

East Fork Lewis River Ridgefield Pits Restoration

Basis of Design Report Preliminary Design:
Attachment 4 – Sediment Sampling & Analysis



PREPARED BY

Lower Columbia Estuary Partnership
811 SW Naito Parkway

Suite 410

Portland, OR 97204

Contents

1.1	Sediment Sampling	1
1.1.1	Overview	1
1.1.2	Sediment sampling results.....	1
1.2	Sediment Transport and Morpho-dynamic Modeling	9
1.2.1	Overview and setup	9
1.2.2	Sediment Transport Modeling Summary and Next Steps.....	11
1.3	References	12
1.4	Appendix A – Sediment Sampling Survey Results.....	13

1.1 SEDIMENT SAMPLING

1.1.1 Overview

To characterize the EFLR channel bed and bank composition throughout the project reach a sediment sampling survey was completed in October 2018. Photo points were used to interpret bank composition, while Wohlman pebble counts were done for random transects at selected channel bed surface and subsurface, as well as floodplain locations. Depth of refusal measurements were also taken in Ridgefield Pits # 4, 5, and 7, to characterize the bottom composition and estimate water depths. The sampling plan is illustrated in Figure 1.

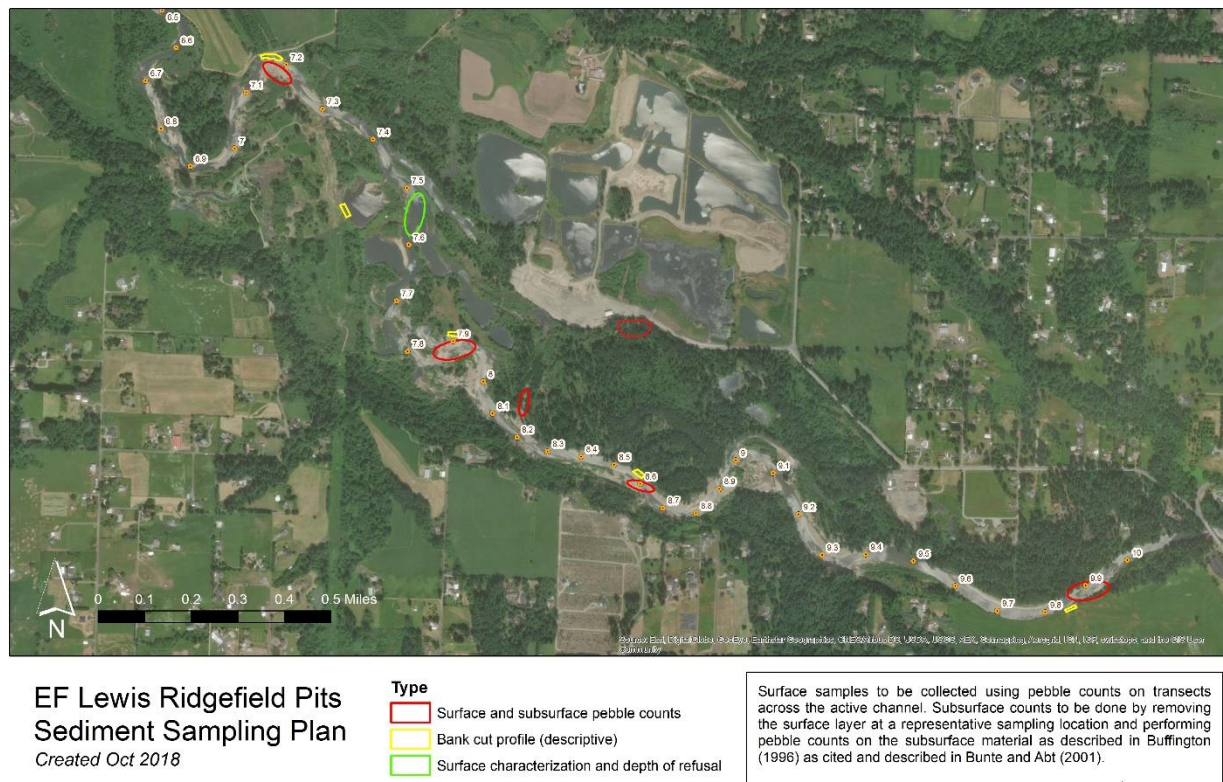


Figure 1. Sediment sampling plan for the project reach.

1.1.2 Sediment sampling results

A complete analysis of the collected sediment data is included as Appendix A of this attachment. The images in Figure 2 provide a summary of results at representative locations.

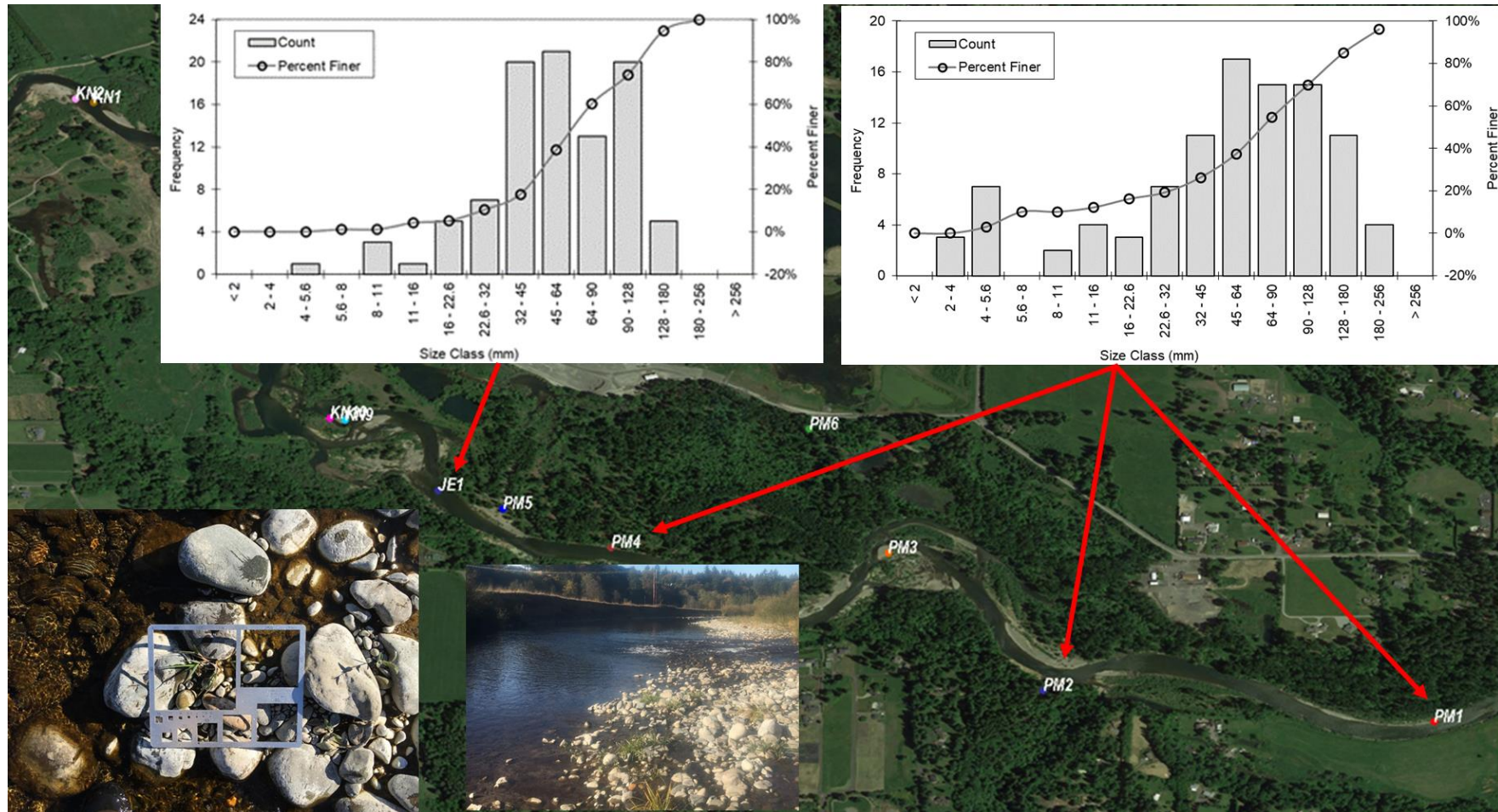


Figure 2a. Grain size analysis at selected locations at the bed surface. The plot on the right is for location PM4, however PM1 and PM2 were similar (see Appendix A of this attachment for complete results). Note large cobbles present in these surface layers in the photos, which act to armor the underlying bed from erosion.

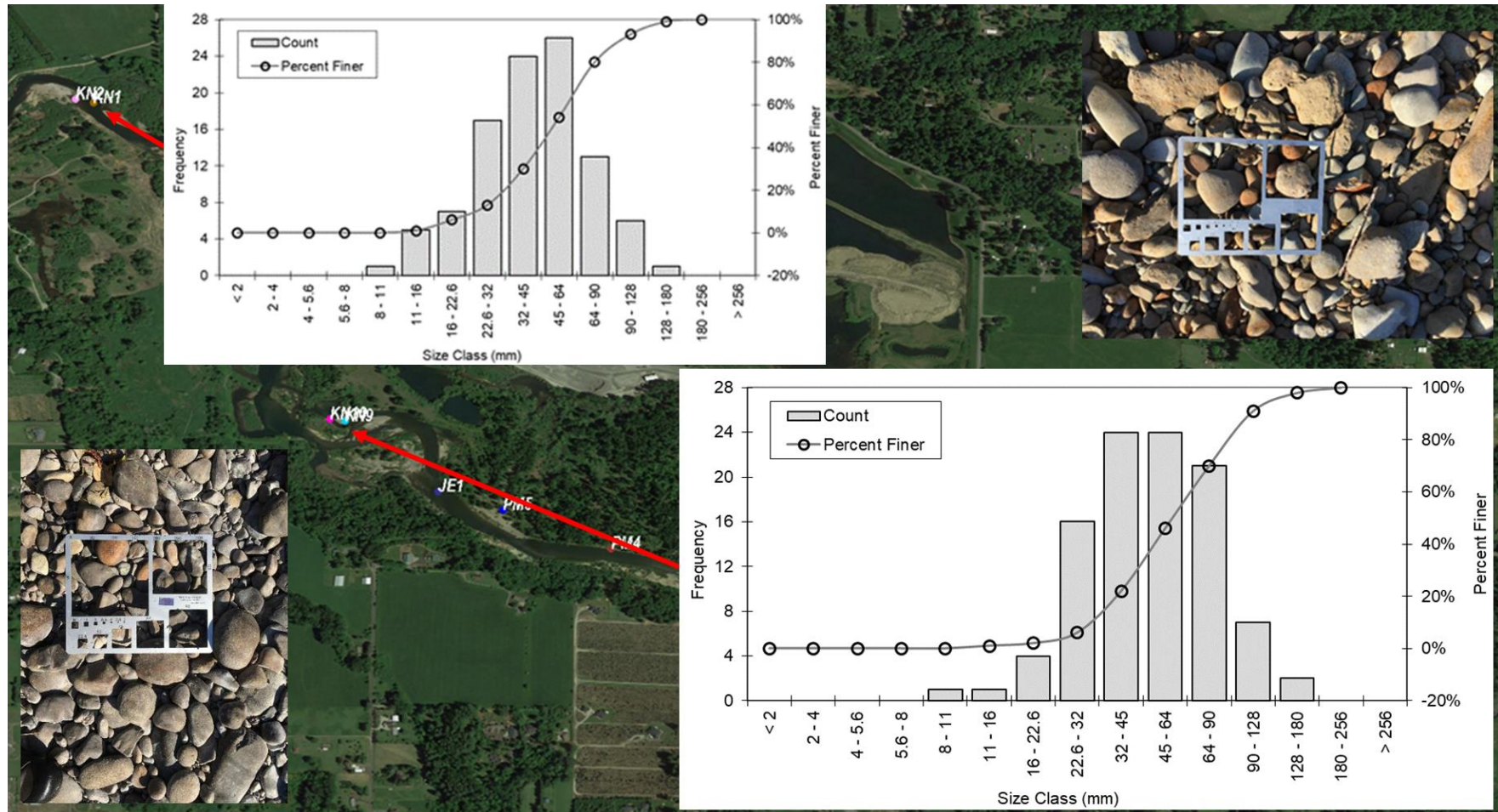


Figure 2b. Grain size analysis at additional bed surface locations. Note large cobbles present in these surface layers in the photos, which act to armor the underlying bed from erosion.

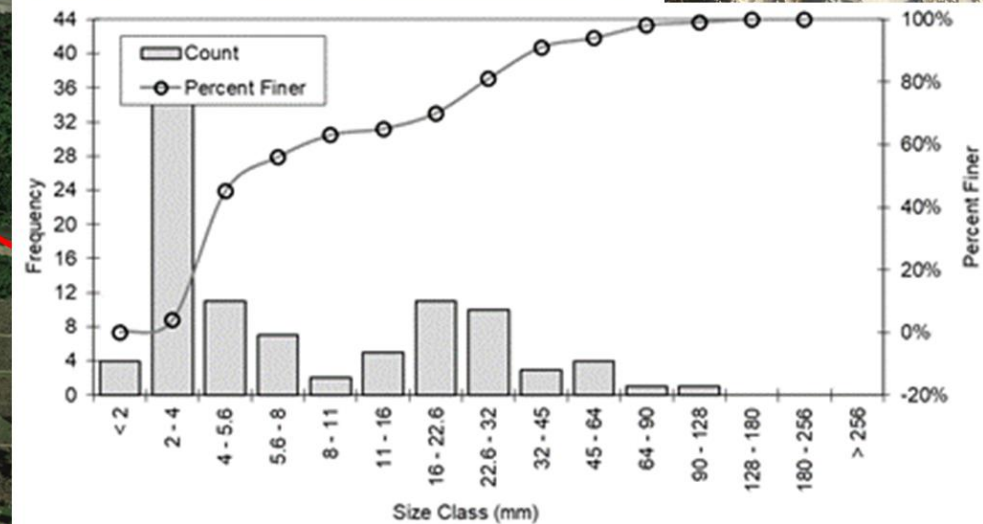
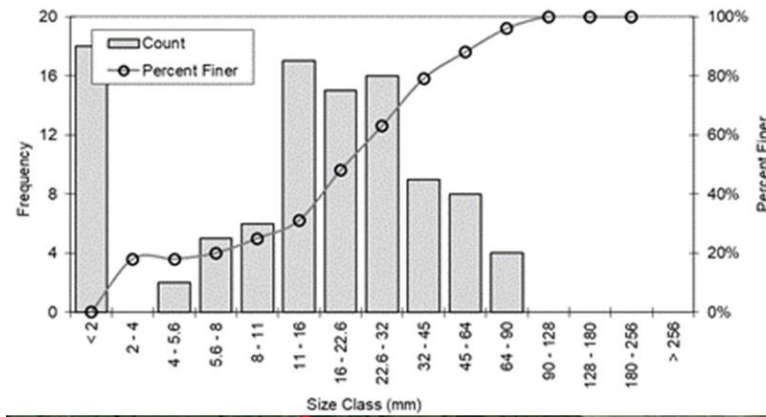


Figure 2c. Grain size analysis at selected bed sub-surface locations. Note finer materials present here, under the overlying armored surface layer with larger cobbles.

