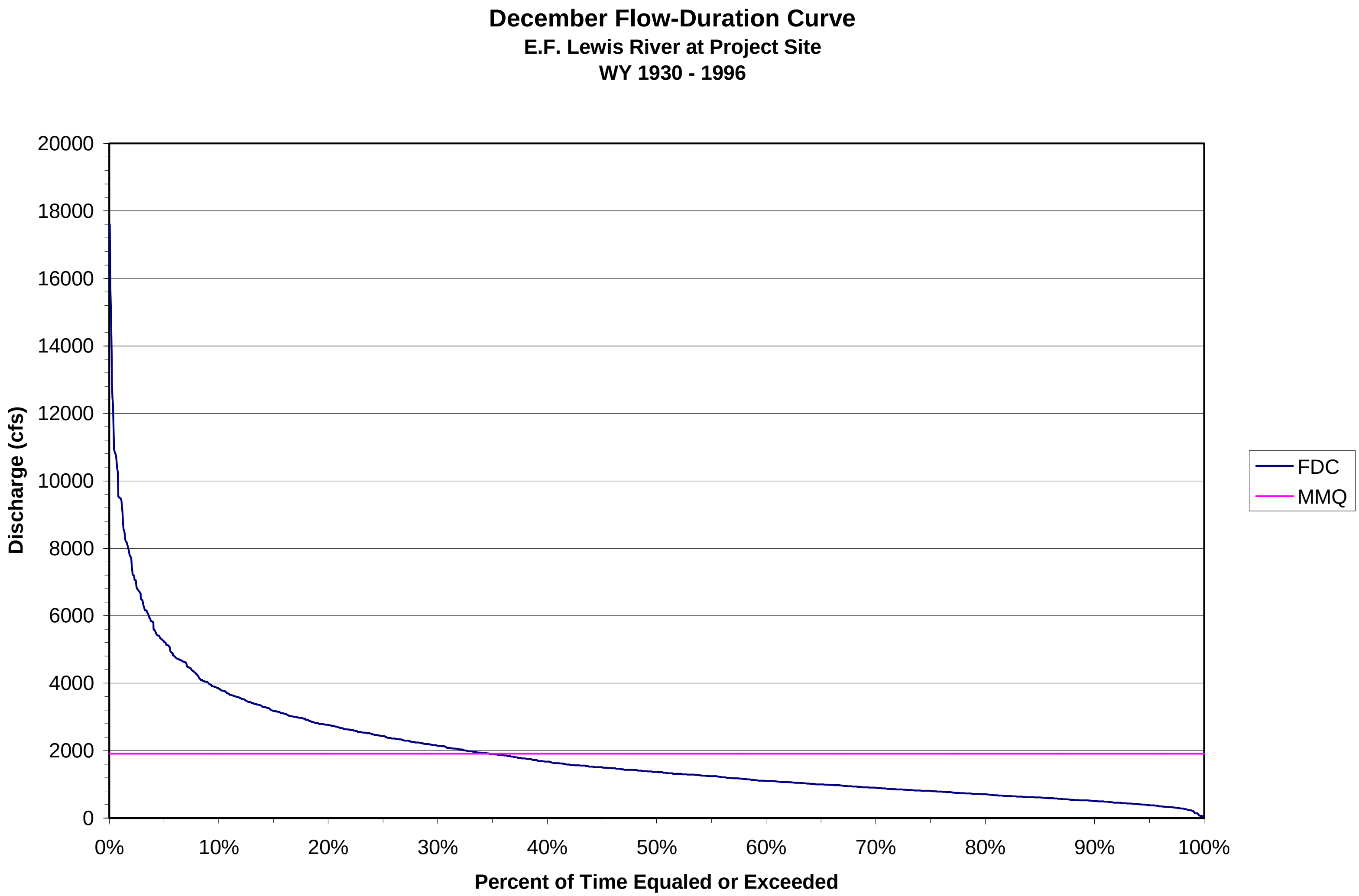
Appendix 1.

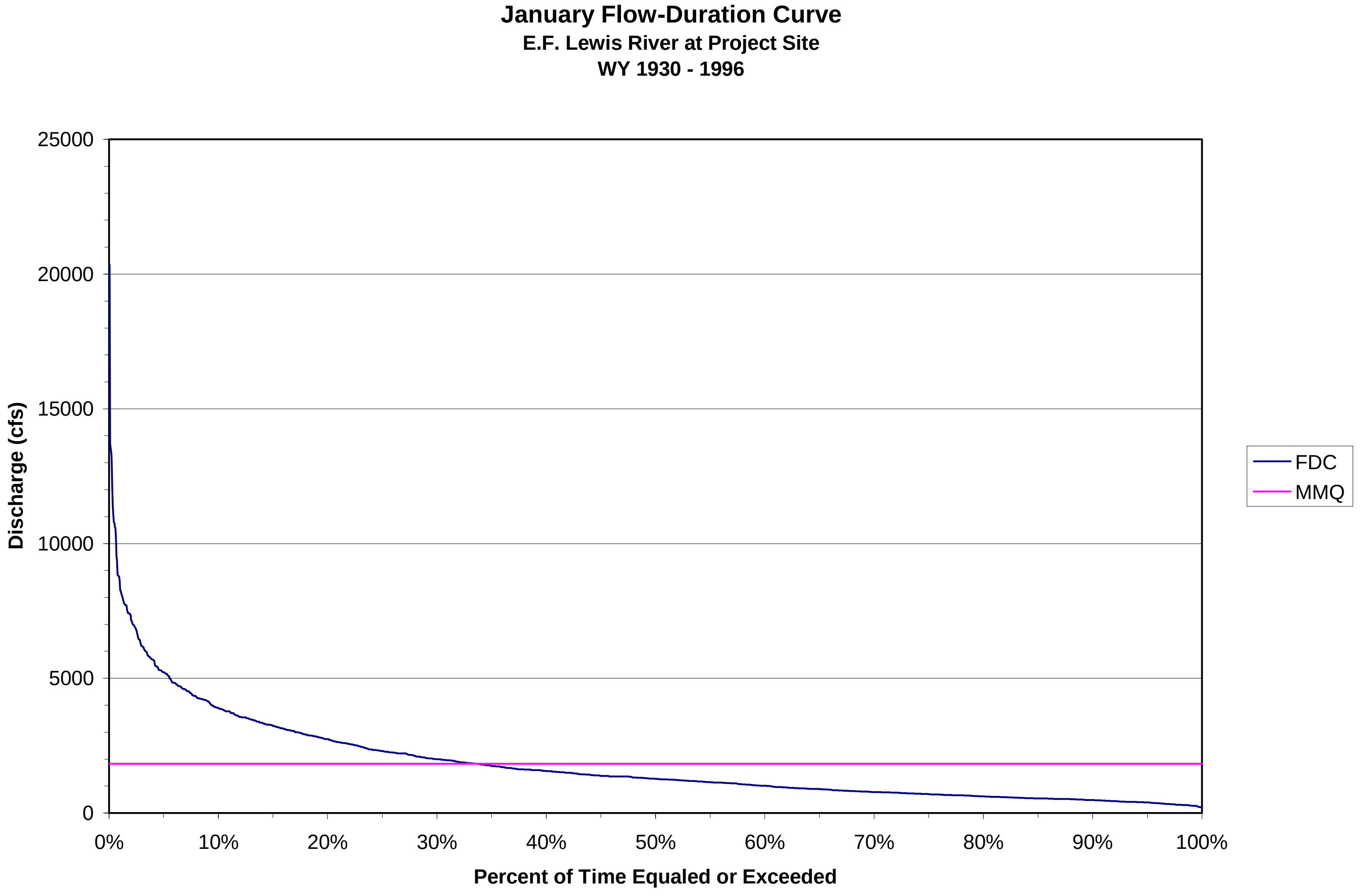
Monthly Flow-duration Curves for the East Fork Lewis River at Project Site.


October Flow-Duration Curve
E.F. Lewis River at Project Site
WY 1930 - 1996
Discharge (cfs)
8000
7000
6000
5000
4000
3000
2000
1000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time Equaled or Exceeded
FDC
MMQ

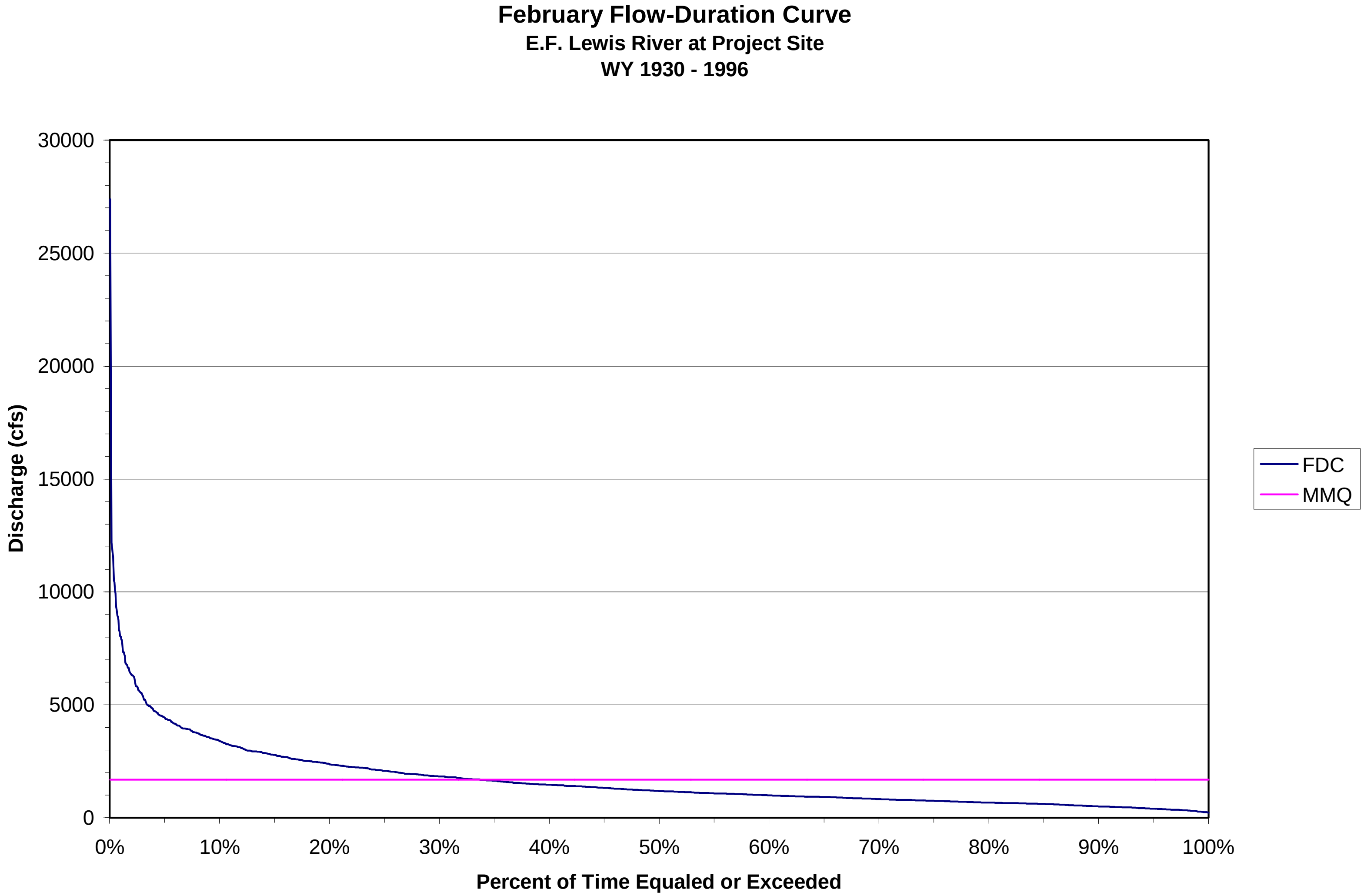

November Flow-Duration Curve
E.F. Lewis River at Project Site
WY 1930 - 1996
Discharge (cfs)
14000
12000
10000
8000
6000
4000
2000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time Equaled or Exceeded
FDC
MMQ



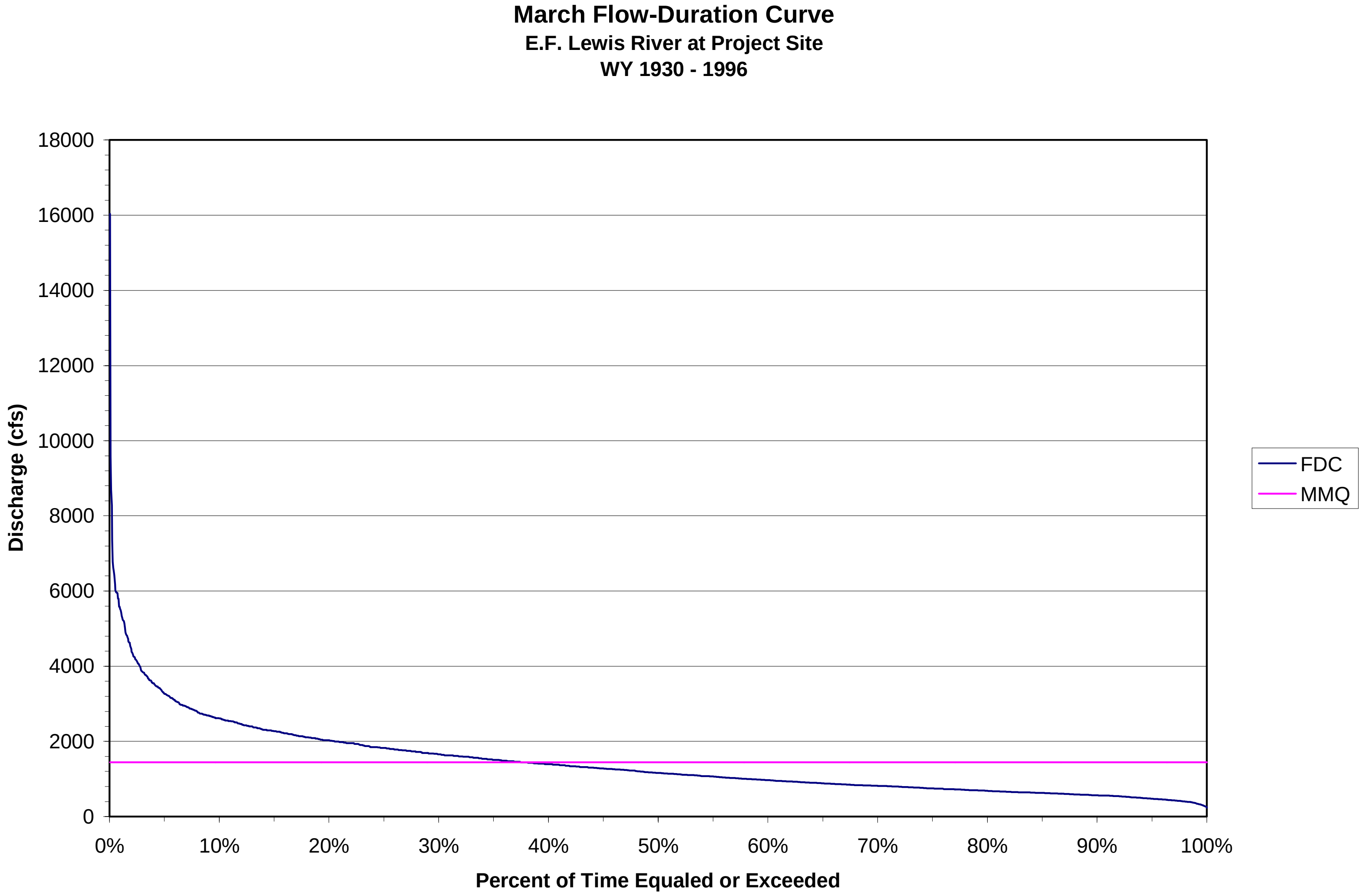
December Flow-Duration Curve
E.F. Lewis River at Project Site
WY 1930 - 1996
Discharge (cfs)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time Equaled or Exceeded
FDC
MMQ



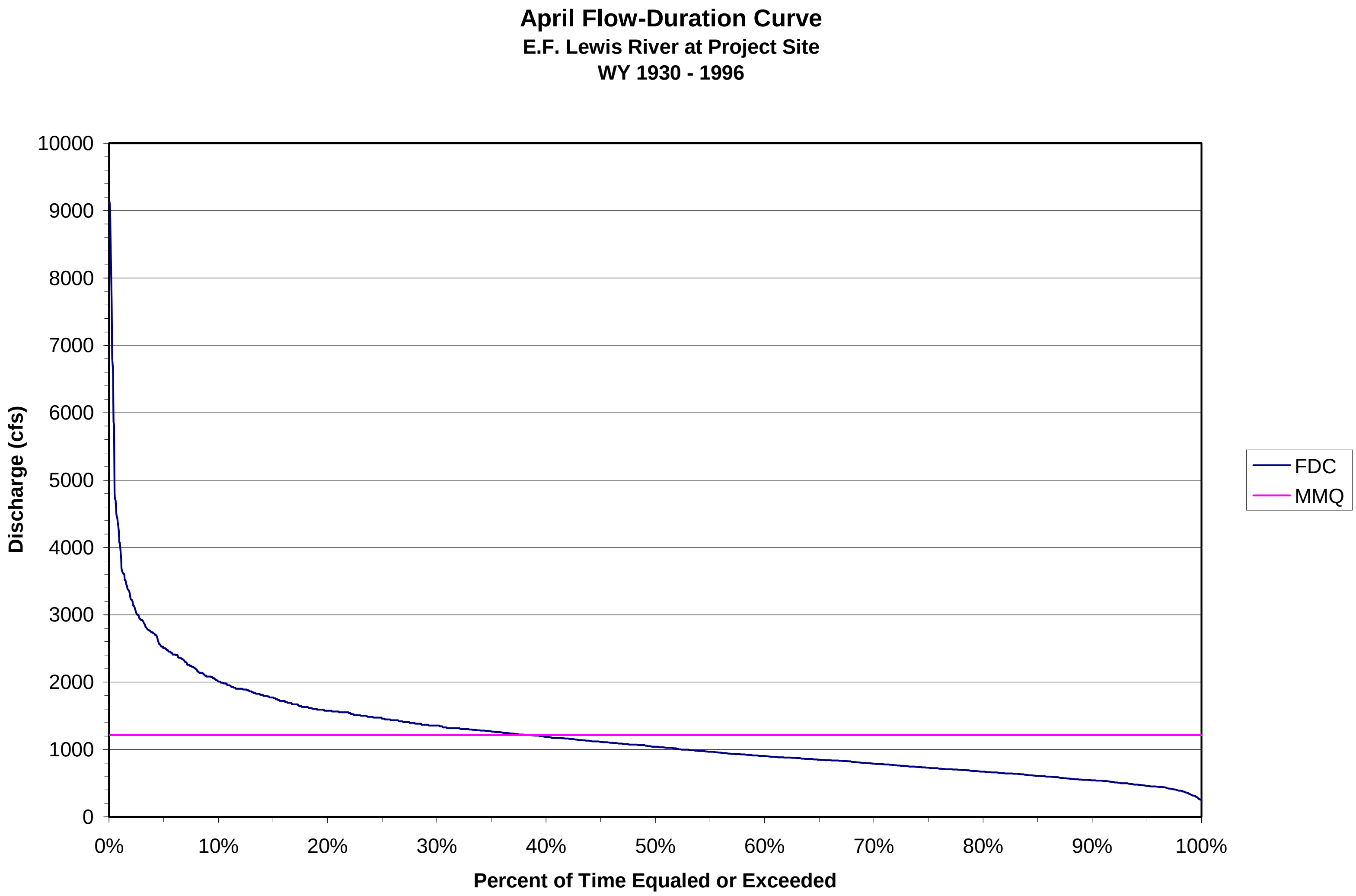
January Flow-Duration Curve
E.F. Lewis River at Project Site
WY 1930 - 1996
Discharge (cfs)
25000
20000
15000
10000
5000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time Equaled or Exceeded
FDC
MMQ



February Flow-Duration Curve
E.F. Lewis River at Project Site
WY 1930 - 1996
Discharge (cfs)
30000
25000
20000
15000
10000
5000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time Equaled or Exceeded
FDC
MMQ



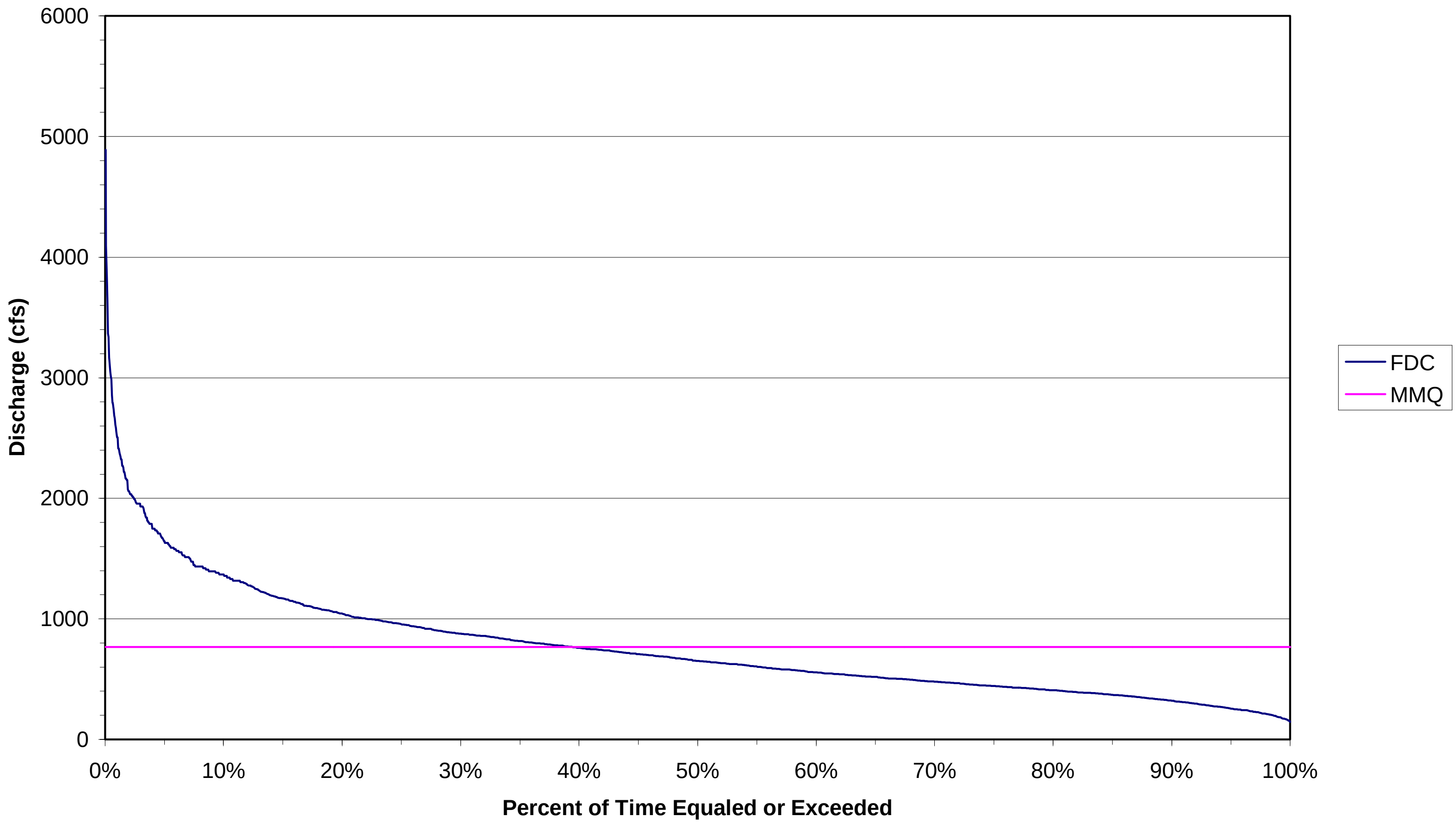
March Flow-Duration Curve
E.F. Lewis River at Project Site
WY 1930 - 1996
Discharge (cfs)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time Equaled or Exceeded
FDC
MMQ



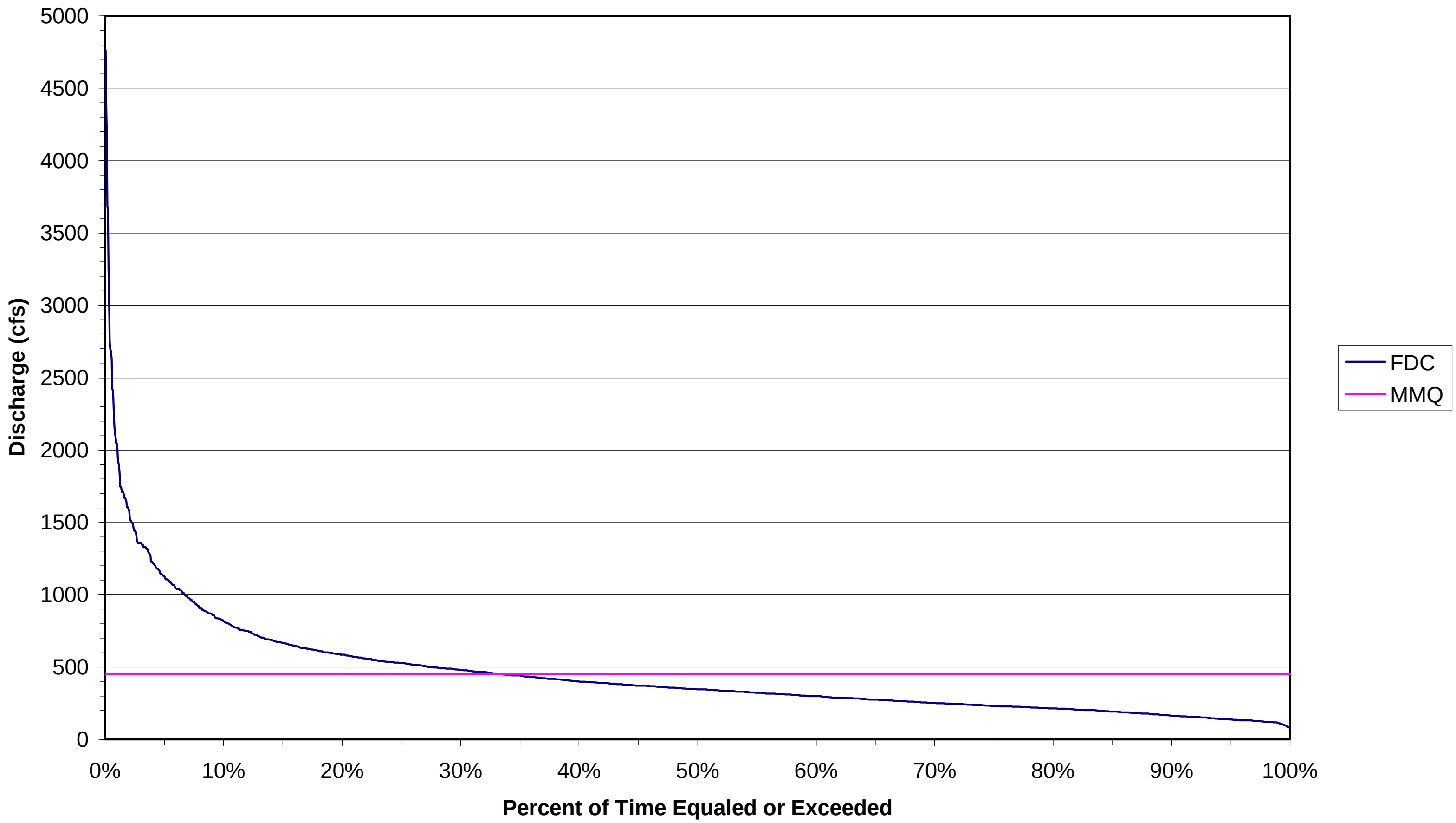
April Flow-Duration Curve
E.F. Lewis River at Project Site
WY 1930 - 1996
Discharge (cfs)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time Equaled or Exceeded
FDC
MMQ

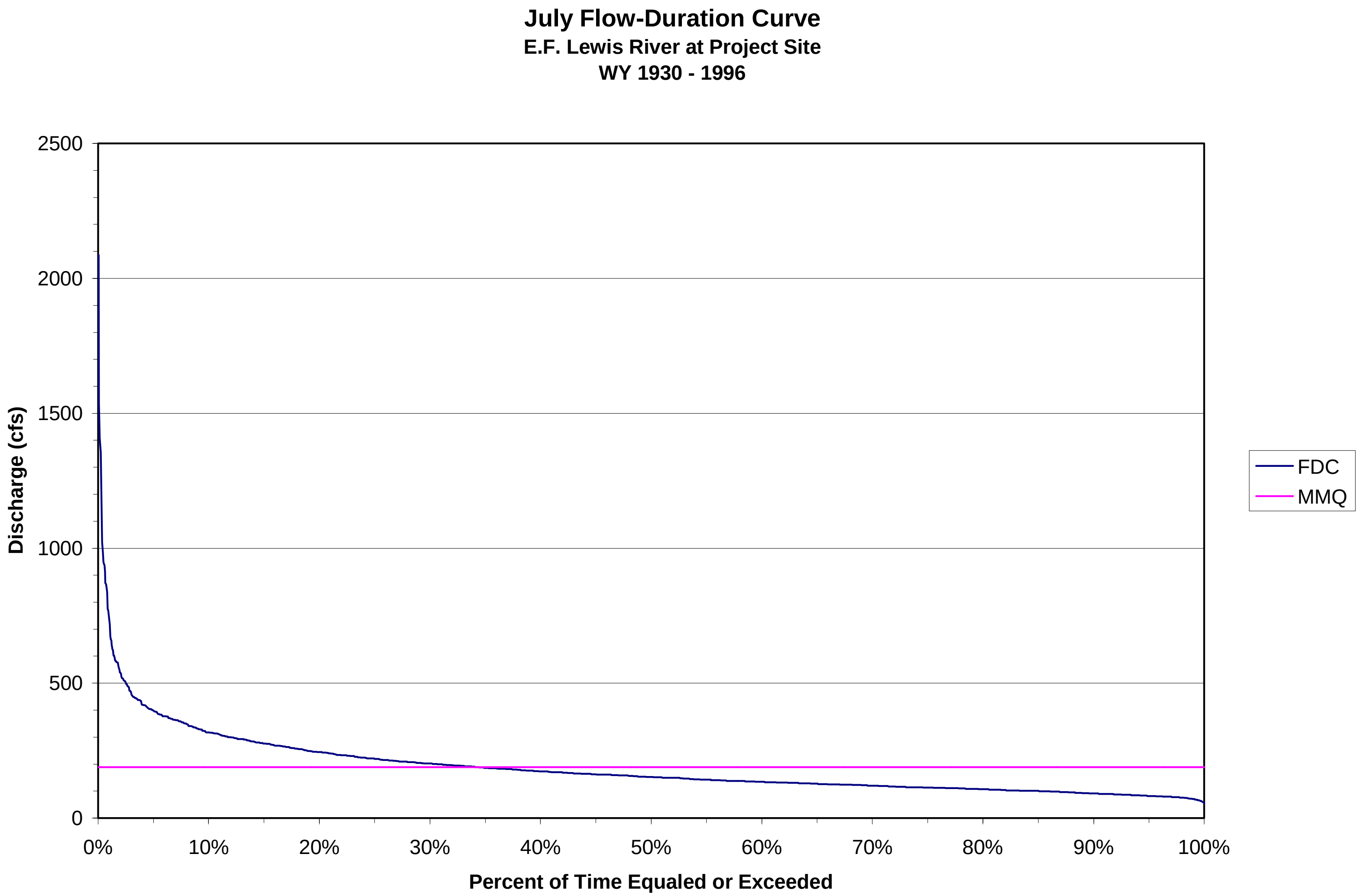
May Flow-Duration Curve

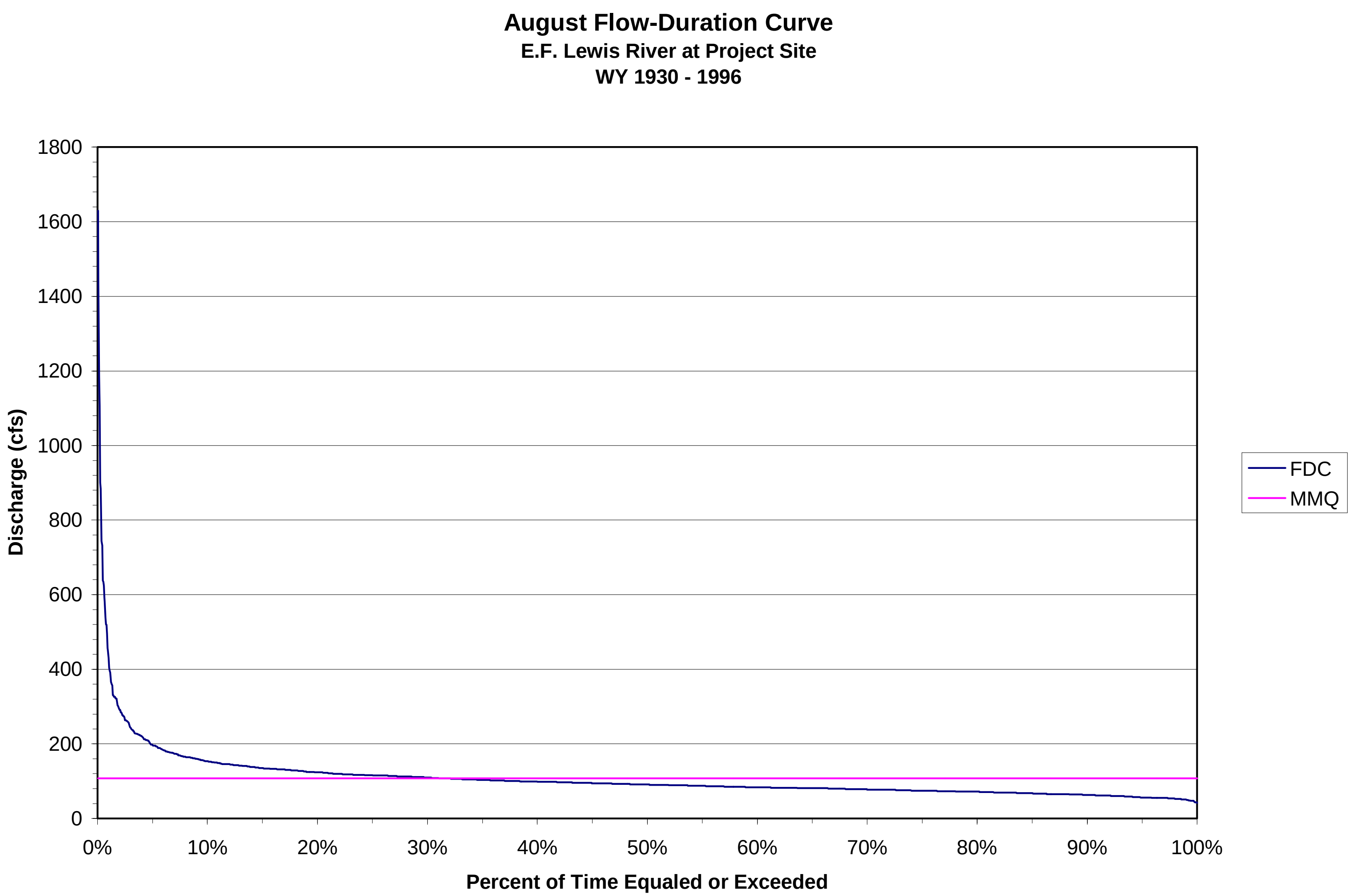
E.F. Lewis River at Project Site
WY 1930 - 1996

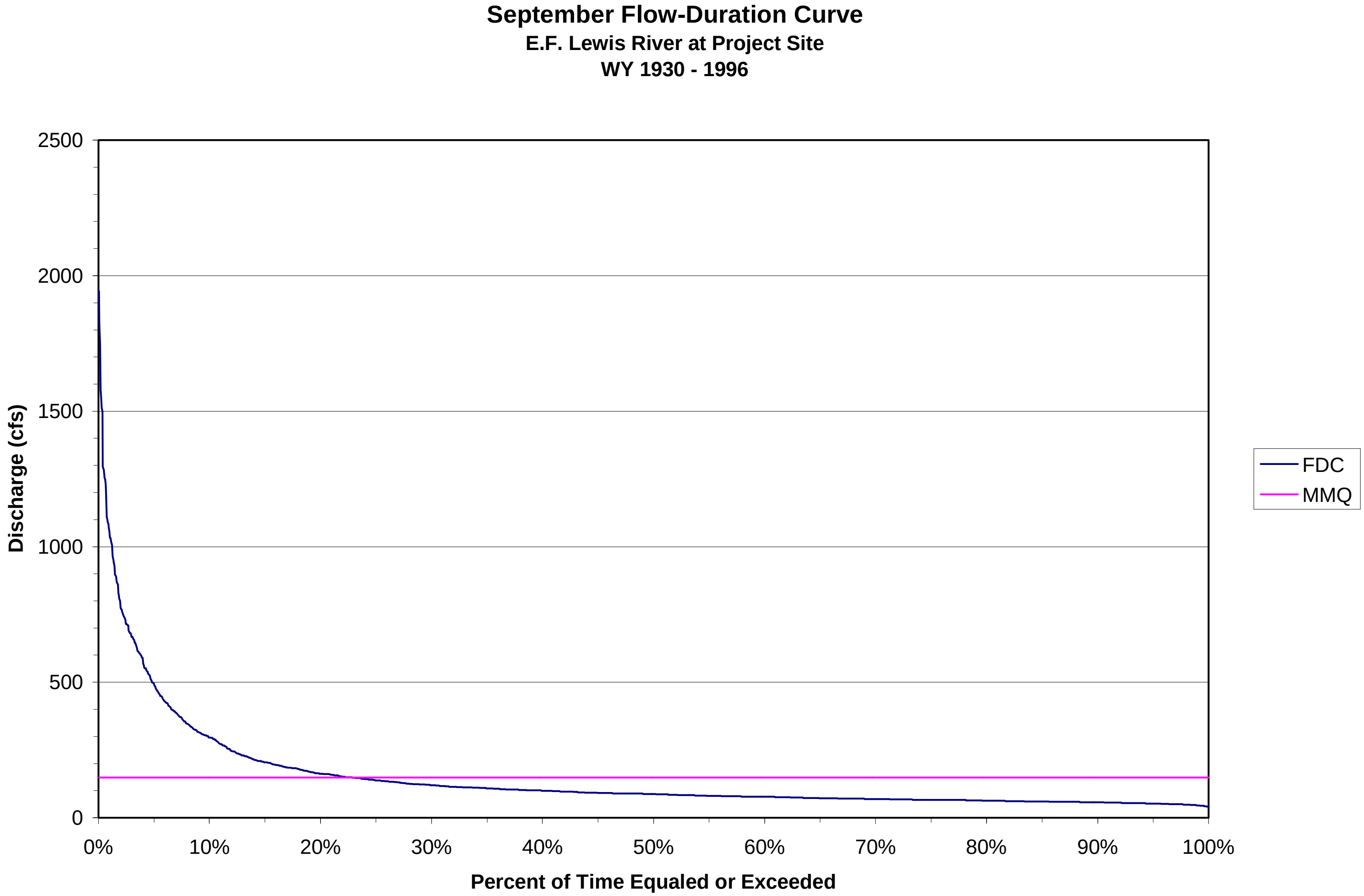


June Flow-Duration Curve
E.F. Lewis River at Project Site
WY 1930 - 1996




July Flow-Duration Curve
E.F. Lewis River at Project Site
WY 1930 - 1996
Discharge (cfs)
2500
2000
1500
1000
500
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time Equaled or Exceeded
FDC
MMQ


August Flow-Duration Curve
E.F. Lewis River at Project Site
WY 1930 - 1996
1800
1600
1400
1200
1000
800
600
400
200
0
Discharge (cfs)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time Equaled or Exceeded
FDC
MMQ



September Flow-Duration Curve
E.F. Lewis River at Project Site
WY 1930 - 1996
Discharge (cfs)
2500
2000
1500
1000
500
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Time Equaled or Exceeded
FDC
MMQ

Addendum 1

Daybreak Ponds Avulsion Mitigation

Addendum 1
Daybreak Ponds Avulsion Mitigation

Geomorphic Analysis of the
East Fork Lewis River in the Vicinity
of the Daybreak Mine
Expansion and Habitat Enhancement Project

May 18, 2001

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Table of Contents

1 Introduction

Avulsions may be triggered by unpredictable random events. Although the possibility of a future avulsion along the East Fork Lewis River can be qualitatively described, the potentially random nature of such events prevents quantitative assessment of the probability (risk) that a future avulsion will occur at any specific location. Consequently, mitigation for an avulsion in areas with a reasonable possibility of occurrence is prudent. A detailed geomorphic investigation of the East Fork Lewis River has identified that an avulsion into the existing Daybreak Ponds has a significant potential for occurrence within several decades (WEST, 2001). Accordingly, an avulsion mitigation plan has been developed.

In the following sections a proposed avulsion mitigation plan for the existing Daybreak Ponds is presented. In Section 2 the objectives and scope of the avulsion mitigation plan are described. Section 3 describes the alternative measures that could be incorporated into an avulsion mitigation plan. Section 4 describes the details of the proposed mitigation plan. Potential impacts of the proposed avulsion mitigation plan are described and evaluated in Section 5. A summary of the proposed avulsion mitigation plan is presented in Section 6.

2 Objectives and Scope

In the following sections the objectives and scope of the Daybreak Ponds Avulsion Mitigation Plan are described.

2.1 Objectives

An avulsion into a floodplain gravel pit can result in both short-term and long-term environmental impacts. These impacts can affect the hydrology, hydraulics, sediment transport, and morphology of the river. A detailed description of avulsion related impacts relevant to the East Fork Lewis River was presented by WEST (2001). A summary of specific types of impacts associated with an avulsion is shown in Table 2-1. An effective avulsion mitigation plan must include measures to avoid, reduce, and minimize these potential impacts.

2.1.1 Prevention of Avulsion

The primary objective of an avulsion mitigation plan is prevention. Prevention of an avulsion would avoid all associated environmental impacts. Since the specific location and characteristics of an avulsion cannot be quantitatively ascertained, the effectiveness of measures to prevent an avulsion cannot be guaranteed. However, implementation of an avulsion mitigation plan is undoubtedly more effective and beneficial than a “Do Nothing” approach to managing a defined avulsion threat. Mitigation measures to prevent an avulsion can be implemented at the most likely avulsion locations identified from qualitative geomorphic evaluations.

2.1.2 Resistance to Avulsion

Assuming that unforeseen circumstances will occur that promote an avulsion, the second objective of an avulsion mitigation plan is to resist the formation of a flow path along which an avulsion may progress into a floodplain gravel pit. Resistance to an avulsion can be achieved by placing physical and hydraulic controls along the potential avulsion path. By controlling the energy gradient between the gravel pit and the river, the energy and quantity of flow along the potential avulsion path can be regulated and channel formation processes required for an avulsion can be prevented.

2.1.3 Control of Avulsion

A third objective for the mitigation plan is to control the magnitude and extent of the avulsion. By defining a preferential flow path for a potential avulsion, the magnitude, extent, and duration of environmental impacts can be minimized. Further, the time necessary for the fluvial system to recover from the disturbance associated with an avulsion will be minimized. Appropriate planning for an avulsion into a floodplain gravel pit can also restore valuable floodplain functions and aquatic habitat that were lost due to previous land uses both prior to the avulsion and after it occurs.

Table 2-1. Summary of the possible effects of a river avulsing into a gravel pit (from WEST, 2001).

Element of Avulsion	Nature of Impact		
	Upstream	**Local**	**Downstream**
Geomorphic Characteristics	• Incision of channel • Increased gradient • Coarsening of bed • Undercutting and erosion of banks • +/- lateral migration rates	• Alluvial fan development • Reshaping of pits • Abandonment of former channel • Loss of natural channel geometry	• Increased lateral migration • Increased channel width
Sediment Transport	• Increased sediment transport capacity • Reduction in bed load deposition	• Deposition of sediment in pits • Short-term increase in turbidity • Erosion of gravel pit banks	• Reduced sediment supply • Erosion of bed • Coarsening of bed • Increased bank erosion • Short-term increase in turbidity
Hydraulics	• Increased slope • Increased velocities • Decreased normal depth • Increased bed roughness	• Decreased slope • Increased channel depth • Increased channel width • Reduced bed roughness	• Increased bed roughness
Hydrology		• Increased flood storage • Increased evaporation	• Reduction of flood levels • Attenuation of flood peaks • Changes of summer low-flows

2.2 Scope

At a minimum, the scope of avulsion mitigation must consider all areas contained within the Channel Migration Zone (CMZ). The CMZ in the vicinity of the Daybreak Processing Site and Daybreak Ponds has been defined to follow along the access road to the Daybreak Processing Site (WEST, 2001). At a maximum, requirements for avulsion mitigation must consider the floodplain area affected by historic channel migration. An analysis of historic plan form characteristics along the East Fork Lewis River (WEST, 2001) showed that the East Fork Lewis River channel was in the location of the existing Daybreak Ponds in the mid-1800s. Accordingly, the scope of the proposed avulsion mitigation plan encompasses the existing Daybreak Pond system.

3 Alternative Avulsion Mitigation Measures

Potential measures to prevent, resist, and control avulsion impacts include: monitoring, biotechnical techniques, hydraulic techniques, structural techniques, and channel restoration. General descriptions of potential engineered solutions are summarized below. Many of these techniques are suggested by WDFW and DNR (WDFW, 1998 and DNR, 1998).

3.1 Monitoring

Monitoring of bank stability at locations identified to have a significant avulsion potential can be used to define when engineered solutions to prevent an avulsion should be implemented. Monitoring criteria can be based on observed bank erosion or changes in flow distribution between the main and secondary channels in the vicinity of likely avulsion points. Monitoring can also be used to evaluate the effectiveness of implemented avulsion mitigation measures and to provide information for adaptive management responses to changed conditions.

3.2 Biotechnical Techniques

Biotechnical techniques use vegetation, wood, and riparian buffers that mimic or reproduce the natural system to provide physical structure that influence flow magnitude, direction, velocity, and sediment transport conditions. Biotechnical measures are routinely used to provide surface erosion protection. Vegetation and wood debris offer hydraulic resistance that reduces flow velocities and dissipates energy, promotes sediment deposition in overbank areas, and concentrates flow in the main channel. Applicable biotechnical techniques would include:

- ***Live Stakes*** Live staking involves the installation of live, rootable woody vegetative cuttings into the ground.

- ***Live Trees*** Lives trees planted along the bankline and in the floodplain provide long-term vegetative structure to cover and stabilize the floodplain and streambanks.

- ***Large Woody Debris*** Large woody debris (particularly if placed in rows) helps dissipate energy and distribute overland flow across the floodplain. They also promote deposition of sediment in the overbank areas and concentrate flow in the main channel.

- ***Debris Jam*** A debris jam is a collection of large woody debris that can train the distribution and direction of flow, create hydraulic roughness, dissipate energy, and reduce flow velocity.

- ***Riparian Buffer*** The channel migration zone (CMZ) in the vicinity of a floodplain gravel pit should be left undisturbed or planted as a riparian buffer. Vegetation along potential avulsion paths should be planted as soon as possible to allow sufficient time for growth. Establishment of mature riparian forests in areas surrounding potential avulsion sites should help slow channel migration into these areas.

3.3 Hydraulic Techniques

Hydraulic techniques can be used to influence flow direction, control energy gradients, and reduce shear stress along channels banks. Hydraulic controls can be used to redistribute flow in the channel, limit flow velocities, and control erosion and sedimentation patterns. Potential hydraulic techniques include:

- ***Fill*** Placement of fill along potential avulsion flow paths can be used to block flow conveyance area, redistribute flow, reduce hydraulic energy gradient, flow depth, and shear stresses on erodible sediments. Further, the elevation difference between the main channel and the floodplain gravel pit can be reduced by the addition of fill. Accordingly, the magnitude and potential significance of impacts associated with a headcut along the upstream channel or reduced sediment supplies to the downstream channel caused by trapping of sediment within the pit are avoided or reduced. Placement of fill in a manner that creates a defined flow path for overbank flood flows eliminates uncertainty about potential avulsion paths and impacts. Furthermore the creation of a defined flow path prior to an avulsion allows the establishment of a riparian forest buffer area that would help minimize impacts and recovery time.

- ***Groins*** The primary function of groins are to provide roughness, dissipate energy, and reduce velocities near the bank. Groins may be oriented upstream, perpendicular, or downstream to the flow. The top elevation is typically about bankfull.

- ***Barbs*** Barbs are small weirs near the toe of a bank angled upstream to turn the flow away from the bank. Barbs create roughness, which dissipate energy and reduce velocity near the bank. They are typically overtopped by moderate stream flows.

- ***Drop Structure*** A drop structure is a solid cross channel weir that redirects flow away from the bank to the center of the channel. Drop structures concentrate energy dissipation and reduce erosion along the bank.

- ***Porous Weir*** A porous weir is a low profile structure consisting of loosely consolidated boulders that span the entire width of the channel. The structure concentrates energy dissipation and reduces erosion along the bank.

3.4 Structural Techniques

Since flood events far in excess of the standard regulatory criteria may occur along the East Fork Lewis River, structural measures to prevent or control the development of potential avulsion flow paths could be instituted. A limitation for applying standard structural techniques for avulsion mitigation is the lost opportunity for the river to access and create diverse riparian and aquatic habitat within the protected areas. Furthermore, long-term maintenance responsibilities may be required for proper function of structural mitigation techniques.

Structural techniques that can be used would include:

- ***Overtopping Erosion Protection*** Non-erodible surfaces can be used to protect remnant ground between floodplain gravel pits and the main river channel from erosion caused by overtopping flows.

- ***Designated spillways*** Designated spillways composed of non-erodible materials can be located along levees separating the river from the gravel pit. Spillways can be used to control hydraulic energy gradients, flow velocities, and erosion potential for flow both entering or exiting a floodplain gravel pit.

- **Fuse Plug Embankment Section** This is a modification to a designated spillway. A designated section of the levee separating the gravel pit from the river can be replaced with easily erodible material. If flow elevations exceed the crest of the levee, the fuse plug embankment section is eroded, allowing a controlled overflow into or out of the pit.

- ***Avulsion Sill*** A sill composed of large rock or other non-erodible material could be placed at key locations to effectively prevent downcutting and shifting of the thalweg of the river or avulsion path.

- ***Rock Toe or Rock Revetment*** Rock revetment can be used to provide bank erosion protection

4 Recommended Daybreak Ponds Avulsion Mitigation Plan

An avulsion mitigation plan to minimize the potential for avulsion into the existing Daybreak Ponds and avoid/minimize associated environmental impacts was developed. The elements of the avulsion mitigation plan were selected in consideration of their associated environmental benefits and impacts. In the following sections, the major components of the mitigation plan are described.

4.1 Fill Existing Ponds

The primary feature of the avulsion mitigation plan is the substantial filling of the existing Daybreak Ponds Nos. 1, 2, 3, and 4. The fill will consist of approximately 571,000 cubic yards of materials imported from off-site sources. A plan view of the proposed fill in the Daybreak Ponds is shown in Figure 4-1.

Approximately 300,000 cubic yards of the fill to be placed in the ponds will be soils that are imported from regional excavation projects. The soils will include a range of silt, clay, sand, gravel, and cobble sized materials. The material will be used to fill the edges of the ponds as shown in Figure 4-1. The slope of the final in-pond fill of imported soils will vary from 3:1 to 5:1.

The remainder of the fill will consist of approximately 271,000 cubic yards of fine-grained sediments derived from processing gravels imported from the Tebo Gravel Mine. These sediments consist primarily of clay, silt and fine sand sized materials. They will be placed in the middle portion of the ponds to a depth that is approximately equal to the thalweg elevation of the main East Fork Lewis River channel. That elevation will be at or slightly below the high water level for the ponds (groundwater level).

The fill placement and revegetation plan has been designed to be consistent with the extent and characteristics of the channel migration zone indicated by historic mapping and aerial photography for the area. It does not reduce the opportunity for the river to create diverse aquatic and riparian habitats that may be restricted by structural methods of bank hardening and revetment. The fill placement and revegetation plan mimics the path and characteristics of the pre-development East Fork Lewis River channel identified from cadastral surveys made in 1853 and 1858. The topography to be created in the ponds will be similar to historic channel characteristics and will provide a preferential flow path for the river should an avulsion occur. The fill in the existing ponds will restore floodplain function more similar to predevelopment conditions.

The fill will reduce the potential for adverse environmental impacts that may be associated with an avulsion into a floodplain gravel pit. The reduced elevation gradient between the bottom of the filled ponds and the river thalweg will reduce the potential for the formation of a headcut and the magnitude of its effects on the upstream river channel. The reduced cross sectional area and volume of the ponds will limit the sediment trapping capability of the ponds and potential impacts to downstream channel reaches. Further, the decreased volume of the ponds will reduce the time for geomorphic recovery of the channel system.

Figure 4-1. Planview of Daybreak Ponds Showing Cross Section Locations

Placement of fill in the Daybreak Ponds will involve placement of fill under water, over sediments previously accumulated in the ponds. Sediment grain size and consistency is variable, grading from a fine silty sand near the point of the process water discharge into the pond, to silty clay and clay within the ponds.

Existing sediments in the ponds likely range from normally consolidated to lightly under consolidated depending on the deposition rates and gradation of the soil. For the purposes of this discussion, normally consolidated soils are those that have expelled any excess pore water between the individual soil particles, resulting from applied external load or subsequent sediment deposition. Under consolidated soils are those that are continuing to compress and expel pore water from the void spaces between individual soil particles.

Shallow normally consolidated soils in an alluvial environment are typically weak and sensitive to rapid changes in load, such as fill placement. If loaded slowly, sediments can be consolidated and strengthened. If loaded quickly, in excess of the material strength, normally consolidated soils will shear and displace.

Fill around the perimeter of the ponds will consist of a top down fill placement process intended to displace existing fine grained sediment towards the center of the pond. Fill will be deposited along the edge of the ponds and graded toward the pond center using a dozer or similar equipment. Lifts of fill will be placed with the intent of displacing existing weaker sediment on the pond slopes toward the pond center, where it will be confined and compressed.

Soil compaction cannot be completed under water using conventional means, as soil compaction consists of squeezing air out of the soil matrix. Once soil is saturated, as is the case for underwater placement, water will fill the void spaces in the soil matrix. Since water is effectively incompressible, any attempt to rapidly compress the soil will result in the water being pressurized, but the volume of soil matrix and water will remain the same, making "compaction," or compression of the void spaces impossible with out expelling the water.

Fill placed underwater can be consolidated however by placement of a surcharge load of excess fill over the top of the planned fill. In this case a surcharge of approximately 10 to 20-feet of soil will be utilized to consolidate the underwater fill. The surcharge will be left in place for several months or a year depending on the soil characteristics, to allow time for the excess pore water to be squeezed out, consolidating the fill.

Stable inclination of the fill slopes will be variable with the variation in material to be placed. Stable slopes will however be established by the material placement in the ponds. Because the fill placement conditions are essentially a worst case for slope stability, slopes that are stable in the short term during soil placement should become stronger in the long term as the fill soil consolidates, and forested wetland as well as emergent wetland plantings mature along the fill-open water interface. In addition, removal of the surcharge will also reduce driving forces on the fill slopes, further increasing slope stability.

Land surrounding the ponds will be disturbed during placement of fill. Minor amounts of sediment may erode from the disturbed areas. The eroded sediments will drain to the ponds. The ponds are connected to each other by a series of gated culverts. Ponds receiving eroded sediments can be isolated; preventing any migration of suspended sediments and will not flow off-site.

4.2 Riparian Buffer

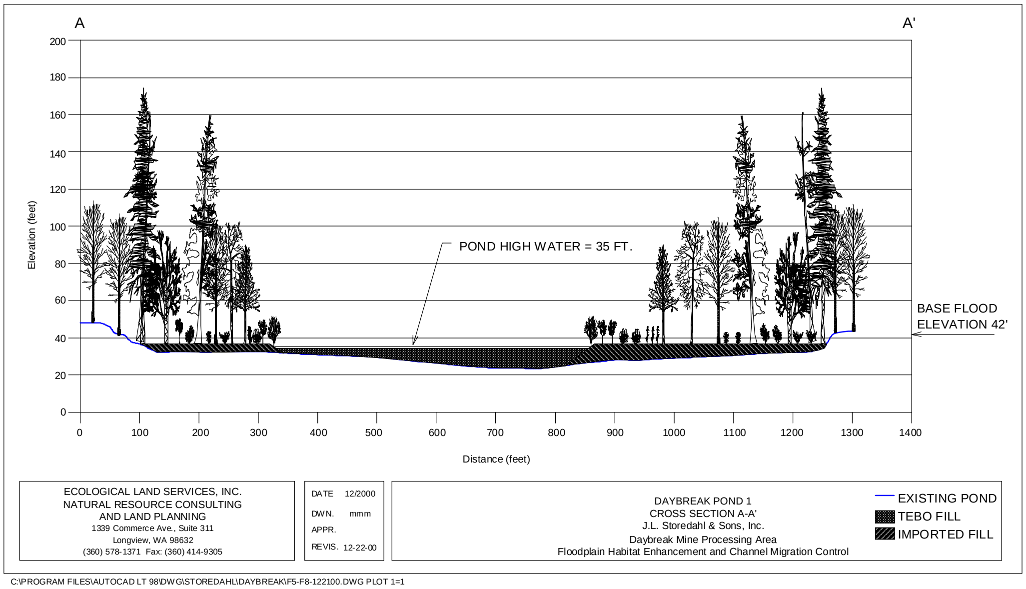
At present there is a limited amount of valley-bottom forest at the Daybreak site and in the surrounding area, as most has been removed due to agricultural and residential land-use and timber harvest. Agricultural fields used for pasture and hay production surrounds most of the site, with only remnant patches of cottonwood-alder and mixed forest remaining. Much of the existing cottonwood-alder forest near the East Fork Lewis River has been disturbed by human activity and subsequently invaded by exotic species, such as Himalayan blackberry and reed canary grass. Other portions of the East Fork Lewis River above and below the Daybreak site also have substantially reduced amounts of valley-bottom forest, resulting in a very fragmented and diminished distribution of this important ecosystem component.

The placement of fill along the borders of the pond will substantially increase the riparian buffer between the active East Fork Lewis River channel and the open water areas of the Daybreak Ponds. The increased riparian buffer is located adjacent to the Storedahl Access Road, which is the boundary of the CMZ as previously defined for the East Fork Lewis River (WEST, 2001). Enlargement of the riparian buffer will allow restoration of riparian forest.

4.3 Vegetation Plantings

Topsoil will be placed over any fill materials extending above the pond high water level to provide a viable medium for vegetation plantings. The plantings are intended to create an early-successional mixed conifer and hardwood valley bottom and riparian forest typical of the East Fork Lewis River valley. The plantings will allow the establishment of a floodplain forest in areas most susceptible to avulsion. The placement of fill in the ponds will increase the riparian buffer distance between the existing river channel location and the ponds and reduce the elevation difference between the bottom of the ponds and the thalweg of the East Fork Lewis River.

Vegetation will be planted within the riparian buffer to allow development of a mature riparian forest that will slow channel migration and resist possible avulsion. Revegetation of the fill as a floodplain forest will provide long-term resistance to erosion and channel formation processes associated with an avulsion. As the trees and understory vegetation becomes established and matures, they will provide dense root mats that bind the soil and resist erosion. In the long-term, the riparian forest will naturally supply large woody debris to the floodplain/channel system. Woody vegetation and debris will increase hydraulic roughness, slow overbank flow velocity, help to dissipate the energy of flood flows across the floodplain and through the ponds, and reduce potential for erosion of the sediments in the pond. Conceptual section views of the proposed fill plan are shown in Figure 4-2.



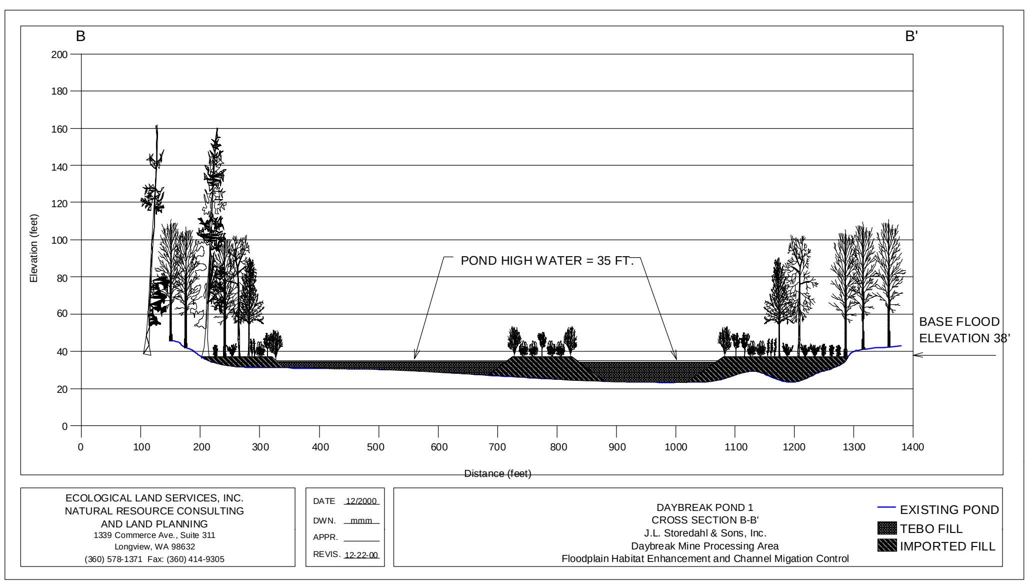
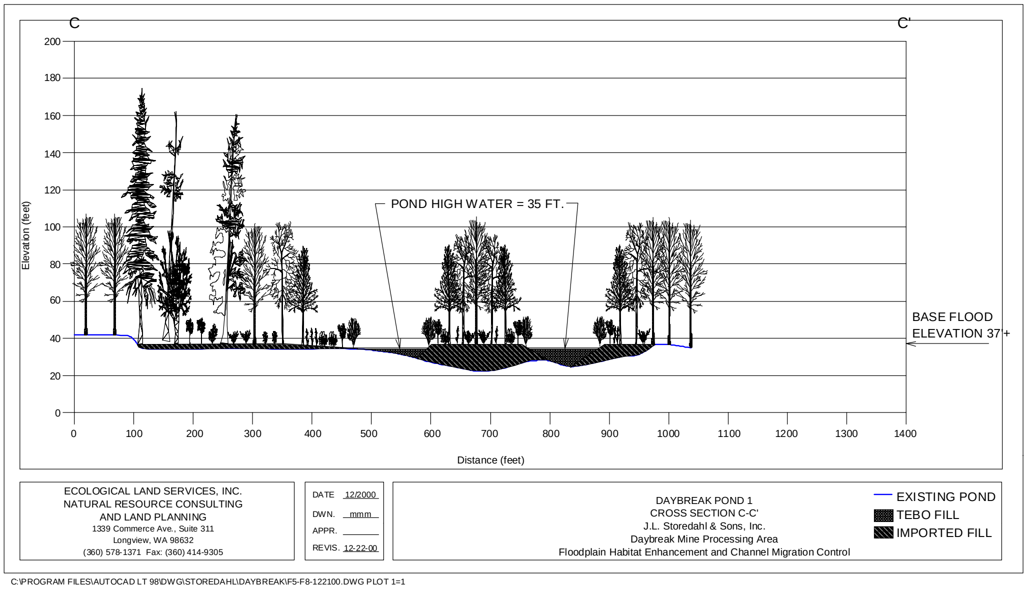


Figure 4-2. Conceptual section view of proposed fill plan for Daybreak Ponds.



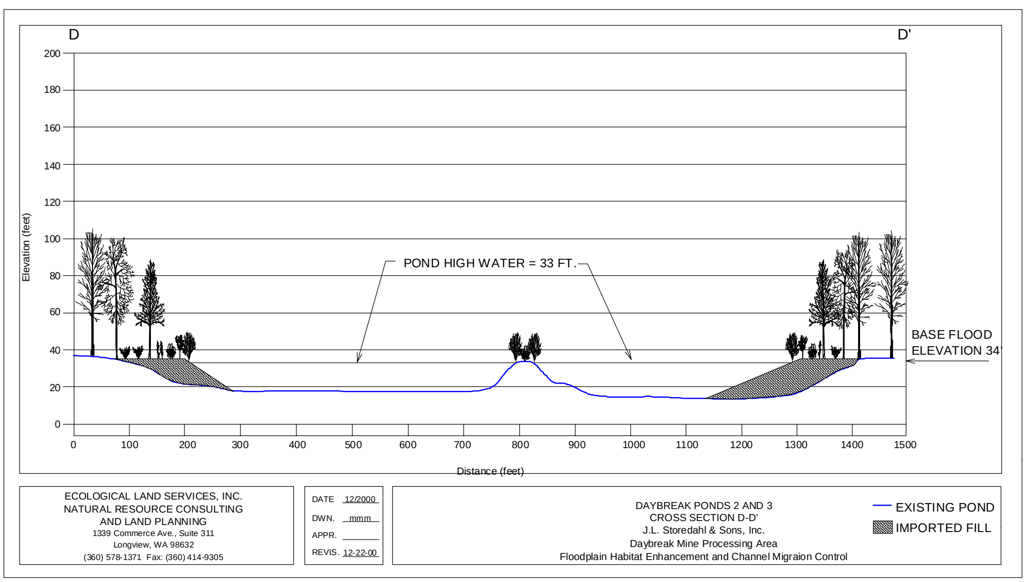


Figure 4-2 (continued). Conceptual section view of proposed fill plan for Daybreak Ponds.

An inherent difficulty in restoring any vegetation type is the desire to achieve late-successional, "climax" communities in a much shorter time frame than natural successional processes would require. Life history, physiological, and morphological characteristics of late seral species are often not suited to establishment, rapid growth, and perhaps even survival in open early seral conditions. For example, conifers such as western hemlock (*Tsuga heterophylla*) and western red cedar (*Thuja plicata*) are usually slower growing than hardwood trees such as black cottonwood (*Populus trichocarpa*) and red alder (*Alnus rubra*). Conversely, weedy, herbaceous species are highly adapted to invading open areas and often outcompete late successional species that are planted or seeded. In addition, previous restoration efforts on the Daybreak Site have found that small mammals, such as voles and rabbits, which use the herbaceous vegetation for cover, browse on woody plants causing high mortality.

With these considerations in mind, a restoration design emphasizing rapid development of a forest canopy is likely to be most successful. Douglas-fir (*Pseudotsuga menziesii*) and red alder will be used in establishing an initial tree canopy on most of the upland areas around the existing ponds. These species grow relatively rapidly and can tolerate some late summer drought, which is expected on the well-drained soils of the site. Along the pond bank slopes and the most outward portions of the proposed fill, western red cedar, Oregon ash (*Fraxinus latifolia*), and black cottonwood will be emphasized. These species are characteristic of wetter areas and can be expected to survive and grow only where sufficient moisture is available through the growing season.

In upland and swale areas, a shrub understory subsequently will be incorporated into the planting scheme to initiate understory development. Timing of understory plantings will be delayed in upland and swale sites until the initial stand of saplings is well established and canopy closure has occurred. Until canopy closure occurs, herbaceous competition and herbivory by small mammals are likely to greatly reduce the establishment of planted shrubs. The shrub understory will consist of species with a range of moisture requirements. In lower spots where the water table is near the surface, salmonberry (*Rubus spectabilis*) and vine maple (*Acer circinatum*) will be planted. In higher elevation areas hazelnut (*Croylus cornuta*), snowberry (*Symphoricarpos albus*) and Nootka rose (*Rosa nutkana*) will be planted. Shrubs will be planted in dispersed patches that will provide heterogeneity and a closer matching of species and moisture conditions.

Along pond margins, a straw mulch will be applied at a rate of 2 tons/acre to exposed soil surfaces immediately following bank contour reclamation. Establishment of a grass ground cover by seeding would be an alternative erosion control, but the grasses would likely result in severe competition to the shrub and tree plantings planned for the pond margins. Grasses also provide cover for herbivores, such as voles and rabbits.

Dense shoreline shrub communities will be established on the margins of the banks of the ponds. The planting scheme uses species characteristic of wetter areas near the shoreline (Hooker's or Sitka willow [*Salix hookeriana = S. piperi, S. sitchensis*], species of intermediate tolerance in transition zones (red-osier dogwood [*Cornus sericea*], spiraea [S*piraea douglasii*]), and species characteristic of somewhat drier conditions at slightly higher elevations but still within the riparian zone (Pacific ninebark [*Physocarpus capitatus*]). In order to utilize locally adapted plant stocks, cuttings and rooted plants from the site will be used for plantings to the extent possible. *Willow (S. hookeriana = S. piperi*) and Pacific ninebark occur along existing pond shorelines at the Daybreak Site, indicating their suitability to local conditions and providing a potential source of cuttings for restoration plantings.

The plantings will be grouped to create patches oriented parallel to the shoreline and dominated by a single species, with patches interspersed among one another. This kind of pattern is more representative of natural communities than a mixing of species on a finer scale. All of these species have been observed at the site, indicating that they are likely to be well suited to site conditions. Tree densities along pond margins will be lower, as a dense shrub community is intended to be the dominant vegetation in those areas. If necessary, Himalayan blackberry (*Rubus discolor*) and other invasive non-native weeds will be controlled. As the shrubs mature and the canopy closes in, these herbaceous weeds will tend to be shaded out.

In addition to plantings, there may be some natural recruitment of tree and shrub species from nearby seed sources. Black cottonwood and willow are the woody species most likely to become established from natural seed fall, as they have light, wind-borne seeds that can travel relatively long distances. Areas having bare mineral soil with a water table at or near the surface during spring and early summer (e.g., pond margins) are where these species are most likely to colonize. Red alder is also likely to colonize from abundant seed sources immediately to the south of the site. Such natural colonization will be monitored and steps taken to encourage the survival and spread of these plants. Once established, naturally colonizing plants are likely to grow more vigorously and have a higher chance of survival than planted stock.

The existing Daybreak ponds consist of approximately 58 acres of open water habitat and small amounts of emergent wetland habitat along shorelines. It is expected that the fine-grained sediments that will be placed in the open-water areas of the ponds will have a final surface elevation that is close to the typical high water elevation in the ponds. Water levels in the ponds are being monitored to provide a more accurate measure of the annual fluctuation. The annual fluctuation is currently estimated to be 1 to 2 feet. Natural recruitment of aquatic vegetation is expected to occur over this surface, as has been observed in shallow areas along the margins of the existing ponds.

The fill and vegetation is expected to create complex wetland habitat, consistent with the historic predevelopment channel conditions in the lower reaches of the East Fork Lewis River. Channel migrations and natural avulsions result in the creation of new channels and the abandonment of old channels. The old channels often become ox-bow ponds that remain connected to the current main channel and have extensive wetlands along their margins. Analysis of historic channel planform information indicates that, prior to alterations following Euro-American settlement, there was considerable channel complexity in the reach of the East Fork Lewis River adjacent to the Daybreak site (Collins 1997). The river was braided and associated with a substantial amount of wetland habitat, in contrast to the present condition, which is described by a single channel and valley bottom that is dominated by pasture of primarily upland plant communities. Immediately downstream of the Daybreak site, the river becomes wider and more meandering as the gradient of the river decreases; numerous natural oxbow ponds also remain along this section of the river.

