

Nickerson Creek Trib No. 2 Stream Simulation Practicum

Nickerson Creek trib information provided in the following parts:

- 1) Nickerson Creek Trib background information
- 2) Exercises
- 3) Channel geometry and tailwater control cross section
- 4) Thalweg profile through crossing
- 5) Pebble count data
- 6) Watershed hydrology
- 7) Site topographic plan map
- 8) Site photos

PART 1 – Nickerson Creek Trib Background Information

Site history and aquatic organism passage concerns

Howland Hill Road is a gravel surfaced road in Jedidiah Smith State Park. At the crossing the road is approximately 24 feet wide. However, many portions of the road are as narrow as 14 feet due to large trees. The roadway parallels Nickerson Creek, and crosses over numerous small tributaries. The entire watershed is considered a pristine old growth redwood forest.

The road crosses Nickerson Creek Tributary No. 2. The crossing consists of a 48-inch diameter CMP with a rusted-through floor. The outlet is perched 1.0 feet above the downstream scour pool. The scour pool directly below the culvert outlet is up to 5 feet deep. Downed large wood is found throughout the channel and adjacent floodplain.

Existing fish passage needs at the crossing include adult and juvenile coho salmon and coastal cutthroat trout. Spawning and rearing habitat for adult and juvenile steelhead trout, coho salmon, and resident cutthroat trout is in good condition upstream.

Geomorphic Assessment

The channel upstream and downstream from the crossing has is gravel bedded and the profile is controlled in-part by wood forced steps. The channel gradient is general around 2 percent. The bed is relatively unarmored. Although there is a broad floodplain, the channel appears relatively entrenched in most locations. The channel appears very stable, with no signs of bank or bed instabilities. Wood controlled steps in the channel profile were rated for long-term stability as high, moderate, and low.

PART 2 – EXERCISE

A - Interpret geomorphic site data: planform, profile, channel geometry

1. Planform assessment

- a. Using the existing condition topo, consider the existing alignment of the culvert and channel. Is it good or poor? Why?

Alignment at the inlet is good for flow and debris conveyance. Downstream of outlet scour pool is a tight bend but it appears to be natural.

- b. What site conditions affect our ability to change alignment and project boundaries?

Large live snag on the east side of the road and large redwood tree on west side of road, but these are a ways from the crossing site

2. Longitudinal profile and cross-sections assessment

- a. Identify unique channel slope segments and calculate the average channel gradient of each segment.
- b. What are the primary grade controls for the channel? Where are they? Are they permanent or temporary?

Wood steps. Most are reasonably stable, except the ones just upstream of the culvert crossing. The moderately stable wood step downstream of the crossing may not persist for the service life of the replacement crossing.

- c. Identify any effects (e.g.; aggradation, degradation, scour, erosion, debris loading) due to the existing culvert and grade controls

Deep scour pool at culvert outlet created by high velocities discharging from culvert. The culvert does not appear to function as a knickpoint.

- d. What are the short- and long-term risks at the site associated with headcutting, lateral adjustment, vertical adjust

The channel may degrade at the crossing if the downstream “moderately stability” wood step fails/degrades. This would be a local adjustment to the channel. No large scale channel headcutting or lateral adjustments are anticipated.

B – Design profile and alignment

1. Set design profile and VAPs

- a. Select your preferred project design profile and draw it on the channel profile.

- b. Estimate the low and high vertical adjustment potential (VAP) profiles through the reach and draw them on the profile.

The low VAP profile was set based on pool bottom elevations and using the elevation of the “high stability” wood step at the downstream end of the profile.

High VAP profile was set based on the overall grade and the elevation of the gravel bar downstream of the outlet. Could also use the elevations of the top of streambanks to assist with setting the high VAP.

- c. What are the project profile bed elevations at each end of the culvert? What is the slope of the project profile?

Outlet at 85.1 ft, Inlet at 86.4 ft.
Culvert length = 62 ft, Culvert slope = 2.1%

- d. Do you expect to have to over-steepen the project profile relative to the overall stable channel slope?

No, the project profile is in-line with the overall profile.

- e. Will you need to add profile controls for the project?

Yes, it would be good to add some forcing features in the stream simulation bed that simulate the wood steps.

- f. Will Stream Simulation Approach be appropriate for this crossing? Why?

Yes, because the project profile matches the overall profile of the channel, there is good alignment between the crossing and upstream channel, and the channel is relatively entrenched, with the overbank areas conveying little to none of the streams flow.

- g. Describe characteristics of the desired reference reach. Is there a reach suitable as a reference reach shown on the thalweg profile?

2. Select project alignment

- a. Draw the alignment of the new crossing on the plan view sketches.
- b. Are there any special design considerations you would recommend for the transitions of the culvert to channel (inlet and outlet)?