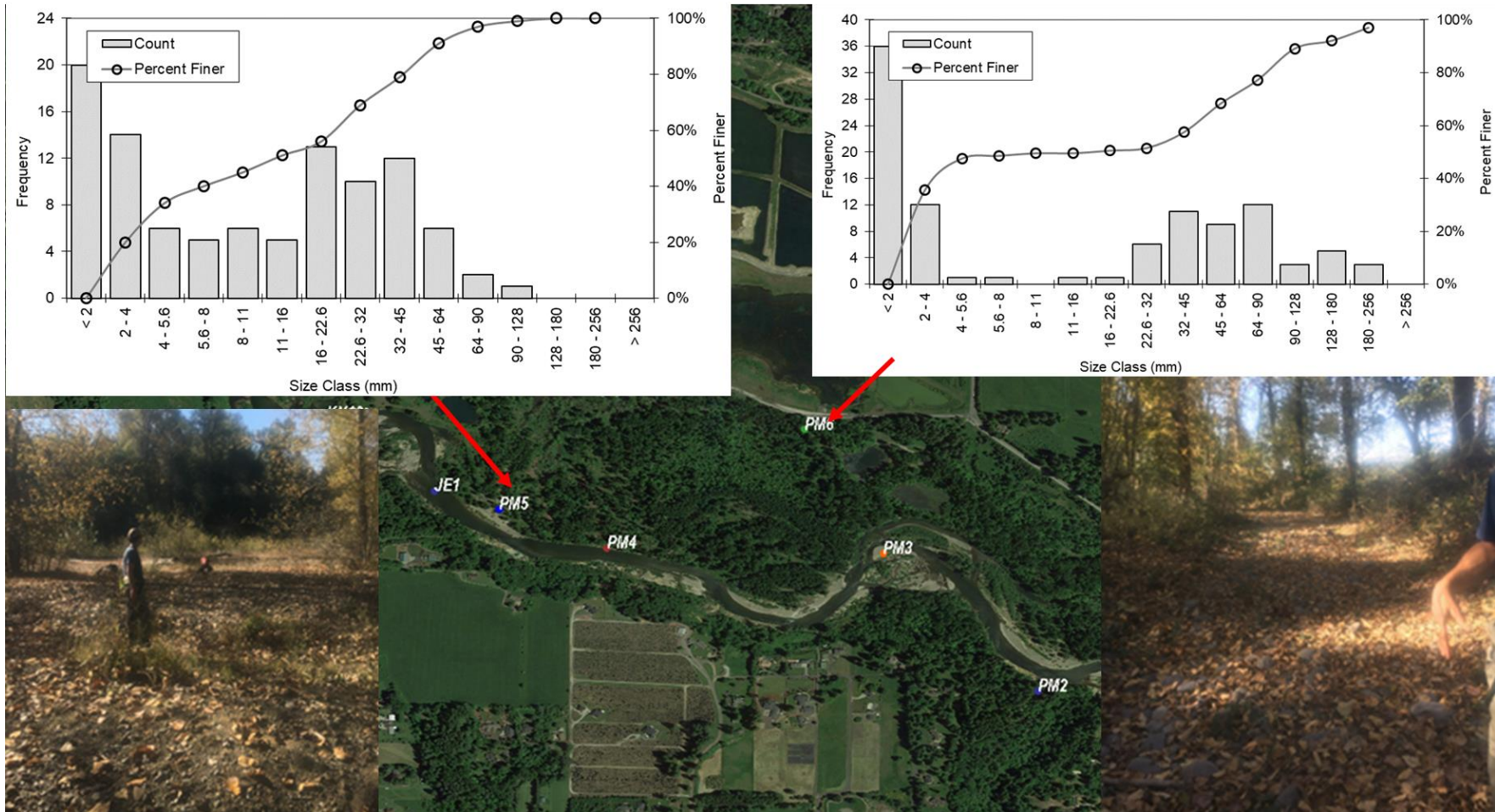


Figure 2d. Grain size analysis at selected floodplain locations.



Figure 2e. Vertical bank profiles at selected EFLR mainstem locations.

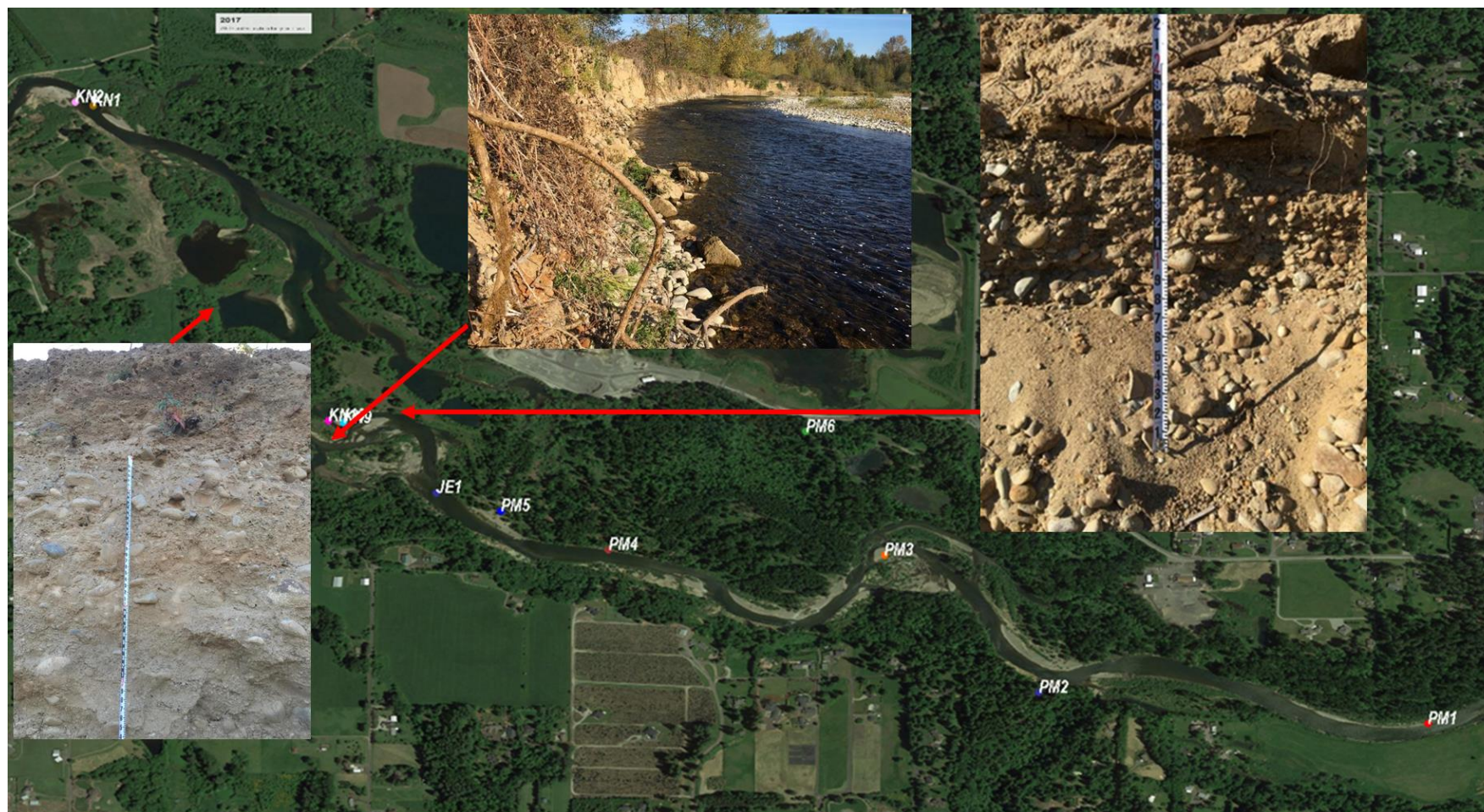
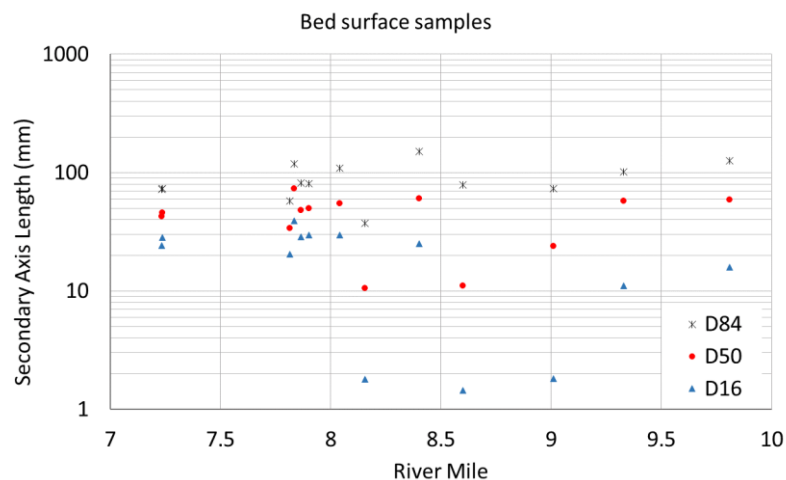


Figure 2f. Vertical bank profiles at additional EFLR mainstem locations.

Grain size distribution for all pebble count locations sampled is summarized in Table 1 and Figure 2. In general, grain size distribution was consistent throughout the project reach (Table 2) for both bed surface and sub-surface. The surface layer consists mostly of coarse gravel and cobble, with very little fine sediment. This ‘armored’ layer acts to shield the underlying (sub-surface) channel bed from erosion over much of the flow regime. Subsurface sediments show a bi-modal distribution, with a significant fine grain component consisting of sands up to ~4 mm and an additional component of coarse gravels and cobble similar to the surface layer. Floodplain composition is similar to that of the channel subsurface. Photos taken of channel banks in exposed locations (Figs. 2e and 2f) show two general patterns of vertical bank profile characteristic of the project reach. The first is a single, consolidated bank layer of mixed sand, gravel, and cobble, with grain size generally decreasing with increased height. The second, and most dominant, profile consists of this same initial mixed grain size layer, with an overlying fine layer of consolidated silts.

Table 1. Grain size analysis summary for all sampling locations, with overall mean and median values for D_{16} , D_{50} , and D_{84} .

Location	Bed sub-surface			Bed surface		
	D_{16} (mm)	D_{50} (mm)	D_{84} (mm)	D_{16} (mm)	D_{50} (mm)	D_{84} (mm)
PM1 (RM 9.8)	2.9	6.3	16.4	15.8	59	125.9
PM2 (RM 9.3)				11.0	57.7	100.9
PM3 (RM 9.0)				1.8	24.0	73.4
PM4 (RM 8.4)	2.6	4.7	24.4	25.1	60.7	150.2
PM5 (RM 8.2)	2.0	3.8	17.1	1.8	10.5	37.4
PM6 (RM 8.6)				1.4	11.0	78.8
KN1 (RM 7.2)				24.3	42.8	72.0
KN2 (RM 7.2)	4.0	11.2	22.2	28.4	45.7	73.5
KN5 (RM 7.8)				20.4	34.0	57.4
KN6 (RM 7.8)	7.7	14.1	29.7			
KN7 (RM 7.9)				29.8	50.1	80.4
KN8 (RM 7.9)	2.8	16.9	39.2			
KN9 (RM 7.9)				28.5	48.2	81.3
KN10 (RM 7.8)				39.3	73	118.1
JE1 (RM 8.0)				29.8	55.0	108.3
Mean	3.7	9.5	24.8	19.8	44.0	89.0
Median	2.9	8.8	23.3	24.3	48.2	80.4



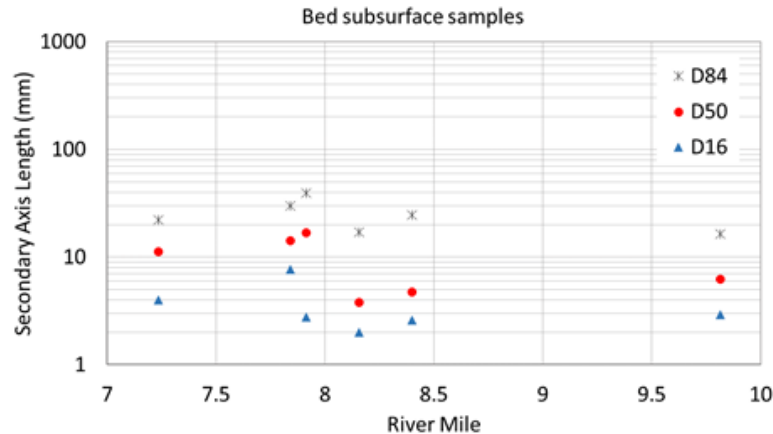


Figure 3. Grain size distribution by river mile. Top: bed surface samples. Bottom: bed sub-surface samples.

1.2 SEDIMENT TRANSPORT AND MORPHO-DYNAMIC MODELING

1.2.1 Overview and setup

A morpho-dynamic sediment transport model with the capability to dynamically adjust bed elevations in response to hydraulically forced movement of bed and suspended load materials was developed to help characterize current transport conditions and inform the restoration alternatives that were assessed using the hydraulic model. The model used is included in the Tuflow FV modelling package (Tuflow 2020b), as an add-on module to the hydraulic modeling engine (Tuflow 2020a, 2013). Figure 3 illustrates the basic module capabilities and function. Multiple bed layers and sediment fractions within each layer can be defined to capture vertical variations in grain size distribution. Bed interaction between the surface and lower layers is included to mimic bed surface armoring effects, such as are present in the project reach. Several bedload and suspended load transport models are available for use within the module. For bedload we applied the Meyer-Peter-Muller equation, applicable to gravel bed rivers, and for suspended load applied the Mehta erosion and deposition model. Full model setup is complex and beyond the scope of this document, with numerous parameters that must be defined for transport, deposition, and erosion rates, bed layer composition, and sediment input rates. Setup is summarized in Tables 3 and 4. A complete description of the Tuflow Sediment Transport module can be found in Tuflow 2020b.

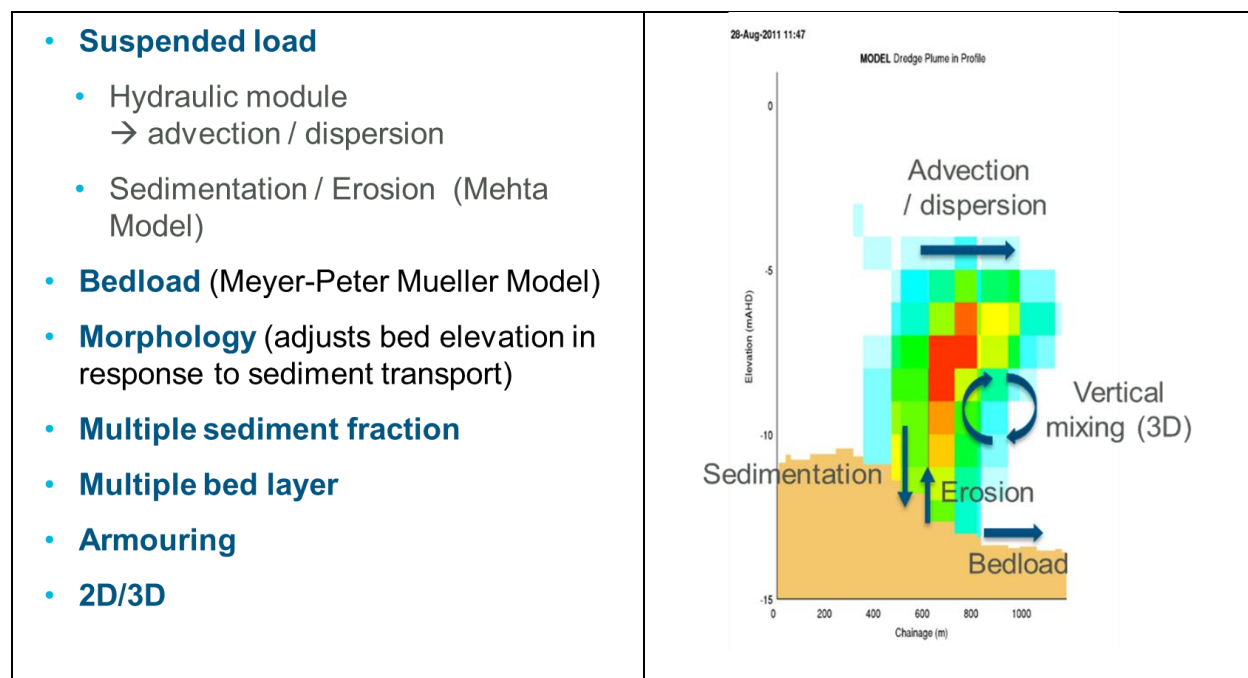


Figure 3. Capabilities and general functionality of the Tuflow FV morpho-dynamic sediment module.