The creation of wetland habitat in the existing ponds will be a substantial contribution to the restoration of this important habitat type in the East Fork Lewis River valley. The created wetlands will be more resistant to avulsion compared to the existing ponds. In the long term, as the sediments on which they are based settle and consolidate, it is expected that the created wetlands will be similar to other existing overflow paths for extreme flood events in the East Fork Lewis River floodplain. It is noted that during the approximate 500-year flood that occurred in 1996, no evidence of channel formation or avulsion was observed along the overflow path that drains to the existing Daybreak Ponds.

4.4 Pond 5 Outlet Modifications

Currently, Daybreak Pond 5 has three discharge outfalls. The outfalls, denoted as Locations A, B, and C on Figure 4-1, allow water to exit the pond under low flow conditions along the East Fork Lewis River and Dean Creek. The amount and primary location of discharge are dependent primarily on beaver activity and pond elevations. Outlet C is connected directly to Dean Creek. Outlets A and B flow into a defined channel and shallow wetland, respectively, eventually draining to a recently excavated ditch on the adjacent property and bypassing most of Dean Creek. The outfalls allow water to enter the pond during high flow conditions along both the East Fork Lewis River and Dean Creek. Backwater from the East Fork Lewis River enters Pond 5 for flood events with return period of about 5 years.

It is proposed that all surface outflows from Pond 5 will be restricted to a single location at the northeast corner of the Pond (Location C in Figure 4-1). The western berm of Pond 5 will be reconstructed to block outlets A and B, and surface water will be discharged during fall, winter, and spring months (October through April) only from the northernmost outlet (Outlet C) into Dean Creek. The restriction of possible outlets from Pond 5 will allow better management of water discharges to the East Fork Lewis River and Dean Creek.

A non-erodible sill will be installed at Location C to control the outlet conditions. The sill will create a barrier to salmonid species for frequently occurring flow conditions. If salmonids enter the ponds during high flow conditions, the uncontrolled sill will allow out migration to occur. The non-erodible sill will have provisions for temporary flashboards or removable gate that could be used to provide temporary control of discharges from Pond 5. This feature would provide capabilities for spill containment and control and water quality management. During placement of fill material in the ponds it may be necessary to briefly control pond outflows to manage turbidity impacts to receiving waters.

The existing outlets at Locations A and B will be filled with erodible sandy soil as a fuse plug spillway. In the event that flood waters enter the Daybreak Ponds at an upstream point, the fuse plug spillways at the existing Location A and B outfalls will allow floodwaters to exit Pond 5 without restriction. The crest of the fuse plugs will be set so that floodwaters first overtop those sections of the western embankment surrounding Pond 5.

4.5 Monitoring

All revegetated areas will be monitored to evaluate the success of plant establishment and seeding and planting. Monitoring will evaluate plant cover, canopy closure, vigor, species composition, and levels of herbivory. Soil moisture and nutrient status and pond water level fluctuations will also be monitored to aid in identifying any physical factors that might be retarding successful establishment and growth of desired plants. Monitoring of vegetation characteristics and soil nutrients will take place annually during the growing season for three years following revegetation. Soil moisture will be monitored monthly during the growing season (April to September) for three years following revegetation.

After final grading, placement of fill in the Daybreak Ponds does not require long-term monitoring. The fill in the ponds will require no maintenance. This avulsion control measure is best suited for long-term sustainability since no long-term management actions are required to ensure its success. Final grading and revegetation of the pond system will establish a floodplain environment that mimics historic conditions, does not preclude development of complex habitat due to channel migration or avulsion, but reduces and minimizes the existing potential for avulsion.

5 Impact Assessment

An assessment of the potential hydrologic, hydraulic and sediment transport impacts associated with the proposed avulsion mitigation plan for the Daybreak Ponds was conducted.

5.1 Surface Water Elevations

An analysis was conducted to evaluate the potential impacts of the proposed plan to fill the existing Daybreak Ponds on flood elevations along the East Fork Lewis River. The Daybreak Ponds are located in the 100-year floodplain of the East Fork Lewis River, but outside of the FEMA designated regulatory floodway (FEMA, 2000). Therefore, fill within the Ponds will not result in a cumulative water surface elevation increase along the East Fork Lewis River greater than one foot.

The ponds are subject to overflows from the main channel during the 100-year flood event. A hydraulic analysis was performed to define the specific impacts to flooding that would be caused as a result of backfilling a portion of the Daybreak Ponds. Two hydraulic models were developed, one for existing conditions and the other for the proposed condition. The models begin at the downstream (west) end of Daybreak Pond 5 and end approximately 2,000 feet upstream (east) of Daybreak Pond 1 (see Figure 5-1). The 10-, 20-, 50- and 100-year recurrence interval discharges were evaluated. Unless otherwise noted, all elevations are referenced to NGVD 1929.

The Corps of Engineers River Analysis System standard-step backwater computer program (HEC-RAS) was used to compute channel hydraulics (U.S. Army Corps of Engineers, 1998). Cross-sections extracted from a digital elevation model developed from survey data (WEST, 1997) (Figure 5-1) and supplemented with bathymetric survey elevations of the ponds (Chase Jones, 1999) were used to develop hydraulic models of the reach. Cross section locations were chosen to provide sufficient detail of flow contraction and expansion. Water surface elevations from FEMA (2000) were used for the downstream boundary of the models. Floodwaters may enter the Daybreak Ponds by flow split from the main channel upstream of the ponds and by backwater from the main channel downstream (west) of Daybreak Pond 5. The magnitudes of the flow splits were determined previously (WEST, 2000) and are summarized in Table 5-1.

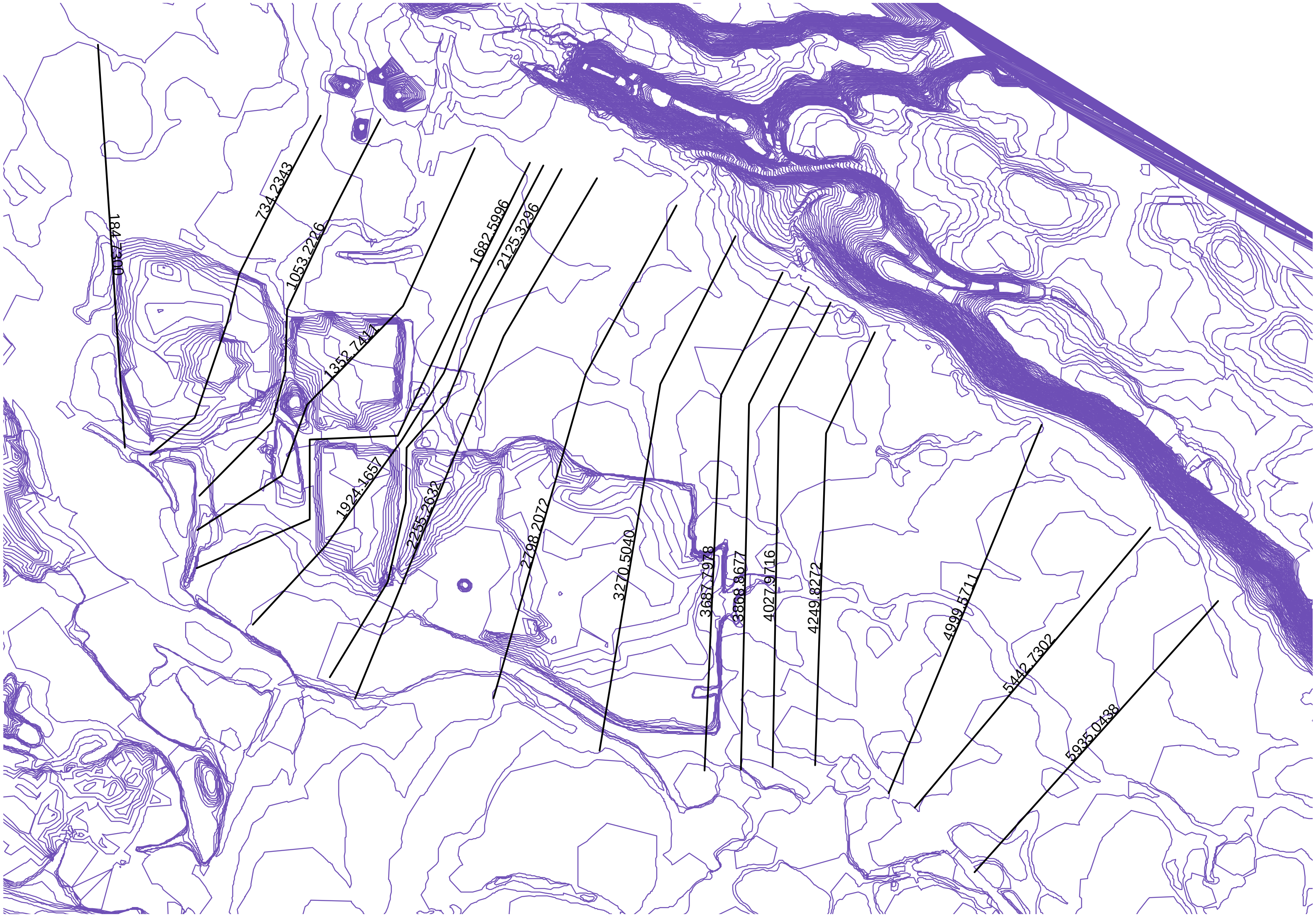


Figure 5-1. Plan view of the Daybreak Ponds showing locations of cross sections used in the hydraulic analysis.

Table 5-1. Summary of split flow magnitudes.

Recurrence Interval (Years)	Discharge (cfs)
10	100
20	285
50	475
100	650

Results of the hydraulic models for the 100-year recurrence interval flood are summarized in Table 5-2 As seen in the table, the water surface elevations for the existing and proposed models are nearly identical. At cross section 3687.8, which is located at the upstream (east) end of Daybreak Pond 1, the water surface elevation decreases by 0.02 ft as a result of the reduced channel width. A reduction in channel width that causes the water surface elevation to decrease would typically cause a backwater effect that would raise the water surface elevation upstream for some distance. However, in this case the profile of the channel is sufficiently steep upstream of this cross section that no backwater effect is created. The only other location where a change in the water surface elevation is observed is at cross section 2798.2, which is located in the middle of Daybreak Pond 1. At this location the water surface elevation increases by 0.01 ft. This is caused by a reduction in channel width downstream that causes a minor backwater effect.

Table 5-2. Modeled water surface elevation for the 100-year flood.

Cross Section No.	Existing W.S. El. (ft)	Proposed W.S. El. (ft)	Difference (ft)
5935.0	55.75	55.75	0.0
5442.7	54.33	54.33	0.0
4999.6	53.06	53.06	0.0
4249.8	50.11	50.11	0.0
4028.0	46.99	46.99	0.0
3868.9	41.40	41.40	0.0
3687.8	33.34	33.32	-0.02
3270.5	33.35	33.35	0.0
2798.2	33.34	33.35	+0.01
2255.3	33.34	33.34	0.0
2125.3	32.22	32.22	0.0
1924.2	32.35	32.35	0.0
1682.6	32.34	32.34	0.0
1352.7	32.34	32.34	0.0
1053.2	32.34	32.34	0.0
734.2	32.34	32.34	0.0
184.7	32.34	32.34	0.0

The water surface elevations in the Daybreak Ponds are controlled by the remnant ground that separates the ponds from one another. The remnant ground acts as a series of weirs that control the water surface elevations in the ponds. Because each pond is controlled by the hydraulics associated with weir flow, the proposed fill in the ponds does not impact the water surface elevation.

The existing Daybreak Ponds are located outside of the FEMA-designated regulatory floodway. The proposed improvements will have no significant impact on the water surface elevations associated with the flow split from the main channel of the East Fork Lewis River. No significant change in water surface elevation was calculated between the existing and proposed conditions models.

5.2 Surface Water Quantity

The placement of fill in the Daybreak Ponds will significantly reduce the open water area and volume of the ponds. The reduced open water area resulting from placement of the fill would be expected to reduce direct evaporation losses that are associated with the existing pond system. However, revegetation of the site will increase evapotranspiration demands for water. Overall, the proposed actions will return evapotranspiration demands to a condition similar to pre-development conditions for the site.

5.3 Surface Water Quality

The proposed action involves the placement of fill in existing floodplain gravel pits. Fill extending above the annual high groundwater level will be covered with topsoil and revegetated. The intent of the fill and revegetation is to increase the riparian buffer between the main channel of the East Fork Lewis River and the existing ponds. The fill material imported from off-site will be certified as free from deleterious materials and chemical contamination prior to placement.

Currently, high water temperature is one of the most important water quality issues in the lower East Fork Lewis River, and the river is listed as water quality impaired by the State of Washington due to water temperatures that exceed 18°C. Relatively recent historical water quality exceedances in the river at the Daybreak Bridge upstream of the project site include 20.2°C on 7/28/97; 19.0°C on 8/28/96; 22.5°C on 7/31/96; 18.6°C on 8/30/95; 18.8°C on 7/26/95; 19.6°C on 6/28/95; 21.3°C on 7/28/92; and 22.0°C on 6/23/92. Spot recordings of monthly water temperatures in the past year collected by Ecology in the East Fork Lewis River at the Daybreak Bridge are listed below:

May 2, 2000	12.6°C
June 2, 2000	18.8°C
July 2, 2000	17.5°C
August 2, 2000	19.3°C
September 2, 2000	15.0°C

Concerns have been raised about increased water temperatures in the East Fork Lewis River, specifically from releases of warm surface water, warm groundwater, and an increased riverine surface area in the event of an avulsion through the project site.

Releases of surface water from the existing ponds have the potential to input water with higher temperatures than already in Dean Creek or the East Fork Lewis River. This existing potential condition will be mitigated by the reduction in water surface area by narrowing and reconfiguring the ponds, and by increased shading provided from trees planted along the pond edges. A riparian forest is to be established on the riparian buffer. The riparian forest would be expected to resist channel migration and avulsion and provide shade to aquatic areas. The shade provided by the riparian forest will help in moderating temperatures in the East Fork Lewis River during summer months.

The potential effect of an avulsion on water temperature in the East Fork Lewis River is relatively unknown. Currently, the East Fork Lewis River flows through the Ridgefield Pits, which were former gravel ponds, and the effect on water temperatures through this reach can be presumed to be similar to the effect if the river avulsed out of this reach and into the Daybreak Ponds. In August of 1998 and 1999, a limited number of water temperature measurements were recorded above and below the reach that flows through the Ridgefield Pits. Storedahl is continuing to monitor water temperatures in the river and in the groundwater to provide further information on the existing conditions. Although water temperatures were observed to be higher downstream of the Ridgefield Pit reach is it unknown how these observations would relate to upstream/downstream measurements in other reaches on the river. Additionally, because these measurements were taken over the course of several hours, the influence of daily water temperature fluctuations is unknown. Nonetheless, a river flowing through an area of greater surface area has the potential to increase in water temperature. To reduce the potential of this phenomenon to occur if the river avulses through the Daybreak Ponds, the width of the existing ponds is proposed to be narrowed and the shoreline revegetated with shrubs and trees. This narrowing of the ponds will direct a potential avulsed flow into a channel that is narrower than the existing ponds and will mimic historic channel shape and location. This narrowed channel would reduce the surface area of open water, and thereby reduce the input of solar radiation and the potential for increased water temperatures with respect to existing conditions. In addition, the revegetated shoreline would provide shade along the expected avulsion flow path.

The fine-grained sediments resulting from gravel processing will be placed to an elevation at or slightly below the annual high water level in the ponds. As the pond water levels are expressions of the local groundwater level, it is expected that the shallow open water areas remaining after reclamation of the ponds will result in complex wetland habitat, consistent with the historic predevelopment channel conditions in the lower reaches of the East Fork Lewis River. Wetlands provide a wide range of water quality benefits including detention of stormwater runoff, moderation of flood peaks, biofiltration of contaminants, and settling of suspended sediment.

5.4 Groundwater

A site water table map (Figure 5-2) shows that the Daybreak Ponds act as a local groundwater sink, and that groundwater locally flows into the up-gradient side of the ponds. Site water table maps have been developed for both wet and dry periods that show a similar condition throughout the year. Under the current configuration of the ponds, surface water discharge from the ponds results in local suppression of the water surface and a net groundwater inflow to the ponds (i.e., groundwater inflow to the ponds is greater than groundwater outflow from the ponds). During the winter, the hydraulic gradient to the ponds is high, groundwater inflow is high, and most water drains from the pond system by surface flow. During the summer, the hydraulic gradient to the ponds is reduced, surface discharge from the ponds is low, and most water leaves the ponds as either groundwater seepage or evaporation.

The fill proposed to be placed in the Daybreak Ponds will reduce the available open water area of the ponds and the influence of the ponds on the local ground water surface. The proposed fill material is expected to have a significantly lower hydraulic conductivity than the coarse sands and gravels naturally occurring at the site. Since the local groundwater gradient is in the same direction as the river flow, fill in the ponds would not be expected to create a significant barrier to groundwater flow.

The project ponds are not believed to increase the temperature of groundwater released to the river. Recent groundwater temperature data collected from a piezometer immediately west of Pond 5 during late summer was 16°C compared to 19°C in both Pond 5 and the East Fork Lewis River, indicating that the ponds do not contribute to higher water temperatures in the river via groundwater input.

Groundwater flow at the project site during the summer was determined to flow from the ponds parallel to the river and then into the river a considerable distance downstream of the ponds, after attenuation of any temperature increase. In addition, seepage from the ponds is estimated to be only 0.9 cfs in the summer, which would have minimal effect on the East Fork Lewis River, even if subsurface water temperatures were higher as a result of the ponds.

5.5 Hyporheic Zone

The extent of the hyporheic zone of the East Fork Lewis River near the Daybreak Ponds is not known. However, the hydrogeomorphic setting of the river and its valley suggest that hyporheic flow on the scale of the fluvial plain (hundreds of meters) is possible. Groundwater contours and flow lines shown in Figure 5-2 indicate that hyporheic flow could intersect the existing Daybreak Ponds.

The effect of the existing Daybreak Ponds on the characteristics of the hyporheic flow are also unknown, but they would be expected to be similar in principle to those of a flow-through reach where hyporheic water enters the channel on the upstream side and goes subsurface on the downstream side. The ponds might have different effects than a river on the biological and chemical properties of water as it is exchange with surface water.

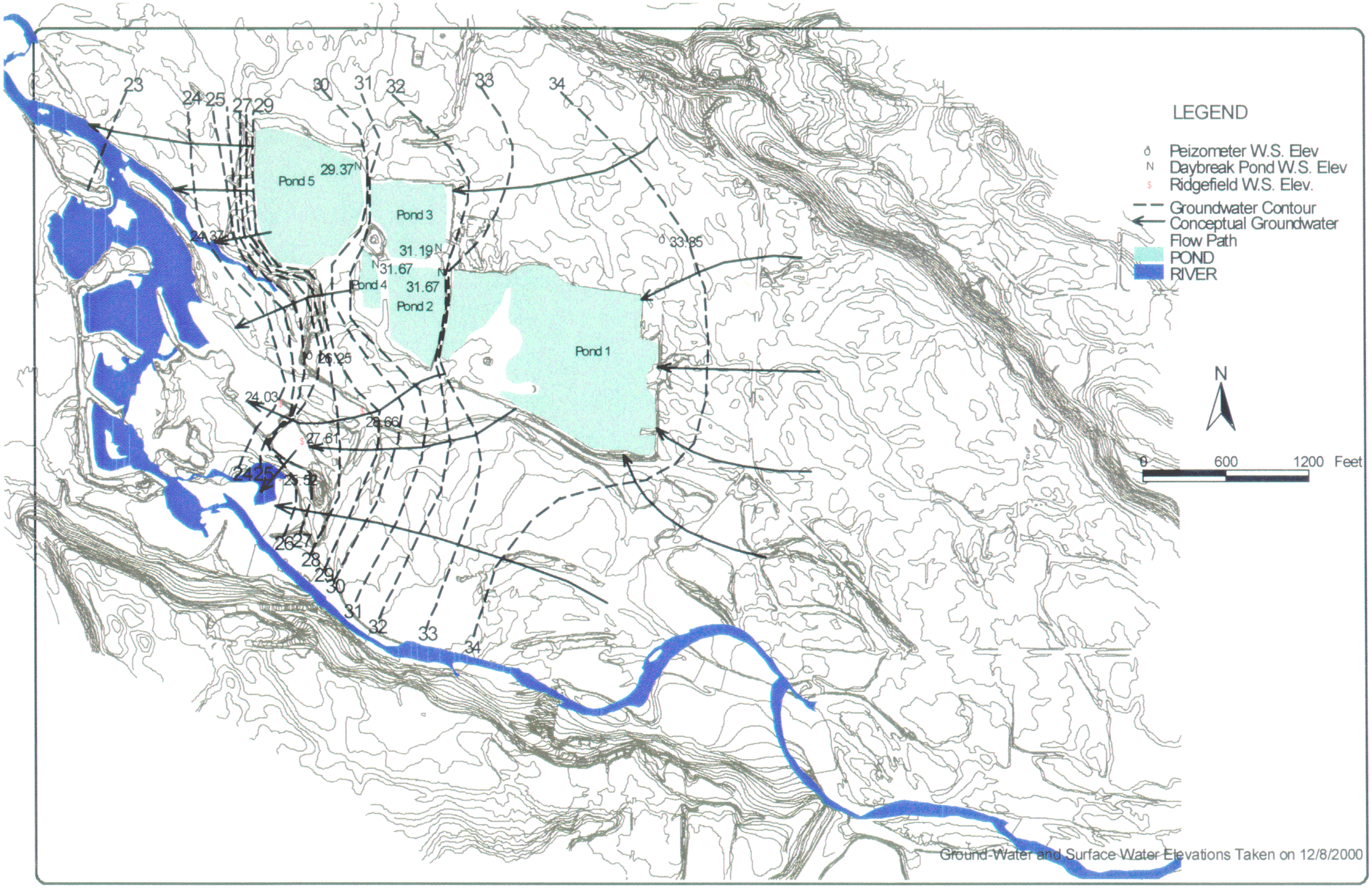


Figure 5-2. December 2000 groundwater contours.

Both past and proposed placement of fine grained sediments in the pond would be expected to retard exchange of hyporheic and surface water in the ponds, if it occurs. Such an impact would be consistent with other natural geomorphic processes in the area, such as, oxbow channel cutoffs or abandoned channel reaches, typical in the lower East Fork River valley, which would be expected to also have similar fine grained sediments in them. The existing ponds effectively replaced hyporheic volume that was present before the ponds were excavated. The proposed fill reestablishes a portion, albeit altered, of the hyporheic volume of the existing ponds.

The Daybreak Ponds are not considered to be a significant impact to the hyporheic zone. Mixing of stream water and groundwater in near-channel sediments below and lateral to the channel is typically limited to a few meters from the channel (D'Angelo et al. 1993; Wroblicky et al. 1998; Woessner 2000). Near channel sediments are inferred to be those within the bounds of a bankfull river. Consequently, exchange of surface and hyporheic water in near channel areas is unlikely to be affected by the existing Daybreak Ponds.

5.6 Sediment Transport Impacts

A detailed analysis of sediment transport conditions along the East Fork Lewis River has been conducted (WEST, 2001). The WEST study defines the hydrology, hydraulics, sediment transport, and geomorphic conditions of the project site. The following sections supplement the previous study by addressing specific issues relevant to the proposed avulsion mitigation plan for the Daybreak Ponds.

5.6.1 Increased supply of fine sediments to the river downstream of Daybreak

The supply of fine sediments to the East Fork Lewis River comes from many sources within the watershed. Sediment is supplied to the river by processes that include such things as hillslope erosion, rill and gully erosion, river bank erosion, mass wasting, and the failure of natural hydraulic controls such as beaver dams and log jams. These processes can supply large-scale short-term introductions of sediment into the channel as well as long-term chronic supplies of sediment in the case of bank erosion. Deposition of fine sediments in the floodplain of the East Fork Lewis River is a natural and ongoing process that is considered to be a primary floodplain function. Natural deposits of fine sediments exist throughout the East Fork Lewis River floodplain including naturally occurring oxbows, abandoned channels that convey flow during floods, backwater areas and locations upstream of beaver dams such as at the mouth of Dean Creek. This also includes large areas of agricultural fields in the lower East Fork Lewis River basin on which the soils were developed from natural deposition of fine sediments on the floodplain. Similar to the Daybreak Ponds, these features can become sources of fine sediment if the river migrates or avulses into their location.

The annual yield of sediment from the East Fork Lewis River basin was estimated to be between 32,000 to 64,000 tons per year (PNRBC, 1970). However, the river is considered to be supply limited, having the capacity to transport much greater amounts of sediment than is supplied to it. In fact, the capacity of the river to transport bed material in the vicinity of the Daybreak Site was estimated to be approximately 145,000 tons per year (see Section 5.7 from WEST 2001). The capacity of the river to transport material finer than that found in the gravel bed portions of the river is considered to be virtually unlimited except where it is tidally influenced in the lower 6 miles of the river.

Material hauled in from the Tebo Pit is proposed to be processed at the Daybreak Site. Approximately 4 percent of this material will be waste product that will be deposited in the existing Daybreak Ponds as part of the washing process and proposed pond reclamation. The total volume of the fine grained sediment material to be placed in the Daybreak Ponds is approximately 271,000 cubic yards or 325,200 tons. Particle size distributions for the individual samples and a composite size distribution for this material are shown in Figure 5-3. Approximately 37 percent of this material is composed of sand sized material and larger, while the remaining 63 percent is silt sized and smaller.

Various concerns exist over whether this material may at some point in the future be eroded and transported downstream by the East Fork Lewis River. Of greatest concern is whether all or a portion of this material will deposit within the 1.25 miles of spawning gravels that exist downstream of the Daybreak Site. Two scenarios were considered in the evaluation of the potential impacts to the downstream channel. The first was to estimate the potential for the river to transport sediment out of the existing ponds during a 100-year flood in which a flow split from the main channel enters the upstream end of Daybreak Pond 1. The second was to estimate the potential for the river to transport sediment downstream of the Daybreak Ponds if an avulsion where to occur.

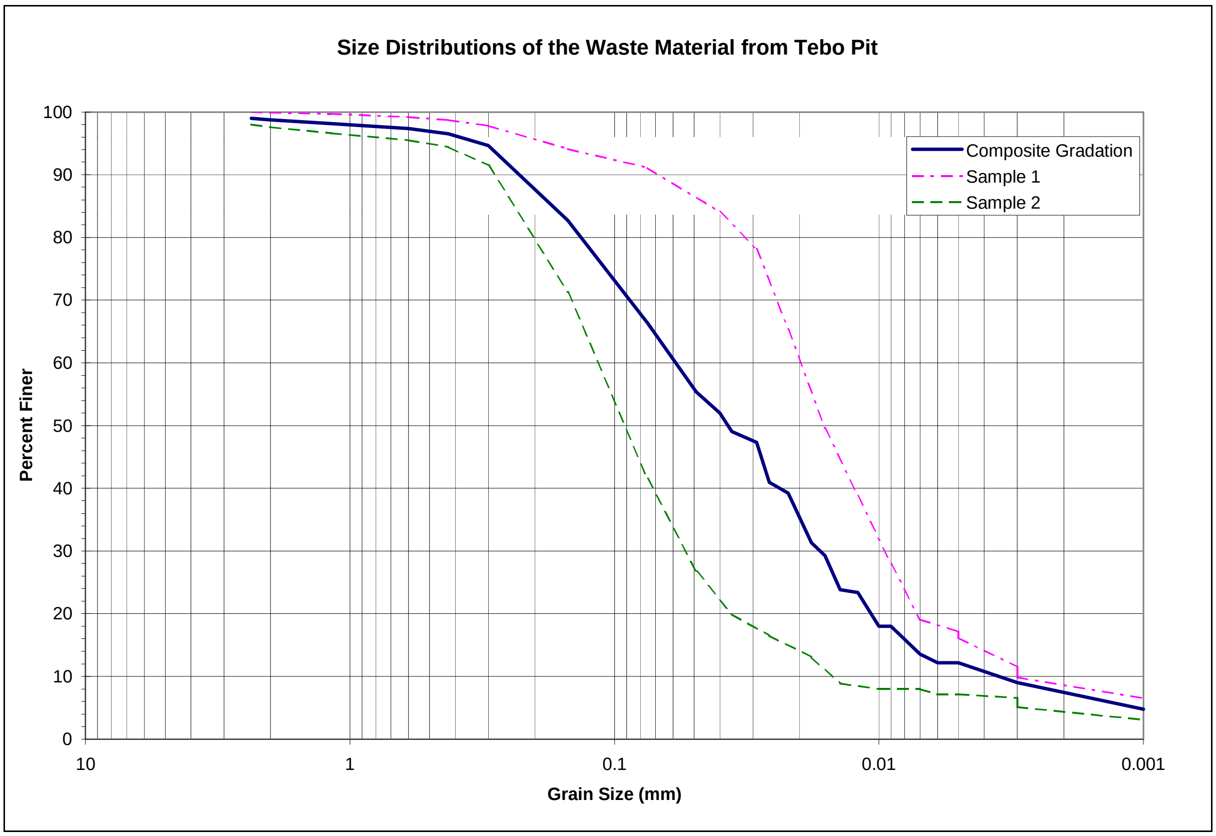


Figure 5-3. Sediment gradations for samples taken from waste material derived from the Tebo pit.

5.6.2 Potential for Sediment to be Transported Out of the Daybreak Ponds during a 100-year Flood

The water surface elevations in the Daybreak Ponds are controlled by the remnant ground that separates the ponds from one another. The remnant ground acts as a series of weirs that control the water surface elevations in the ponds. Because each pond is controlled by the hydraulics associated with weir flow, the proposed fill in the ponds does not impact the water surface elevation. The potential for erosion of materials filled in the ponds was also evaluated. Comparison of the output for existing and proposed conditions demonstrates no significant change in the expected shear stress. Within the ponds, where filling is proposed, the shear stress against the pond boundary is calculated to be zero during a 100-year flood due to the low energy gradient through the ponds. This is due to the hydraulic control provided by remnant ground between the ponds. At the upstream boundary of Daybreak Pond No. 1 (Section 3687.798) and at sections that overflow the remnant ground between ponds (Sections 1682.6 and 2125.330) the shear stress was calculated to range between 0.13 and 2.12 lb/ft^2 during the 100-year return period flood. The only increase in shear stress (erosion potential) between existing and proposed conditions occurs at Section 3687.798, the overflow inlet to Daybreak Pond No. 1. The shear stress at that location increases slightly from 0.02 to 0.13 lb/ft^2 for the 100-year flood. The identified range of shear stresses, and associated erosion potential, is not significant since it is well within the range of permissible shear stresses (0.35 to 3.70 lb/ft$^{2)}$ for vegetative linings (FWHA, 1985). A wetland marsh and riparian forest are to be established on the proposed fill.

5.6.3 Sediment Transport Associated with an Avulsion

As previously described, there is a potential for the East Fork Lewis River to avulse into the existing Daybreak Ponds. An avulsion could cause a portion of the fines deposited with in the ponds to be transported downstream. An evaluation of the rivers ability to transport this material downstream was conducted using three methods. The first was to determine the fall velocity of the particles that comprise the fill material to estimate the downstream extent of expected transport and deposition. The second was to estimate the transport capacity of the river to understand the ability of the river to transport material shown to not remain in suspension by the fall velocity calculations. The third was to estimate the incipient motion particle size.

5.6.3.1 Fall Velocity Calculations

The fall velocities for individual particle sizes were determined using the Corps of Engineers computer program H0910 “Determination of Particle Fall Velocity by Shape Factor” that is included in the SAM Hydraulic Design Package for Channels (USACE, 1998). The fall velocity that a particle attains in a quiescent column of water is directly related to the relative flow conditions between the sediment particle and the water during conditions of sediment entrainment, transportation, and deposition. The fall velocity reflects the integrated result of size, shape, surface roughness, specific gravity, and the viscosity of the fluid. The fall velocity is calculated as the difference between the particles buoyant weight and the resisting forces resulting from fluid drag.

Because fall velocity calculations are considered appropriate for conditions of quiescent water conditions, the effects of turbulence associated with flow in a river channel would tend to keep a particle in suspension for much longer than the fall velocity would indicate. Therefore, estimates of downstream travel distance based on the particle fall velocity are considered to be smaller and therefore conservative for estimation of particle deposition location in the East Fork Lewis River. The travel distance of individual particles was calculated using the average channel velocities and depths for the 10- and 100-year flood calculated from the 1992 FEMA hydraulic model for the East Fork Lewis River. Results of the fall velocity calculations showed that particle sizes finer than medium silt (0.031 mm) would be transported through the entire length of the river. Coarse silt sized particles (0.0625 mm to 0.031 mm) where shown to drop out of suspension below river mile 6.24 and 5.61 for the 100- and 10- year floods, respectively. The sand sized particles where shown to drop out below river mile 7.29 for both the 100- and 10-year floods. Particle travel distances tended to be lower for the 100-year flood vs. the 10-year flood due to higher backwater effects from the downstream Lewis and Columbia Rivers during the 100-year event.

In order to understand the magnitude of the greatest possible impact to downstream locations from fine sediments transported out of the Daybreak Ponds, the total volume of material proposed to be deposited in the ponds was considered in the evaluation. Of the total amount of fine sediments proposed to be deposited in the Daybreak Ponds, approximately 48 percent (156,100 tons) is medium silt or smaller and would be expected to be transported out of the East Fork Lewis River. Approximately 15 percent (48,800 tons) is coarse silt that could potentially deposit in the river below river mile 6.24. The remaining 37 percent (120,300 tons) of material is very fine sand sized and larger. This material is indicated by the calculation to potentially deposit within the 1.25 mile spawning gravel reach located below the Daybreak Ponds. However, given the extremely conservative nature of the travel distances estimated from fall velocity calculations, it should be expected that some portion of this material would be transported beyond this reach. Additionally, it should be recognized that although fall velocity calculations indicate the time necessary for a characteristic particle to settle in a water column, it does not address the potential for the sediment particle to be transported by the flow of the water. Further, it must also be recognized that it is also unlikely that the entire amount of fine sediments would be transported out of the ponds during an avulsion. It is more likely that the majority of the sand-sized material would deposit within the downstream Daybreak Ponds 3 and 5, as these ponds are not proposed to be filled with sediment from Tebo. The trapping of fines would likely be similar to that observed to have occurred in the downstream-most Ridgefield Ponds after the avulsion in 1996.

5.6.3.2 Sediment Transport Capacity Estimates

Estimates of sediment transport capacity in the East Fork Lewis River were made for the channel at river mile 6.43, which is near the downstream end of the spawning gravel reach. Sediment transport capacity was estimated for the 2-year flood and the 5-, 10-, 25-, and 50-percent exceedance flows for the very fine sand sized material and larger (see Table 5-3) that was shown to by fall velocity calculations to deposit within the spawning gravel reach during both the 10- and 100-year flood. These estimates were made using the sediment transport formula of Toffaleti (1968). Values shown in Table 5-3 are the capacity of the river to carry the very fine sand sized and larger material in suspension. The ability of the river channels to transport particles that are silt sized and finer is considered to be unlimited (Simons and Senturk, 1976), therefore the amount of silt sized and finer material in suspension is only limited by the supply. However, in locations such as the lower reach of the East Fork Lewis that are affected by tidal backwater, conditions may exist during tidal cycles that would allow these particles to settle out of suspension.

Table 5-3. Sediment transport capacity estimates at RM 6.43 of the East Fork Lewis River.

Flow	Discharge (cfs)	Transport Capacity (tons/day)	Time to Transport Material (days)
50% exceedance	579	37,600	3.2
25% exceedance	1,249	64,700	1.9
10% exceedance	2,282	80,000	1.5
5% exceedance	3,221	90,000	1.3
2-year flood	11,200	112,500	1.1

As seen in Table 5-3, the sediment transport capacity of the channel for the very fine sand sized material and larger is fairly large, even for relatively low flows. For 50 percent of the time, the river has a flow of 579 cfs or greater. Given this flow, the river would be able to transport the entire volume of very fine sand sized material and larger in approximately 3.2 days. If the entire volume of very fine sand and large material were to be transported out of the ponds in less that 3.2 days for this flow, then deposition within the spawning gravel could occur. Alternately, if the material were removed from the ponds over a period of time exceeding approximately 3.2 days, then no deposition would occur. For a large event, such as the 2-year flood, the river has the capacity to transport the entire volume in approximately 1.1 days. Flood events on the East Fork Lewis River typically last 4 or 5 days. Therefore, it is expected that the entire volume of very fine sand sized material and larger would be transported in suspension to locations downstream of the spawning gravel reach during a 2-year flood.

If the very fine sand sized and larger material where to deposit within the spawning gravel reach, it is possible that some of this material may infiltrate into the interstitial spaces of the gravel bed, potentially leading to suffocation of salmon eggs or entrapment of fry. This would only occur if an avulsion and sediment deposition where to occur while reds are in the river. If no reds are present in the river at the time of an avulsion, the fine material in the interstitial spaces of the gravel is expected to be flushed out by the spawning adults during the construction of the red or during the next high flow event that has the ability to disrupt the armor layer. Disruption of the armor layer typically occurs during floods equal to or in excess of the bank full event. Bank full events typically have a recurrence interval of 1.5 to 2 years.

It is recognized that the ability of the river to transport the very fine sand sized and larger material derived from the Daybreak Ponds would be reduced by the amount of that sized material already in suspension that was derived from upstream sources. However, it is expected that the majority of this material would settle out in Daybreak Ponds 3 and 5, allowing nearly the entire transport capacity of the channel to be utilized for the downstream transport of the Daybreak Pond fill material. Additionally, it is expected that a large portion of any Daybreak Pond fill material that was eroded during an avulsion would also deposit in the downstream Ponds 3 and 5, therefore reducing the supply of very fine sand sized material and larger to the downstream 1.25 mile spawning gravel reach.

5.6.3.3 Incipient Motion Analysis

An analysis of incipient motion particle size was conducted to determine the size of material in the bed that is considered to be stable for given flows. The Shields (1936) method was used to estimate stable particle size for the 50-, 25-, 10-, 5-percent exceedance flows and the 2-year flood. Table 5-4 summarizes the results of the analysis.

Table 5-4. Summary of incipient motion particle sizes at RM 6.43 of the East Fork Lewis River.

Flow	Critical Particle Size (mm)	Classification
50% exceedance	18	Coarse Gravel
25% exceedance	19	Coarse Gravel
10% exceedance	24	Coarse Gravel
5% exceedance	27	Coarse Gravel
2-year flood	41	Very Coarse Gravel

As seen in Table 5-4, for 50 percent exceedance flows the critical particle size at incipient motion is 18 mm. Therefore, particles smaller than 18 mm, which includes the proposed fill material, would tend to remain in transport and are unlikely to deposit on the bed.

5.6.4 Qualitative Assessment of Sediment Transport

An historical account of fish use in the East Fork Lewis River noted that “spawning habitat is poor in the lower six miles of stream where the bottom is largely mud and sand” (Washington Department of Fisheries 1951). The lower six miles is tidally influenced, and the twice-daily backwatering that occurs in this reach results in fine sediments being deposited along the banks and within the channel. This limit on spawning habitat is generally believed to begin near the mouth of Mason Creek based on visual observations of the bank and substrates and from conversations with Dan Rawding of WDFW. Visual observations included deposition of sands on the cobbles and muddy banks that delimit the typical river height fluctuations. The substrate in the riffle areas upstream of RM 6 to the Daybreak Bridge at RM 10 is generally cobble and gravel. In this four mile reach, substrates are coarser (large cobble and boulders) in the swiftly flowing portions of the river (outer bends and confined runs) and are finer substrates along the inner bends and in the bottom of pools. Specifically, the substrates in the pools that comprise the Ridgefield Pit reach are predominantly sand. The areal extent of cobble and gravel in this reach is limited to the upstream most section where the first pool (Ridgefield Pond 1) is now filled in and the river flows over deposited gravels and short gravel/cobble sections in the shallows between each of the pools.

The existing bed material observed in the East Fork Lewis River channel would suggest that fine sand, silt and clay sized particles are typically transported downstream of the spawning gravel reach as wash load into the tidally influenced lower portion of the river. Within the tidal portion of the channel fine sands and silts are seen to form the channel bed, suggesting that the transport capacity of the channel is sufficiently reduced by the backwater to deposit this material. The lack of fine sands and silts in the spawning gravel reach would suggest that the transport capacity is large enough to prevent this material from depositing on the bed. Further, the Ridgefield Ponds have likely trapped a large portion of the fine sands and silts reducing the supply to downstream areas.

If an avulsion into the Daybreak Ponds occurred, it is likely that an additional amount of fine sands and silts would temporally be added to the wash load of the river. Although an avulsion could occur during frequent occurring flows, the potential for an avulsion to occur during a high flow event is much more likely. Therefore, it is more likely that the concentration of fines in the wash load would already be large as a result of natural erosional processes in the watershed. Additionally, it is expected that a portion of the sediments in the natural wash load of the river may settle out within Daybreak Ponds 3 and 5, thereby reducing the concentration of fines remaining in suspension.

5.6.5 Suspended Sediment Concentration Estimates

Erosion and transport of fine sediments out of the Daybreak Ponds during an avulsion would likely increase the concentration of suspended sediment in the river. In order to understand the potential magnitude of impacts to sediment concentrations in the river from such an event, estimates were made of the potential suspended sediment concentrations associated with an avulsion. The majority of the time sediment concentrations in the East Fork Lewis River are relatively low, on the order of a few milligrams per liter. However, during high flow events, concentrations can be quite large on the order of thousands of milligrams per liter. On average, Western Cascade streams have an average annual concentration of approximately 50 mg/L (Majors et al., 2000).

An estimate of the average suspended sediment concentration was made for 100-year flood assuming the entire volume of fill was entrained in the flow. A simulated 5-day hydrograph with a peak of 32,200 cfs was used to calculate the involved volume of water. The resulting average concentration is approximately 1,500 mg/L. For comparison, a flood in December 1977 on Wildhorse Creek, a tributary to the nearby Kalama River, had an average concentration of approximately 1,460 mg/L (Wooldridge, 1978)

An additional analysis was performed to understand the potential magnitude of impacts of the fine sediments on downstream locations such as the Columbia River. Sediment concentrations in the Columbia River at Vancouver, WA were measured between 1964 and 1969. The average annual discharge during the period of record was approximately 240,000 cfs with an average sediment concentration of approximately 34 mg/L. Concentrations as high as 2,700 mg/L have been measured. The addition of the proposed Daybreak fill material to the Columbia River would yield an average annual sediment concentration of about 1.4 mg/L.

5.6.6 Bedload Trapping

If an avulsion into the existing Daybreak Ponds occurred, the majority of bed material would likely be trapped within Ponds 3 and 5. This would cause the supply of bed material to the downstream spawning reach to be reduced. This could potentially lead to coarser bed material in that reach. However, given the reduction in the rivers ability to transport coarse bed material out of the reach to locations below river mile 6, it is expected that the bed would remain fairly stable in the spawning reach below Daybreak. This is further supported by the lack of observed impacts to the bed of the river in this reach since the bed material supply was reduced by the avulsion into the Ridgefield Ponds in November 1996.

6 Summary

The proposed mitigation plan will reduce the risk of avulsion into the existing man-made ponds, enhance the long-term stability of the East Fork Lewis River, minimize the potential avulsion impacts, and restore important valley-bottom forest. This proposal will enhance the ecological function of the site and support Clark County's planned expansion of restored habitat along the East Fork Lewis River. The ecological functions of the site and the East Fork Lewis River will be enhanced from this project, because it will:

- Provide terrestrial wildlife habitat for nesting, dispersal, and foraging
- Provide shade to help minimize water temperatures
- Help control erosion from surface runoff
- Provide a future source of roots and woody debris for habitat complexity
- Improve habitat for amphibians, birds, and aquatic organisms
- Increase availability of terrestrial invertebrate prey items for fish
- Enhance linkages among upland and aquatic ecosystems

No significant adverse impacts to the hydrology, hydraulics, sediment transport conditions, or geomorphic characteristics will occur as a result of the proposed Daybreak Pond avulsion mitigation plan.

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Appendix D

Storm Water Erosion Control Plan and Storm Water Pollution Prevention Plan

STORMWATER POLLUTION PREVENTION PLAN, EROSION AND SEDIMENT CONTROL PLAN, MONITORING PLAN, AND SPILL PLAN

DAYBREAK MINE

Prepared for

J. L. Storedahl and Sons

April 29, 2002
(Revised June 7, 2002)

Prepared by

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Project 9045.06.01

Stormwater Pollution Prevention Plan, Erosion and Sediment Control Plan, Monitoring Plan, and Spill Plan
Daybreak Mine

I have personally examined this document and the information contained herein is, to the best of my knowledge and belief, true, accurate, and complete.

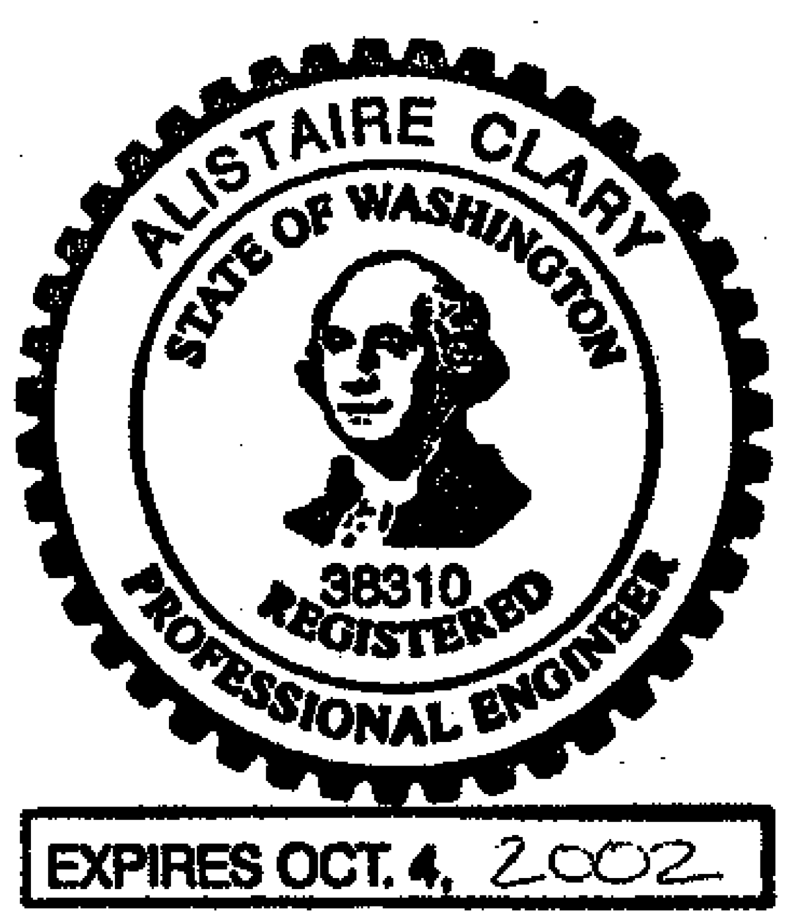
J. L. Storedahl and Sons, Inc.

____
Kevin Storedahl

The material and data in this report were prepared under the supervision and direction of the undersigned.

Maul Foster & Alongi, Inc.

Neil R. Alongi, P. E.



Alistaire Clary, P.E.

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GLOSSARY OF TERMS

The following defines pertinent terms used in this report, taken from Appendix C of the NPDES permit for the Daybreak Mine.

Active Site means a location where current mining or processing operations (including, but not limited to, crushing, classifying, or operating a concrete or hot mix asphalt plant) or stockpiles associated with current mining or processing operations, are located.

Best Management Practices (BMPs) means schedules of activities, prohibitions of practices, maintenance procedures, and other physical, structural, or managerial practices to prevent or reduce the pollution of waters of the state. BMPs include treatment systems, operating procedures, and practices used to control plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage.

Closed Site means a location where all activities associated with permit coverage have been terminated with no intent to return to operation in the future.

Ecology means the Washington State Department of Ecology.

Erosion means the wearing away of the land surface by running water, ice, or other geological agents, including such processes as gravitational creep.

Erosion and Sediment Control BMPs means BMPs intended to prevent erosion and sedimentation, such as preserving natural vegetation, seeding, mulching and matting, plastic covering, filter fences, and sediment traps and ponds. Erosion and sediment control BMPs are synonymous with stabilization and structural BMPs.

Final Stabilization means completion of all soil disturbing activities at the site and establishment of a permanent vegetative cover, or installation of equivalent permanent stabilization measures (such as riprap, gabions, or geotextiles) that will prevent erosion.

Groundwater means water in a saturated zone or stratum beneath the land surface or a surface water body.

Mine Dewatering Water means any water that is impounded or that collects in the mine and is pumped, drained, or otherwise removed from the mine through the efforts of the mine operator. This term shall also include wet pit overflows caused solely by direct rainfall and groundwater seepage. However, if a mine is used for treatment of process generated waste water, discharges of commingled water from the mine shall be deemed discharges of process generated water.

NTU means nephelometric turbidity units, a measure of turbidity.

Operational BMPs means schedule of activities, prohibition of practices, maintenance procedures, employee training, good housekeeping, and other managerial practices to prevent or reduce the pollution of waters of the state. Not included are BMPs that require construction of pollution control devices.

pH – The pH of a liquid measures its acidity or alkalinity. A pH of 7 is defined as neutral, and large variations above or below this value are harmful to most aquatic life.

Pollutant means the discharge of any of the following to waters of the state: dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste. This term does not include sewage from vessels within the meaning of section 312 of the FWPCA, nor does it include dredged or fill material discharged in accordance with a permit issued under Section 404 of the FWPCA.

Process Water means any water that comes into direct contact or results from the production or use of any raw material, intermediate product, finished product, by-product, or waste product. The term shall also mean any waste water used in the slurry transport of mined material, air emissions control, or processing exclusive of mining.

Sediment means the fragmented material that originates from the weathering and erosion of rocks or unconsolidated deposits and is transported by, suspended in, or deposited by water.

Site means the land or water area where any facility or activity is physically located or conducted.

Source Control BMPs means physical, structural, or mechanical devices or facilities intended to prevent pollutants from entering stormwater. A few examples of source control BMPs are erosion control practices, maintenance of stormwater facilities, construction of roofs over storage and working areas, and direction of washwater and similar discharges to the sanitary sewer or a dead end sump.

Stabilization means the application of appropriate BMPs to prevent the erosion of soils, such as temporary and permanent seeding, vegetative covers, mulching and matting, plastic covering, and sodding.

Standard Industrial Classification (SIC) is the statistical classification standard underlying all establishment-based federal economic statistics classified by industry as reported in the 1987 SIC Manual by the Office of Management and Budget.

Stormwater means rainfall and snowmelt.

Stormwater Drainage System means constructed and natural features that function together as a system to collect, convey, channel, hold, inhibit, retain, detain, infiltrate, or divert stormwater.

Stormwater Pollution Prevention Plan (SWPPP) means a documented plan to implement measures to identify, prevent, and control the contamination of point source discharges of stormwater.

Total Suspended Solids (TSS) is the particulate material in an effluent. Large quantities of TSS discharged to a receiving water may result in solids accumulation. Apart from any toxic effects attributable to substances leached out by water, suspended solids may kill fish, shellfish, and any other aquatic organisms by causing abrasive injuries and by clogging the gills and respiratory passages of various aquatic fauna. Indirectly, suspended solids can screen out light and can promote and maintain the development of noxious conditions through oxygen depletion.

Treatment BMPs means BMPs intended to remove pollutants from stormwater. A few examples of treatment BMPs are detention ponds, oil/water separators, biofiltration, and constructed wetlands.

Turbidity means the clarity of water as expressed by nephelometric turbidity units (NTU) and measured with a calibrated turbidimeter.

Type 1 Stormwater means stormwater from portions of a site where no industrial activities have occurred or from a site or area within a site that has been reclaimed and the reclamation bond (if any) has been released.

Type 2 Stormwater means stormwater from (1) portions of a site where mining has temporarily or permanently ceased; (2) storage areas for stockpiles of raw materials or finished products; or (3) from portions of a site with exposed soils in areas cleared in preparation for mining or other industrial activity.

Type 3 Stormwater means stormwater discharges from (1) industrial plant yards; (2) immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility; (3) material handling sites; (4) sites used for the storage and maintenance of material handling equipment; (5) sites used for residual treatment, storage, or disposal; (6) shipping and receiving areas; (7) storage areas for raw materials or intermediate and finished products at active sites; and (8) areas where industrial activity has taken place in the past and *significant materials* remain and are exposed to stormwater.

Water Quality means the chemical, physical, and biological characteristics of water, normally with respect to its suitability for a particular purpose.

1 INTRODUCTION

1.1 Site Description

The Daybreak Mine site is located approximately 3 ½ miles southeast of La Center, Clark County, Washington, and approximately 4 ½ miles northwest of Battle Ground, Clark County, Washington, in the alluvial valley of the East Fork Lewis River (Figure 1). The 300-acre site comprises portions of the south half of section 18 and the north half of section 19, township 4 north, range 2 east, Willamette meridian.

The site is generally flat, with surface elevations ranging from approximately 30 feet above mean sea level (MSL) in the southwest corner of the site to approximately 60 feet above MSL in the northeast corner of the site.

Adjacent land use is generally rural residential to the north and east, and rural residential, agricultural (livestock grazing), and open space to the northwest. The site is bordered on the south and southeast by undeveloped land and the East Fork Lewis River. Dean Creek is located immediately northeast of the site (see Figure 2). Dean Creek is an intermittent Type III stream adjacent to the west side of the site that flows to the south and west. Dean Creek eventually flows into the East Fork Lewis River. The East Fork Lewis River is listed as a water quality limited stream for fecal coliform and temperature on Ecology's final 303(d) list for 1998[1].

To date, approximately 71 acres of the site have been mined for sand and gravel. The site is currently not used for mining. On-site gravel processing is currently occurring as a pre-existing, non-conforming use. Gravel is produced at the site from aggregate materials brought in from off site. The processing area consists of equipment storage areas; rock crushing, screening, and washing equipment; truck scales; an office; a maintenance and repair shop; and crushed and washed rock stockpiles.

1.2 Regulatory Background

The Federal Water Pollution Control Act (The Clean Water Act) establishes a National Pollution Discharge Elimination System (NPDES) permitting program (40 CFR § 122

[1] Ecology 2001. www.ecy.wa.gov/programs/wq/303d. Downloaded 2/19/01.

through 125), delegated to the State of Washington, that establishes discharge limits and monitoring requirements for stormwater discharges from several groups of industries and certain municipalities. In compliance with the provisions of the State of Washington Water Pollution Control Law (Chapter 90.48 Revised Code of Washington), the Washington Department of Ecology (Ecology) created a general permits for process water, stormwater, and mine dewatering water discharges associated with sand and gravel operations, rock quarries, and similar mining facilities, including stockpiles of mined materials, concrete batch operations and hot mix asphalt operation.

Ecology has issued the sand and gravel general permit number WAG-50-1359 to J.L. Storedahl and Sons, Inc. (Storedahl) for discharges at the Daybreak Mine. A site-specific fact sheet has also been issued to Storedahl (see Appendix A). The general permit requires the mine operator to develop and implement a stormwater pollution prevention plan (SWPPP), an erosion and sediment control plan (ESCP), a monitoring plan, and a spill plan. This report is intended to fulfill the requirements for these four plans.

1.3 Purpose

This report is a general guidance document for use by operations personnel in minimizing pollution releases to surface and groundwater from the mining operations at the Daybreak Mine. The report is intended to guide operations personnel in how to evaluate stormwater pollution prevention strategies, maintain stormwater control structures and best management practices (BMPs), sample stormwater and groundwater discharges, and respond appropriately to spills.

2 STORMWATER POLLUTION PREVENTION PLAN

According to the NPDES permit, the SWPPP documents the BMPs, the location of structures and drainages, personnel training, and inspection procedures for the control of Type 3 stormwater.

Storedahl will retain this SWPPP on site, or within reasonable access to the site, and make it immediately available upon request by Ecology. The SWPPP will be reviewed and updated whenever there is a failure to comply with stormwater discharge limits. The SWPPP will also be updated whenever there is a change in design, construction, operation, or maintenance at the site that necessitates a change to maintain control of stormwater. The plan will be reviewed on no less than an annual basis. Each review and revision will be logged on the review and revision form (Appendix B).

2.1 Stormwater System Overview

2.1.1 Type 3 Stormwater

Type 3 stormwater at the site includes stormwater discharged from the areas where material handling and processing occurs, the access roads traveled by carriers of raw materials, the areas used for storage and maintenance of equipment, and the areas where mining has taken place in the past and significant materials remain and are exposed to stormwater. The majority of Type 3 stormwater from the site flows into Pond 1, where it is treated before it enters Pond 2, both of which are inside the mine area (see Figure 3).

2.1.2 Type 2 Stormwater

Type 2 stormwater at the site consists of stormwater from storage areas for stockpiles of raw materials or finished products. The majority of Type 2 stormwater flows into Pond 1 where it mixes with Type 3 stormwater and is then considered Type 3 stormwater.

2.1.3 Type 1 Stormwater

Type 1 stormwater at the site includes stormwater from the undeveloped parts of the site. During large storm events, there is run-on onto the site from approximately 30 acres of adjacent property to the northeast of the site. Stormwater from this adjacent area drains onto the site via 12-, 18-, and 32-inch culverts under JA Moore Road (see Figure 2). Except for one area on the east side of the site, any Type 1 stormwater that enters the site flows to Ponds 1 through 5, where it mixes with Type 3 stormwater and is then considered Type 3 stormwater.

Type 1 stormwater from a small drainage area to the east side of the site drains off the property via an 18-inch culvert into a depression east of NE 61st Avenue. If mining ever progresses into the portion of the property that contributes to the runoff, the existing culvert will be isolated from the mine site to ensure that no stormwater from the mined area will discharge off site.

2.1.4 Stormwater Treatment System

A series of five ponds (Ponds 1 though 5), resulting from previous gravel mining, are located on the site (see Figure 2). The total surface area of the ponds is approximately 64 acres and the total volume of the ponds is approximately 306 acre-feet. The ponds improve the process water and stormwater quality by reducing the velocity of water and providing adequate time for suspended solids to settle. During washing operations, water is pumped from Pond 2, used in the wash plant, and recycled to Pond 1 for reuse.

An Ecology-approved process water treatment system is used to improve the water quality of the ponds when process water is generated by washing operations. The system includes a pre-treatment settling trench, a mixing/additive basin, and a post-treatment settling trench. Chemical additives are added to the process water in the mixing basin. A small amount of additives is used at the culvert between Pond 1 and Pond 2. The purpose of the additives is to increase the settling speed of the solids in the ponds. Operation of the process water treatment system significantly reduces the turbidity of the water discharging from the site.

Storedahl limits the concentration of additive used to no more than half of the LC_{50} (the concentration of test material estimated to cause 50% mortality) for the organisms of concern (*Daphnia magna* and *Oncorhynchus mykiss*). When additives are used, Storedahl conducts regular aquatic toxicity testing. There have been no reported significant toxic impacts to fish or invertebrates. The additive system has proven to be effective and safe and is now used on an operational basis when the facility is wet processing.

Accumulated sediment from the pre- and post-treatment settling trenches are periodically removed and stockpiled to allow dewatering and their future use in reclamation activities. When excessive sediments build up in the bottom of the ponds, the sediment is redistributed to create sinusoidal-shaped earthen areas on the exterior edges and within the ponds. These areas will be shaped and planted to form forested, emergent and submerged wetlands.

2.1.5 Discharge Points and Receiving Waters

Each pond is unlined and, therefore, is considered a discharge to groundwater by the NPDES permit. Groundwater discharge monitoring points are located in each pond (GW1, GW2, GW3, GW5) (see Figure 3). Storedahl has eliminated the monitoring at the former Pond 4 because reclamation fill has reduced it to less than 1 acre of wetland that is now a stagnant backwater area of Pond 2 with a depth of less than 6 feet.

Surface water at the site is discharged from Pond 5 to Dean Creek. The surface water discharge monitoring point is located at the southern overflow from Pond 3 to Pond 5 (Pond 3 Outfall, see Figure 3). The surface water discharge monitoring point is located at the discharge point from Pond 3 rather than the discharge point from Pond 5 because of the problematic nature of trying to monitor at Pond 5 (the existence of three possible surface water discharge points, off-site activities changing the flow regimen, and periodic inflow from Dean Creek). The Pond 3 Outfall monitoring point is also a more conservative point of compliance than the discharge to Pond 5, as it is closer to the source (i.e., the upgradient ponds and the operations area).

2.2 Inventory of Materials and Potential Pollutants

2.2.1 Sediment

Gravel is processed at the site. The gravel processing activities produce sediment that has a potential for being transported with stormwater runoff.

2.2.2 Petroleum Products

A variety of petroleum products are used for equipment maintenance activities. New oil is stored inside the maintenance building. Equipment used for processing operations is refueled on site next to the maintenance building. The refueling area consists of an aboveground 15,000-gallon, double-contained diesel fuel tank, an aboveground, 1,100-gallon, double-walled tank for unleaded gasoline, and a concrete pad that drains to an oil/water separator (see Figure 3). Tank refilling and fuel and oil dispensing activities present the potential for the release of petroleum products and the subsequent impact of stormwater.

2.2.3 Stormwater Treatment Additives

The additive dosing system includes a shed (with secondary containment) that contains some stormwater treatment additives and electrically operated control mechanisms. Next to the shed is a double-walled 5,100-gallon tank for Nalco 7888 Clarification Aid. Additives are added to the stormwater at the additive metering/mixing location in the settling/treatment channel and also with a drip mechanism in the culvert connecting Pond 1 and Pond 2 (see Figure 3). Spills could result from the operation of the additive dosing system.

2.3 Operational BMPs

Operational BMPs include items such as maintenance procedures, employee training, good housekeeping, and other managerial practices that reduce the potential for the discharge of significant amounts of pollutants.

2.3.1 Pollution Prevention Team

Kevin Storedahl is the manager of the pollution prevention team. His responsibilities include signatory authority, coordination of plan development and implementation, coordination of the employee training program, oversight of inspection and recordkeeping, and ensuring that reports are submitted to Ecology.

Pat Hadaller is responsible for stormwater inspections, sampling, and recordkeeping, as specified in the monitoring plan (Section 4). He also updates the site map to reflect any new site features.

2.3.2 Good Housekeeping

Good housekeeping requires the maintenance of clean and orderly facility areas that may potentially discharge stormwater. Good housekeeping measures include the following:

- Conduct routine inspections and maintenance of equipment and vehicles to prevent leakage of oil, grease, and fuels.
- Do not pour waste oils, solvents, fuels, or other hazardous chemicals on the ground or pavement.

- Do not leave vehicles or equipment unattended during fuel dispensing.
- Prevent overfilling of tanks when dispensing fuel.
- Maintain nonpaved areas to prevent excessive soil erosion.
- Keep activities that are likely to contaminate stormwater separate from activities that will not contaminate stormwater.
- Inspect and clean culverts.
- Be on the lookout for opportunities to make operational changes that could reduce stormwater pollution.

2.3.3 Preventive Maintenance

Routine preventive maintenance is crucial to reducing the amount of pollutants contacting stormwater runoff. The preventive maintenance program is designed to ensure the effective operation of all the facilities that could impact stormwater quality. The preventive maintenance schedule includes a thorough inspection of stormwater drainage and treatment facilities before each wet season, and inspections during or after significant storms.

The items inspected include conveyance facilities (culverts, etc.), stockpile areas (for evidence of erosion), ponds, additive storage areas and pumps associated with additive dosing, pond pumps, and discharge piping from the ponds. Each inspection is noted on a preventative maintenance report form that is kept with the SWPPP in the stormwater sampling and monitoring folder (a copy of the form is provided in Appendix E). Any repairs or improvements that are required are noted on the form and reported to management.

2.3.4 Employee Training

Key site personnel and personnel involved with site operations and maintenance are familiar with all components of the SWPPP.

All employees will participate in an employee awareness program that informs site personnel of the goals of the SWPPP, spill response procedures, good housekeeping practices, and pollution prevention methods. An employee information training sheet (Appendix C) summarizes employee training requirements.

2.3.5 Stormwater Inspections and Recordkeeping

A minimum of two stormwater inspections are made at the site each year. One inspection is made during the wet season (October 1 to April 30) and one inspection is made during the dry season (May 1 to September 30). As previously mentioned, preventative maintenance inspections also occur after significant storms.

The wet season inspection is conducted during a rainfall event adequate in intensity and duration to verify that (1) the description of potential pollutant sources required under the NPDES permit is accurate, (2) the site map reflects current conditions, and (3) the controls to reduce pollutants in stormwater discharges are being implemented and are adequate. The wet season inspection will include observations for the presence of floating materials, suspended solids, oil and grease, discoloration, turbidity, odor, etc., in the stormwater discharge.

The dry season inspection, conducted after at least seven consecutive days of no precipitation, determines the presence of nonstormwater discharges, such as process water, to the stormwater drainage system. The NPDES permit requires a certification by a responsible official of the facility that the discharge has been investigated for the presence of nonstormwater discharges.

Pat Hadaller is responsible for stormwater inspections at the site. Each bi-annual stormwater inspection will be documented on a bi-annual inspection report form that is kept with the SWPPP in the sampling and monitoring folder (a copy of the form is provided in Appendix E). The reports will summarize the scope of each stormwater inspection, the personnel conducting the inspection, the date(s) of the inspection, major observations relating to the implementation of the SWPPP, and actions taken. If a problem is observed during the inspections, Mr. Hadaller notes them on an inspection form and reports them to Kevin Storedahl. Mr. Storedahl is responsible for ensuring that the problems are resolved. As part of the follow-up procedure, Mr. Storedahl documents the action taken for each problem noted on the inspection form.

The inspection reports will be retained at the site for at least three years from the date of the inspection. The period of retention is extended during the course of any unresolved litigation regarding the discharge of pollutants by the permittee, or when requested by Ecology.

2.4 Source Control BMPS

Source control BMPs prevent the pollution of stormwater.

2.4.1 Secondary Containment for Additive Storage Containers

The additive dosing shed has secondary containment of sufficient volume to contain the contents of the additive containers inside the shed. The 5,100 gallon tank for Nalco 7888 Clarification Aid is double walled which provides protection against accidental punctures or tank failure.

2.4.2 Revegetation

Revegetation, including temporary and permanent seeding, may be implemented for new areas of the site that are exposed during the course of operations. This will reduce the amount of erosion and thus reduce the amount of sediment entering stormwater runoff.

2.4.3 Access Road

The vehicle entrance road is paved with asphalt from Bennett Road to the truck loading area and lined with gravel throughout the processing and loading area. The 1,800 lineal feet of paved road is sufficient to minimize the potential for tracking of dirt onto the county road. The paved portion of the access road is periodically swept and/or washed as needed to prevent sediment from being tracked onto public roads.

2.5 Treatment BMPs

2.5.1 Ponds

Ponds 1 through 5 improve water quality by reducing the velocity of stormwater and providing adequate time for suspended solids to settle. See Section 2.1.4 for additional information on the ponds.

2.5.2 Additive Dosing System

When additives are used to treat process wastewater, they are dosed into the pond system at the mixing basin and the culvert between Pond 1 and Pond 2. The additives increase the settling speed of the solids in the water, thereby reducing the turbidity. As required by Ecology, the additives used at the site are effective in treating the water using concentrations less than 50 percent of the LC_{50}. Additive concentrations are adjusted to use the lowest concentrations that will produce the required water quality. Additive dosing records are kept in the stormwater sampling and monitoring folder with the SWPPP (a copy of the form is provided in Appendix E).

3 EROSION AND SEDIMENT CONTROL PLAN

According to the NPDES permit, the ESCP identifies erosion and sediment control BMPs, including stabilization and structural practices, implemented to minimize erosion and the transport of sediments during facility operation.

Storedahl will retain this ESCP on site, or within reasonable access to the site, and make it immediately available upon request by Ecology. The ESCP will be updated as necessary to adequately represent facility changes. The plan will be reviewed on no less than an annual basis. Each review and revision will be logged on the review and revision form (Appendix B). The ESCP must be retained for at least three years after the date of final stabilization of the site.

3.1 Stabilization BMPs

Stabilization BMPs are necessary in parts of the site where mining activities have been temporarily or permanently ceased. The BMPs are described below.

3.1.1 Preservation of Mature Vegetation

Vegetative cover is the most important form of erosion control because it prevents or reduces erosion rather than attempting to trap sediment after soil has already eroded. Setbacks and other areas where vegetation is not to be disturbed are permanently marked.

3.1.2 Temporary Seeding

Temporary seeding measures provide a quick cover to soils that are exposed for longer than six months. Temporary seeding should be completed no later than mid-October of each year.

3.1.3 Permanent Seeding and Revegetation

Reclaimed or regraded areas will be permanently seeded or otherwise revegetated as part of reclamation. The work is to be done as soon as practicable in areas where mining activities have ceased and the final reclamation grading is completed.

3.2 Structural BMPs

Structural BMPs are used to divert flows from exposed soils, store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. The Daybreak Mine uses only sedimentation ponds.

3.2.1 Sediment Ponds

Sediment ponds reduce the velocity of the stormwater. As the velocity decreases, suspended solids settle out of the water and the turbidity of the water is reduced.

3.3 Inspections and Maintenance

All on-site erosion and sediment control measures listed above are inspected at least once every seven days, and within 24 hours after any storm event of greater than 0.5 inches of rain per 24-hour period. An operations and maintenance manual is included in Appendix D. All inspections are recorded on a preventative maintenance report form and kept with the ESCP in the stormwater sampling and monitoring folder (a copy of the form is provided in Appendix E).

Structural and stabilization practices are maintained and repaired as needed to assure continued performance of their intended function.

4 MONITORING PLAN

According to the NPDES permit, the monitoring plan identifies the required parameters for monitoring, the frequency of sampling, the location(s) for sampling, and the procedures for sampling. The monitoring plan must also identify the industrial activities at the site. Although not required by the NPDES permit, a summary of recordkeeping procedures, reporting requirements, and required inspections has been added to the monitoring plan. In addition, a quick reference document titled "Stormwater and Process Water Sampling and Monitoring Folder," has been prepared for Storedahl employees. The sampling and monitoring folder also contains forms to be used for recordkeeping. Copies of the forms included in the sampling and monitoring folder are included in Appendix E

Storedahl will retain this monitoring plan on site, or within reasonable access to the site, and make it immediately available upon request by Ecology. The monitoring plan will be updated as necessary to adequately represent facility changes. The plan will be reviewed on no less than an annual basis. Each review and revision will be logged on the review and revision form (Appendix B).

4.1 Industrial Activities

4.1.1 Gravel Processing Operations

Gravel processing activities at the site may consist of the following:

- Aggregate is brought on site in trucks and stockpiled.
- The raw aggregate is screened to segregate larger cobbles and boulders.
- Smaller fractions may be further separated in the sand classifier.
- Larger materials are crushed into gravel and screened.
- Gravel may be washed.
- Gravel is moved and stockpiled on site with heavy equipment.

- Gravel is loaded into trucks with heavy equipment and weighed for shipment.

The processing activities expose aggregate stockpiles to rainfall and runoff, which may create turbid water. Wet processing operations (e.g. operation of sand classifier and gravel washing), when they occur, create turbid process water that is conveyed to Pond 1.