C - Design bed shape, mix, key features, and bed/bank or edge structure

1. Channel geometry. Using the reference reach geometry, set the active channel bottom width, bankfull width, and bank heights.
ACW = 5 ft
BFW = 8 ft BFD = 1.5 ft
2. Bed material size.
Particle sizes were measured using a Wollman pebble count at locations upstream and downstream of the crossing.
 - a. Calculate and plot the particle-size distribution on the particle distribution graph form. From the graph, determine the D95, D84, and D50 particle sizes for the cross section.
 - b. Compare how the bed material sizes vary upstream and downstream of the crossing. Do they vary by much?
Downstream is much Coarser
3. Bed material design
 - a. Provide an initial recommendation for grain size mix of the alluvial portion of the stream simulation bed. Use the pebble count data for D50 and larger material. Use Fuller-Thompson equation for smaller material.

I used the Coarser Material Pebble Count from Downstream to add a factor of safety

D95 = 31 mm D84 = 28 mm D50 = 15 mm

D30 = 8.6 mm D15 = 4.0 mm D8 = 2 mm

D8 = $0.16^{1/n} \times D50 = 2 \text{ mm}$ $n = 0.91$ to make D8 = 2 mm

D15 = $0.30^{1/n} \times D50$ D15 = $0.30^{1/0.91} \times 15 \text{ mm} = 4.0 \text{ mm}$

D30 = $0.60^{1/n} \times D50$ D30 = $0.60^{1/0.91} \times 15 \text{ mm} = 8.6 \text{ mm}$

D - Stability Analysis for Bankline Rock and Forcing Features

1. Sizing key pieces

- a. Estimate the size of key pieces, such as banks, for the stream simulation channel.

- b. Chose design flow recurrence and discharge for stability analysis of the key pieces. What was your reasoning for selecting the specific design discharge?

Used Q100 = 118 cfs based on local streamflow gage data

- c. Calculate the size of material needed to remain stable at the selected design event using the USACE equation 3-5:

$$D_{30-ACOE} = \frac{1.95S^{0.555}1.25q^{\frac{2}{3}}}{g^{\frac{1}{3}}} \qquad q = \frac{Q_{channel}}{b}$$

b = channel bottom width (ft)

S = channel slope (ft/ft)

g = 32.2 ft/s²

b = 5 ft

S = 0.021 ft/ft (2.1%)

q = 118 cfs/5 ft = 0.74 cfs/ft

D30 = 0.74 ft

- d. What size material do you plan to use for the banklines and other key pieces? Will they be larger than calculated using the USACE equation? How does this affect the size of the structure for the site?

I'll upsize it to better construct banklines. I'll also use the rock to simulate the steps in the channel created by wood

E – Selection of Structure

1. Based on the design, what is your recommended minimum structure width?

2. From the vertical adjustment potential shown in the long profile and the bed material design, select the elevation of the floor of the culvert at the inlet and outlet.

3. Choose a preferred crossing structure type and dimensions for the project. Give consideration to:
 - Overall fit with channel width
 - Adequate cover over structure
 - Adequate embedment for bed thickness at the low vertical adjustment potential
 - Adequate width to construct streambanks
 - Debris passage
 - Constructability
 - Cost and longevity

4. Check the proposed structure hydraulic capacity using HY8 or FishXing software (if available). The tailwater cross-section is provided.
 - a. Is the headwater below the soffit at the selected capacity design flow ($HW/D < 1$)? How much freeboard is there (if any)?

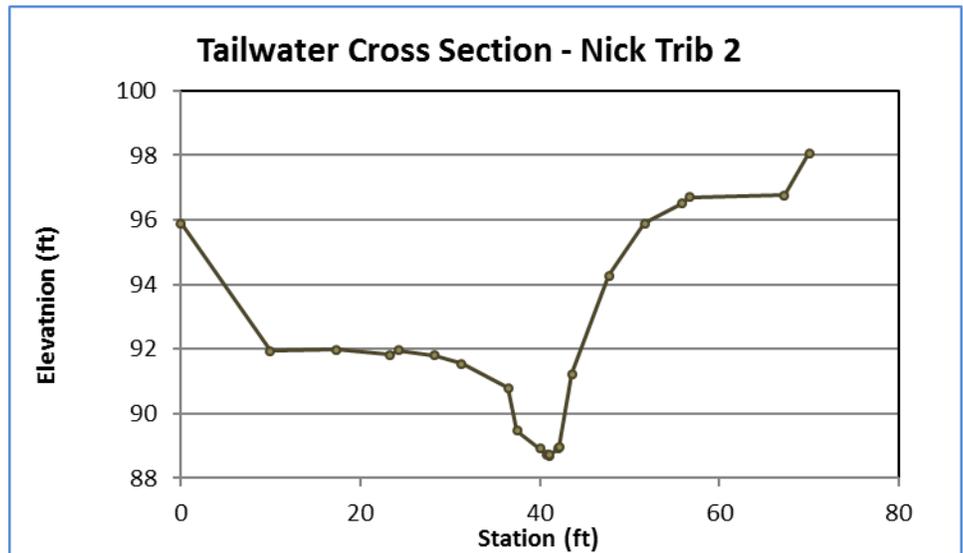
PART 3 – CHANNEL GEOMETRY AND TAILWATER SECTION