Table 2 - Sediment transport and morpho-dynamic model setup: transport parameter assignments.

Model Parameter	Selected Option/Input	Notes
Sediment Fraction	Based on bed material (see Table 5)	Sediment makeup of a specific layer within the bed. Each layer can have varying amounts of sediment types.
Sediment Layers	Based on bed material (see Table 5)	Any bed material can have a single, or multiple, layers.
Bed roughness	Nikuradse bed roughness height, ks	Fixed bed roughness height specified.
Bed shear model	Default	Selected the default option.
Settling model	Constant w_s	Constant settling velocity defined by the settling parameters.
Deposition model	Unhindered (w_s)	Deposition rate based on settling velocity and susp. sed. concentration.
Erosion model	Mehta	Corresponding stage based on HQ relation.
Bed load model	Meyer-Peter-Mueller (MPM)	Applicable for gravel bed rivers.
Critical stress model	None	Built into the MPM model
Sediment Input concentrations (mg/L)	Bedload: zero gradient Suspended load: TBD	Constant input supply.

Table 3 - Sediment transport and morpho-dynamic model setup: bed composition.

Material	# of layers	Layer Material Composition
Higher gradient armored channel bed	2	Layer 1: 0.15m thick armor layer with 22% med-coarse gravels ($D_{50} = 25$ mm), 48% very coarse gravel ($D_{50} = 50$ mm), 30% small-medium cobbles ($D_{50} = 100$ mm). Layer 2: 10 m thick underlying sand/gravel layer with 63% sand ($D_{50} = 2$ mm), 28% med-coarse gravels ($D_{50} = 25$ mm), 7% very coarse gravel ($D_{50} = 50$ mm), 2% small-medium cobbles ($D_{50} = 100$ mm)
Gravel pits, and lower - gradient channel through pits	2	Layer 1: 0.5 m thick layer of finer materials with 82% silt ($D_{50} = 0.05$ mm); 18% sand (0.2mm) Layer 2: 5 m thick underlying sand/gravel layer with 63% sand ($D_{50} = 2$ mm), 28% med-coarse gravels ($D_{50} = 25$ mm), 7% very coarse gravel ($D_{50} = 50$ mm), 2% small-medium cobbles ($D_{50} = 100$ mm)
Floodplain	2	Layer 1: 0.5 m thick sand/gravel layer with 63% sand ($D_{50} = 2$ mm), 28% med-coarse gravels ($D_{50} = 25$ mm), 7% very coarse gravel ($D_{50} = 50$ mm), 2% small-medium cobbles ($D_{50} = 100$ mm) Layer 2: 10 m thick underlying sand/gravel layer with 63% sand ($D_{50} = 2$ mm), 28% med-coarse gravels ($D_{50} = 25$ mm), 7% very coarse gravel ($D_{50} = 50$ mm), 2% small-medium cobbles ($D_{50} = 100$ mm)

1.2.2 Sediment Transport Modeling Summary and Next Steps

Objectives of sediment transport modeling for this project include comparing transport rates, changes in bedform, and channel stability of the Existing Condition to those of the proposed restoration alternatives; and informing the design of a preferred alternative that will achieve improved overall transport conditions relative to the Existing Condition. Because the model was being developed concurrently with the Technical Oversight Group process, its use in helping to identify and define the restoration alternatives was limited.

To date LCEP has run a limited set of sediment transport simulations for the Existing Conditions model. A significant effort was expended testing the sensitivities of the model to changes in various bedload and transport parameters and their associated coefficients, as well as other elements of the model setup and simulation process. We have found results to be sensitive to changes in the underlying model grid. This presented challenges when updates to the grid were necessary to accommodate various iterations of design alternatives. Due to the required time to setup and run these models, we were not able to complete simulations for the latest grid revisions, including the Existing Condition, and restoration Alternatives 2 (the single thread channel) & 3 (the preferred alternative three channel network) for the Ridgefield Pits reach, in time for this report.

LCEP is currently in the process of refining model surfaces for Alternatives 2 & 3. We were able to compare water temperature performance for these (see Section 2.6 of the main report and Attachment 5), however channel geometries have not been optimized for higher flow conditions where sediment transport occurs. This step will be completed early in the next design phase, after which we will run the transport model and compare results for the preferred Alternative 3 and the Existing Condition, and for Alternatives 2 and 3 at the behest of the Technical Oversight Group, who have requested this additional analysis.

1.3 REFERENCES

Tuflow FV Flexible Mesh Modeling. 2020a. [Tuflow FV User Manual](#), Build 2020.02. Hydrodynamic Modeling Engine.

Tuflow FV Flexible Mesh Modeling. 2020b. [Tuflow FV User Manual](#), Build 2020.01. Sediment Transport and Particle Tracking Modules.

Tuflow FV Flexible Mesh Modeling. 2013. [Tuflow FV Science Manual](#).

1.4 APPENDIX A – SEDIMENT SAMPLING SURVEY RESULTS

Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	PK/Matt	Personnel
PM1	Identifier / Unit		Location		
	Longitudinal Description (Pool, Riffle, Bend, Crossing, etc.)		Latitude or Northing		
Sub-surface	Sample Type: Surface or Sub-surface		Longitude or Easting		
	Dominant / Subdominant Substrate		Waypoint		



Notes

Text

Photo

Photo

PM1_Subsurface.jpg



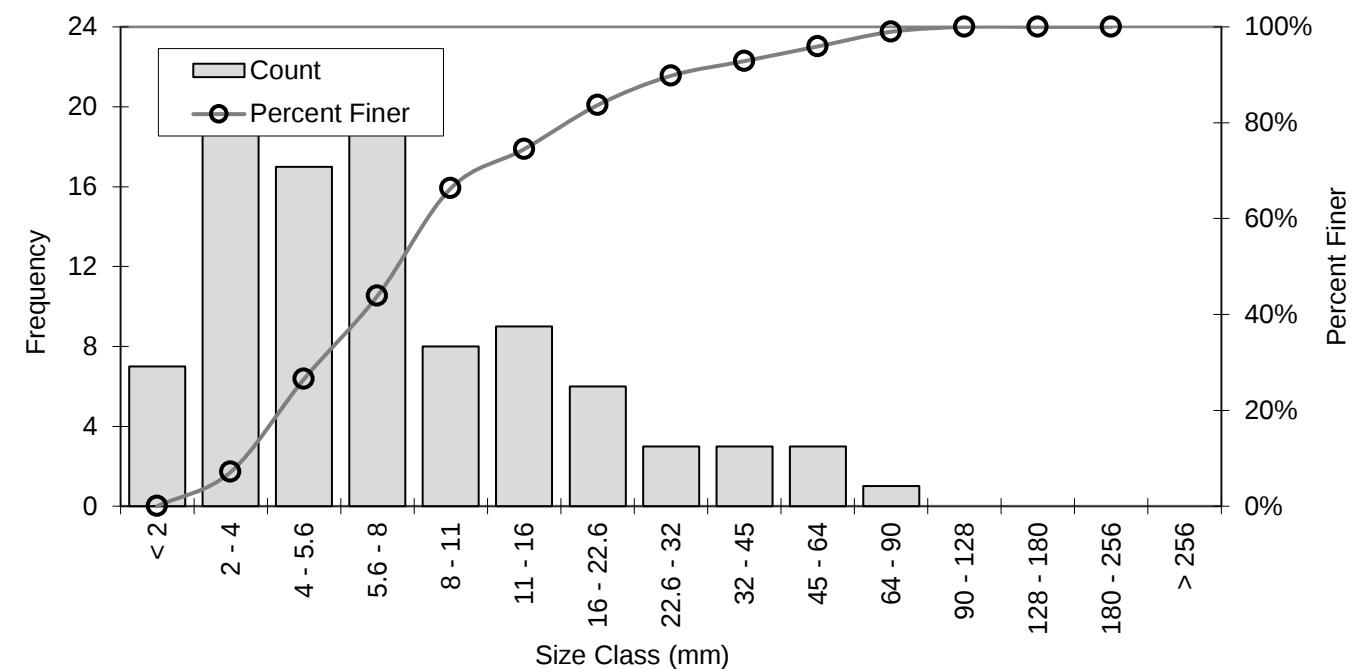
Distribution Statistic Points (Percent Finer)

D_{16}	2.9	mm
D_{50}	6.3	mm
D_{84}	16.4	mm

Assumes a linear interpolation

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2	7	0%
Very Fine Gravel	2 - 4	19	7%
Fine Gravel	4 - 5.6	17	27%
Fine Gravel	5.6 - 8	22	44%
Medium Gravel	8 - 11	8	66%
Medium Gravel	11 - 16	9	74%
Coarse Gravel	16 - 22.6	6	84%
Coarse Gravel	22.6 - 32	3	90%
Very Coarse Gravel	32 - 45	3	93%
Very Coarse Gravel	45 - 64	3	96%
Small Cobble	64 - 90	1	99%
Small Cobble	90 - 128		100%
Large Cobble	128 - 180		100%
Small Boulders	180 - 256		100%
Boulders	> 256		100%
Total		98	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	PK/Matt	Personnel
PM4	Identifier / Unit		Location		
Main Channel Pool Tailout	Longitudinal Description (Pool, Riffle, Bend, Crossing, etc.)	45.816039	Latitude or Northing		
Sub-surface	Sample Type: Surface or Sub-surface	-122.618059	Longitude or Easting		
	Dominant / Subdominant Substrate		Waypoint		



Notes

Text

Photo

PM4_Subsurface.jpg



Photo

PM4Subsurface_SurfaceDownstream.jpg



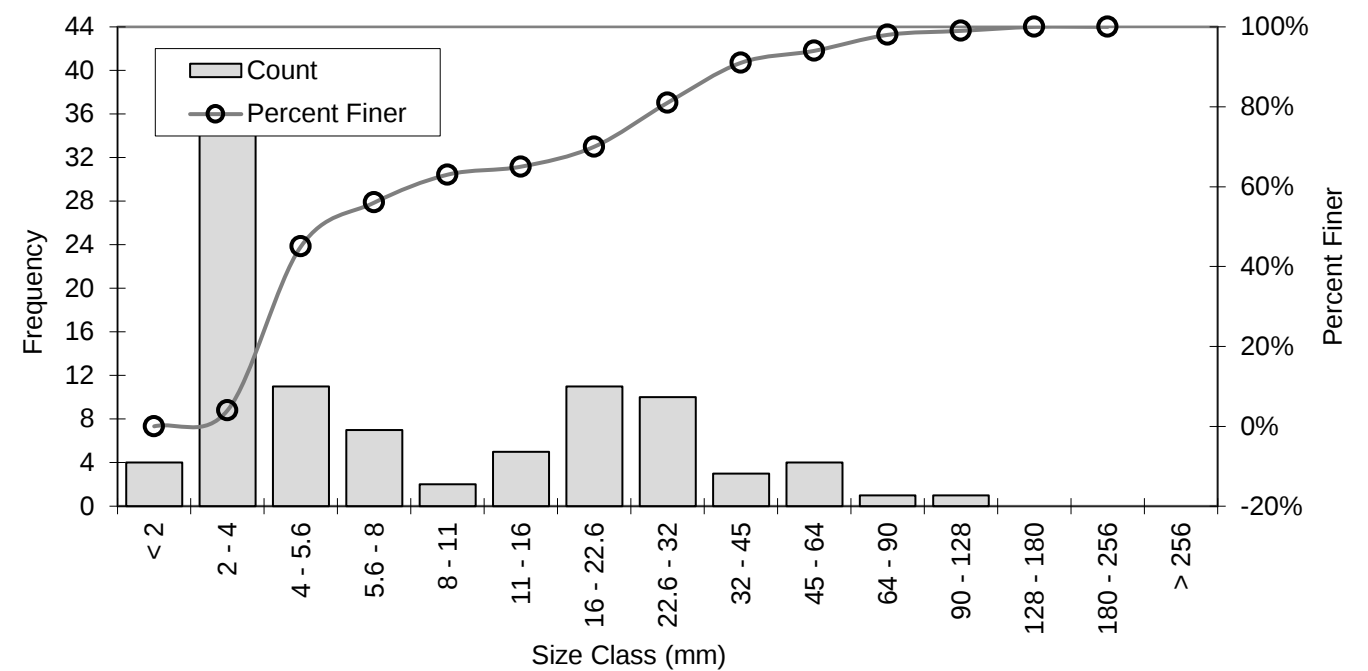
Distribution Statistic Points (Percent Finer)

D_{16}	2.6	mm
D_{50}	4.7	mm
D_{84}	24.4	mm

Assumes a linear interpolation

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2	4	0%
Very Fine Gravel	2 - 4	41	4%
Fine Gravel	4 - 5.6	11	45%
Fine Gravel	5.6 - 8	7	56%
Medium Gravel	8 - 11	2	63%
Medium Gravel	11 - 16	5	65%
Coarse Gravel	16 - 22.6	11	70%
Coarse Gravel	22.6 - 32	10	81%
Very Coarse Gravel	32 - 45	3	91%
Very Coarse Gravel	45 - 64	4	94%
Small Cobble	64 - 90	1	98%
Small Cobble	90 - 128	1	99%
Large Cobble	128 - 180		100%
Small Boulders	180 - 256		100%
Boulders	> 256		100%
Total		100	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	PK/Matt	Personnel
PM5	Identifier / Unit		Location		
Secondary Channel - Floodplain	Longitudinal Description (<i>Pool, Riffle, Bend, Crossing, etc.</i>)	45.817369	Latitude or Northing		
Sub-surface	Sample Type: Surface or Sub-surface	-122.622199	Longitude or Easting		
	Dominant / Subdominant Substrate		Waypoint		