4.1.2 Equipment Repair and Fueling Area

A covered equipment repair area is located on the site. The equipment repair area contains stored oils and solvents owned by the property owners. Used petroleum products generated in ordinary maintenance are stored in 55-gallon drums inside the building. All transfers of used petroleum products into the drums occur inside the building so the risk of a spill entering the stormwater is minimal.

Diesel fuel is stored in an aboveground, 15,000-gallon, double-contained tank near the maintenance building. Gasoline is stored in an aboveground 1,100-gallon, double-walled tank. Fueling is accomplished on a concrete pad that drains to an oil/water separator. New oil is stored inside the maintenance building. Tank refilling, and fuel and oil dispensing activities present the potential for the release of petroleum products and the subsequent impact of stormwater.

4.2 Sampling

4.2.1 Sampling Points

NPDES discharge sampling points and discharge types are listed in Table 1 and are shown in Figure 3. Storedahl will use the sampling point names when reporting monitoring results to Ecology. All samples collected at the site will be collected according to established methods and as described in Section S4.G of the NPDES permit.

Table 1 NPDES Sampling Points

Sample Point Name	Sample Point Location	Discharge Type	Discharges to
GW1	Pond 1	Stormwater, process water	Groundwater
GW2	Pond 2	Stormwater, process water	Groundwater
GW3	Pond 3	Stormwater, process water	Groundwater
GW5	Pond 5	Stormwater, process water	Groundwater
Pond 3 Outfall	Southern overflow from Pond 3 to Pond 5	Stormwater, process water	Surface Water

4.2.2 Sampling Procedures

Samples will be collected during normal working hours, except as necessary to capture a representative sample of a stormwater event. Samples to be sent to an accredited laboratory will be collected in clean, laboratory-supplied containers and will be sent to the accredited laboratory following chain-of-custody procedures. Samples to be analyzed in the field will be collected in clean containers. Portable monitoring equipment calibrated according to the manufacturer's specifications may be used to analyze the pH and temperature of the samples. Turbidity and TSS measurements must be completed by an accredited laboratory (unless the measurements are in addition to the minimum number of measurements required by the permit).

4.2.3 Monitoring Parameters and Schedule

The water that collects in the ponds during wet processing operations is considered to be process wastewater. If no washing operations are occurring at the site, the water in the ponds is considered to be Type III Stormwater. Table 2 lists the monitoring required by the NPDES permit.

Table 2 NPDES Permit Monitoring Parameters and Schedule

Parameter	Sample Points	Sample Type	Minimum Sampling Frequency
Stormwater Discharges to Surface Water			
Turbidity	Pond 3 Outfall	Grab	Twice Monthly[a]
pH	Pond 3 Outfall	Measurement	Monthly
Temperature	Pond 3 Outfall	Measurement	Weekly[b]
Process Wastewater Discharges to Surface Water			
Turbidity	Pond 3 Outfall	Grab	Twice Monthly[a,c]
pH	Pond 3 Outfall	Measurement	Monthly[c]
Temperature	Pond 3 Outfall	Measurement	Weekly[b,c]
TSS	Pond 3 Outfall	Grab	Quarterly
Stormwater Discharges to Ground Water			
pH	GW 1, GW 2, GW 3, GW 5	Measurement	Quarterly
Process Wastewater Discharges to Ground Water			
pH	GW 1, GW 2, GW 3, GW 5	Measurement	Monthly[c]

[a] There must be at least 24 hours between sampling.
[b] During July, August, and September.
[c] Only one set of samples is necessary for stormwater and process wastewater

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Storedahl may monitor the parameters listed above more frequently than required by the permit. The results of additional monitoring of the parameters above are included in the calculation and reporting of data to Ecology. In addition to the parameters listed above, Storedahl may monitor the dissolved oxygen in the ponds and may measure water quality parameters in Dean Creek.

When additives are used to treat the water in the ponds, quarterly toxicity testing is completed on samples taken at Point D (see Figure 4). The toxicity testing is designed to ensure that the discharges from the site do not exhibit unacceptable aquatic toxicity characteristics. Acute toxicity screening tests are performed in accordance with the applicable procedures defined in the current version of WAC 173-205, "Whole Effluent Toxicity Testing and Limits." Acute toxicity tests are performed using *Oncorhynchus mykiss* (rainbow trout) and *Daphnia magna* (water flea) by an analytical laboratory certified by Ecology to perform toxicity testing.

A visual inspection of the surface water monitoring point at the Pond 3 outfall is completed at least monthly. The inspection date and any visible changes in turbidity or color in the receiving water caused by the discharge are recorded on the Preventive Maintenance and Inspection Report and filed with this monitoring plan.

All places where water collects are monitored visually for oil sheen. When water is present, monitoring should be completed each day of operation for most locations onsite, and never less than monthly. If a sheen is present, cleanup will occur as described in Section 5.3, "Emergency Spill Containment," and the incident will be documented with this monitoring plan.

4.2.4 Discharge Limits

The discharge limits listed in the NPDES permit for SIC Code 1442 Construction Sand and Gravel are summarized in Table 3. According to the NPDES permit, discharges must not cause a visible change in turbidity or color, or cause a visible oil sheen in the receiving water.

Table 3 NPDES Effluent Limitations for Construction Sand and Gravel

Parameter	Effluent Limitations	
	Average Monthly[a]	Maximum Daily[b]
TSS (for discharges to surface water)	40 mg/L	80 mg/L
Turbidity (for discharges to surface water)	50 NTU	50 NTU
	Minimum	**Maximum**
pH (for discharges to surface water)	6	9
pH (for discharges to groundwater)	6.5	8.5

mg/L = milligrams per liter.
NTU = nephelometric turbidity unit.
[a] Average monthly effluent limitation is defined as the highest allowable average of daily discharges over a calendar month divided by the number of daily discharges measured during that month.
[b] Maximum daily effluent limitation is defined as the highest allowable daily discharge.

The following surface water quality criteria are specified in WAC 173-201A-030 for Class A waters. They are provided for informational purposes only.

Table 4 Washington State Surface Water Quality Criteria

Parameter	Discharge Limits
Temperature (within receiving water)	Cannot exceed 18° C[a]
Turbidity (within receiving water)	Cannot exceed 5 NTU above background turbidity when background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.
Dissolved Oxygen (within receiving water)	Cannot be below 8.0 mg/L

Note:
mg/L = milligrams per liter.
NTU = nephelometric turbidity unit.
[a] When natural conditions are 18° C or lower, no temperature increases will be allowed which will raise the receiving water temperature by greater than $28/(T_{background}+7)$. When natural conditions exceed 18° C, no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3° C.

In addition, if the treated stormwater exhibits toxicity to aquatic life, toxicity tests will be repeated at Point D and the Pond 3 Outfall to confirm the results. If the results are confirmed, additive use will be discontinued until the cause of the toxicity can be determined and corrective actions are implemented.

4.3 Inspections

Visual inspections of the surface water monitoring point at the Pond 3 outfall for turbidity and color change are required at least monthly, as described above. Visual inspections for oil sheen are required at least monthly where water collects on the site, as described above. All onsite erosion and sediment control measures described in the ESCP (Section 3) are inspected at least once every seven days, and within 24 hours after any storm event of greater than 0.5 inches of rain per 24-hour period. A log of observations is recorded on the Preventive Maintenance and Inspection Report form located in the stormwater sampling and monitoring folder that is kept with the monitoring plan (A copy of the form is provided in Appendix E).

A minimum of two stormwater inspections are made at the site each year. One inspection is made during the wet season (October 1 to April 30) and one inspection is made during the dry season (May 1 to September 30). The requirements of the stormwater inspections are described in Section 2.3.5 of the SWPPP.

4.4 Recordkeeping and Reporting Requirements

Pat Hadaller is responsible for recordkeeping at the site. Storedahl will retain records of all monitoring information for at least three years. The period of retention will be extended during the course of any unresolved litigation regarding the discharge of pollutants or when requested by Ecology.

4.4.1 Recordkeeping and Reporting as Part of the Monitoring Plan

For each sample or measurement taken, the following information will be recorded:

- Date, exact place, method, and time of sampling
- Name of sampler
- Dates analyses were performed
- Name of the person or laboratory that performed the analyses
- Analytical techniques, methods used, and method detection limits
- Results of all analyses.

Additional records to be kept at the site with the monitoring plan are as follows:

- Copies of sampling logs
- Chain-of-custody forms
- Analytical reports and laboratory quality assurance and quality control reports
- Calibration and maintenance records
- Original recordings for continuous monitoring instrumentation
- Information on any additives used at the site, including name and source of additive, material safety data sheet, LC_{50} and application rate

- Reports of incidents, such as discharge of spills, and other noncompliance notification.

The NPDES general permit requires that discharge monitoring report forms (DMRs) be prepared and submitted quarterly to the Water Quality Permit Coordinator of the Department of Ecology Southwest Regional Office. If there was no discharge or the facility was not operating during a given monitoring period, the form should be submitted with the words "no discharge" entered in place of the monitoring results. Reports must be received by Ecology on or before January 15 (data for October, November, and December), April 15 (for January, February, and March), July 15 (for April, May, and June), and October 15 (for July, August, and September).

4.4.2 Other Records to be Kept at Site

- Weekly preventative maintenance reports for erosion and sediment control measures (see Section 3.3) and for other facilities with the potential for impacting stormwater, such as stormwater facilities and stockpile areas (see Section 2.3.3).

- Reports for each wet season and dry season stormwater inspection (see Section 2.3.5).

- Documentation of any procedural changes that affect the stormwater system. Documentation can be in the written report or on the figures. Revisions are noted on the review and revision log (see Appendix B).

4.5 Noncompliance Notification

If Storedahl is unable to comply with any of the permit terms and conditions due to any cause, Storedahl will:

- Immediately take action to stop, contain, and cleanup unauthorized discharges or otherwise stop the violation, correct the problem, and, if applicable, repeat sampling and analysis of any violation immediately;

- Immediately notify Ecology of the failure to comply; and

- Submit a detailed written report to Ecology within thirty days (5 days for upsets and bypasses), unless requested earlier by Ecology. The report will describe the nature of the violation, corrective action taken and/or planned, steps to be taken to prevent a recurrence, results of the resampling, and any other pertinent information. Data from resampling shall not be substituted for ongoing permit monitoring required under Special Condition S4 and shall not be reported on the DMR.

5 SPILL PLAN

According to the NPDES permit, the spill plan covers the prevention, containment, control, and cleanup of spills or unplanned discharges.

Storedahl will retain this spill plan on site, or within reasonable access to the site, and make it immediately available upon request by Ecology. The spill plan will be updated as necessary to adequately represent facility changes. The spill plan will be reviewed on no less than an annual basis. Each review and revision will be logged on the review and revision form (Appendix B).

There is also a Spill Prevention Control and Countermeasure (SPCC) plan kept on site.

5.1 Materials with Potential to Spill

The site uses petroleum products and stormwater treatment additives that, if spilled, could contaminate stormwater runoff. The potential for spills is reduced by following the spill prevention measures outlined in Section 5.2.

5.1.1 Petroleum Products

Petroleum products are used in the vehicles and equipment at the site. Petroleum is stored on site. There is one 1,100-gallon tank for unleaded fuel and another 15,000-gallon tank for diesel. Vehicle and equipment maintenance is completed on site in the maintenance building. Vehicles and equipment refuel daily at the refueling area. Fuel is brought to the site in tanker trucks.

5.1.2 Stormwater Treatment Additives

When stormwater treatment additives are used on site, they are stored in the additive dosing shed and next to it in a double walled 5,100-gallon tank. The additives are dosed into the water with metering pumps as the water flows through the mixing box and at the culvert from Pond 1 to Pond 2.

5.2 Spill Prevention Measures

Prevention of spills is the cornerstone of the spill plan. The following sections describe spill prevention measures, including material storage and handling procedures.

5.2.1 Fuel Dispensing Operations

The following procedures will be followed when dispensing fuel and lubricants to vehicles and equipment at the site:

- Visually inspect the dispensing system components to confirm that there are no leaks or seeps.
- Unlock the dispensing nozzle and carefully insert the nozzle into the unit to be filled. The dispensing handle must be under the constant supervision and control of the employee during dispensing operations.
- Visually inspect for any leaks or seeps during dispensing operations.
- Carefully return the dispensing handle to its original position after dispensing is complete. Lock the dispensing handle in place.
- Verify that no products have been spilled and resume operations.
- Mobile fueling operations shall be done in compliance with DOT regulations.

5.2.2 Storing and Handling Stormwater Treatment Additives

The shed functions as secondary containment for the additives stored inside it and, therefore, minimizes the potential for spilling the additives into site surface water. The 5100 gallon tank for Nalco 7888 Clarification Aid is double walled which provides protection against accidental punctures or tank failure.

5.3 Emergency Spill Containment and Reporting

Every effort is taken to eliminate the possibility of spills; however, in the event of a spill, rapid and proper response is required. Suitable cleanup materials are kept on site near the fueling area to allow for prompt cleanup should a spill occur. A portable spill containment unit with the necessary materials to contain and clean a large spill may be deployed to the spill site.

If a spill occurs, Storedahl is committed to resolving the situation rapidly and professionally. All spills, regardless of size, will be cleaned. Emergency containment will be coordinated by management. The following procedures are followed when a spill occurs:

1. Immediately notify management. Management will be responsible for alerting authorities as necessary. If a spill exceeds facility capabilities, management will contact an emergency response contractor.

2. Contain the spill to the best of your ability until help arrives.

3. Assist in all efforts until the situation is controlled and cleaned.

4. Dispose of the material used to contain or clean the spill in containers provided for that purpose.

For any release of oil or petroleum products to the environment that exceeds 25 gallons or that cannot be cleaned up within 24 hours, or that results in groundwater contamination or causes a sheen on groundwater or surface water, the following agencies will be notified:

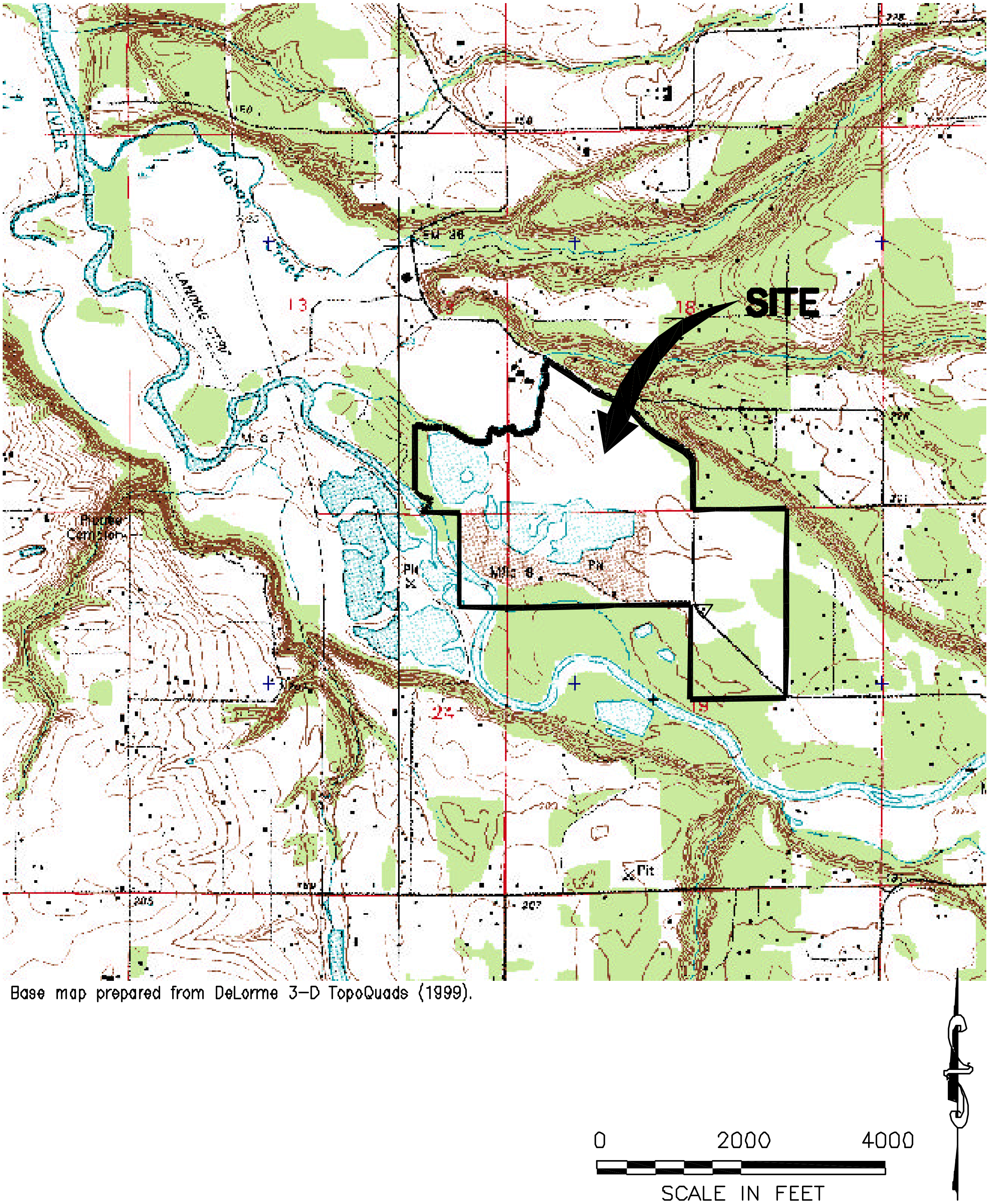
- National Response Center (1-800-424-8802)
- Washington State Spill Response Center (1-800-258-5990 or 1-800-OILS-911)

LIMITATIONS

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, nor the use of segregated portions of this report.

FIGURES



Base map prepared from DeLorme 3-D TopoQuads (1999).

Suite B
7223 NE Hazel Dell Ave.
Vancouver, WA 98665

P 360.694.2691
F 360.906.1958

MAUL FOSTER ALONGI

DATE 04/08/02
DWN. AJY
APPR.
REVIS.
PROJECT NO.
9045.06.01

Figure 1
J.L. STOREDAHL & SONS, INC.
DAYBREAK MINE

SITE LOCATION MAP

File: G:\9000\9045-STOREDAHL\006-DAYBREAK\SWPPP\001-01.DWG Last edited: APR. 29, 02 @ 09:12 a.m. by: JNESS Xrefs: none Black/White

LAYOUT: 1

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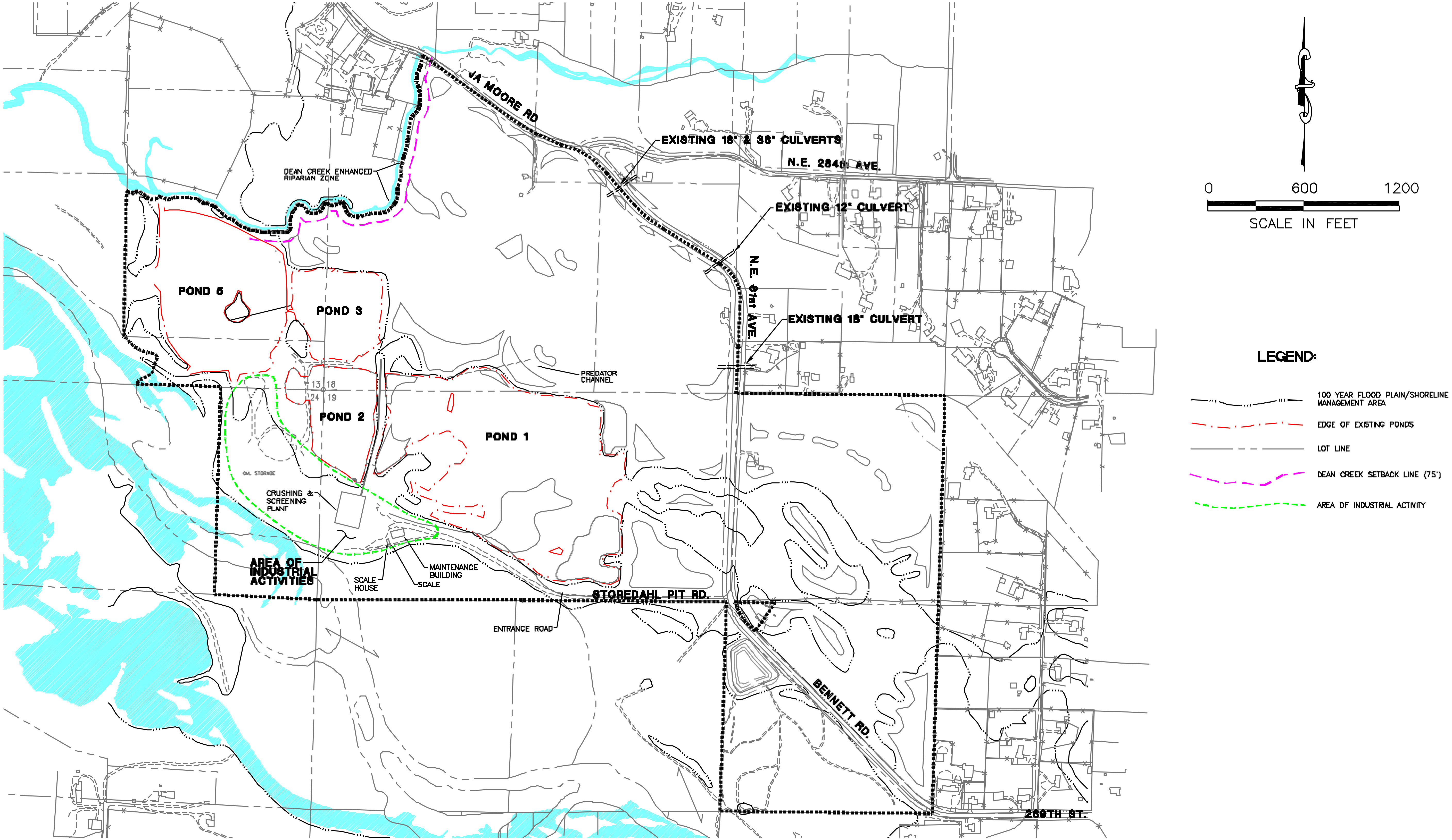

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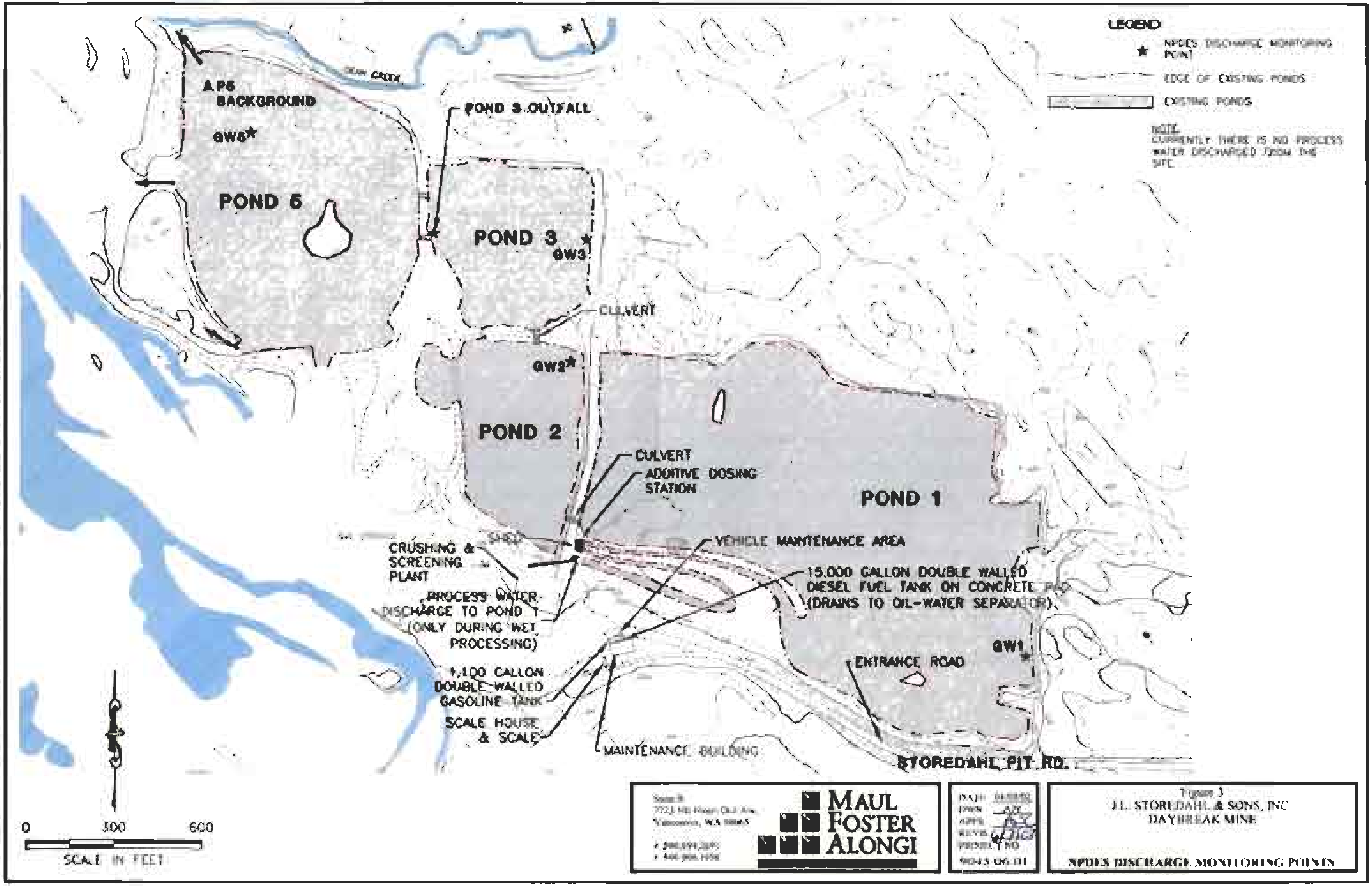
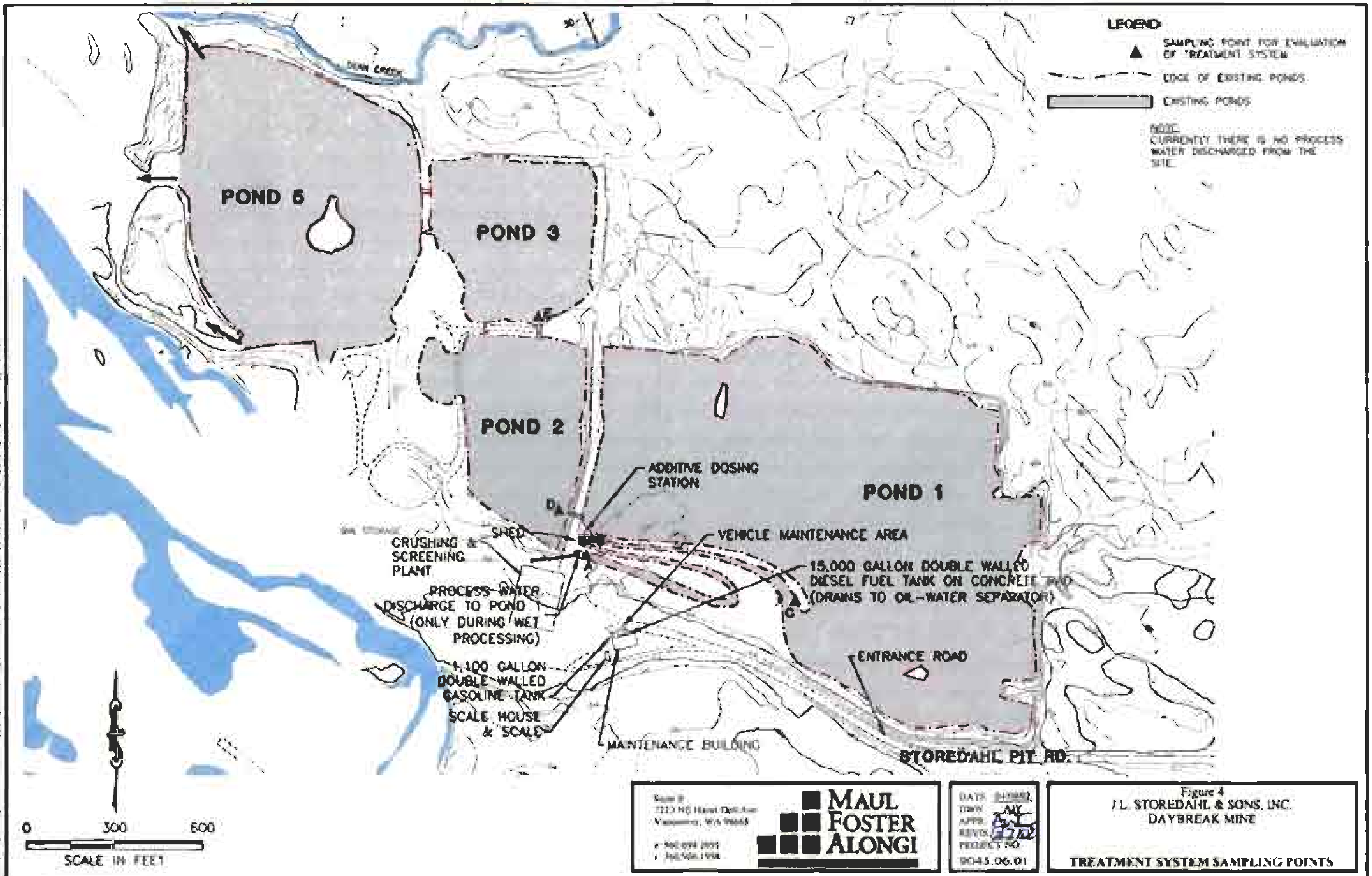
Figure 2
J.L. STOREDAHL & SONS, INC.
DAYBREAK MINE

SITE MAP

LAYOUT: 1



LEGEND
NPDES DISCHARGE MONITORING POINT
EDGE OF EXISTING PONDS
EXISTING PONDS
NOTE
CURRENTLY THERE IS NO PROCESS WATER DISCHARGED FROM THE SITE
AP6 BACKGROUND
GW5
POND 5
POND 3 OUTFALL
POND 3
GW3
CULVERT
GW2
POND 2
CULVERT
ADDITIVE DOSING STATION
POND 1
VEHICLE MAINTENANCE AREA
CRUSHING & SCREENING PLANT
15,000 GALLON DOUBLE WALLED DIESEL FUEL TANK ON CONCRETE PAD (DRAINS TO OIL-WATER SEPARATOR)
PROCESS WATER DISCHARGE TO POND 1 (ONLY DURING WET PROCESSING)
1,100 GALLON DOUBLE WALLED GASOLINE TANK
SCALE HOUSE & SCALE
MAINTENANCE BUILDING
ENTRANCE ROAD
GW1
STOREDAHL PIT RD.
0 300 600
SCALE IN FEET
MAUL FOSTER ALONGI
Figure 3
J.L. STOREDAHL & SONS, INC
DAYBREAK MINE
NPDES DISCHARGE MONITORING POINTS


LEGEND
SAMPLING POINT FOR EVALUATION OF TREATMENT SYSTEM
EDGE OF EXISTING PONDS
EXISTING PONDS
NOTE:
CURRENTLY THERE IS NO PROCESS WATER DISCHARGED FROM THE SITE.
POND 6
POND 3
POND 2
POND 1
ADDITIVE DOSING STATION
SHED
CRUSHING & SCREENING PLANT
VEHICLE MAINTENANCE AREA
15,000 GALLON DOUBLE WALLED DIESEL FUEL TANK ON CONCRETE PAD (DRAINS TO OIL-WATER SEPARATOR)
PROCESS WATER DISCHARGE TO POND 1 (ONLY DURING WET PROCESSING)
1,100 GALLON DOUBLE WALLED GASOLINE TANK
SCALE HOUSE & SCALE
MAINTENANCE BUILDING
ENTRANCE ROAD
STOREDAHL PIT RD.
0 300 600
SCALE IN FEET
MAUL FOSTER ALONGI
PROJECT NO
9045.06.01
Figure 4
J.L. STOREDAHL & SONS, INC.
DAYBREAK MINE
TREATMENT SYSTEM SAMPLING POINTS

APPENDIX A

WASHINGTON STATE DEPARTMENT OF ECOLOGY NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM AND STATE WASTE DISCHARGE GENERAL PERMIT

RECEIVED
JUL 31 2000
BY: CB

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

P.O. Box 47775 • Olympia, Washington 98504-7775 • (360) 407-6300

July 25, 2000

CERTIFIED MAIL

Mr. Kevin Storedahl
J.L. Storedahl & Sons
2253 Talley Way
Kelso, WA 98626-5510
Z 183 866 169

Dear Mr. Storedahl:

Re: Re-issuance of National Pollutant Discharge Elimination System (NPDES) Permit No. WAG-50-1359

The Department of Ecology (Ecology) received a timely application for renewal of your Sand and Gravel General Permit on February 11, 1999. As a result of that application, you have been authorized to continue your operation at the Daybreak site under the conditions of the original permit. In the interim period, since your application, many issues regarding your site operation have come under review by various federal and state agencies as well as local jurisdictions. Environmental review for your proposed expanded operation has not been completed and some additional land use questions are under review by the aforementioned agencies and jurisdictions. Ecology cannot issue a permit for activities which have not undergone appropriate environmental review. Therefore, Ecology's decision regarding this permit is to re-issue the permit with the original conditions in place.

At the time environmental review has been completed, should a significant change in the nature of the operation take place, we will require you to submit a new Application for Coverage. The application must adequately identify all activities, which are subject to permit conditions. Also, review and analysis of the application may result in the requirement for an individual permit. As you are well aware, the East Fork - Lewis River is an extremely important resource for many salmonid species, including Steelhead, Chum Salmon, Chinook Salmon, Coho Salmon, Sea-Run Cutthroat Trout, and Bull Trout. Other species of fish and the Oregon Spotted Frog are also species of concern.

If you have any questions regarding the determination my staff has made, please contact me at (360) 407-6271.

Sincerely,

For
Keli McKay
Southwest Region Manager
Water Quality Program

KM:SM:cg(1359)
Enclosure

cc: Karl Anuta, Sokol & Anuta
Alistair Clary, Maul, Foster, and Alongi
Tom Loranger, SEA Program, Ecology
Phil Miller, Salmon Recovery Team

Surface Mining and Associated Activities General Permit

Site Specific Fact Sheet

WAG 50-1359

Facility:
J L Storedahl & Sons - Daybreak Pit
Bennett Road & NE 61st Ave
La Center WA

Mailing Address:
J L Storedahl & Sons
2233 Talley Way
Kelso WA 98626-5510

County: Clark

WRIA: 27

Phone Number: (360) 636 2420
Contact Person: Kevin Storedahl

Latitude: 45° 49' 51"
Longitude: 122° 36' 32"

Status of Facility and Discharges

Process Water: 2 discharge points to ground water
1 discharge points to surface water

BMPs: Infiltration; detention; management BMPs; collection/routing; water recycling

Storm Water: 2 discharge points to ground water (comingle w/ process water)
1 discharge points to surface water (comingles w/ process water)

BMPs: Oil/ water separator; spill prevention; infiltration; detention; management BMPs; vegetation management; collection/routing; water recycling

SIC Codes for this site:	Quantity produced:
1429 - Crushed and Broken Stone	MG (rock imported from Tebo site)

Coverage date: July 25, 2000

Scott E. Morrison
Permit Manager
Sand and Gravel General Permit
Southwest Regional Office

PERMIT No. WAG-50-1359

Coverage Date: July 25, 2000
Issuance Date: June 25, 1999
Effective Date: August 6, 1999
Expiration Date: August 6, 2004

THE SAND AND GRAVEL GENERAL PERMIT

A NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM AND STATE WASTE DISCHARGE GENERAL PERMIT FOR PROCESS WATER, STORMWATER, AND MINE DEWATERING WATER DISCHARGES ASSOCIATED WITH SAND AND GRAVEL OPERATIONS, ROCK QUARRIES, AND SIMILAR MINING FACILITIES, INCLUDING STOCKPILES OF MINED MATERIALS, CONCRETE BATCH OPERATIONS AND HOT MIX ASPHALT OPERATIONS

State of Washington
DEPARTMENT OF ECOLOGY
Olympia, Washington

In compliance with the provisions of
The State of Washington Water Pollution Control Law
Chapter 90.48 Revised Code of Washington
and
The Federal Water Pollution Control Act
(The Clean Water Act)
Title 33 United States Code, Section 1251 et seq.

Until this permit expires, is modified or revoked, permittees that have properly obtained coverage under this general permit are authorized to discharge in accordance with the special and general conditions which follow.

Megan White

Megan White, P.E., Manager
Water Quality Program
Washington State Department of Ecology

TABLE OF CONTENTS

GENERAL CONDITIONS

SUMMARY OF PERMIT REPORT SUBMITTALS

Refer to the Special and General Conditions of this permit for additional submittal requirements.

Permit Section	Submittal	Frequency	First Submittal Date
S6.A	Discharge Monitoring Report	Quarterly	October 15, 1999
S6.E	Noncompliance Notification	As necessary	
G4.	Notification of Spill, Overflow, or Bypass	As necessary	
G6.	Permit Application for Coverage for Substantive Changes to the Discharge	As necessary	
G9.	Notice of Change in Activities	As necessary	
G17.	Notice of Permit Transfer	As necessary	
G18.	Application for permit renewal	1/permit cycle	February 3, 2004

SPECIAL CONDITIONS

S1. PERMIT COVERAGE

A. What Facility Activities Are Covered

This *general permit*[1] issued by the Department of Ecology (Ecology) will cover all new and existing facilities, *active sites* and *inactive sites* that:

1. Conduct activities designated by one or more of the following *Standard Industrial Classification (SIC)* codes (see Appendix A for a more complete description of activities covered):

   0811 Timber Tracts (sand and gravel point source activities)
   1411 Dimension Stone
   1422 Crushed and Broken Limestone
   1423 Crushed and Broken Granite
   1429 Crushed and Broken Stone, Not Elsewhere Classified
   1442 Construction Sand and Gravel
   1446 Industrial Sand
   1455 Kaolin and Ball Clay
   1459 Clay, Ceramic, and Refractory Minerals, Not Otherwise Classified
   1499 Miscellaneous Nonmetallic Minerals, Except Fuels
   2411 Logging (sand and gravel point source activities)
   2951 Asphalt Paving Mixtures and Blocks
   3273 Ready-Mixed Concrete

   In addition to the activities designated by the above SIC codes, related activities (e.g. SIC 3272 - Concrete Products, Except Concrete Blocks and Brick) may be considered for coverage under this general permit when Ecology determines that discharge characteristics are similar and the permit conditions satisfy applicable state and federal requirements.

2. Are owned or operated by private entities, state government or *local government*, or, if the discharge is to *ground water*, by the federal government, **and**

3. Have one or more of the following characteristics:

   a. Any facility that ditches, routes, collects, contains, or impounds *process water*, *mine dewatering water*, or *Type 3 stormwater*; or

---

[1] Definitions are provided in Appendix C for many of the terms used in this permit. The first occurrence of words with a definition will be in italics.

b. Any facility that discharges *stormwater*, mine dewatering water, or process water to *surface waters of the State*; or

c. Any facility that discharges to a municipal *storm sewer*; or

d. Any facility with a discharge to surface water or ground water that operates a concrete batch plant or a *hot mix asphalt plant* that uses a wet scrubber for air emissions control; or

e. Any facility located inside a designated *wellhead protection area*; or

f. Any *silvicultural point source.*

B. What Facility Activities Are Not Covered

The sand and gravel general permit only provides coverage for those activities that fall within the SIC codes listed in S1.A.1. above. No other activities that may result in a discharge to surface water or ground water or have the potential to contaminate stormwater are covered under this permit.

C. Who May Apply For Coverage

Any party that has the legal authority to manage a *site* under the terms and conditions of this permit may apply for coverage. This can include a site where the owner of site is not the operator for all activities at a site (see S2.E.) and where the facility is a portable operation (see S2.F.)

D. Facilities EXCLUDED From Coverage Under This Permit

1. *Ecology* will not provide coverage under this general permit for activities that fall under SIC codes listed in S1.A.1. above when:

a. The facility has a pit design that will intercept more than one aquifer; or

b. The facility discharges to a water body with control plans[1] that the general permit does not adequately address; or

c. Any facility that discharges to a water body listed pursuant to Section 303(d) of the Clean Water Act where the pollutant is present at levels of concern and the requirements of the permit are inadequate to provide sufficient reduction of the listed pollutant; or

d. Any facility that uses materials that are not *inert* for reclamation or backfill and also is not covered by a DNR reclamation permit; or

---

[1] Control plans may be total maximum daily load (TMDL) determinations, restrictions for the protection of endangered species, ground water management plans, or other legally binding limitations.

e. Any facility that conducts mining operations below the ordinary high water mark in a river or stream channel; or

f. Any facility that would impair adjacent water rights as a result of pit operations lowering the water table.

Any facility excluded from coverage under this condition shall apply to Ecology for an individual discharge permit unless the activity is regulated under permit requirements of another section of the Federal Clean Water Act.

2. Any facility covered under a *National Pollutant Discharge Elimination System (NPDES)* permit or state waste discharge individual permit that includes requirements for process water or stormwater management, treatment, or monitoring that are more stringent than the requirements in this general permit.

E. Change of Permit Status

Any facility that changes permit status from active to inactive, or inactive to active, shall notify Ecology in writing. Notification must be received by Ecology as follows: If the change is inactive to active, notice shall be given no less than ten (10) days before the change. If the change is active to inactive, notice shall be given no more than ten (10) days after the change. The letter shall be directed to the Water Quality Permit Coordinator at the regional office that issued the permit and shall contain the following information:

1. The permit number;

2. The name of the site owner and operator (if different);

3. The site location;

4. The Standard Industrial Classification Code(s) appropriate to the industrial activity at the site; and

5. If activating an inactive site, the amount and type of raw material or finished product to be produced.

F. Terminating Coverage

A permittee may request termination of coverage for a *closed site*. In addition to discontinuing all activities at the site, restoration of the site must be completed.

1. A mining site will be considered restored when DNR has completely released the reclamation bond or if not subject to DNR reclamation, the site has been reclaimed to the satisfaction of the Ecology permit manager.

2. Processing sites (includes concrete and asphalt batch operations) will be considered restored when processing equipment has been removed and the Ecology permit manager determines site conditions have been returned to a state appropriate for the location.

S2. COVERAGE REQUIREMENTS

A. How Do I Obtain Coverage Under the General Permit?

1. All facilities that had coverage under the previous sand and gravel general permit and who reapplied for coverage as required by General Condition G24. of that permit, continue coverage under this permit unless otherwise notified by Ecology. Their coverage date under this permit begins August 6, 1999.

2. All new facilities shall submit to Ecology a completed and signed Sand & Gravel General Permit *Application for Coverage*. The application for coverage shall be submitted no less than one hundred and eighty (180) days before beginning any activity that may result in the discharge of any *pollutant*. No discharge is authorized until the effective date of permit coverage as provided in Special Condition S2.E.

   a. Any facility (except as noted in b. below) is considered a new facility if not in operation before the effective date of the original sand and gravel general permit, August 6, 1994.

   b. Portable asphalt batch plants, portable concrete batch plants and portable rock crushing operations are considered new facilities if the portable unit was not in operation in Washington State before the effective date of this permit, August 6, 1999.

3. Any existing facilities that do not have permit coverage and are subject to the permit coverage provisions of S.1.A., shall submit to Ecology a completed and signed Sand & Gravel General Permit application for coverage. No discharge is authorized until the effective date of permit coverage as provided in Special Condition S2.E. Existing facilities are:

   a. Portable asphalt batch plants, portable concrete batch plants, and portable rock crushers that operated before the effective date of this permit, August 6, 1999.

   b. Any other facilities that were operating before August 6, 1994 and do not meet the requirements of S2.A.1. above.

4. Any facility with coverage under this general permit that intends to implement a significant process change[1] shall submit an application for coverage that reflects the proposed process change.

B. Do I Go Through Public Notice?

1. All existing facilities under S2.A.3. and all facilities that meet the requirements of S2.A.1. above (had coverage and reapplied for coverage in a timely fashion) do not require public notice unless they are planning a significant process change.

2. All new facilities and any existing facility planning a significant process change shall satisfy public notice requirements. Ecology will provide instructions for complying with public notice.

C. Is SEPA Required?

All new facilities and any existing facility planning a significant process change shall submit to Ecology, along with the application for coverage, proof that the facility has complied with *SEPA*.

D. Does Coverage Preempt Local Government Requirements?

The permittee shall comply with local government requirements. Where the permit and local government requirements overlap, the most restrictive requirements should be followed.

Facilities with stormwater discharge to a storm sewer operated by any of the following municipalities shall send a copy of their application for coverage to the appropriate *municipality*:

Seattle, King County, Snohomish County, Tacoma, Pierce County, Clark County.

E. When Does Coverage Under the General Permit Become Effective?

1. Unless Ecology notifies the applicant in writing to the contrary, coverage under this general permit will begin on the later of the following:

a. The thirty-first (31^{st}) day following receipt by Ecology of a completed application for coverage;

[1] Significant process change for this industry group will be any modification of the facility that would change the characteristics of the discharge or include for coverage a new activity (SIC) that was not previously covered.

b. The thirty-first (31st) day following the end of a thirty (30) day public comment period; or

c. The effective date of the general permit.

2. If the application is incomplete, an appeal or public comments has been filed, or more information is necessary to determine whether a facility requires coverage under the general permit, additional time may be required to review the application. When additional time is required:

   a. Ecology will notify the applicant in writing and identify the issues that must be resolved before a decision can be reached.

   b. Ecology will submit the final decision to the applicant in writing. If the application for coverage is approved, coverage begins the thirty-first (31st) day following approval.

3. If the applicant has an individual permit but applies for coverage under the general permit, the individual permit will remain in effect until terminated in writing by Ecology. However, an expired individual permit, pursuant to WAC 173-220-180(5), will terminate upon coverage by the general permit.

F. When Site Permittee Is Different From Operator of Industrial Activity

A permittee may include in the application for coverage, activities that are, or could be performed by an operator(s) other than the permittee. These activities may be ongoing or intermittent. As the permit holder, the site permittee is responsible for compliance with all conditions of the permit. Except when the activity will be conducted by a portable facility with permit coverage (see S2.G. below), the site permittee shall notify Ecology when an activity changes from inactive to active and active to inactive.

1. The site permittee shall notify Ecology according to the requirements listed in Special Condition S1.E., Change of Permit Status.

2. The site permittee will inform the operator of all permit conditions that are applicable to the operation and assure that the activity complies with these conditions.

G. Portable Facilities

An owner and/or operator of a portable concrete batch plant, portable asphalt batch plant, or portable rock crusher may apply for coverage under this general permit for the portable facility. Coverage will apply only to the specific portable facility identified in the application for coverage. Permit coverage is provided for the portable facility at sites throughout the state subject to the following requirements:

1. Coverage of the portable facility at a site is for a limited time, not to exceed one (1) year. However, when related to a specific project, one six-month extension may be requested. The request must be submitted to Ecology in writing, at least 30 days before the facility will exceed one year at a site and explain why a six-month extension is warranted.

2. Ecology shall receive written notification no less than ten (10) days before beginning each operation. The letter shall be sent to the Water Quality Permit Coordinator at the regional office appropriate for the site at which the operation will be located. Notification on a form approved by Ecology, shall include:

   a. The permit number;

   b. The name of the site owner and operator;

   c. The site location;

   d. The approximate date that the operation will begin and end at this site

   e. A site evaluation demonstrating ability to comply with permit conditions and documentation that applicable SEPA, air quality, and local government requirements have been satisfied; and

   f. A brief description of the actions that will be taken to restore the site after the operation has been completed.

3. For each site where it operates, a portable rock crushing operation shall also comply with one of the following:

   a. Provide Ecology with documentation that there is no mining or other activity at the site subject to coverage under this permit, or

   b. Provide Ecology with documentation that the site has coverage, or

   c. Notify Ecology and the land owner in writing that the site appears to require coverage under the sand and gravel general permit, or

   d. When operation of the portable is completed, return overburden, reseed, and stabilize the site to minimize soil *erosion* and encourage natural vegetation.

S3. DISCHARGE LIMITATIONS

A. All Discharges to Surface Water

Beginning on the effective date of this permit and lasting through its expiration date, the Permittee is authorized to discharge process water, mine dewatering water, and stormwater to surface waters of the State at the permitted location subject to the following limitations (see Appendix B - Monitoring Requirements Matrix):

1. The following operations are not allowed to discharge process water to surface waters of the State:

   SIC 2951, Asphalt batch plants
   SIC 1411, Dimension Stone
   SIC 1455, Kaolin and Ball Clay
   SIC 1459, Clay, Ceramic, & Refractory Mineral Not Elsewhere Classified
   SIC 1499, Miscellaneous Nonmetallic Minerals, Except Fuels

2. For industrial sand facilities, SIC 1446, process water and mine dewatering water discharges to surface water shall not exceed the following limits:

Process/Mine Dewatering Water	Discharge Limits	
	Average Monthly[a]	Maximum Daily[b]
Total Suspended Solids (TSS)	25 mg/liter	45 mg/liter
Turbidity	50 *NTU*	50 NTU
	Discharge Limits	
	Minimum	Maximum
pH	6.0	9.0

[a]the average monthly effluent limitation is defined as the highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month (e.g. measurements of 20, 33, and 10 would be: 63 ÷ 3 = 21).

[b]the maximum daily effluent limitation is defined as the highest allowable daily discharge.

3. For the following operations: SIC 0811 (Timber Tracts), SIC 1422 (Crushed and Broken Limestone), SIC 1423 (Crushed and Broken Granite), SIC 1429 Crushed and Broken Stone, Not Elsewhere Classified), SIC 1442 (Construction Sand and Gravel, SIC 2411 (Logging), and SIC 3273 (Ready-Mixed Concrete); process water and mine dewatering water discharges to surface water shall not exceed the following limitations:

Process/Mine Dewatering Water	Discharge Limits	
Parameter	**Average Monthly[a]**	**Maximum Daily[b]**
Total Suspended Solids	40 mg/liter	80 mg/liter
Turbidity	50 *NTU*	50 NTU
	Discharge Limits	
	Minimum	**Maximum**
pH	6.0	9.0
[a]The average monthly effluent limitation is defined as the highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.		
[b]The maximum daily effluent limitation is defined as the highest allowable daily discharge.		

4. All facilities covered under this permit that discharge stormwater to surface water shall not exceed the following limitations:

Stormwater	Discharge Limits	
Parameter	**Average Monthly[a]**	**Maximum Daily[b]**
Turbidity	50 NTU	50 NTU
	Discharge Limits	
	Minimum	**Maximum**
pH	6.0	9.0
[a]The average monthly effluent limitation is defined as the highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.		
[b]The maximum daily effluent limitation is defined as the highest allowable daily discharge.		

5. If a facility is not able to meet state water quality standards based on the characteristics of their discharge, the available dilution, and the background turbidity in the receiving water as determined by the receiving water study of condition S4.C., coverage under this general permit will be revoked and an individual NPDES permit will be required.

6. Discharges shall not cause a visible change in turbidity or color; or cause a visible oil sheen in the receiving water.

7. The mixing zone allowed in this general permit will be no larger than the maximum allowed in Chapter 173-201A WAC.

B. All Discharges to Ground Water

1. Beginning on the effective date of this permit and lasting through its expiration date, the Permittee is authorized to discharge process water, mine dewatering water, and stormwater to ground waters of the State subject to the following limitations:

Process Water, Mine Dewatering Water and Stormwater	**Discharge Limits**	
	Minimum	**Maximum**
pH	6.5	8.5

2. There shall be no visible oil sheen at any points of *discharge to ground water.*

C. Discharge To Sanitary Sewers

Discharge of stormwater to *sanitary sewers* is prohibited pursuant to WAC 173-216-060(b)(vii).

S4. DISCHARGE MONITORING

A. All Authorized Discharges to Surface Water

1. Except as noted in S4.E. below all authorized discharges of process water, mine dewatering water, and stormwater that discharge to surface water, including those that discharge to a storm sewer that discharges to surface water, shall be monitored according to the following schedule:

Category	Parameter	Units	Minimum Sampling Frequency	Sample Type
Process, dewatering, and stormwater	Turbidity	NTU	Twice monthly[1]	Grab
" "	pH	Standard Units	Monthly	Measurement
" "	Temperature	° Fahrenheit	Weekly[2]	Measurement
Process and dewatering water	TSS	mg/l	Quarterly	Grab

[1]There must be at least 24 hours between sampling.

[2]During the months of July, August, and September

2. The following additional monitoring schedule applies to SIC Code 3273 Ready-Mixed Concrete:

Category	Parameter	Units	Minimum Sampling Frequency	Sample Type
Process water	TDS	mg/l	Monthly	Grab

3. Sampling shall be conducted as close to the point where the discharge comes into contact with the receiving water as is reasonably achievable.

4. The Permittee shall conduct a visual inspection of the point of discharge to a receiving water at least monthly when discharges occur. The date of the inspection and any visible change in turbidity or color in the receiving water caused by the discharge shall be recorded and filed with the Permittee's monitoring plan.

5. Facilities may receive a reduction in the frequency of monitoring for turbidity subject to the following conditions:

   a. The facility has demonstrated continuous compliance with permit terms and conditions for a period of 18 or more consecutive months;

   b. The facility submits a written request for reduced monitoring to Ecology;

   c. A review of the facility's site conditions and turbidity data by Ecology support the likelihood of continued compliance; and

   d. Ecology submits written approval to the facility.

   Upon receipt of written approval from Ecology, monitoring will be reduced from twice monthly to four times annually. The sampling and reporting schedule for reduced monitoring will accompany written approval. Ecology may restore twice monthly monitoring when a facility implements a significant process change or there is a violation of the turbidity limit.

6. In addition to other enforcement mechanisms available to Ecology to secure compliance, the monitoring frequency for turbidity may be increased for facilities which have demonstrated two or more violations of the turbidity limit in any three month period, or there is evidence to indicate the discharge has a reasonable potential to exceed water quality standards. Any increased monitoring requirements beyond the twice monthly monitoring required in this permit will be imposed through the issuance of an Administrative Order[1] issued to an individual facility by Ecology.

B. <u>All Discharges to Ground Water</u>

1. Except as noted in S4.E. below, the permittee is required to provide *representative sampling* of all discharges to ground. Representative sampling shall include all discharges of process water and mine dewatering water to unlined ponds, infiltration trenches, or land. Representative sampling of type 3 stormwater requires sufficient sample sites to represent differences in the characteristics between places where stormwater collects.

Category	Parameter	Units	Minimum Sampling Frequency	Sample Type
Process water	pH	Standard Units	Monthly	Grab
Stormwater	pH	Standard Units	Quarterly	Grab

2. The following additional monitoring schedule applies to SIC Code 3273 Ready-Mixed Concrete and to SIC Code 2951 Asphalt Paving when there is a process water discharge:

Category	Parameter	Units	Minimum Sampling Frequency	Sample Type
Process water	TDS	mg/l	Monthly	Grab

C. <u>Receiving Water Study</u>

If Ecology determines that the facility's surface water discharge may be causing a violation of state surface water quality standards, Ecology will require a receiving water study to evaluate the receiving water body characteristics and available

[1] Ecology's determination to issue an Order to increase monitoring frequency is an appealable action under RCW 43.21B.310.

dilution. The requirement for a receiving water study will be made on a case-by-case basis and will be imposed through the issuance of an Administrative Order[1].

D. Ground Water Impact Study

Facilities that typically exceed 500 mg/l *total dissolved solids (TDS)* in a discharge to ground water may be required to conduct a ground water impact study. The study would be conducted in accordance with the implementation guidance for the ground water quality standards (Ecology publication #96-02) and would consider the point of compliance, the quantity of discharge, and the vulnerability of ground water. The requirement for the study will be made on a case-by-case basis and will be imposed through the issuance of an Administrative Order[2].

E. Stormwater Discharges at Inactive Sites

Monitoring for compliance with stormwater discharge limits is not required for the following operations during the time they are inactive and they have notified Ecology in writing that the site is inactive. They are still subject to the discharge limits for stormwater and shall maintain control measures necessary to assure compliance.

SIC Code 0811 Timber Tracts
SIC Code 1422 Crushed and Broken Limestone
SIC Code 1423 Crushed and Broken Granite
SIC Code 1429 Crushed and Broken Stone, Not Elsewhere Classified
SIC Code 1442 Construction Sand and Gravel
SIC Code 1446 Industrial Sand
SIC Code 2411 Logging
SIC Code 1411 Dimension Stone
SIC Code 1455 Kaolin and Ball Clay
SIC Code 1459 Clay, Ceramic, and Refractory Minerals, Not Elsewhere Classified
SIC Code 1499 Miscellaneous Nonmetallic Minerals, Except Fuels

F. Monitoring for Oil Sheen

All places at an active site where water collects shall be monitored visually for oil sheen. When water is present, monitoring should be each day of operation for most locations on site and never less than monthly. If a sheen is present, cleanup shall occur and the incident documented, identifying the probable source of petroleum and actions taken to prevent further petroleum contamination. Documentation shall be kept with the monitoring plan.

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[1] Ecology's determination to issue an Order to conduct a receiving water study is an appealable action under RCW 43.21B.310.
[2] Ecology's determination to issue an Order to conduct a ground water impact study is an appealable action under RCW 43.21B.310.

G. Sampling and Analytical Procedures

Samples and measurements taken to meet the requirements of this permit shall be representative of the volume and nature of the monitored parameters, including representative sampling of any unusual discharge or discharge condition, including *bypasses*, upsets and maintenance-related conditions affecting effluent quality.

Sampling and analytical methods used to meet the water and wastewater monitoring requirements specified in this permit shall conform to the latest revision of the *Guidelines Establishing Test Procedures for the Analysis of Pollutants* contained in *40 CFR* Part 136 or to the latest revision of *Standard Methods for the Examination of Water and Wastewater* (APHA), unless otherwise specified in this permit or approved in writing by the Department of Ecology.

H. Laboratory Accreditation

All monitoring data required by Ecology shall be prepared by a laboratory registered or accredited under the provisions of, *Accreditation of Environmental Laboratories*, Chapter 173-50 WAC. Flow, temperature, settleable solids, conductivity, pH, and internal process control parameters are exempt from this requirement. When an accredited laboratory prepares the conductivity and pH data, the laboratory shall be accredited for conductivity and pH. Crops, soils and hazardous waste data are exempted from this requirement pending accreditation of laboratories for analysis of these media by Ecology.

S5. MONITORING PLAN

Permittees shall maintain and comply with a monitoring plan developed for active sites in accordance with the monitoring requirements of Special Condition S4. and the requirements of this Special Condition.

A. Monitoring Plan Requirements

The monitoring plan will identify the required parameters for monitoring, the frequency of sampling, the location(s) for sampling, and the procedures for sampling.

1. The plan will list all the industrial activities at the site.

2. The permittee will review the monitoring requirements of Special Condition S4. and identify in the plan those parameters that require monitoring and the frequency of monitoring.

    a. Where a discharge combines two or more industrial activities and each activity requires the same monitoring parameter and frequency, only one sample and analysis for that parameter will be required.

b. No sampling is required of water held in a lined impoundment that is designed, constructed, and maintained in accordance with Special Condition S7.B. Any discharges from a lined impoundment to *waters of the state* must be sampled in accordance with the monitoring plan.

3. The plan will identify the location of all sampling points, the types (e.g. process water, mine dewatering water, stormwater) of discharge that occur at each point and whether the discharge is to surface water or ground water. The plan shall identify enough sample points to provide representative sampling of all *point source* discharges to surface water or ground water.

4. The plan will assign a unique label (e.g. name or number) to the sampling points and the permittee will use these location names when reporting monitoring results to Ecology. If facility conditions require the addition or deletion of a sampling point, the permittee will inform Ecology of the addition/deletion when filing a monitoring report that contains the new information.

5. The plan will list the standard procedures used at the facility for collecting samples for laboratory analysis.

a. The *USEPA* NPDES Stormwater Sampling Guidance Document (EPA 833-B-92-001, July 1992), or equivalent sampling methods, will be used as guidance for both stormwater, mine dewatering water, and process water sampling procedures.

b. Samples taken to meet the requirements of this general permit shall be collected during the facility's normal working hours and while processing is at normal levels, except as may be necessary to capture a representative sample of a stormwater event.

B. <u>Maintaining Monitoring Plan</u>

1. The permittee(s) will retain the monitoring plan on-site or within reasonable access to the site and make it immediately available upon request by Ecology. The monitoring plan and all of its modifications shall be signed in accordance with General Condition G20.

2. The monitoring plan shall be updated as necessary to adequately represent facility changes. The plan will be reviewed on no less than an annual basis. Employees will receive training on what is included in the plan and how facility activities relate to monitoring requirements.

S6. REPORTING AND RECORDKEEPING REQUIREMENTS

The Permittee shall monitor and report in accordance with the following conditions. The falsification of information submitted to Ecology shall constitute a violation of the terms and conditions of this permit.

A. Reporting

Discharge Monitoring Report forms shall be submitted quarterly for all active sites whether or not the facility was discharging. If there was no discharge or the facility was not operating during a given monitoring period, submit the form as required with the words "no discharge" entered in place of the monitoring results.

The first monitoring period begins on the effective date of the permit. Monitoring results obtained during the previous three (3) months shall be reported on the quarterly reporting forms as provided, or otherwise approved, by Ecology. The reports shall be sent to the Water Quality Permit Coordinator at the Department of Ecology regional office that issued coverage under this general permit. Reports shall be received by Ecology on or by January 15 (October, November, December), April 15 (January, February, March), July 15 (April, May, June), and October 15 (July, August, September), for each reporting period or partial reporting period of coverage under this general permit.

B. Records Retention

The Permittee shall retain records of all monitoring information for a minimum of three years. Such information shall include all calibration and maintenance records and all original recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit. This period of retention shall be extended during the course of any unresolved litigation regarding the discharge of pollutants by the Permittee or when requested by the *Director*.

C. Recording of Results

For each measurement or sample taken, the Permittee shall record the following information: (1) the date, exact place, method, and time of sampling; (2) the individual who performed the sampling or measurement; (3) the dates the analyses were performed; (4) who performed the analyses; (5) the analytical techniques or methods used; and (6) the results of all analyses.

D. Additional Monitoring by the Permittee

If the Permittee monitors any pollutant more frequently than required by this permit using test procedures specified by Condition S4. of this permit, then the results of this monitoring shall be included in the calculation and reporting of the data submitted in the Permittee's self-monitoring reports.

E. Noncompliance Notification

In the event the Permittee is unable to comply with any of the permit terms and conditions due to any cause, the Permittee shall:

1. Immediately take action to stop, contain, and cleanup unauthorized discharges or otherwise stop the violation, correct the problem and, if applicable, repeat sampling and analysis of any violation immediately;

2. Immediately notify Ecology of the failure to comply; and

3. Submit a detailed written report to the Ecology within thirty days (5 days for upsets and bypasses), unless requested earlier by the Ecology. The report should describe the nature of the violation, corrective action taken and/or planned, steps to be taken to prevent a recurrence, results of the resampling, and any other pertinent information. Data from resampling shall not be substituted for ongoing permit monitoring required under Special Condition S4 and shall not be reported on the discharge monitoring report form (DMR).

Compliance with these requirements does not relieve the Permittee from responsibility to maintain continuous compliance with the terms and conditions of this permit or the resulting liability for failure to comply.

S7. DISCHARGE WATER MANAGEMENT

A. Most Stringent Limits Apply

The limits on discharge water are stated in Special Condition S3. If the discharges from two or more industrial activities are combined, the most stringent limits will apply.

B. Lined Impoundment Required

This permit prohibits the direct discharge of process water from concrete batch plants (SIC 3273) and asphalt batch plants (SIC 2951), including any wastewater from truck washout areas, except to a lined impoundment. The lined impoundment shall have adequate structural load-bearing design to support any mechanical method used for sludge removal and shall be maintained to prevent any discharge to ground. After treatment the wastewater may be discharged subject to the limits of S3. At a minimum, the impoundment shall be constructed of:

1. Synthetic or flexible membrane material not less than 30 mils thick that shall not react with the discharge; or

2. Concrete with a minimum thickness of 6 inches; or

3. Asphalt with a minimum thickness of 6 inches; or

4. Steel-walled containment tank; or

5. Any other impoundment structure or technique approved by Ecology to meet the intention of this section.

C. Impoundment Hydraulic Loading Capacity

Any impoundment shall have adequate hydraulic loading capacity to provide treatment of wastewater for all conditions except when all known available and reasonable methods of prevention control and treatment have been applied to the wastewater and precipitation exceeds the *design storm*.

D. Maintenance Shop Zero Discharge

No wastewater shall be discharged to surface water or ground water from a maintenance shop unless the permittee requests and Ecology grants an exception. An exception will only be considered if it is from existing equipment, a discharge to sanitary sewer is not available, treatment before discharge is provided, and the discharge will comply with applicable surface water quality standards and ground water quality standards.

E. Mined Pit Pond

A permittee is not required to comply with suspended solid limits and turbidity limits when discharging to a mined pit pond if the addition of suspended solids is consistent with the goals of the reclamation plan for that site. When pit reclamation is complete, any discharge to the pit pond shall fully comply with surface water quality standards.

F. Use of Discharge Treatment Additives

The Permittee shall document the use of any additives in the treatment of discharge water. Documentation shall identify the additives used, their commercial source, the material safety data sheet, and the appropriate application rate. The Permittee shall retain this information on-site or within reasonable access to the site and make it immediately available, upon request, to Ecology.

Additives to enhance solids settling before discharge to surface water must be applied according to the manufacturer's recommended dose. In addition, only additives of low toxicity to aquatic organisms, an LC_{50} equal to or greater than 100 mg/l, shall be used. The use of additives to enhance settling before discharge to surface water will not be allowed if the toxicity to aquatic organisms is not known.

G. Soil Stabilization Polymers

Polymers may only be applied to soils at the site for soil stabilization if stormwater from the application area is captured and treated by a stormwater detention pond.

The Permittee shall keep a record of the polymer used, the commercial source, the material safety data sheet, and the application rate. The Permittee shall retain this information with their stormwater management plan. In addition, only polymers of low toxicity to aquatic organisms, an LC_{50} equal to or greater than 100 mg/L, will be allowed. The use of polymers for soil stabilization shall not be allowed if the toxicity to aquatic organisms is not known.

H. Ligninsulfonate Use Prohibited

Any facility requiring dust suppression shall not utilize ligninsulfonate in excavated areas.

I. Physical Coverage of Toxic Materials

Any facility that stores or uses toxic materials, petroleum contaminated soils (PCS) that fail to meet the most protective MTCA Method 'A' treatment levels (WAC 173-340-740(2)), chemicals, cement, admixtures, fuels, lubricants, asphalt concrete that has not been used for construction, tar, or other petroleum products shall provide physical coverage and containment for such materials.

J. Conveyance BMPs

Any diversion ditch or channel, or other BMP constructed at the site for routing of process water or stormwater shall be designed, constructed, and maintained to contain all flows except when precipitation exceeds the design storm.

K. Asphalt/Concrete Stormwater Control

No type 3 stormwater shall be discharged from a hot mix asphalt plant, a concrete batch plant, asphalt release agent application area, or concrete truck washout area into a pit or excavation that penetrates the water table.

S8. OPERATION AND MAINTENANCE

The Permittee shall at all times be responsible for the proper operation and maintenance of any facilities or systems of control installed to achieve compliance with the terms and conditions of the permit.

A. Lined Impoundment Inspections

The structural integrity of a lined impoundment shall be inspected whenever sludge removal occurs. Necessary repairs shall be made before refilling.

B. Unauthorized Use of Site

The permittee shall maintain inactive sites to prevent misuse of the site during the inactive state. The permittee shall manage the site to prevent such activities as illegal dumping, spilling, or other misuse of the site. Site management may include but is not limited to, visual inspections, signage, and physical security measures.

S9. STORMWATER POLLUTION PREVENTION PLAN

Permittees shall prepare, maintain, and comply with their *stormwater pollution prevention plan (SWPPP).* The SWPPP shall document the *best management practices* (BMPs), location of structures and drainages, personnel training, and inspection procedures for the control of Type 3 stormwater. *Capital improvements* will be in place as necessary to comply with the conditions of this permit.

A. General Requirements

The permittee(s) shall retain the SWPPP on-site or within reasonable access to the site and make it immediately available, upon request, to Ecology. If discharge is to a municipal storm sewer system, the municipal operator of the storm sewer system will also have access to the SWPPP. The responsible party as identified in General Condition G20., Signatory Requirements, shall sign the SWPPP and all of its modifications.

1. The SWPPP shall include measures to prevent the addition of process water or mine dewatering water into type 3 stormwater and to verify that non-stormwater discharges do not enter the stormwater treatment system. Stormwater that commingles with process water is considered process water and subject to the requirements for process water.

2. Modifications

   a. The permittee shall review and update the SWPPP whenever there is a failure to comply with stormwater discharge limits. Changes shall be implemented to address future compliance with the discharge limits.

   b Ecology may require a modification of the SWPPP if it does not comply with the minimum requirements of this section. Within 30 days of such notice, the permittee shall modify the SWPPP and submit to Ecology a schedule for implementing the modification(s).

   c. The permittee shall modify the SWPPP whenever there is a change in design, construction, operation, or maintenance at the site that necessitates a change to maintain control of stormwater. Implementation of the SWPPP revision(s) shall occur in a timely fashion.

d. The permittee shall modify the SWPPP as necessary to correct for any observed inadequacies in the description of potential pollutant sources or the *pollution* prevention measures and controls identified in the SWPPP. The SWPPP shall be revised to reflect the observed inadequacies within two weeks of their identification. Implementation of the SWPPP revision(s) shall occur in a timely fashion.

3. The Permittee may include in the SWPPP by reference, applicable portions of plans prepared for other purposes. The referenced plans shall be available on-site or within reasonable access to the site and become enforceable requirements of the SWPPP. (A Pollution Prevention Plan prepared under the Hazardous Waste Reduction Act, Chapter 70.95C RCW, is an example of such a plan.)

B. SWPPP Contents and Requirements

The SWPPP shall contain, at a minimum, the following:

1. Site Map

The site map will locate and document the stormwater drainage and discharge.structures, an outline of the stormwater drainage areas for each stormwater discharge point (including discharges to ground water). The site map shall also identify nearby and onsite surface water bodies and any known underlying aquifers.

The site map shall also identify all areas associated with industrial activities including, but not limited to, the following:

a. Loading and unloading of dry bulk materials or liquids,
b. Outdoor storage of materials or products,
c. Outdoor processing,
d. Processes that generate dust and particles,
e. Roofs or other surfaces exposed to air emissions from a process area,
f. On-site waste treatment, storage, or disposal,
g. Vehicle and equipment maintenance and/or cleaning.
h. Paved areas and buildings
i. Underground storage of materials or products

Lands adjacent to the site shall also be depicted where helpful in identifying discharge points or drainage routes.

2. Inventory of Materials

The inventory of materials will list all of the types of materials handled at the site (for example: cement and cement admixtures, petroleum products, gravel piles, recycle storage) that can be exposed to precipitation or run-off.