Measured hydraulic geometry of upstream channel

Location of Cross Section	Active Channel Width, feet	Bankfull Width, feet	Bankfull Depth, feet
Riffle (Submerged)	4.0	6.5	1.4
Riffle (U/S Pebble Count)	4.6	7.9	1.6
Riffle Tailout @ U/S end topo	4.5	6.5	1.9
Riffle transverse	7.0	9.5	2.0
Average:	5.0	7.6	1.7

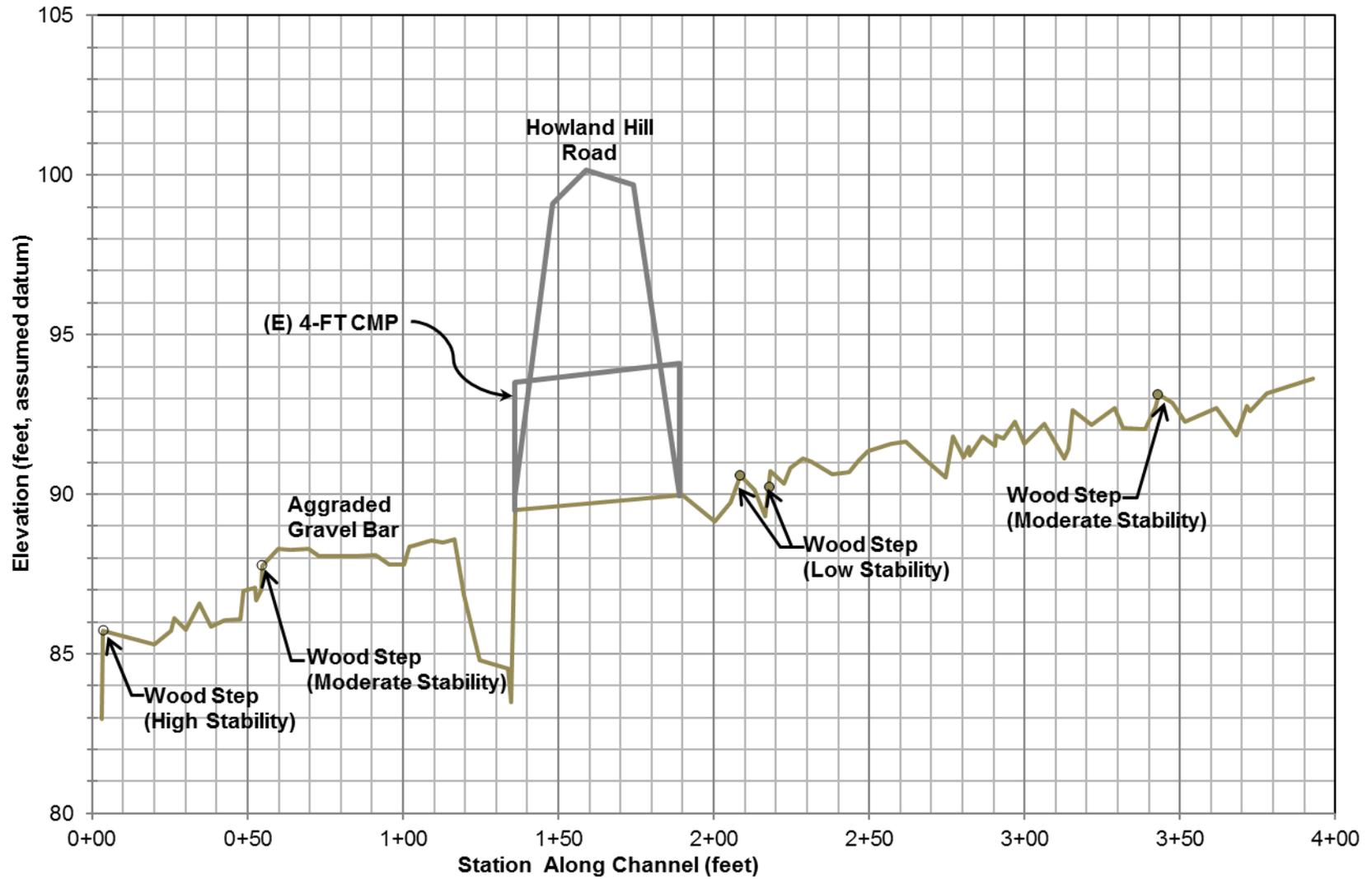
Tailwater Cross Section

Station	Elevation
0	95.9
10.0	91.9
17.3	92.0
23.3	91.8
24.3	91.9
28.3	91.8
31.3	91.5
36.4	90.8
37.5	89.5
40.0	88.9
40.8	88.7
41.0	88.7
41.1	88.7
42.1	88.9
42.1	88.9
43.6	91.2
47.7	94.3
51.7	95.9
55.8	96.5
56.7	96.7
67.2	96.8
70.0	98.1