Notes

Text

Photo

PM5_Subsurface.jpg

Photo



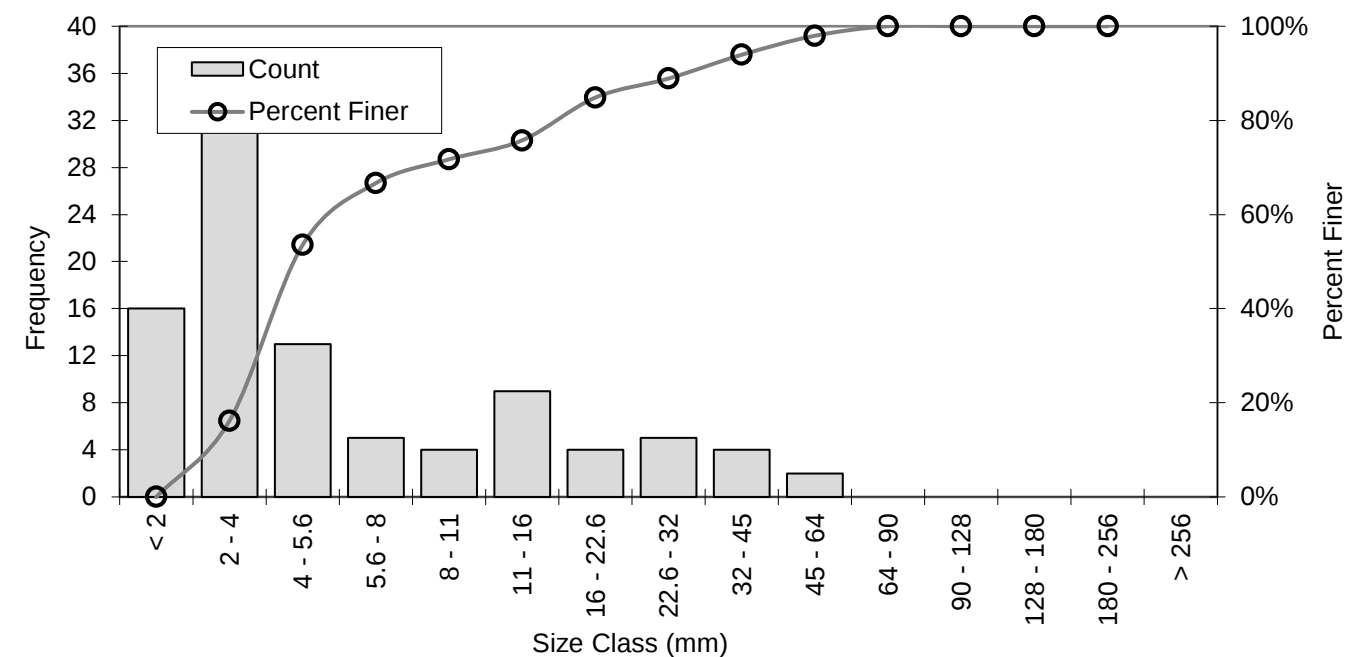
Distribution Statistic Points (Percent Finer)

PM5	2.0	mm
D ₅₀	3.8	mm
D ₈₄	17.1	mm

Assumes a linear interpolation

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2	16	0%
Very Fine Gravel	2 - 4	37	16%
Fine Gravel	4 - 5.6	13	54%
Fine Gravel	5.6 - 8	5	67%
Medium Gravel	8 - 11	4	72%
Medium Gravel	11 - 16	9	76%
Coarse Gravel	16 - 22.6	4	85%
Coarse Gravel	22.6 - 32	5	89%
Very Coarse Gravel	32 - 45	4	94%
Very Coarse Gravel	45 - 64	2	98%
Small Cobble	64 - 90		100%
Small Cobble	90 - 128		100%
Large Cobble	128 - 180		100%
Small Boulders	180 - 256		100%
Boulders	> 256		100%
Total		99	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	PK/Matt	Personnel
PM1-Surface	Identifier / Unit		Location		
Main Channel Bar Deposit	Longitudinal Description (<i>Pool, Riffle, Bend, Crossing, etc.</i>)	45.811971	Latitude or Northing		
Surface	Sample Type: Surface or Sub-surface	-122.598658	Longitude or Easting		
	Dominant / Subdominant Substrate		Waypoint		



Notes

Photo PM1_SurfaceDownstream.jpgPhoto PM1_SurfaceUpstream.jpg

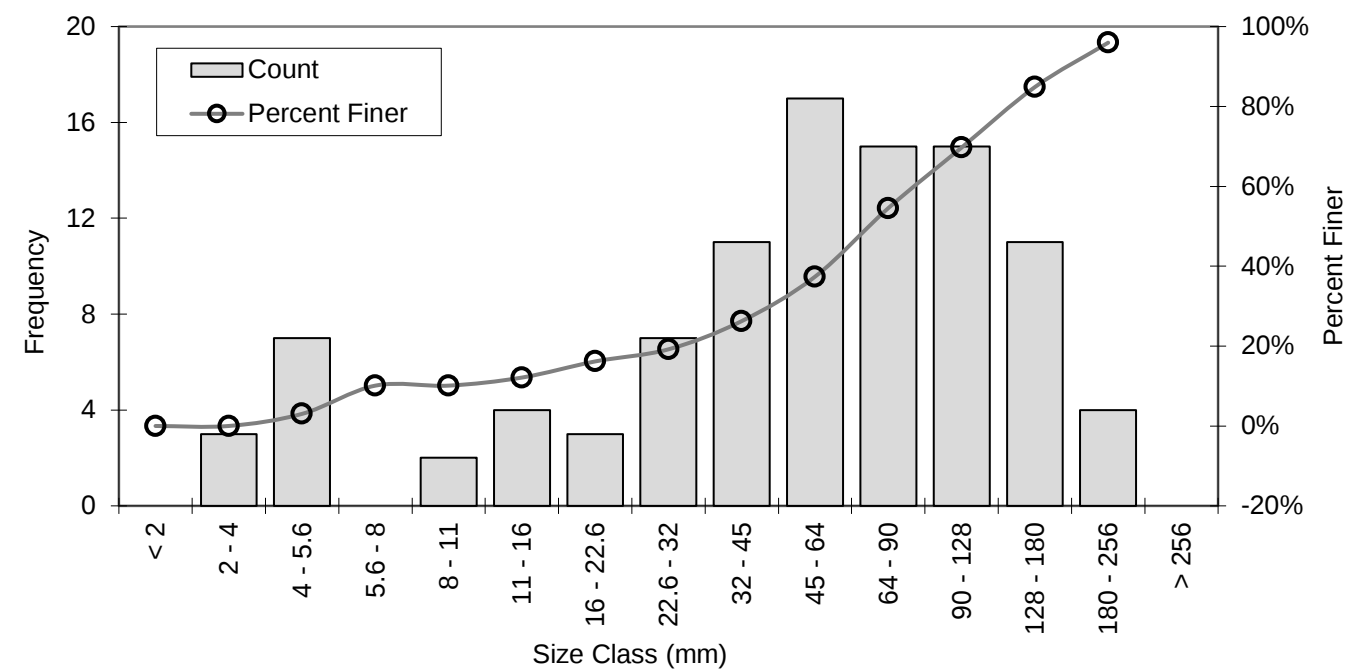
Distribution Statistic Points (Percent Finer)

<i>PM5</i>	15.8	mm
<i>D</i> ₅₀	59.0	mm
<i>D</i> ₈₄	125.9	mm

Assumes a linear interpolation

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2		0%
Very Fine Gravel	2 - 4	3	0%
Fine Gravel	4 - 5.6	7	3%
Fine Gravel	5.6 - 8		10%
Medium Gravel	8 - 11	2	10%
Medium Gravel	11 - 16	4	12%
Coarse Gravel	16 - 22.6	3	16%
Coarse Gravel	22.6 - 32	7	19%
Very Coarse Gravel	32 - 45	11	26%
Very Coarse Gravel	45 - 64	17	37%
Small Cobble	64 - 90	15	55%
Small Cobble	90 - 128	15	70%
Large Cobble	128 - 180	11	85%
Small Boulders	180 - 256	4	96%
Boulders	> 256		100%
Total		99	



Sediment Grain Size Analysis				
EF Lewis River	Stream	10/18/2018	Date	PK/Matt
PM2-Surface	Identifier / Unit		Location	Personnel
Main Channel Bar Deposit / Pool Tailout	Longitudinal Description (Pool, Riffle, Bend, Crossing, etc.)	45.81276	Latitude or Northing	
Surface	Sample Type: Surface or Sub-surface	-122.608541	Longitude or Easting	
	Dominant / Subdominant Substrate		Waypoint	



Notes

Main channel braided section

Photo PM2_SurfaceReference.jpg



Photo PM2_SurfaceUpstream.jpg

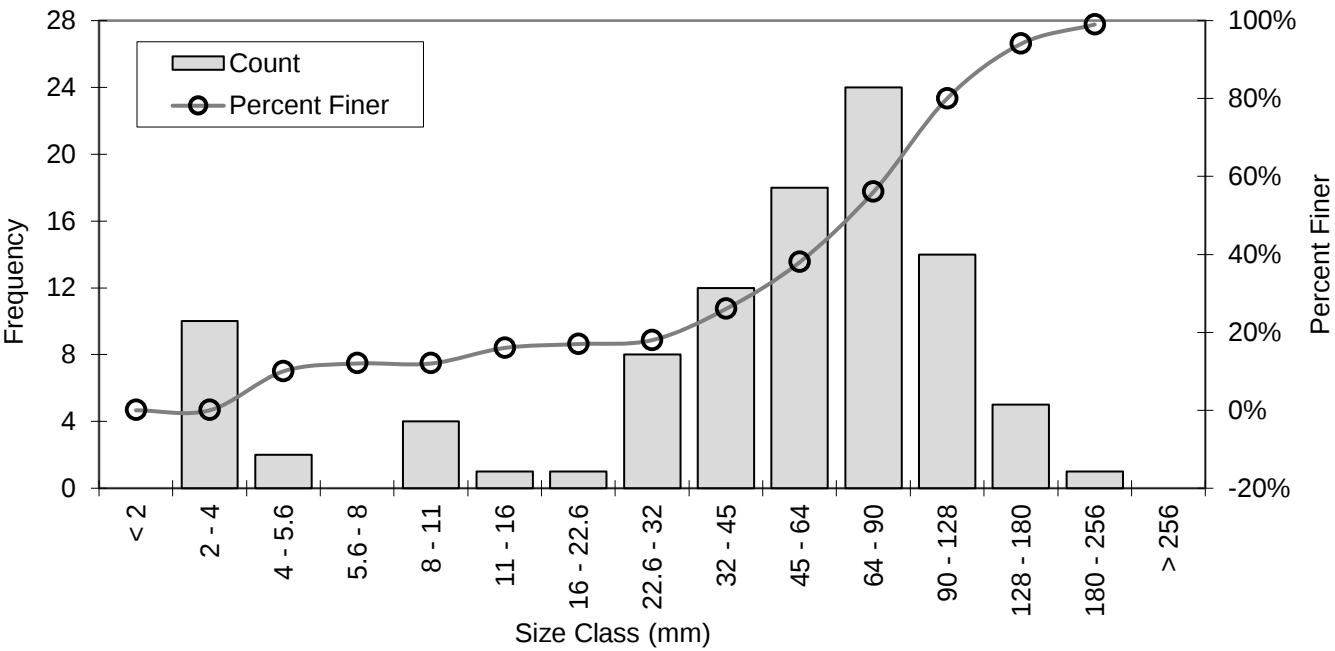


Distribution Statistic Points (Percent Finer)

PM5	11.0	mm
D ₅₀	57.7	mm
D ₈₄	100.9	mm

Assumes a linear interpolation

Pebble Count Data			
Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2		0%
Very Fine Gravel	2 - 4	10	0%
Fine Gravel	4 - 5.6	2	10%
Fine Gravel	5.6 - 8		12%
Medium Gravel	8 - 11	4	12%
Medium Gravel	11 - 16	1	16%
Coarse Gravel	16 - 22.6	1	17%
Coarse Gravel	22.6 - 32	8	18%
Very Coarse Gravel	32 - 45	12	26%
Very Coarse Gravel	45 - 64	18	38%
Small Cobble	64 - 90	24	56%
Small Cobble	90 - 128	14	80%
Large Cobble	128 - 180	5	94%
Small Boulders	180 - 256	1	99%
Boulders	> 256	0	100%
Total		100	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	PK/Matt	Personnel
PM3-Surface	Identifier / Unit		Location		
Main Channel Bar Deposit	Longitudinal Description (<i>Pool, Riffle, Bend, Crossing, etc.</i>)	-122.612459 45.8	Latitude or Northing		
Surface	Sample Type: Surface or Sub-surface	-122.612459 45.8	Longitude or Easting		
	Dominant / Subdominant Substrate		Waypoint		



Notes

Text

Photo PM3_SurfaceSandReference.jpg



Photo PM3_SurfaceUpstream.jpg



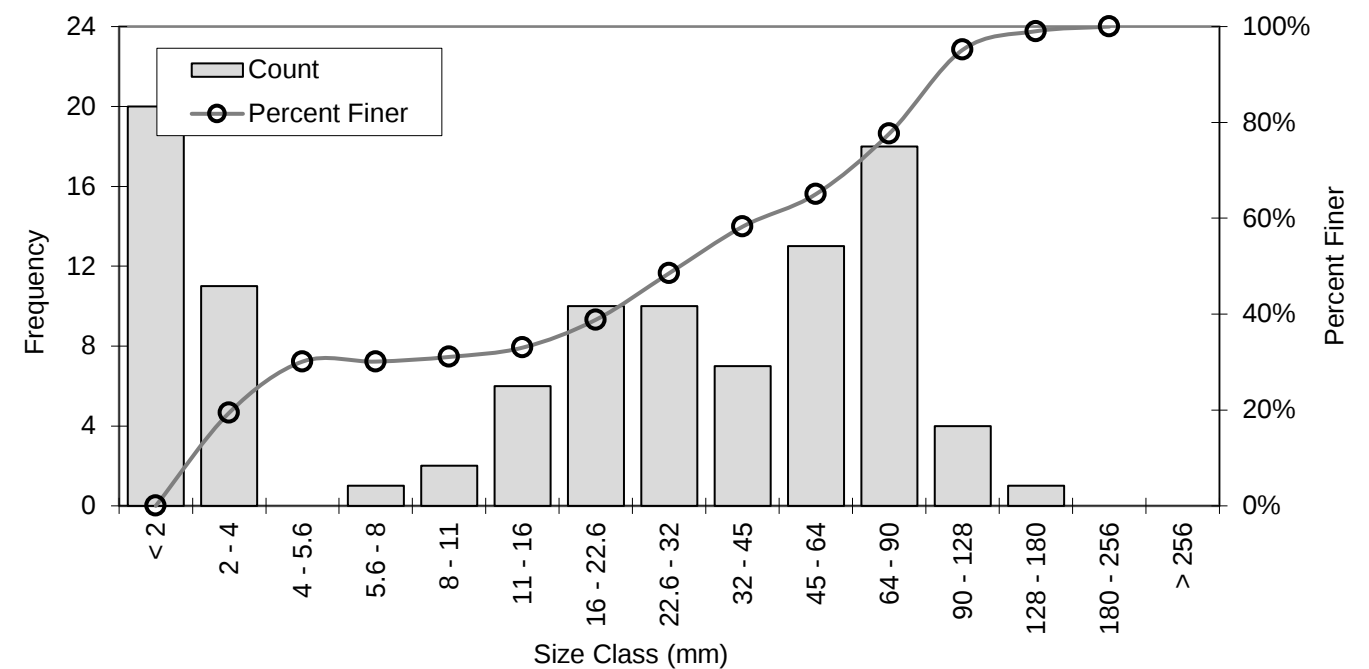
Distribution Statistic Points (Percent Finer)

<i>PM5</i>	1.8	mm
<i>D₅₀</i>	24.0	mm
<i>D₈₄</i>	73.4	mm

Assumes a linear interpolation

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2	20	0%
Very Fine Gravel	2 - 4	11	19%
Fine Gravel	4 - 5.6		30%
Fine Gravel	5.6 - 8	1	30%
Medium Gravel	8 - 11	2	31%
Medium Gravel	11 - 16	6	33%
Coarse Gravel	16 - 22.6	10	39%
Coarse Gravel	22.6 - 32	10	49%
Very Coarse Gravel	32 - 45	7	58%
Very Coarse Gravel	45 - 64	13	65%
Small Cobble	64 - 90	18	78%
Small Cobble	90 - 128	4	95%
Large Cobble	128 - 180	1	99%
Small Boulders	180 - 256		100%
Boulders	> 256		100%
Total		103	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	PK/Matt	Personnel
PM4-Surface	Identifier / Unit		Location		
Main Channel Pool Tailout	Longitudinal Description (<i>Pool, Riffle, Bend, Crossing, etc.</i>)	45.816382	Latitude or Northing		
Surface	Sample Type: Surface or Sub-surface	-122.619471	Longitude or Easting		
	Dominant / Subdominant Substrate		Waypoint		