3. Operational BMPs

The SWPPP shall include site operation BMPs that reduce the potential for the discharge of ***significant amounts*** of pollutants. At a minimum these BMPs will include:

a. Pollution Prevention Team: The Permittee will identify specific individuals and their positions within the organization who are responsible for developing the SWPPP and assisting the responsible official in its implementation, maintenance, and modification. The activities and responsibilities of the team should address all aspects of the facility's SWPPP.

b. Good Housekeeping: The permittee will conduct ongoing maintenance and cleanup, as appropriate, of areas that may contribute pollutants to stormwater discharges. The SWPPP will document cleaning and maintenance schedules.

c. Preventive Maintenance: The permittee will inspect and maintain the stormwater drainage and treatment systems and the equipment and systems that could fail, resulting in contamination of stormwater.

d. Employee Training: The permittee will provide annual training of employees on the SWPPP that emphasizes spill response, good housekeeping, and material management practices.

e. Inspection and Recordkeeping: The Permittee will identify plant personnel who will inspect designated equipment and plant areas as required in Special Condition S11. The Permittee shall also provide a tracking or follow-up procedure to ensure that appropriate action has been taken in response to the inspection. There will be documentation of inspection reporting and recordkeeping procedures and schedules as required in Special Condition S11. and S6. of this permit.

4. Source Control BMPs

The SWPPP shall include *source control BMPs* that prevent the pollution of stormwater. For the industrial activities listed below, the permittee shall implement the BMPs described in Volume IV of Ecology's *Stormwater Management Manual* (SWMM) for the *Puget Sound Basin*, or equivalent

BMPs. For industrial activities not listed below, such as release agent application at asphalt batch plants, BMPs that prevent the pollution of stormwater shall be employed.

a. Fueling Stations - SWMM BMP S1.10[1]
b. Vehicle/Equipment Washing and Steam Cleaning - SWMM BMP S1.20
c. Loading and Unloading Liquid Materials - SWMM BMP S1.30
d. Liquid Storage in Above-Ground Tanks - SWMM BMP S1.40
e. Container Storage of Liquids, Food Wastes or Dangerous Wastes - SWMM BMP S1.50
f. Outside Storage of Raw Materials, By-Products or Finished Products - SWMM BMP S1.60

Consistent with RCW 46.61.655(4), vehicles shall be cleaned of mud, rock, and other material before entering a paved public highway so that tracking onto the highway does not occur.

5. Treatment BMPs

The SWPPP shall include *treatment BMPs* as necessary to achieve compliance with the stormwater discharge limits. Treatment BMPs may include but are not limited to: oil/water separators, biofiltration, infiltration basins, detention facilities, and *constructed wetlands*.

It is the Permittee's responsibility to identify and comply with any construction requirements. Implementation of structural BMPs may require the Permittee to comply with additional requirements (e.g. county permit or US Army Corps of Engineers' regulations). Impoundment structures of 10 acre-feet or more of water above natural ground must comply with the Dam Safety Regulations, Chapters 173-175 WAC.

6. Innovative BMPs

Innovative treatment, source control, reduction or recycling, or operational BMPs beyond those identified in Ecology's SWMM are encouraged if they help achieve the objectives listed in this Special Condition.

S10. EROSION AND SEDIMENT CONTROL PLAN

Permittees of active sites and inactive sites shall prepare, maintain, and comply with an *erosion and sediment control plan (ESCP)* for *Type 2 stormwater*. The ESCP shall identify the *erosion and sediment control BMPs*, including *stabilization* and structural practices, implemented to minimize erosion and the transport of *sediment*s during the operation of

[1] SWMM BMP S1.10 does not address mobile fueling. BMPs must be established for mobile fueling to prevent pollution of storm water for this activity.

the facility. The permittee is responsible for ensuring the coordination of the ESCP with any other site activities that regulate maintenance of the site (e.g. reclamation plans).

A. General Requirements

1. Compliance with local or state requirements

This general permit does not relieve the permittee of compliance with any more stringent requirements of local agencies or other state agencies with jurisdiction.

2. Retention and Availability

The permittee shall retain the ESCP, inspection reports, and all other reports required by this Special Condition for at least three years after the date of *final stabilization* of the site. The permittee shall make these documents available immediately upon request to Ecology and to local agencies or other state agencies that have jurisdiction. The ESCP and all of its modifications shall be signed in accordance with General Condition G20.

B. ESCP Contents and Requirements

1. Stabilization Practices

The ESCP shall include a description of stabilization BMPs, including site-specific scheduling of implementation of the practices. Stabilization practices may include: temporary seeding, permanent seeding, mulching, geotextiles, sod stabilization, vegetative buffer strips, protection of trees, preservation of mature vegetation, decreasing slope angles or lengths, and other appropriate measures. Stabilization measures shall be initiated as soon as practicable in portions of the site where mining activities have temporarily or permanently ceased. The plan shall ensure that the following requirements are satisfied:

a. All soils shall be stabilized by suitable and timely application of BMPs.

b. Existing vegetation should be preserved where feasible. In the field, areas that are not to be disturbed shall be permanently marked; these include setbacks, sensitive/critical areas and their buffers, trees, and drainage courses.

c. Cut slopes and fill slopes shall be designed and constructed in a manner that will minimize erosion.

d. Stabilization adequate to prevent erosion of outlets and adjacent stream banks shall be provided at the outlets of all conveyance systems.

2. Structural Practices

In addition to stabilization practices, the ESCP shall include a description of structural BMPs to divert flows from exposed soils, store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Such practices may include silt fences, earth dikes, drainage swales, sediment traps, check dams, subsurface drains, pipe slope drains, level spreaders, storm drain inlet protection, rock outlet protection, reinforced soil retaining systems, gabions, and sediment basins. The installation of these devices may be subject to Section 404 of the Federal *Clean Water Act*. The plan shall ensure that the following requirements are satisfied:

a. Properties adjacent to the project site shall be protected from sediment deposition caused by activities at the site.

b. Sediment ponds and traps, perimeter dikes, sediment barriers, and other BMPs intended to trap sediment on-site shall be constructed as a first step. These BMPs shall be functional before land is disturbed. Slopes of earthen structures used for sediment control such as dams, dikes, and diversions shall be stabilized immediately after construction.

c. Any BMP constructed at an active site should be designed to maintain separation of Type 2 stormwater from Type 3 stormwater and *Type 1 stormwater* for the peak flow from the design storm. If any commingling of Type 1, Type 2, or Type 3 stormwater occurs, the most restrictive requirements shall be met.

Implementation of structural BMPs may require the Permittee to comply with additional requirements (e.g. county permit or US Army Corps of Engineers' regulations). Impoundment structures of 10 acre-feet or more of water above natural ground must comply with the Dam Safety Regulations, Chapters 173-175 WAC. It is the Permittee's responsibility to identify and comply with any construction requirements.

3. Selection of Stabilization and Structural BMPs

Permittees shall select from BMPs described in Volume II of Ecology's SWMM, adapted as necessary for local conditions, or other equivalent and appropriate BMPs.

4. Maintenance

All structural and stabilization practices shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function.

5. Inspections

For active sites, all on-site erosion and sediment control measures shall be inspected at least once every seven days, and within 24 hours after any storm event of greater than 0.5 inches of rain per 24 hour period. A file containing a log of observations shall be maintained.

For inactive sites, a Registered Professional Engineer or equivalent (e.g. Certified Professional Erosion and Sediment Control Specialist) shall certify every three years that the facility is in compliance with this general permit.

S11. STORMWATER INSPECTIONS

An assessment of the SWPPP BMPs is required by this permit. As a minimum, the Permittee shall conduct two inspections each year of all active sites covered under this permit. At least one inspection will be conducted during the wet season (October 1 - April 30) and at least one inspection will be conducted during the dry season (May 1 - September 30).

A. <u>Wet Season Inspection</u>

The wet season inspection will be conducted by personnel named in the SWPPP and will include observations for the presence of floating materials, suspended solids, oil and grease, discoloration, turbidity, odor, etc. in the stormwater discharge(s).

It will be conducted during a rainfall event adequate in intensity and duration to verify that:

1. The description of potential pollutant sources required under this permit is accurate;

2. The site map as required in the SWPPP (Special Condition S7.) has been updated or otherwise modified to reflect current conditions; and

3. The controls to reduce pollutants in stormwater discharges associated with industrial activity identified in the SWPPP are being implemented and are adequate.

B. <u>Dry Season Inspection</u>

The dry season inspection shall be conducted by personnel named in the SWPPP and after at least seven (7) consecutive days of no precipitation. It shall determine the presence of non-stormwater discharges such as process water to the *stormwater drainage system*. If a discharge related directly or indirectly to process water is discovered, the permittee shall comply with non-compliance notification requirements of Special Condition S6.E. and shall eliminate the discharge within ten days. If the discharge cannot be eliminated within ten days, the discharge shall be considered process water and subject to all process water conditions of this general permit.

C. Inspection Report

A report on each inspection will be prepared and retained as part of the SWPPP. The report will summarize the scope of the inspection, the personnel conducting the inspection, the date(s) of the inspection, major observations relating to the implementation of the SWPPP, and any actions taken. The report shall be signed in accordance with General Condition 20 and shall certify that the discharge of stormwater has been investigated for the presence of non-stormwater discharge.

S12. SPILL PLAN

A. Emergency Cleanup

BMP S1.80 in Volume IV of Ecology's *Stormwater Management Manual (SWMM)* should be used for emergency cleanup guidance.

B. Materials of Concern

The Permittee shall maintain and comply with a spill control plan for the prevention, containment, control and cleanup of spills or unplanned discharges of:

1. Oil and petroleum products including accidental release from equipment,

2. Materials, which when spilled, or otherwise released into the environment, are designated Dangerous (DW) or Extremely Hazardous Waste (EHW) by the procedures set forth in WAC 173-303-070, and

3. Other materials which may become pollutants or cause pollution upon reaching waters of the state.

C. Spill Plan Contents

The Permittee will review and update the Spill Plan, as needed, but at least annually. The spill control plan will include the following:

1. A description of the reporting system which will be used to alert responsible managers and legal authorities in the event of a spill,

2. A list of equipment and materials onsite that have the potential to leak and spill,

3. A description of preventive measures and facilities (including an overall facility plot showing drainage patterns) which prevent, contain, or treat spills of these materials, and

4. Specific handling procedures and storage requirements for materials kept onsite.

D. Spill Response

The permittee shall have the necessary cleanup materials available and respond to all spills in a timely fashion, preventing their discharge to waters of the state. All employees shall receive appropriate training to assure that spills are reported and responded to appropriately.

S13. SOLID WASTE DISPOSAL

A. Solid Waste Handling

The Permittee shall handle and dispose of all solid waste material, including material from cleaning catch basins and any sludge generated by impounding process water or Type 3 stormwater, in such a manner as to prevent its entry into state ground or surface water. Disposal shall comply with all applicable local, state, and federal regulations.

B. Leachate

The Permittee shall not allow *leachate* from its solid waste material to enter state waters without providing all known, available and reasonable methods of treatment, nor allow such leachate to cause violations of the State Surface Water Quality Standards, Chapter 173-201A WAC, or the State Ground Water Quality Standards, Chapter 173-200 WAC. The Permittee shall apply for a permit or permit modification as may be required for such discharges to state ground or surface waters.

S14. COMPLIANCE WITH STANDARDS

Violation of ground water quality standards (Chapter 173-200 WAC), surface water quality standards (Chapter 173-201A WAC), or sediment management standards (Chapter 173-204 WAC) of the state of Washington is a violation of this permit.

A. Discharge to Ground Water

Any discharge to a pond, lagoon, or other type of impoundment or storage facility that is unlined is considered a discharge to ground water and is subject to the ground water standards (Chapter 173-200 WAC). Industrial discharges below the surface of the ground, such as to a dry well, drainfield, or injection well, are subject to the ground water standards and are also regulated by the Underground Injection Control Program (Chapter 173-218 WAC).

B. Ground Water Monitoring Wells

Ecology may require installation of ground water monitoring wells at any facility that has the potential to pollute ground water as demonstrated by discharge of process water that is not in compliance with the ground water standards to an unlined pond or other point of discharge.

GENERAL CONDITIONS

G1. DISCHARGE VIOLATIONS

All discharges and activities authorized by this general permit shall be consistent with the terms and conditions of this general permit. The discharge of any pollutant more frequently than, or at a concentration in excess of, that authorized by this general permit shall constitute a violation of the terms and conditions of this general permit.

G2. PROPER OPERATION AND MAINTENANCE

The Permittee shall at all times properly operate and maintain all facilities and systems of collection, treatment, and control (and related appurtenances) which are installed or used by the Permittee for pollution control.

G3. REDUCED PRODUCTION FOR COMPLIANCE

The Permittee, in order to maintain compliance with its general permit, shall control production and/or all discharges upon reduction, loss, failure, or bypass of the treatment facility until the facility is restored or an alternative method of treatment is provided. This requirement applies in the situation where, among other things, the primary source of power of the treatment facility is reduced, lost, or fails.

G4. BYPASS PROCEDURES

The Permittee shall immediately notify Ecology of any spill, overflow, or bypass from any portion of the wastewater collection or treatment system.

The bypass of wastes from any portion of the wastewater treatment system is prohibited unless one of the following conditions (1, 2, or 3) applies:

1. Unavoidable Bypass -- Bypass is unavoidable to prevent loss of life, personal injury, or severe property damage. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass.

   If the resulting bypass from any portion of the treatment system results in noncompliance with this permit the Permittee shall notify Ecology in accordance with Special Condition S6.E. "Noncompliance Notification."

2. Anticipated Bypass That Has the Potential to Violate Permit Limits or Conditions -- Bypass is authorized by an administrative order[1] issued by Ecology. The Permittee shall apply to Ecology for the administrative order at least thirty (30) days before the planned date of bypass. The written submission shall contain (1) a description of the bypass and its cause; (2) an analysis of all known alternatives which would eliminate, reduce, or mitigate the need for bypassing; (3) a cost-effectiveness analysis of alternatives including comparative resource damage assessment; (4) the minimum and maximum duration of bypass under each alternative; (5) a recommendation as to the preferred alternative for conducting the bypass; (6) the projected date of bypass initiation; (7) a statement of compliance with SEPA; (8) a request for a *water quality* modification, as provided for in WAC 173-201A-110, and (9) steps taken or planned to reduce, eliminate, and prevent reoccurrence of the bypass.

   For probable construction bypasses, the need to bypass is to be identified as early in the planning process as possible. The analysis required above shall be considered during preparation of the engineering report or facilities plan and plans and specifications and shall be included to the extent practical. In cases where the probable need to bypass is determined early, continued analysis is necessary up to and including the construction period in an effort to minimize or eliminate the bypass.

   Ecology will consider the following prior to authorizing a bypass:

   a. If the bypass is necessary to perform construction or maintenance-related activities essential to meet the requirements of the permit.

   b. If there are feasible alternatives to bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, maintenance during normal periods of equipment down time, or transport of untreated wastes to another treatment facility.

   c. If the bypass is planned and scheduled to minimize adverse effects on the public and the environment.

   After consideration of the above and the adverse effects of the proposed bypass and any other relevant factors, Ecology will approve or deny the request. The public shall be notified and given an opportunity to comment on bypass incidents of significant duration, to the extent feasible. Approval of a request to bypass will be by administrative order issued by Ecology under RCW 90.48.120.

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[1] Ecology's determination to issue an Order to increase monitoring frequency is an appealable action under RCW 43.21B.310.

3. Bypass For Essential Maintenance Without the Potential to Cause Violation of Permit Limits or Conditions -- Bypass is authorized if it is for essential maintenance and does not have the potential to cause violations of limitations or other conditions of the permit, or adversely impact public health as determined by Ecology prior to the bypass.

G5. RIGHT OF ENTRY

The Permittee shall allow an authorized representative of Ecology, upon the presentation of credentials and such other documents as may be required by law:

A. To enter upon the premises where a discharge is located or where any records shall be kept under the terms and conditions of this permit;

B. To have access to and copy at reasonable times any records that shall be kept under the terms of this permit;

C. To inspect at reasonable times any monitoring equipment or method of monitoring required in this permit;

D. To inspect at reasonable times any collection, treatment, pollution management, or discharge facilities; and

E. To sample at reasonable times any discharge of pollutants.

G6. NOTIFICATION OF CHANGE IN COVERED ACTIVITIES

The Permittee shall submit a new application for coverage whenever facility expansions, production increases, or process modifications are anticipated that will (1) result in new or substantially changed discharges of pollutants[1]; or (2) violate the terms and conditions of this permit. This new application for coverage shall be submitted at least 60 days prior to the proposed changes. Submission of the application for coverage does not relieve the Permittee of the duty to comply with the existing permit.

G7. PERMIT COVERAGE REVOKED

Pursuant with Chapter 43.21B RCW and Chapter 173-226 WAC, the Director may require any *discharger* authorized by this permit to apply for and obtain coverage under an individual permit or another more specific and appropriate general permit. Cases where revocation of coverage may be required include, but are not limited to, the following:

A. Violation of any term or condition of this permit;

B. Obtaining coverage under this permit by misrepresentation or failure to disclose fully all relevant facts;

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[1] Substantial change of discharge for this industry group will be any modification of the facility that would change the characteristics of the discharge or include for coverage a new activity (SIC) that was not previously covered.

C. A change in any condition that requires either a temporary or permanent reduction or elimination of the permitted discharge;

D. Failure or refusal of the Permittee to allow entry as required in RCW 90.48.090;

E. A determination that the permitted activity endangers human health or the environment, or contributes to water quality standards violations;

F. Nonpayment of permit fees or penalties assessed pursuant to RCW 90.48.465 and Chapter 173-224 WAC;

G. Failure of the Permittee to satisfy the public notice requirements of WAC 173-226-130(5), when applicable; or

H. Incorporation of an approved local pretreatment program into a municipality's permit.

Permittees who have their coverage revoked for cause according to WAC 173-226-240 may request temporary coverage under this permit during the time an individual permit is being developed, provided the request is made within ninety (90) days from the time of revocation and is submitted along with a complete individual permit application form.

G8. GENERAL PERMIT MODIFICATION AND REVOCATION

This permit may be modified, revoked and reissued, or terminated in accordance with the provisions of Chapter 173-226 WAC. Grounds for modification or revocation and reissuance include, but are not limited to, the following:

A. When a change which occurs in the technology or practices for control or abatement of pollutants applicable to the category of dischargers covered under this permit;

B. When effluent limitation guidelines or standards are promulgated pursuant to the FWPCA or Chapter 90.48 RCW, for the category of dischargers covered under this permit;

C. When a water quality management plan containing requirements applicable to the category of dischargers covered under this permit is approved; or

D. When information is obtained which indicates that cumulative effects on the environment from dischargers covered under this permit are unacceptable.

G9. REPORTING A CAUSE FOR MODIFICATION

A Permittee who knows or has reason to believe that any activity has occurred or will occur which would constitute cause for modification or revocation under Condition G6. above, or 40 CFR 122.62 shall report such plans, or such information, to Ecology so that a decision can be made on whether action to modify coverage or revoke coverage under this permit will be required. Ecology may then require submission of a new application for coverage under this, or another general permit, or an application for an individual permit. Submission of a new application does not relieve the Permittee of the duty to comply with all the terms and conditions of the existing permit until the new application for coverage has been approved and corresponding permit has been issued.

G10. TOXIC POLLUTANTS

If any applicable toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Clean Water Act for a toxic pollutant and that standard or prohibition is more stringent than any limitation upon such pollutant in this general permit, Ecology shall institute proceedings to modify or revoke and reissue this permit to conform to the new toxic effluent standard or prohibition.

G11. OTHER REQUIREMENTS OF 40 CFR

All other requirements of 40 CFR 122.41 and 122.42 are incorporated in this general permit by reference.

G12. COMPLIANCE WITH OTHER LAWS AND STATUTES

Nothing in this permit shall be construed as excusing the Permittee from compliance with any applicable Federal, State, or local statutes, ordinances, or regulations.

G13. ADDITIONAL MONITORING

Ecology may establish specific monitoring requirements in addition to those contained in this permit by administrative order[1] or permit modification.

G14. PAYMENT OF FEES

The Permittee shall submit payment of fees associated with this permit as assessed by Ecology. Ecology may revoke this permit or take enforcement, collection, or other actions, if the permit fees established under Chapter 173-224 WAC are not paid.

G15. REMOVED SUBSTANCES

Collected screenings, grit, solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall not be resuspended or reintroduced to the final effluent stream for discharge to State waters.

G16. REQUESTS TO BE EXCLUDED FROM COVERAGE UNDER A GENERAL PERMIT

Any discharger authorized by this permit may request to be excluded from coverage under the sand and gravel general permit by applying for an individual permit. The discharger shall submit to the Director an application as described in WAC 173-220-040 or WAC

[1] Ecology's determination to issue an Order to increase monitoring frequency is an appealable action under RCW 43.21B.310.

173-216-070, whichever is applicable, with reasons supporting the request. The Director shall either issue an individual permit or deny the request with a statement explaining the reason for the denial. When an individual permit is issued to a discharger otherwise subject to the sand and gravel general permit, the applicability of the sand and gravel general permit to that Permittee is automatically terminated on the effective date of the individual permit.

G17. PERMIT TRANSFER

Coverage under this permit is automatically transferred to a new owner or operator if:

A. A written agreement between the old and new owner or operator containing a specific date for transfer of permit responsibility, coverage, and liability is submitted to Ecology;

B. A copy of this permit is provided to the new owner; and

C. Ecology does not notify the Permittee of the need to submit a new application for coverage under the general permit or for an individual permit pursuant to Chapters 173-216, 173-220, and 173-226 WAC.

Unless this permit is automatically transferred according to section A. above, this permit may be transferred only if it is modified to identify the new Permittee and to incorporate such other requirements as determined necessary by Ecology.

G18. DUTY TO REAPPLY

The Permittee shall reapply for coverage under this permit, at least, one hundred and eighty (180) days prior to the specified expiration date of this permit. An expired permit continues in force and effect until a new permit is issued or until Ecology cancels it. Only those facilities which have reapplied for coverage under this permit are covered under the continued permit.

G19. PENALTIES FOR VIOLATING PERMIT CONDITIONS

Any person who is found guilty of willfully violating the terms and conditions of this permit shall be deemed guilty of a crime, and upon conviction thereof shall be punished by a fine of up to ten thousand dollars and costs of prosecution, or by imprisonment in the discretion of the court. Each day upon which a willful violation occurs may be deemed a separate and additional violation.

Any person who violates the terms and conditions of a waste discharge permit shall incur, in addition to any other penalty as provided by law, a civil penalty in the amount of up to ten thousand dollars for every such violation. Each and every such violation shall be a separate and distinct offense, and in case of a continuing violation, every day's continuance shall be and be deemed to be a separate and distinct violation.

G20. SIGNATORY REQUIREMENTS

All applications for coverage and termination, plans (including the SWPPP and the ESCP), reports, certifications, or information either submitted to Ecology or to the operator of a municipal storm sewer system or that this permit requires be maintained by the permittee, shall be signed as follows:

A. In the case of corporations, by a responsible corporate officer or a duly authorized representative, if such representative is responsible for the overall operation of the facility from which the discharge originates;

B. In the case of a partnership, by a general partner;

C. In the case of a sole proprietorship, by the proprietor; or

D. In the case of a municipal, state, or other public agency, by either a principal executive officer, ranking elected official, or other duly authorized employee.

G21. APPEALS

The terms and conditions of the sand and gravel general permit:

A. As they apply to the appropriate class of dischargers are subject to appeal within thirty (30) days of issuance of the sand and gravel general permit in accordance with Chapter 43.21(B) RCW and Chapter 173-226 WAC; and

B. As they apply to an individual discharger are subject to appeal in accordance with Chapter 43.21(B) RCW within thirty (30) days of the effective date of coverage of that discharger.

Consideration of an appeal of the sand and gravel general permit coverage of an individual discharger is limited to the applicability or non-applicability of the sand and gravel general permit to that same discharger. Appeal of this permit coverage of an individual discharger will not affect any other individual dischargers. If the terms and conditions of the sand and gravel general permit are found to be inapplicable to any discharger(s), the matter shall be remanded to Ecology for consideration of issuance of an individual permit or permits.

G22. SEVERABILITY:

The provisions of this permit are severable, and if any provision of this general permit or application of any provision of this general permit to any circumstance is held invalid, the application of such provision to other circumstances, and the remainder of this general permit, shall not be affected thereby.

APPENDIX A

FACILITIES REQUIRED TO APPLY

The coverage provided in this general permit is limited to the specific facilities identified within the following Standard Industrial Classification (SIC) Codes, the cited Subparts of 40 CFR Part 436, Mineral Mining and Processing Point Source Category or 40 CFR Part 443, Effluent Limitations Guidelines For Existing Sources And Standards Of Performance And Pretreatment Standards For New Sources For The Paving And Roofing Materials (Tars And Asphalt) Point Source Category:

SIC Code 811 Timber Tracts
SIC Code 2411 Logging

Coverage for timber tracts and logging activities is limited to those mining activities associated with the forestry industry that classify as silvicultural point source. A silvicultural point source applies only to the production of materials for use in forest management. For this industry, covered activities are limited to rock crushing or gravel washing facilities that use a discernible, confined and discrete conveyance to discharge pollutants to waters of the state.

SIC Code 1411 Dimension Stone
40 CFR Part 436 Subpart A--Dimension Stone Subcategory

Coverage is provided for mining and quarrying of dimension stone, including rough blocks and slabs. The types of mines or quarries covered in this general permit are: basalt, diabase, diorite, dolomite, dolomitic marble, flagstone, gabbro, gneiss, granite, limestone, marble, quartzite, sandstone, serpentine, slate, and volcanic rock.

SIC Code 1422 Crushed and Broken Limestone
SIC Code 1423 Crushed and Broken Granite
SIC Code 1429 Crushed and Broken Stone, Not Elsewhere Classified
40 CFR Part 436 Subpart B--Crushed Stone Subcategory

Coverage is provided for mining, quarrying, and onsite processing of crushed and broken stone or riprap. The types of mines or quarries included in this category for this permit are: basalt, dolomite, dolomitic marble, granite, limestone, marble, quartzite sandstone, traprock, and volcanic rock. Processing means washing, screening, crushing, or otherwise preparing rock material for use.

SIC Code 1442 Construction Sand and Gravel
40 CFR Part 436 Subpart C--Construction Sand and Gravel Subcategory

Coverage is provided for mining and onsite processing of sand and gravel for construction or fill purposes. Processing means washing, screening, crushing, or otherwise preparing sand and gravel for construction uses.

SIC Code 1446 Industrial Sand
40 CFR Part 436 Subpart D--Industrial Sand Subcategory

Coverage is provided for mining and onsite processing of sand for uses other than construction, including but not limited to glassmaking, molding, filtration, refractories, refractory bonding, and abrasives. Processing employing a HF flotation method is not covered by this general permit.

SIC Code 1499 Miscellaneous Nonmetallic Minerals, Except Fuels
40 CFR Part 436 Subpart H Lightweight Aggregates Subcategory

Coverage is provided for mining, quarrying, and onsite processing of perlite, pumice, or vermiculite.

SIC Code 1459 Clay, Ceramic, and Refractory Minerals, Not Elsewhere Classified
40 CFR Part 436 Subpart V--Bentonite Subcategory

Coverage is provided for the mining and onsite processing of bentonite.

SIC Code 1499 Miscellaneous Nonmetallic Minerals, Except Fuels
40 CFR Part 436 Subpart X--Diatomite Subcategory

Coverage is provided for mining and onsite processing of diatomite or diatomaceous earth.

SIC Code 1459 Clay, Ceramic, and Refractory Minerals, Not Elsewhere Classified
40 CFR Part 436 Subpart AD--Shale and Common Clay Subcategory

Coverage is provided for the mining and onsite processing of clays and refractory minerals. Mines operated in conjunction with plants manufacturing cement, brick, or other structural clay products are included in this industry. Establishments engaged in grinding, pulverizing, or otherwise treating clay, ceramic, and refractory minerals not in conjunction with mining or quarrying operations are not included in this general permit.

SIC Code 1455 Kaolin and Ball Clay
40 CFR Part 436 Subpart AH--Ball Clay Subcategory

Coverage is provided for the mining and onsite processing of kaolin, ball clay, china clay, paper clay, and slip clay.

SIC Code 2951 Asphalt Paving Mixtures and Blocks
40 CFR Part 443 Subpart B--Asphalt Concrete Subcategory

Coverage is provided for hot mix asphalt plants.

SIC Code 3273 Ready-Mixed Concrete

Coverage is provided for facilities engaged in manufacturing portland concrete delivered to a purchaser in a plastic and unhardened state. This includes production and sale of central-mixed concrete and portable ready-mixed concrete.

APPENDIX B - MONITORING REQUIREMENTS

Monitoring Requirements & Effluent Limits Matrix

Discharge Type	SIC	Discharge To:	pH		Turbidity		Total Suspended Solids		Temp	TDS[1]
			Min	Max	Monthly Ave	Max Daily	Monthly Ave	Max Daily		
Process Water, Dewatering Water	0811, 1422, 1423, 1429, 1442, 2411	Surface	Monthly		2 Times Monthly		Quarterly		Weekly (Jul-Sep)	----
			6.0	9.0	50 NTU	50 NTU	40 mg/l	80 mg/l	----	----
		Ground	Monthly		----		----		----	----
			6.5	8.5	----	----	----	----	----	----
	1411, 1455, 1459, 1499	Surface	-------------------- Surface Water Discharge Not Permitted --------------------							
		Ground	Monthly		----		----		----	----
			6.5	8.5	----	----	----	----	----	----
	1446	Surface	Monthly		2 Times Monthly		Quarterly		Weekly (Jul-Sep)	----
			6.0	9.0	50 NTU	50 NTU	25 mg/l	45 mg/l	----	----
		Ground	Monthly		----		----		----	----
			6.5	8.5	----	----	----	----	----	----
	2951	Surface	-------------------- Surface Water Discharge Not Permitted --------------------							
		Ground	Monthly		----		----		----	Monthly
			6.5	8.5	----	----	----	----	----	500mg/l[2]
	3273	Surface	Monthly		2 Times Monthly		Quarterly		Weekly (Jul-Sep)	Monthly
			6.0	9.0	50 NTU	50 NTU	40 mg/;	80 mg/l	----	----
		Ground	Monthly		----		----		----	Monthly
			6.5	8.5	----	----	----	----	----	500mg/l[2]

Stormwater	All Facilities	Surface	Monthly		2 Times Monthly		----		Weekly (Jul-Sep)	----
			6.0	9.0	50 NTU	50 NTU	----	----	----	----
		Ground	Quarterly		----		----		----	----
			6.5	8.5	----	----	----	----	----	----

[1]TDS = Total Dissolved Solids

[2]Not a true limit. However, if 500 mg/l is typically exceeded, a groundwater impact study may be required

APPENDIX C

DEFINITIONS

These definitions pertain to terms indicated in italics in this permit. The term has been indicated in italics only the first time it is used.

Active Site means a location where current mining or processing operations (including, but not limited to, crushing, classifying, or operating a concrete or hot mix asphalt plant) or stockpiles associated with current mining or processing operations, are located. Also see definitions for Inactive Site and Closed Site.

Application for Coverage means the application for, or a request for, coverage under this General Permit pursuant to WAC 173-226-200. An application for coverage is also known as a "Notice of Intent (NOI)".

Best Management Practices (BMPs - general definition) means schedules of activities, prohibitions of practices, maintenance procedures, and other physical, structural and/or managerial practices to prevent or reduce the pollution of waters of the State. BMPs include treatment systems, operating procedures, and practices used to control plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage. In this permit BMPs are further categorized as operational, source control, erosion and sediment control, and treatment.

Bypass means the diversion of waste streams from any portion of a treatment facility.

Capital Improvements means the following improvements that will require capital expenditures:

1. Treatment BMPs, including but not limited to: biofiltration systems including constructed wetlands, settling basins, oil separation equipment, impoundments, and detention and retention basins.
2. Manufacturing modifications, including process changes for source reduction, if capital expenditures for such modifications are incurred.
3. Concrete pads and dikes and appropriate pumping for collection of stormwater, process water or mine dewatering water and transfer to control systems from manufacturing areas such as loading, unloading, outside processing, fueling and storage of chemicals and equipment and wastes.
4. Roofs and appropriate covers for storage and handling areas.

Clean Water Act (CWA) means the Federal Water Pollution Control Act enacted by Public Law 92-500, as amended by Public Laws 95-217, 95-576, 96-483, and 97-117; USC 1251 et seq.

Closed Site means a location where all activities associated with permit coverage have been terminated with no intent to return to operation in the future. Also see definitions for Inactive Site and Active Site.

Constructed Wetland means wetlands intentionally created for the primary purpose of wastewater or stormwater treatment and managed as such. Constructed wetlands are normally considered as part of the stormwater collection and treatment system. Wetlands constructed for treatment of stormwater shall not be eligible for use as compensatory mitigation for authorized impacts to regulated wetland systems.

Design Storm means the maximum volume of water resulting from the *10 year, 24 hour precipitation event.* The term "10 year 24 hour precipitation event" is the maximum 24 hour precipitation event with a probable reoccurrence interval of once in 10 years. The maximum volume of water is the total from all areas contributing runoff to the individual treatment facility without consideration of loss of water from processes such as infiltration.

Director means the Director of the Washington Department of Ecology or his/her authorized representative.

Discharge to Ground Water means the discharge of water into an unlined impoundment or onto the surface of the ground that allows the discharged water to percolate, or potentially percolate, to ground water. Discharge to ground water, discharge to land, and discharge to ground all have the same meaning.

Discharger means an owner or operator of any facility or activity subject to regulation under Chapter 90.48 RCW or the Federal Clean Water Act.

Ecology means the Washington State Department of Ecology.

Erosion means the wearing away of the land surface by running water, ice, or other geological agents, including such processes as gravitational creep.

Erosion and Sediment Control BMPs means BMPs intended to prevent erosion and sedimentation, such as preserving natural vegetation, seeding, mulching and matting, plastic covering, filter fences, and sediment traps and ponds. Erosion and sediment control BMPs are synonymous with stabilization and structural BMPs.

Erosion and Sediment Control Plan(ESCP) means a document that describes the potential for erosion and sedimentation problems and explains and illustrates the measures to be taken to control those problems.

Final Stabilization means completion of all soil disturbing activities at the site and establishment of a permanent vegetative cover, or installation of equivalent permanent stabilization measures (such as riprap, gabions or geotextiles) that will prevent erosion.

"40 CFR" means Title 40 of the Code of Federal Regulations, which is the codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the Federal government.

General Permit means a permit that covers multiple dischargers of a point source category within a designated geographical area, in place of individual permits being issued to each discharger.

Ground Water means water in a saturated zone or stratum beneath the land surface or a surface water body.

Hot Mix Asphalt Plant means a plant that blends together aggregate and asphalt cement to produce a hot, homogeneous asphalt paving mixture. The term includes batch plants, continuous mix plants, and drum mix plants.

Inactive Site means a location where previous mining or processing operations (including, but not limited to, crushing, classifying, or operating a concrete or hot mix asphalt plant) has occurred; has not been closed and restored; and has no current mining or processing operations but may include stockpiles of raw materials or finished products. The permittee may add or withdraw raw materials or finished products from the stockpiles for transportation offsite for processing, use, or sale and still be considered an inactive site. Also see definitions for Active Site and Closed Site.

Inert means nonreactive, nondangerous solid materials that are likely to retain their physical and chemical structure under expected conditions of use or disposal.

LC_{50} means the concentration of test material estimated to cause 50% mortality of the test organisms. The aquatic toxicity tests should include both an invertebrate and a fish species as test organisms.

Leachate means water or other liquid that has percolated through raw material, product, or waste and contains substances in solution or suspension as a result of the contact with these materials.

Local Government means any county, city, or town having its own government for local affairs.

Mine Dewatering Water means any water that is impounded or that collects in the mine and is pumped, drained, or otherwise removed from the mine through the efforts of the mine operator. This term shall also include wet pit overflows caused solely by direct rainfall and ground water seepage. However, if a mine is used for treatment of process generated waste water, discharges of commingled water from the mine shall be deemed discharges of process generated water.

Municipality means a political unit such as a city, town, or county, incorporated for local self-government.

National Pollutant Discharge Elimination System (NPDES) means the national program for issuing, modifying, revoking, and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Federal Clean Water Act, for the discharge of pollutants to surface waters of the State from point sources. These permits are referred to as NPDES permits and, in Washington State, are administered by the Washington Department of Ecology.

NTU means Nephelometric Turbidity Units, a measure of turbidity.

Operational BMPs means schedule of activities, prohibition of practices, maintenance procedures, employee training, good housekeeping, and other managerial practices to prevent or reduce the pollution of waters of the state. Not included are BMPs that require construction of pollution control devices.

pH--The pH of a liquid measures its acidity or alkalinity. A pH of 7 is defined as neutral, and large variations above or below this value are harmful to most aquatic life.

Point Source means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, and container from which pollutants are or may be discharged to waters of the State. This term does not include return flows from irrigated agriculture.

Pollutant means the discharge of any of the following to waters of the state: dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste. This term does not include sewage from vessels within the meaning of section 312 of the FWPCA, nor does it include dredged or fill material discharged in accordance with a permit issued under section 404 of the FWPCA.

Pollution means contamination or other alteration of the physical, chemical, or biological properties of waters of the state, including change in temperature, taste, color, turbidity, or odor of the waters; or such discharge of any liquid, gaseous, solid, radioactive or other substance into any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental or injurious to the public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish, or other aquatic life.

Process Water means any water that comes into direct contact or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product. The term shall also mean any waste water used in the slurry transport of mined material, air emissions control, or processing exclusive of mining.

Puget Sound Basin means the Puget Sound south of Admiralty Inlet (including Hood Canal and Saratoga Passage); the waters north to the Canadian border, including portions of the Strait of Georgia; the Strait of Juan de Fuca south of the Canadian border; and all the lands draining into these waters as mapped in Water Resources Inventory Areas numbers 1 through 19, set forth in WAC 173-500-040.

Representative Sampling means taking sufficient samples to accurately represent the nature of the discharge for parameters of concern. Many factors contribute to variability of pollutants in a discharge including quantity of water, time and date of sampling, and physical events and location of discharge.

Ground Water Discharges: If water puddles/collects and discharges to ground at multiple locations onsite it is unlikely that all puddles must be sampled. Consider the source of the water. If all the water is coming from a gravel stockpile area it is likely that just one sampling point is required. However, if some puddles are from a gravel stockpile area and others are receiving water from a concrete batch area, two sample points are likely. It may be helpful to test multiple puddles for pH. Those with essentially the same pH value can probably be represented by one sample.

Surface Water Discharges: Discharges of process water should be timed to occur when the facility is running at full capacity. Discharges of stormwater may be taken at any time a stormwater discharge occurs. For all parameters required by this permit, a grab sample of instantaneous measurement will be considered representative. The intensity of a storm event and the number of dry days preceding a storm can have dramatic effects on the characteristics of a stormwater discharge. Frequency of sampling must be sufficiently frequent to represent this variability. Since weather can not be readily predicted far in advance, sampling on short notice is likely.

Sanitary Sewer means a sewer designed to convey domestic wastewater.

Sediment means the fragmented material that originates from the weathering and erosion of rocks or unconsolidated deposits and is transported by, suspended in, or deposited by water.

SEPA (State Environmental Policy Act) means the Washington State Law, RCW 43.21C.020, intended to prevent or eliminate damage to the environment.

Significant Amounts means those amounts of pollutants that are amenable to treatment or prevention or that have the potential to cause or contribute to a violation of standards for surface or ground water quality or sediment management.

Significant Materials includes, but is not limited to: raw materials; fuels; materials such as solvents and detergents; hazardous substances designated under section 101(14) of CERCLA; any chemical the facility is required to report pursuant to section 313 of title III of SARA; fertilizers; pesticides; and waste products such as ashes, slag, and sludge that have the potential to be released with stormwater or process water discharges.

Silvicultural Point Sources are timber tract and logging activities (SIC codes 0811 and 2411) that produce mined materials for use in forest management. Additionally, silvicultural point source activities are limited to rock crushing or gravel washing operations that use a discernible, confined and discrete conveyance to discharge pollutants to surface waters of the state.

Site means the land or water area where any "facility or activity" is physically located or conducted.

Source Control BMPs means physical, structural, or mechanical devices or facilities intended to prevent pollutants from entering stormwater. A few examples of source control BMPs are erosion control practices, maintenance of stormwater facilities, construction of roofs over storage and working areas, and direction of wash water and similar discharges to the sanitary sewer or a dead end sump.

Stabilization means the application of appropriate BMPs to prevent the erosion of soils, such as temporary and permanent seeding, vegetative covers, mulching and matting, plastic covering, and sodding. See also the definition of Erosion and Sediment Control BMPs.

Standard Industrial Classification (SIC) is the statistical classification standard underlying all establishment-based federal economic statistics classified by industry as reported in the 1987 SIC Manual by the Office of Management and Budget.

Storm Sewer means a sewer that is designed to carry stormwater. Also called a storm drain.

Stormwater means rainfall and snowmelt runoff.

Stormwater Drainage System means constructed and natural features that function together as a system to collect, convey, channel, hold, inhibit, retain, detain, infiltrate, or divert stormwater.

Stormwater Management Manual (SWMM) means the technical manual prepared by Ecology for use by local governments that contains BMPs to prevent, control, or treat pollution in stormwater.

Stormwater Pollution Prevention Plan (SWPPP) means a documented plan to implement measures to identify, prevent, and control the contamination of point source discharges of stormwater.

Surface Waters of the State includes lakes, rivers, ponds, streams, wetlands, inland waters, salt waters, and all other surface waters and water courses within the jurisdiction of the state of Washington.

10 year, 24 hour precipitation event means the maximum 24 hour precipitation event with a probable reoccurrence interval of once in 10 years.

Total Dissolved Solids (TDS) means those solids that are capable of passing through a glass fiber filter (1.0 - 1.5 μm) and dried to a constant weight at 180 degrees centigrade.

Total Suspended Solids (TSS) is the particulate material in an effluent that does not pass through a glass fiber filter. Large quantities of TSS discharged to a receiving water may result in solids accumulation. Apart from any toxic effects attributable to substances leached out by water, suspended solids may kill fish, shellfish, and other aquatic organisms by causing abrasive injuries and by clogging the gills and respiratory passages of various aquatic fauna. Indirectly, suspended solids can screen out light and can promote and maintain the development of noxious conditions through oxygen depletion.

Treatment BMPs means BMPs intended to remove pollutants from stormwater. A few examples of treatment BMPs are detention ponds, oil/water separators, biofiltration, and constructed wetlands.

Turbidity means the clarity of water as expressed by nephelometric turbidity units (NTU) and measured with a calibrated turbidimeter.

Type 1 Stormwater means stormwater from portions of a site where no industrial activities have occurred or from a site or area within a site that has been reclaimed and the reclamation bond portion thereof (if any) has been released. If type 1 stormwater enters areas associated with type 2 stormwater, it becomes type 2 stormwater. Likewise, if it enters areas associated with type 3 stormwater, it becomes type 3 stormwater.

Type 2 Stormwater means stormwater from: 1) portions of a site where mining has temporarily or permanently ceased; 2) storage areas for stockpiles of raw materials or finished products; 3) or, from portions of a site with exposed soils in areas cleared in preparation for mining or other industrial activity. If type 2 stormwater enters areas associated with type 3 stormwater, it becomes type 3 stormwater.

Type 3 Stormwater means stormwater discharges from 1) industrial plant yards; 2) immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility; 3) material handling sites; 4) sites used for the storage and maintenance of material handling equipment; 5) sites used for residual treatment, storage, or disposal; 6) shipping and receiving areas; 7) storage areas for raw materials or intermediate and finished products at active sites; 8) and, areas where industrial activity has taken place in the past and *significant materials* remain and are exposed to stormwater.

USEPA means the United States Environmental Protection Agency.

Water Quality means the chemical, physical, and biological characteristics of water, normally with respect to its suitability for a particular purpose.

Waters of the State includes those waters as defined as "waters of the United States" in 40 CFR Subpart 122.2 within the geographic boundaries of Washington State and "waters of the state" as defined in Chapter 90.48 RCW. This includes ground water, lakes, rivers, ponds, streams, wetlands, inland waters, salt waters and all other surface waters and water courses within the jurisdiction of the State of Washington.

Wellhead Protection Area (WHPA) means the portion of a well's, well field's, or spring's zone of contribution defined as such using WHPA criteria established by the Washington Department of Health.

APPENDIX B

REVIEW AND REVISION FORMS

REVIEW AND REVISION DOCUMENTATION FORM

This report, including the Stormwater Pollution Prevention Plan, Erosion and Sediment Control Plan, monitoring plan, and spill plan, should be revised and updated as necessary to include modifications in site conditions, new or revised regulatory requirements, and additional on-site stormwater pollution controls. It shall be modified whenever there is a change in design, construction, operation, or maintenance which cause(s) this report to be less effective in controlling the pollutants.

All revisions to the report should be documented and should be included in the original report as part of this appendix. The Revision Documentation Form should be used to record the date, author, and name and signature of the facility representative that authorized the revision. The authorized facility representative should be an individual at or near the top of the facility's management organization, such as the facility manager or environmental manager. The signature of the authorized facility representative attests that the revision information is true and accurate. Previous authors are not responsible for the new revisions.

Review and Revision Documentation Form

Revision Number	Revision Date	Revision Author	Storedahl Representative Signature
1	6/7/02	A. Clary (revised drawings, forms, and tank volume on page 4-2)	
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			

APPENDIX C

EMPLOYEE INFORMATION TRAINING SHEET

EMPLOYEE INFORMATION TRAINING SHEET

The following summarizes spill prevention and response procedures, good housekeeping practices, and general stormwater management guidelines that should be implemented at all times during site activities.

Spill Prevention Procedures

- Store or dispose of motor oils and hydraulic oils in specific containers. Do not pour them onto the ground nor into the storm sewer system.
- Maintain equipment to reduce the number of fuel and oil leaks.

Spill Response Procedures

1. Immediately notify management.
2. Contain the spill to the best of your ability until assistance arrives.
3. Emergency containment will be coordinated by management. The portable spill containment unit will be deployed to the site of the spill. This unit contains the necessary materials to contain and clean a large spill. Assist in all efforts until the situation has been controlled and cleaned.
4. The material used to contain/clean the spill is disposed of in containers provided for this purpose.

Good Housekeeping Procedures

Good housekeeping is necessary to maintain clean and orderly facility areas that may potentially discharge stormwater and should include the following:

- Conduct routine inspections and maintenance of equipment and vehicles to prevent leakage of oil, grease, and fuels.

- Do not pour waste oils, solvents, fuels, or other hazardous chemicals on the ground or pavement.
- Do not leave vehicles or equipment unattended during fuel dispensing.
- Prevent overfilling of tanks when dispensing diesel fuel.
- Maintain nonpaved areas to prevent excessive soil erosion.
- Keep those activities which are likely to contaminate stormwater separated from those activities which will not contaminate stormwater.
- Inspect and clean stormwater conveyance structures.
- Be on the lookout for opportunities to make operational changes that could reduce stormwater pollution.
- Be on the lookout for opportunities to make operational changes that could reduce stormwater pollution.

APPENDIX D

OPERATIONS AND MAINTENANCE MANUAL

OPERATIONS AND MAINTENANCE MANUAL

Sedimentation/Detention Ponds

- Conduct regular inspections, especially after large storm events.
- Continually monitor sediment deposition and buildup in the settling trenches and pond. Periodically remove and stockpile settling trench materials for future reclamation activities. When excessive sediments build up in the bottom of the ponds, redistribute the sediment to create sinusoidal-shaped earthen areas on the exterior edges and within the ponds.
- Check for areas of erosion around the edges of the ponds. Repair any eroded areas by filling them with silt or clay soil and replanting if necessary.
- Remove significant trash or debris.
- Remove any poisonous vegetation that may constitute a hazard (e.g., tansy, poison oak, stinging nettles, devils club).
- Remove any trees or vegetation that do not allow maintenance access or that interfere with maintenance activity.
- Repair the pond slopes when eroded damage is greater than two inches deep. Stabilize the slopes with seeding, plastic covers, or riprap when necessary.

Culverts

- Conduct regular inspections of the culverts, especially after large storm events.
- Examine culverts on a regular basis for scour around the inlet and outlet, and repair as necessary.
- Remove all trash and debris that may accumulate in culverts so that they may convey capacity flow.

APPENDIX E

FORMS FOR SAMPLING AND MONITORING FOLDER

J. L. Storedahl and Sons, Inc.
Daybreak Mine
Sampling Schedule and Reporting Requirements
When Not Wet Processing or Using Additives

Schedule	Location	Parameter (s)
Daily during operations and no less than weekly	All places where water collects	Oil sheen (Note on Preventative Maintenance and Inspection Report)
Weekly	Pond 3 Outfall, P5 Background	Temperature (June, July, August, September)
Twice monthly	Pond 3 Outfall	Turbidity (by accredited lab and using site meter), and pH
Monthly	GW1, GW2, GW3, and GW5	pH

All data should be recorded on forms and filed with the SWPPP.

All pH, temperature, and lab-analyzed turbidity results for the Pond 3 Outfall and all of the pH results for groundwater should be included on Ecology's Discharge Monitoring Report (DMR) forms and submitted to Ecology each quarter. Backup analytical reports from laboratory and log sheets should be attached to the back of the DMRs. DMRs are due on April 15 (for January, February, and March), July 15 (for April, May, and June), October 15 (for July, August, September), and January 15 (for October, November and December).

J. L. Storedahl and Sons, Inc.
Daybreak Mine
Sampling Schedule and Reporting Requirements
During Wet Processing or Additive Usage

Schedule	Location	Parameter (s)
Daily	Point B (at pump)	Note additive details on Daily Additive Dosing Log.
Daily during operation and no less than weekly	All places where water collects	Oil sheen (note on Preventative Maintenance and Inspection Report)
Weekly*	Point D, Pond 3 Outfall	Turbidity (using site meter), and pH
Weekly*	Pond 3 Outfall, P5 Background	Temperature (June, July, August, September)
Twice monthly	Pond 3 Outfall	Turbidity (by accredited lab)
Monthly	Point D and Pond 3 Outfall	Total suspended solids
Monthly	GW1, GW2, GW3, and GW5	pH
Quarterly	Point D	Toxicity
* Increase to daily monitoring if operational changes are made or additive is changed until system stabilizes.		

All data should be recorded on forms and filed with the SWPPP.

All pH, total suspended solid, temperature, and lab-analyzed turbidity results for the Pond 3 Outfall and all of the pH results for groundwater should be included on Ecology's Discharge Monitoring Report (DMR) forms and submitted to Ecology each quarter. Backup analytical reports from laboratory and log sheets should be attached to the back of the DMRs. DMRs are due on April 15 (for January, February, and March), July 15 (for April, May, and June), October 15 (for July, August, September), and January 15 (for October, November and December).

The Master Additive Dosing Record should be used to record the additive name, LC_{50}, and range of dosing concentrations used at the site. This record should be updated before additive concentrations are increased and before a new additive is used. The record should be used to ensure that the maximum dosing concentration is less than 50 percent of the LC_{50}. The record, as well as the MSDS sheets for each additive should be filed with the SWPPP at each site.

J. L. Storedahl and Sons, Inc.
Daybreak Mine
Discharge Limits and Required Actions

Parameter	NPDES Permit Limit or Title 173-201A WAC Limit	Levels that Triggers Action	Action to be Taken
Oil Sheen in Ponds	Must be no visible oil sheen in ponds	Visible Oil Sheen in ponds	Stop discharging water from site (if applicable). Notify management. Immediately clean up water with absorbent pads or other absorbent materials. Identify and remove the source of oil sheen.
Turbidity of process water and stormwater discharges to surface water	Must be less than 50 NTU at Pond 3 Outfall	100 NTU at Point D or 40 NTU at Pond 3 Outfall	Increase monitoring frequency. Look at modifying additive dosing to decrease turbidity. Notify management.
		50 NTU at Pond 3 Outfall	If possible, block the discharge to Pond 5. Notify management. Permit requires notification of exceedance to Ecology.
pH of process water and stormwater discharges to surface water	Must be between 6.0 and 9.0 standard units at Pond 3 Outfall	If pH reaches 6.5 or 8.5 at Point D or at Pond 3 Outfall	Increase monitoring frequency. Notify management. Analyze a sample for alkalinity. Try to identify any process changes that would have caused a change in pH.
		If pH reaches 6.0 or 9.0 at Pond 3 Outfall	If possible, block the discharge to Pond 5. Notify management. Permit requires notification of exceedance to Ecology.
pH of process water and stormwater discharges to groundwater	Must be between 6.5 and 8.5 standard units in discharges to groundwater (GW1, GW2, GW3, GW5)	If pH reaches 6.8 or 8.3 in discharges to groundwater	Increase monitoring frequency. Notify management. Analyze a sample for alkalinity. Try to identify any process changes that would have caused a change in pH.
		If pH reaches 6.5 or 8.5 in discharges to groundwater	Notify management. Permit requires notification of exceedance to Ecology.

J. L. Storedahl and Sons, Inc.
Daybreak Mine
Discharge Limits and Required Actions (continued)

Parameter	NPDES Permit Limit or Title 173-201A WAC Limit	Levels that Triggers Action	Action to be Taken
Temperature increase in receiving water	If receiving water temperature is less than 18^o C, can't raise temperature of receiving water by more than 28^o C/($T_{background}$+7).	If P5 Background is less than 18^o C and temperature at Pond 3 Outfall is more than 28^o C/ ($T_{P5\ background}$ + 7) higher than P5 Background	If possible, block the discharge to Pond 5 until the discharge temperature can be reduced. Increase monitoring frequency. Notify management. Permit requires notification of exceedance to Ecology.
	If receiving water temperature is greater than 18^o C, can't raise temperature of the receiving water by more than 0.3^o C	If P5 Background is higher than 18^o C and temperature at Pond 3 Outfall is more than 0.3^o C higher than P5 Background	If possible, block the discharge to Pond 5. Increase monitoring frequency. Notify management. Permit requires notification of exceedance to Ecology.
Total Suspended Solids (TSS) of process water and stormwater discharges to surface water	Must be less than 40 mg/liter at Pond 3 Outfall	50 mg/liter at Point D or 30 mg/liter at Pond 3 Outfall	Increase monitoring frequency. Notify management.
		40 mg/liter at Pond 3 Outfall	If possible, block the discharge to Pond 5. Notify management. Permit requires notification of exceedance to Ecology.
Toxicity of process water discharges to surface water	N/A	Sample Point D has less than 90 percent survival of species.	Re-run test at Point D and at Pond 3 Outfall to verify result. If second test shows less than 90 percent survival at Pond 3 Outfall, stop discharging until cause of toxicity is identified and corrected.

J. L. Storedahl and Sons, Inc.
Daybreak Mine
Log Sheet for Turbidity, pH, and TSS
During Wet Processing or Additive Usage

Month: ______________________________

Date	Location	Turbidity by accredited lab[a] (NTU)	Turbidity by site meter (NTU)	pH (Std. Units)
	Point D			
	Pond 3 Outfall			
	Point D			
	Pond 3 Outfall			
	Point D			
	Pond 3 Outfall			
	Point D			
	Pond 3 Outfall			

Date	Location	TSS (mg/L)	pH (Std. Units)
	Point D		
	Pond 3 Outfall		
	GW1		
	GW2		
	GW3		
	GW5		

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J. L. Storedahl and Sons, Inc.
Daybreak Mine
Log Sheet for Turbidity and pH
When Not Wet Processing
or Using Additives

Quarter: ____________________________

Date	Location	Turbidity by accredited lab[a] (NTU)	Turbidity by site meter (NTU)	pH (Std. Units)
	Pond 3 Outfall			
	Pond 3 Outfall			
	Pond 3 Outfall			
	Pond 3 Outfall			
	Pond 3 Outfall			
	Pond 3 Outfall			

Date	Location	pH (Std. Units)
	GW1	
	GW2	
	GW3	
	GW5	
	GW1	
	GW2	
	GW3	
	GW5	
	GW1	
	GW2	
	GW3	
	GW5	

J. L. Storedahl and Sons, Inc.
Daybreak Mine
Weekly Log Sheet for Temperature
(June, July, August, and September Only)

Date	Location	Temperature (°Celcius)
	Pond 3 Outfall	
	P5 Background	
	Pond 3 Outfall	
	P5 Background	
	Pond 3 Outfall	
	P5 Background	
	Pond 3 Outfall	
	P5 Background	
	Pond 3 Outfall	
	P5 Background	
	Pond 3 Outfall	
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	P5 Background	
	Pond 3 Outfall	
	P5 Background	
	Pond 3 Outfall	
	P5 Background	
	Pond 3 Outfall	
	P5 Background	

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J. L. Storedahl and Sons, Inc.
Daybreak Mine
Weekly Log Sheet for Dissolved Oxygen
(June, July, August, and September Only)

Date	Location	DO (mg/L)
	Point D	
	Pond 3 Outfall	
	Point D	
	Pond 3 Outfall	
	Point D	
	Pond 3 Outfall	
	Point D	
	Pond 3 Outfall	
	Point D	
	Pond 3 Outfall	
	Point D	
	Pond 3 Outfall	
	Point D	
	Pond 3 Outfall	
	Point D	
	Pond 3 Outfall	
	Point D	
	Pond 3 Outfall	
	Point D	
	Pond 3 Outfall	
	Point D	
	Pond 3 Outfall	
	Point D	
	Pond 3 Outfall	

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J. L. Storedahl and Sons, Inc.
Daybreak Mine
Daily Additive Dosing Log Sheet

Additive Name: ____________________________

Date	Dosing Location	Dosing Minutes	Additive Density (lb/gal)	Additive LC_{50} (mg/L = PPM)	Additive Flow Rate (gal/day)	Additive Mass Flow Rate[1] (lb/min)	Water Flow Rate (gal/min)	Water Mass Flow Rate[2] (lb/min)	Dosing Concentration[3] (PPM by weight)

[1] Additive mass flow rate (lb/min) = Additive dosing rate (gpd) x Additive Density (lb/gal) / 1440 (min/day)
[2] Water mass flow rate (lb/min) = Water flow rate (gpm) x Water Density of 8.34 (lb/gal)
[3] Concentration (ppm) = Additive mass flow rate (lb/min) / water mass flow rate (lb/min) x 1,000,000

J. L. Storedahl and Sons, Inc.
Daybreak Mine
Maintenance and Inspection Requirements

Schedule	Action	Details
Daily	Follow good housekeeping and spill prevention procedures.	Maintain clean and orderly facilities. Handle fuel and oil properly. Maintain vehicles and prevent leaks.
Weekly	Inspect on-site erosion and sediment controls and stormwater treatment system.	Inspect sedimentation ponds, conveyance ditches and culverts. Note observations on Preventative Maintenance Report.
After rain event of more than 0.5 inches in 24 hours	Inspect on-site erosion and sediment controls within 24 hours.	Inspect sedimentation ponds, conveyance ditches and culverts. Note observations on Preventative Maintenance Report.
Monthly	Observe discharge.	Inspect for turbidity and color change. Note observations on Preventive Maintenance and Inspection Report.
Dry Season (5/1-9/30)	Inspect site after seven consecutive days of no precipitation.	Look for the presence of non-stormwater discharges. Prepare an inspection report summarizing observations and actions. The report must be signed by Kevin Storedahl and filed with SWPPP.
Wet Season (10/1-4/30)	Inspect site during a rain event.	Look for any potential pollution sources not addressed, verify accuracy of site map, and adequacy of pollution controls. Look for floating materials, suspended solids, oil and grease, discoloration, turbidity, etc, in stormwater discharge. Prepare an inspection report summarizing observations and actions. The report must be signed by Kevin Storedahl and filed with SWPPP.

J. L. Storedahl and Sons, Inc.
Weekly Preventative Maintenance and Inspection Report
Daybreak Mine

Inspected By: ____________________ Title: ________________ Date: __________

Check each item that was inspected and note the status and initial action.

ELEMENTS	Checked		ELEMENT STATUS										INITIAL ACTION			
			Working	Spill	Scour	Plugged	Erosion Cracks	Excessive Vegetation	Excessive Sedimentation	Damaged	Other ____		None	Cleaned	Repaired	Verbally Reported to Facility Manager
Culverts																
Sedimentation Ponds																
Additive Storage Area																
Additive Dosing Pump																
Pond Transfer Pumps																
Discharge Piping																
Stockpiles																
Access Road (sediment)																
Equip.Repair Area																
Other ____________																

If element status requires further description, please note:

____

____

Describe follow-up action taken (to be completed by facilities manager):

____

____

If a visible change in turbidity or color, or if an oil sheen is observed, note observations below and report to Ecology.____

____

____

Reviewed By: ____________________ Title: ________________ Date: __________

J.L. Storedahl and Sons, Inc.
Daybreak Mine
Bi-Annual Stormwater Inspection Form - Dry Season (May 1-Sept 30)

1. General Information:

Date of Inspection: ________________________	**Inspectors:** ________________________ ________________________
Weather Conditions: ______________________ ________________________	**Note: The dry season inspection must be performed after 7 consecutive days of no precipitation.**

2. Facility Modifications:

Descriptions of significant changes at facility since last inspections, including new equipment, buildings, operations, stormwater system, etc.: ____

____

____

____

____

Do any changes noted above have the potential to impact stormwater runoff? ______________

If yes, describe: ____

____

____

Has site map been updated to reflect current conditions? __________ Yes ________ No

3. Inspection of Potential Pollutant Sources:

Source Area/Operation	Observations (Note problems in Section 5)
1. Mining area, material storage piles	
2. Maintenance activities	
3. Fueling activities	
4. Stormwater treatment additive activities	
5. Others ________________________________	

4. Inspection of Best Management Practices:

Have any new BMPs been added since last inspection? ________________________________

If yes, describe: ____

____

____

J.L. Storedahl and Sons, Inc.
Daybreak Mine
Bi-Annual Stormwater Inspection Form - Dry Season (May 1-Sept 30)

4. Inspection of Best Management Practices (continued):

Best Management Practice	Yes or No (Note problems in Section 5)
1. Spill kit properly stocked	
2. Equipment and vehicles in good condition with no leaks of oil, grease, or fuel	
3. Nonpaved areas maintained to prevent excessive soil erosion	
4. Activities that are likely to contaminate stormwater are separate from activities that will not contaminate stormwater	
5. Culverts free of sediment and debris	
6. Preventive maintenance program in place	
7. Erosion of stockpiles prevented or repaired	
8. Periodic employee training completed.	
9. Recordkeeping requirements per Monitoring Plan Met	

5. Potential Problems and Corrective Actions Taken:

List any problems or potential problems identified during the inspection, and describe the corrective action (including the date action was taken) as each problem is corrected.

Potential Problem	Corrective Action Taken and Date

J.L. Storedahl and Sons, Inc.
Daybreak Mine
Bi-Annual Stormwater Inspection Form - Dry Season (May 1-Sept 30)

6. Dry Season Non-Stormwater Inspection and Certification:

Were any non-stormwater discharges to the stormwater drainage system observed during the site inspection? __________ Yes ______ No

If yes, are these discharges permitted under the NPDES permit? _______ Yes _______ No

Describe approximate volume and characteristics of non-stormwater discharges (e.g., odor, color). ____
____
____
____

Was any flow observed in the drainage system? (Note: this observation should be made at least seven consecutive days after the last significant rainfall event.) _______ Yes _______ No

If yes, describe approximate volume and characteristics (e.g., odor, color).. ________________
____
____
____

Inspected by: ____________________	Reviewed by: ____________________
Signature: ____________________	Signature: ____________________
Date: ____________________	Date: ____________________

J.L. Storedahl and Sons, Inc.
Daybreak Mine
Bi-Annual Stormwater Inspection Form - Wet Season (Oct 1-April 30)

1. General Information:

Date of Inspection: ________________________	**Inspectors:** ____________________________ ____
Weather Conditions: ______________________ ____	**Note: The wet season inspection should be performed when it is raining so that runoff patterns and characteristics can be observed.**

2. Facility Modifications:

Descriptions of significant changes at facility since last inspections, including new equipment, buildings, operations, stormwater system, etc.: ____

____

____

____

____

Do any changes noted above have the potential to impact stormwater runoff? ________________

If yes, describe: ____

____

____

Has site map been updated to reflect current conditions? ________ Yes _______ No

3. Inspection of Potential Pollutant Sources:

Source Area/Operation	Observations (Note problems in Section 5)
1. Mining area, material storage piles.	
2. Maintenance activities.	
3. Fueling activities.	
4. Stormwater treatment additive activities.	
5. Others ________________________________	

4. Inspection of Best Management Practices:

Have any new BMPs been added since last inspection? ___________________________________

If yes, describe: ____

____

____

J.L. Storedahl and Sons, Inc.
Daybreak Mine
Bi-Annual Stormwater Inspection Form - Wet Season (Oct 1-April 30)

4. Inspection of Best Management Practices (continued):

Best Management Practice	Yes or No (Note problems in Section 5)
1. Spill kit properly stocked.	
2. Equipment and vehicles in good condition with no leaks of oil, grease, or fuel.	
3. Nonpaved areas maintained to prevent excessive soil erosion.	
4. Activities that are likely to contaminate stormwater are separate from activities that will not contaminate stormwater.	
5. Culverts free of sediment and debris.	
6. Preventive maintenance program in place.	
7. Erosion of stockpiles prevented or repaired.	
8. Periodic employee training completed.	
9. Recordkeeping requirements per Monitoring Plan met.	

5. Potential Problems and Corrective Actions Taken

List any problems or potential problems identified during the inspection, and describe the corrective action (including the date action was taken) as each problem is corrected.

Potential Problem	Corrective Action Taken and Date

6. Wet Season Stormwater Discharge Inspection and Certification:

Were any floating materials, suspended solids, oil and grease, discoloration, turbidity, odor, etc. observed in the stormwater discharges from the site? ______ Yes ______ No

If yes, describe the observations ____
____
____

Inspected by: ______________________________	Reviewed by: ______________
Signature: ________________________________	Signature: ________________
Date: ____________________________________	Date: ____________________

Appendix E

Letters from Federal Emergency Management Agency to Clark County

Federal Emergency Management Agency

Washington, D.C. 20472

RECEIVED
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PERKINS COIE

JAN 23 1998

The Honorable Mel Gordon
Chairman, Clark County Board
of Commissioners
P.O. Box 5000
Vancouver, Washington 98666-5000

IN REPLY REFER TO:
Case No.: 97-10-205P
Community: Clark County, Washington
Community No.: 530024

316-PMR(1)

Dear Mr. Gordon:

This is in reference to a request for a revision to the effective Flood Insurance Rate Map (FIRM), Flood Boundary and Floodway Map (FBFM), and Flood Insurance Study (FIS) report for your community. Information pertinent to this revision request is listed below.

Requester:	Mr. Thomas R. Grindeland, P.E. Senior Hydraulic Engineer WEST Consultants, Inc.
Flooding Source:	East Fork Lewis River
FIRM Panels Affected:	0159 B, 0178 B, 0179 B, 0186 B, and 0187 B
FBFM Panels Affected:	0159, 0178, 0179, 0186, and 0187

We reviewed the information submitted in support of this request and determined that we should revise and republish the FIRM, FBFM, and FIS report. Based on the revised hydrologic and hydraulic analyses submitted, the elevations and floodplain and floodway boundary delineations of the flood having a 1-percent chance of being equaled or exceeded in any given year (base flood) will be revised along the East Fork Lewis River, from approximately 17,000 feet downstream to just downstream of Daybreak Road. We will send preliminary copies of the revised FIRM, FBFM, and FIS report to your community for review in approximately 30 days. At that time, your community will have 30 days to provide information to support other changes to the affected portions of the FIS report and maps. We will review all information submitted during that 30-day period and incorporate it as appropriate before the FIS report and maps are republished and distributed.

At the end of the comment period, we will initiate a 90-day appeal period. You will receive formal notification of the 90-day appeal period. During this time, community officials and/or affected property owners may submit scientific or technical information to support reconsideration of the proposed base flood elevations presented in the revised FIS report and maps. Notification of this appeal period will also appear in *The Columbian*.

In addition, we have determined that the floodway boundary delineation shown on the FBFM dated August 2, 1982, is no longer valid and must be revised. The proposed floodway boundary delineation that will be shown on the preliminary copies of the FBFM is based on the revised hydrologic and hydraulic data submitted with this request. We have not received a request from the community to revise the floodway. Because the regulatory floodway is adopted by the community, as part of floodplain management ordinances required by Section 60.3 of the National Flood Insurance Program (NFIP) regulations (copy enclosed), any request for changes to the regulatory floodway must be made or approved by the community. Therefore, the proposed floodway boundary delineation that will be shown on the preliminary FBFM, while acceptable to the Federal Emergency Management Agency, must also be acceptable to your community and adopted by appropriate community action as specified in Paragraph 60.3(d) of the NFIP regulations. The community may adopt the proposed floodway, or propose an alternate floodway that meets minimum NFIP regulations.

If you have any questions about the revision and republication process, please contact Mr. Karl Mohr of our staff in Washington, DC, either by telephone at (202) 646-2770 or by facsimile at (202) 646-4596.

Sincerely,

Frederick H. Sharrocks, Jr., Chief
Hazard Identification Branch
Mitigation Directorate

cc: Mr. Steven Hall, P.E.
Manager
Water Resources and
Development Engineering Division
Clark County Department of
Community Development

Mr. Richard Dyrland
Supervisory Hydrologist
Friends of the East Fork

Ms. Lois J. Miller
Friends of the East Fork

Mr. Jeffery P. Wriston
General Counsel
Pacific Rock Environmental
Enhancement Group

Mr. David T. MacDonald

Mr. Thomas R. Grindeland, P.E.
Senior Hydraulic Engineer
WEST Consultants, Inc.

Federal Emergency Management Agency
Washington, D.C. 20472

JUN 16 1999

The Honorable Betty Sue Morris
Chairperson, Clark County
Board of Commissioners
P.O. Box 5000
Vancouver, Washington 98666-5000

Dear Ms. Morris:

This responds to your letter dated September 3, 1998, regarding the Preliminary revised Flood Insurance Study (FIS) report and Flood Insurance Rate Map (FIRM) for the unincorporated areas of Clark County, Washington, dated March 10, 1998. With your letter, you forwarded a letter dated August 28, 1998, from Mr. David McDonald, representative of the Friends of the East Fork and the Pacific Rock Environmental Enhancement Group, appealing the proposed base (1-percent-annual-chance) flood elevations (BFEs) along the East Fork Lewis River. In your letter, you indicated that the County does not wish to join the appeal in its own name. In addition, you requested that the Federal Emergency Management Agency (FEMA) consult with the National Marine Fisheries Service under Section 7 of the Endangered Species Act, regarding the impact that the revision to the Special Flood Hazard Area (SFHA), the area that would be inundated by the base flood, and the BFEs would have on the Anadromus Steelhead fish population of the East Fork Lewis River. The Anadromus Steelhead have recently been listed as a Threatened Species. As indicated in our letter to you, dated September 21, 1998, we have reviewed the submitted information as an appeal in accordance with the provisions of Part 67 of the National Flood Insurance Program (NFIP) regulations.

In support of his appeal, Mr. McDonald enclosed a report entitled, "Hydraulics Study," dated August 1998, prepared by Rodgers Engineering, Friends of the East Fork, and MRM Consulting and a HEC-RAS computer hydraulic model for the East Fork Lewis River. The submitted report indicates that the appeal is based on a revised hydraulic analysis and a geologic analysis that show that the proposed BFEs along the East Fork Lewis River are too low.