PART 4 – THALWEG PROFILE THROUGH CROSSING

Nickerson Creek Tributary No. 2



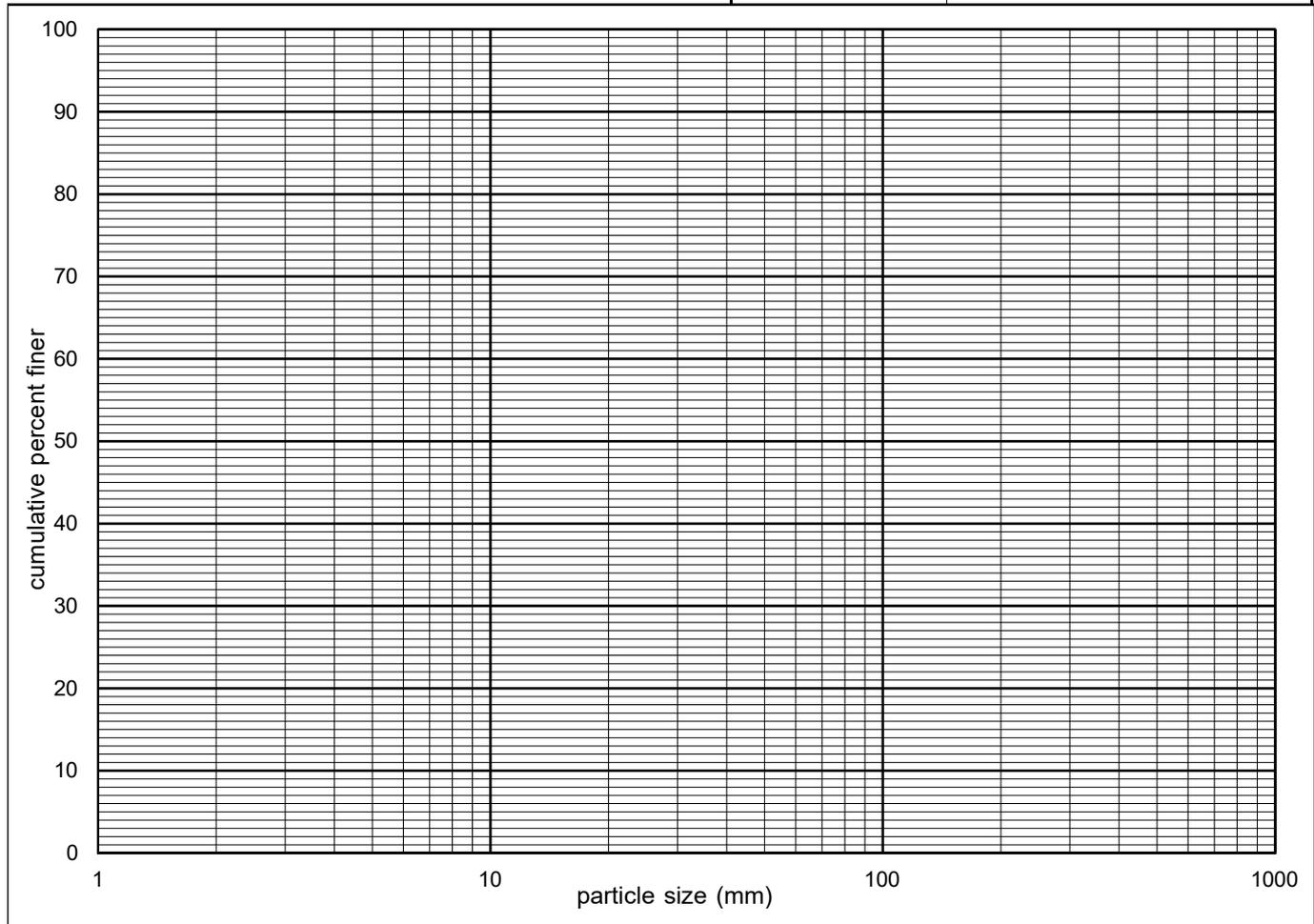
Nickerson Creek Tributary 2 - pebble count data, 0+30 (downstream)

particle size interval name	size interval (mm)	count or frequency	percent frequency	cumulative percent finer
medium boulders	512 to 724	0	0%	100%
	362 to 512	0	0%	100%
small boulders	256 to 362	0	0%	100%
	181 to 256	0	0%	100%
large cobbles	128 to 181	0	0%	100%
	90.5 to 128	2	2%	100%
small cobbles	64.0 to 90.5	5	5%	98%
	45.2 to 64.0	7	7%	93%
very coarse gravel	32.0 to 45.2	5	5%	86%
	22.6 to 32.0	6	6%	81%
coarse gravel	16.0 to 22.6	8	8%	75%
	11.3 to 16.0	23	23%	67%
medium gravel	8.0 to 11.3	8	8%	44%
	5.7 to 8.0	16	16%	36%
fine gravel	4.0 to 5.7	7	7%	20%
	2.8 to 4.0	5	5%	13%
very fine gravel	2.0 to 2.8	0	0%	8%
sand, silt, or clay	< 2	8	8%	8%
Total count		100	100	

Project Name:	Nickerson Creek Tributary 2
Sample ID:	Downstream of Crossing, 0+30
Sample Date:	1/10/2012
Sampler Name:	Shea
Sample Locaton:	Riffle upstream of log step
Sample Method:	Wollman Pebble Count

percentile	particle size (mm)
d95	
d84	
d50	
d16	
d5	

Sample site descriptions by observation	
Channel type	
D100 (inches)	
Colluvium	
Debris	