Notes

Text

Photo

Photo

PM4Subsurface_SurfaceDownstream.jpg



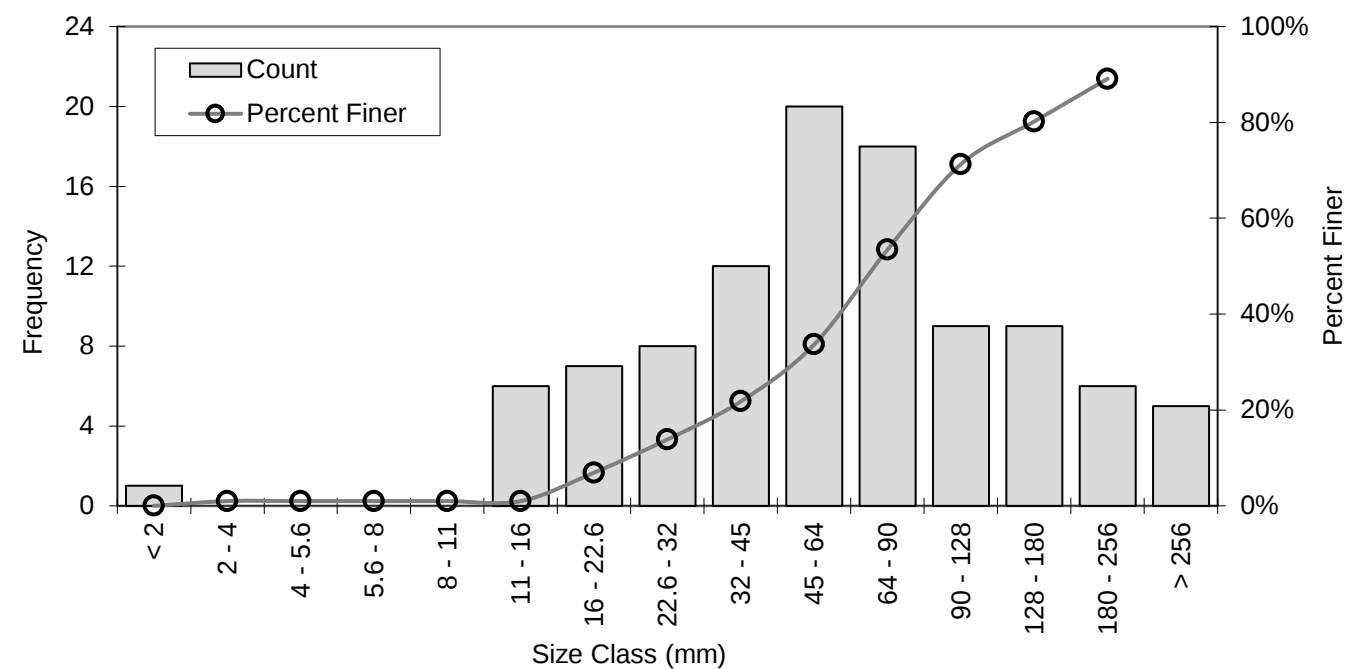
Distribution Statistic Points (Percent Finer)

PM5	25.1	mm
D ₅₀	60.7	mm
D ₈₄	150.2	mm

Assumes a linear interpolation

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2	1	0%
Very Fine Gravel	2 - 4		1%
Fine Gravel	4 - 5.6		1%
Fine Gravel	5.6 - 8		1%
Medium Gravel	8 - 11		1%
Medium Gravel	11 - 16	6	1%
Coarse Gravel	16 - 22.6	7	7%
Coarse Gravel	22.6 - 32	8	14%
Very Coarse Gravel	32 - 45	12	22%
Very Coarse Gravel	45 - 64	20	34%
Small Cobble	64 - 90	18	53%
Small Cobble	90 - 128	9	71%
Large Cobble	128 - 180	9	80%
Small Boulders	180 - 256	6	89%
Boulders	> 256	5	95%
Total		101	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	PK/Matt	Personnel
PM5-Surface	Identifier / Unit		Location		
	Longitudinal Description (<i>Pool, Riffle, Bend, Crossing, etc.</i>)		Latitude or Northing		
Surface	Sample Type: Surface or Sub-surface		Longitude or Easting		
	Dominant / Subdominant Substrate		Waypoint		



Notes

Text

Photo PM5_SurfaceDownstream.jpgPhoto PM5_SurfaceUpstream.jpg

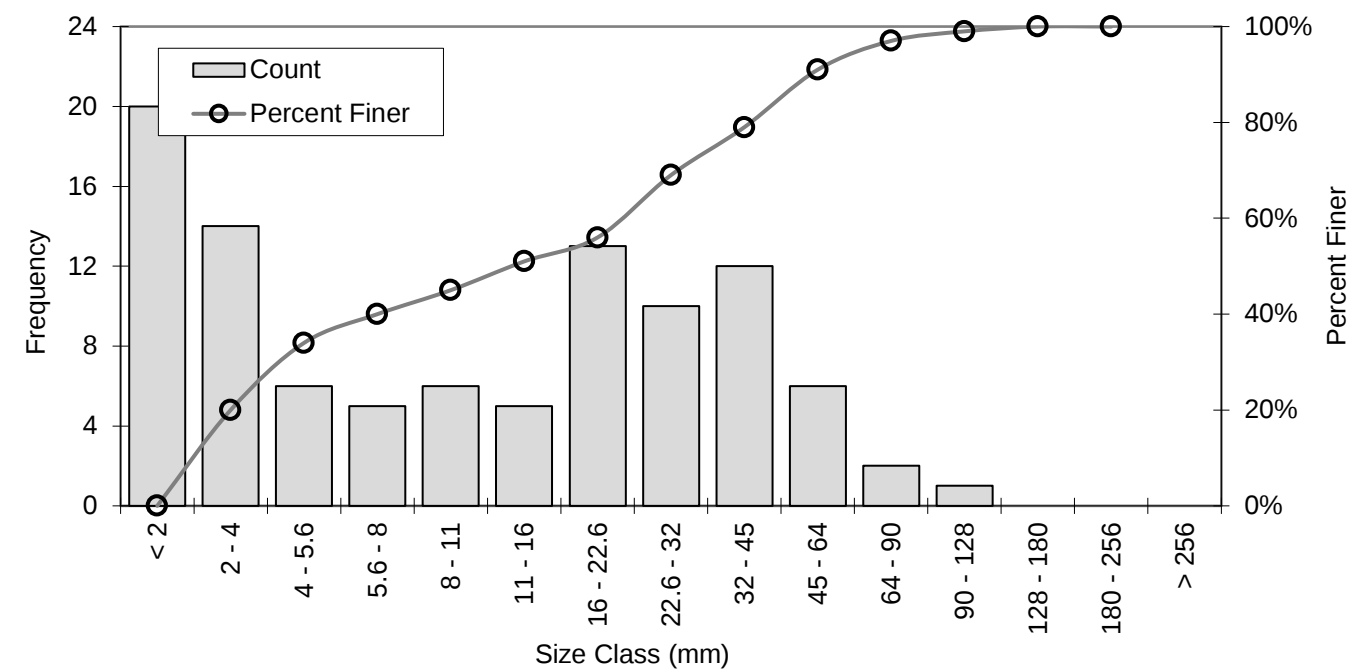
Distribution Statistic Points (Percent Finer)

PM5	1.8	mm
D ₅₀	10.5	mm
D ₈₄	37.4	mm

Assumes a linear interpolation

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2	20	0%
Very Fine Gravel	2 - 4	14	20%
Fine Gravel	4 - 5.6	6	34%
Fine Gravel	5.6 - 8	5	40%
Medium Gravel	8 - 11	6	45%
Medium Gravel	11 - 16	5	51%
Coarse Gravel	16 - 22.6	13	56%
Coarse Gravel	22.6 - 32	10	69%
Very Coarse Gravel	32 - 45	12	79%
Very Coarse Gravel	45 - 64	6	91%
Small Cobble	64 - 90	2	97%
Small Cobble	90 - 128	1	99%
Large Cobble	128 - 180		100%
Small Boulders	180 - 256		100%
Boulders	> 256		100%
Total		100	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	PK/Matt	Personnel
PM6-Surface	Identifier / Unit		Location		
Secondary Channel	Longitudinal Description (<i>Pool, Riffle, Bend, Crossing, etc.</i>)	45.819391	Latitude or Northing		
Surface	Sample Type: Surface or Sub-surface	-122.614461	Longitude or Easting		
	Dominant / Subdominant Substrate		Waypoint		



Notes

Text

Photo PM6Surface_Downstream.jpgPhoto PM6Surface_Upstream.jpg

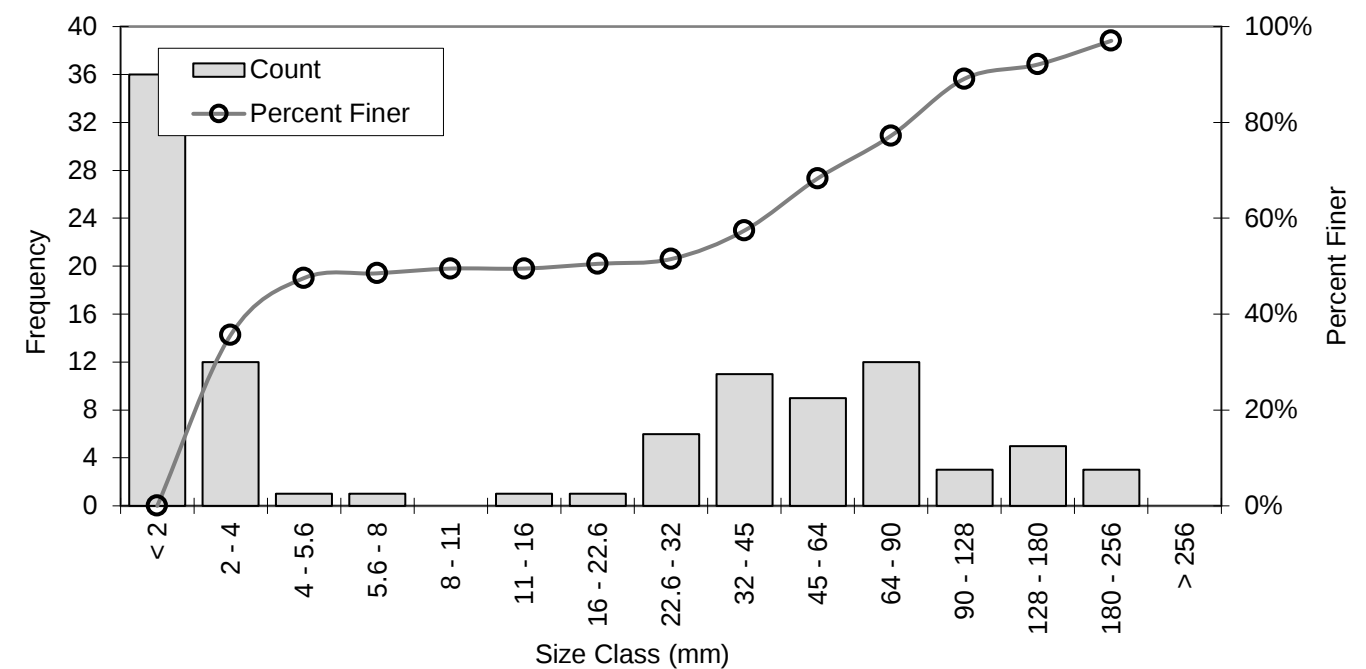
Distribution Statistic Points (Percent Finer)

<i>PM5</i>	1.4	mm
<i>D</i> ₅₀	11.0	mm
<i>D</i> ₈₄	78.8	mm

Assumes a linear interpolation

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2	36	0%
Very Fine Gravel	2 - 4	12	36%
Fine Gravel	4 - 5.6	1	48%
Fine Gravel	5.6 - 8	1	49%
Medium Gravel	8 - 11	1	50%
Medium Gravel	11 - 16	1	50%
Coarse Gravel	16 - 22.6	1	50%
Coarse Gravel	22.6 - 32	6	51%
Very Coarse Gravel	32 - 45	11	57%
Very Coarse Gravel	45 - 64	9	68%
Small Cobble	64 - 90	12	77%
Small Cobble	90 - 128	3	89%
Large Cobble	128 - 180	5	92%
Small Boulders	180 - 256	3	97%
Boulders	> 256		100%
Total		101	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	KM / Niko	Personnel
KN2	Identifier / Unit		Location		
Gravel Bar	Longitudinal Description (Pool, Riffle, Bend, Crossing, etc.)	45.827759	Latitude or Northing		
Sub-surface	Sample Type: Surface or Sub-surface	-122.633011	Longitude or Easting		
Gravel / Cobble	Dominant / Subdominant Substrate		Waypoint		



Notes

Photo [field_4-20181018-181420.jpg](#)



Photo [field_12-20181018-182302.jpg](#)



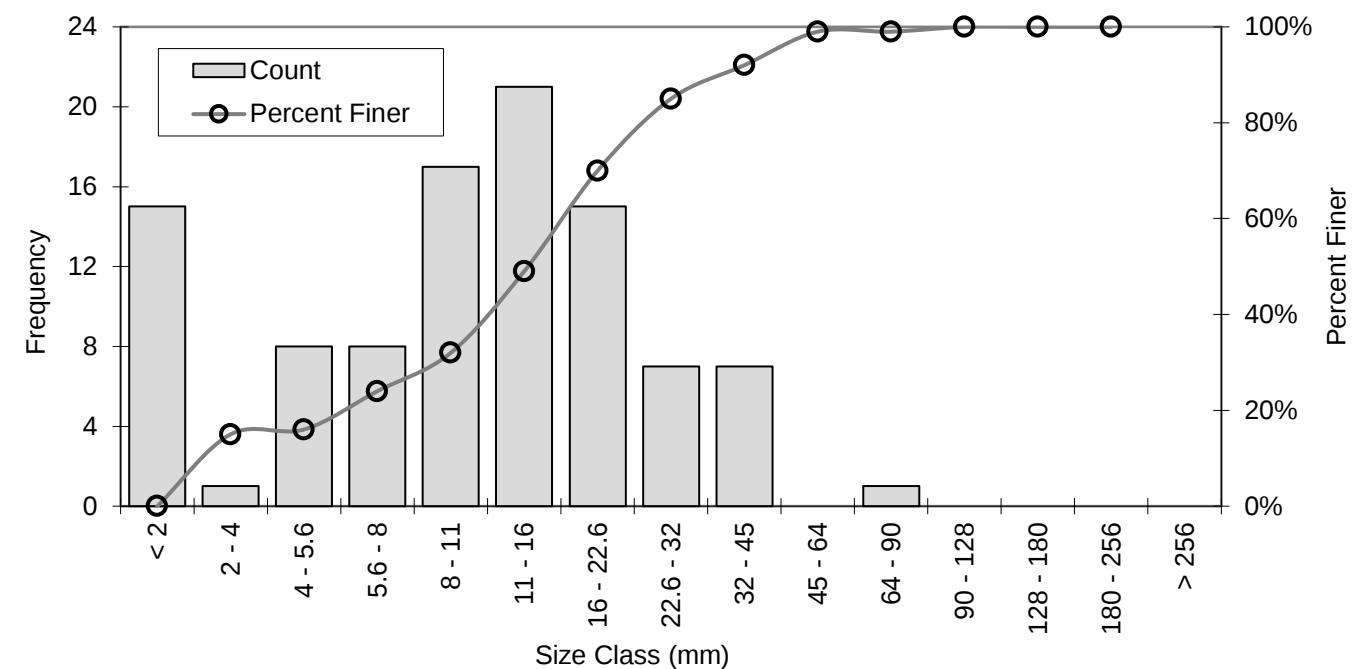
Distribution Statistic Points (Percent Finer)