We have completed our review of the submitted information and the flood hazard information shown on the Preliminary FIRM and in the Preliminary FIS report and have determined that a revision is not warranted at this time. A detailed response to the issues raised in the submitted report and the concern regarding the Endangered Species Act follows.

Hydraulic Roughness

The submitted report indicates that the hydraulic roughness coefficients, the Manning's n-values (n-values), used in the submitted hydraulic analysis were determined through several methods, including field observation, review of existing hydraulic analyses, inspection of aerial photographs and use of engineering calculations. The report states that, for the East Fork Lewis River, the n-values used in the submitted hydraulic analysis vary from approximately 0.040 to 0.113 in the channel and approximately 0.060 to 0.150 in the overbanks. We have reviewed the submitted calculations, photographs and hydraulic analysis, and the hydraulic analysis used to prepare the preliminary FIRM. The methods used to calculate the n-values in the submitted hydraulic analysis do not appear to produce results that are consistent with actual conditions along the East Fork Lewis River. For example, in the submitted calculations for the channel n-value, a correction factor for channel meander was used. According to the United States Geological Survey (USGS) *Guide for Selecting Manning's N-Values*, an adjustment for channel meander is only applicable when the flow is contained in the channel, which is not true of the base flood on the East Fork Lewis River. We have determined that n-values in the hydraulic analysis used to prepare the Preliminary FIRM which range from approximately 0.040 to 0.079 in the channel and from approximately 0.040 to 0.100 in the overbanks are consistent with the channel and overbank conditions shown in the submitted photographs and the effective hydraulic model, wherein the n-values range from approximately 0.032 to 0.065 in the channel and from approximately 0.045 to 0.107 in the overbanks.

Levees

The submitted report states that no levees or dikes are functioning on this reach of the East Fork Lewis River and that none of the various earthen embankments ("levees") are maintained. In addition, the report indicates that these levees do not qualify as FEMA "defined" levees. FEMA itself does not certify levees, however, it is true that these levees do not meet the requirements of Part 65.10 of the NFIP regulations. This does not preclude including these levees in the hydraulic analysis of the East Fork Lewis River. For levees that do not meet NFIP requirements, use of a two scenario system of hydraulic analyses is indicated in FEMA's *Flood Insurance Study Guidelines and Specifications for Study Contractors* (FEMA 37), January 1995 (copy enclosed). The first scenario is an analysis of the flooding source with the levees in place and the second scenario is an analysis of the flooding source as if the levees did not exist. These two scenarios are referred to as the "with levee" analysis and the "without levee" analysis, respectively. The hydraulic analyses used to prepare the Preliminary FIRM incorporated these two analyses.

Downstream Starting Water Surface Elevation

The submitted report indicates that the location of the cross section and the starting water surface elevation used in the hydraulic analysis used to prepare the Preliminary FIRM is inadequate, because it is not a "control point." The report suggests that Stream Mile 5.81 is a more appropriate location because the cross section at this point has the smallest effective flow area and conveyance. We have reviewed the submitted hydraulic analysis and have determined that the hydraulic roughness coefficients (n-values) are the controlling factor in the calculation of the water surface elevation at the downstream cross sections. As discussed above, we have determined that the n-values in the hydraulic analysis used to prepare the Preliminary FIRM are consistent with the channel and overbank conditions shown in the submitted photographs and those in the submitted hydraulic analysis are not. Therefore, revising the Preliminary FIRM based on the submitted hydraulic analysis is not appropriate.

Roads and Culverts

The submitted report indicates that the roads and culverts in the floodplain are overflowed by floods and act as channel conveyance. Another section of the report states that some of the culverts are blocked and are considered nonconveyant. Please note that, where appropriate, in the hydraulic analysis used to prepare the Preliminary FIRM, the culverts were considered nonconveyant.

FEMA Appeal Criteria Used in Study

The submitted report includes a list of concerns regarding the hydrologic and hydraulic methodologies used to prepare the Preliminary FIRM. These issues are summarized below in italicized type and are followed by our responses.

The requester utilized a split flow analysis of the floodplain where there is existing and new data that shows a continuous water surface elevation across the flood plain. This analysis methodology is not supported for the submitted HEC-RAS model because the United States Army Corps of Engineers (USACE) did not use a split flow analysis in the "official legally standing flood insurance analysis." (Comments 1 & 2)

As outlined in FEMA 37, a split flow analysis must be considered when flows overflow the banks of the main channel and follow a different flow path. Between Stream Miles 7.7 and 8.3, approximately, the flow is divided by areas of high ground into three distinct flow paths. The flow is isolated in each path until the paths converge. The discharge in each path is calculated based on the balance of energy at a point upstream of each divide. The BFEs for each path are calculated independently, based on the cross section area of the isolated path and the discharge confined to that path, among other variables. The hydraulic analysis in the submitted report computed the water surface elevations for the East Fork Lewis River based on assuming the entire discharge would be confined within one flow path and modeling ineffective flow areas for large portions of the cross sections. Confining the entire discharge within one flow path results in artificially high water surface elevations because the conveyance area has been reduced substantially. In addition, the submitted report states that flow overflows the banks of the main channel of the East Fork Lewis River at several locations between Stream Miles 8.5 and 10 and flows north to northwest in the overbank area. The report also indicates that the flow stays in this flow path, rather than returning to the channel. In addition, the submitted topographic information supports the occurrence of a split flow condition during the base flood. Therefore, using a split flow analysis is appropriate for these reaches of the East Fork Lewis River.

The base flood elevations computed by the submitted hydraulic analysis are between 6 inches and 4 feet higher than those shown on the Preliminary FIRM. This would significantly change the proposed floodplain boundaries. (Comment 3)

The new high-water marks that have been established by local residents and are shown in the submitted photographs indicate that the BFEs shown on the Preliminary FIRM are too low. (Comment 4)

The results of the submitted hydraulic analysis indicate that the SFHA is too narrow in places, as shown on the submitted map. In addition, the submitted report includes a new floodplain map showing the revised BFEs. (Comments 5 & 6)

As discussed above, the submitted hydraulic analysis uses n-values that are too high and does not include a split flow analysis. We have determined that the hydraulic analysis used to prepare the Preliminary FIRM is consistent with the flooding conditions along the East Fork Lewis River and the requirements set forth in the NFIP regulations. Therefore, a revision based on the submitted hydraulic model is not warranted. In addition, based on information provided by the USGS, the magnitude of the 1996 flood was greater than the magnitude of the base flood. The submitted report indicates that the approximate annual chance of exceedance for this flood is 0.33 percent. The submitted high-water mark elevations appear to indicate that the water surface elevations resulting from the 1996 flood were lower than the water surface elevations computed for the base flood in the submitted hydraulic model. Furthermore, the revised SFHA delineation shown on the map contained in the submitted report does not match the delineation indicated by the submitted hydraulic model.

The hydraulic roughness coefficients (n-values) used in the hydraulic analysis used to prepare the Preliminary FIRM are 50-percent too low. These extremely low coefficients do not accurately reflect the topographic features of this area: dense forest, dense willow trees, dense brush, etc. (Comment 7)

As discussed in the Hydraulic Roughness section above, we have determined that n-values in the hydraulic analysis used to prepare the Preliminary FIRM are consistent with the channel and overbank conditions shown in the submitted photographs.

The cross sections in the hydraulic analysis used to prepare the Preliminary FIRM do not reflect the existing ground (channel and overbanks) in several reaches on the river. For example, the channel is too deep in the cross section located at Stream Mile 8.

We have compared the cross section geometries used in the hydraulic analysis used to prepare the Preliminary FIRM to the submitted topographic information and the submitted hydraulic analysis. We have determined that the only cross section that is substantially different from those used in the hydraulic analysis used to prepare the Preliminary FIRM is Cross Section 9.53. We have determined that the cross section geometries used in the hydraulic analysis used to prepare the Preliminary FIRM are consistent with the available topographic information, including the topographic information submitted for this appeal.

The "down stream control cross-section at Mile 6.78 does not provide for a true control section" to determine the correct starting water surface elevation for the hydraulic analysis of the base flood. The submitted control point at Stream Mile 5.81 reflects the correct control point because the floodplain is narrow at the cross section.

As discussed in the Downstream Starting Water Surface Elevation section, we have determined that, in the submitted hydraulic analysis, the hydraulic roughness coefficients (n-values) are the controlling factor in the calculation of the water surface elevation at the downstream cross sections. As discussed above, we have determined that the n-values in the hydraulic analysis used to prepare the Preliminary FIRM are consistent with the channel and overbank conditions shown in the submitted photographs and those in the submitted hydraulic analysis are not. Therefore, revising the Preliminary FIRM based on the submitted hydraulic analysis is not appropriate.

Endangered Species Act

In your letter, you requested that the FEMA consult the National Marine Fisheries Service under Section 7 of the Endangered Species Act (ESA), regarding the impact that the revision would have on the Anadromus Steelhead fish population of the East Fork Lewis River. The Anadromus Steelhead have recently been listed as a Threatened Species.

As noted in Part 65.1 of the NFIP regulations, FEMA is authorized by the National Flood Insurance Act of 1968 to identify and publish information with respect to all areas in the United States having special flood hazards. Upon identification of a special flood hazard, FEMA produces the FIRM and FIS report to disseminate that information to the community and the public. The FIRM and FIS report are tools provided to the community and the public, for use in determining flood risk and for making floodplain management decisions. The publication of the FIRM and FIS report, and subsequent revisions, does not physically impact the watershed environment on any given flooding source.

Section 7 of the ESA states that "each Federal agency shall ... insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any threatened species or result in the destruction or adverse modification of habitat of such species which is determined ... to be critical." Since the action FEMA is funding and carrying out is a map revision, the map itself is not jeopardizing the salmon population. We are required to accurately map *existing* conditions. FEMA's action in identifying and publishing flood hazard information is environmentally neutral; therefore, no consultation under Section 7 of the Endangered Species Act is required.

As described in a letter dated April 23, 1998, to Mr. Steve Landino, Washington State Habitat Branch Chief, National Marine Fisheries Service (NMFS), from Mr. David de Courcy, Regional Director, FEMA Region X, a meeting was held on March 26, 1998, between representatives of FEMA and the NMFS to discuss the specifics of this particular case. During the meeting, it was mutually agreed that since FEMA's action of changing the maps to incorporate new engineering data is simply a reflection of best available data, the map revision by itself does not require an assessment or consultation.

This letter hereby resolves the appeal for your community. To assist us in processing the FIRM and FIS report for your community in a timely manner, we request that your community review and comment on the findings in this letter within 30 days of the date of this letter. We will review all requested changes or comments received during the 30-day comment period and revise the FIRM and FIS report, if appropriate, before resuming the publication process. If we do not receive any changes or comments before the 30-day comment period ends, we will resume the publication process at that time.

The next step in the publication process is issuance of a final flood elevation determination letter. The final flood elevation determination letter finalizes BFEs for your community, begins the 6-month compliance period, and establishes an effective date for the FIRM and FIS report. During the 6-month compliance period, your community must adopt a compliant floodplain management ordinance based on the flood hazard information shown on the FIRM.

If you have any questions regarding this matter, the flood hazard mapping for your community, or the NFIP in general, please contact Mr. Max Yuan of my staff in Washington, DC, either by telephone at (202) 646-3843 or by facsimile at (202) 646-4596.

Sincerely,

Michael K. Buckley, P.E., Chief
Technical Services Division
Mitigation Directorate

Enclosure

cc:

Ms. Nancy McCarter
Development Services Division
Office of Development
Engineering Review
Department of Community Development
Clark County

Mr. Gary Fish
Department of Community Development
Clark County

Mr. Tom Fitzsimmons
Director, Department of Ecology
State of Washington

Mr. Jeff Koenings
Director, Department of Fish and Wildlife
State of Washington

Mr. Richard Dyrland
Supervisory Hydrologist
Friends of the East Fork

Ms. Lois Miller
Friends of the East Fork

Mr. Jeffery Wriston
General Counsel
Pacific Rock Environmental
Enhancement Group

Mr. David McDonald

Mr. Thomas Grindeland, P.E.
Senior Hydraulic Engineer
West Consultants, Inc.

Need Information on
FEMA FLOOD HAZARD MAPS?

CONTACT 1-877-FEMA MAP
(Toll Free 1-877-336-2627)

National Flood Insurance Program
Administered by FEMA

This release is intended to acquaint the public with the Federal Emergency Management Agency's new toll-free number established to respond to questions regarding National Flood Insurance Program (NFIP) Flood Hazard maps, including:

- How do I go about getting a Letter of Map Amendment (LOMA)? A Letter of Map Revision Based on Fill (LOMR-F)? A Letter of Map Revision (LOMR)?
- What is the status of my request for a LOMA? LOMR-F? Study?
- How long does it take to get the map revised?
- Did FEMA receive my request for a Letter of Map Amendment?
- I was just told by my lender that my house is in a floodplain and I need flood insurance, what are my options?
- Was a LOMA ever issued for my property?
- Has the National Flood Insurance Program Flood Hazard map for my community been revised?

The following procedures have been established by FEMA for changing and correcting the NFIP Flood Hazard maps. They are: Letters of Map Amendment (LOMAs), Letters of Map Revision(LOMRs), Letters of Map Revision Based on Fill (LOMR-Fs), and Physical Map Revisions.

As a result of numerous requests for revisions or corrections to the NFIP Flood Hazard maps, FEMA has assigned a dedicated staff of trained professionals to respond to the public's requests for information on the procedures to revise or correct the NFIP Flood Hazard maps.

If you have any questions regarding the NFIP Flood Hazard maps or need current information and facts on FEMA Mapping Procedures, call 1-877-FEMA-MAP.

Below are additional Toll-Free numbers that can be used to obtain other information regarding the NFIP and its products.

- For information about the NFIP's Preferred Risk Policy, ask your insurance agent or company, or call the NFIP's toll-free number at 1-800-427-9662.

- For any current FEMA publications, call FEMA's Publication Center at 1-800-480-2520.

- For answers to flood insurance related questions, call the National Flood Insurance Telephone Response Center at 1-800-427-4661.

- For ordering printed copies of effective NFIP Flood Hazard maps and related documents, call the FEMA Map Service Center at 1-800-358-9616.

Additional information on flood insurance and other FEMA programs and activities is available on the FEMA World Wide Web Site (http://www.FEMA.gov) and from FEMA's 24-hour-FAX-on-Demand system at (202) 646-FEMA. TDD# 1-800-427-5593.

Edition 1.0 2/25/99

Appendix F

Implementation Agreement

IMPLEMENTING AGREEMENT FOR THE DAYBREAK MINE EXPANSION AND HABITAT ENHANCEMENT PROJECT

HABITAT CONSERVATION PLAN

Prepared for:

DAYBREAK MINE
Clark County, Washington
Operated and Managed by
J. L. Storedahl & Sons, Inc.

Owned by
Storedahl Properties LLC

CONTENTS

IMPLEMENTING AGREEMENT

1.0 PARTIES

The parties to this Implementing Agreement are J. L. Storedahl & Sons, Inc. and Storedahl Properties LLC (jointly referred to as "Storedahl"), the United States Fish and Wildlife Service ("F&WS"), and the National Marine Fisheries Service ("NMFS"). In this Agreement, F&WS and NMFS are collectively referred to as the "Services."

2.0 RECITALS AND PURPOSES

2.1 Recitals

The parties have entered into this Agreement in consideration of the following facts:

(a) Storedahl owns approximately 300 acres of land adjacent to the East Fork Lewis River. Approximately 80 acres of this land have been operated as a sand and gravel mine or are used to process sand and gravel. Those lands not used for mining purposes have been used for agricultural and such land is comprised primarily of relatively flat pastures;

(b) Historically, the Storedahl property was likely comprised of a number of braided channels, wetlands, alluvial fans and oxbow ponds and, in terms of plant communities, was occupied by wetland, riparian, and upland woodlands. By the mid-1900s, these lands had been cleared, leveled, and graded and put to agricultural uses. Most if not all of the natural features conducive to supporting diverse populations of fish and wildlife were changed to features conducive to agriculture. The Storedahl property has the potential to be managed over the long-term in a manner that would benefit fish and wildlife generally and, more specifically, to create and enhance habitat for a variety of fish and wildlife listed as threatened or endangered under the Endangered Species Act;

(c) The East Fork Lewis River and portions of the Storedahl property have been determined to provide, or have the potential to provide habitat for a variety of fish and wildlife either candidate for listing or listed as threatened or endangered under the Endangered Species Act. These species are identified and discussed in Section 3 of the Daybreak Mine Expansion and Habitat Enhancement Project Habitat Conservation Plan (the "HCP");

(d) The East Fork Lewis River and portions of the Storedahl property have been determined to provide, or have the potential to provide, habitat for fishes that are proposed for listing, are candidates for listing, or identified as "species of concern" by the Services. These species are identified and discussed in Section 3 of the HCP;

(e) Storedahl has developed a series of conservation measures, described in the HCP, that would tailor mining expansion and processing operations so as to minimize and mitigate, to the maximum extent practicable, the impact of potential take on Covered Species incidental to Storedahl's covered activities and to provide long term benefits to Covered Species as well as fish and wildlife generally.

(f) Among other things, Storedahl would: (i) undertake mining and processing activity concomitantly with number of conservation measures designed to benefit Covered Species; (ii) once covered activity (mining and processing) is completed and conservation measures and reclamation activities are implemented, convey a conservation easement to an appropriate conservation organization; (iii) create an endowment fund to further the conservation purposes of covered lands as set forth in the conservation easement and the HCP; and (iv) convey fee title to an appropriate not-for-profit conservation organization when covered activities, conservation measures, and reclamation activities are completed.

2.2 Purposes

The purposes of this Agreement are:

(a) To ensure implementation of each of the terms of the HCP;

(b) To describe remedies and recourse should any party fail to perform its obligations as set forth in this Agreement; and

(c) To provide assurances to Storedahl, consistent with the No Surprises regulations adopted by the Services and as may be modified, clarified or nullified by subsequent regulation or by a court of competent jurisdiction that, as long as the terms of the HCP, the Permit, and this Agreement are performed, no additional mitigation will be required of

Storedahl with respect to Covered Species, except as expressly provided for in this Agreement or required by law.

3.0 DEFINITIONS

The following terms as used in this Agreement will have the meanings set forth below:

3.1 Terms Defined in Endangered Species Act

Terms used in this Agreement and specifically defined in the Endangered Species Act ("ESA") or in regulations adopted by the Services under the ESA have the same meaning as in the ESA and those implementing regulations, unless this Agreement expressly provides otherwise.

3.2 "Changed circumstances" means changes in circumstances affecting a Covered Species or the geographic area covered by the HCP that can reasonably be anticipated by Storedahl and that can reasonably be planned for in the HCP (e.g., the listing of a new species or a fire or other natural catastrophic event in areas prone to such event). Changed circumstances and the planned responses to those circumstances are described in Section 2.1.2.3 of the HCP. Changed circumstances are not unforeseen circumstances.

3.3 "Covered activities" means certain activities carried out by Storedahl on covered lands described in Section 1.5 of the HCP. Covered activities also includes conservation and monitoring measures set forth in the HCP in Sections 4 and 5.

3.4 "Covered lands" means the lands, waters, and facilities located within the Project HCP area as described in Section 1.4 of the HCP and upon which the Permit authorizes incidental take of Covered Species and the lands to which the HCP's conservation and mitigation measures apply. These lands are known as the Daybreak Mine Lands and are described in Exhibit 1 of this Agreement.

3.5 "Covered species" means the species identified in Section 1.7 of the HCP, each of which the HCP addresses in a manner sufficient to meet all of the criteria for issuing an incidental take Permit under ESA § 10(a)(1)(B).

3.6 "Force majeure" means events that are beyond the reasonable control of Storedahl or entities controlled by Storedahl, including its contractors and subcontractors, to the extent that such entities are carrying out activities and measures authorized and including but not limited to Acts of God, sudden actions of the elements including fire, earthquake, floods, or the actions or inaction of state and local agencies that may prevent the implementation of conservation measures.

3.7 **"HCP"** means the Daybreak Mine Expansion and Habitat Enhancement Project Habitat Conservation Plan prepared by Storedahl for the Daybreak Mine Lands.

3.8 **"Listed species"** means a species (including a subspecies or a distinct population segment of a vertebrate species) that is listed as endangered or threatened under the ESA.

3.9 **"Permit"** or "**Permits**" means the incidental take Permit issued by the Services to Storedahl pursuant to Section 10(a)(1)(B) of ESA for take of Covered Species incidental to covered activities on the covered lands as such Permit may be amended from time to time.

3.10 **"Storedahl"** means Storedahl LLC or J. L. Storedahl & Sons, Inc., or both.

3.11 **"Take"** means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any listed or unlisted Covered Species. Harm means an act that actually kills or injures a member of a Covered Species, including an act that causes significant habitat modification or degradation where it actually kills or injures a member of a Covered Species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering.

3.12 **"Unforeseen circumstances"** means changes in circumstances affecting a species or geographic area covered by a conservation plan that could not reasonably have been anticipated to occur during the term of the Permit by plan developers and the Services at the time of the conservation plan's negotiation and development, and that result in a substantial and adverse change in the status of the Covered Species.

3.13 **"Unlisted species"** means a species (including a subspecies or a distinct population segment of a vertebrate species) that is not listed as endangered or threatened under the ESA.

4.0 OBLIGATIONS OF THE PARTIES

4.1 Obligations of Storedahl

Upon execution of this Agreement by all parties, and satisfaction of all other applicable legal requirements, Storedahl will fully and faithfully perform all obligations assigned to it under this Agreement, the Permit, and the HCP.

4.2 Obligations of the Services

The Services will fully and faithfully perform all obligations under this Agreement, the corresponding HCP, and relevant Permits. Further, upon execution of this Agreement by all parties and satisfaction of all other applicable legal requirements, the Services will issue Storedahl a Permit authorizing current and future take, if any, as provided under Section 10 of the ESA, for each listed Covered Species incidental to covered activities.

4.2.1 Permit Coverage

The Permit issued by the Services will identify all of the Covered Species within their respective jurisdictions. The Permit will take effect for Listed Covered Species at the time the Permit is issued. Subject to compliance with all other terms of this Agreement, the Permit will take effect for an unlisted Covered Species upon the listing of such species.

4.2.2 "No Surprises" Assurances

Provided that Storedahl has complied with its obligations under the HCP, this Agreement, and the Permits, the Services may require Storedahl to provide mitigation beyond that provided for in the HCP only under Unforeseen Circumstances and only in accordance with the "no surprises" regulations at 50 C.F.R. §§ 17.22(b)(5), 17.32(b)(5), and 222.307(g)-(h). However, these no surprises assurances may be modified, clarified or nullified by subsequently adopted rules or by order of a court of competent jurisdiction.

5.0 INCORPORATION OF HCP

The HCP and each of its provisions are intended to be, and by this reference are, incorporated herein. In the event of any direct contradiction between the terms of this Agreement and the HCP, the terms of this Agreement will control. In all other cases, the terms of this Agreement and the terms of the HCP will be interpreted to be supplementary to each other.

6.0 TERM

6.1 Initial Term

This Agreement and the HCP will become effective on the date that each Services issue their respective Permits. This Agreement, the HCP, and the Permit will remain in effect for a period of 25 years from issuance of the original Permit, except as provided below.

6.2 Permit Suspension or Revocation

The Services may suspend or revoke the Permit for cause in accordance with the laws and regulations in force at the time of such suspension or revocation. (The regulations applicable to the Permits are found at 50 C.F.R. §§ 13.27 - 13.29, 222.306, and 15 C.F.R. Part 904.) Such suspension or revocation may apply to the entire Permit or only to specified Covered Species, covered lands, or covered activities. In the event of suspension or revocation, Storedahl's obligations under this Agreement and the HCP will continue to the extent that the Services determine that take of Covered Species occurred under the Permit but such take was not fully mitigated in accordance with the HCP. In such event, mitigation measures shall take place until such take has been mitigated to the maximum extent practicable.

6.3 Relinquishment of the Permit

6.3.1 Generally

Storedahl may elect to relinquish the Permit, or each of them, in whole or in part, as to specified covered activities or as to certain species, or both. In the event that Storedahl elects to relinquish the permit(s), then Storedahl will be obligated to implement all applicable conservation measures on those lands on which mining of sand or aggregate was conducted during the period of time the ITP was in effect. Further, in the event that Storedahl elects to relinquish the Permit prior to completion of mining at the Daybreak Mine, Storedahl will implement CM-12 on a pro-rata basis by granting, to an appropriate conservation organization or government entity, fee-simple title to 1.8 acres of land for each acre of covered land that was first disturbed by mining or processing activity conducted during the period of time that the ITP was in effect. In selecting land to be granted, Storedahl shall give priority consideration to land located in the 100-year floodplain and closest to the East Fork Lewis River.

Otherwise, at the time of the relinquishment, Storedahl will have no post-relinquishment requirement to continue mitigation measures developed specifically for a relinquished activity unless the Services determine that:

(a) continuation of a specific mitigation measure as set forth in the HCP is necessary to offset the impacts of take that are caused by or associated with another activity for which Storedahl is retaining Permit coverage;

(b) continuation is necessary to mitigate the impacts of take that occurred as a result of the relinquished activity during the time it was covered by the Permit.

If any post-relinquishment conservation measures are required, as set forth above, to mitigate for the impact of take, Storedahl's obligations for such measures will continue until the specified activities are completed and the Services concur that the post-relinquishment mitigation is completed or no longer required. Unless the parties agree otherwise, the Services may not require more mitigation than would have been provided if Storedahl had carried out the full term of the HCP.

6.3.2 Procedure for Relinquishment

If Storedahl elects to relinquish the Permit as to any but less than all of the specified Covered Species, or specified Covered Activities at any time during the term of the Permits, Storedahl will provide notice to the Services at least 120 days prior to the planned relinquishment. Such notice will include a status report detailing the nature and amount of take of all Covered Species, the mitigation provided for those species prior to relinquishment, the number of acres first disturbed by mining or processing activities while the ITP was in effect, and the status of Storedahl's compliance with all other terms of the HCP. Within 120 days after receiving a notice and status report meeting the requirements of this paragraph, the Services will give notice to Storedahl stating whether any post-relinquishment mitigation is required and, if so, the amount and terms of such mitigation and the basis for the Services' conclusions. If the Services determine that no post-relinquishment mitigation is required, all obligations assumed by the parties under this Agreement will terminate upon the Services' issuance of such notice. If Storedahl disagrees with the Services' determination, the parties may choose to use the dispute resolution procedures described in Section 14 of this Agreement. Storedahl will continue to carry out its obligations under the HCP until any such dispute is resolved. If the parties are unable to agree, the Services will have the final authority to determine whether Storedahl is required to provide post-relinquishment mitigation.

6.3.2 Procedure for Relinquishment

If Storedahl elects to relinquish the Permit as to any but less than all of the specified Covered Species or specified Covered Activities at any time during the term of the Permits, Storedahl will provide notice to the Services at least 120 days prior to the planned relinquishment. Such notice will include a status report detailing the nature and amount of take of all Covered Species, the mitigation provided for those species prior to relinquishment, and the status of Storedahl's compliance with all other terms of the HCP. Within 120 days after receiving a notice and status report meeting the requirements of this paragraph, the Services will give notice to Storedahl stating whether any post-relinquishment mitigation is required and, if so, the amount and terms of such mitigation and the basis for the Services' conclusions. If the Services determine that no post-relinquishment mitigation is required, all obligations assumed by the parties under this Agreement will terminate upon the Services' issuance of such notice. If Storedahl disagrees with the Services' determination, the parties may choose to use the dispute resolution procedures described in Section 14 of this Agreement. Storedahl will continue to carry out its obligations under the HCP until any such dispute is resolved. If the parties are unable to agree, the Services will have the final authority to determine whether Storedahl is required to provide post-relinquishment mitigation.

6.4 Extension of the Permit

Upon Agreement of the parties and compliance with all applicable laws, the Permit may be extended beyond its initial term under regulations of the Services in force on the date of such extension. If Storedahl desires to extend the Permit, it will so notify the Services at least 180 days before the then-current term is scheduled to expire. Extension of the Permit constitutes extension of the HCP and this Agreement for the same amount of time, subject to any modifications that the Services may require at the time of extension.

7.0 FUNDING

Storedahl warrants that it has, and will expend, such funds as may be necessary to fulfill its obligations under the HCP and this Agreement. Storedahl will promptly notify the Services of any material change in Storedahl's financial ability to fulfill its obligations. To ensure notification of any material change in Storedahl's financial ability to discharge its obligations during the life of the Permit, Storedahl will, upon request, convene a meeting with the Services and present current reclamation bond information and the financial status of the conservation endowment fund and other reasonably available financial information as is mutually agreeable to Storedahl and the Services.

8.0 MONITORING AND REPORTING

8.1 Planned Periodic Reports

As described in Section 5 of the HCP, Storedahl will submit periodic reports describing its activities and results of the monitoring program provided for in the HCP.

8.2 Other Reports

Storedahl will provide, within 30 days of being requested by the Services, any additional information in its possession or control pertaining to implementation of the HCP that is requested by the Services for the purpose of assessing whether the terms and conditions of the HCP, including the HCP's adaptive management plan, are being fully implemented. Responsive information need not be presented in any form other than the manner in which it is kept in the ordinary course of business.

8.3 Certification of Reports

All reports will include the following certification from a responsible Storedahl official who supervised or directed preparation of the report:

> I certify that, to the best of my knowledge, after appropriate inquiries of all relevant persons involved in the preparation of this report, the information submitted is true, accurate, and complete.

8.4 Monitoring by Services

The Services may conduct inspections and monitoring in connection with the Permit in accordance with their respective regulations. (See 50 C.F.R. §§ 13.47, 220.301(j).)

9.0 CHANGED CIRCUMSTANCES

9.1 Storedahl-Initiated Response to Changed Circumstances

Storedahl will give notice to the Services within seven days after learning that any of the Changed Circumstances listed in Section 2 of the HCP has occurred. As soon as practicable thereafter, but no later than 30 days after learning of the Changed Circumstances, Storedahl will modify its activities in the manner described in Section 2 of the HCP, to the extent necessary to mitigate the effects of the Changed Circumstances on Covered Species, and will report to the Services on its actions. Storedahl will make such modifications without awaiting notice from the Services.

9.2 Service-Initiated Response to Changed Circumstances

If the Services determine that Changed Circumstances have occurred and that Storedahl has not responded as set forth in Section 2 of the HCP, the Services will so notify Storedahl as provided in the HCP and this Agreement. As soon as practicable after receiving such notice, Storedahl will make the required changes in accord with Section 2 of the HCP and report to the Services on its actions, or respond that it does not believe that Changed Circumstances exist. In the event of disagreement concerning any aspect of the Changed Circumstances provision of the HCP and this Agreement, the parties shall use the dispute resolution procedure set forth in Section 14 of this Agreement.

9.3 Listing of Species That Are Not Covered Species

The Services will promptly notify Storedahl of the Listing of a Species that is not a Covered Species and is known or believed by the Services to use Covered Lands. In the event that a non-Covered Species that may be affected by covered activities becomes listed under the ESA, and is present on Covered Lands, Storedahl will avoid activities that would result in take of such species and will consult with the Services as to measures that may be implemented to avoid take.

10.0 ADAPTIVE MANAGEMENT

10.1 Storedahl-Initiated Adaptive Management

The HCP analyzes and identifies adaptive management measures based on monitoring activities and research and is described in Section 5 of the HCP. As provided in Section 5 of the HCP, Storedahl will implement adaptive management measures when identified triggers are satisfied or met. When changes in management practices are necessary to achieve conservation measures identified in the HCP, Storedahl will make such changes as provided in the HCP without awaiting notice from the Services, and will report to the Services, as provided in the HCP and this Agreement, on any actions taken pursuant to this section.

10.2 Service-Initiated Adaptive Management

If the Services determine that one or more of the adaptive management provisions in Section 5 of the HCP have been triggered and that Storedahl has not changed its management practices in accordance with Section 5 of the HCP, the Services will so notify Storedahl. As soon as practicable after receiving such notice, Storedahl will make the required adaptive management changes in accord with Section 5 of the HCP and within 30 days report to the Services on its actions, or respond that it does not believe that adaptive management triggers have been reached.

In the event of disagreement concerning any aspect of the adaptive management provision of the HCP and this Agreement, the parties shall use the dispute resolution procedure set forth in Section 14 of this Agreement. Such changes are provided for in the HCP, and hence do not constitute unforeseen circumstances or require amendment of the Permit or HCP, except as provided in this section.

10.3 Reductions in Mitigation

Storedahl will not implement adaptive management changes not specifically identified in the HCP where such changes that will may result in less mitigation than provided for Covered Species under the terms of the HCP unless the Services first provide written approval. Storedahl may propose any such adaptive management changes by notice to the Services, specifying the adaptive management modifications proposed, the basis for them, including supporting data, and the anticipated effects on Covered Species, and other environmental impacts. Within 120 days of receiving such a notice, the Services will either approve the proposed adaptive management changes, approve them as modified by the Services, or notify Storedahl that the proposed changes would constitute Permit amendments that must be reviewed under Section 13.2 of this Agreement.

10.4 No Increase in Take

This section does not authorize any modifications that would result in an increase in the amount and nature of take, or increase the impacts of take, of Covered Species beyond that analyzed under the original HCP and any amendments thereto. Any such modification must be reviewed as a Permit amendment under Section 13.2 of this Agreement.

11.0 FORCE MAJEURE

11.1 Force Majeure Procedures

In the event Storedahl is wholly or partially prevented from performing the obligations under this Agreement because of a force majeure event, Storedahl will be excused from whatever performance is affected by such force majeure event to the extent so affected, and such failure to perform will not be considered a material breach of this Agreement, provided that nothing in this paragraph will be deemed to authorize the Permittee to violate the ESA or to render the goals of the HCP unobtainable, and provided further that:

(a) The suspension of performance is no greater in scope or duration than is reasonably required by force majeure.

(b) The Permittee will promptly notify the Services, by telephone or facsimile, generally, not to exceed 72 hours of becoming aware of an event that constitutes force majeure and provide notice, in writing, within one week of such event. Such notice will identify the event preventing the performance of obligations, whether the prevention of performance may be permanent or temporary and, if temporary, the delay or anticipated timeframe by which the performance may be achieved. Notice is not required where the Services have actual notice of delays or events causing force majeure.

(c) Storedahl will use reasonable efforts to avoid and mitigate the effects of delay in performance of obligations. A force majeure event may be mitigated by use of adaptive management provisions of this Agreement, the HCP, and by measures subject to the mutual Agreement of Storedahl and the Services.

(d) When and if Storedahl is able to perform suspended obligations, it will provide prompt notice as set forth in paragraph (b) to the Services to such effect.

11.2 Termination Through Force Majeure

Any party may terminate the Permit if a force majeure event renders the goals of the HCP unobtainable. Post-termination mitigation otherwise required under Section 6.0 of this Agreement may, where reasonable, still be required in the event of early termination resulting from force majeure to the extent that such mitigation remains feasible on covered lands.

12.0 LAND TRANSACTIONS

12.1 Acquisition of Land by Storedahl

Nothing in this Agreement, the HCP, or the Permit limits Storedahl's right to acquire additional lands. Any lands that may be acquired will not be covered by the Permit except upon amendment of the Permit as provided in section 13.2 of this Agreement.

12.2 Disposal of Land by Storedahl

As provided in the HCP, Storedahl's transfer of ownership or control of covered land will require prior approval by the Services and an amendment of the Permit in accordance with section 13.2 of this Agreement, except that grants of title or easements under CM-12 of the HCP will not require a Permit amendment, and other transfers of covered lands may be processed as minor modifications in accordance with section 13.1 of this Agreement if:

(a) The land will be transferred to an agency of the federal government and, prior to transfer, the Services have determined that transfer will not compromise the effectiveness of the HCP based on adequate commitments by that agency regarding management of such land;

(b) The land will be transferred to a non-federal entity that has entered into an Agreement acceptable to the Services (e.g., an easement held by the state fish and wildlife agency with the Services as third-party beneficiaries) to ensure that the lands will be managed in such a manner and for such duration so as not to compromise the effectiveness of the HCP;

(c) The land will be transferred to a not-for-profit non-federal entity where (i) the entity is approved in advance by the Services, (ii) the entity's purpose is the conservation of wildlife habitat, or preservation of parks lands, or both, (iii) the land to be transferred is encumbered by a conservation easement acceptable to the Services where the purposes of such conservation easement is to ensure that the lands will be managed in such a manner and for such duration so as not to compromise the effectiveness of the HCP, and (iv) adequate funds are made available to manage such lands;

(d) The land will be transferred to a non-federal entity that, prior to completion of the land transaction, has agreed to be bound by the HCP as it applies to the transferred land and has obtained an incidental take Permit following normal Permit procedures covering all species then covered by Storedahl's Permit; or

(e) The Services determine that the amount of land to be transferred does not exceed a cumulative total of 20 acres for all such transactions over the term of the permit, and will not have a material impact on the ability of Storedahl to comply with the requirements of the HCP and the terms and conditions of the Permit.

13.0 MODIFICATIONS AND AMENDMENTS

13.1 Minor Modifications

(a) Any party may propose minor modifications to the HCP or this Agreement by providing notice to all other parties. Such notice shall include a statement of the reason for the proposed modification and an analysis of its environmental effects including its effects on operations under the HCP and on Covered Species. The parties will use best efforts to respond to proposed modifications within 60 days of receipt of such notice. Proposed modifications will become effective upon all other parties' written approval. If, for any reason, a receiving party objects to a proposed modification, it must be processed as an amendment of the Permit in accordance with subsection 13.2 of this section. The Services will not propose or approve minor modifications to the HCP or this Agreement if the Services determine that such modifications would result in operations under the HCP that are significantly different from those analyzed in connection with the original HCP, adverse effects on the environment that are new or significantly different from those analyzed in connection with the original HCP, or additional take not analyzed in connection with the original HCP.

(b) Minor modifications to the HCP and IA processed pursuant to this subsection may include but are not limited to the following:

(1) corrections of typographic, grammatical, and similar editing errors that do not change the intended meaning;

(2) correction of any maps or exhibits to correct errors in mapping or to reflect previously approved changes in the Permit or HCP;

(3) minor changes to survey, monitoring or reporting protocols.

(c) Any other modifications to the HCP or IA will be processed as amendments of the Permit in accordance with subsection 13.2 of this section.

13.2 Amendment of the Permit

The Permit may be amended in accordance with all applicable legal requirements, including but not limited to the ESA, the National Environmental Policy Act, and the Services' Permit regulations. The party proposing the amendment shall provide a statement of the reasons for the amendment and an analysis of its environmental effects including its effects on operations under the HCP and on Covered Species.

14.0 REMEDIES, ENFORCEMENT, AND DISPUTE RESOLUTION

14.1 In General

Except as set forth below, each party shall have all remedies otherwise available to enforce the terms of this Agreement, the Permit, and the HCP.

14.2 No Monetary Damages

No party shall be liable in damages to any other party or other person for any breach of this Agreement, any performance or failure to perform a mandatory or discretionary obligation imposed by this Agreement, or any other cause of action arising from this Agreement.

14.3 Enforcement Authority of the United States

Nothing contained in this Agreement is intended to limit the authority of the United States government to seek civil or criminal penalties or otherwise fulfill its enforcement responsibilities under the ESA or other applicable law.

14.4 Dispute Resolution

The parties recognize that disputes concerning implementation of, compliance with, or termination of this Agreement, the HCP, and the Permit may arise from time to time. The parties agree to work together in good faith to resolve such disputes, using the informal dispute resolution procedures set forth in this section or such other procedures upon which the parties may later agree. However, if at any time any party determines that circumstances so warrant, it may seek any available remedy without waiting to complete informal dispute resolution.

14.5 Informal Dispute Resolution Process

Unless the parties agree upon another dispute resolution process or unless an aggrieved party has initiated administrative proceedings or suit in federal court as provided in this section, the parties may use the following process to attempt to resolve disputes:

(a) The aggrieved party will notify the other parties of the provision that may have been violated, the basis for contending that a violation has occurred, and the remedies it proposes to correct the alleged violation.

(b) The party alleged to be in violation will have 30 days, or such other time as may be agreed, to respond. During this time it may seek clarification of the information provided in the initial notice. The aggrieved party will use its best efforts to promptly provide any information then available to it that may be responsive to such inquiries.

(c) Within 30 days after such response was provided or was due, representatives of the parties having authority to resolve the dispute will meet and negotiate in good faith toward a solution satisfactory to all parties or will establish a specific process and timetable to seek such a solution.

(d) If any issues cannot be resolved through such negotiations, the parties will consider non-binding mediation and other alternative dispute resolution processes and, if a dispute resolution process is agreed upon, will make good faith efforts to resolve all remaining issues through that process.

15.0 MISCELLANEOUS PROVISIONS

15.1 No Partnership

Neither this Agreement nor the HCP shall make or be deemed to make any party to this Agreement the agent for or the partner of any other party.

15.2 Notices

Any notice permitted or required by this Agreement shall be in writing, delivered personally to the persons listed below, or shall be deemed given five (5) days after deposit in the United States mail, certified and postage prepaid, return receipt requested and addressed as follows, or at such other address as any party may from time to time specify to the other parties in writing. The name, address, telephone, and facsimile numbers of the designated representative may be changed at any time by notice to all other parties. Notices may be delivered by facsimile or other electronic means provided that they are also delivered personally or by certified mail. Notices shall be transmitted so that they are received within the specified deadlines.

Assistant Regional Director
United States Fish and Wildlife Service
911 N.E. 11th Ave.
Portland, Oregon 97232-4181
Telephone: 503-231-6159
Telefax: 503-231-2019

Regional Administrator
National Marine Fisheries Service
7600 Sand Point Way N.E.
Seattle, Washington 98115-0070
Telephone: 206-526-6150
Telefax: 206-526-6426

Storedahl Properties LLC
Jerry Lee Storedahl, Manager
2233 Talley Way,
Kelso, Washington 98626
Telephone: 360-636-2420
Telefax: 360-577-3906

J. L. Storedahl & Sons, Inc.
Kimball L. Storedahl, Vice President
2233 Talley Way,
Kelso, Washington 98626
Telephone: 360-636-2420
Telefax: 360-577-3906

15.3 Entire Agreement

This Agreement, together with the HCP and the Permit, constitutes the entire Agreement among the parties. This Agreement supersedes any and all other Agreements, either oral or in writing, among the parties with respect to the subject matter herein and contains all of the covenants and Agreements among them with respect to said matters and each party acknowledges that no representation, inducement, promise, or Agreement, oral or otherwise, has been made by any other party or anyone acting on behalf of any other party that is not embodied herein.

15.4 Severability

If any provision of this Agreement is held to be invalid or otherwise unenforceable, all other provisions shall remain in effect to the extent that they can reasonably be applied in the absence of the invalid or unenforceable provision and continue to generally accomplish the purpose identified in Section 4 of the HCP.

15.5 Elected Officials Not to Benefit

No member of or delegate to Congress shall be entitled to any share or part of this Agreement or to any benefit that may arise from it.

15.6 Availability of Funds

Implementation of this Agreement and the HCP by the Services is subject to the requirements of the Anti-Deficiency Act and the availability of appropriated funds. Nothing in this Agreement will be construed by the parties to require the obligation, appropriation, or expenditure of any money from the U.S. Treasury. The parties acknowledge that the Services will not be required under this Agreement to expend any federal agency's appropriated funds unless and until an authorized official of that agency affirmatively acts to commit to such expenditures as evidenced in writing.

15.7 Duplicate Originals

This Agreement may be executed in any number of duplicate originals. A complete original of this Agreement shall be maintained in the official records of each of the parties hereto.

15.8 No Third-Party Beneficiaries

Without limiting the applicability of rights granted to the public pursuant to the ESA or other federal law, this Agreement shall not create any right or interest in the public, or any member thereof, as a third-party beneficiary or otherwise, nor shall it authorize anyone not a party to this Agreement to maintain a suit for personal injuries or damages pursuant to the provisions of this Agreement. The duties, obligations, and responsibilities of the parties to this Agreement with respect to third parties shall remain as imposed under existing law.

15.9 Services Authorities

Nothing in this Agreement is intended to limit the authority of the Services to seek penalties or otherwise fulfill their responsibilities under the ESA. Moreover, nothing in this Agreement is intended to limit or diminish the legal obligation and responsibility of the Services as agencies of the federal government.

15.10 References to Regulations

Any reference in this Agreement, the HCP, or the Permit to any regulation or rule of the Services shall be deemed to be a reference to such regulation or rule in existence at the time an action is taken.

15.11 Applicable Laws

All activities undertaken pursuant to this Agreement, the HCP, or the Permit must be in compliance with applicable local, state, and federal laws and regulations.

15.12 Successors and Assigns

This Agreement and each of its covenants and conditions shall be binding on and shall inure to the benefit of the parties and their respective successors and assigns. Assignment or transfer of the Permit shall be governed be the Services' regulations.

16.0 CONTENTS NOT BINDING IN OTHER LITIGATION

The contents of the HCP, Permit, and this Agreement shall not constitute statements against interest or admissions and shall not be binding in litigation except among parties to this Agreement in matters related to enforcement of the HCP, Permit, and this Agreement. Storedahl reserves the right to assert in any proceeding that one or more activities comprehended by the HCP, Permit, and this Agreement do not require a Permit.

IN WITNESS WHEREOF, THE PARTIES HERETO have executed this Implementing Agreement to be in effect as of the date that the Services issue the Permit.

By____ Date______________________

David Allen
Regional Director
United States Fish and Wildlife Service
Portland, Oregon

By____ Date______________________

D. Robert Lohn
Regional Administrator
National Marine Fisheries Service
Seattle, Washington

By____ Date______________________

Kimball L. Storedahl
Vice President
J. L. Storedahl & Sons, Inc.

By____ Date______________________

Jerry Lee Storedahl
Manager
Storedahl Properties LLC

EXHIBIT A FOR THE
DAYBREAK MINE EXPANSION AND HABITAT ENHANCEMENT PROJECT

HABITAT CONSERVATION PLAN

Prepared for:

DAYBREAK MINE
Clark County, Washington
Operated and Managed by
J. L. Storedahl & Sons, Inc.

Owned by
Storedahl Properties LLC

The Daybreak Mine Expansion and Habitat Enhancement Project Habitat Conservation Plan and Implementing Agreement shall apply to the following covered lands:

I. DAYBREAK PROPERTY

TRACT A

The Southwest quarter of the Southwest Quarter (Government Lot 4) of Section 18, Township 4 North, Range 2 East of the Willamette Meridian in Clark County, Washington.

EXCEPT any portion thereof lying North of Dean Creek

TRACT B

The East half of the Southeast quarter of Section 13, Township 4 North, Range 1 East of the Willamette Meridian in Clark County, Washington.

EXCEPT any portion thereof lying North of Dean Creek.

EXCEPT County Roads and right of ways thereto.

TRACT C

The Southeast quarter of the Southwest quarter of Section 18, Township 4 North, Range 2 East of the Willamette Meridian in Clark County, Washington.

EXCEPT any portion lying Northerly and Easterly of Bevin Road as conveyed to John Hanger by instrument recorded under Auditors File No. 9506160047.

EXCEPT any portion lying within NE Bevin Road or within NE 61st Avenue or right of ways thereto.

TRACT D

The Northwest quarter of the Northeast quarter of Section 19, Township 4 North, Range 2 East of the Willamette Meridian in Clark County, Washington.

EXCEPT any portion lying within NE 61st Avenue or right of ways thereto.

TRACT E

The Southwest quarter of the Northeast quarter of Section 19, Township 4 North, Range 2 East of the Willamette Meridian in Clark County, Washington.

EXCEPT the following described tract:

BEGINNING at the Northwest corner of the Southwest quarter of the Northeast quarter of said Section 19; thence running in a Southeasterly direction along the center of the county road known as Lewis River Bottom Road, a distance of 265 feet; thence in a Northerly direction to a point on the North line of the Southwest quarter of the Northeast quarter of said Section 19, which is 300 feet East of the point of beginning; thence West 300 feet to the point of beginning.

EXCEPT any portion lying within NE Bennett Road or within NE 61st Avenue or right of way thereto

TRACT F

The Northeast quarter of the Northwest quarter of Section 19, Township 4 North, Range 2 East of the Willamette Meridian in Clark County, Washington.

EXCEPT any portion lying within NE 61st Avenue or right of way thereto.

TRACT G

The Northwest quarter of the Northwest quarter (Government Lot 1) of Section 19, Township 4 North, Range 2 East of the Willamette Meridian, Clark County, Washington.

TRACT H

The East half of the Northeast quarter of the Northeast quarter of Section 24, Township 4 North, Range 1 East of the Willamette Meridian, Clark County, Washington.

EXCEPT County Roads and right of way thereto.

TRACT I

That portion of the Northwest quarter of the Southwest quarter (Government Lot 3), Section 18, Township 4 North, Range 1 East of the Willamette Meridian, Clark County, Washington, lying South and West of the County Road (now known as NE J.A. Moore Road).

EXCEPT any portion thereof lying North and West of Dean Creek

TRACT J

All of that portion of the Northeast quarter of the Southwest quarter of Section 18, Township 4 North, Range 2 East of the Willamette Meridian in Clark County, Washington lying Southerly of the J.A. Moore Road and Westerly of the Lewis River Bottom Road, (now known as NE Bevin Road).

II. EAST FORK LEWIS RIVER

Those portions of the East Fork Lewis River, located in Clark County, Washington adjacent to the Daybreak mine site and extending downstream to the beginning of tidal-influence (river mile 5.9) and upstream of the Daybreak mine site to the Daybreak Bridge (river mile 10).

III. DEAN CREEK

Those portions of Dean Creek located in Clark County, Washington adjacent to the Daybreak mine site and extending downstream to the East Fork Lewis River.

Appendix G

Daybreak Quarry Process Water Treatment Report

DAYBREAK QUARRY
PROCESS WATER TREATMENT REPORT

Prepared for

J.L. Storedahl & Sons, Inc.

July 12, 2000

Prepared by

Maul Foster & Alongi, Inc.
7223 NE Hazel Dell Avenue, Suite B
Vancouver, Washington 98665

Project 9045.006.002

Daybreak Quarry
Process Water Treatment Report

The material and data in this report were prepared under the supervision and direction of the undersigned.

Maul Foster & Alongi, Inc.

Neil R. Alongi, P.E.

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CONTENTS (Continued)

TABLES AND ILLUSTRATIONS

Following Report:

Tables

Figures

1 INTRODUCTION

J. L. Storedahl & Sons, Inc. (Storedahl) operates a sand- and aggregate-processing facility at the Daybreak Mine site. The site is near the East Fork Lewis River, between river miles 8 and 9, approximately 4 miles southeast of La Center, Clark County, Washington (see Figure 1). Currently, no mining activities are occurring at the site; however, a site plan and rezoning proposal for on-site mining and reclamation is being reviewed by Clark County Community Development. A Habitat Conservation Plan (HCP) is also being developed in cooperation with the US Fish and Wildlife Service and the National Marine Fisheries Service. Storedahl proposes to use the Daybreak facility to process and store material that is mined on site, as well as to continue to process materials imported from off site.

This report summarizes the results of field tests on water treatment additives. The water treatment additives were tested to assess whether they would improve the water quality of the ponds and the water that is eventually discharged to Dean Creek and the East Fork Lewis River. The report also describes a closed-loop treatment system being evaluated by Storedahl as a way to treat and reuse process water from the aggregate washing operation. This report supplements the HCP being prepared by R2 Resource Consultants.

1.1 Background Information

The Daybreak site contains a series of five interconnected ponds (see Figure 2). Pond 4 is being reclaimed and is no longer used for managing water. Process water for the facility is pumped from Pond 2, used for processing, and discharged to Pond 1 for settling before being recirculated to Pond 2 through a culvert. Process water is recovered and recycled from Pond 2. Water from rainfall and groundwater discharge flows from Pond 2 into Pond 3 through a culvert. Overflow from Pond 4 to Pond 5 is blocked. Pond 3 flows into Pond 5 through two cut channels.

The total surface area of the existing ponds is approximately 58 acres and the total volume of the ponds is approximately 160 million gallons. Water balance calculations show that the ponds are primarily recharged by groundwater seepage and precipitation, except for Pond 5, which receives significant inflow from Dean Creek during the winter.

Water exits the ponds as subsurface flow, as surface flow from the Pond 5 outlets, and as evaporation. When not rerouted by off-site activities, surface water from Pond 5 overflows into Dean Creek, which eventually flows into the East Fork Lewis River (see Figure 2). Current activities at the Daybreak Mine are covered under National Pollutant Discharge Elimination System (NPDES) general permit WAC-50-1359.

After receiving approval from the Washington State Department of Ecology (Ecology), Storedahl installed and is field-testing a system that improves the water quality of the ponds at the Daybreak facility by dosing the process water with an additive to increase the settling speed of the solids. The system consists of a pretreatment settling trench, a mixing/additive basin, and a post-treatment settling trench. Three different flocculent/coagulant combinations from three chemical manufacturers (NALCO, Calgon, and Wesmar) were evaluated for efficacy in removing solids and cost-effectiveness. The original plan specified one month of testing for each manufacturer. Actual tests were longer to fully test each additive. *The Sand and Gravel General Permit* also specifies that aquatic toxicity tests should be performed and should include both an invertebrate and a fish species as test organisms. The process water treatment testing plan is described in Attachment 1.

1.2 Report Organization

This report is organized as follows:

- **Section 2** describes the project.
- **Section 3** presents the results of the of the testing program.
- **Section 4** describes the closed-loop process water treatment system.
- **Section 5** presents findings and conclusions.

2 PROJECT DESCRIPTION

2.1 Field Tests

Storedahl installed and field-tested a system that adds water treatment chemicals to recycled process water to increase the settling efficiency of the solids in the water. The water treatment additives were used to improve the water quality of the ponds and the water that eventually discharges to Dean Creek and the East Fork Lewis River.

The field tests were used to confirm the results of a bench test under operating conditions that had identified additives from three manufacturers for further testing. The field tests included monitoring and bioassay tests. They assessed the effectiveness of a system operated using the selected additives and the potential environmental impacts of each additive.

To field-test the new system, the mine's process water management system was modified. The channel that had conveyed process water from its discharge point to Pond 1 was lengthened to provide increased settling time before the water reached the additive addition point (see Figure 3). To maximize settling time, the channel flows approximately 600 feet east, then turns and flows back west in a parallel channel. The additives are dosed into the process water at a point near the end of the return channel (see Figure 3). The treated process water flows east in a channel to a discharge point in Pond 1 that is as far as possible from the culvert that connects Pond 1 to Pond 2. This allows the maximum possible settling time before process water is released from Pond 1 and recycled to the processing plant.

The tests were performed by adding the water treatment chemicals into the mixing vault. A small amount of the additives was also dosed at the culvert between Ponds 1 and 2.

2.2 Bench Tests

Several water treatment additives were evaluated during the bench test, including nonionic, anionic and cationic. The manufacturers' product information was used to screen the additives for those with lower toxicity characteristics.

The chemical bench test report is an appendix to Attachment 1. Chemicals selected for field-testing after the bench tests were NALCO 7888, in conjunction with NALCO 9806 (NALCO products); Calgon Catfloc 4900, Catfloc L, and Pol E-Z 7736 (Calgon products); and Poly Alum 60 and Photafloc 1123 (Wesmar products).

2.3 Solids Handling

Solids were excavated as needed from the settling channels to maintain an adequate flow rate. Solids excavated from the settling channels were used to reclaim selected areas of the mine pits as wetlands.

2.4 System Operation

The additive addition area is located in the southwest corner of Pond 1 (Figure 3). Process water is discharged from the washing process into a settling channel that allows some of the entrained solids to settle before they reach the additive addition station. The settling channel flows into a vault, where the settling additive is added and the water constantly mixed. The treatment occurs as a continuous flow process. Treated process water is directed into a channel that conveys the water to the east end of Pond 1 (see Figure 3). By directing the treated water to the east end of Pond 1, the settling time is maximized before the water flows through the culvert connecting Ponds 1 and 2.

2.5 Operator Training

Storedahl personnel who operate the additive discharge system received training on additive dosing system operation, additive dosing adjustment procedures, additive handling procedures, and spill prevention, reporting, and cleanup procedures.

3 TESTING PROGRAM

This section describes the field-testing program and the toxicity tests performed on the process water.

3.1 Field Testing of Process Water

Storedahl began field-testing the process water treatment system on May 25, 1999. NALCO additives 7888 and 9806 were tested until July 13, 1999. Material safety data sheets (MSDS) for the additives are found in Attachment 1.

NALCO 7888 and 9806 proved to be effective in treating the Daybreak process water. Turbidity was reduced to acceptable levels (< 29 nephelometric turbidity units [NTU] maximum) with dosages less than 50% of the LC_{50} of the additives. A detailed description of the testing of NALCO 7888 and 9806 is found in Attachment 2.

On completion of the tests of the NALCO additives, Storedahl began field-testing Calgon additives Catfloc 4900, Catfloc L, and Pol E-Z 7736 on July 14, 1999. MSDSs for those additives are found in Attachment 3. Calgon additives were tested through August 31, 1999, although the Calgon additives were used through the end of 1999.

Calgon Catfloc 4900, Catfloc L, and Pol E-Z 7736 also proved effective in treating the Daybreak process water. Turbidity was reduced to acceptable levels (< 20 NTU maximum) with dosages less than 50% of the LC_{50} of the additives. A detailed description of the tests found in Attachment 2.

Although the field tests for both the NALCO and Calgon additives were successful, Storedahl decided to do an additional field test using additives supplied by Wesmar. Field-testing of the Wesmar additives began in January 2000. Wesmar additives included Poly Alum 60 and Photafloc 1123. MSDSs for the Wesmar additives Catfloc 4900, Catfloc L (CFL), and Pol-E-Z 7736 are included in Attachment 3. The field tests of the Wesmar additives were completed in March 2000. Turbidity was reduced to acceptable levels (< 20 NTU maximum) with dosages less than 50% of the LC_{50} of the additives.

3.2 Toxicity Testing

Storedahl also conducted aquatic toxicity tests throughout the additive trial period. Results are summarized in Table 1.

Toxicity tests were performed on the treated process water for each additive that was field-tested. Water samples were collected from the Pond 1 overflow culvert for testing (sampling location D, Figure 3). The pump intakes for the process water are near the Pond 1 overflow culvert. This configuration facilitates efficient recycling and makes a large portion of Pond 2 available for additional settling and "buffering" of any additives before water overflows into Pond 3.

A second sampling point was located on the south bank of Pond 3, in the vicinity of the culvert (point E, Figure 3). This sampling point provided backup to the primary sampling at the Pond 1 culvert, and an early warning of any accumulation and subsequent discharge of water to Pond 3. The significant volume of Ponds 3 and 5 provided additional mixing and settling time and capacity for the system, and a safety factor for dilution before any discharge from the NPDES sampling point.

Toxicity testing was performed in accordance with the applicable procedures defined in the current Washington Administrative Code (WAC 173-205, "Whole Effluent Toxicity Testing and Limits"). Acute toxicity tests were performed using rainbow trout (*Oncorhynchus mykiss*) and *Daphnia magna* or *Ceriodaphnia dubia* by an analytical laboratory certified by Ecology to perform toxicity testing. Table 2 shows the sampling locations and testing frequency.

The toxicity testing showed that at the dosages necessary to treat the process water, there were no significant toxic impacts to fish (*Oncorhynchus mykiss*). There was one incident of significant mortality of *Ceriodaphnia dubia* during the test of the sample collected on June 9, 1999 (NALCO 7888 and 9806). In discussions with Rick Cardwell, the toxicologist at the Parametrix Lab, it was noted that *Ceriodaphnia dubia* are sensitive to total suspended solids or turbidity. (The only significant mortality to *Ceriodaphnia* dubia was for the samples that had high turbidity.) Testing was therefore switched to *Daphnia magna*, which is the same organism tested during the city of Redmond study (Resource Planning Associates, 1999) on treatment of stormwater from construction sites. Detailed information on the aquatic tests is found in Attachment 2.

Operation of the process water treatment system at Daybreak has significantly reduced the turbidity of the water discharged to Dean Creek. Turbidity exceeded 20 NTU at the outfall only a single time, once system operation was optimized. For nearly three months, outfall turbidity was approximately 5 NTU. Figure 4 compares turbidity at the Daybreak outfall for 1998, 1999, and 2000.

4 CLOSED-LOOP PROCESS WATER TREATMENT SYSTEM

Storedahl is evaluating the possible use of a closed-loop process water treatment system at the Daybreak site. A closed-loop system would involve treating and reusing the process water from the aggregate washing process without releasing water to the ponds. The treatment system being evaluated contains the following components:

- A presettling basin or tank that will remove settleable solids such as sand from the wash water.
- A treatment additive injection system consisting of a storage tank or drum, and a metering pump. A mixing tank may be required for sufficient contact between the wash water and the additive. The additive will enhance the formation of floc particles and subsequent separation of solids from the wash water.
- A clarifier that will settle out floc. The clarifier will have a continuous solids removal system to clean sludge from the clarifier.
- A belt press that will press the sludge to decrease its water content. Water from the press will be recirculated to the treatment system.

Clean water from the clarifier will be recirculated to the aggregate washing process. Makeup water will be provided by a well or pond to compensate for evaporative loss and carryover of water in the processed rock. An advantage of the closed-loop system is that no wash water will be discharged to the ponds. Solids from the presettling basin or tank and sludge from the belt press will be used as backfill for habitat improvement. A flow chart of the proposed treatment system is shown in Figure 5.

The closed loop process water treatment system design would be developed using standard treatment units similar to systems currently being used at other aggregate facilities in the Pacific Northwest. The process to select treatment additives, others than those already tested, will involve evaluating products to determine their effectiveness, costs, and operational requirements. Since the system would not discharge water, the toxicity of the treated water to organisms would not be of concern. The dewatered sediment from the treatment process would contain some of the additives and will be used for reclamation of the ponds. The sediment, which will be exposed to water in the

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reclaimed ponds, may require development of a toxicity testing protocol and subsequent evaluation of the additive selected for use in the treatment process.

5 FINDINGS AND CONCLUSIONS

Storedahl installed and field-tested a system to add water treatment additives to recycled process water to increase the settling efficiency of the solids in the water. The additives were tested to assess whether they improved the water quality of the ponds and the water that is eventually discharged to Dean Creek and the East Fork Lewis River. Storedahl is also evaluating the possible use of a closed-loop process water treatment system at the Daybreak site. A closed loop system would involve treating and reusing water from the aggregate washing process. The findings and conclusions presented below are based on the results of the field and toxicity tests.

5.1 Findings

- NALCO 7888 and 9806 reduced turbidity in the process water to acceptable levels (< 29 NTU maximum).
- Calgon Catfloc 4900, Catfloc L, and Pol E-Z 7736 reduced the turbidity in process water to acceptable levels (< 20 NTU maximum).
- Poly Alum 60 and Photafloc 1123 reduced turbidity in the process water to acceptable levels (< 20 NTU maximum).
- The water treatment additives had no significant toxic effects on fish (*Oncorhynchus mykiss*) or invertebrates (*Daphnia magna*).

5.2 Conclusions

- The water treatment additives increased the settling efficiency of the solids in the process water.
- The water treatment additives did not significantly adversely affect aquatic organisms.

On the basis of the results of the field-testing program and the toxicity tests, MFA recommends that Ecology approve the use of the water treatment additives tested in this study.

LIMITATIONS

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, nor the use of segregated portions of this report.

REFERENCES

MFA. (Maul Foster & Alongi, Inc.). 1999a. *Process Water Treatment System Monthly Report.* Prepared for J.L. Storedahl and Sons, Inc., Vancouver, WA. Maul Foster & Alongi, Inc. August 9.

MFA. 1999. *Supplement to the Daybreak Quarry Stormwater Pollution Prevention Plan.* Prepared for J.L. Storedahl and Sons, Inc., Vancouver, WA. Maul Foster & Alongi, Inc. September 17.

MFA. 1999c. *Process Water Treatment System Monthly Report.* Prepared for J.L. Storedahl and Sons, Inc., Vancouver, WA. Maul Foster & Alongi, Inc. November 30.

Resource Planning Associates. 1999. Polymer-Assisted Clarification of Stormwater from Construction Sites. Prepared for City of Redmond, Washington. February 8.

TABLES

Table 1

J. L. Storedahl & Sons, Inc.
Daybreak Toxicity Testing Results

Sample Date	Additive Supplier	Product Name	Sample Location	Organism	Percent Survival
5/19/99	NALCO	NALCO 7888 and 9806	D	Ceriodaphnia dubia Oncorhynchus mykiss	95 98
6/1/99	NALCO	NALCO 7888 and 9806	D	Ceriodaphnia dubia	70
6/4/99	NALCO	NALCO 7888 and 9806	D	Oncorhynchus mykiss	100
6/9/99	NALCO	NALCO 7888 and 9806	D	Ceriodaphnia dubia Oncorhynchus mykiss	20 100
6/21/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	Pond 3 to Pond 5	Daphnia magna	100
6/23/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	D	Daphnia magna Oncorhynchus mykiss	100 100
7/13/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	D	Ceriodaphnia dubia Oncorhynchus mykiss	95 100
7/21/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	D	Daphnia magna Oncorhynchus mykiss	100 100
8/3/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	D	Daphnia magna Oncorhynchus mykiss	100 100
8/25/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	D	Daphnia magna Oncorhynchus mykiss	* 100
9/7/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	Pond 3 to Pond 5	Daphnia magna Oncorhynchus mykiss	90 100
9/21/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	D	Daphnia magna	90*
11/15/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	D	Daphnia magna Oncorhynchus mykiss	90 100
12/29/99	Calgon	Cat Floc 4900, Cat Floc L, and Pol E-Z 7736	Pond 3 to Pond 5	Daphnia magna Oncorhynchus mykiss	95 100
2/7/00	Wesmar	Poly Alum 60 and Photafloc 1123	D	Daphnia magna Oncorhynchus mykiss	95 100

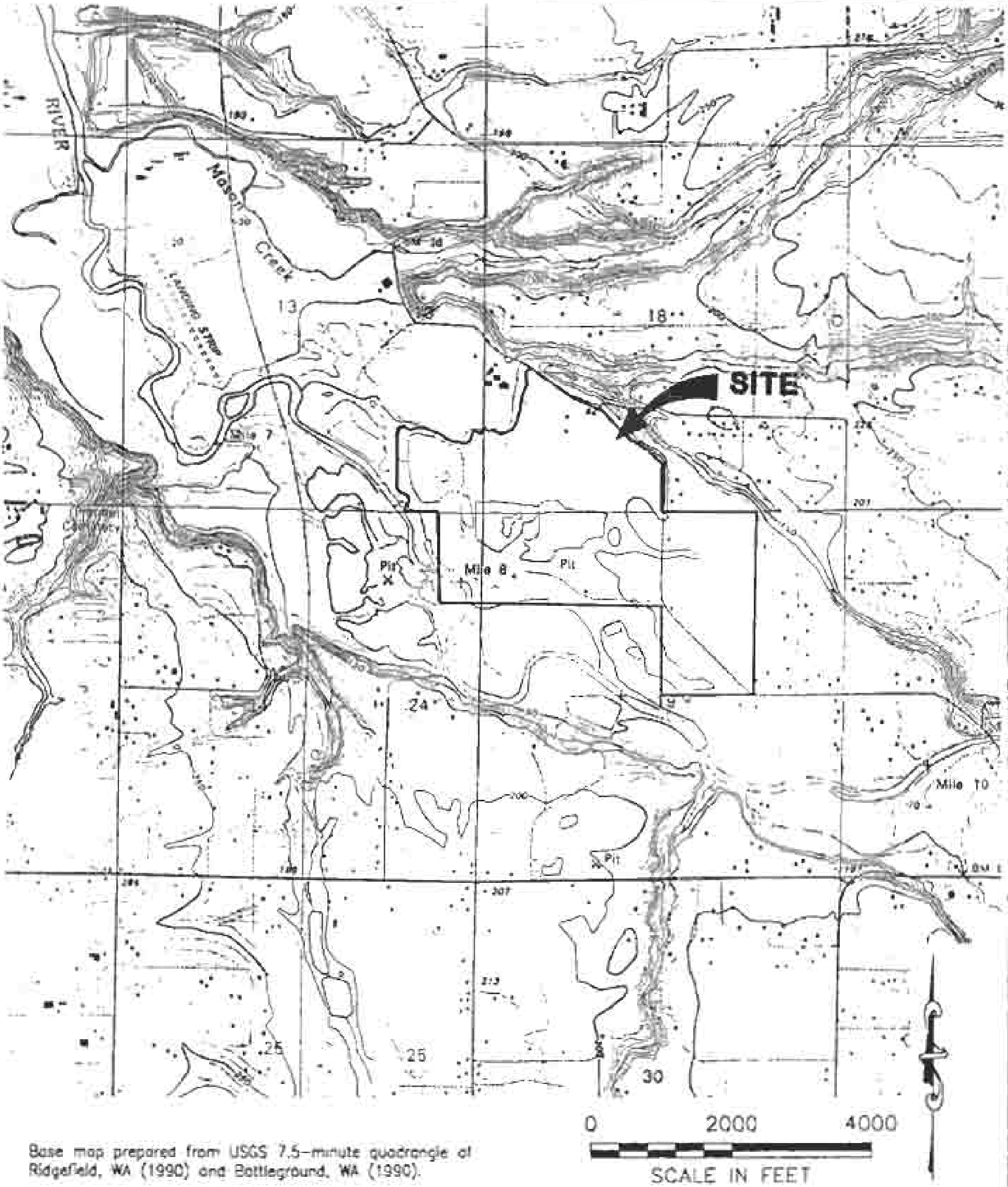
* Daphnia magna test invalidated due to mortality level of control group. An additional sample was collected 9/21 and tested with Daphnia magna.

Table 2

J. L. Storedahl & Sons, Inc.
Sampling Locations and Testing Frequency

Sample Date	Sampling Location	
	Pond 1 Overflow Culvert (Location D)	South Bank of Pond 3 (Location E)
Background	**X**	
Day 7	**X**	
Day 15	**X**	
Day 30	**X**	**X**

FIGURES



Base map prepared from USGS 7.5-minute quadrangle of Ridgefield, WA (1990) and Battleground, WA (1990).