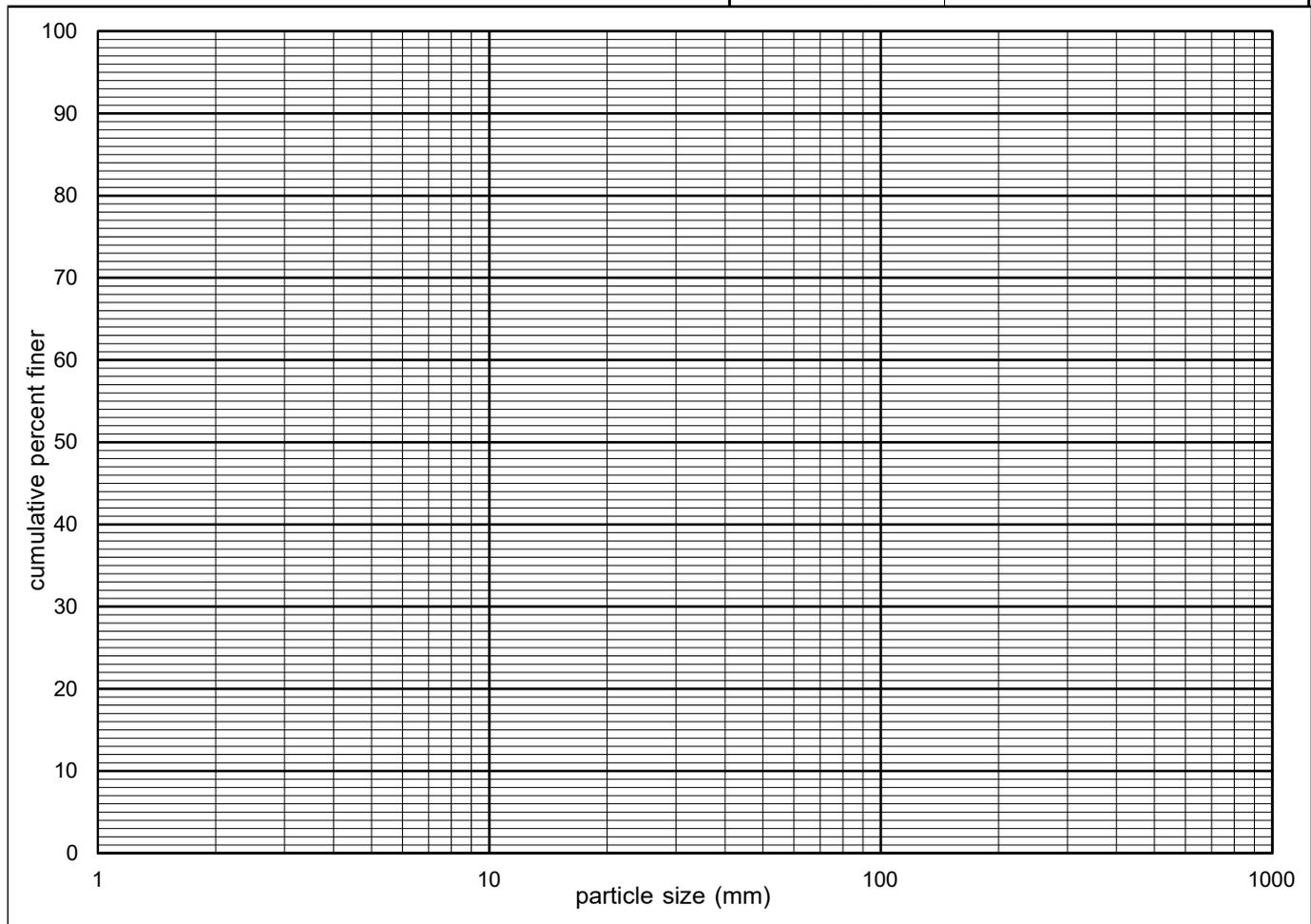
Nickerson Creek Tributary 2 - pebble count data, 3+00 (upstream)

particle size interval name	size interval (mm)	count or frequency	percent frequency	cumulative percent finer
medium boulders	512 to 724	0	0%	100%
	362 to 512	0	0%	100%
small boulders	256 to 362	0	0%	100%
	181 to 256	0	0%	100%
large cobbles	128 to 181	0	0%	100%
	90.5 to 128	0	0%	100%
small cobbles	64.0 to 90.5	0	0%	100%
	45.2 to 64.0	3	3%	100%
very coarse gravel	32.0 to 45.2	0	0%	97%
	22.6 to 32.0	35	35%	97%
coarse gravel	16.0 to 22.6	4	4%	62%
	11.3 to 16.0	22	22%	58%
medium gravel	8.0 to 11.3	7	7%	36%
	5.7 to 8.0	15	15%	29%
fine gravel	4.0 to 5.7	1	1%	14%
	2.8 to 4.0	4	4%	13%
very fine gravel	2.0 to 2.8	6	6%	9%
sand, silt, or clay	< 2	3	3%	3%
	Total count	100	100	