D_{16}	-70.1	mm
D_{50}	#DIV/0!	mm
D_{84}	-326.0	mm

Assumes a linear interpolation

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2	15	0%
Very Fine Gravel	2 - 4	1	15%
Fine Gravel	4 - 5.6	8	16%
Fine Gravel	5.6 - 8	8	24%
Medium Gravel	8 - 11	17	32%
Medium Gravel	11 - 16	21	49%
Coarse Gravel	16 - 22.6	15	70%
Coarse Gravel	22.6 - 32	7	85%
Very Coarse Gravel	32 - 45	7	92%
Very Coarse Gravel	45 - 64		99%
Small Cobble	64 - 90	1	99%
Small Cobble	90 - 128		100%
Large Cobble	128 - 180		100%
Small Boulders	180 - 256		100%
Boulders	> 256		100%
Total		100	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	KM / Niko	Personnel
KN6	Identifier / Unit		Location		
Bar Deposit	Longitudinal Description (Pool, Riffle, Bend, Crossing, etc.)	45.819065	Latitude or Northing		
Sub-Surface	Sample Type: Surface or Sub-surface	-122.626668	Longitude or Easting		
Gravel / Sand	Dominant / Subdominant Substrate		Waypoint		



Notes

Thin armor layer, lots of sand

Photo KN6subcount_armor_removed_pre_mix.JPG

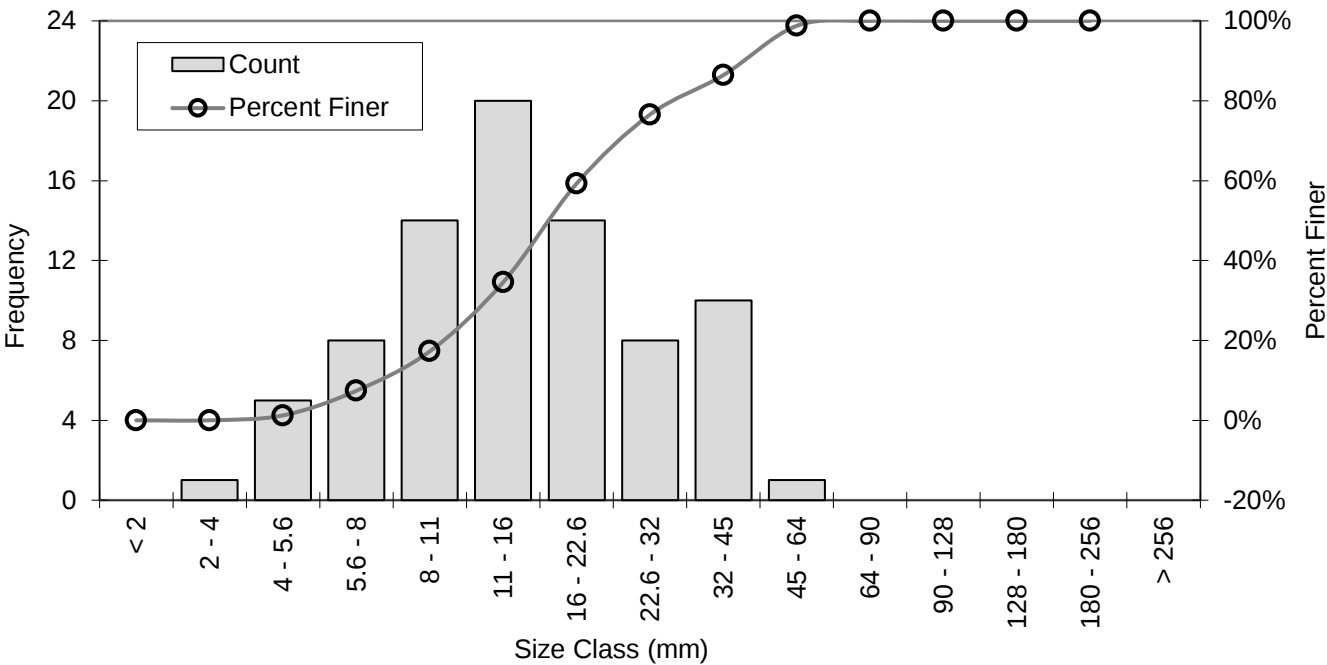


Photo KN6subcount_armor_removed_post_mix.JPG



Distribution Statistic Points (Percent Finer)		
D_{16}	7.7	mm
D_{50}	14.1	mm
D_{84}	29.7	mm
Assumes a linear interpolation		

Pebble Count Data			
Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2		0%
Very Fine Gravel	2 - 4	1	0%
Fine Gravel	4 - 5.6	5	1%
Fine Gravel	5.6 - 8	8	7%
Medium Gravel	8 - 11	14	17%
Medium Gravel	11 - 16	20	35%
Coarse Gravel	16 - 22.6	14	59%
Coarse Gravel	22.6 - 32	8	77%
Very Coarse Gravel	32 - 45	10	86%
Very Coarse Gravel	45 - 64	1	99%
Small Cobble	64 - 90		100%
Small Cobble	90 - 128		100%
Large Cobble	128 - 180		100%
Small Boulders	180 - 256		100%
Boulders	> 256		100%
Total		81	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	KM / Niko	Personnel
KN8	Identifier / Unit		Location		
	Longitudinal Description (<i>Pool, Riffle, Bend, Crossing, etc.</i>)	45.819694	Latitude or Northing		
Sub-Surface	Sample Type: Surface or Sub-surface	-122.625368	Longitude or Easting		
Gravel / Sand	Dominant / Subdominant Substrate		Waypoint		



Notes

Lots of fine sand mixed with gravel and cobble

Photo KN8subcount_armor_layer.JPG



Photo KN8subcount_armor_removed_pre_mix



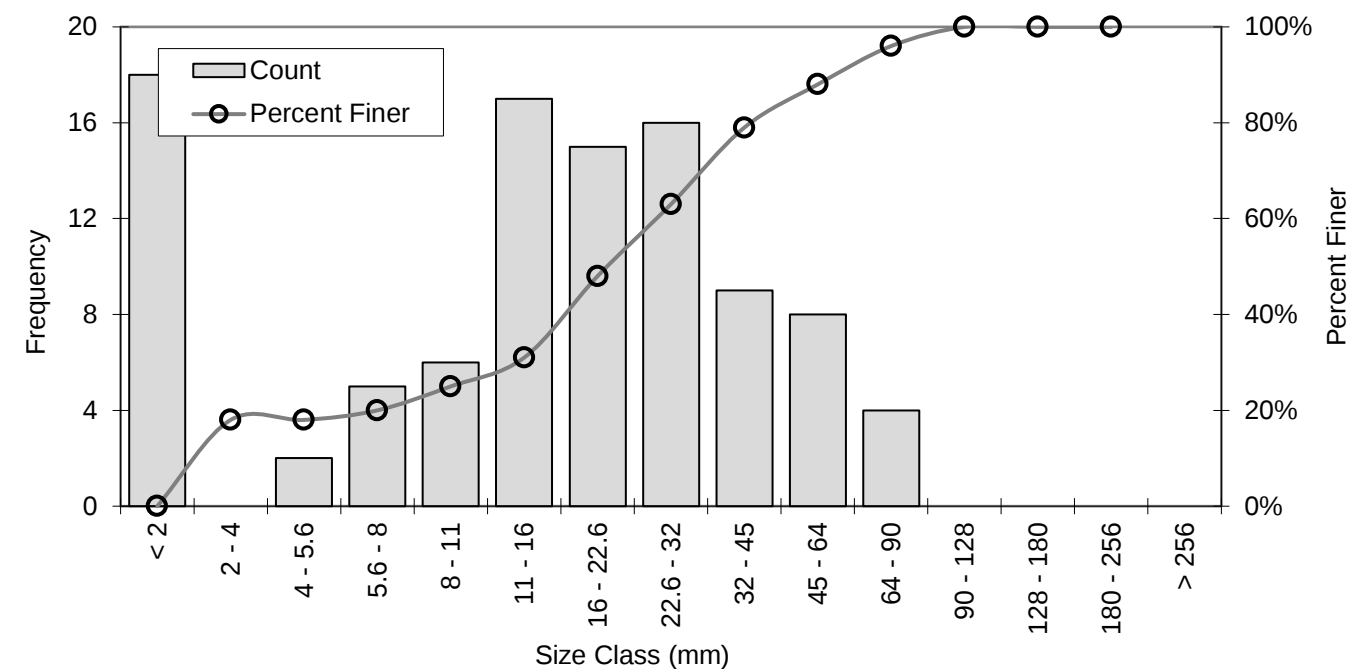
Distribution Statistic Points (Percent Finer)

D_{16}	2.8	mm
D_{50}	16.9	mm
D_{84}	39.2	mm

Assumes a linear interpolation

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2	18	0%
Very Fine Gravel	2 - 4	0	18%
Fine Gravel	4 - 5.6	2	18%
Fine Gravel	5.6 - 8	5	20%
Medium Gravel	8 - 11	6	25%
Medium Gravel	11 - 16	17	31%
Coarse Gravel	16 - 22.6	15	48%
Coarse Gravel	22.6 - 32	16	63%
Very Coarse Gravel	32 - 45	9	79%
Very Coarse Gravel	45 - 64	8	88%
Small Cobble	64 - 90	4	96%
Small Cobble	90 - 128		100%
Large Cobble	128 - 180		100%
Small Boulders	180 - 256		100%
Boulders	> 256		100%
Total		100	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	KM / Niko	Personnel
KN1	Identifier / Unit		Location		
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing, etc.)	45.827668	Latitude or Northing		
Surface	Sample Type: Surface or Sub-surface	-122.632556	Longitude or Easting		
Gravel / Cobble	Dominant / Subdominant Substrate		Waypoint		



Notes

Diagonal riffle transects, redds upstream in tailout, riffle not in high flow main energy line, pebble count all in water

Photo [field_6-20181018-180552.jpg](#)

Photo [field_5-20181018-175149.jpg](#)



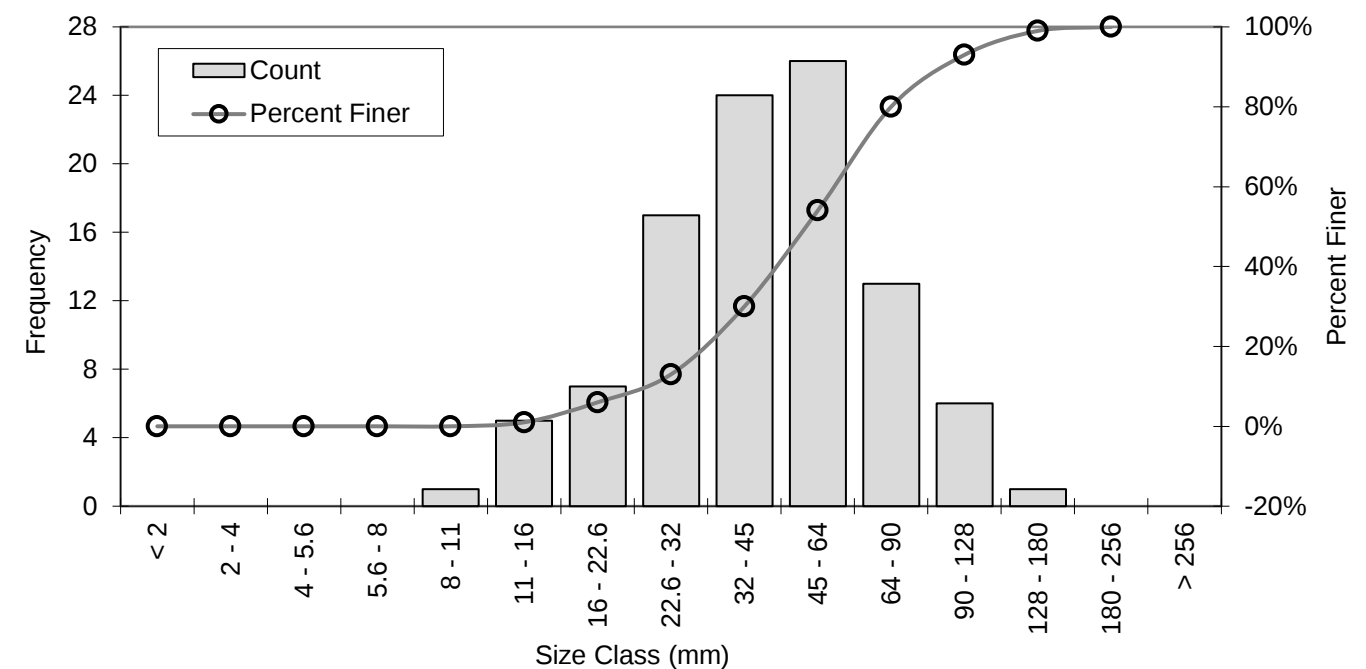
Distribution Statistic Points (Percent Finer)

D_{16}	24.3	mm
D_{50}	42.8	mm
D_{84}	72.0	mm

Assumes a linear interpolation

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2		0%
Very Fine Gravel	2 - 4		0%
Fine Gravel	4 - 5.6		0%
Fine Gravel	5.6 - 8		0%
Medium Gravel	8 - 11	1	0%
Medium Gravel	11 - 16	5	1%
Coarse Gravel	16 - 22.6	7	6%
Coarse Gravel	22.6 - 32	17	13%
Very Coarse Gravel	32 - 45	24	30%
Very Coarse Gravel	45 - 64	26	54%
Small Cobble	64 - 90	13	80%
Small Cobble	90 - 128	6	93%
Large Cobble	128 - 180	1	99%
Small Boulders	180 - 256		100%
Boulders	> 256		100%
Total		100	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	KM / Niko	Personnel
KN2	Identifier / Unit		Location		
Gravel Bar	Longitudinal Description (Pool, Riffle, Bend, Crossing, etc.)	45.827759	Latitude or Northing		
Surface	Sample Type: Surface or Sub-surface	-122.633011	Longitude or Easting		
Gravel / Cobble	Dominant / Subdominant Substrate		Waypoint		



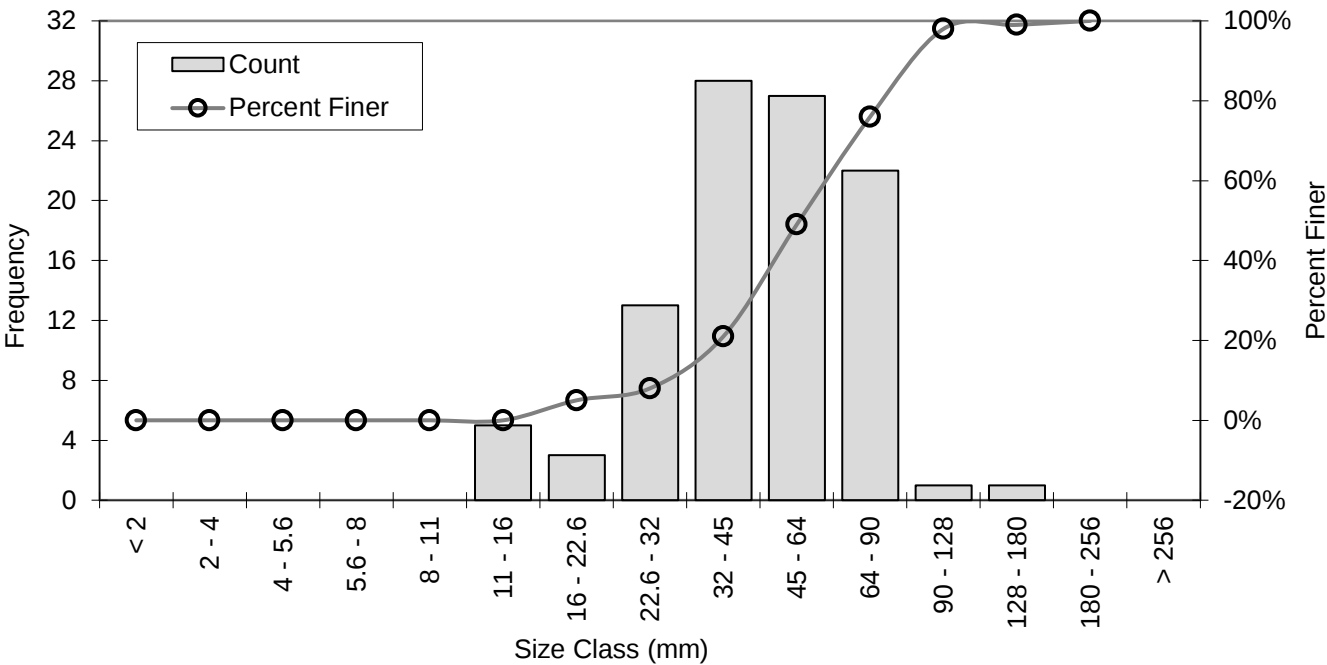
Notes	Photo	field_4-20181018-181420.jpg	Photo
Text			