Maul Foster & Alongi, Inc.	DATE 5/99 DWN. JLN APPR. REVIS. PROJECT NO. 9045-006.002	Figure 1 J.L. STOREDAHL DAYBREAK MINE SITE LOCATION

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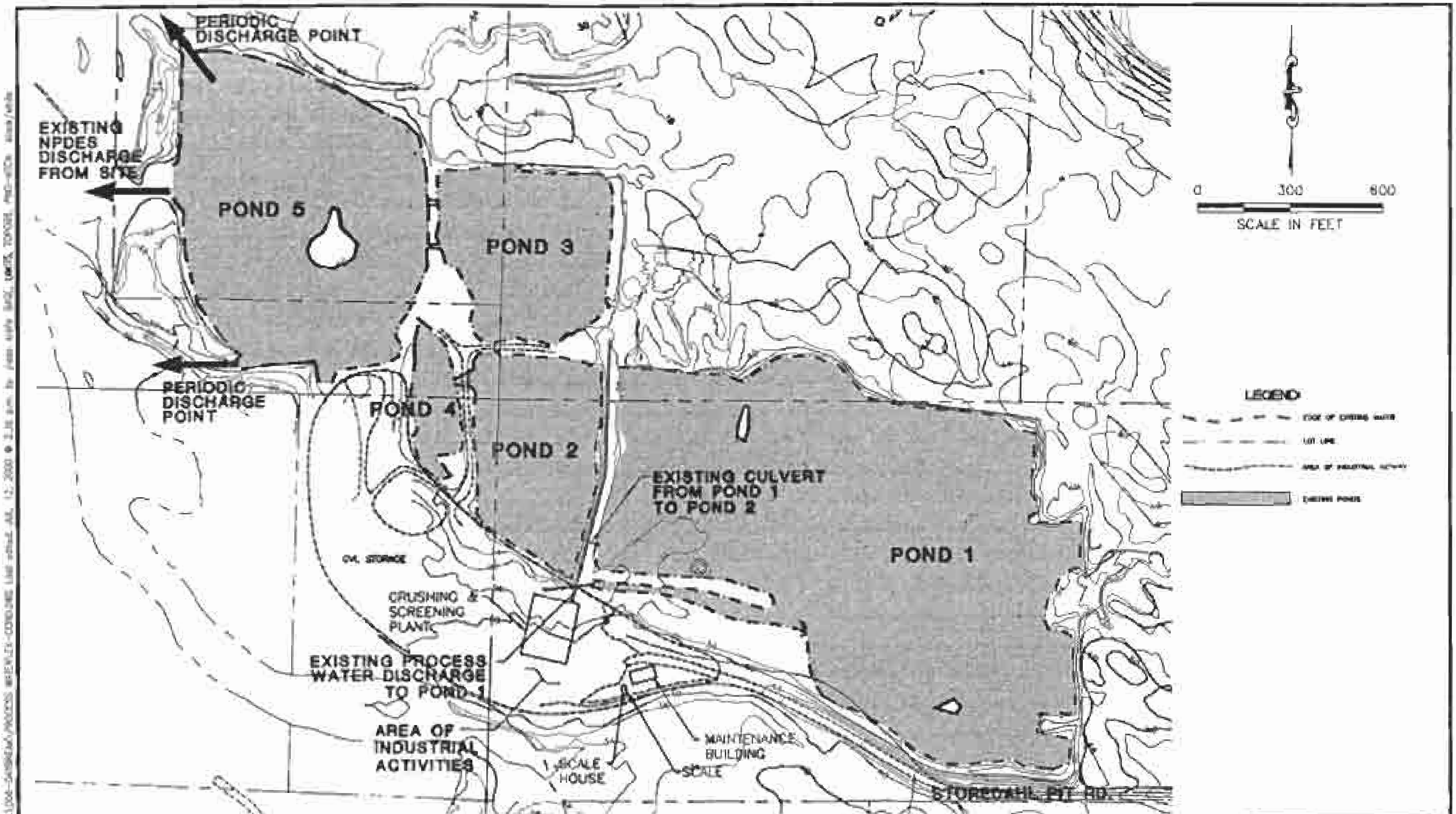

Maul Foster & Alongi, Inc.

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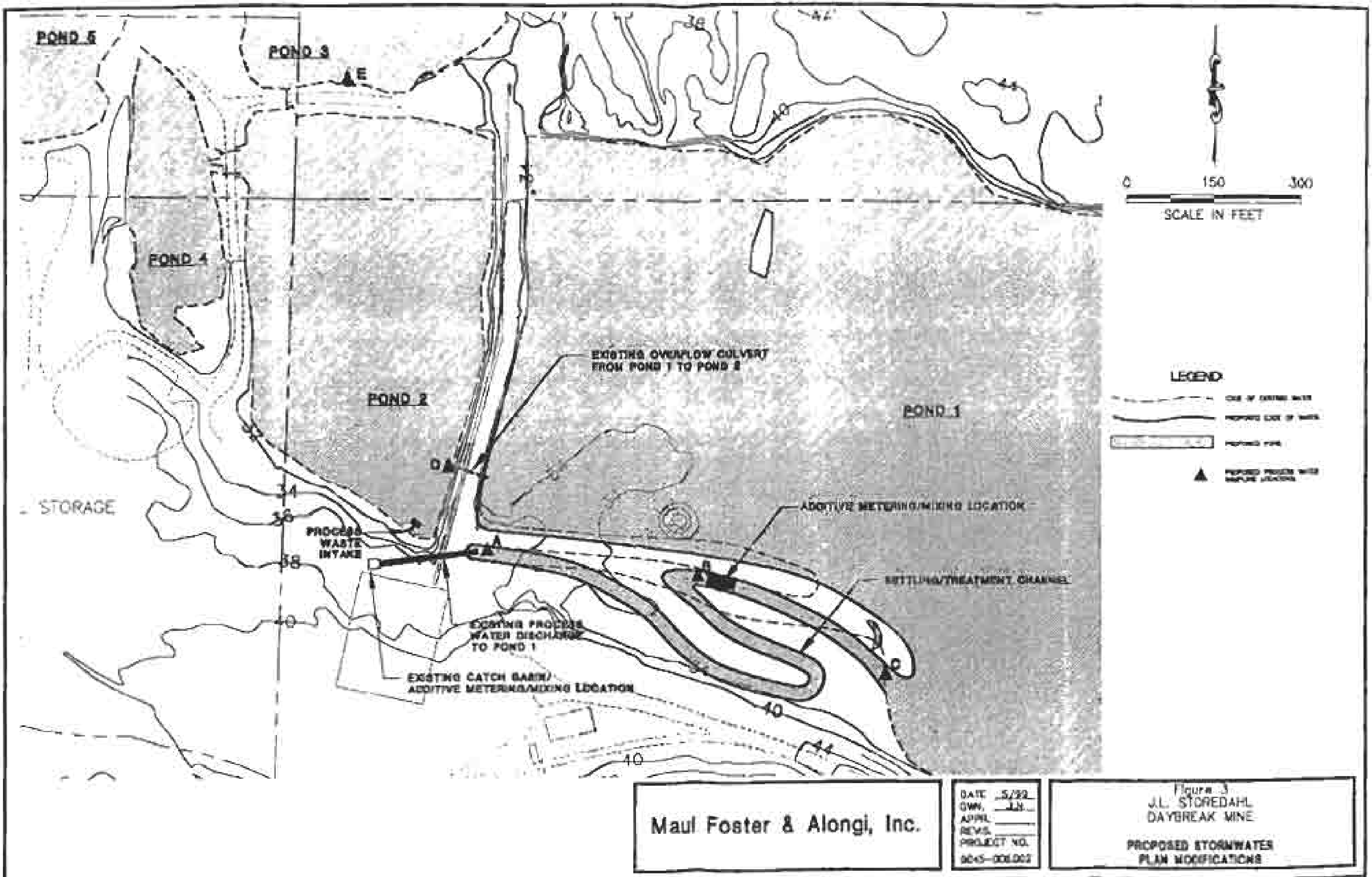
PROJECT NO.
9045.006.002

Figure 2
J.L. STOREDAHL & SONS, INC.
DAYBREAK MINE

EXISTING CONDITIONS



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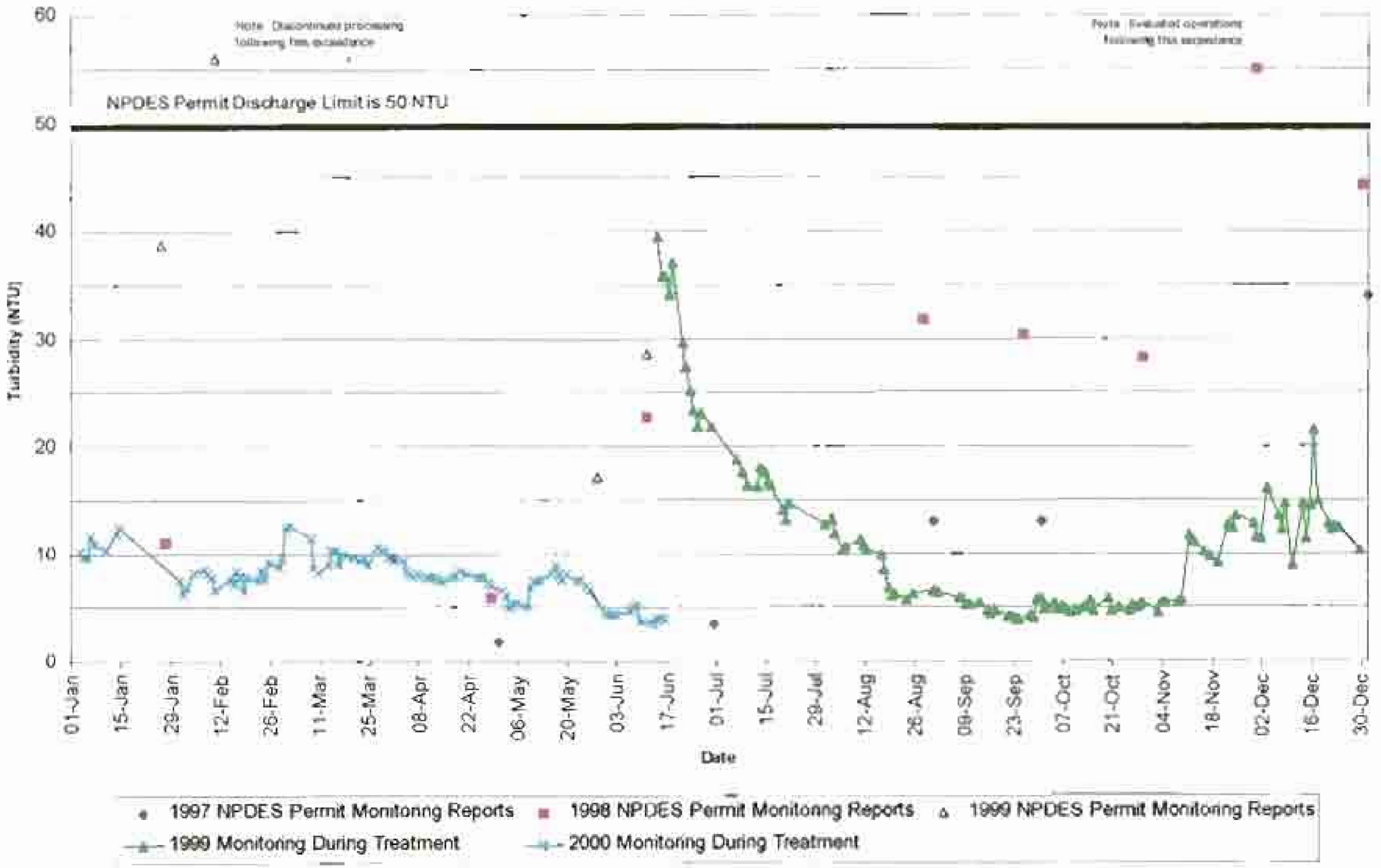

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9045.006.002

Figure 4
J.L. STOREDAHL & SONS, INC.
DAYBREAK MINE

TURBIDITY COMPARISON

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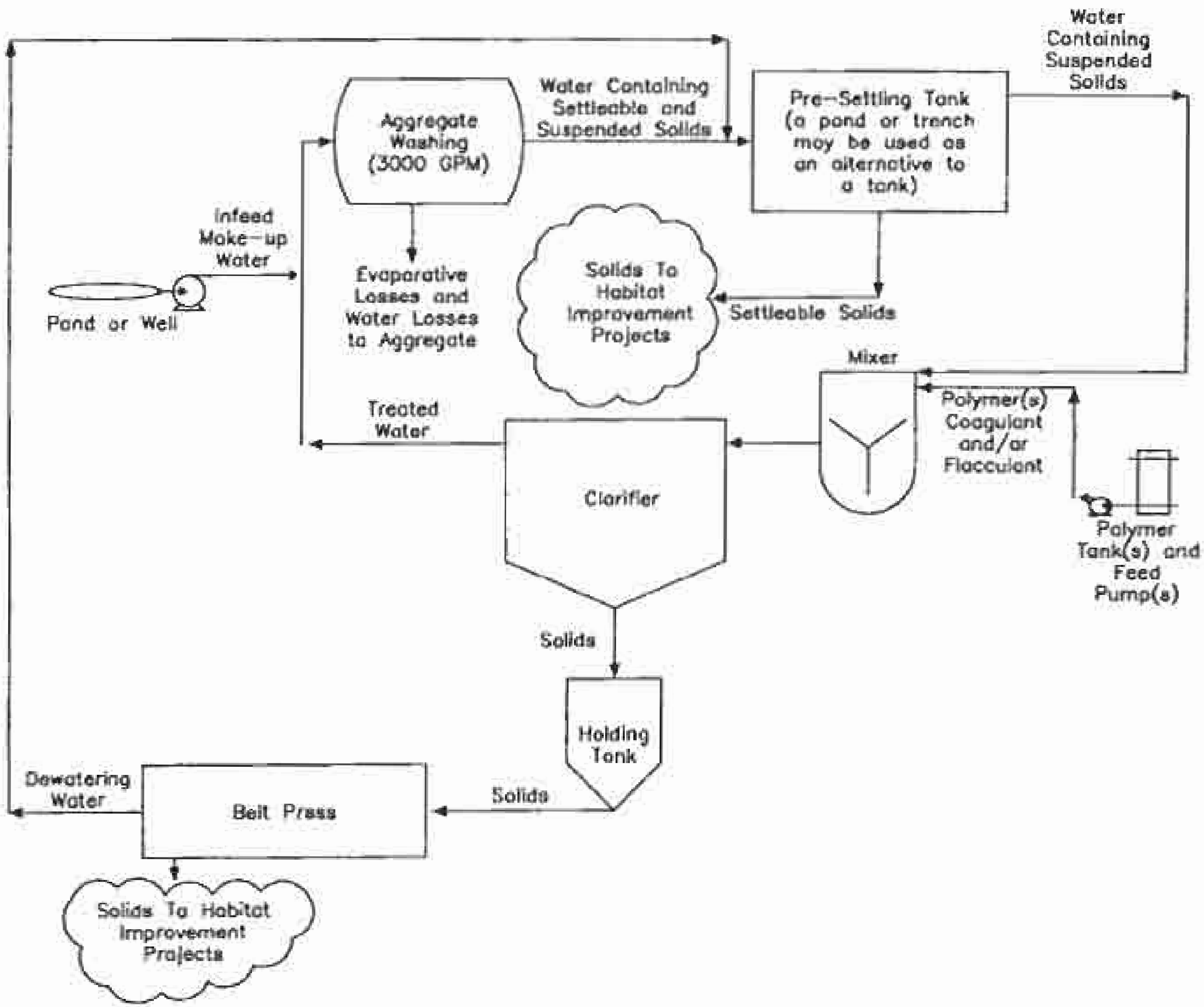

Maul Foster & Alongi, Inc.	DATE 6/00 DWN. JLN APPR. REVIS. PROJECT NO. 9045.008.002	Figure 5 J.L. STOREDAHL & SONS, INC. DAYBREAK MINE **CLOSED-LOOP TREATMENT SYSTEM**

ATTACHMENT 1
SUPPLEMENT TO THE DAYBREAK QUARRY STORMWATER POLLUTION PREVENTION PLAN

SUPPLEMENT TO THE DAYBREAK QUARRY STORMWATER POLLUTION PREVENTION PLAN

CHEMICAL TREATMENT OF PROCESS WATER (TEMPORARY PLAN)

Prepared for

J. L. Storedahl and Sons, Inc.

September 17, 1999

Prepared by

Maul Foster & Alongi, Inc.
7223 NE Hazel Dell Avenue, Suite B
Vancouver, Washington 98665

Project 9045.006.002

Supplement to the Daybreak Quarry Stormwater Pollution Prevention Plan
Chemical Treatment of Process Water (Temporary Plan)

The material and data in this report were prepared under the supervision and direction of the undersigned.

Maul Foster & Alongi, Inc.

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CONTENTS

1 INTRODUCTION

J.L. Storedahl & Sons, Inc. (Storedahl) operates a sand and aggregate processing facility at the Daybreak Mine site. The site is located near the East Fork Lewis River, between river miles 8 and 9, approximately 4 miles southeast of LaCenter, Clark County, Washington (see Figure 1). Currently, no mining activities are occurring at the site, however a site plan and rezoning proposal for on-site mining and reclamation is currently being reviewed by Clark County Community Development. A Habitat Conservation Plan (HCP) is also being developed in cooperation with the US Fish and Wildlife Service and the National Marine Fisheries Service. Storedahl is proposing to use the Daybreak facility to process and store material that is mined on-site as well as to continue to process some materials imported from off-site.

1.1 Background Information

The Daybreak site contains a series of five interconnected ponds (see Figure 2). Process water for the facility is pumped from Pond 2, used for processing activities, and discharged to Pond 1 for settling before the water is re-circulated to Pond 2. Process water is recovered and recycled from Pond 2 at just under 8 cubic feet per second (cfs) and the total ranges from 35,000 to 45,000 cubic feet per day. Water generally flows from Pond 2 into Ponds 3 and 4, and from there into Pond 5. The water levels in Ponds 2 and 3 are usually in equilibrium due to the hydraulic interconnection between them, provided by a constructed permeable rock fill and also by overflow during high water extremes. Pond two is also hydraulically connected to Pond 4 by a similar permeable rock fill. Overflow from Pond 4 to Pond 5 has been blocked. Pond 3 flows into Pond 5 through two cut channels.

The total surface area of the existing ponds is approximately 58 acres and the total volume of the ponds is approximately 160 million gallons. Water balance calculations show that the ponds are primarily recharged by groundwater seepage and precipitation, with the exception of Pond 5, which receives a significant amount of inflow from Dean Creek during the winter. The water balance for the site is shown in the following table.

Water Balance for Existing Ponds

J.L. Storedahl & Sons Daybreak Mine

Flow Category	Flow Rate(cfs) Winter	Summer
Inflow		
Groundwater Seepage Inflow	5.2	1.2
Surface Inflow	20.9	0.2
Total Inflow	26.1	1.4
Outflow		
Groundwater Seepage Outflow	0.9	0.9
Surface Outflow	25.2	0.5
Total Outflow	26.1	1.4

Outflow from Pond 5 has been measured at 24.1 cfs. The discharge point(s) from Pond 5 are currently not fixed and change due to beaver activity and ditching and the relocation of the Dean Creek channel on the adjacent downstream property. Surface outflow to Dean Creek from Pond 5 has been measured as low as 0.5 cfs and has been observed to cease altogether late in the summer. No flow data are available for Dean Creek, but it has also been observed to cease flowing during the late summer.

Mean annual flow in the East Fork Lewis River, into which Dean Creek discharges, is 967 cfs. Reported monthly mean flows range from as low as 108 cfs in August to 1,909 cfs in December.

Water exits the ponds as subsurface flow, as surface flow from outlets in Pond 5, and as evaporation. When not rerouted due to off-site activities, surface water from Pond 5 overflows into Dean Creek, which eventually flows into the East Fork Lewis River (see Figure 2). The current activities at the Daybreak Mine are covered under National Pollutant Discharge Elimination System (NPDES) general permit number WAC-50-1359. Effluent discharge limits specified in the facility NPDES permit are:

- Total Suspended Solids 40 mg/L
- Turbidity 50 NTU
- pH 6.0 to 9.0 for surface water discharges
  6.5 to 8.5 for groundwater discharges

The existing process and storm water management system has maintained compliance with the current facility NPDES permit requirements by providing sufficient detention time for settling and by recycling process water from the Pond 1/Pond 2 system. However, processing of imported materials having higher levels of fines than the on-site aggregate has resulted in turbidity levels at the Pond 5 discharge approaching the 50 NTU permit limit. The high soil content of the raw material and the high flow rate through the process units reduces the ability of the facility to further improve the quality of water in the ponds using the existing management system. Storedahl intends to limit the discharge of turbid water from Pond 5 to Dean Creek by restricting the discharge of Pond 5 to one outlet equipped with a flow control structure, and by significantly reducing the turbidity of the discharge from Pond 5 to 25 NTU, well below permitted limits.. A longer detention time or additional process water treatment is required to achieve improved water quality in the ponds.

1.2 Purpose

Following approval from the Department of Ecology (Ecology), Storedahl will install and field test a system that will improve the water quality of the ponds at the Daybreak facility by adding an additive to the process water to increase the settling speed of the solids. This report supplements the existing Storm Water Pollution Prevention Plan (SWPPP) for the site (MFA, 1998) to reflect the modifications required for more aggressive treatment, i.e. chemical additive use, of the recycled process water.

2 PROJECT DESCRIPTION

2.1 Project Overview

To improve the water quality of the ponds and the water that is eventually discharged to Dean Creek and the East Fork Lewis River, Storedahl will install and field test a system to add water treatment additives to the recycled process water to increase the settling efficiency of the solids in the water.

The field test will be used to confirm the results of a previous bench test under operating conditions. The field test will evaluate the effectiveness of 3 additives that were identified for further testing during a series of bench tests. The field test will include monitoring and bioassay tests, and will compare the cost and effectiveness of a system operated using the selected additives, to a system operated using alum. Each additive will be tested for approximately one month. After all of the additives have been tested, the results will be evaluated to determine the overall effectiveness, cost and potential environmental impacts of each additive.

In order to complete field testing of the new system, modifications will be made to the current process water management system. The current channel that conveys the process water from its discharge point to its release point into Pond 1 will be lengthened to provide as much settling time as possible before reaching the additive addition point (see Figure3). In order to maximize the settling time, the channel will flow approximately 600 feet east, turn and flow back to the west in a parallel channel (see Figure 3). The additive will be dosed into the process water at a point near the end of the return channel (see Figure 3). The treated process water will be directed to the east in a channel to a discharge point in Pond 1 that is as far as possible from the culvert that connects Pond 1 to Pond 2. This will ensure the maximum possible settling time before process water is released from Pond 1 and recycled to the processing plant.

The test will also be performed by adding the water treatment chemical into the catch basin immediately adjacent to the processing area. By adding the chemical to the catch basin, the solids would settle in the first section of the channel and may make removal and disposal easier. The addition of the chemical in two different locations will allow Storedahl to make a comparison of the amount of treatment chemical required based on whether any solids have been settled out of the process water.

If Storedahl is unable to achieve the desired water quality in the ponds using the chemical treatment system described in this report, an additional system for polishing the water discharged from Pond 2 to Pond 3 may be installed at the facility.

2.2 Bench Testing

Several different types of water treatment additives were evaluated during the bench test including non-ionic, anionic and cationic. Only additives having low toxicity levels were selected for bench testing. Additives selected were required to have the potential to produce the required water quality at a concentration no greater than 50% of the L_C50 for the tested organisms. Restricting the chemical concentration to this level will minimize the potential for adverse impacts to the environment due to the toxicity effects of the water treatment additives. The monitoring and bioassay program will be used to confirm that no toxicity effects are occurring due to the operation of the water treatment system. This level is recommended in *Polymer-Assisted Clarification of Stormwater from Construction Sites*, prepared for the City of Redmond (Resource Planning Associates, 1999).

The chemical bench testing report is included as Appendix A. Chemicals selected for field testing after bench testing include NALCO 7888 in conjunction with NALCO 9806, Calgon Cat Floc 4954 or 2953 in conjunction with Calgon Pol E-Z, and alum.

2.3 Solids Handling Plan

Solids will be excavated as needed from the settling channels to ensure that an adequate flow rate is maintained. Solids excavated from the settling channels will be used to reclaim selected areas of the mine pits as wetlands.

2.4 System Operation

The additive addition area will be located in the vicinity of the washing equipment, between Ponds 1 and 2 (see Figure 3). Process water will be discharged from the washing process into a settling channel that will allow some of the entrained solids to settle before reaching the additive addition station. The catch basin near the processing station has been identified as an alternate additive addition location (see Figures 2 and 3) that would allow treatment additives to be added prior to reaching the channel. The settling channel will flow into a basin, where the settling additive will be added and the water constantly mixed. This will occur as a continuous flow process. Treated process water is directed into a channel that conveys the water to the east end of Pond 1 (see

Figure 3). By directing the treated water to the east end of Pond 1, the settling time is maximized before the water flows through the culvert connecting Ponds 1 and 2.

A decision has not been made as to whether the additive addition will be a wet or dry process. The economics of the raw material cost and material handling cost will be evaluated to make this determination.

Each additive will be tested for approximately 30 days. If it becomes evident prior to the end of the 30 day trial period that the additive is not effective or is cost-prohibitive to use, the test will be terminated at that time.

2.5 Operator Training

Storedahl personnel who operate the additive discharge system will receive training on additive dosing system operation, additive dosing adjustment procedures, additive handling procedures, and spill prevention, reporting and cleanup procedures

3 TOXICITY TESTING

One of the criteria for additive selection was a low toxicity value. The additives selected for field testing were required to meet the water quality requirements when used in a concentration of no more than 50% of the L_C50 during bench testing.

Toxicity testing will be performed on the treated process water for each additive that is field tested. Water samples will be collected from the Pond 1 overflow culvert for testing. The pump intakes for the process water are near the Pond 1 overflow culvert (see Figure 2). This configuration facilitates efficient recycling and provides a large portion of Pond 2 for additional settling and "buffering" of any additives, prior to their overflow into Pond 3.

A second sampling point will be located on the south bank of Pond 3, in the vicinity of the permeable fill (Point D). This sampling point will provide backup to the primary sampling at the Pond 1 culvert, and an early warning if there is any accumulation and subsequent discharge of toxic water to Pond 3. The significant volume of Ponds 3 and 5 provide additional mixing and settling time and capacity for the system, acting as a safety valve prior to any discharge from the NPDES sampling point.

Toxicity testing will be performed in accordance with the applicable procedures defined in the current version of WAC 173-205 "Whole Effluent Toxicity Testing and Limits". Acute toxicity tests will be performed using rainbow trout and *Daphnia* by an analytical laboratory certified to perform toxicity testing by Ecology. The following table shows the proposed sampling locations and testing frequency.

Sample Date	**Sampling Location**	
	Pond 1 Overflow Culvert	South Bank of Pond 3
Background	**X**	
Day 7	**X**	
Day 15	**X**	
Day 30	**X**	**X**

After the field testing is complete, toxicity testing will continue quarterly as long as additives are used to treat the process water.

If the process water released from Pond 1 to Pond 2 exhibits toxicity to aquatic life at any time, a new sample will be collected from the overflow culvert between Ponds 1 and 2 and from the south bank of Pond 3 immediately. The intent of this sample is to determine whether toxic conditions have been created in Pond 3. If the additional sample confirms the toxic levels in Pond 3, additive use will be discontinued until the cause of the toxicity can be determined and corrective actions implemented.

4 MONITORING PLAN

4.1 Environmental Monitoring

4.1.1 Sampling

Process water is currently monitored monthly for Total Suspended Solids (TSS), turbidity, pH, and Total Petroleum Hydrocarbons (TPH). The current point of monitoring of process water is at the stormwater overflow discharge point at Pond 5 (see Figure 2). Storedahl will continue to perform the monthly monitoring specified in the facility NPDES permit following the procedures specified by the permit.

During additive testing and use, additional environmental monitoring will be required. The additional environmental monitoring will occur at:

- Point D - The Outlet from Pond 1 to Pond 2
- Point E - The Discharge from Pond 2 into Pond 3

The sampling locations are shown on Figure 3.

The table below summarizes the additional environmental monitoring required during the field testing of the additive treatment system.

Environmental Monitoring

J.L. Storedahl & Sons Daybreak Mine

Parameter	Sampling Locations		
	Point D	**Point E**	**Pond 5 Outfall**
Dissolved Oxygen	Daily	Twice Monthly	Monthly
Turbidity	Daily	Twice Monthly	Monthly
pH	Daily	Twice Monthly	Monthly
Temperature	Daily	Weekly during July, August and September	Weekly during July, August and September
Total Dissolved Solids			Monthly
Total Suspended Solids	Quarterly	Quarterly	Monthly
Total Phosphorus			Monthly
Ammonia			Monthly
Alkalinity	Weekly	Monthly	

Monthly reports will be submitted to Ecology. The reports will contain the quantities of additive used, and a data summary which at the least, will report maximum, minimum, and median values for monitoring parameters. Laboratory data can be submitted later but shall be reported as soon as it becomes available.

4.1.2 Reporting and Record Keeping

Stormwater Sampling:

The NPDES general permit requires that an annual stormwater monitoring report be prepared and submitted to the Water Quality Permit Coordinator of the Department of Ecology Southwest Regional Office by July 15 of each year. The annual report must also be made available to Ecology upon request.

Copies of the test results, sampling logs, chain-of-custody forms, analytical reports, and laboratory quality assurance and control reports should be maintained at the site for at least five years from the date of sample collection. The name of the sampler, date, time, and exact location, of each sampling event will be recorded and signed by an authorized representative of Storedahl. In addition, information on the analytical method used, the detection limits, who performed the analyses, the date, and the results of each analysis will be recorded.

Process Wastewater Sampling:

The NPDES general permit requires that monthly process wastewater monitoring results be reported on a form provided or otherwise approved by Ecology and must be submitted to the Water Quality Permit Coordinator of the Department of Ecology Southwest Regional Office by January 15th, April 15th, July 15th, and October 15th, for each reporting period or partial reporting period.

Copies of the test results, sampling logs, chain-of-custody forms, analytical reports, and laboratory quality assurance and control reports should be maintained at the site for at least five years from the date of sample collection. The name of the sampler, date, time, and exact location, of each sampling event will be recorded and signed by an authorized representative of Storedahl. In addition, information on the analytical method used, the detection limits, who performed the analyses, the date, and the results of each analysis will be recorded.

All information collected during the field test will be included in the reports provided to Ecology.

4.2 Operational Monitoring

In addition to the environmental monitoring required to ensure that operation of the water treatment system does not adversely impact the environment, operational monitoring is required to optimize system performance. Operational monitoring will be performed to determine the correct dosage and dosage location that will meet the water quality requirements using the minimum amount of additives. Operational monitoring will be performed at the following locations:

- Point A - The Process Water Discharge to the Settling Channel
- Point B - Just Upstream from the Additive Addition Location
- Point C - The Treated Process Water Discharge to Pond 1

The sampling locations are shown on Figure 3.

The following table summarizes the operational monitoring required during the field testing of the additive treatment system.

Operational Monitoring

J.L. Storedahl & Sons Daybreak Mine

Parameter	Sampling Locations		
	Point A	**Point B**	**Point C**
Turbidity	Three per Day	Three per Day	Three per Day
pH	Three per Day	Three per Day	Three per Day
Temperature	Three per Day	Three per Day	Three per Day
Total Settleable Solids	Daily - Middle of the Day	Daily - Middle of the Day	Daily - Middle of the Day

This data will be used to optimize the quantity of additive used to treat the process water. It will also be used to evaluate the effectiveness of each additive in meeting the water quality goals and its cost-effectiveness.

5 SPILL PREVENTION

To minimize the potential for accidental discharge of water treatment chemicals into the surface water on-site, they will be stored inside of the facility maintenance building. Any material spilled inside or near the maintenance building can be cleaned up easily and rapidly. The chemicals will be transported to the treatment area as they are needed by the system.

The treatment areas will be constructed with secondary containment using an impermeable membrane and temporary concrete or other curbing. The containers of additive will be stored inside of the secondary containment. The volume of the containment area will exceed the volume of the largest container by 10%. Storm water will be removed from the containment area as needed. Storm water collected in the containment will be inspected prior to discharge by testing the pH. A permanent, covered treatment area will be constructed after a treatment chemical is selected and the size of the area required can be determined.

LIMITATIONS

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

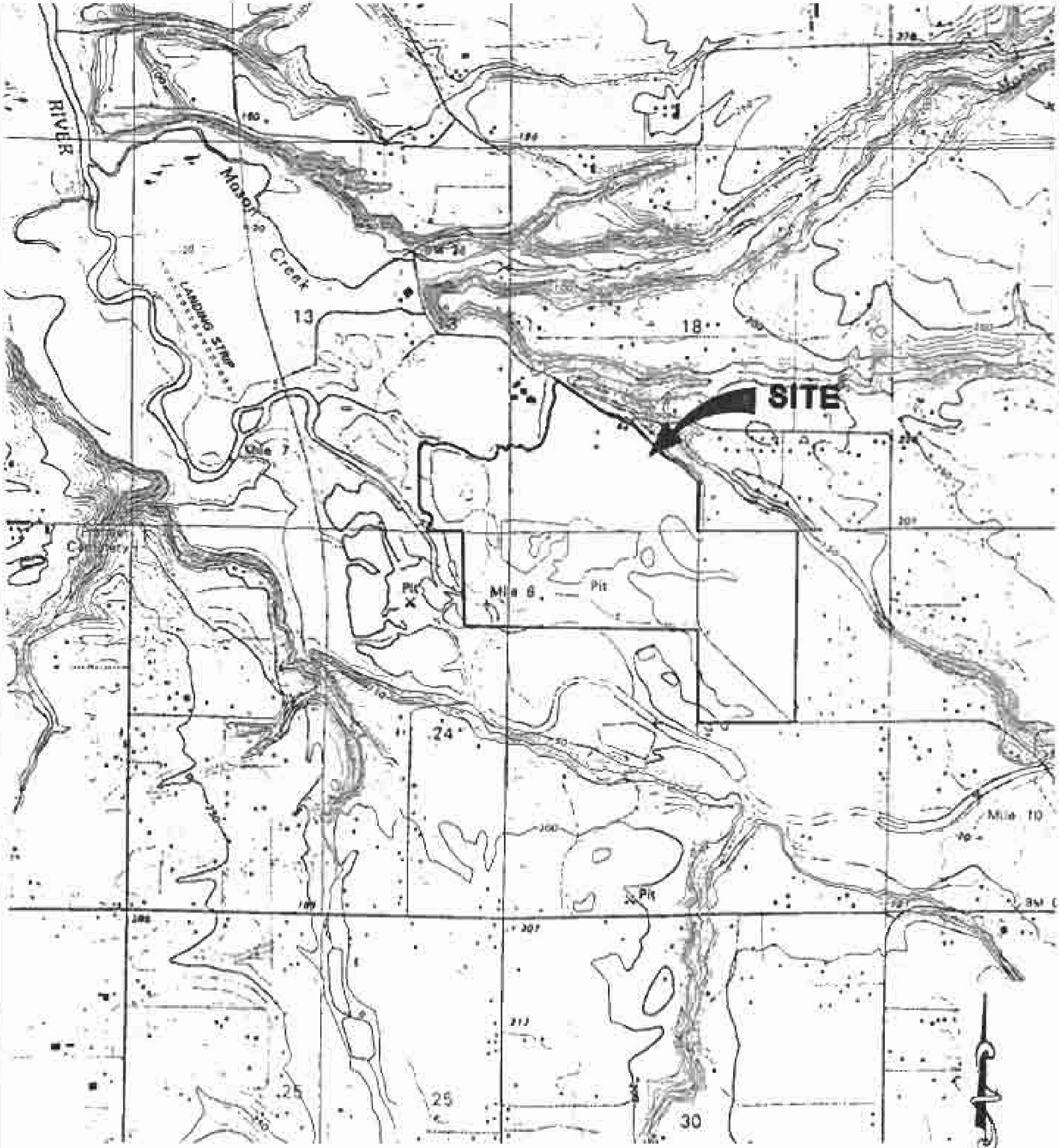
Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, nor the use of segregated portions of this report.

REFERENCES

MFA. 1998. Preliminary Stormwater and Erosion Control Plan and Stormwater Pollution Prevention Plan for Daybreak Mine. Prepared for J.L. Storedahl and Sons, Inc. by Maul Foster and Alongi. November 29.

Resource Planning Associates. 1999. Polymer-assisted Clarification of Stormwater from Construction Sites Experience in the City of Redmond, Washington. Prepared for the City of Redmond by Resource Planning Associates. February 8.

FIGURES

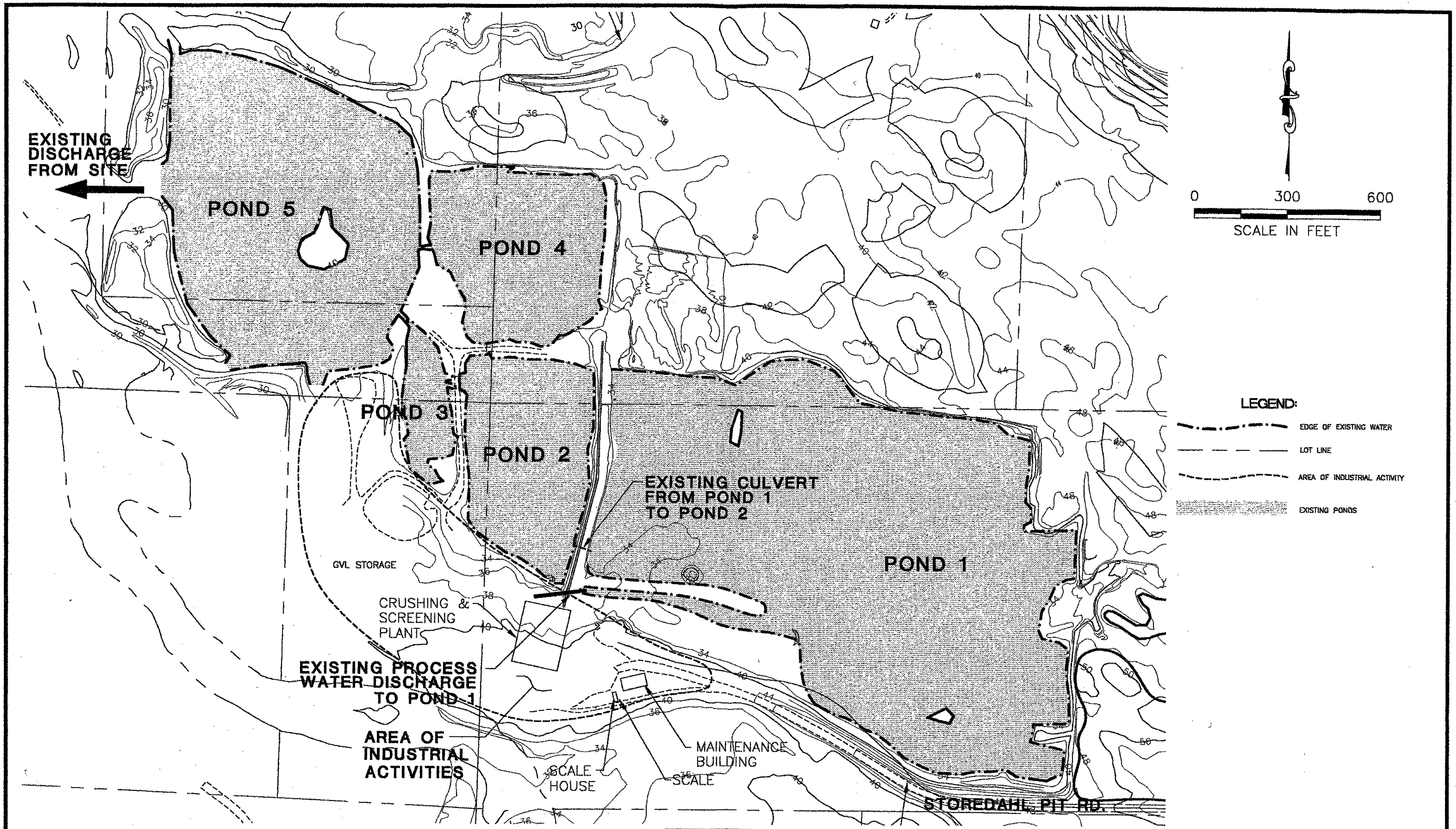


0 2000 4000
SCALE IN FEET

Base map prepared from USGS 7.5-minute quadrangle of Ridgefield, WA (1990) and Battleground, WA (1990).

Maul Foster & Alongi, Inc.	DATE 5/99 DWN. JLN APPR. REVIS. PROJECT NO. 9045-006.002	Figure 1 J.L. STOREDAHL DAYBREAK MINE **SITE LOCATION**

C:\MFA\9045\006\002\SWPPP-03 PLOT AT 1 = 1P



Maul Foster & Alongi, Inc.

DATE 5/99
DWN. JLN
APPR.
REVIS.
PROJECT NO.
9045-006.001

Figure 2
J.L. STOREDAHL
DAYBREAK MINE

EXISTING CONDITIONS

PLOT DATE: 5/7/99 1:19P

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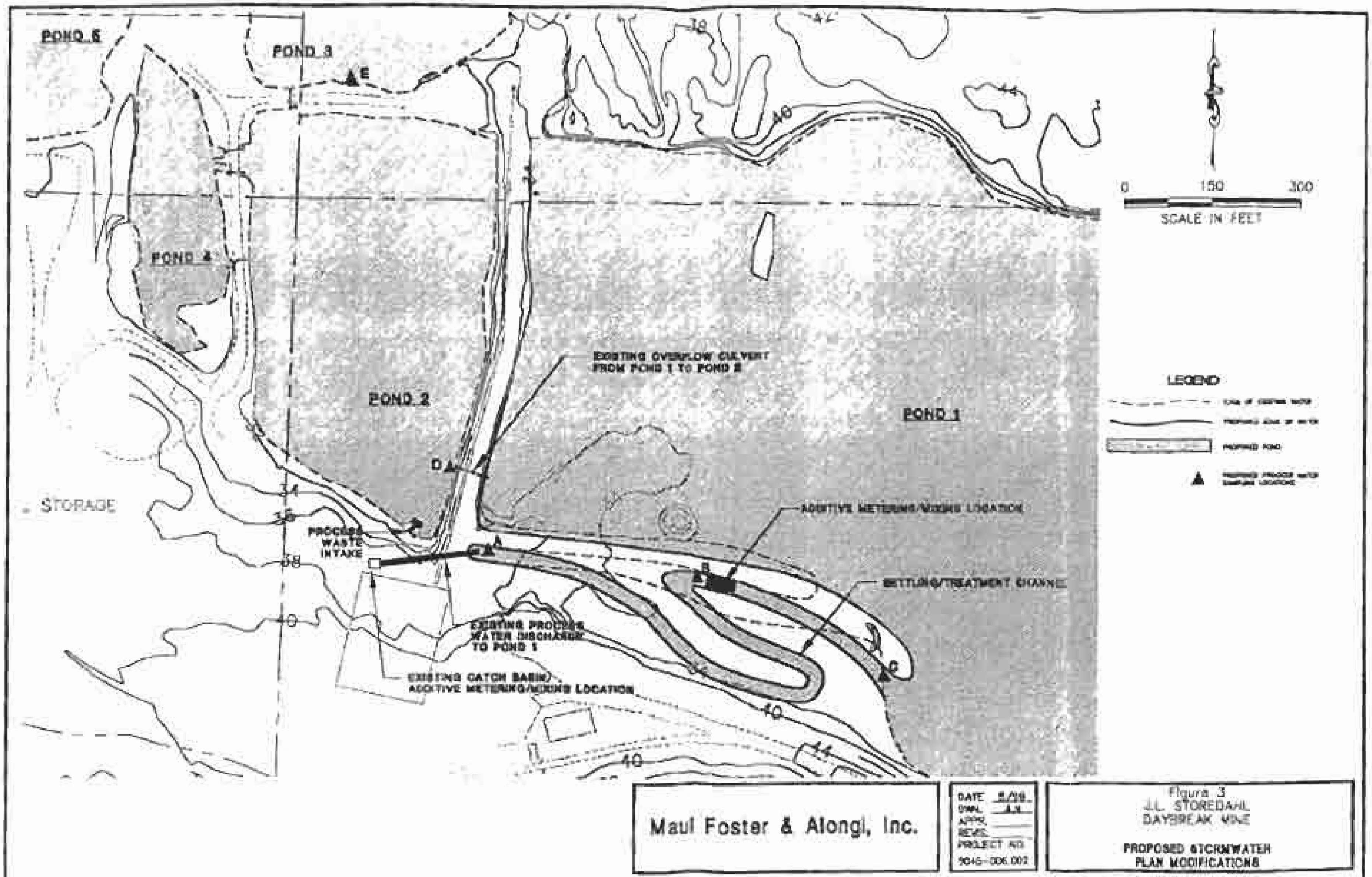
PLOT AT 1 = 1P



POND 6
POND 3
E
POND 4
POND 2
POND 1
STORAGE
EXISTING OVERFLOW CULVERT FROM POND 1 TO POND 2
PROCESS WASTE INTAKE
ADDITIVE METERING/MIXING LOCATION
SETTLING/TREATMENT CHANNEL
EXISTING PROCESS WATER DISCHARGE TO POND 1
EXISTING CATCH BASIN/ ADDITIVE METERING/MIXING LOCATION
D
A
B
C
34
36
38
40
44
0
150
300
SCALE IN FEET
LEGEND
Maul Foster & Alongi, Inc.
DATE
DWN.
APPR.
REVS.
PROJECT NO.
Figure 3
J.L. STOREDAHL
DAYBREAK MINE
PROPOSED STORMWATER PLAN MODIFICATIONS

APPENDIX A

POLYMER BENCH TESTING REPORT

Post-it® Fax Note 7671	Date 4-28	# of pages ▶ 20
To Neil	From John Wodzinski	
Co./Dept.	Co.	
Phone #	Phone #	
Fax # 360 906 1958	Fax #	

DRAFT

April 28, 1999
Project 41144-002.001

Neil Alongi
Maul Foster
7223 NE Hazel Dell Suite B
Vancouver, Washington 98665

Re: Daybreak Mine Washwater Treatment

Dear Mr. Alongi:

This report summarizes briefly the results of screening water treatment chemicals for use in treating the rock crusher washwater at the Daybreak Mine facility in southwest Washington. For consistency in comparing different types of polymers, the screening was performed using only Cytec polymers. Cytec is the largest polymer manufacturer in the U.S.

Testing Protocol

Three separate classifications of treatment agents were screened to determine their effectiveness in coagulating/flocculating suspended solids in the washwater:

- **Poly DADMAC** cationic polymer (polydiallyl, dimethyl ammonium chloride)
- **Polyacrylamide,** non-ionic, anionic, and cationic
- **Inorganic coagulant,** aluminum sulfate (alum) - cationic coagulant

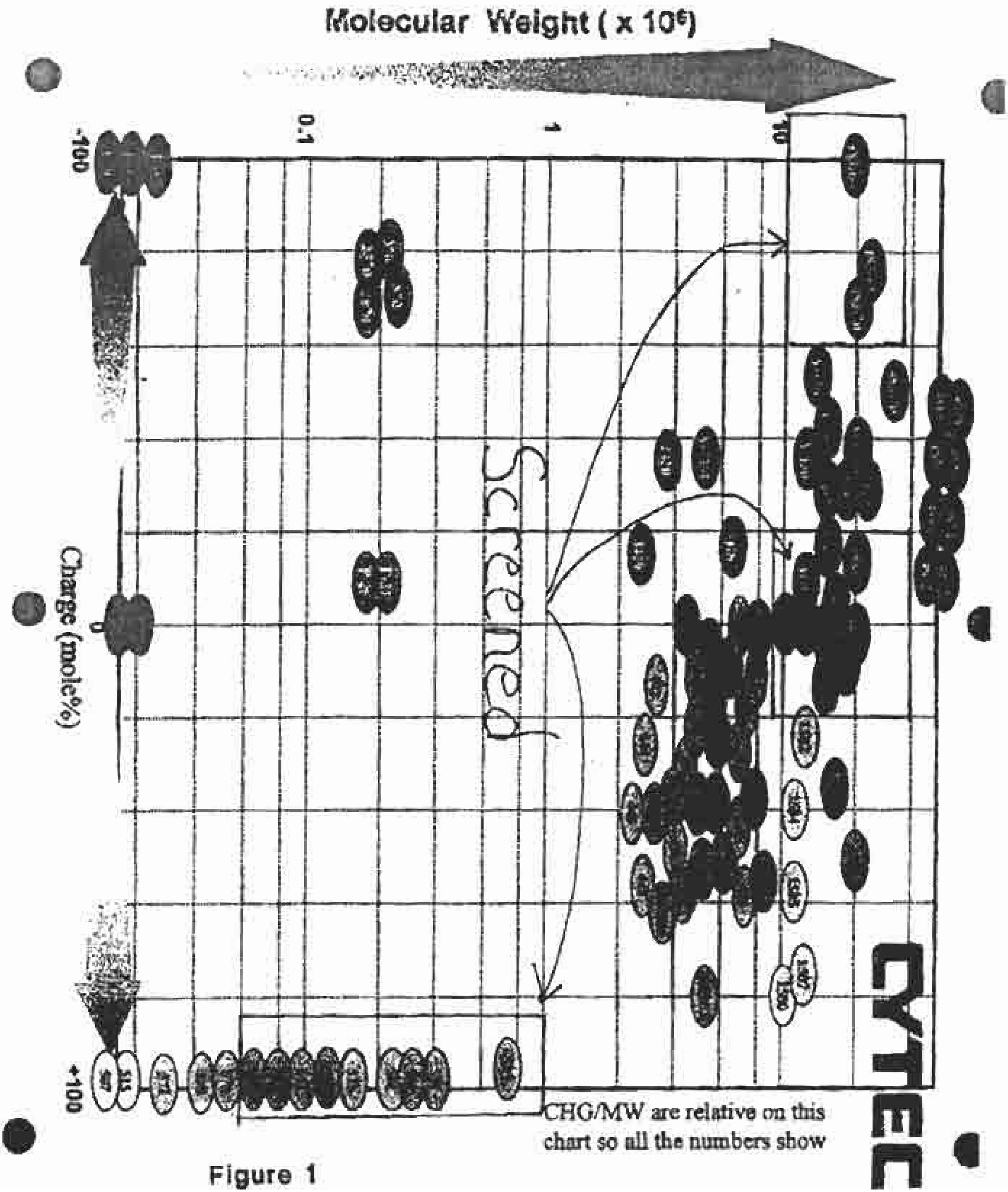
These polymer/coagulant materials were first screened informally at 20 to 40 mg/L dose rates and the results observed. Those treatment agents showing promise were tested further to determine the dosage required to induce rapid settling and clear supernatant. The results of the screening test are provided in Table 1.

The categories of polymers screened and their relative charge density and molecular weight are shown in Figure 1

Polymer Test Results

Dose Rate (mg/L)	DADMAC cationic	Polyacrylamide anionic	Polyacrylamide non-ionic	Polyacrylamide cationic	Aluminum Sulfate cationic
20	moderately effectife	not effective	not effective	not effective	not effective
40	very effective	not effective	not effective	not effective	not effective
100	very effective	not effective	not effective	not effective	slightly effective
200	-	-	-	-	moderately effective
250	-	-	-	-	very effective

- Not tested at these dose rates because they exceed toxicity ratio.



Molecular Weight (x 10^6)
0.1
1
10
-100
Charge (mole%)
0
+100
Screened
CHG/MW are relative on this chart so all the numbers show
CYTEC

Figure 1

Results

As can be seen in Table 1, the only polymer effective at the lower dose rates (40 mg/L) was the DADMAC cationic polymer (Superfloc C-581). The anionic and non-ionic polymers were not effective at all. After treatment with 20 mg/L Superfloc C-581, the supernatant turbidity was reduced from greater than 1,000 NTU to approximately 80 NTU. After treatment with 40 mg/L Superfloc C-581, the turbidity dropped to about 10 NTU and the water was clear and colorless.

Aluminum sulfate (granular technical grade) was effective only at 200 mg/L and above. At 200 mg/L the clarified supernatant measured about 100 NTU. At 250 mg/L the result was about 5 NTU and the water was extremely clear and colorless.

Aquatic Toxicity

The DADMAC Superfloc C-581 performed the best at a low dose rate but the listed LC_{50} for trout is 0.42 mg/L (see Appendix A, MSDS for C-581). This probably excludes it from use where there is a chance it could be released to receiving water.

Aluminum sulfate has an aquatic toxicity in the range of 1,500 mg/L (toxicity literature to follow) and has a long history of use for algae control in lakes (see Appendix B).

It should be noted that prior to this test a poly-aluminum hydroxy chloride treatment agent (Calgon Catfloc 2953) was screened and found effective at about 150 mg/L dose rate. The aquatic toxicity of this material is listed at 1,555 mg/L for trout (LC_{50}). See Appendix C MSDS for Catfloc.

Cost

The cost for bagged aluminum sulfate in 2,000 pound pallet loads is $0.26 per pound.

The cost for Calgon Catfloc 2953 (as well as most other polymers) is approximately $1.20 per pound.

Conclusion

Of all the traditional polymers/coagulants tested, aluminum sulfate appears to satisfy the requirements for low aquatic toxicity, effectiveness, and reasonable cost.

Sincerely,

EMCON

John Macpherson

John Macpherson
Water Quality Program Manager

Attachments:

cc:

Appendix A

CYTEC

MATERIAL SAFETY DATA

MSDS No: 3004
Date: 07/01/97
Supersedes: 12/12/96

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: **SUPERFLOC® C-581 Flocculant**

SYNONYMS: None

CHEMICAL FAMILY: Polymer

MOLECULAR FORMULA: Mixture

MOLECULAR WGT: Mixture

CYTEC INDUSTRIES INC., FIVE GARRET MOUNTAIN PLAZA, WEST PATERSON, NEW JERSEY 07424, USA
For Product Information call 1-800/652-6013. Outside the USA and Canada call 973/357-3193.
EMERGENCY PHONE: For emergency involving spill, leak, fire, exposure or accident call CHEMTREC: 1-800/424-9300. Outside the USA and Canada call 703/527-3887.

2. COMPOSITION/INFORMATION ON INGREDIENTS

OSHA REGULATED COMPONENTS

COMPONENT	CAS. NO.	%	TWA/CEILING	REFERENCE
No Permissible Exposure Limits (PEL/TLV) have been established by OSHA or ACGIH.				

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

APPEARANCE AND ODOR: Amber liquid; slight amine odor

STATEMENTS OF HAZARD:
CAUTION! MAY CAUSE EYE AND SKIN IRRITATION

POTENTIAL HEALTH EFFECTS

EFFECTS OF OVEREXPOSURE:
The acute oral (rat) and dermal (rabbit) LD50 values are estimated to be 4.67 ml/kg and greater than 10.0 ml/kg, respectively. The 4-hour LC50 (rat) value is estimated to be greater than 2500 ppm.
Direct contact with this material may cause mild eye and skin irritation.

4. FIRST AID MEASURES

In case of skin contact, wash affected areas of skin with soap and water.
In case of eye contact, immediately irrigate with plenty of water for 15 minutes.
Material is not expected to be harmful if inhaled. If inhaled, remove to fresh air.

5. FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES

FLASH POINT: >200 F; 93 C
METHOD: Closed Cup

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FLAMMABLE LIMITS
(% BY VOL): Not available

AUTOIGNITION TEMP: Not available

DECOMPOSITION TEMP: Not available

EXTINGUISHING MEDIA AND FIRE FIGHTING INSTRUCTIONS

Use water spray, carbon dioxide or dry chemical to extinguish fires. Use water to keep containers cool. Wear self-contained, positive pressure breathing apparatus.

6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Where exposure level is not known, wear NIOSH approved, positive pressure, self-contained respirator. Where exposure level is known, wear NIOSH approved respirator suitable for level of exposure. In addition to the protective clothing/equipment in Section 8 (Exposure Controls/Personal Protection), wear impervious boots. Spills of this product are very slippery. Spilled material should be absorbed onto an inert material and scooped up. The area should be thoroughly flushed with water and scrubbed to remove residue. If slipperiness remains apply more dry-sweeping compound.

7. HANDLING AND STORAGE

Avoid contact with eyes, skin, and clothing. Wash thoroughly after handling.

To avoid product degradation and equipment corrosion, do not use iron, copper or aluminum containers or equipment.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

Engineering controls are not usually necessary if good hygiene practices are followed. Before eating, drinking, or smoking, wash face and hands thoroughly with soap and water. Avoid unnecessary skin contact. Impervious gloves and apron are recommended to prevent skin contact. For operations where eye or face contact can occur, wear eye protection such as chemical splash-proof goggles or face shield. For operations where inhalation exposure can occur, a NIOSH approved respirator recommended by an industrial hygienist may be necessary.

9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE AND ODOR: Amber liquid; slight amine odor

BOILING POINT: Similar to water

MELTING POINT: Similar to water

VAPOR PRESSURE: Similar to water

SPECIFIC GRAVITY: 1.14-1.18

VAPOR DENSITY: Similar to water

% VOLATILE (BY WT): ~60; (weight/weight)

pH: 5-7

SATURATION IN AIR (% BY VOL): Similar to water

EVAPORATION RATE: Similar to water

SOLUBILITY IN WATER: Complete

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10. STABILITY AND REACTIVITY

STABILITY: Stable
CONDITIONS TO AVOID: None known

POLYMERIZATION: Will Not Occur
CONDITIONS TO AVOID: None known

INCOMPATIBLE MATERIALS: Strong oxidizing agents

HAZARDOUS DECOMPOSITION PRODUCTS: Carbon monoxide, carbon dioxide, ammonia, oxides of nitrogen and/or hydrogen chloride

11. TOXICOLOGICAL INFORMATION

Toxicological information for the product is found under Section 3. HAZARDS IDENTIFICATION. Toxicological information on the OSHA regulated components of this product is as follows:

This product contains no OSHA regulated (hazardous) components.

This product contains (a) chemical(s) known to the State of California to cause cancer and birth defects or other reproductive harm.

12. ECOLOGICAL INFORMATION

LC50 determinations without added suspended solids overestimate the true toxicity of cationic polymers. Suspended solids and other dissolved organic materials like humic acid are present in natural waters and reduce the effective concentration of the polymer and thereby its toxicity.

LC50

BLUEGILL, 96 HOUR: 0.53 mg/L

TROUT 96 HOUR: 0.42 mg/L

DAPHNIA, 48 HOUR: 0.29 mg/L

OCTANOL/H_2O PARTITION COEF.: Not available

13. DISPOSAL CONSIDERATIONS

The information on RCRA waste classification and disposal methodology provided below applies only to the Cytec product, as supplied. If the material has been altered or contaminated, or it has exceeded its recommended shelf life, the guidance may be inapplicable. Hazardous waste classification under federal regulations (40 CFR Part 261 et seq) is dependent upon whether a material is a RCRA "listed hazardous waste" or has any of the four RCRA "hazardous waste characteristics." Refer to 40 CFR Part 261.33 to determine if a given material to be disposed of is a RCRA "listed hazardous waste"; information contained in Section 15 of this MSDS is not intended to indicated if the product is a "listed hazardous waste." RCRA Hazardous Waste Characteristic. There are four characteristics defined in 40 CFR Section 261.21-61.24: Ignitability, Corrosivity, Reactivity, and Toxicity. To determine Ignitability, see Section 5 of this MSDS (flash point). For Corrosivity, see Sections 9 and 14 (pH and DOT corrosivity). For Reactivity, see Section 10 (incompatible materials). For Toxicity, see Section 2 (composition). Federal regulations are subject to change. State and local requirements, which may differ from or be more stringent than the federal regulations, may also apply to the classification of the material if it is to be disposed. Cytec encourages the recycle, recovery and reuse of materials, where permitted, as an alternate to disposal as a waste. Cytec recommends that organic materials classified as RCRA hazardous wastes be disposed of by thermal treatment or incineration at EPA approved facilities. Cytec has provided the foregoing for information only; the person generating the waste is responsible for determining the waste classification and disposal method.

14. TRANSPORT INFORMATION

This section provides basic shipping classification information. Refer to appropriate transportation regulations for specific requirements.

	D.O.T. SHIPPING INFORMATION	IMO SHIPPING INFORMATION
SHIPPING NAME:	NOT APPLICABLE/NOT REGULATED	NOT APPLICABLE/NOT REGULATED
HAZARD CLASS/ PACKING GROUP:	Not Applicable	Not Applicable
UN NUMBER:	Not Applicable	Not Applicable
IMDG PAGE:	Not Applicable	Not Applicable
D.O.T. HAZARDOUS SUBSTANCES:	(PRODUCT REPORTABLE QUANTITY) Not Applicable	Not Applicable
TRANSPORT LABEL REQUIRED:	None Required	None Required

	ICAO/IATA	TRANSPORT CANADA
SHIPPING NAME:	NOT APPLICABLE/NOT REGULATED	NOT APPLICABLE/NOT REGULATED
HAZARD CLASS:	Not Applicable	Not Applicable
SUBSIDIARY CLASS:	Not Applicable	Not Applicable
UN / ID NUMBER:	Not Applicable	Not Applicable
PACKING GROUP:	Not Applicable	Not Applicable
TRANSPORT LABEL REQUIRED:	None Required	None Required
PACKING INSTR:	PASSENGER Not Applicable CARGO Not Applicable	Not Applicable
MAX NET QTY:	PASSENGER Not Applicable CARGO Not Applicable	Not Applicable

ADDITIONAL TRANSPORT INFORMATION

TECHNICAL NAME (N.O.S.): Not Applicable

15. REGULATORY INFORMATION

INVENTORY INFORMATION

US TSCA: This product is manufactured in compliance with all provisions of the *Toxic Substances Control Act*, 15 U.S.C. 2601 et. seq.
This product contains a chemical substance that is subject to export notification under Section 12 (b) of the Toxic Substances Control Act, 15 U. S. C. 2601 et. seq.

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CANADA DSL:	Components of this product have been reported to Environment Canada in accordance with subsection 25 of the Canadian Environmental Protection Act and are included on the Domestic Substances List.
EEC EINECS:	All components of this product are included in the European Inventory of Existing Chemical Substances (EINECS) in compliance with Council Directive 67/548/EEC and its amendments.

OTHER ENVIRONMENTAL INFORMATION

The following components of this product may be subject to reporting requirements pursuant to Section 313 of CERCLA (40 CFR 372), Section 12(b) of TSCA, or may be subject to release reporting requirements (40 CFR 307, 40 CFR 311, etc.) See Section 13 for information on waste classification and waste disposal of this product.

COMPONENT	CAS. NO.	%	TPQ(lbs)	RQ(lbs)	S313	TSCA 12B
1,3-Dichloropropanol	000096-23-1	<0.05	NONE	NONE	NO	YES

PRODUCT CLASSIFICATION UNDER SECTION 311 OF SARA
Not Applicable under SARA TITLE III

16. OTHER INFORMATION

NFPA HAZARD RATING (National Fire Protection Association)

Fire 1
Health 1 0 Reactivity
— Special

FIRE: Materials that must be preheated before ignition can occur.

HEALTH: Materials which on exposure would cause irritation but only minor residual injury even if no treatment is given.

REACTIVITY: Materials which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.

REASON FOR ISSUE:

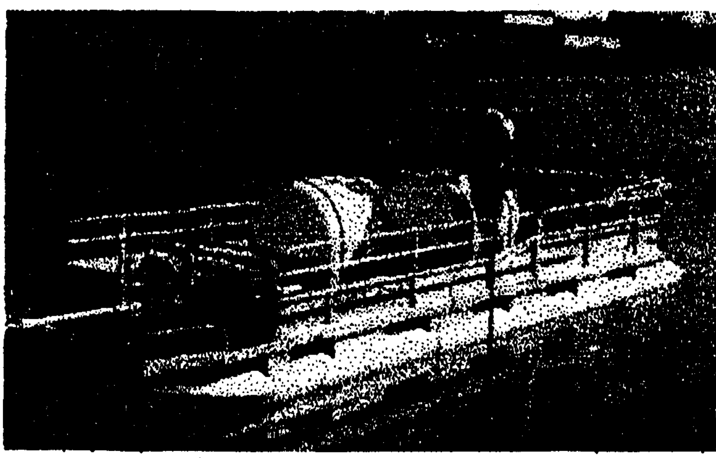
Area Code Change

Larry R. Johnson, DVM, PhD, DABT

Appendix B

ALUMINUM SULFATE TREATMENT

Phosphorus is often the limiting nutrient in the growth of algae. As little as 15 parts per billion of total phosphorous can encourage excessive production of either unicellular or filamentous algae. Through the application of aluminum compounds such as aluminum sulfate (alum), to lakes, reservoirs and ponds, much of the available phosphorus can be removed, thereby depriving algae of a vital nutrient for growth. When added to water, these compounds bind to phosphorus and coagulate other suspended materials. They then precipitate from the water column and settle on the lake bottom as a floc, further impeding the release of phosphorus from the sediments. As a result, aluminum compounds can be an effective means of decreasing available nutrient concentrations thereby controlling nuisance algae and greatly improving water clarity.



In the process of nutrient inactivation, aluminum compounds may alter the pH in a lake. To maintain safe conditions for aquatic organisms, ALLIED BIOLOGICAL performs a series of chemical analyses to determine the most effective dose rate for maximum nutrient removal and minimum pH change Buffering materials such as lime or soda ash, which stabilize the pH, are added to the lake prior to or during treatment, if needed. The pH is then constantly monitored during the application. Nutrient inactivation can provide dramatic improvements in waterbody conditions, but must be conducted carefully to preserve a healthy aquatic biota. ALLIED BIOLOGICAL has the expertise to employ this

Appendix C

Cat-Floc 2953

CALGON CORPORATION

P.O. Box 1346
Pittsburgh, PA 15230-1346
Phone--(412)494-8000
CHEMTREC® 1-800-424-9300

MATERIAL SAFETY DATA SHEET

Section 1. PRODUCT IDENTIFICATION

PRODUCT NAME: **Cat-Floc 2953**

CHEMICAL DESCRIPTION: Acidic aqueous solution
PRODUCT CLASS: Cationic coagulant
MSDS CODE: 0B89-06-28-93

Section 2. INFORMATION ON INGREDIENTS

Chemical Name	CAS Number	% by Weight	OSHA PEL	ACGIH TLV
Poly(aluminum hydroxy) chloride	1327-41-9	~ 26	TWA 2 mg/m^3 (as Al) for Al soluble salts	TWA 2 mg/m^3 (as Al) for Al soluble salts
Hydrochloric acid	7647-01-0	1 - 5	Ceiling 5 ppm, 7 mg/m^3	Ceiling 5 ppm, 7.5 mg/m^3
Sulfuric acid	7664-93-9	1 - 5	TWA 1 mg/m^3	TWA 1 mg/m^3, STEL 3 mg/m^3

Section 3. HAZARDS IDENTIFICATION

*********************** EMERGENCY OVERVIEW ***********************

Clear, pale yellow, slightly viscous liquid.
DANGER!
May cause severe eye damage and skin irritation.
May cause severe digestive tract burns if swallowed.
May cause respiratory tract irritation.
Corrosive to metals.

****

PRIMARY ROUTES OF ENTRY: Eye and skin contact, ingestion, inhalation

TARGET ORGANS: Eye, skin, mucous membranes

Continued on Page 2

Cat-Floc 2953

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: No data available.

POTENTIAL HEALTH EFFECTS:

EYE CONTACT: Contact with the eye will cause painful burning or stinging of the eyes and lids, watering of the eyes, and inflammation of the conjunctiva (the mucous membrane covering the front surface of the eyeball and lining the lids).

SKIN CONTACT: This product may cause irritation, redness, swelling, or dermatitis upon contact. The product is not expected to be absorbed through the skin.

INGESTION: Ingestion of this product may cause severe irritation or burns of the mucous membranes of the mouth, throat, esophagus and stomach.

INHALATION: Inhalation of product mist or vapor may be irritating to the respiratory tract.

SUBCHRONIC, CHRONIC:
No applicable information was found concerning any potential health effects resulting from subchronic or chronic exposure to the product.

Information is available concerning potential health effects resulting from subchronic or chronic exposure to ingredient(s) of the product. See Section 11 for available data.

CARCINOGENICITY:
NTP:
No ingredients listed in this section
IARC:
No ingredients listed in this section
OSHA:
No ingredients listed in this section

Section 4. FIRST AID MEASURES

EYE CONTACT: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Seek medical aid immediately.

SKIN CONTACT: In case of contact, flush skin with plenty of water. Remove contaminated clothing. Seek medical aid if irritation persists. Wash clothing before reuse.

INGESTION: If swallowed, do NOT induce vomiting. Give large quantities of water. Seek medical aid immediately. Never give anything by mouth to an unconscious person.

INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Seek medical aid.

Section 5. FIRE-FIGHTING MEASURES

FLASH POINT: > 200°F
This product is not by definition a "flammable liquid" or a "combustible liquid".

LOWER FLAMMABLE LIMIT: Not applicable UPPER FLAMMABLE LIMIT: Not applicable

Continued on Page 3

Cat-Floc 2953

AUTO-IGNITION TEMPERATURE: Not applicable

EXTINGUISHING MEDIA: Use extinguishing media appropriate for the surrounding fire.

FIRE-FIGHTING INSTRUCTIONS: Exercise caution when fighting any chemical fire. A self-contained breathing apparatus and protective clothing are essential.

FIRE & EXPLOSION HAZARDS: Poly(aluminum hydroxy) chloride reacts with aluminum or zinc to form hydrogen gas.

DECOMPOSITION PRODUCTS: Thermal decomposition or combustion may produce carbon monoxide, carbon dioxide, hydrogen chloride gas, and oxides of nitrogen and sulfur.

NFPA RATINGS: Health = 3 Flammability = 0 Reactivity = 0 Special Hazard = None

Hazard rating scale: 0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe

Section 6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: Wearing appropriate personal protective equipment, contain spill, collect onto inert absorbent and place into suitable container. Spilled product may be neutralized carefully with weak caustic solutions or sodium carbonate. Neutralization releases large amounts of heat.

Section 7. HANDLING AND STORAGE

HANDLING: Do not get in eyes.
Avoid contact with skin and clothing.
Avoid breathing vapor or mist.
Use with adequate ventilation.
Wash thoroughly after handling.
Keep container closed when not in use.

STORAGE: Store away from strong bases.
Store only in compatible plastic or rubber-lined vessels.
Store between 50° - 86°F (10° - 30°C).

Section 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

PERSONAL PROTECTIVE EQUIPMENT:

EYE/FACE PROTECTION: Chemical splash goggles
SKIN PROTECTION: Chemical resistant gloves
RESPIRATORY PROTECTION: If airborne concentrations exceed published exposure limits, use a NIOSH approved respirator in accordance with OSHA respiratory protection requirements (29 CFR 1910.134).

ENGINEERING CONTROLS: Local exhaust ventilation may be required in addition to general room ventilation to maintain airborne concentrations below exposure limits.

WORK PRACTICES: An eye wash station should be accessible in the immediate area of use.

Continued on Page 4

Cat-Floc 2953

SATISFACTORY MATERIALS OF CONSTRUCTION: Storage, transfer lines and feed equipment should be constructed of acid resistant materials, such as polyethylene, PVC, fiberglass or rubber lined.

Section 9. PHYSICAL AND CHEMICAL PROPERTIES

BOILING POINT: > 212°F

SOLUBILITY IN WATER: Complete

VAPOR PRESSURE: Not determined

SPECIFIC GRAVITY: 1.18 - 1.20 @ 25°C

VAPOR DENSITY (air=1): Not determined

pH: 2.5 - 3.0 @ 25°C

%VOLATILE BY WEIGHT: Not determined

FREEZING POINT: Not available

APPEARANCE AND ODOR: Clear, pale yellow, slightly viscous liquid.

Section 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable

HAZARDOUS POLYMERIZATION: Will not occur

CONDITIONS TO AVOID: Poly(aluminum hydroxy) chloride reacts with aluminum or zinc to form hydrogen gas.

INCOMPATIBILITY: Strong alkalies and most metals

DECOMPOSITION PRODUCTS: Thermal decomposition or combustion may produce carbon monoxide, carbon dioxide, hydrogen chloride gas, and oxides of nitrogen and sulfur.