Project Name:	Nickerson Creek Tributary 2
Sample ID:	Upstream of Crossing 3+00
Sample Date:	1/10/2012
Sampler Name:	Shea
Sample Locaton:	Riffle upstream of log step
Sample Method:	Wollman Pebble Count

percentile	particle size (mm)
d95	
d84	
d50	
d16	
d5	

Sample site descriptions by observation	
Channel type	
D100 (inches)	
Colluvium	
Debris	



PART 6 – HYDROLOGY

Peak Flow Calculation Summary Nickerson Creek Trib No. 2 at Howland Hill Road

Method	Q-1.5yr (cfs)	Q-2yr (cfs)	Q-5yr (cfs)	Q-10yr (cfs)	Q-25yr (cfs)	Q-50yr (cfs)	Q-100yr (cfs)
Nearby Stream Gaging Records ¹	16	21	37	51	73	93	118
North Coast Regional Regression Equations ²		50	80	109	143	175	197
Crescent City Flood Study ³		25		40	58	78	108
¹ USGS, 1982							
² Estimates using regional regression equations developed for the North Coast Region of California by the USGS (Waananen and Crippen, 1977). $Q_{2-yr} = 3.52 A^{0.90} P^{0.89} H^{-0.47}$ $Q_{5-yr} = 5.04 A^{0.89} P^{0.91} H^{-0.35}$ $Q_{10-yr} = 6.21 A^{0.88} P^{0.93} H^{-0.27}$ $Q_{25-yr} = 7.64 A^{0.87} P^{0.94} H^{-0.17}$ $Q_{50-yr} = 8.57 A^{0.87} P^{0.96} H^{-0.08}$ $Q_{100-yr} = 9.23 A^{0.87} P^{0.97}$ A (drainage area) = 0.224 mi ² H (mean elevation of main channel (1000-ft). If less than 1000 ft, H = 1) = 1 P (mean annual precipitation) = 90 in/yr							
³ Estimates using peak discharge-area-recurrence interval relationships developed for lowland forest, presented in "Flood Drainage Study for an Area North of Crescent City, Del Norte County - Volume 1" (CH2M Hill, 1978). Fig 4-4							

Nickerson Creek Tributary No. 2



Roadway (upstream on right)



Culvert outlet



Downstream channel approximately 0+75



Upstream channel wood step at 3+43



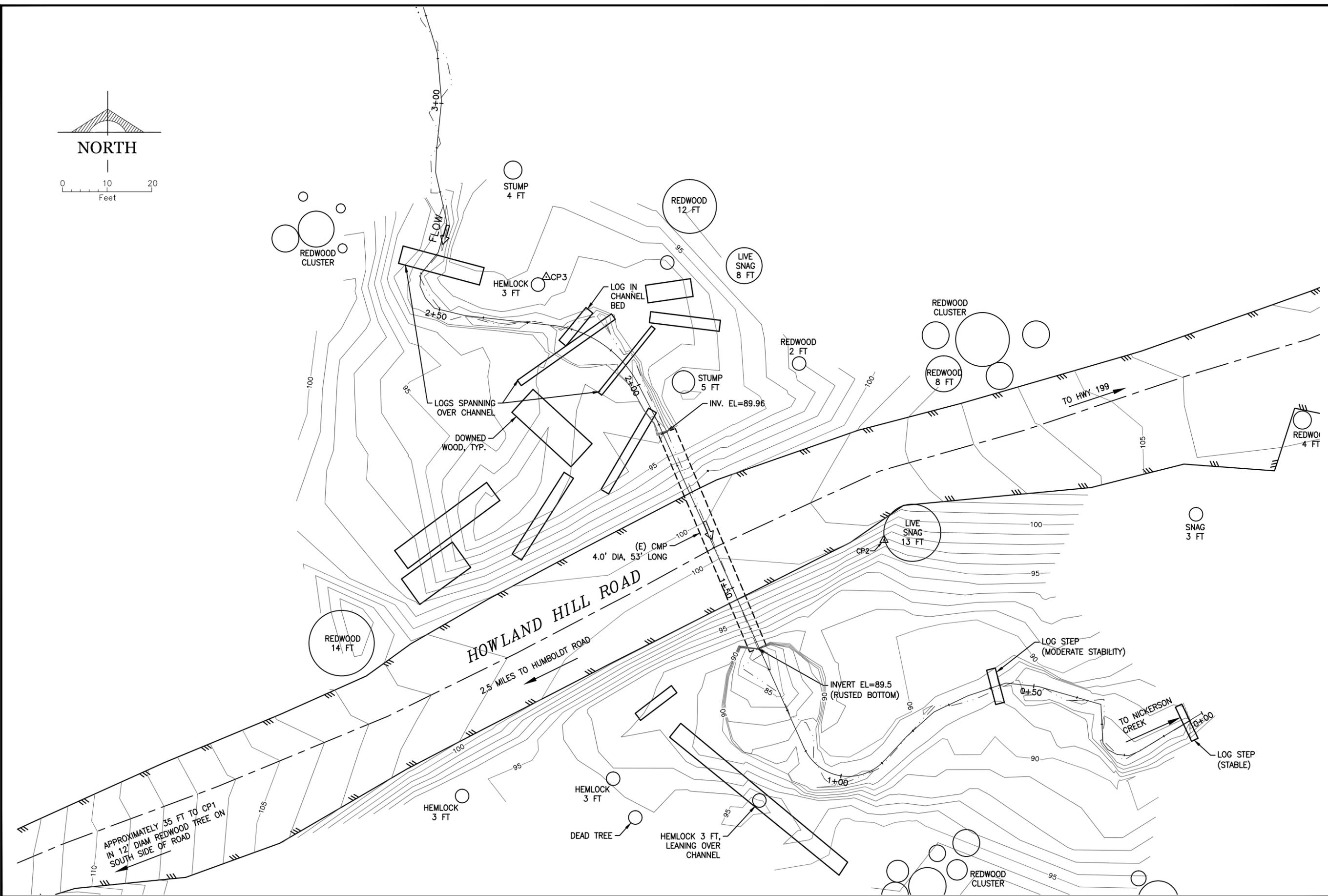
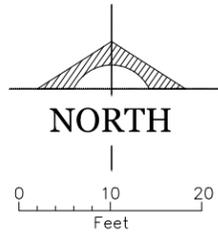
Upstream channel reference reach