Distribution Statistic Points (Percent Finer)			
D_{16}	28.4	mm	
D_{50}	45.7	mm	
D_{84}	73.5	mm	
Assumes a linear interpolation			

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2		0%
Very Fine Gravel	2 - 4		0%
Fine Gravel	4 - 5.6		0%
Fine Gravel	5.6 - 8		0%
Medium Gravel	8 - 11		0%
Medium Gravel	11 - 16	5	0%
Coarse Gravel	16 - 22.6	3	5%
Coarse Gravel	22.6 - 32	13	8%
Very Coarse Gravel	32 - 45	28	21%
Very Coarse Gravel	45 - 64	27	49%
Small Cobble	64 - 90	22	76%
Small Cobble	90 - 128	1	98%
Large Cobble	128 - 180	1	99%
Small Boulders	180 - 256		100%
Boulders	> 256		100%
Total		100	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	KM / Niko	Personnel
KN5	Identifier / Unit		Location		
Riffle / Bar Deposit	Longitudinal Description (Pool, Riffle, Bend, Crossing, etc.)	45.819065	Latitude or Northing		
Surface	Sample Type: Surface or Sub-surface	-122.626668	Longitude or Easting		
Gravel / Cobble	Dominant / Subdominant Substrate		Waypoint		



Notes

Narrow riffle with bar, just above entrance to a pit. Sand dune above bar on downstream side. River mile 7.8.

Photo

KN5surfcount_Ref.JPG



Photo

KN5_transect_W.JPG



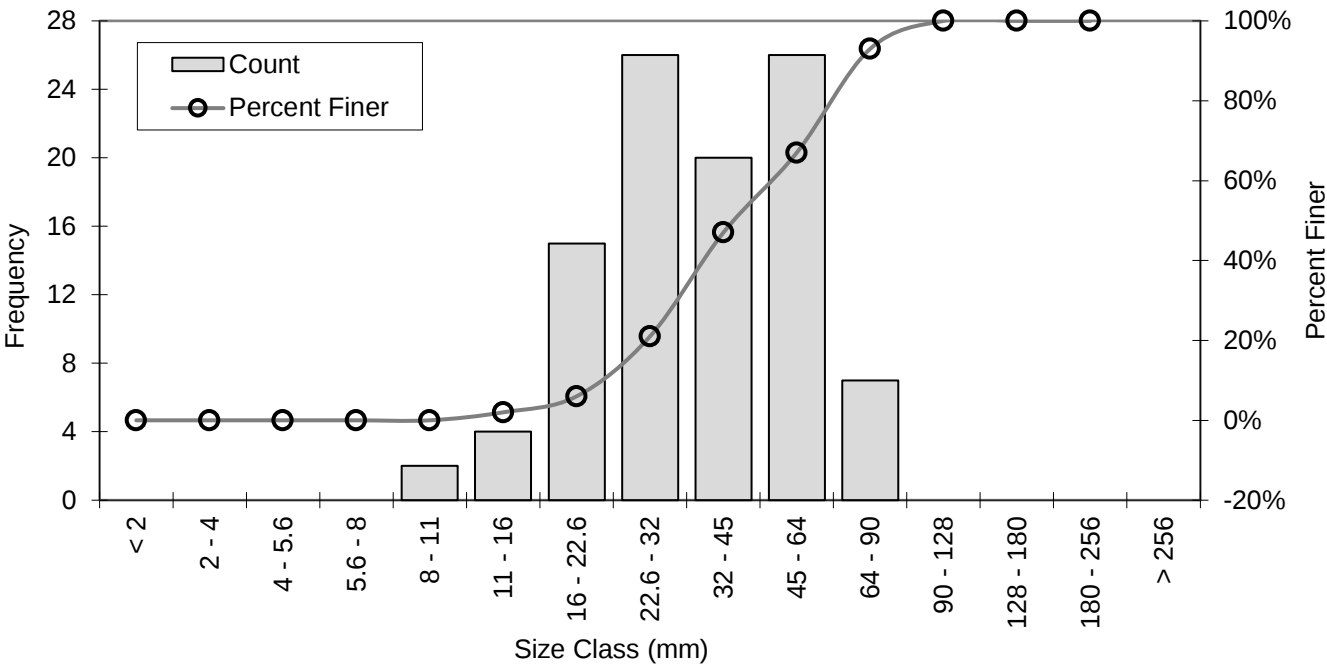
Distribution Statistic Points (Percent Finer)

D_{16}	20.4	mm
D_{50}	34.0	mm
D_{84}	57.4	mm

Assumes a linear interpolation

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2		0%
Very Fine Gravel	2 - 4		0%
Fine Gravel	4 - 5.6		0%
Fine Gravel	5.6 - 8		0%
Medium Gravel	8 - 11	2	0%
Medium Gravel	11 - 16	4	2%
Coarse Gravel	16 - 22.6	15	6%
Coarse Gravel	22.6 - 32	26	21%
Very Coarse Gravel	32 - 45	20	47%
Very Coarse Gravel	45 - 64	26	67%
Small Cobble	64 - 90	7	93%
Small Cobble	90 - 128		100%
Large Cobble	128 - 180		100%
Small Boulders	180 - 256		100%
Boulders	> 256		100%
Total		100	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	KM / Niko	Personnel
KN7	Identifier / Unit		Location		
	Longitudinal Description (Pool, Riffle, Bend, Crossing, etc.)	45.819694	Latitude or Northing		
Surface	Sample Type: Surface or Sub-surface	-122.625368	Longitude or Easting		
Cobble / Gravel	Dominant / Subdominant Substrate		Waypoint		



Notes

Mid-channel bar deposit in the middle of a floodplain expansion adjacent to riffle, upstream of recent avulsion. Several adult salmon spawning in the riffle.

Photo KN7surfcount_Ref.JPG



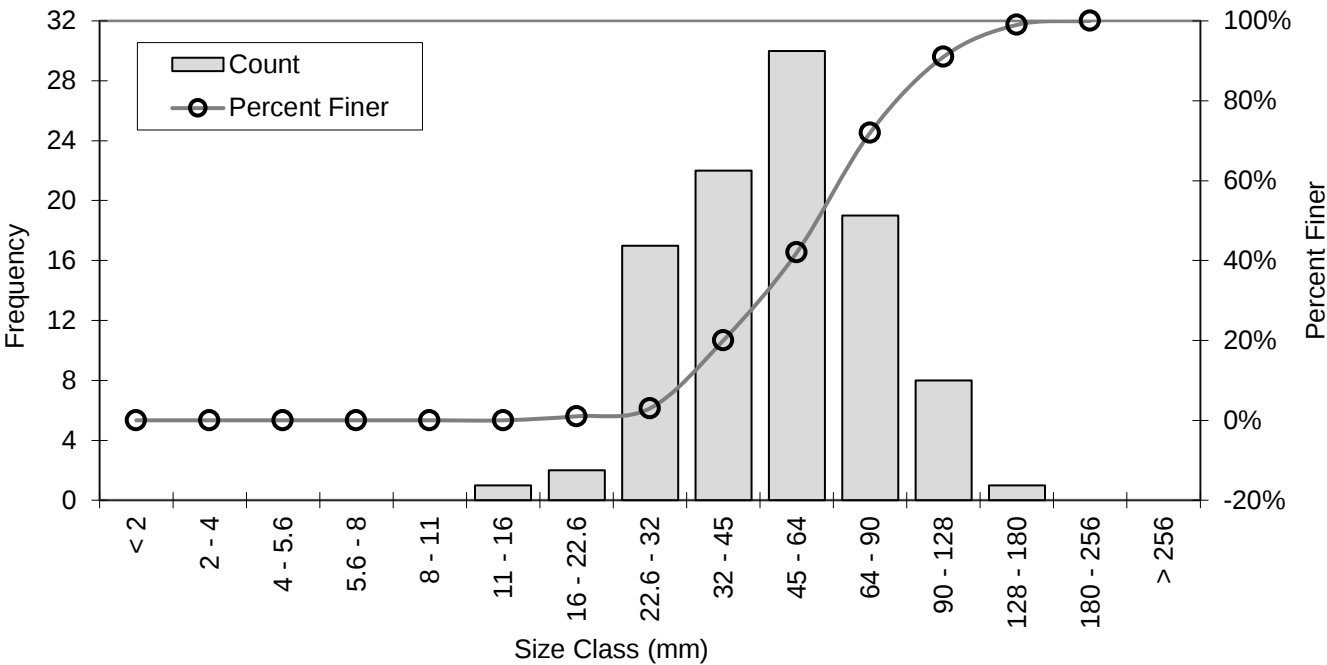
Photo KN7_transect_W.JPG



Distribution Statistic Points (Percent Finer)			
D_{16}	29.8	mm	
D_{50}	50.1	mm	
D_{84}	80.4	mm	
Assumes a linear interpolation			

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2		0%
Very Fine Gravel	2 - 4		0%
Fine Gravel	4 - 5.6		0%
Fine Gravel	5.6 - 8		0%
Medium Gravel	8 - 11		0%
Medium Gravel	11 - 16	1	0%
Coarse Gravel	16 - 22.6	2	1%
Coarse Gravel	22.6 - 32	17	3%
Very Coarse Gravel	32 - 45	22	20%
Very Coarse Gravel	45 - 64	30	42%
Small Cobble	64 - 90	19	72%
Small Cobble	90 - 128	8	91%
Large Cobble	128 - 180	1	99%
Small Boulders	180 - 256		100%
Boulders	> 256		100%
Total		100	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	KM / Niko	Personnel
KN9	Identifier / Unit		Location		
Riffle / Bar Deposit	Longitudinal Description (Pool, Riffle, Bend, Crossing, etc.)	45.81962	Latitude or Northing		
Surface	Sample Type: Surface or Sub-surface	-122.626196	Longitude or Easting		
Cobble / Gravel	Dominant / Subdominant Substrate		Waypoint		



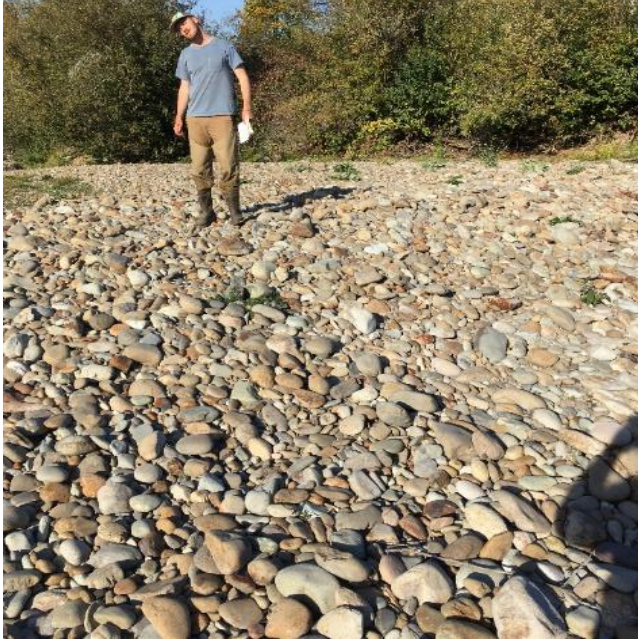
Notes

Just bar, no riffle. Last riffle on main channel below pits

Photo KN9surfcount_Ref.JPG

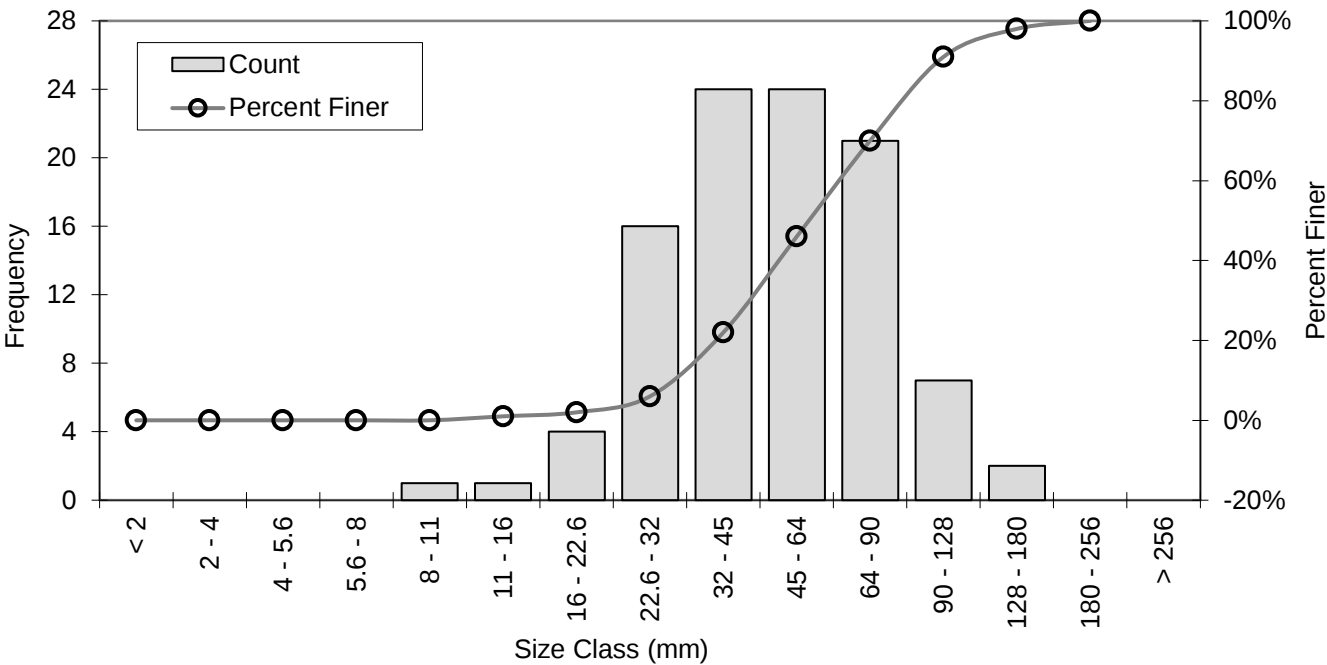


Photo KN9_transect_N.JPG



Distribution Statistic Points (Percent Finer)			
D_{16}	28.5	mm	
D_{50}	48.2	mm	
D_{84}	81.3	mm	
Assumes a linear interpolation			