Section 11. TOXICOLOGICAL INFORMATION

ON PRODUCT:

Toxicological data on chronic effects of some ingredients: Workers exposed to hydrochloric acid have suffered from gastritis and chronic bronchitis. Prolonged exposure to HCl gas at low concentrations causes erosion of the teeth. In animal tests with HCl, exposures of 6 hours daily at 100 ppm repeated for 50 days caused only slight unrest and irritation of the eyes and nose of rabbits, guinea pigs, and pigeons. The hemoglobin content of the blood was only slightly diminished. Limited data on long-term human exposure to sulfuric acid with respect to occupational settings are available. Recent studies suggest that sulfuric acid aerosols at levels as low as 0.02 to 0.04 mg/m^3 may cause significant effects on lung function in humans. Effects noted include increased risk of chronic bronchitis in smokers and reduced tracheobronchial clearance rate. Chronic exposure to sulfuric acid solutions may also result in conjunctivitis, various lesions of the skin, gastrointestinal disturbances, and erosion and discoloration of the teeth.

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ON INGREDIENTS:

Chemical Name	Oral LD_{50} (rat)	Dermal LD_{50} (rabbit)	Inhalation LC_{50} (rat)
Poly(aluminum hydroxy) chloride	12.8 g/kg	Not available	Not available
Hydrochloric acid	900 mg/kg (rabbit)	Not available	Human LC_{Lo}: 1300 ppm/30 min.
Sulfuric acid	2140 mg/kg	Not available	510 mg/m³/2H

Section 12. ECOLOGICAL INFORMATION

ON PRODUCT:
No information available on the formulated product.

ON INGREDIENTS:

Chemical Name	Aquatic Toxicity Data
Poly(aluminum hydroxy) chloride (~20% in water)	96 hr LC_{50} (rainbow trout): 1555 ppm 96 hr LC_{50} (fathead minnow): 870 ppm 48 hr EC_{50} (Daphnia magna): 1400 ppm 48 hr EC_{50} (Ceriodaphnia dubia): 2000 ppm
Cationic polyamine (50% aqueous solution)	96 hr LC_{50} (bluegill sunfish): 42.3 ppm (clarified water) 96 hr LC_{50} (bluegill sunfish): 79.7 ppm (turbid water)

Section 13. DISPOSAL CONSIDERATIONS

RCRA STATUS: Discarded product, as sold, would be considered a RCRA Hazardous Waste based on the characteristic of corrosivity because the product corrodes steel at a rate > 0.250 inch/year at 130°F. The EPA Hazardous Waste Number is D002.

DISPOSAL: Dispose of in accordance with local, state and federal regulations.

Section 14. TRANSPORT INFORMATION

DOT CLASSIFICATION:
- Class/Division: 8
- Proper Shipping Name: Corrosive liquid, acidic, inorganic, n.o.s. [contains Poly(aluminum hydroxy)chloride, hydrochloric acid, and sulfuric acid]
- Label: Corrosive
- Packing Group: III
- ID Number: UN 3264

Section 15. REGULATORY INFORMATION

OSHA Hazard Communication Status: Hazardous
TSCA: The ingredients of this product are listed on the Toxic Substances Control Act (TSCA) Chemical Substances Inventory.

Continued on Page 6

Cat-Floc 2953

CERCLA reportable quantity of EPA hazardous substances in product:

Chemical Name	RQ
Hydrochloric acid	5000 lb
Sulfuric acid	1000 lb

Product RQ: 20,000 lb (Notify EPA of product spills exceeding this amount.)

SARA TITLE III:

Section 302 Extremely Hazardous Substances:

Chemical Name	CAS #	RQ	TPQ
Hydrochloric acid	7647-01-0	5000 lb (gas)	500 lb (gas)
Sulfuric acid	7664-93-9	1000 lb	1000 lb

Section 311 and 312 Health and Physical Hazards:

Immediate	Delayed	Fire	Pressure	Reactivity
[yes]	[no]	[no]	[no]	[no]

Section 313 Toxic Chemicals:

Chemical Name	CAS #	% by Weight
Hydrochloric acid	7647-01-0	1 - 5
Sulfuric acid	7664-93-9	1 - 5

Section 16. OTHER INFORMATION

HMIS RATINGS: Health = 3 Flammability = 0 Reactivity = 0
Personal Protective Equipment = X (to be specified by user depending on use conditions)

Hazard rating scale: 0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe

MSDS REVISION SUMMARY: Supersedes MSDS issued on 09/18/96.

PREPARED BY: P.J. Maloney

APPENDIX B

CHEMICAL ADDITIVE MATERIAL SAFETY DATA SHEETS

NALCO

MATERIAL SAFETY DATA SHEET

PRODUCT

NALCO 7888 CLARIFICATION AID

Emergency Telephone Number

Medical(800)462-5378(24 hours)(800)I-M-ALERT

SECTION 1 PRODUCT IDENTIFICATION

TRADE NAME: NALCO 7888 CLARIFICATION AID
DESCRIPTION: An aqueous solution of an aluminum hydroxychloride

NFPA 704M/HMIS RATING: 1/1 HEALTH 0/0 FLAMMABILITY 0/0 REACTIVITY 0 OTHER
0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

SECTION 2 COMPOSITION/INGREDIENT INFORMATION

Our hazard evaluation has identified the following chemical ingredient(s) as hazardous under OSHA's Hazard Communication Rule, 29 CFR 1910.1200. Consult Section 15 for the nature of the hazard(s).

INGREDIENT(S)	CAS #	APPROX.%
Aluminum hydroxychloride	1327-41-9	40-70

SECTION 3 HAZARD IDENTIFICATION

EMERGENCY OVERVIEW:
WARNING: Causes irritation to skin and eyes. Do not get in eyes, on skin, or on clothing. Wear goggles and face shield when handling. Avoid prolonged or repeated breathing of vapor. Use with adequate ventilation. Do not take internally. Keep container closed when not in use.

Empty containers may contain residual product. Do not reuse container unless properly reconditioned.

PRIMARY ROUTE(S) OF EXPOSURE: Eye, Skin

EYE CONTACT: Can cause moderate irritation and redness.
SKIN CONTACT: Can cause moderate irritation and redness.

SYMPTOMS OF EXPOSURE: A review of available data does not identify any symptoms from exposure not previously mentioned.

AGGRAVATION OF EXISTING CONDITIONS: A review of available data does not identify any worsening of existing conditions.

SECTION 4 FIRST AID INFORMATION

EYES: Immediately flush with water for at least 15 minutes while holding eyelids open. Call a physician at once.
SKIN: Wash thoroughly with soap and rinse with water. Call a physician.

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SECTION 4 FIRST AID INFORMATION (CONTINUED)

INGESTION: Do not induce vomiting. Give water. Call a physician.
INHALATION: Remove to fresh air. Treat symptoms. Call a physician.

NOTE TO PHYSICIAN: Based on the individual reactions of the patient, the physician's judgment should be used to control symptoms and clinical condition.

CAUTION: If unconscious, having trouble breathing or in convulsions, do not induce vomiting or give water.

SECTION 5 FIRE FIGHTING

FLASH POINT: Not applicable

EXTINGUISHING MEDIA: Not applicable

UNUSUAL FIRE AND EXPLOSION HAZARD: Containers exposed in a fire should be cooled with water to prevent vapor pressure buildup leading to a rupture.

SECTION 6 ACCIDENTAL RELEASE MEASURES

IN CASE OF TRANSPORTATION ACCIDENTS, CALL THE FOLLOWING 24-HOUR TELEPHONE NUMBER (800) I-M-ALERT or (800) 462-5378.

SPILL CONTROL AND RECOVERY:

Small liquid spills: Contain with absorbent material, such as clay, soil or any commercially available absorbent. Shovel reclaimed liquid and absorbent into recovery or salvage drums for disposal. Refer to CERCLA in Section 15.

Large liquid spills: Dike to prevent further movement and reclaim into recovery or salvage drums or tank truck for disposal. Refer to CERCLA in Section 15.

SECTION 7 HANDLING AND STORAGE

Storage : Keep container closed when not in use.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

RESPIRATORY PROTECTION: Respiratory protection is not normally needed since the volatility and toxicity are low. If significant vapors, mists or aerosols are generated, wear a NIOSH approved or equivalent respirator.

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SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION (CONTINUED)

For large spills, entry into large tanks, vessels or enclosed small spaces with inadequate ventilation, a positive pressure, self-contained breathing apparatus is recommended.

VENTILATION: General ventilation is recommended.

PROTECTIVE EQUIPMENT: Use impermeable gloves and chemical splash goggles when attaching feeding equipment or doing maintenance.

The availability of an eye wash fountain and safety shower is recommended.

If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

COLOR:	Clear	FORM:	Liquid
SOLUBILITY IN WATER:	Completely		
SPECIFIC GRAVITY:	1.34 @ 70 Degrees F		ASTM D-1298
pH (NEAT) =	3.5		ASTM E-70
BOILING POINT:	220 Degrees F @ 760 mm Hg		ASTM D-86
FLASH POINT:	Not applicable		
VOLATILE ORGANIC COMPOUND (VOC):	0 lbs/gal.		

NOTE: These physical properties are typical values for this product.

SECTION 10 STABILITY AND REACTIVITY

INCOMPATIBILITY: Avoid alkaline materials (eg. ammonia and its solutions, carbonates, sodium hydroxide (caustic), potassium hydroxide, calcium hydroxide (lime), cyanides, sulfides, hypochlorites, chlorites) which can generate heat with splattering or boiling and the release of toxic fumes.

THERMAL DECOMPOSITION PRODUCTS: None known

SECTION 11 TOXICOLOGICAL INFORMATION

TOXICITY STUDIES: No toxicity studies have been conducted on this product.

HUMAN HAZARD CHARACTERIZATION: Based on our hazard characterization, the potential human hazard is: LOW

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SECTION 12 ECOLOGICAL INFORMATION

BIOCHEMICAL OXYGEN DEMAND (5-day BOD): Less than 14 mg/L

CHEMICAL OXYGEN DEMAND (COD): 490 mg/L

TOTAL ORGANIC CARBON (TOC): 99 mg/L

AQUATIC DATA:

Results below are based on the product.

In a 7-day reproductive effect to Ceriodaphnia Dubia, the following results were obtained:

7-day Reproduction IC25 = 7.2 mg/L
7-day Reproduction IC50 = 10.3 mg/L
7-day LOEC for survival = 30 mg/L
7-day NOEL for survival = 15 mg/L

If released into the environment, see CERCLA in Section 15.

ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION: Based on our Hazard Characterization, the potential environmental hazard is: LOW.

SECTION 13 DISPOSAL CONSIDERATIONS

DISPOSAL: If this product becomes a waste, it does not meet the criteria of a hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261, since it does not have the characteristics of Subpart C, nor is it listed under Subpart D.

As a non-hazardous liquid waste, it should be solidified with stabilizing agents (such as sand, fly ash, or cement) so that no free liquid remains before disposal to an industrial waste landfill. A non-hazardous liquid waste can also be deep-well injected in accordance with local, state, and federal regulations.

SECTION 14 TRANSPORTATION INFORMATION

PROPER SHIPPING NAME/HAZARD CLASS MAY VARY BY PACKAGING, PROPERTIES, AND MODE OF TRANSPORTATION. TYPICAL PROPER SHIPPING NAMES FOR THIS PRODUCT ARE:

ALL TRANSPORTATION MODES : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

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SECTION 14 TRANSPORTATION INFORMATION (CONTINUED)

SECTION 15 REGULATORY INFORMATION

The following regulations apply to this product.

FEDERAL REGULATIONS:

OSHA'S HAZARD COMMUNICATION RULE, 29 CFR 1910.1200:
Based on our hazard evaluation, the following ingredients in this product are hazardous and the reasons are shown below.

Aluminum soluble salts = TWA 2 mg/m3 ACGIH/TLV

CERCLA, 40 CFR 117, 302:
Notification of spills of this product is not required.

SARA/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986
(TITLE III) - SECTIONS 302, 311, 312 AND 313:

SECTION 302 - EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355):
This product does not contain ingredients listed in Appendix A and B as an Extremely Hazardous Substance.

SECTIONS 311 and 312 - MATERIAL SAFETY DATA SHEET REQUIREMENTS (40 CFR 370):
Our hazard evaluation has found this product to be hazardous. The product should be reported under the following EPA hazard categories:

XX Immediate (acute) health hazard
-- Delayed (chronic) health hazard
-- Fire hazard
-- Sudden release of pressure hazard
-- Reactive hazard

Under SARA 311 and 312, the EPA has established threshold quantities for the reporting of hazardous chemicals. The current thresholds are: 500 pounds or the threshold planning quantity (TPQ), whichever is lower, for extremely hazardous substances and 10,000 pounds for all other hazardous chemicals.

SECTION 313 - LIST OF TOXIC CHEMICALS (40 CFR 372):
This product does not contain ingredients on the List of Toxic Chemicals.

TOXIC SUBSTANCES CONTROL ACT (TSCA):
The chemical ingredients in this product are on the 8(b) Inventory List

SECTION 15 REGULATORY INFORMATION (CONTINUED)

(40 CFR 710).

FOOD AND DRUG ADMINISTRATION (FDA) Federal Food, Drug and Cosmetic Act:
When use situations necessitate compliance with FDA regulations, this product is acceptable under 21 CFR 176.170 components of paper and paperboard in contact with aqueous and fatty foods; and under 21 CFR 176.180 components of paper and paperboard in contact with dry food.

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA), 40 CFR 261 SUBPART C & D:
Consult Section 13 for RCRA classification.

FEDERAL WATER POLLUTION CONTROL ACT, CLEAN WATER ACT, 40 CFR 401.15 (formerly Sec. 307), 40 CFR 116 (formerly Sec. 311):
None of the ingredients are specifically listed.

CLEAN AIR ACT, Sec. 111 (40 CFR 60), Sec. 112 (40 CFR 61, 1990 Amendments), Sec. 611 (40 CFR 82, CLASS I and II Ozone depleting substances):
This product does not contain ingredients covered by the Clean Air Act.

STATE REGULATIONS:

CALIFORNIA PROPOSITION 65:
This product does not contain any chemicals which require warning under California Proposition 65.

MICHIGAN CRITICAL MATERIALS:
This product does not contain ingredients listed on the Michigan Critical Materials Register.

STATE RIGHT TO KNOW LAWS:
The following ingredient(s) are disclosed for compliance with State Right To Know Laws:

Aluminum hydroxychloride	1327-41-9
Water	7732-18-5

INTERNATIONAL REGULATIONS:

All components in this product are either on the Domestic Substance List, have been notified under Section 26 of CEPA, or are exempt.

This is a WHMIS controlled product under The House of Commons of Canada Bill C-70 (Class D2B). The product contains the following substance(s), from the Ingredient Disclosure List or has been evaluated based on its toxicological

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MATERIAL SAFETY DATA SHEET

PRODUCT

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SECTION 15 REGULATORY INFORMATION (CONTINUED)

properties, to contain the following hazardous ingredient(s):

Chemical Name	CAS #	% Concentration Range
Aluminum hydroxychloride	1327-41-9	40-70

SECTION 16 OTHER INFORMATION

None

SECTION 17 RISK CHARACTERIZATION

Our Risk Characterization is being determined.

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should be evaluated so that appropriate handling practices and training programs can be established to insure safe workplace operations. Please consult your local sales representative for any further information.

SECTION 18 REFERENCES

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists, OH.

Hazardous Substances Data Bank, National Library of Medicine, Bethesda, Maryland (CD-ROM version), Micromedex, Inc., Englewood, CO.

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Geneva: World Health Organization, International Agency for Research on Cancer.

Integrated Risk Information System, U.S. Environmental Protection Agency, Washington, D.C. (CD-ROM version), Micromedex, Inc., Englewood, CO.

Annual Report on Carcinogens, National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service.

Title 29 Code of Federal Regulations, Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA).

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SECTION 18 REFERENCES (CONTINUED)

Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health, Cincinnati, Ohio (CD-ROM version), Micromedex, Inc., Englewood, CO.

Shepard's Catalog of Teratogenic Agents (CD-ROM version), Micromedex, Inc., Englewood, CO.

Suspect Chemicals Sourcebook (a guide to industrial chemicals covered under major regulatory and advisory programs), Roytech Publications (a Division of Ariel Corporation), Bethesda, MD.

The Teratogen Information System, University of Washington, Seattle, Washington (CD-ROM version), Micromedex, Inc., Englewood, CO.

PREPARED BY: William S. Utley, PhD., DABT, Manager, Product Safety
DATE CHANGED: 11/05/98 DATE PRINTED: 03/01/99

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MATERIAL SAFETY DATA SHEET

PRODUCT

OPTIMER 9806 FLOCCULANT

Emergency Telephone Number
Medical (800) 462-5378 (24 hours) (800) I-M-ALERT

SECTION 01 CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

TRADE NAME: OPTIMER 9806 FLOCCULANT
DESCRIPTION: An acrylamide/acrylate polymer in a hydrocarbon solvent and water

NFPA 704M/HMIS RATING: 1/2 HEALTH 1/1 FLAMMABILITY 0/0 REACTIVITY 0 OTHER
0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

SECTION 02 COMPOSITION AND INFORMATION ON INGREDIENTS

Our hazard evaluation has identified the following chemical ingredient(s) as hazardous under OSHA's Hazard Communication Rule, 29 CFR 1910.1200. Consult Section 15 for the nature of the hazard(s).

INGREDIENT(S)	CAS #	APPROX.%
Ethoxylated alcohol	68002-97-1	1-5
Hydrotreated light distillate	64742-47-8	20-40

SECTION 03 HAZARD IDENTIFICATION

EMERGENCY OVERVIEW:
CAUTION: May cause irritation to skin and eyes. Avoid contact with skin, eyes and clothing. Do not take internally.

Empty containers may contain residual product. Do not reuse container unless properly reconditioned.

PRIMARY ROUTE(S) OF EXPOSURE: Eye, Skin

EYE CONTACT: Can cause moderate irritation.
SKIN CONTACT: Can cause mild, short-lasting irritation.

SYMPTOMS OF EXPOSURE: A review of available data does not identify any symptoms from exposure not previously mentioned.

AGGRAVATION OF EXISTING CONDITIONS: A review of available data does not identify any worsening of existing conditions.

SECTION 04 FIRST AID INFORMATION

EYES: Flush with water for 15 minutes. Call a physician.
SKIN: Wash thoroughly with soap and rinse with water. Call a physician.
INGESTION: Do not induce vomiting. Give water. Call a physician.
INHALATION: Remove to fresh air. Treat symptoms. Call a physician.

NOTE TO PHYSICIAN: Based on the individual reactions of the patient, the physician's judgment should be used to control symptoms and clinical condition.

CAUTION: If unconscious, having trouble breathing or in convulsions, do not

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induce vomiting or give water.

SECTION 05 FIRE FIGHTING MEASURES

FLASH POINT: Greater than 200 Degrees F (PMCC) ASTM D-93

EXTINGUISHING MEDIA: This product would not be expected to burn unless all the water is boiled away. The remaining organics may be ignitable. Use water to cool containers exposed to fire.

UNUSUAL FIRE AND EXPLOSION HAZARD: May evolve NOx under fire conditions. If the water is driven off, the remaining organics may be ignitable.

SECTION 06 ACCIDENTAL RELEASE MEASURES

IN CASE OF TRANSPORTATION ACCIDENTS, CALL THE FOLLOWING 24-HOUR TELEPHONE NUMBER (800) I-M-ALERT or (800) 462-5378.

SPILL CONTROL AND RECOVERY:

Small liquid spills: Contain with absorbent material, such as clay, soil or any commercially available absorbent. Shovel reclaimed liquid and absorbent into recovery or salvage drums for disposal. Refer to CERCLA in Section 15.

Large liquid spills: Dike to prevent further movement and reclaim into recovery or salvage drums or tank truck for disposal. Refer to CERCLA in Section 15.

For large indoor spills, evacuate employees and ventilate area. Those responsible for control and recovery should wear the protective equipment specified in Section 8.

SECTION 07 HANDLING AND STORAGE

Storage : Keep container closed when not in use.

SECTION 08 EXPOSURE CONTROLS AND PERSONAL PROTECTION

RESPIRATORY PROTECTION: Respiratory protection is not normally needed since the volatility and toxicity are low. If significant mists are generated, use either a chemical cartridge respiratory with a dust/mist prefilter or supplied air.

For large spills, entry into large tanks, vessels or enclosed small spaces with inadequate ventilation, a positive pressure, self-contained breathing apparatus is recommended.

VENTILATION: General ventilation is recommended.

PROTECTIVE EQUIPMENT: Use impermeable gloves and chemical splash goggles when attaching feeding equipment, doing maintenance or handling product. Examples of impermeable gloves available on the market are neoprene, nitrile, PVC, natural

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MATERIAL SAFETY DATA SHEET

PRODUCT

OPTIMER 9806 FLOCCULANT

Emergency Telephone Number
Medical (800) 462-5378 (24 hours) (800) I-M-ALERT

rubber, viton, and butyl (compatibility studies have not been performed).

The availability of an eye wash fountain and safety shower is recommended.

If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse.

HUMAN EXPOSURE CHARACTERIZATION: Based on Nalco's recommended product application and our recommended personal protective equipment, the potential human exposure is: LOW.

SECTION 09 PHYSICAL AND CHEMICAL PROPERTIES

COLOR:	Clear to opaque, off-white	FORM: Liquid
ODOR:	Mildly pungent	
DENSITY:	8.6-9.0 lbs/gal.	
SOLUBILITY IN WATER:	Dispersible	
SPECIFIC GRAVITY:	1.03-1.08	
VISCOSITY:	400 cps @ 75 Degrees F	ASTM D-2983
FREEZE POINT:	Less than -50 Degrees F	ASTM D-1177
POUR POINT:	-36 Degrees F	ASTM D-97
FLASH POINT:	Greater than 200 Degrees F (PMCC)	ASTM D-93

NOTE: These physical properties are typical values for this product.

SECTION 10 STABLILITY AND REACTIVITY

INCOMPATIBILITY: Avoid water contamination which may cause gelling.

Avoid contact with strong oxidizers (eg. chlorine, peroxides, chromates, nitric acid, perchlorates, concentrated oxygen, permanganates) which can generate heat, fires, explosions and the release of toxic fumes.

THERMAL DECOMPOSITION PRODUCTS: In the event of combustion CO, CO_2, NO_x may be formed. Do not breathe smoke or fumes. Wear suitable protective equipment.

SECTION 11 TOXICOLOGICAL INFORMATION

TOXICITY STUDIES: No toxicity studies have been conducted on this product.

HUMAN HAZARD CHARACTERIZATION: Based on our hazard characterization, the potential human hazard is: MODERATE.

SECTION 12 ECOLOGICAL INFORMATION

BIOCHEMICAL OXYGEN DEMAND (5-day BOD): 32,320 ppm

CHEMICAL OXYGEN DEMAND (COD): 97,310 ppm

TOTAL ORGANIC CARBON (TOC): 64,810 ppm

NALCO CHEMICAL COMPANY . ONE NALCO CENTER • NAPERVILLE, ILLINOIS 60563-1198
AREA (630) 305-1000

NALCO

MATERIAL SAFETY DATA SHEET

PRODUCT

OPTIMER 9806 FLOCCULANT

Emergency Telephone Number
Medical (800) 462-5378 (24 hours) (800) I-M-ALERT

AQUATIC DATA:

Results below are based on a 1% aqueous solution of the product.

96 hour static acute LC50 to Rainbow Trout = 8,800 mg/L
96 hour no observed effect concentration is 3,600 mg/L based on no mortality or abnormal effects.

48 hour static acute LC50 to Daphnia magna = 190 mg/L
48 hour no observed effect concentration is 80 mg/L based on no mortality or abnormal effects.

Results below based on a 1% aqueous solution of a similar product.

96 hour static acute LC50 to Sheepshead Minnow = Greater than 1,000 mg/l
96 hour no observed effect concentration is 1,000 mg/l (highest concentration tested) based on no mortality or abnormal effects.

TOXICITY RATING: Essentially non-toxic

96 hour static acute LC50 to Mysid Shrimp = 400 mg/l
96 hour no observed effect concentration is 180 mg/l based on no mortality or abnormal effects.

TOXICITY RATING: Slightly toxic

If released into the environment, see CERCLA in Section 15.

ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION: Based on our Hazard Characterization, the potential environmental hazard is: MODERATE. Based on Nalco's recommended product application and the product's characteristics, the potential environmental exposure is: MODERATE.

SECTION 13 DISPOSAL CONSIDERATIONS

DISPOSAL: If this product becomes a waste, it does not meet the criteria of a hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261, since it does not have the characteristics of Subpart C, nor is it listed under Subpart D.

As a non-hazardous liquid waste, it should be solidified with stabilizing agents (such as sand, fly ash, or cement) so that no free liquid remains before disposal to an industrial waste landfill. A non-hazardous liquid waste can also be incinerated in accordance with local, state, and federal regulations.

SECTION 14 TRANSPORTATION INFORMATION

PROPER SHIPPING NAME/HAZARD CLASS MAY VARY BY PACKAGING, PROPERTIES, AND MODE OF TRANSPORTATION. TYPICAL PROPER SHIPPING NAMES FOR THIS PRODUCT ARE:

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AREA (630) 305-1000

NALCO

MATERIAL SAFETY DATA SHEET

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OPTIMER 9806 FLOCCULANT

Emergency Telephone Number
Medical (800) 462-5378 (24 hours) (800) I-M-ALERT

ALL TRANSPORTATION MODES : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

SECTION 15 REGULATORY INFORMATION

The following regulations apply to this product.

FEDERAL REGULATIONS:

OSHA'S HAZARD COMMUNICATION RULE, 29 CFR 1910.1200:
Based on our hazard evaluation, the following ingredients in this product are hazardous and the reasons are shown below.

Ethoxylated alcohol - Eye irritant
Hydrotreated light distillate - Skin/eye irritant

CERCLA, 40 CFR 117, 302:
Notification of spills of this product is not required.

SARA/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 (TITLE III) - SECTIONS 302, 311, 312 AND 313:

SECTION 302 - EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355):
This product does not contain ingredients listed in Appendix A and B as an Extremely Hazardous Substance.

SECTIONS 311 and 312 - MATERIAL SAFETY DATA SHEET REQUIREMENTS (40 CFR 370):
Our hazard evaluation has found this product to be hazardous. The product should be reported under the following EPA hazard categories:

XX Immediate (acute) health hazard
-- Delayed (chronic) health hazard
-- Fire hazard
-- Sudden release of pressure hazard
-- Reactive hazard

Under SARA 311 and 312, the EPA has established threshold quantities for the reporting of hazardous chemicals. The current thresholds are: 500 pounds or the threshold planning quantity (TPQ), whichever is lower, for extremely hazardous substances and 10,000 pounds for all other hazardous chemicals.

SECTION 313 - LIST OF TOXIC CHEMICALS (40 CFR 372):
This product does not contain ingredients on the List of Toxic Chemicals.

TOXIC SUBSTANCES CONTROL ACT (TSCA):
The chemical ingredients in this product are on the 8(b) Inventory List (40 CFR 710).

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA), 40 CFR 261 SUBPART C & D:
Consult Section 13 for RCRA classification.

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FEDERAL WATER POLLUTION CONTROL ACT, CLEAN WATER ACT, 40 CFR 401.15 (formerly Sec. 307), 40 CFR 116 (formerly Sec. 311):
None of the ingredients are specifically listed.

CLEAN AIR ACT, Sec. 111 (40 CFR 60), Sec. 112 (40 CFR 61, 1990 Amendments), Sec. 611 (40 CFR 82, CLASS I and II Ozone depleting substances):
This product does not contain ingredients covered by the Clean Air Act.

STATE REGULATIONS:

CALIFORNIA PROPOSITION 65:
This product does not contain any chemicals which require warning under California Proposition 65.

MICHIGAN CRITICAL MATERIALS:
This product does not contain ingredients listed on the Michigan Critical Materials Register.

STATE RIGHT TO KNOW LAWS:
The following ingredient(s) are disclosed for compliance with State Right To Know Laws:

Acrylic polymer	Trade secret
Ethoxylated alcohol	68002-97-1
Fatty acid ester	Trade secret
Hydrotreated light distillate	64742-47-8
Water	7732-18-5

INTERNATIONAL REGULATIONS:

This is a WHMIS controlled product under The House of Commons of Canada Bill C-70 (Class D2B). The product contains the following substance(s), from the Ingredient Disclosure List or has been evaluated based on its toxicological properties, to contain the following hazardous ingredient(s):

Chemical Name	CAS #	% Concentration Range
Ethoxylated alcohol	68002-97-1	1-5
Hydrotreated light distillate	64742-47-8	20-40

SECTION 16 OTHER INFORMATION

Nalco internal number F102331

SECTION 17 RISK CHARACTERIZATION

Due to our commitment to Product Stewardship, we have evaluated the human and environmental hazards and exposures of this product. Based on our recommended use of this product, we have characterized the product's general risk. This information should provide assistance for your own risk management practices. We have evaluated our product's risk as follows:

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Emergency Telephone Number
Medical (800) 462-5378 (24 hours) (800) I-M-ALERT

* The human risk is: LOW.

* The environmental risk is: MODERATE.

Any use inconsistent with Nalco's recommendations may affect our risk characterization. Our sales representative will assist you to determine if your product application is consistent with our recommendations. Together we can implement an appropriate risk management process.

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should be evaluated so that appropriate handling practices and training programs can be established to insure safe workplace operations. Please consult your local sales representative for any further information.

SECTION 18 REFERENCES

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists, OH.

Hazardous Substances Data Bank, National Library of Medicine, Bethesda, Maryland (CD-ROM version), Micromedex, Inc., Englewood, CO.

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Geneva: World Health Organization, International Agency for Research on Cancer.

Integrated Risk Information System, U.S. Environmental Protection Agency, Washington, D.C. (CD-ROM version), Micromedex, Inc., Englewood, CO.

Annual Report on Carcinogens, National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service.

Title 29 Code of Federal Regulations, Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA).

Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health, Cincinnati, Ohio (CD-ROM version), Micromedex, Inc., Englewood, CO.

Shepard's Catalog of Teratogenic Agents (CD-ROM version), Micromedex, Inc., Englewood, CO.

Suspect Chemicals Sourcebook (a guide to industrial chemicals covered under major regulatory and advisory programs), Roytech Publications (a Division of Ariel Corporation), Bethesda, MD.

The Teratogen Information System, University of Washington, Seattle,

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OPTIMER 9806 FLOCCULANT

Emergency Telephone Number
Medical (800) 462-5378 (24 hours) (800) I-M-ALERT

Washington (CD-ROM version), Micromedex, Inc., Englewood, CO.

PREPARED BY: William S. Utley, PhD., DABT, Manager, Product Safety
DATE CHANGED: 02/23/1999 DATE PRINTED: 03/28/1999

CALGON CORPORATION

CAT-FLOC 2953
Cationic Liquid Coagulant

Product Description: CALGON CAT-FLOC 2953 coagulant is a high charged liquid cationic polyelectrolyte. It is used as a primary coagulant in water and wastewater clarification. **CAT-FLOC 2953** is highly effective for coagulating fine colloidal turbidity and color and for treating oily wastewater. It produces a dense, fast-settling floc. **CAT-FLOC 2953** is chlorine resistant and tolerant of pH and water temperature variation. **CAT-FLOC 2953** is available in pails, drums, recyclable bins, and bulk.

Features:	**Benefits:**
• Water soluble liquid coagulant	• Easy to feed
• NSF *International* certified	• Acceptable for use in drinking water applications
• Produces a compact, easily dewatered sludge	• Reduced sludge volume and sludge handling costs
• Chlorine resistant	• Consistent product performance in the presence of chlorine
• Effective over a broad pH and temperature range	• Consistent product performance during pH upsets and cold water conditions

Environmental and Toxicity Data: See product MSDS for complete toxicological and environmental information.

Regulatory Status: CAT-FLOC 2953 conforms to the requirements of ANSI/NSF Standard 60 - Drinking Water Treatment Chemicals - Health Effects. **CAT-FLOC 2953** is certified by **NSF** *International* as a coagulation and flocculation drinking water treatment chemical to a maximum feed rate of 262 mg/l.

NSF®

D.O.T. Class 8
D.O.T. Proper Shipping Name....................Corrosive liquid,
n.o.s (contains Polyaluminum hydroxychlorosulfate)...........
UN Number...1760

Handling and Storage: Improper handling of this product can be injurious to workers. This product is not by definition a "flammable liquid" or combustible liquid". ***Observe all safety precautions shown on the label and in the Material Safety Data Sheet.***

Keep from freezing. Store **CAT-FLOC 2953** coagulant in heated buildings or heat-traced tanks to prevent freezing. Although this product is freeze-thaw stable, crystallization may occur upon freezing. **CAT-FLOC 2953** coagulant will become uniform again upon heating and agitation.

Typical Properties (@ 25° C)	
Form	liquid
Appearance	Clear, pale yellow
Specific Gravity	1.19
pH	2.5-3.0
Viscosity of Product, cps	<10
Freeze Point (°F)	14
Flash Point (°F)	>200

Bulletin No. 00-66J3; Rev.7/7/98

Feeding: CAT-FLOC 2953 coagulant may be fed neat as long as in-line dilution is provided. However, dilution to 1% as product is recommended to assure better contact of the coagulant with the impurities in the water. A Calgon SD, P-18 or MDS feed system is recommended. A variety of chemical feed systems are available from Calgon to satisfy your specific application needs. Please contact your local Calgon representative or our Chemical Equipment Group for feed system recommendations.

Dosage Requirements: Product feed rate will be site and application specific, and may vary as conditions change. Product demand may be determined by a screening test using Jar Test procedures.

Materials of Compatibility: CAT-FLOC 2953 coagulant is corrosive to iron and copper, including their alloys. Storage tanks, chemical feed systems, and piping should be constructed of high density (HDPE) or crosslinked (XLPE) polyethylene, fiberglass (FRP) with polyester or vinylester resins.

Disposal: Dispose of in accordance with local, state and federal regulations. Discarded product, as sold, is not considered a RCRA hazardous waste.

Materials of Compatibility

Material	Satis.	Un-Satis.
Carbon Steel		X
304 Stainless Steel		X
316 Stainless Steel		X
Polyethylene - crosslinked	X	
Polyethylene - low den	X	
Polyethylene - high den	X	
Polypropylene	X	
Kynar	X	
Viton	X	
Neoprene	X	
Buna-N Rubber	X	
FRP (bisphenol)		X
FRP (isophthalic)	X	

Information concerning human and environmental exposure may be reviewed on the Material Safety Data Sheet for the product. For additional information regarding incidents involving human and environmental exposure call 1-800-955-0090 and ask for the Health and Environmental Affairs Department.

For more information, contact your local Calgon representative, call 1-800-955-0090, or write: Calgon Corporation, P.O. Box 1346, Pittsburgh, PA 15230. Internet address: http://www.calgon.com

INNOVATIVE TECHNOLOGIES, CREATIVE SOLUTIONS ... SINCE 1918

CALGON CORPORATION

Bulletin No. 00-66J3; Rev. 7/7/98

CALGON CORPORATION

P.O. Box 1346
Pittsburgh, PA 15230-1346
Phone--(412)494-8000
CHEMTREC® 1-800-424-9300

MATERIAL SAFETY DATA SHEET

Section 1. PRODUCT IDENTIFICATION

PRODUCT NAME: **Cat-Floc 2953**

CHEMICAL DESCRIPTION: Acidic aqueous solution
PRODUCT CLASS: Cationic coagulant
MSDS CODE: 0B89-06-28-93

Section 2. INFORMATION ON INGREDIENTS

Chemical Name	CAS Number	% by Weight	OSHA PEL	ACGIH TLV
Poly(aluminum hydroxy) chloride	1327-41-9	~ 26	TWA 2 mg/m³ (as Al) for Al soluble salts	TWA 2 mg/m³ (as Al) for Al soluble salts
Hydrochloric acid	7647-01-0	1 - 5	Ceiling 5 ppm, 7 mg/m³	Ceiling 5 ppm, 7.5 mg/m³
Sulfuric acid	7664-93-9	1 - 5	TWA 1 mg/m³	TWA 1 mg/m³, STEL 3 mg/m³

Section 3. HAZARDS IDENTIFICATION

********************** EMERGENCY OVERVIEW **********************

Clear, pale yellow, slightly viscous liquid.
DANGER!
May cause severe eye damage and skin irritation.
May cause severe digestive tract burns if swallowed.
May cause respiratory tract irritation.
Corrosive to metals.

****

PRIMARY ROUTES OF ENTRY: Eye and skin contact, ingestion, inhalation

TARGET ORGANS: Eye, skin, mucous membranes

Continued on Page 2

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: No data available.

POTENTIAL HEALTH EFFECTS:

EYE CONTACT: Contact with the eye will cause painful burning or stinging of the eyes and lids, watering of the eyes, and inflammation of the conjunctiva (the mucous membrane covering the front surface of the eyeball and lining the lids).

SKIN CONTACT: This product may cause irritation, redness, swelling, or dermatitis upon contact. The product is not expected to be absorbed through the skin.

INGESTION: Ingestion of this product may cause severe irritation or burns of the mucous membranes of the mouth, throat, esophagus and stomach.

INHALATION: Inhalation of product mist or vapor may be irritating to the respiratory tract.

SUBCHRONIC, CHRONIC:
No applicable information was found concerning any potential health effects resulting from subchronic or chronic exposure to the product.

Information is available concerning potential health effects resulting from subchronic or chronic exposure to ingredient(s) of the product. See Section 11 for available data.

CARCINOGENICITY:
NTP:
No ingredients listed in this section
IARC:
No ingredients listed in this section
OSHA:
No ingredients listed in this section

Section 4. FIRST AID MEASURES

EYE CONTACT: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Seek medical aid immediately.

SKIN CONTACT: In case of contact, flush skin with plenty of water. Remove contaminated clothing. Seek medical aid if irritation persists. Wash clothing before reuse.

INGESTION: If swallowed, do NOT induce vomiting. Give large quantities of water. Seek medical aid immediately. Never give anything by mouth to an unconscious person.

INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Seek medical aid.

Section 5. FIRE-FIGHTING MEASURES

FLASH POINT: > 200°F
This product is not by definition a "flammable liquid" or a "combustible liquid".

LOWER FLAMMABLE LIMIT: Not applicable UPPER FLAMMABLE LIMIT: Not applicable

Continued on Page 3

AUTO-IGNITION TEMPERATURE: Not applicable

EXTINGUISHING MEDIA: Use extinguishing media appropriate for the surrounding fire.

FIRE-FIGHTING INSTRUCTIONS: Exercise caution when fighting any chemical fire. A self-contained breathing apparatus and protective clothing are essential.

FIRE & EXPLOSION HAZARDS: Poly(aluminum hydroxy) chloride reacts with aluminum or zinc to form hydrogen gas.

DECOMPOSITION PRODUCTS: Thermal decomposition or combustion may produce carbon monoxide, carbon dioxide, hydrogen chloride gas, and oxides of nitrogen and sulfur.

NFPA RATINGS:	Health = 3	Flammability = 0	Reactivity = 0	Special Hazard = None

Hazard rating scale: 0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe

Section 6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: Wearing appropriate personal protective equipment, contain spill, collect onto inert absorbent and place into suitable container. Spilled product may be neutralized carefully with weak caustic solutions or sodium carbonate. Neutralization releases large amounts of heat.

Section 7. HANDLING AND STORAGE

HANDLING: Do not get in eyes.
Avoid contact with skin and clothing.
Avoid breathing vapor or mist.
Use with adequate ventilation.
Wash thoroughly after handling.
Keep container closed when not in use.

STORAGE: Store away from strong bases.
Store only in compatible plastic or rubber-lined vessels.
Store between 50° - 86°F (10° - 30°C).

Section 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

PERSONAL PROTECTIVE EQUIPMENT:

EYE/FACE PROTECTION: Chemical splash goggles
SKIN PROTECTION: Chemical resistant gloves
RESPIRATORY PROTECTION: If airborne concentrations exceed published exposure limits, use a NIOSH approved respirator in accordance with OSHA respiratory protection requirements (29 CFR 1910.134).

ENGINEERING CONTROLS: Local exhaust ventilation may be required in addition to general room ventilation to maintain airborne concentrations below exposure limits.

WORK PRACTICES: An eye wash station should be accessible in the immediate area of use.

Continued on Page 4

SATISFACTORY MATERIALS OF CONSTRUCTION: Storage, transfer lines and feed equipment should be constructed of acid resistant materials, such as polyethylene, PVC, fiberglass or rubber lined.

Section 9. PHYSICAL AND CHEMICAL PROPERTIES

BOILING POINT: > 212°F

SOLUBILITY IN WATER: Complete

VAPOR PRESSURE: Not determined

SPECIFIC GRAVITY: 1.18 - 1.20 @ 25°C

VAPOR DENSITY (air=1): Not determined

pH: 2.5 - 3.0 @ 25°C

%VOLATILE BY WEIGHT: Not determined

FREEZING POINT: Not available

APPEARANCE AND ODOR: Clear, pale yellow, slightly viscous liquid.

Section 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable

HAZARDOUS POLYMERIZATION: Will not occur

CONDITIONS TO AVOID: Poly(aluminum hydroxy) chloride reacts with aluminum or zinc to form hydrogen gas.

INCOMPATIBILITY: Strong alkalies and most metals

DECOMPOSITION PRODUCTS: Thermal decomposition or combustion may produce carbon monoxide, carbon dioxide, hydrogen chloride gas, and oxides of nitrogen and sulfur.

Section 11. TOXICOLOGICAL INFORMATION

ON PRODUCT:

Toxicological data on chronic effects of some ingredients: Workers exposed to hydrochloric acid have suffered from gastritis and chronic bronchitis. Prolonged exposure to HCl gas at low concentrations causes erosion of the teeth. In animal tests with HCl, exposures of 6 hours daily at 100 ppm repeated for 50 days caused only slight unrest and irritation of the eyes and nose of rabbits, guinea pigs, and pigeons. The hemoglobin content of the blood was only slightly diminished. Limited data on long-term human exposure to sulfuric acid with respect to occupational settings are available. Recent studies suggest that sulfuric acid aerosols at levels as low as 0.02 to 0.04 mg/m^3 may cause significant effects on lung function in humans. Effects noted include increased risk of chronic bronchitis in smokers and reduced tracheobronchial clearance rate. Chronic exposure to sulfuric acid solutions may also result in conjunctivitis, various lesions of the skin, gastrointestinal disturbances, and erosion and discoloration of the teeth.

Continued on Page 5

ON INGREDIENTS:

Chemical Name	Oral LD_{50} (rat)	Dermal LD_{50} (rabbit)	Inhalation LC_{50} (rat)
Poly(aluminum hydroxy) chloride	12.8 g/kg	Not available	Not available
Hydrochloric acid	900 mg/kg (rabbit)	Not available	Human LC_{Lo}: 1300 ppm/30 min.
Sulfuric acid	2140 mg/kg	Not available	510 mg/m^3/2H

Section 12. ECOLOGICAL INFORMATION

ON PRODUCT:
No information available on the formulated product.

ON INGREDIENTS:

Chemical Name	Aquatic Toxicity Data
Poly(aluminum hydroxy) chloride (~20% in water)	96 hr LC_{50} (rainbow trout): 1555 ppm 96 hr LC_{50} (fathead minnow): 870 ppm 48 hr EC_{50} (Daphnia magna): 1400 ppm 48 hr EC_{50} (Ceriodaphnia dubia): 2000 ppm
Cationic polyamine (50% aqueous solution)	96 hr LC_{50} (bluegill sunfish): 42.3 ppm (clarified water) 96 hr LC_{50} (bluegill sunfish): 79.7 ppm (turbid water)

Section 13. DISPOSAL CONSIDERATIONS

RCRA STATUS: Discarded product, as sold, would be considered a RCRA Hazardous Waste based on the characteristic of corrosivity because the product corrodes steel at a rate > 0.250 inch/year at 130°F. The EPA Hazardous Waste Number is D002.

DISPOSAL: Dispose of in accordance with local, state and federal regulations.

Section 14. TRANSPORT INFORMATION

DOT CLASSIFICATION:
Class/Division: 8
Proper Shipping Name: Corrosive liquid, acidic, inorganic, n.o.s. [contains Poly(aluminum hydroxy)chloride, hydrochloric acid, and sulfuric acid]
Label: Corrosive
Packing Group: III
ID Number: UN 3264

Section 15. REGULATORY INFORMATION

OSHA Hazard Communication Status: Hazardous
TSCA: The ingredients of this product are listed on the Toxic Substances Control Act (TSCA) Chemical Substances Inventory.

Continued on Page 6

Cat-Floc 2953

CERCLA reportable quantity of EPA hazardous substances in product:

Chemical Name	RQ
Hydrochloric acid	5000 lb
Sulfuric acid	1000 lb

Product RQ: 20,000 lb (Notify EPA of product spills exceeding this amount.)

SARA TITLE III:

Section 302 Extremely Hazardous Substances:

Chemical Name	CAS #	RQ	TPQ
Hydrochloric acid	7647-01-0	5000 lb (gas)	500 lb (gas)
Sulfuric acid	7664-93-9	1000 lb	1000 lb

Section 311 and 312 Health and Physical Hazards:

Immediate	Delayed	Fire	Pressure	Reactivity
[yes]	[no]	[no]	[no]	[no]

Section 313 Toxic Chemicals:

Chemical Name	CAS #	% by Weight
Hydrochloric acid	7647-01-0	1 - 5
Sulfuric acid	7664-93-9	1 - 5

Section 16. OTHER INFORMATION

HMIS RATINGS: Health = 3 Flammability = 0 Reactivity = 0
Personal Protective Equipment = X (to be specified by user depending on use conditions)

Hazard rating scale: 0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe

MSDS REVISION SUMMARY: Supersedes MSDS issued on 09/18/96.

PREPARED BY: P.J. Maloney

Cat-Floc 4954

CALGON CORPORATION

P.O. Box 1346
Pittsburgh, PA 15230-1346
Phone--(412)494-8000

MATERIAL SAFETY DATA SHEET

Section 1. PRODUCT IDENTIFICATION

PRODUCT NAME: **Cat-Floc 4954**

CHEMICAL DESCRIPTION: Acidic aqueous solution
PRODUCT CLASS: Cationic coagulant
MSDS CODE: 0F02-11-02-94

Section 2. INFORMATION ON INGREDIENTS

Chemical Name	CAS Number	% by Weight	OSHA PEL	ACGIH TLV
Poly(aluminum hydroxy) chloride	1327-41-9	25	TWA 2 mg/m^3 (as Al) for Al soluble salts	TWA 2 mg/m^3 (as Al) for Al soluble salts

Section 3. HAZARDS IDENTIFICATION

********************** EMERGENCY OVERVIEW **********************

WARNING!
May cause eye and skin irritation.
May be harmful if swallowed.
May cause respiratory tract irritation.

****

PRIMARY ROUTES OF ENTRY: Eye and skin contact, ingestion, inhalation

TARGET ORGANS: Eye, skin, mucous membranes

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: No data available.

POTENTIAL HEALTH EFFECTS:

EYE CONTACT: Contact with the eye will cause painful burning or stinging of the eyes and lids, watering of the eyes, and inflammation of the conjunctiva (the mucous membrane covering the front surface of the eyeball and lining the lids).

Continued on Page 2

Cat-Floc 4954

SKIN CONTACT: This product may cause irritation, redness, swelling, or dermatitis upon contact. The product is not expected to be absorbed through the skin.

INGESTION: Ingestion of this product may cause severe irritation or burns of the mucous membranes of the mouth, throat, esophagus and stomach.

INHALATION: Inhalation of product mist will irritate the respiratory tract.

SUBCHRONIC, CHRONIC:
No applicable information was found concerning any potential health effects resulting from subchronic or chronic exposure to the product.

CARCINOGENICITY:
NTP:
No ingredients listed in this section
IARC:
No ingredients listed in this section
OSHA:
No ingredients listed in this section

Section 4. FIRST AID MEASURES

EYE CONTACT: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Seek medical aid.

SKIN CONTACT: In case of contact, flush skin with plenty of water. Remove contaminated clothing. Seek medical aid if irritation persists. Wash clothing before reuse.

INGESTION: If swallowed, do NOT induce vomiting. Give large quantities of water. Seek medical aid immediately. Never give anything by mouth to an unconscious person.

INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Seek medical aid.

Section 5. FIRE-FIGHTING MEASURES

FLASH POINT: > 200°F
This product is not by definition a "flammable liquid" or a "combustible liquid".

LOWER FLAMMABLE LIMIT: Not available UPPER FLAMMABLE LIMIT: Not available

AUTO-IGNITION TEMPERATURE: Not available

EXTINGUISHING MEDIA: Use extinguishing media appropriate for the surrounding fire.

FIRE-FIGHTING INSTRUCTIONS: Exercise caution when fighting any chemical fire. A self-contained breathing apparatus and protective clothing are essential.

FIRE & EXPLOSION HAZARDS: Poly(aluminum hydroxy) chloride reacts with aluminum or zinc to form hydrogen gas.

Continued on Page 3

Cat-Floc 4954

DECOMPOSITION PRODUCTS: Thermal decomposition or combustion may produce carbon monoxide, carbon dioxide, hydrogen chloride, ammonia, and/or nitrogen oxides.

NFPA RATINGS: Health = 2 Flammability = 0 Reactivity = 0 Special Hazard = None

Hazard rating scale: 0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe

Section 6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: Wearing appropriate personal protective equipment, contain spill, collect onto inert absorbent and place into suitable container. Hose spill area well since product can make floors slippery.

Section 7. HANDLING AND STORAGE

HANDLING: Avoid contact with eyes, skin and clothing.
Avoid breathing mist.
Use with adequate ventilation.
Wash thoroughly after handling.
Keep container closed when not in use.

STORAGE: Protect from low temperatures.

Section 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

PERSONAL PROTECTIVE EQUIPMENT:

EYE/FACE PROTECTION: Chemical splash goggles
SKIN PROTECTION: Chemical resistant gloves
RESPIRATORY PROTECTION: If airborne concentrations exceed published exposure limits, use a NIOSH approved respirator in accordance with OSHA respiratory protection requirements (29 CFR 1910.134).

ENGINEERING CONTROLS: Use local exhaust ventilation where mist or spray may be generated.

WORK PRACTICES: An eye wash station should be accessible in the immediate area of use.

SATISFACTORY MATERIALS OF CONSTRUCTION: Storage, transfer lines and feed equipment should be constructed of acid resistant materials, such as polyethylene, PVC, fiberglass or rubber lined.

Section 9. PHYSICAL AND CHEMICAL PROPERTIES

BOILING POINT: Not available

VAPOR PRESSURE: Similar to water

VAPOR DENSITY (air=1): Similar to water

SOLUBILITY IN WATER: Complete

SPECIFIC GRAVITY: 1.15 - 1.20 @ 25°C

pH: 3.5 - 3.8 @ 25°C

Continued on Page 4

Cat-Floc 4954

%VOLATILE BY WEIGHT: .65 FREEZING POINT: Not available

APPEARANCE AND ODOR: Clear to slightly hazy, pale yellow liquid.

Section 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable HAZARDOUS POLYMERIZATION: Will not occur

CONDITIONS TO AVOID: Reacts with aluminum or zinc to form hydrogen gas.

INCOMPATIBILITY: Strong bases

DECOMPOSITION PRODUCTS: Thermal decomposition or combustion may produce carbon monoxide, carbon dioxide, hydrogen chloride, ammonia, and/or nitrogen oxides.

Section 11. TOXICOLOGICAL INFORMATION

ON PRODUCT:
No information available on the formulated product.

ON INGREDIENTS:

Chemical Name	Oral LD_{50} (rat)	Dermal LD_{50} (rabbit)	Inhalation LC_{50} (rat)
Poly(aluminum hydroxy) chloride	12.8 g/kg	Not available	Not available

Section 12. ECOLOGICAL INFORMATION

ON PRODUCT:
No information available on the formulated product.

ON INGREDIENTS:

Chemical Name	Aquatic Toxicity Data
Poly(dimethyldiallylammonium chloride)-40% solution	96 hr LC50 (bluegill sunfish): 0.82 - 1.3 ppm 96 hr LC50 (rainbow trout): 0.37 ppm 48 hr LC50 (Daphnia magna): 0.9 ppm (in clear water) 48 hr LC50 (Daphnia magna): 1.2 - 2.5 ppm (in 50 ppm clay suspension) 48 hr LC50 (Daphnia magna): 24.8 ppm (in 1000 ppm clay suspension) Note a substantial reduction in toxicity is observed under turbid conditions.

Section 13. DISPOSAL CONSIDERATIONS

RCRA STATUS: Discarded product, as sold, would be considered a RCRA Hazardous Waste based on the characteristic of corrosivity. The EPA Hazardous Waste Number is D002.

Continued on Page 5

DISPOSAL: Dispose of in accordance with local, state and federal regulations.

Section 14. TRANSPORT INFORMATION

DOT CLASSIFICATION:
- Class/Division: 8
- Proper Shipping Name: Corrosive liquid, acidic, inorganic, n.o.s. (contains Poly(aluminum hydroxy) chloride)
- Label: Corrosive
- Packing Group: III
- ID Number: UN 3264

Section 15. REGULATORY INFORMATION

OSHA Hazard Communication Status: Hazardous

TSCA: The ingredients of this product are listed on the Toxic Substances Control Act (TSCA) Chemical Substances Inventory.

CERCLA reportable quantity of EPA hazardous substances in product:

Chemical Name	RQ
No ingredients of this product have CERCLA reportable quantities.	

Product RQ: Not applicable (Notify EPA of product spills exceeding this amount.)

SARA TITLE III:

Section 302 Extremely Hazardous Substances:

Chemical Name	CAS #	RQ	TPQ
There are no SARA 302 Extremely Hazardous Substances in this product.			

Section 311 and 312 Health and Physical Hazards:

Immediate	Delayed	Fire	Pressure	Reactivity
[yes]	[no]	[no]	[no]	[no]

Section 313 Toxic Chemicals:

Chemical Name	CAS #	% by Weight
There are no reportable SARA 313 Toxic Chemicals in this product.		

Section 16. OTHER INFORMATION

HMIS RATINGS: Health = 2 Flammability = 0 Reactivity = 0
Personal Protective Equipment = X (to be specified by user depending on use conditions)

Hazard rating scale: 0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe

Continued on Page 6

Cat-Floc 4954

MSDS REVISION SUMMARY: Supersedes MSDS issued on 03/15/95. The MSDS has been changed in Section 14.

PREPARED BY: P.J. Maloney

POL-E-Z 8736

CALGON CORPORATION

P.O. Box 1346
Pittsburgh, PA 15230-1346
24-Hour Emergency Telephone
Phone–(412)494-8000
CHEMTREC® 1-800-424-9300

MATERIAL SAFETY DATA SHEET

Section 1. PRODUCT IDENTIFICATION

PRODUCT NAME: **POL-E-Z 8736**

CHEMICAL DESCRIPTION: Anionic emulsion polymer
PRODUCT CLASS: Water treatment
MSDS CODE: 0A49

Section 2. INFORMATION ON INGREDIENTS

Chemical Name	CAS Number	% by Weight	OSHA PEL	ACGIH TLV
Petroleum distillates, straight-run middle	64741-44-2	~ 20	TWA 5 mg/m3 (for Oil mist, mineral)	TWA 5 mg/m3, STEL 10 mg/m3 (for Oil mist, mineral) [1996 proposal to remove STEL.]

Section 3. HAZARDS IDENTIFICATION

**************************** EMERGENCY OVERVIEW ********************************

Off-white, viscous, opaque liquid with slight hydrocarbon odor.
WARNING!
May cause eye and skin irritation.

****

PRIMARY ROUTES OF ENTRY: Eye and skin contact, inhalation

TARGET ORGANS: Eye, skin

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Pre-existing skin disorders.

POTENTIAL HEALTH EFFECTS:

EYE CONTACT: This product may produce irritation upon contact with the eye.

SKIN CONTACT: Prolonged or repeated contact with the skin may dry and defat the skin, leading to irritation and dermatitis. This product is not expected to be absorbed through the skin in harmful amounts or to produce an allergic skin reaction.

POL-E-Z 8736

INGESTION: This product would be expected to be practically non-toxic by ingestion. However, ingestion of petroleum distillate may produce gastrointestinal tract irritation, vomiting and central nervous system depression.

INHALATION: This product is not expected to present an inhalation hazard unless mists or vapors are generated.

SUBCHRONIC, CHRONIC: No applicable information was found concerning any potential health effects resulting from subchronic or chronic exposure to the product. Studies have shown that certain representative middle distillate petroleum products have been found to be tumorigenic in mice when applied to the skin repeatedly at very high doses without washing between applications in long-term bioassays. The petroleum distillate in this product has been found to be non-mutagenic in modified Ames testing.

CARCINOGENICITY:
NTP: No ingredients listed in this section.
IARC: No ingredients listed in this section.
OSHA: No ingredients listed in this section.

Section 4. FIRST AID MEASURES

EYE CONTACT: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Seek medical aid.

SKIN CONTACT: In case of contact, flush skin with plenty of water. Remove contaminated clothing. Seek medical aid if irritation persists. Wash clothing before reuse.

INGESTION: Not an expected route of overexposure. If swallowed, do not induce vomiting. Call a physician. This product would be expected to be practically non-toxic by ingestion.

INHALATION: Not an expected route of overexposure. However, if exposure by inhalation is suspected, remove to fresh air. Aid in breathing if necessary and seek medical aid if symptoms occur.

Section 5. FIRE-FIGHTING MEASURES

FLASHPOINT: > 200°F (> 93°C)
This product is not by definition a "flammable liquid" or a "combustible liquid".

LOWER FLAMMABLE LIMIT: Not available

UPPER FLAMMABLE LIMIT: Not available

AUTO-IGNITION TEMPERATURE: Not available

EXTINGUISHING MEDIA: Water spray/fog, carbon dioxide, foam, dry chemical.

FIRE-FIGHTING INSTRUCTIONS:
Exercise caution when fighting any chemical fire. A self-contained breathing apparatus and protective clothing are essential.

FIRE & EXPLOSION HAZARDS: Product emits toxic gases under fire conditions.

DECOMPOSITION PRODUCTS: Thermal decomposition or combustion may produce carbon dioxide, carbon monoxide, ammonia, and/or nitrogen oxides.

POL-E-Z 8736

NFPA CODES: Health = 2 Flammability = 1 Reactivity = 0 Special Hazard = None

Hazard rating scale: 0=Minimal; 1=Slight; 2=Moderate; 3=Serious; 4=Severe

Section 6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:
Wearing appropriate personal protective equipment, contain spill, collect onto inert absorbent and place into suitable container. Spilled product may make floor slippery; spills should be cleaned up immediately to prevent falls.

Section 7. HANDLING AND STORAGE

HANDLING: Avoid contact with eyes, skin and clothing.
Avoid breathing mist.
Keep product thoroughly mixed.
Use with adequate ventilation.
Wash thoroughly after handling.
Keep container closed when not in use.

STORAGE: Store between 50 and 90°F. Avoid frequent temperature changes.

Section 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

PERSONAL PROTECTIVE EQUIPMENT:

EYE/FACE PROTECTION: Chemical splash goggles
SKIN PROTECTION: Chemical resistant gloves
RESPIRATORY PROTECTION: If airborne concentrations exceed published exposure limits, use a NIOSH approved respirator in accordance with OSHA respiratory protection requirements (29 CFR 1910.134).

ENGINEERING CONTROLS: Use local exhaust ventilation where mist or spray may be generated.

WORK PRACTICES: An eye wash station should be accessible in the immediate area of use. Wash areas of skin contaminated with this product thoroughly with soap and water soon after exposure. Do not allow this product to remain on skin for prolonged periods.

Section 9. PHYSICAL AND CHEMICAL PROPERTIES

BOILING POINT: Not available

SOLUBILITY IN WATER: Miscible

VAPOR PRESSURE: Not available

SPECIFIC GRAVITY: 1.01 - 1.07 @ 25°C

VAPOR DENSITY (air = 1): Not available

pH: Not applicable

%VOLATILE BY WEIGHT: ~ 49 (water)

FREEZING POINT: Not available

APPEARANCE AND ODOR: Off-white, viscous, opaque liquid with slight hydrocarbon odor.

POL-E-Z 8736

VISCOSITY: 750 - 5000 cps @ 25°C #2 @ 6 rpm

Section 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable

HAZARDOUS POLYMERIZATION: Will not occur

CONDITIONS TO AVOID: Do not expose to extreme temperatures. Do not contaminate with water as it will adversely affect product quality.

INCOMPATIBILITY: Strong oxidizers

DECOMPOSITION PRODUCTS: Thermal decomposition or combustion may produce carbon dioxide, carbon monoxide, ammonia, and/or nitrogen oxides.

Section 11. TOXICOLOGICAL INFORMATION

Test material	Oral LD50(rat)	Dermal LD50(rabbit)	Inhalation LC50(rat)
Petroleum distillates, straight-run middle	> 5 g/kg	> 2 g/kg	1.7 mg/L/4H

Section 12. ECOLOGICAL INFORMATION

Test Material	Aquatic Toxicity Data
Product	48 hr LC50 (mysid shrimp): 132 ppm No-observed-adverse-effect concentration: 50 ppm

Section 13. DISPOSAL CONSIDERATIONS

RCRA STATUS: Discarded product, as sold, would not be considered a RCRA Hazardous Waste.

DISPOSAL: Dispose of in accordance with local, state and federal regulations.

Section 14. TRANSPORT INFORMATION

DOT CLASSIFICATION:
- Proper Shipping Name: Not applicable
- Class/Division: Not restricted
- ID Number: Not applicable
- Packing Group: Not applicable
- Label: None

POL-E-Z 8736

Section 15. REGULATORY INFORMATION

OSHA Hazard Communication Status: Hazardous

TSCA: The ingredients of this product are listed on the Toxic Substances Control Act (TSCA) Chemical Substances Inventory.

CERCLA reportable quantity of EPA hazardous substances in product:

Chemical Name	RQ
No ingredients have a CERCLA RQ.	

Product RQ: Not applicable (Notify EPA of product spills exceeding this amount.)

SARA TITLE III:

Section 302 Extremely Hazardous Substances:

Chemical Name	CAS #	RQ	TPQ
None			

Section 311 and 312 Health and Physical Hazards:

Immediate	Delayed	Fire	Pressure	Reactivity
[yes]	[no]	[no]	[no]	[no]

Section 313 Toxic Chemicals:

Chemical Name	CAS #	% by Weight
None		

FDA: This product is FDA approved under 21 CFR Section(s):
176.110 (Acrylamide-acrylic acid resins for use only as components of paper and paperboard)
Consult your sales representative for any use limitations.

Section 16. OTHER INFORMATION

HMIS RATINGS: Health = 2 Flammability = 1 Reactivity = 0

Personal Protective Equipment = X (to be specified by user depending on use conditions)

Hazard rating scale: 0=Minimal; 1=Slight; 2=Moderate; 3=Serious; 4=Severe

MSDS REVISION SUMMARY: Supersedes MSDS issued on 02/06/96.

PREPARED BY: **P.J. Maloney**

ATTACHMENT 2
PROCESS WATER TREATMENT SYSTEM MONTHLY REPORTS

November 30, 1999
Project 9045.006.001

Mr. Scott Morrison
Department of Ecology
Southwest Regional Office
P.O. Box 47775
Olympia, WA 98504-7775

Re: J.L. Storedahl & Sons, Daybreak Mine
Process Water Treatment System Monthly Report

Dear Scott:

J.L. Storedahl & Sons (Storedahl) and Maul Foster & Alongi, Inc. (MFA) are submitting this report for operation of the process water treatment system at the Daybreak Mine. This report covers system operation from July 14, 1999 through August 31, 1999.

SYSTEM OPERATION

Storedahl began processing mined material at the Daybreak Mine near the end of May. Storedahl installed and also began operation of a process water treatment system to treat the turbidity of the effluent from the processor. The treatment system consists of a pre-addition settling channel to settle out heavier solids, an additive dosing station with secondary containment to dose the coagulant and flocculent into the effluent stream, and a post-addition settling channel to settle the finer material after additive dosing. The system is described in detail in the update to the Storm Water Pollution Prevention Plan (SWPPP) previously submitted to the Department of Ecology (Ecology). Storedahl facility personnel are responsible for system operation and record data related to additive usage and water quality on a daily basis.

ADDITIVE USAGE

Storedahl is evaluating several different flocculents and coagulants to compare the effectiveness, costs, and toxicity impacts of the different products. Calgon Catfloc 4900, Catfloc L, and Pol E-Z 7736 additives were evaluated during the time period covered by this report.

The concentration of additives was varied during the test to determine the most effective dosage. Initially, both the Catfloc 4900 and Pol E-Z 7736 were dosed into the process water at or near the LC_{50} during the hours when processing was taking place. On August 5, the concentration of the Catfloc 4900 was reduced and supplemented with a small addition of Catfloc L in an effort to reduce overall chemical usage. During the hours when no processing was taking place (nights and weekends), pond water was continually circulated through the system and coagulant (Catfloc 4900) was dosed at approximately 1/10 of the concentration dosed during processing.

The following table includes the data on additive usage:

Product	Total Additive Usage (Gallons)	Average Dosage During Processing (ppm)	LC_{50} (ppm)
Catfloc 4900	3,620	60 *	150**
Catfloc L	122	3.8	25***
Pol E-Z 7736	183	3.0	****

* During the beginning of the operation period, concentration slightly exceeded 50% of the LC_{50} as adjustments were made to the dosages.

** LC_{50} for fathead minnow.

*** LC_{50} for Daphnia magna.

**** Specific toxicity information for Pol E-Z was not available. Information obtained from the City of Redmond Study (Resource Planning Associates, 1999) indicates that Pol E-Z used in conjunction with Catfloc CL (a more concentrated version of Catfloc L) does not create harmful toxicity levels.

During the testing period, process water is continually flowing through the system at approximately 3,000 gpm, whether processing is taking place or not. At this water flow rate for the test period and the additive usage specified in the above table, the overall average concentrations of the Catfloc 4900, the Catfloc L, and the Pol E-Z are 25 ppm, 1.1 ppm and 1.0 ppm respectively.

MONITORING

Storedahl performed monitoring at several site locations during the additive testing period. Storedahl continued to perform the monitoring required by the facility NPDES permit and to submit these results to Ecology. Storedahl also performed additional monitoring at the site to evaluate the effectiveness of the additives and to ensure that no adverse impacts were created.

The following table identifies the monitoring locations (see Figure 1).

Monitoring Location Designation	Location
A	The Process Water Discharge to the Settling Channel
B	Just Upstream from the Additive Addition Location
C	The Treated Process Water Discharge to Pond 1
D	The Outlet from Pond 1 to Pond 2
E	The Discharge from Pond 2 into Pond 3
F	The Discharge from Pond 3 to Pond 5
Outfall 1	Site discharge point to creek

The monitoring results are included in the following table:

Parameter	Sampling Location						
	Point A	Point B	Point C	Point D	Point E	Point F	Pond 5 Outfall
pH							
Max	7.97	7.99	7.87	8.14	7.60	8.10	8.14
Min	6.90	6.70	6.72	6.81	7.00	7.05	7.57
Avg	7.23	7.20	7.13	7.25	7.29	7.45	7.85
Temp. (° C)							
Max	24.80	25.60	25.20	30.30	24.50	23.40	25.60
Min	18.70	18.60	18.80	19.10	20.30	20.20	20.80
Avg	21.79	21.90	21.98	22.74	21.68	21.53	22.24
Turbidity							
(NTU)	7565	6890	5652	150	31	14	19
Max	2480	1045	861	75	6	6	6
Min	4897	4660	2459	106	15	9	12
Avg							

Parameter	Sampling Location						
	Point A	**Point B**	**Point C**	**Point D**	**Point E**	**Point F**	**Pond 5 Outfall**
Dissolved Oxygen (mg/l)							
Max	9.9	9.4	9.3	9.6	9.9	10.8	11.4
Min	6.6	6.5	7.1	6.6	7.8	8.9	7.6
Avg	8.4	8.3	8.5	8.4	9.2	9.9	9.1
TDS (mg/l)	NA	NA	NA	127	83	110	85
TSS (mg/l)	NA	NA	NA	57	6	11	ND
Phosphorus (mg/l)	NA	NA	NA	NA	0.04	NA	0.02
Ammonia (mg/l)	NA	NA	NA	NA	NA	NA	ND
Alkalinity (mg/l)	NA	NA	NA	39	45	45	NA

Operation of the process water treatment system has been effective in reducing the turbidity of the discharge from the site. Figure 2 shows a comparison of the turbidity at the outfall between the period of operation of the process water treatment system and the corresponding time period in 1998. The figure shows a substantial decrease in turbidity once the correct additive dosages were achieved.

TOXICITY TESTING

During the additive testing period, Storedahl collected water samples and performed aquatic organism toxicity testing to ensure that the process water treatment was not creating an adverse impact.

The results of the aquatic organism toxicity testing are included in the following table:

Sample Date	Sample Location	Organism	% Survival
7/13	Pond 2 Outfall	Ceriodaphnia dubia Oncorhynchus mykiss	95 100
7/21	Pond 2 Outfall	Daphnia magna Oncorhynchus mykiss	100 100
8/3	Pond 2 Outfall	Daphnia magna Oncorhynchus mykiss	100 100

8/25	Pond 2 Outfall	Daphnia magna Oncorhynchus mykiss	* 100
9/7	Pond 3 to Pond 5	Daphnia magna Oncorhynchus mykiss	90 100
9/21	Pond 2 Outfall	Daphnia magna	90*

* Daphnia magna test invalidated due to mortality level of control group. An additional sample was collected 9/21 and tested with Daphnia magna.

Toxicity testing has included rainbow trout (Oncorhynchus mykiss) and Daphnia magna as invertebrates. Ceriodaphnia dubia was substituted as the invertebrate species during one test when Daphnia magna was unavailable. There were no reported significant toxic impacts to the fish or to the invertebrates.

Due to the recent purchase of both Nalco and Calgon by the same European chemical company, Storedahl has begun preliminary testing of another set of additives in order to ensure a competitive bidding process. The Wesmar Company is currently evaluating the process water to recommend a set of additives that meets the toxicity requirements while still meeting the water quality criteria.

If the proposed additives have acceptable toxicity and dosages, these additives will be tested for approximately one month. Upon completion of this testing, results for the additives will be evaluated and one set will be selected for continued usage in the process water treatment system at the Daybreak Mine. Storedahl will submit a report to Ecology upon completion of the evaluation of the next set of additives.

Sincerely,

Maul Foster & Alongi, Inc.