Log step at downstream limit of survey



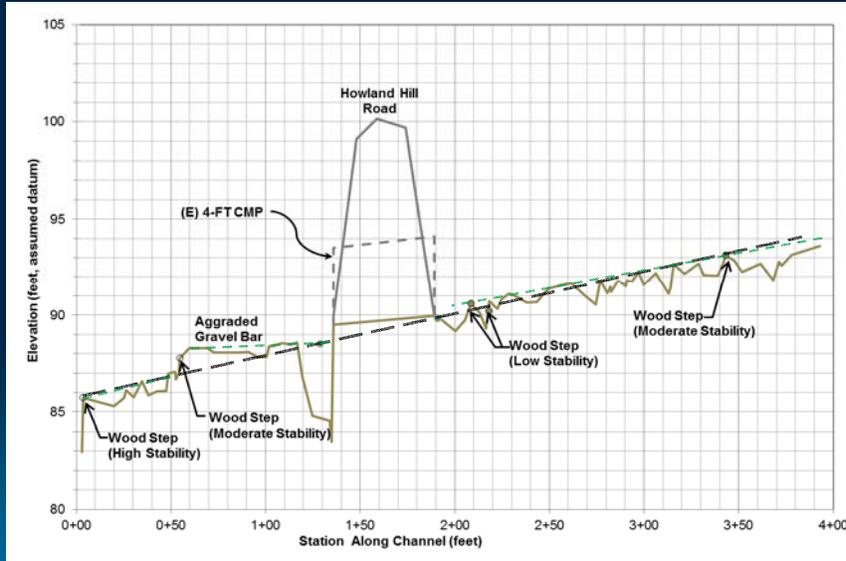
Log step in upstream channel



Michael Love & Associates, Inc. PO Box 4477 • Arroyo, CA 95518 (707) 822-2411	
NICKERSON CREEK TRIBUTARY No. 2 CROSSING REPLACEMENTS	
TRIB NO 2 EXISTING CONDITIONS	
DATE	APR. 2015
SUBMITTAL	
DESIGN	
DRAWN	AL / NN
SHEET	