Pebble Count Data			
Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2		0%
Very Fine Gravel	2 - 4		0%
Fine Gravel	4 - 5.6		0%
Fine Gravel	5.6 - 8		0%
Medium Gravel	8 - 11	1	0%
Medium Gravel	11 - 16	1	1%
Coarse Gravel	16 - 22.6	4	2%
Coarse Gravel	22.6 - 32	16	6%
Very Coarse Gravel	32 - 45	24	22%
Very Coarse Gravel	45 - 64	24	46%
Small Cobble	64 - 90	21	70%
Small Cobble	90 - 128	7	91%
Large Cobble	128 - 180	2	98%
Small Boulders	180 - 256		100%
Boulders	> 256		100%
Total		100	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	KM / Niko	Personnel
KN10	Identifier / Unit		Location		
Riffle / Bar Deposit	Longitudinal Description (<i>Pool, Riffle, Bend, Crossing, etc.</i>)	45.819665	Latitude or Northing		
Surface	Sample Type: Surface or Sub-surface	-122.62658	Longitude or Easting		
Gravel / Cobble	Dominant / Subdominant Substrate		Waypoint		



Notes

Transect crosses riffle goes up slope of bar, stops below top. New main channel alignment at downstream end of deltaic deposit

Photo

KN10_transect_E.JPG



Photo

KN10surfcount_Ref.JPG



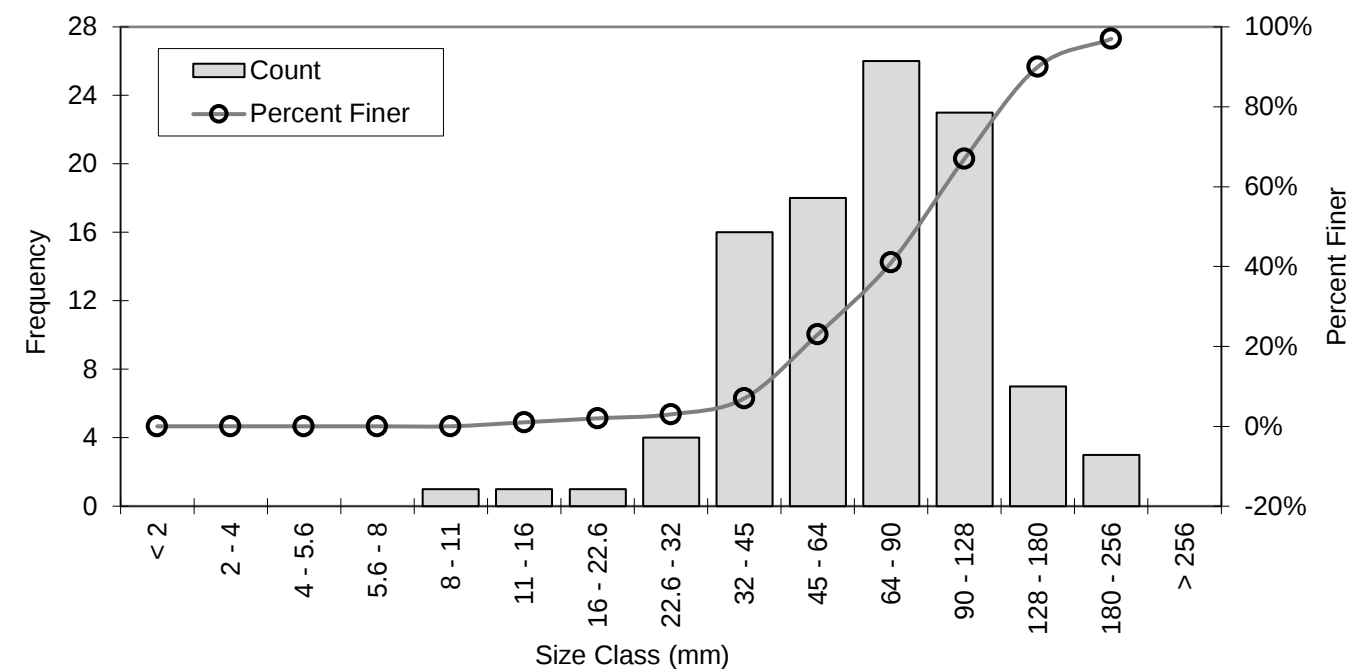
Distribution Statistic Points (Percent Finer)

D_{16}	39.3	mm
D_{50}	73.0	mm
D_{84}	118.1	mm

Assumes a linear interpolation

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2		0%
Very Fine Gravel	2 - 4		0%
Fine Gravel	4 - 5.6		0%
Fine Gravel	5.6 - 8		0%
Medium Gravel	8 - 11	1	0%
Medium Gravel	11 - 16	1	1%
Coarse Gravel	16 - 22.6	1	2%
Coarse Gravel	22.6 - 32	4	3%
Very Coarse Gravel	32 - 45	16	7%
Very Coarse Gravel	45 - 64	18	23%
Small Cobble	64 - 90	26	41%
Small Cobble	90 - 128	23	67%
Large Cobble	128 - 180	7	90%
Small Boulders	180 - 256	3	97%
Boulders	> 256		100%
Total		100	



Sediment Grain Size Analysis

EF Lewis River	Stream	10/18/2018	Date	KM / Niko	Personnel
JE1	Identifier / Unit		Location		
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing, etc.)	45.817832	Latitude or Northing		
Surface	Sample Type: Surface or Sub-surface	-122.623838	Longitude or Easting		
Cobble / Gravel	Dominant / Subdominant Substrate		Waypoint		



Notes

Coarse inundated riffle/bar unit, large redd upstream in tailout

Photo

field_6-20181018-215000.jpg



Photo

field_4-20181018-214854.jpg



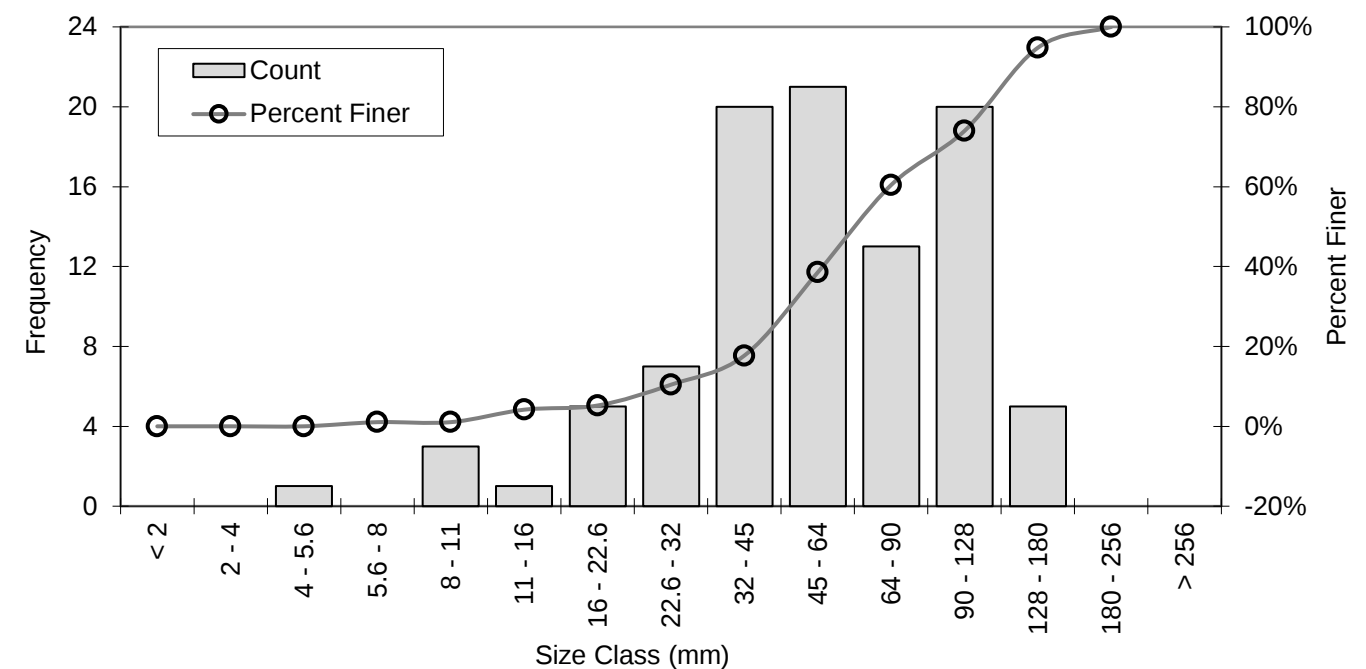
Distribution Statistic Points (Percent Finer)

D_{16}	29.8	mm
D_{50}	55.0	mm
D_{84}	108.3	mm

Assumes a linear interpolation

Pebble Count Data

Class (Wentworth)	Size Class (mm)	Count	Percent Finer
Sand	< 2		0%
Very Fine Gravel	2 - 4		0%
Fine Gravel	4 - 5.6	1	0%
Fine Gravel	5.6 - 8		1%
Medium Gravel	8 - 11	3	1%
Medium Gravel	11 - 16	1	4%
Coarse Gravel	16 - 22.6	5	5%
Coarse Gravel	22.6 - 32	7	10%
Very Coarse Gravel	32 - 45	20	18%
Very Coarse Gravel	45 - 64	21	39%
Small Cobble	64 - 90	13	60%
Small Cobble	90 - 128	20	74%
Large Cobble	128 - 180	5	95%
Small Boulders	180 - 256		100%
Boulders	> 256		100%
Total		96	



Bank Profile					
EF Lewis River		Stream	10/18/2018	Date	JE
BP1		Identifier / Unit	45.819611	Location	Personnel
Notes: Outside of bend in new avulsion at the top of the pits reach			-122.626694	Latitude or Northing	
				Longitude or Easting	
				Waypoint	

		Photo	field_6-20181018-220730.jpg
--	--	-------	-----------------------------

Profile Range (ft)	Description
4-14	nd /gravel with cobble
0-4	sand/gravel with cobble at surface

Photo field_4-20181018-220649.jpg



Bank Profile					
EF Lewis River		Stream	10/18/2018	Date	JE
BP2		Identifier / Unit		Location	Personnel
Notes: Outside of bend in new avulsion at the top of the pits reach, Upstream of BP1			45.819466	Latitude or Northing	
			-122.626459	Longitude or Easting	
				Waypoint	

Profile Range (ft)	Description
2-12	silt/sand w cobble and gr
0-2	cobble
4:1 slope of cobble at toe	

Photo field_5-20181018-221420.jpg



Photo field_6-20181018-221448.jpg



Photo field_4-20181018-221352.jpg



Bank Profile

EF Lewis River	Stream	10/18/2018	Date	JE	Personnel
BP3	Identifier / Unit	45.819741	Location		
Notes:		-122.625944	Latitude or Northing		
			Longitude or Easting		
			Waypoint		



Profile Range (ft)	Description
12-13	Fines / Gravel / Sand
9-12	Sand / Silt
5-9	Silt / Sand
0-5	Alluvium

Photo field_5-20181018-221856.jpg



Photo field_12-20181018-222201.jpg



Bank Profile

EF Lewis River	Stream	10/18/2018	Date	JE	Personnel
BP4	Identifier / Unit	45.819796	Location		
Notes:		-122.625783	Latitude or Northing		
			Longitude or Easting		
			Waypoint		



	Photo	field_4-20181018-222838.jpg	Photo	field_6-20181018-223331.jpg
--	-------	-----------------------------	-------	-----------------------------

Profile Range (ft)	Description
9.5-11	soil
7-9.5	silt / sand
4.5-7	gravel / silt / cobble
3.5-4.5	Cobble w/ gravel (old riffle?)
2-3.5	Alluvium
0-2	Alluvium (red from iron)



Photo field_12-20181018-223342.jpg



Bank Profile

EF Lewis River	Stream	10/18/2018	Date	JE	Personnel
BP5	Identifier / Unit	45.818971	Location		
Notes:		-122.625728	Latitude or Northing		
			Longitude or Easting		
			Waypoint		



Profile Range (ft)	Description
4-7	Sand / Silt
0-4	Gravel / Sand

Photo field_4-20181018-224851.jpg



Photo field_6-20181018-224930.jpg



Photo field_5-20181018-224913.jpg



Bank Profile					
EF Lewis River		Stream	10/18/2018	Date	JE
BP-KN3		Identifier / Unit	45.827254	Location	Personnel
Notes:			-122.632613	Latitude or Northing	
				Longitude or Easting	
				Waypoint	



			Photo	field_5-20181018-184741.jpg
--	--	--	-------	-----------------------------

Profile Range (ft)	Description
5-6	soil
0-5	alluvium

Photo [field_4-20181018-184732.jpg](#)



Bank Profile			
EF Lewis River	Stream	10/18/2018	Date
BP-KN4	Identifier / Unit	45.819796	Location
Notes:		-122.625783	Latitude or Northing
			Longitude or Easting
			Waypoint
		JE	Personnel



Profile Range (ft)	Description
5.5-7	soil
1-5.5	silt / sand w/ some cobble
0-1	alluvium

Photo field_4-20181018-185426.jpg



Photo field_5-20181018-185436.jpg



Bank Profile

EF Lewis River	Stream	10/18/2018	Date	JE	Personnel
PM1-Bank	Identifier / Unit	45.811775	Location		
Notes: Upper layer- all fines including sands and clays. Visual estimate of D50= 2.8 cm			Latitude or Northing		
Middle layer - fines and gravels. Visual estimate of D50 is 22cm (likely bimodal dist.)-	Toe	-122.598443	Longitude or Easting		
zone- gravels (coarser than middle layer)	Unconsolidated		Waypoint		



Profile Range (ft)	Description
6.5	upper layer- fines
3	middle layer- fines and gravels
6.5	toe- gravels

Photo PM1_Bank_1.jpg



Photo PM1_Bank_Close_LowerSubstrate.jpg



Photo PM1_Bank_Downstream.jpg



Bank Profile

EF Lewis River	Stream	10/18/2018	Date	Paul / Matt	Personnel
PM4-Bank	Identifier / Unit		Location		
Notes: <u>top layer</u> - all fines including sands and clays. Visual estimate of D50= 2.8 cm		45.815699	Latitude or Northing		
<u>bottom layer</u> - gravels. Visual estimate of D50 is 22cm (likely bimodal dist.)		-122.616793	Longitude or Easting		
cause for brown layer?		Unconsolidated	Waypoint		

Profile Range (ft)	Description
1.5- 2	Top Layer- fines
3	Bottom Layer- gravels and fines



Type	Sample ID	D16	D50	D84	RM
Sub-surface	PM1		2.9	6.3	16.4
Sub-surface	PM4		2.6	4.7	24.4
Sub-surface	PM5		2.0	3.8	17.1
Sub-surface	KN2	-70.1	#DIV/0!		-326.0
Sub-Surface	KN6		7.7	14.1	29.7
Sub-Surface	KN8		2.8	16.9	39.2
Surface	PM1-Surface		15.8	59.0	125.9
Surface	PM2-Surface		11.0	57.7	100.9
Surface	PM3-Surface		1.8	24.0	73.4
Surface	PM4-Surface		25.1	60.7	150.2
Surface	PM5-Surface		1.8	10.5	37.4
Surface	PM6-Surface		1.4	11.0	78.8
Surface	KN1		24.3	42.8	72.0
Surface	KN2		28.4	45.7	73.5
Surface	KN5		20.4	34.0	57.4
Surface	KN7		29.8	50.1	80.4
Surface	KN9		28.5	48.2	81.3
Surface	KN10		39.3	73.0	118.1
Surface	JE1		29.8	55.0	108.3
	KN3				7.265151515
	KN4				7.271969697