NEIL R. ALONGI
STATE OF WASHINGTON
16656
REGISTERED
PROFESSIONAL ENGINEER

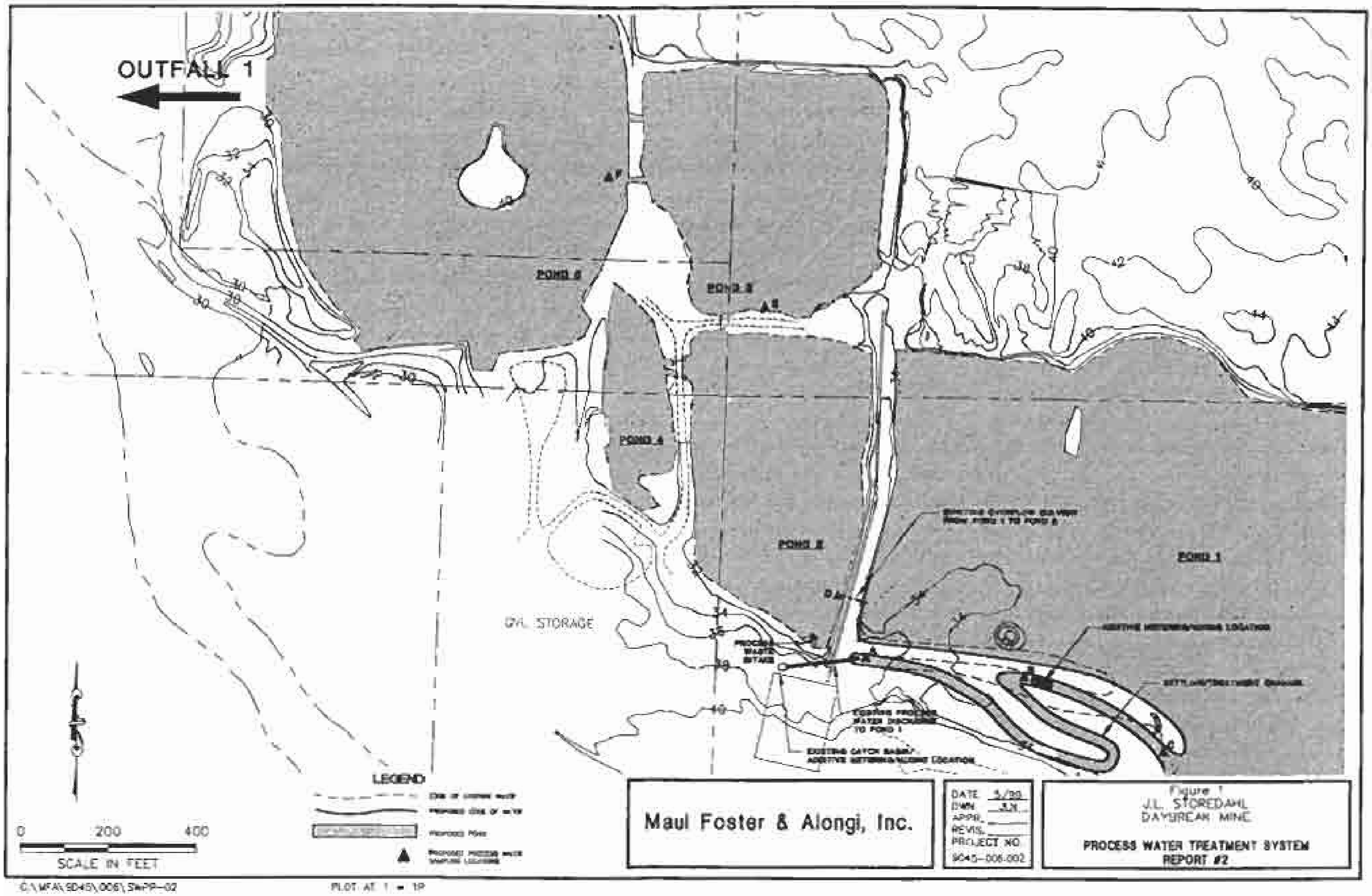
Neil R. Alongi, P.E.
Vice President

David C. Hoffman, P.E.
Project Engineer

Attachments: Figures

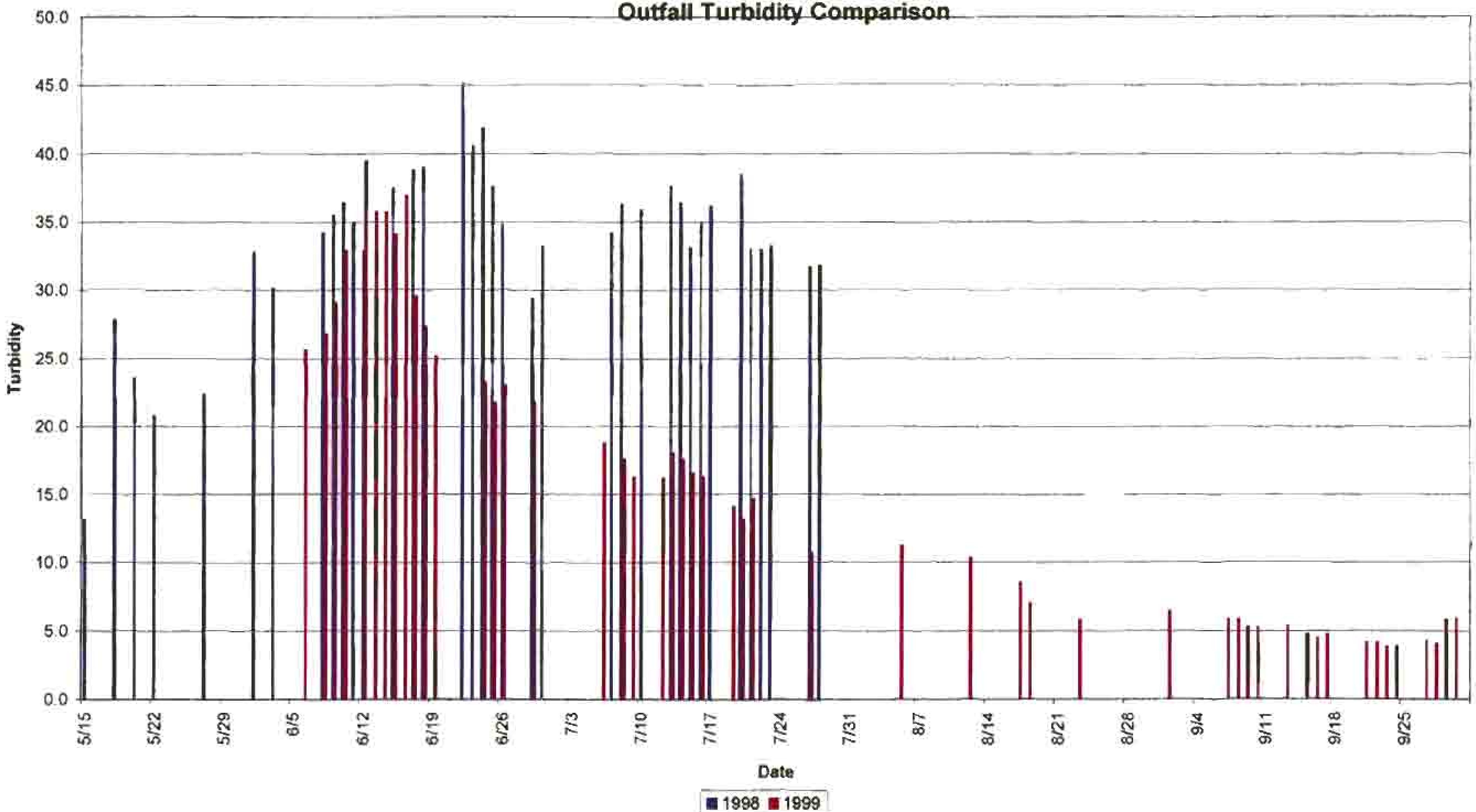
EXPIRES: 9/23/ 01

cc: Randy Sweet
Kevin Storedahl
Kimball Storedahl



OUTFALL 1
POND 6
POND 5
POND 4
POND 2
POND 1
GVL. STORAGE
LEGEND
0
200
400
SCALE IN FEET
Maul Foster & Alongi, Inc.
Figure 1
J.L. STOREDAHL
DAYBREAK MINE
PROCESS WATER TREATMENT SYSTEM
REPORT #2
PROJECT NO.
9045-006-002
C:\MFA\9045\006\SWPP-02

Figure 2
J. L. Storedahl & Sons Daybreak Mine
Outfall Turbidity Comparison



Maul Foster & Alongi, Inc.

Environmental & Engineering Services

August 9, 1999
Project 9045.006.001

Mr. Scott Morrison
Department of Ecology
Southwest Regional Office
P.O. Box 47775
Olympia, WA 98504-7775

Re: J.L. Storedahl & Sons, Daybreak Mine
Process Water Treatment System Monthly Report

Dear Scott:

J.L. Storedahl & Sons (Storedahl) and Maul Foster & Alongi, Inc. (MFA) are submitting this monthly report for operation of the process water treatment system at the Daybreak Mine. This report covers system operation from May 25, 1999 through June 30, 1999.

SYSTEM OPERATION

Storedahl began processing mined material at the Daybreak Mine near the end of May. Storedahl installed and also began operation of a process water treatment system to treat the turbidity of the effluent from the processor. The treatment system consists of a pre-addition settling channel to settle out heavier solids, an additive dosing station with secondary containment to dose the coagulant and flocculant into the effluent stream, and a post-addition settling channel to settle the finer material after additive dosing. The system is described in detail in the update to the Storm Water Pollution Prevention Plan (SWPPP) previously submitted to the Department of Ecology (Ecology). Storedahl facility personnel are responsible for system operation and record data related to additive usage and water quality on a daily basis.

ADDITIVE USAGE

Storedahl is evaluating several different flocculants and coagulants to compare the effectiveness, costs, and toxicity impacts of the different products. NALCO 7888 and 9806 additives were evaluated during the time period covered by this report.

The concentration of additives was varied during the test to determine the most effective dosage. However, the additives were never dosed at a concentration above one-half of the additive LC_{50}. Both the flocculant and coagulant were dosed into the process water at or

7223 N.E. Hazel Dell Avenue, Suite B • Vancouver, WA 98665 • (360) 694-2691 • Fax: (360) 906-1958

near this level during the hours when processing was taking place. During the hours when no processing was taking place (nights and weekends), pond water was continually circulated through the system and coagulant (NALCO 7888) was dosed at approximately 1/10 of the concentration dosed during processing.

The following table includes the data on additive usage:

Product	Usage (Gallons)	Dosage During Processing (ppm)	LC_{50} (ppm)
7888	3,113	< 75	150
9806	263	< 5	10

During the testing period, process water is flowing through the system at approximately 3,000 gpm. At this water flow rate for the test period and the additive usage specified in the above table, the overall concentrations of the 7888 and the 9806 are 27.7 ppm and 1.4 ppm respectively.

MONITORING

Storedahl performed monitoring at several site locations during the additive testing period. Storedahl continued to perform the monitoring required by the facility NPDES permit and to submit these results to Ecology. Storedahl also performed additional monitoring at the site to evaluate the effectiveness of the additives and to ensure that no adverse impacts were created.

The following table identifies the monitoring locations (see Figure 1).

Monitoring Location Designation	Location
A	The Process Water Discharge to the Settling Channel
B	Just Upstream from the Additive Addition Location
C	The Treated Process Water Discharge to Pond 1

D	The Outlet from Pond 1 to Pond 2
E	The Discharge from Pond 2 into Pond 3
Outfall 1	Site discharge point to

The monitoring results are included in the following table:

Parameter	**Sampling Location**					
	Point A	**Point B**	**Point C**	**Point D**	**Point E**	**Pond 5 Outfall**
pH					7.67	7.65
Max	7.56	8.42	7.55	8.61		
Min	6.95	6.92	6.74	6.86		
Avg	7.38	7.40	7.25	7.47		
Temp. (° C)					21.6	18.8
Max	24.9	23.9	22.4	27.0		
Min	14.3	14.6	14.5	15.0		
Avg	18.6	19.5	18.4	19.2		
Turbidity					48	28.6
(NTU)	5226	5010	2732	200		
Max	3385	2509	639	103		
Min	4329	3657	1378	158		
Avg						
Dissolved Oxygen (mg/l)					7.8	9.1
Max	9.4	9.5	11.1	8.4		
Min	5.8	5.5	5.5	5.5		
Avg	6.8	7.5	7.3	6.5		
TDS (mg/l)	NA	NA	NA	NA	101	NA
TSS (mg/l)	NA	NA	NA	54	8	16
Phosphorus (mg/l)	NA	NA	NA	NA	0.04	0.02
Ammonia (mg/l)	NA	NA	NA	NA	ND	ND
Alkalinity	NA	NA	NA	43	42	NA

(mg/l)						

Operation of the process water treatment system has been effective in reducing the turbidity of the discharge from the site. Figure 2 shows a comparison of the turbidity at the outfall between the period of operation of the process water treatment system and the corresponding time period in 1998. The figure shows a substantial decrease in turbidity once the correct additive dosages were achieved.

TOXICITY TESTING

During the additive testing period, Storedahl collected water samples and performed aquatic organism toxicity testing to ensure that the process water treatment was not creating an adverse impact.

The results of the aquatic organism toxicity testing are included in the following table:

Sample Date	Sample Location	Organism	% Survival
5/19	Pond 2 Outfall	Ceriodaphnia dubia	95
5/19	Pond 2 Outfall	Oncorhynchus mykiss	98
6/1	Pond 2 Outfall	Ceriodaphnia dubia	70
6/4	Pond 2 Outfall	Oncorhynchus mykiss	100
6/9	Pond 2 Outfall	Ceriodaphnia dubia	20
6/9	Pond 2 Outfall	Oncorhynchus mykiss	100
6/21	Pond 3 to Pond 5	Daphnia magna	100
6/23	Pond 2 Outfall	Daphnia magna	100
6/23	Pond 2 Outfall	Oncorhynchus mykiss	100

Toxicity testing has included rainbow trout (Oncorhynchus mykiss) and Ceriodaphnia dubia and Dapnia magna as invertebrates. There were no reported significant toxic impacts to fish. However, there was some mortality with the C. dubia. In discussions with Rick Cardwell, the toxicologist at the Parametrix Lab, it was noted that C. dubia. are sensitive to total suspended solids or turbidity. Ironically, the purpose of using the chemical additives is to reduce turbidity levels and the testing is directed at determining the toxicity of the chemicals and not the turbidity. Note that the only significant mortality to C. dubia. was for relatively highly turbid samples. Testing was switched to Daphnia magna, since it is the same organism tested during the City of Redmond study on treatment of stormwater from construction sites.

As briefly discussed with you, the use of Ceriodaphnia as test organisms was based on their common acceptance in toxicity testing. However, since the toxicity to listed fish species or their food chain is the objective of the testing we have been searching for information or a rational for selection of a more representative invertebrate. Stan Gregory at the Oregon State University Department of Fish and Wildlife, pointed out to us that the use of zooplankton was probably not appropriate, and that an amphipod, e.g., Gammarus sp. or a Chironomid may be more applicable to the question at hand. Dudley Reiser of R2 Resource Consultants has suggested the use of Hyallela azteca or Gammarus sp. He also suggested that we consider other organisms that would be representative of the receiving water biota, e.g., Plecopterans.

We are looking into the availability of the various organisms for future testing. You said that you would be working with Ecology in the development of some guidance in this testing. We would appreciate any suggestions and/or direction you could provide to us in our ongoing and proposed future bioassay work.

Storedahl has begun testing of the next set of additives. These additives will also be tested for one month. Upon completion of this testing, results for both additives will be evaluated and one set will be selected for continued usage in the process water treatment system at the Daybreak Mine. Storedahl will submit a report to Ecology upon completion of the evaluation of the next set of additives.

Sincerely,

Maul Foster & Alongi, Inc.

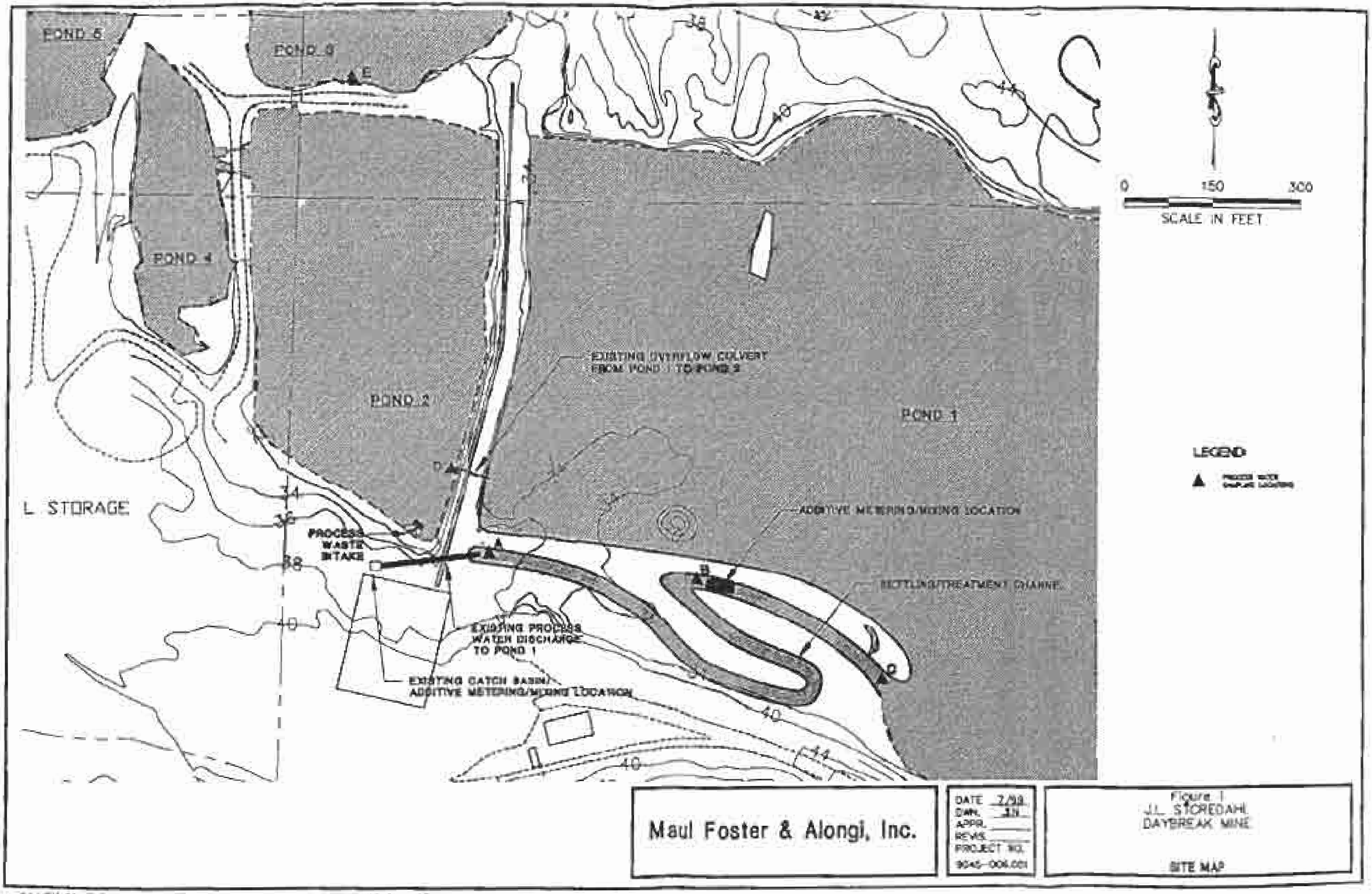
Neil R. Alongi, P.E.
Vice President

David C. Hoffman, P.E.
Project Engineer

Attachments: Figures

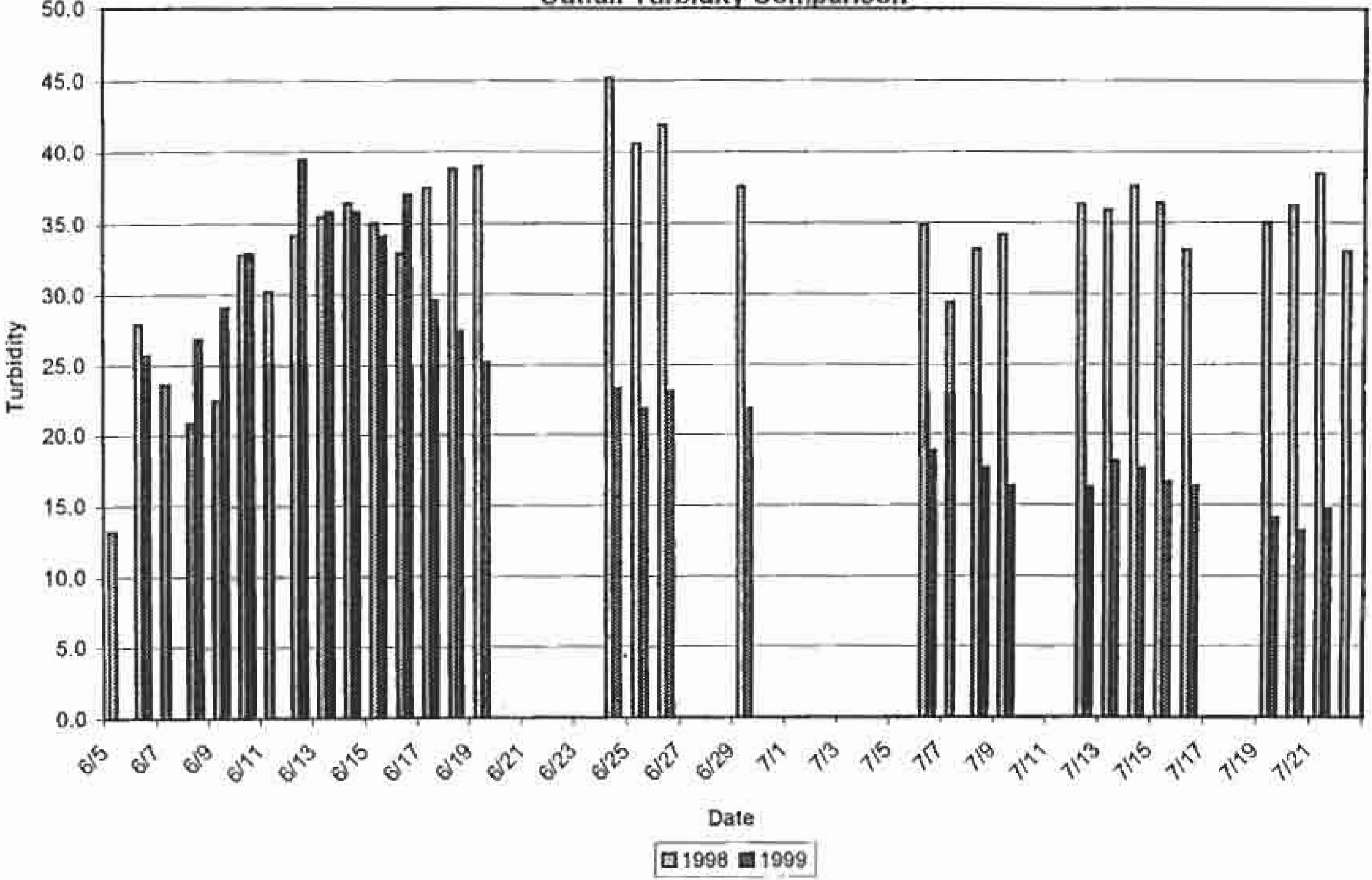
cc: Randy Sweet
Kevin Storedahl
Kimball Storedahl

MFA\\\Dhoffman\mfa\9045-Stordahl\rept1.doc-97



POND 6
POND 0
POND 4
POND 2
POND 1
L. STORAGE
EXISTING OVERFLOW CULVERT FROM POND 1 TO POND 2
PROCESS WASTE INTAKE
ADDITIVE METERING/MIXING LOCATION
SETTLING/TREATMENT CHANNEL
EXISTING PROCESS WATER DISCHARGE TO POND 1
EXISTING CATCH BASIN/ ADDITIVE METERING/MIXING LOCATION
SCALE IN FEET
0
150
300
LEGEND
Maul Foster & Alongi, Inc.
DATE 7/99
PROJECT NO.
9045-006.001
Figure 1
J.L. STOREDAHL
DAYBREAK MINE
SITE MAP

Figure 2
J. L. Storedahl & Sons Daybreak Mine
Outfall Turbidity Comparison



ATTACHMENT 3
MATERIAL SAFETY DATA SHEETS

MATERIAL SAFETY DATA SHEET

POLY ALUM 60

SECTION I - IDENTIFICATION

COMPANY NAME............... WESMAR CO. INC. 1451 NW 46 ST. SEATTLE, WA. 98107
EMERGENCY PHONE NUMBER... (206)783-5344, (800)824-4917, CHEMTREC (800)424-9300
EFFECTIVE DATE...........
REVISED DATE.............. JULY 23, 1996
CHEMICAL NAME............. N/A
TRADE NAME................ POLY ALUM 60
CHEMICAL FAMILY........... MODERATELY ACIDIC COMPOUND
CHEMICAL FORMULA.......... N/A

SECTION II - HAZARDOUS INGREDIENTS

HAZARDOUS COMPONENTS	HAZARDOUS %	TLV (Units)	PROD. CAS #
POLYHYDROXY ALUMINUM CHLORIDE	30-60	2 mg/M3 (as Al)	1327-41-9

(SEE SECTION V FOR ADDITIONAL TLV INFORMATION)

SECTION III - PHYSICAL DATA

BOILING Point(F).......... N/D
FREEZING POINT (F)........ N/D
VOLATILITY/VOL(%)......... N/D
MELTING POINT............. N/D
VAPOR PRESSURE (mm Hg).... N/D
VAPOR DENSITY (Air=1)..... N/D
SOLUBILITY IN H20......... COMPLETELY SOLUBLE IN WATER
APPEARANCE/ODOR........... CLEAR LIGHT YELLOW LIQUID WITH MILD ODOR
SPECIFIC GRAVITY (H20=1).. 1.4
EVAPORATION RATE.......... N/D
PH........................ < 2

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT............... NON COMBUSTIBLE
LOWER FLAME LIMIT......... N/A
HIGHER FLAME LIMIT........ N/A
EXTINGUISH MEDIA.......... Use extinguishing media appropriate to primary cause of fire.
FOR FIRE.................. Avoid contact with fire fighting personnel. Wear complete protective clothing and self contained breathing apparatus.

UNUSUAL FIRE HAZARD...... Contact with soft metals may produce flammable or explosive hydrogen gas.

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE.... The TLV in section II is the ACGIH TLV-TWA and OSHA-PEL, (the time-weighted average concentration for an eight hour work day.) TLV-STEL's (short term esposure limits) have been established for the following products:

POLYHYDROXY ALUMINUM CHLORIDE: OSHA/PEL and ACGIH/TLV is 2 mg/M3. (as Al)
None of the components present in this material at concentrations of 0.1% or greater are listed by IARC, NTP or WISHA/OSHA as carcinogens.

OVER EXPOSURE EFFECTS.... ACUTE HAZARDS:
Product is moderately acidic. Brief exposure causes skin and eye irritation. Permanent eye damage with impairment of vision may occur. Prolonged and or repeated exposure may cause chemical burns to skin, eyes and respiratory tract. Vapors and mists may cause respiratory tract irritation. Harmful if swallowed.

CHRONIC EFFECTS:
No relevant information found.
May irritate existing skin and respiratory disorders.

FIRST AID PROCEDURES.....

EYES: Immediately flush eyes with plenty of water for at least 15 minutes. If irritation remains, get immediate medical attention.
SKIN: Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing. Wash contaminated clothing before reuse.
INGESTION: Do not induce vomiting. Give two or three glasses of water or milk if available and transport to medical facility. Never give anything by mouth to an unconscious person.
INHALATION: Remove to fresh air if effects occur. Consult medical personnel.

SECTION VI - REACTIVITY DATA

CHEMICAL STABILITY....... STABLE

CONDITIONS TO AVOID...... Excessive heat and contact with incompatible materials.

INCOMPATIBLE MATERIALS... Chlorinated products such as bleach, alkaline materials, metals, metal powder, carbides, chlorates, fumigates, nitrates, picrates, strong oxidizing, reducing, or combustible organic material. Hazardous gases are evolved on contact with chemicals such as chlorine bleach, cyanides, sulfides and carbides.

DECOMPOSITION PRODUCTS... Carbon monoxide, carbon dioxide. Oxides of sulfur, nitrogen and/or phosphorous may be released at extremely high temperatures. Reactions with chlorinated products produces deadly chlorine gas.

HAZARDOUS POLYMERIZATION. Will not occur.

POLYMERIZATION AVOID..... N/A

SECTION VII - SPILL OR LEAK PROCEDURE

FOR SPILL .... Always use appropriate protective equipment during clean-up. Stop leaks if possible. Review "Fire, reactivity hazards, and precautions" before proceeding with clean-up. Soak up small spills with dry sand, clay, or diatemaceous earth. Dike large spills. Cautiously dilute with water, neutralize with lime or soda ash and transfer to waste water treatment system.

WASTE DISPOSAL METHOD.... Dispose of in approved chemical disposal area or in a manner which complies with all local, state and federal regulations.

SECTION VIII - SPECIAL PROTECTION

RESPIRATORY PROTECTION... Use NIOSH/MSHA approved dust/mist filter respirator when exposure to mists exceed the permissible exposure limits or if irritation occurs. The respirator use limitations made by NIOSH/MSHA or the manufacturer must be observed. Respirator protection programs must be in accordance with 29 CFR 1910.134.

VENTILATION.............. Local exhaust sufficient to maintain TLV below permissible exposure limits.

PROTECTIVE GLOVES........ Rubber, polyethylene or other acid proof gloves.

EYE PROTECTION........... Chemical safety goggles plus full face shield to protect against splashing. Contact lenses should not be worn when working with any chemicals.

OTHER PROTECTIVE EQUIPMENT............... Impervious protective clothing and chemical resistant safety shoes should be worn to minimize contact. Emergency shower and eyewash facility should be in close proximity. (ANSI Z358.1).

HANDLING AND STORAGE..... Do not get into eyes, on skin or on clothing. Avoid breathing dust, mists, or spray. Do not take internally. Wash thoroughly after handling or contact- exposure can cause burns which are not immediately painful or visible. Keep out of sun and away from heat, sparks and flames. Keep container tightly closed when not in use to prevent leakage. Do not use pressure to empty. Be sure closure is securely fastened before moving container. Do not wash out container or use it for other purposes. Replace closure after each withdrawal and return it with empty container. Empty containers retain product residue and must be handled as if they were full. KEEP OUT OF REACH OF CHILDREN!

SECTION IX - SPECIAL PRECAUTIONS

HAZARD CLASS............. 8 (CORROSIVE)
DOT SHIPPING NAME........ CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S. (CONTAINS POLYHYDROXY ALUMINUM CHLORIDE) 8 UN-3264 PG-II

REPORTABLE QUANTITY (RQ). SEE SECTION VII
UN NUMBER................ UN-3264
NA #..................... N/A
PACKAGING SIZE........... N/A

FOOT NOTES SECTION 313:
THIS PRODUCT CONTAINS THE FOLLOWING TOXIC CHEMICAL(S) SUBJECT TO THE reporting requirements of section 313 of TITLE III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR PART 372 if over 10,000 lbs. are used:

NONE

REFERENCES The information contained herein has been compiled from sources believed to be reliable and accurate to the best of our knowledge at this date. It is provided without warranty, expressed or implied, as to the results of use of this information or to the product to which it relates. WESMAR CO. INC. assumes no responsibility for injury to any person or property resulting from any use of the material if reasonable safety procedures are not adhered to. Each user assumes the risk in their use of this product and should review the data and recommendations in the specific context of their intended use.

QUALITY SERVICE

PRODUCT DATA

TOXCITY DATA

PRODUCT NAME: Poly-Alum 60

INGREDIENTS:

CHEMICAL	% BY WEIGHT
Poly (aluminum Hydroxy) chloride	30-60
Hydrochloric acid	1-5
Sulfuric acid	1-5

TOXICOLOGICAL DATA ON INGREDIENTS:

	ORAL LD_{50} (rat)	INHALATION LC_{50} (rat)
POLY (aluminum hydroxy) CHLORIDE:	12.8 g/kg	NA
HYDROCHLORIC ACID:	900 mg/kg	HUMAN LC_{LO} 1300 ppm/30 min.
SULFURIC ACID:	2140 mg/kg	510 mg/m³ /2H

ECOLOGICAL INFORMATION:

POLY (ALUMINUM HYDROXY) CHLORIDE (~20% in water).

96 HR LC_{50} (rainbow trout) : 1555 ppm

96 HR LC_{50} (fathead minnow): 870 ppm
48 HR EL_{50} (Daphnia magna): 1400 ppm
48 HR EL_{50} (Ceriodophnia dubia): 2000 ppm

WESMAR CO., INC. 1451 NW 46th, SEATTLE, WA 98107
(206) 783-5344 • TOLL FREE - 1-800-824-4917

MATERIAL SAFETY DATA SHEET
NEUTRON PRODUCTS INC.

Revised September 29, 1992

I. PRODUCT IDENTIFICATION

Product Name: Photafloc 1123
Chemical Name: Anionic copolymer of acrylamide and sodium acrylate
Chemical Formula: $-(CH_2-CH)_x-(CH_2-CH)_y-$

$\quad\quad CO \quad\quad CO$ CAS NO. 25085-02-3

$\quad\quad NH_2 \quad\quad ONa$

Appearance: Photafloc 1123 is a slightly basic, water soluble, high molecular weight polymer in the form of a gel log. It varies in color from water white to slightly yellow and has a mild, slightly sweet odor.

II. HAZARD SPECIFICATIONS

Product Hazard: The polymer gel and its solutions are nonhazardous.

Hazardous Ingredients: The polymer gel contains a small amount of unreacted acrylamide monomer, CAS 79-06-1, (0.1 - 0.3%), which has an OSHA-PEL (permissible exposure limit) of 0.03 mg/m³. The American Council of Governmental Hygenists recommends a TLV-TWA (threshold value limit; 8 hour time weighted average) of 0.03 mg/m³, A2, skin. This acrylamide monomer level will not normally be reached when handling the polymer gel or its solutions. Also present is a small amount of sodium acrylate.

NFPA Hazard Rating:

Health -	0	minimal
Flammability -	0	minimal
Reactivity -	0	minimal
Special -	0	minimal

III. PHYSICAL HAZARDS

Flammability: The polymer gel and its solutions are nonflammable, noncombustible, and nonexplosive. No special fire extinguishing methods are needed.

Stability: The product is stable and compatible with aqueous systems. It has no hazardous decomposition products. Combustion products are carbon monoxide, carbon dioxide, ammonia, nitrogen oxides, and water.

Spillage: The spilled product solution and wet gel logs are very slippery. Use caution to avoid injury when handling. Follow cleanup and disposal methods listed in Section VI.

Irritation: Overexposure may result in the following:
Eyes: May cause mild eye irritation.
Skin: May cause irritation and dermatitis.
Ingestion: May cause irritation of eyes and throat, nausea, and vomiting.

neutron PRODUCTS inc

22301 Mt. Ephraim Road • P. O. Box 68 • Dickerson, Maryland 20842 USA
301-349-5001 • FAX: 301-349-2433

Emergency and First Aid Procedures:

Eyes: Flush gently with water for at least 15 minutes. Contact physician.

Skin: Wash with soap and running water. Remove contaminated clothing and wash before reuse.

Ingestion: Drink a large quantity of liquid to dilute the product. Induce vomiting. Call a physician.

Special Handling Requirements: Gloves should be worn when handling gel logs, polymer solutions, and surfaces contacted by them. Safety glasses are recommended. Product should be handled in ventilated areas. No special respiratory protection is required. Skid prevention methods should be employed in wet areas.

IV. TYPICAL PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point: >100°C (212°F)
Freezing Point: <-17°C (1°F)
Vapor Pressure @ 10°C: 8 mm of Hg
Vapor Density: Not determined
% Volatile (vol): Negligible at 70°F
Water Solubility: Infinite
Specific Gravity: 1.12 - 1.15
pH of 1% Solution: 8.5 - 10
Evaporation Rate: Slower than butyl acetate

V. HEALTH HAZARD INFORMATION

Medical conditions generally recognized as aggravated by exposure: None

Primary route of entry: If standard industrial hygiene and recommended procedure are followed, entry of the product or listed ingredients is not expected.

Product: Photafloc 1123 is not listed as a carcinogen by the NTP, not regulated by OSHA, and not evaluated by IARC. No human effects are known for the polymer.

Ingredients: Acrylamide, present as a residual monomer, has been given an A2 notation "suspected of carcinogenic potential for man," by the ACGIH. Symptoms reported in humans, due to excessive exposure to acrylamide monomer, generally thought to be due to skin absorption, include: fatigue, difficulty climbing stairs, weakness in hands and feet, tremors, ataxia, loss of deep tendon reflexes, numbness in the feet, tingling or cold sensations, and increased sensitivity to touch, all of which occur early. Secondary muscle atrophy, particularly in hands and feet, and weight loss, occur later. Urinary retention may occur. Central nervous system effects, which may occur, are abnormal sleepiness, poor memory, confusion, hallucinations, slurred speech,

neutron products inc
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301-349-5001 • FAX: 301-349-2433

hyperactive reflexes, abnormal behavior, positive Romberg sign, abnormal EEG, and changes in visual fields. Recovery can occur, but can take months to years. Increased sweating and erythema of the hands is reported as being characteristic; peeling of the skin of the palms has occurred.

VI. SPILL AND LEAK PROCEDURES

Polymer Gel: Avoid getting gel wet, as it becomes slippery and makes surfaces it contacts slippery. Sweep up or collect dry gel pieces, using gloves, and reuse or dispose of in accordance with local, state, and Federal regulations. Wet gel may be handled more easily by applying baking soda (sodium bicarbonate) to the slippery gel surfaces. The product is not listed in Federal hazardous waste regulations 40 CFR 261.33, Paragraphs (e) and (f). It does not exhibit any of the hazardous characteristics listed in 40 CFR 261, Subpart C.

Polymer Solutions: Contacted surfaces are slippery. Rinse with large amounts of water until slickness can no longer be detected. If extensive rinsing is impractical, apply an absorbant material, such as sawdust, and discard as a solid waste. Areas that remain slick can be treated with household bleach (aqueous sodium hypochlorite) and washed.

VII. CONTROL MEASURES

Appropriate Hygienic Practices: Avoid breathing mist. Do not allow eye or skin contact. Wash thoroughly after handling. Remove and wash contaminated clothing. Avoid contamination of food, beverages, or smoking materials.

Protective Equipment: Impervious gloves; safety glasses or goggles.

Work Practices: Keep work areas clean and dry. Surfaces subject to spills can become slippery.

Handling and Storage: Store in a cool, dry, well-ventilated area.

Engineering Controls: Provide adequate ventilation. Install antiskid devices on steps and potentially slippery areas.

Manufacturer Data

Neutron Products, Inc.
22301 Mt. Ephraim Road
Dickerson, Maryland 20842

Contacts: Joannes C. Tang, Jeffrey D. Williams

Inquiry Telephone Number: 301/349-5001

CAT-FLOC 4900

CALGON CORPORATION

P.O. Box 1346
Pittsburgh, PA 15230-1346
24-Hour Emergency Telephone
Phone--(412) 494-8000
CHEMTREC® 1-800-424-9300

MATERIAL SAFETY DATA SHEET

Section 1. PRODUCT IDENTIFICATION

PRODUCT NAME: CAT-FLOC 4900

CHEMICAL DESCRIPTION: Al2(OH)5Cl.2H2O
PRODUCT CLASS: Flocculant
MSDS CODE: 0832-03-20-96

Section 2. INFORMATION ON INGREDIENTS

Chemical Name	CAS Number	% by Weight	OSHA PEL	ACGIH TLV
Poly(aluminum hydroxy) chloride	1327-41-9	50	TWA 2 mg/m3 (as Al) for Al soluble salts	TWA 2 mg/m3 (as Al) for Al soluble salts

Section 3. HAZARDS IDENTIFICATION

*************************** EMERGENCY OVERVIEW ********************************

Clear to slightly hazy, colorless liquid with no odor.
CAUTION!
May cause eye, skin and respiratory tract irritation.

****

PRIMARY ROUTES OF ENTRY: Eye and skin contact, inhalation

TARGET ORGANS: Eye, skin, mucous membranes

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: No data available.

POTENTIAL HEALTH EFFECTS:

EYE CONTACT: This product may produce irritation upon contact with the eye.

SKIN CONTACT: This product may produce some minor skin irritation upon contact. No data is available to suggest that this product may produce an allergic skin reaction or be absorbed through the skin in harmful amounts.

INGESTION: Swallowing this product may irritate the gastrointestinal tract and cause nausea and vomiting.

INHALATION: This product is not expected to present an inhalation hazard unless mists are generated. Inhalation of product mist may be irritating to the respiratory tract.

CAT-FLOC 4900

SUBCHRONIC, CHRONIC: No applicable information was found concerning any potential health effects resulting from subchronic or chronic exposure to the product.

CARCINOGENICITY:
NTP: No ingredients listed in this section.
IARC: No ingredients listed in this section.
OSHA: No ingredients listed in this section.

Section 4. FIRST AID MEASURES

EYE CONTACT: In case of contact, immediately flush eyes with plenty of water. Seek medical aid if irritation persists.

SKIN CONTACT: Not expected to require first aid measures. However, follow good industrial hygiene practices and, in case of contact, wash affected skin areas thoroughly with soap and water. Seek medical aid if irritation occurs.

INGESTION: If ingested, do not induce vomiting. If conscious, drink two glasses of water. Seek medical advice.

INHALATION: Not an expected route of overexposure. However, if exposure by inhalation is suspected, remove to fresh air. Aid in breathing if necessary and seek medical aid if symptoms occur.

Section 5. FIRE-FIGHTING MEASURES

FLASH POINT: None

LOWER FLAMMABLE LIMIT: Not applicable

UPPER FLAMMABLE LIMIT: Not applicable

AUTO-IGNITION TEMPERATURE: Not applicable

EXTINGUISHING MEDIA: This material does not burn. If exposed to fire from another source, use suitable fire extinguishing agent for that fire.

FIRE-FIGHTING INSTRUCTIONS:
Exercise caution when fighting any chemical fire. A self-contained breathing apparatus and protective clothing are essential.

FIRE & EXPLOSION HAZARDS: Product emits toxic gases under fire conditions.

DECOMPOSITION PRODUCTS: Product may decompose to hydrogen chloride in a fire.

NFPA RATINGS: Health = 1 Flammability = 0 Reactivity = 0 Special Hazard = None

Hazard rating scale: 0=Minimal; 1=Slight; 2=Moderate; 3=Serious; 4=Severe

Section 6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:
Wearing appropriate personal protective equipment, contain spill, collect onto inert absorbent and place into suitable container.

CAT-FLOC 4900

Section 7. HANDLING AND STORAGE

HANDLING: Avoid contact with eyes, skin and clothing.
Avoid breathing mist.
Use with adequate ventilation.
Wash thoroughly after handling.
Keep container closed when not in use.

STORAGE: No specific information.

Section 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

PERSONAL PROTECTIVE EQUIPMENT:

EYE/FACE PROTECTION: Chemical splash goggles
SKIN PROTECTION: Chemical resistant gloves
RESPIRATORY PROTECTION: If airborne concentrations exceed published exposure limits, use a NIOSH approved respirator in accordance with OSHA respiratory protection requirements (29 CFR 1910.134).

ENGINEERING CONTROLS: Use local exhaust ventilation where mist or spray may be generated.

WORK PRACTICES: An eye wash station should be accessible in the immediate area of use.
SATISFACTORY MATERIALS OF CONSTRUCTION:
Storage, transfer lines and feed equipment should be constructed of acid resistant materials, such as polyethylene, PVC, fiberglass or rubber lined.
UNSATISFACTORY MATERIALS OF CONSTRUCTION: Product may slowly corrode iron, brass, copper, aluminum and mild steel. 304 and 316 Stainless Steel are also unsatisfactory for use with this product.

Section 9. PHYSICAL AND CHEMICAL PROPERTIES

BOILING POINT: 220°F (104°C)

SOLUBILITY IN WATER: Complete

VAPOR PRESSURE: Similar to water

SPECIFIC GRAVITY: 1.33 - 1.35 @ 25°C

VAPOR DENSITY (air = 1): Similar to water

pH: 3.5 (as is)

%VOLATILE BY WEIGHT: ~ 50 (water)

FREEZING POINT: 19°F (- 7.2°C)

APPEARANCE AND ODOR: Clear to slightly hazy, colorless liquid with no odor.

VISCOSITY: < 100 cps @ 25°C

Section 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable

HAZARDOUS POLYMERIZATION: Will not occur

CONDITIONS TO AVOID: Product may slowly corrode iron, brass, copper, aluminum and mild steel.

INCOMPATIBILITY: Strong bases

CAT-FLOC 4900

DECOMPOSITION PRODUCTS: Product may decompose to hydrogen chloride in a fire.

Section 11. TOXICOLOGICAL INFORMATION

Test material	Oral LD50(rat)	Dermal LD50(rabbit)	Inhalation LC50(rat)
No data			

Section 12. ECOLOGICAL INFORMATION

Test Material	Aquatic Toxicity Data
Product	48 hr EC50 (Ceriodaphnia dubia): 6.0 ppm

Section 13. DISPOSAL CONSIDERATIONS

RCRA STATUS: Discarded product, as sold, would not be considered a RCRA Hazardous Waste.

DISPOSAL: Dispose of in accordance with local, state and federal regulations.

Section 14. TRANSPORT INFORMATION

DOT CLASSIFICATION:
- Proper Shipping Name: Not applicable
- Class/Division: Not restricted
- ID Number: Not applicable
- Packing Group: Not applicable
- Label: None

Section 15. REGULATORY INFORMATION

OSHA Hazard Communication Status: Hazardous

TSCA: The ingredients of this product are listed on the Toxic Substances Control Act (TSCA) Chemical Substances Inventory.

CERCLA reportable quantity of EPA hazardous substances in product:

Chemical Name	RQ
No ingredients have a CERCLA RQ.	

Product RQ: Not applicable (Notify EPA of product spills exceeding this amount.)

CAT-FLOC 4900

SARA TITLE III:

Section 302 Extremely Hazardous Substances:

Chemical Name	CAS #	RQ	TPQ
None			

Section 311 and 312 Health and Physical Hazards:

Immediate	Delayed	Fire	Pressure	Reactivity
[yes]	[no]	[no]	[no]	[no]

Section 313 Toxic Chemicals:

Chemical Name	CAS #	% by Weight
None		

Section 16. OTHER INFORMATION

HMIS RATINGS: Health = 1 Flammability = 0 Reactivity = 0

Personal Protective Equipment = X (to be specified by user depending on use conditions)

Hazard rating scale: 0=Minimal; 1=Slight; 2=Moderate; 3=Serious; 4=Severe

MSDS REVISION SUMMARY: Supersedes MSDS issued on 07/19/99. The MSDS has been changed in Section 3, 5, 12, 14, and 16.

PREPARED BY: **Elaine L. Puglielli**

NALCO

MATERIAL SAFETY DATA SHEET

PRODUCT

CAT-FLOC® CFL

Also known as Cat-Floc L

EMERGENCY TELEPHONE NUMBER

(800)462-5378 (24 Hours) (800) I-M-ALERT

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME : **CAT-FLOC® CFL**

APPLICATION : WATER TREATMENT

CHEMICAL DESCRIPTION : Polymer, Water

COMPANY IDENTIFICATION : Nalco Chemical Company
One Nalco Center
Naperville, Illinois
60563-1198

EMERGENCY TELEPHONE NUMBER : (800)462-5378 (24 Hours) (800) I-M-ALERT

NFPA 704M/HMIS RATING
HEALTH : 0 / 1 FLAMMABILITY : 1 / 1 REACTIVITY : 0 / 0 OTHER :
0 = Insignificant 1 = Slight 2 = Moderate 3 = High 4 = Extreme

2. COMPOSITION/INFORMATION ON INGREDIENTS

Based on our hazard evaluation, none of the substances in this product are hazardous.

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

CAUTION
May cause irritation with prolonged contact. Toxic to aquatic organisms.
Do not get in eyes, on skin, on clothing. Do not take internally. Wear suitable protective clothing. Keep container tightly closed. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. After contact with skin, wash immediately with plenty of soap and water.
May evolve oxides of carbon (COx) under fire conditions. May evolve oxides of nitrogen (NOx) under fire conditions. May evolve ammonia (NH4) under fire conditions. May evolve HCl under fire conditions.

PRIMARY ROUTES OF EXPOSURE :
Eye, Skin

HUMAN HEALTH HAZARDS - ACUTE :

EYE CONTACT :
May cause irritation with prolonged contact.

SKIN CONTACT :
May cause irritation with prolonged contact.

INGESTION :
Not a likely route of exposure. No adverse effects expected.

INHALATION :
Not a likely route of exposure. No adverse effects expected.

SYMPTOMS OF EXPOSURE :
Acute :
A review of available data does not identify any symptoms from exposure not previously mentioned.
Chronic :
A review of available data does not identify any symptoms from exposure not previously mentioned.

AGGRAVATION OF EXISTING CONDITIONS :
A review of available data does not identify any worsening of existing conditions.

4. FIRST AID MEASURES

EYE CONTACT :
Flush affected area with water. If symptoms develop, seek medical advice.

SKIN CONTACT :
Remove contaminated clothing. Wash off affected area immediately with plenty of water. If symptoms develop, seek medical advice.

INGESTION :
Do not induce vomiting without medical advice. If conscious, washout mouth and give water to drink. If symptoms develop, seek medical advice.

INHALATION :
Remove to fresh air, treat symptomatically. If symptoms develop, seek medical advice.

NOTE TO PHYSICIAN :
Based on the individual reactions of the patient, the physician's judgement should be used to control symptoms and clinical condition.

5. FIRE FIGHTING MEASURES

FLASH POINT : > 200 °F / > 93 °C (PMCC)

EXTINGUISHING MEDIA :
This product would not be expected to burn unless all the water is boiled away. The remaining organics may be ignitable. Use extinguishing media appropriate for surrounding fire. Water mist may be used to cool closed containers.

FIRE AND EXPLOSION HAZARD :
May evolve oxides of carbon (COx) under fire conditions. May evolve oxides of nitrogen (NOx) under fire conditions. May evolve ammonia (NH4) under fire conditions. May evolve HCl under fire conditions.

SPECIAL PROTECTIVE EQUIPMENT FOR FIRE FIGHTING :
In case of fire, wear a full face positive-pressure self contained breathing apparatus and protective suit.

6. ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS :
Notify appropriate government, occupational health and safety and environmental authorities. Do not touch spilled material. Stop or reduce any leaks if it is safe to do so. Use personal protective equipment recommended in Section 8 (Exposure Controls/Personal Protection).

METHODS FOR CLEANING UP :
SMALL SPILLS: Soak up spill with absorbent material. Place residues in a suitable, covered, properly labeled container. Wash affected area. LARGE SPILLS: Contain liquid using absorbent material, by digging trenches or by dyking. Reclaim into recovery or salvage drums or tank truck for proper disposal. Contact an approved waste hauler for disposal of contaminated recovered material. Dispose of material in compliance with regulations indicated in Section 13 (Disposal Considerations).

ENVIRONMENTAL PRECAUTIONS :
This product is toxic to fish. It should not be directly discharged into lakes, ponds, streams, waterways or public water supplies.

7. HANDLING AND STORAGE

HANDLING :
Do not take internally. Have emergency equipment (for fires, spills, leaks, etc.) readily available. Ensure all containers are labelled. Avoid eye and skin contact.

STORAGE CONDITIONS :
Store separately from oxidizers. Store the containers tightly closed.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS :
This product does not contain any substance that has an established exposure limit.

ENGINEERING MEASURES :
General ventilation is recommended.

RESPIRATORY PROTECTION :
Respiratory protection is not normally needed.

HAND PROTECTION :
Nitrile gloves, PVC gloves

SKIN PROTECTION :
Wear standard protective clothing.

EYE PROTECTION :
Wear chemical splash goggles.

HYGIENE RECOMMENDATIONS :
Keep an eye wash fountain available. Keep a safety shower available.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE	Viscous liquid
APPEARANCE	Clear Yellow
ODOR	None

SPECIFIC GRAVITY	1.018 - 1.058 @ 77 °F / 25 °C
DENSITY	8.4 - 8.8 lb/gal
SOLUBILITY IN WATER	Complete
pH ()	6.5
VISCOSITY	1,500 - 3,200 cps @ 77 °F / 25 °C
BOILING POINT	> 212 °F / > 100 °C
VAPOR DENSITY	Same as water

10. STABILITY AND REACTIVITY

STABILITY :
Stable under normal conditions.

HAZARDOUS POLYMERIZATION :
Hazardous polymerization will not occur.

CONDITIONS TO AVOID :
Freezing temperatures

MATERIALS TO AVOID :
Contact with strong oxidizers (e.g. chlorine, peroxides, chromates, nitric acid, perchlorate, concentrated oxygen, permanganate) may generate heat, fires, explosions and/or toxic vapors.

HAZARDOUS DECOMPOSITION PRODUCTS :
Under fire conditions: Oxides of carbon, Oxides of nitrogen, HCl, ammonia

11. TOXICOLOGICAL INFORMATION

No toxicity studies have been conducted on this product.

CARCINOGENICITY :
None of the substances in this product are listed as carcinogens by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP) or the American Conference of Governmental Industrial Hygienists (ACGIH).

12. ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL EFFECTS :

The following results are for the product.

ACUTE FISH RESULTS :

Species	Exposure	LC50	Tested Substance
Rainbow Trout	96 hrs	0.76 mg/l	Product

Rating : Very toxic

ACUTE INVERTEBRATE RESULTS :

Species	Exposure	LC50	EC50	Tested Substance
Daphnia magna	48 hrs	1.8 mg/l		Product

Rating : Toxic

If released into the environment, see CERCLA/SUPERFUND in Section 15.

13. DISPOSAL CONSIDERATIONS

If this product becomes a waste, it is not a hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA) 40 CFR 261, since it does not have the characteristics of Subpart C, nor is it listed under Subpart D.

As a non-hazardous waste, it is not subject to federal regulation. Consult state or local regulation for any additional handling, treatment or disposal requirements. For disposal, contact a properly licensed waste treatment, storage, disposal or recycling facility.

14. TRANSPORT INFORMATION

Proper Shipping Name / Hazard Class may vary by packaging, properties, and mode of transportation. Typical Proper Shipping Names for this product are:

LAND TRANSPORT :

Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

AIR TRANSPORT (ICAO/IATA) :

Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

MARINE TRANSPORT (IMDG/IMO) :

Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

15. REGULATORY INFORMATION

NATIONAL REGULATIONS, USA :

OSHA HAZARD COMMUNICATION RULE, 29 CFR 1910.1200 :
Based on our hazard evaluation, none of the substances in this product are hazardous.

CERCLA/SUPERFUND, 40 CFR 117, 302 :
Notification of spills of this product is not required.

SARA/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 (TITLE III) - SECTIONS 302, 311, 312, AND 313 :

SECTION 302 - EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355) :
This product does not contain substances listed in Appendix A and B as an Extremely Hazardous Substance.

SECTIONS 311 AND 312 - MATERIAL SAFETY DATA SHEET REQUIREMENTS (40 CFR 370) :
Our hazard evaluation has found that this product is not hazardous under 29 CFR 1910.1200.

Under SARA 311 and 312, the EPA has established threshold quantities for the reporting of hazardous chemicals. The current thresholds are: 500 pounds or the threshold planning quantity (TPQ), whichever is lower, for extremely hazardous substances and 10,000 pounds for all other hazardous chemicals.

SECTION 313 - LIST OF TOXIC CHEMICALS (40 CFR 372) :
This product does not contain substances on the List of Toxic Chemicals.

TOXIC SUBSTANCES CONTROL ACT (TSCA) :
The chemical substances in this product are on the TSCA 8(b) Inventory (40 CFR 710).

FOOD AND DRUG ADMINISTRATION (FDA) Federal Food, Drug and Cosmetic Act :
When use situations necessitate compliance with FDA regulations, this product is acceptable under : 21 CFR 176.170 Components of paper and paperboard in contact with aqueous and fatty foods and 21 CFR 176.180 Components of paper and paperboard in contact with dry foods.

FEDERAL WATER POLLUTION CONTROL ACT, CLEAN WATER ACT, 40 CFR 401.15 / formerly Sec. 307, 40 CFR / formerly Sec. 311 :
None of the substances are specifically listed in the regulation.

CLEAN AIR ACT, Sec. 111 (40 CFR 60, Volatile Organic Compounds), Sec. 112 (40 CFR 61, Hazardous Air Pollutants), Sec. 602 (40 CFR 82, Class I and II Ozone Depleting Substances) :
None of the substances are specifically listed in the regulation.

CALIFORNIA PROPOSITION 65 :
This product does not contain substances which require warning under California Proposition 65.

MICHIGAN CRITICAL MATERIALS :
None of the substances are specifically listed in the regulation.

STATE RIGHT TO KNOW LAWS :
None of the substances are specifically listed in the regulation.

NATIONAL REGULATIONS, CANADA :

WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS) :
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

WHMIS CLASSIFICATION :
Not considered a WHMIS controlled product.

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) :
All substances in this product are listed on the Domestic Substances List (DSL), are exempt, or have been reported in accordance with the New Substances Notification Regulations.

16. OTHER INFORMATION

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should be evaluated so that appropriate handling practices and training programs can be established to insure safe workplace operations. Please consult your local sales representative for any further information.

REFERENCES

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists, OH., (Ariel Insight™ CD-ROM Version), Ariel Research Corp., Bethesda, MD.

Hazardous Substances Data Bank, National Library of Medicine, Bethesda, Maryland (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, Co.

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Geneva: World Health Organization, International Agency for Research on Cancer.

Integrated Risk Information System, U.S. Environmental Protection Agency, Washington, D.C. (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

Annual Report on Carcinogens, National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service.

Title 29 Code of Federal Regulations, Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA), (Ariel Insight™ CD-ROM Version), Ariel Research Corp., Bethesda MD.

Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health, Cincinnati, OH, (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

Ariel Insight™ (An integrated guide to industrial chemicals covered under major regulatory and advisory programs), North American Module, Western European Module, Chemical Inventories Module and the Generics Module (Ariel Insight™ CD-ROM Version), Ariel Research Corp., Bethesda, MD.

The Teratogen Information System, University of Washington, Seattle, WA (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO

Prepared By : Product Safety Department
Date issued : 01/14/2000
Replaces :

POL-E-Z® 7736
Anionic Emulsion Polymer

Product Description:

POL-E-Z 7736 is a high molecular weight, high anionic charge density, water-soluble polymer. It is effective as a coagulant aid in various liquid/solid separation applications, such as clarification, dissolved air flotation, and dewatering. **POL-E-Z 7736** is supplied as an emulsion for ease in handling.. **POL-E-Z 7736** is available in plastic pails, steel or plastic drums, recyclable bins, and bulk.

Features:

- Emulsion polymer
- Unique medium charge, high molecular weight anionic polymer
- Forms a strong floc
- Improved sludge drainage

Benefits:

- More concentrated that a liquid, easier to feed that a dry polymer
- Effective thickener in mineral and metals processing and coal prep applications.
- Improved filtrate quality
- Better DAF and belt press capture
- Higher cake solids and throughput

Environmental and Toxicity Data: **POL-E-Z 7736** is intended for industrial and municipal use, and may not be fed to potable water systems. See product MSDS for complete toxicological and environmental information.

Regulatory Status:
D.O.T. Class ....Not Restricted
D.O.T. Proper Shipping Name...................... Not Applicable

Handling and Storage: Improper handling of this product can be injurious to workers. ***Observe all safety precautions shown on the label and in the Material Safety Data Sheet.***

Do not contaminate with water. Keep from freezing. Store **POL-E-Z 7736** at temperatures between 50° and 90° F and avoid frequent temperature changes. Exposure of this product to temperatures outside of this range could adversely affect product viscosity and appearance, and may alter product efficiency. Mix **POL-E-Z 7736** thoroughly before use. Bulk tanks bins, and drums should be equipped with a means of mixing or recirculating this product.

Typical Properties (@ 25° C)	
Form	liquid emulsion
Appearance	off-white opaque
Odor	mineral oil
Specific Gravity	1.08
pH of 1% Solution	3.0
Viscosity of Product, cps	3000
Viscosity of 1% Sol., cps	2500
Viscosity of 0.5% Sol., cps	1100
Freeze Point (°F)	38
Flash Point (°F)	>200

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Feeding: POL-E-Z 7736 should be diluted with water prior to use. This product is most effective when diluted to "working solution" concentrations of approximately 1.0%, by weight, and allowed to "age" for at least 30 minutes with mixing. Neat polymer feed pumps should be capable of pumping 5,000 cps viscosity material. A variety of chemical feed systems are available from Calgon to satisfy your specific application needs. Please contact your local Calgon representative or our Chemical Equipment Group for feed system recommendations.

Dosage Requirements: Product feed rate will be site and application specific, and may vary as conditions change. Product demand may be determined by screening tests such as Jar Test or Buchner Funnel Test procedures.

Materials of Compatibility:
For Storage Tanks: Bulk Storage Tanks, Chemical Feed Systems - High density polyethylene, polypropylene, PVC, epoxy lined steel, 304 or 316 SS, fiberglass with bisphenol or isophthalic resin liner. ***For pump "liquid ends", gaskets, and Piping:*** High Density Polyethylene, Polypropylene, PVC, 304 or 316 SS, Kynar, or Viton.

Disposal: Dispose of in accordance with local, state and federal regulations. Discarded product, as sold, is not considered a RCRA hazardous waste.

Materials of Compatibility

Material	Satis.	Un-Satis.
Carbon Steel		X
304 Stainless Steel	X	
316 Stainless Steel	X	
Polyethylene - crosslinked		X
Polyethylene - low den		X
Polyethylene - high den	X	
Polypropylene	X	
PVC	X	
CPVC	X	
Kynar	X	
Viton	X	
Neoprene		X
Buna-N Rubber		X
Silicone 65		X
FRP (bisphenol)	X	
FRP (isophthalic)	X	
Plascite 7122 (epoxy)	X	
Plascite 4100 (vinyl ester)		X

Information concerning human and environmental exposure may be reviewed on the Material Safety Data Sheet for the product. For additional information regarding incidents involving human and environmental exposure call 1-800-955-0090 and ask for the Health and Environmental Affairs Department.

For more information, contact your local Calgon representative, call 1-800-955-0090, or write: Calgon Corporation, P.O. Box 1346, Pittsburgh, PA 15230.

Internet address: http://www.calgon.com

CALGON CORPORATION

Bulletin No. 00-6F19; Rev. 7/98

CALGON CORPORATION

P.O. Box 1346
Pittsburgh, PA 15230-1346
Phone--(412)494-8000

MATERIAL SAFETY DATA SHEET

Section 1. PRODUCT IDENTIFICATION

PRODUCT NAME: **POL-E-Z 7736**

CHEMICAL DESCRIPTION: Anionic emulsion polymer
PRODUCT CLASS: Water treatment
MSDS CODE: 0689-03-01-96

Section 2. INFORMATION ON INGREDIENTS

Chemical Name	CAS Number	% by Weight	OSHA PEL	ACGIH TLV
Petroleum distillates, straight-run middle	64741-44-2	~ 20	TWA 5 mg/m^3 (for Oil mist, mineral)	TWA 5 mg/m^3, STEL 10 mg/m^3 (for Oil mist, mineral) [1993-94 proposal to specify for "severely refined" and to remove STEL]

Section 3. HAZARDS IDENTIFICATION

********************** EMERGENCY OVERVIEW **********************

WARNING!
May cause eye and skin irritation.

****

PRIMARY ROUTES OF ENTRY: Eye and skin contact, inhalation

TARGET ORGANS: Eye, skin

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Pre-existing skin disorders.

POTENTIAL HEALTH EFFECTS:

EYE CONTACT: This product may produce irritation upon contact with the eye.

Continued on Page 2

SKIN CONTACT: Prolonged or repeated contact with the skin may dry and defat the skin, leading to irritation and dermatitis. This product is not expected to be absorbed through the skin in harmful amounts or to produce an allergic skin reaction.

INGESTION: This product would be expected to be practically non-toxic by ingestion. However, ingestion of petroleum distillate may produce gastrointestinal tract irritation, vomiting and central nervous system depression.

INHALATION: This product is not expected to present an inhalation hazard unless mists or vapors are generated.

SUBCHRONIC, CHRONIC:
No applicable information was found concerning any potential health effects resulting from subchronic or chronic exposure to the product.

Studies have shown that certain representative middle distillate petroleum products have been found to be tumorigenic in mice when applied to the skin repeatedly at very high doses without washing between applications in long-term bioassays. The petroleum distillate in this product has been found to be non-mutagenic in modified Ames testing.

CARCINOGENICITY:
NTP:
No ingredients listed in this section
IARC:
No ingredients listed in this section
OSHA:
No ingredients listed in this section

Section 4. FIRST AID MEASURES

EYE CONTACT: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Seek medical aid.

SKIN CONTACT: In case of contact, flush skin with plenty of water. Remove contaminated clothing. Seek medical aid if irritation persists. Wash clothing before reuse.

INGESTION: Not an expected route of overexposure. If swallowed, do not induce vomiting. Call a physician. This product would be expected to be practically non-toxic by ingestion.

INHALATION: Not an expected route of overexposure. However, if exposure by inhalation is suspected, remove to fresh air. Aid in breathing if necessary and seek medical aid if symptoms occur.

Section 5. FIRE-FIGHTING MEASURES

FLASH POINT: > 200°F
This product is not by definition a "flammable liquid" or a "combustible liquid".

LOWER FLAMMABLE LIMIT: Not available UPPER FLAMMABLE LIMIT: Not available

AUTO-IGNITION TEMPERATURE: Not available

Continued on Page 3

EXTINGUISHING MEDIA: Water fog, dry chemical, foam, or CO_2.

FIRE-FIGHTING INSTRUCTIONS: Exercise caution when fighting any chemical fire. A self-contained breathing apparatus and protective clothing are essential.

FIRE & EXPLOSION HAZARDS: Product emits toxic gases under fire conditions.

DECOMPOSITION PRODUCTS: Thermal decomposition or combustion may produce carbon dioxide, carbon monoxide, ammonia, and/or nitrogen oxides.

NFPA RATINGS: Health = 2 Flammability = 1 Reactivity = 0 Special Hazard = None

Hazard rating scale: 0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe

Section 6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: Wearing appropriate personal protective equipment, contain spill, collect onto inert absorbent and place into suitable container. Spilled product may make floor slippery; spills should be cleaned up immediately to prevent falls.

Section 7. HANDLING AND STORAGE

HANDLING: Avoid contact with eyes, skin and clothing.
Avoid breathing mist.
Keep product thoroughly mixed.
Use with adequate ventilation.
Wash thoroughly after handling.
Keep container closed when not in use.

STORAGE: Store between 50 and 90°F. Avoid frequent temperature changes.

Section 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

PERSONAL PROTECTIVE EQUIPMENT:

EYE/FACE PROTECTION: Chemical splash goggles
SKIN PROTECTION: Chemical resistant gloves
RESPIRATORY PROTECTION: If airborne concentrations exceed published exposure limits, use a NIOSH approved respirator in accordance with OSHA respiratory protection requirements (29 CFR 1910.134).

ENGINEERING CONTROLS: Use local exhaust ventilation where mist or spray may be generated.

WORK PRACTICES: An eye wash station should be accessible in the immediate area of use. Wash areas of skin contaminated with this product thoroughly with soap and water soon after exposure. Do not allow this product to remain on skin for prolonged periods.

Continued on Page 4

Section 9. PHYSICAL AND CHEMICAL PROPERTIES

BOILING POINT: Not available

SOLUBILITY IN WATER: Miscible

VAPOR PRESSURE: Not available

SPECIFIC GRAVITY: 1.08

VAPOR DENSITY (air=1): Not available

pH: Not applicable

%VOLATILE BY WEIGHT: ~ 48 (water)

FREEZING POINT: 23°F (-5°C)

APPEARANCE AND ODOR: Off-white, viscous, translucent liquid with greenish tint and slight hydrocarbon odor.

Section 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable

HAZARDOUS POLYMERIZATION: Will not occur

CONDITIONS TO AVOID: Do not expose to extreme temperatures. Do not contaminate with water as it will adversely affect product quality.

INCOMPATIBILITY: Strong oxidizers

DECOMPOSITION PRODUCTS: Thermal decomposition or combustion may produce carbon dioxide, carbon monoxide, ammonia, and/or nitrogen oxides.

Section 11. TOXICOLOGICAL INFORMATION

ON PRODUCT:
No information available on the formulated product.

ON INGREDIENTS:

Chemical Name	Oral LD_{50} (rat)	Dermal LD_{50} (rabbit)	Inhalation LC_{50} (rat)
Petroleum distillates, straight-run middle	> 5 g/kg	> 2 g/kg	1.7 mg/L/4H

Section 12. ECOLOGICAL INFORMATION

ON PRODUCT:
Aquatic toxicity data:
48 hr LC_{50} (fathead minnow): 150 ppm

Section 13. DISPOSAL CONSIDERATIONS

RCRA STATUS: Discarded product, as sold, would not be considered a RCRA Hazardous Waste.

DISPOSAL: Dispose of in accordance with local, state and federal regulations.

Continued on Page 5

Section 14. TRANSPORT INFORMATION

DOT CLASSIFICATION:
- Class/Division: Not restricted
- Proper Shipping Name: Not applicable
- Label: None
- Packing Group: Not applicable
- ID Number: Not applicable

Section 15. REGULATORY INFORMATION

OSHA Hazard Communication Status: Hazardous

TSCA: The ingredients of this product are listed on the Toxic Substances Control Act (TSCA) Chemical Substances Inventory.

CERCLA reportable quantity of EPA hazardous substances in product:

Chemical Name	RQ
No ingredients of this product have CERCLA reportable quantities.	

Product RQ: Not applicable (Notify EPA of product spills exceeding this amount.)

SARA TITLE III:

Section 302 Extremely Hazardous Substances:

Chemical Name	CAS #	RQ	TPQ
There are no SARA 302 Extremely Hazardous Substances in this product.			

Section 311 and 312 Health and Physical Hazards:

Immediate	Delayed	Fire	Pressure	Reactivity
[yes]	[no]	[no]	[no]	[no]

Section 313 Toxic Chemicals:

Chemical Name	CAS #	% by Weight
There are no reportable SARA 313 Toxic Chemicals in this product.		

FDA: This product is FDA approved under 21 CFR Section(s):
173.5 (Acrylate-acrylamide resins. Subpart A - Polymer substances and polymer adjuvants for food treatment)
176.110 (Acrylamide-acrylic acid resins for use only as components of paper and paperboard)
Consult your Calgon representative for any use limitations.

Continued on Page 6

Section 16. OTHER INFORMATION

HMIS RATINGS: Health = 2 Flammability = 1 Reactivity = 0
Personal Protective Equipment = X (to be specified by user depending on use conditions)

Hazard rating scale: 0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe

MSDS REVISION SUMMARY: Supersedes MSDS issued on 6/16/93. The MSDS has been changed in Section 15 on the U.S. form to display FDA information.

PREPARED BY: P.J. Maloney

Appendix H

Legal Description for Conservation Measure 12

APPENDIX H
FOR
CONSERVATION MEASURE 12

LEGAL DESCRIPTION

Conservation Measure 12 as more fully described in Chapter 4 of the HCP involves, within 60 days of the issuance of ITPs by the Services, the conveyance of a conservation easement on a portion of a parcel of property known as TRACT E and which is not planned for mining activity. The legal description for said portion of Tract E is as follows:

The Southwest quarter of the Northeast quarter of Section 19, Township 4 North, Range 2 East of the Willamette Meridian in Clark County, Washington

EXCEPT the following described area:

All lands of said Southwest quarter of the Northeast quarter of Section 19 that are North and East of NE Bennett Road or those portions of said area falling within NE Bennett Road or right of way thereto.

FURTHER

Said area that would be the subject of the conservation easement comprises approximately 19 acres and has been ascribed tax parcel 22516700 by Clark County, Washington.