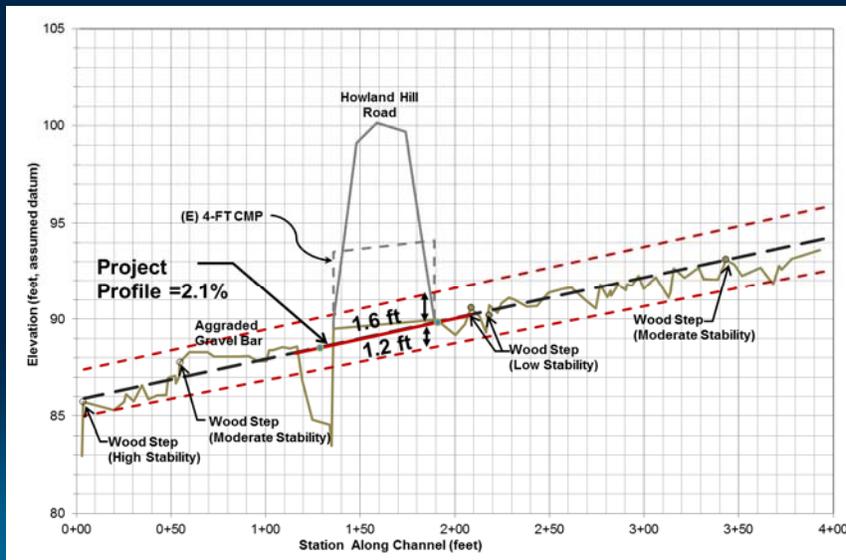
Nickerson Creek

Setting the VAP Profiles and Design Profile

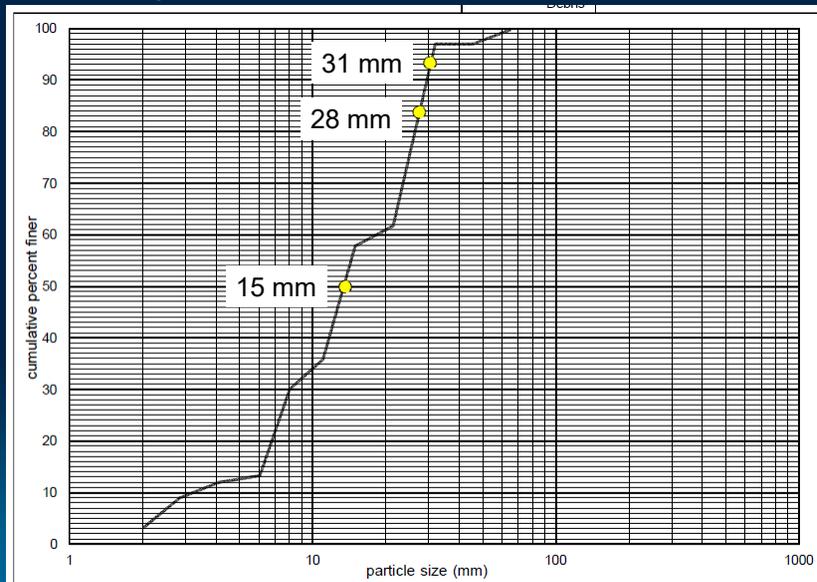


Nickerson Creek

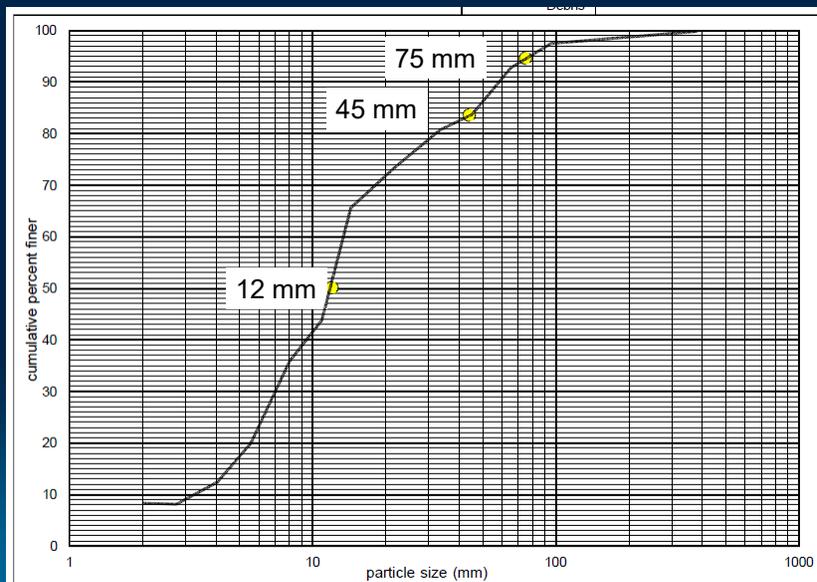
Setting the VAP Profiles and Design Profile



Nickerson Creek Upstream Pebble Count Gradation

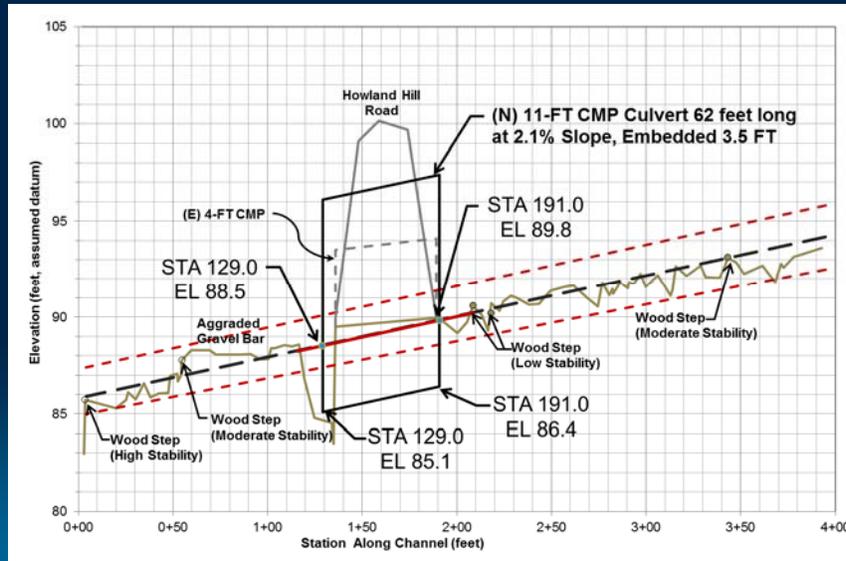


Nickerson Creek Downstream Pebble Count Gradation



Nickerson Creek

Setting the VAP Profiles and Design Profile



Nickerson Creek

Loading the Bed



Nickerson Creek
Bed and Banks Built



Nickerson Creek
Post-construction Monitoring



Nickerson Creek

2-years after construction

