

Race Lagoon Tributaries Crossing Race Road Fish Passage Culvert Replacement for Culverts 1893 and 1894; RCO 22-1089

Basis of Design, Hydraulics, HECRAS Analysis Report

Preliminary Design Complete Revisions

2-14-2024



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The technical material and data contained in this report were prepared under the supervision and direction of the undersigned, whose seal as a professional engineer licensed to practice as such in the State of Washington, are affixed below.



2-14-2024

Jay S. Kidder, P. E.

Civil Engineer
and Fisheries Biologist

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Table of Contents

Page Number

1. Introduction.....	6
Purpose of the Basis of Design Report	6
Project Goals	7
Site Description.....	7
2. Hydrology and Hydraulics	12
Hydrology at the two stream crossings	14
Established Culvert Width.....	14
Pebble Count at Site Reach.....	15
3. Hydraulic Modeling for the crossing sites.....	19
Q 100 Flood Hydraulic Characteristics.....	20
5. Construction Costs	25
6. References.....	28
7. Appendices.....	30
Appendix A stream simulation memo by Chinook Engineering.....	31
Appendix B Conceptual Alternative Designs.....	100

List of Figures

	Page Number
Figure 1 Vicinity map.	8
Figure 2 Race Lagoon estuary below Culvert West 1893.	8
Figure 3 The inlet of the Eastern culvert looking downstream.	9
Figure 4 The inlet of the Western culvert looking downstream.	10
Figure 5 The outlet of the Western culvert.	11
Figure 6 Preliminary width calculations for the east culvert.	12
Figure 7 Preliminary width calculations for the West culvert.	13
Figure 8 Race Lagoon Tributary 1893, pebble count data at the road crossing site showing the D5, D15, D84, D95 % finer diameters. This clearly shows a clayey silt base to the stream bed with fine gravel present locally in the riffle reaches.	15
Figure 9 Race Lagoon Tributary 1893, sediment distribution curve at the road crossing site. Showing the clayey silt base to the stream bed.	16
Figure 10 Race Lagoon Tributary 1894 East, pebble count data at the road crossing site showing the D5, D15, D84, D95 % finer diameters. This clearly shows a clayey silt base to the stream bed.	17
Figure 11 Race Lagoon Tributary 1894, sediment distribution curve at the road crossing site. Showing the clayey silt base to the stream bed.	18
Figure 12 HECRAS output for Culvert West 1893, showing the 100 year water surface elevation in light blue.	21
Figure 13 HECRAS output profile of water surface for the 100 year return interval at the Culvert East 1894.	23
Figure 14 Summary of estimated construction costs for the Race Lagoon Road crossings.	25
Figure 15 Construction cost estimate West 1893 culvert crossing at Race Lagoon.	26
Figure 16 Construction cost estimate East 1894 culvert crossing at Race Lagoon.	27

List of Tables

Table 1 Stream flows shown for each culvert and return intervals
used in the HECRAS Modeling and Fish Xing Modeling. 19

Table 2 HECRAS tabular output for Culvert West 1893 for 100
year and 2 year return intervals. 22

Table 3 HECRAS tabular output for the Culvert East 1894 for the
100 year and 2 year return intervals. 24

1. Introduction

Purpose of the Basis of Design Report

This Basis of Design Report, BOD Report, is prepared and revised to set the goals for the restoration of fish passage at the subject site. It presents solutions for the Race Lagoon Crossings.

Purpose of the BOD Report: The BOD Report serves as a critical document that outlines the foundational principles and objectives for the restoration of fish passage at the project site. It essentially sets the goals and guidelines for the entire project.

Development Phases: The BOD Report is prepared and revised at several key phases of the project, including the 30% and 60% design completion phase. At the 60% design completion phase, the report presents final solutions for addressing the road crossing fish passage issue, which is the key aspect of ensuring fish passage.

Iterative Nature: The report is described as "iterative," meaning that it evolves and is updated throughout the project's lifecycle. This is because, as the project progresses through different phases like Preliminary Design, Final Design, and As Built Record, new information becomes available, and adjustments may be needed to achieve the project's goals effectively.

Preliminary Design: During the Preliminary Design phase, the report undergoes further refinement as more detailed information is gathered and analyzed for the preferred solution. This phase often involves the development of more concrete plans and specifications.

Final Design: In the Final Design phase, the report is finalized with specific engineering details, construction plans, and materials specified. It ensures that the project is ready for implementation.

As Built Record: After the project is constructed, the BOD Report continues to be relevant during the As Built Record phase. Any changes or variations from the original design are documented here, providing a historical record of what was actually built.

In summary, the BOD Report is a dynamic and essential document that guides the restoration of fish passage at the project site. It outlines project goals, presents various design concepts, and evolves through multiple phases of the project, from initial planning to final construction, to ensure that the objectives are met effectively and that changes are documented for future reference.

This basis of design report has been revised to the Preliminary Design submittal phase.

Project Goals

The Skagit Fisheries Enhancement Group and Island County Public Works are working to replace two fish barrier culverts, culvert 1893 and 1894, under Race Road near Coupeville, WA and a private crossing immediately downstream of Culvert #1894.

Removal of these fish passage barriers will open up critical rearing habitat for juvenile salmonids including ESA-listed Threatened Chinook as well as pink, coho, and chum salmon. These two coastal streams drain to Race Lagoon which has been identified as important pocket estuary habitat for out-migrating salmon from the Skagit, Stillaguamish, and Snohomish Rivers. Pocket estuaries and small coastal streams such as these provide important feeding, resting, and refuge habitat as juvenile salmon transition from freshwater to saltwater habitat.

These culverts were identified during the Culvert Prioritization Inventory conducted by SFEG and Island County during which time a Chinook smolt was found in the stream above culvert #1893. In addition, SFEG has been working with local landowners who are open to additional wetland and riparian restoration upstream of these culverts as a future project. This grant would fund the design of two fish passable structures at culverts 1893 and 1894, and the design of a small bridge crossing and channel meander immediately downstream of culvert 1894 to enhance fish passage. Fish passage barrier removal is one of the most rapid and cost-effective ways of increasing the amount of accessible habitat for salmon. Alternatively, the small private culvert crossing may be removed, the stream restored at that location, and an alternative access from Race Road property will be considered.

Excerpted from project goals on PRISM.

Site Description

The site is located on the eastern side of Whidbey Island in Island County, Washington. Race Road travels across two small ephemeral tributaries to Race Lagoon adjacent to Saratoga Passage in the Salish Sea. The pocket lagoon has been identified as a primary location for refuge and rearing habitat for Chinook salmon.

Race Road at this site runs east and west. The 2 culverts are approximately 500 feet apart from each other and are oriented in opposite skewed orientations to the road.

Each culvert is a corroded corrugated metal pipe formed from galvanized steel. The

West culvert, 1893, is deformed and approximately 30 inches in diameter. The east culvert, 1894, is corroded and 24 inches in diameter.

Both culverts are partial barriers to fish passage. A small amount of bed material has Elevation.

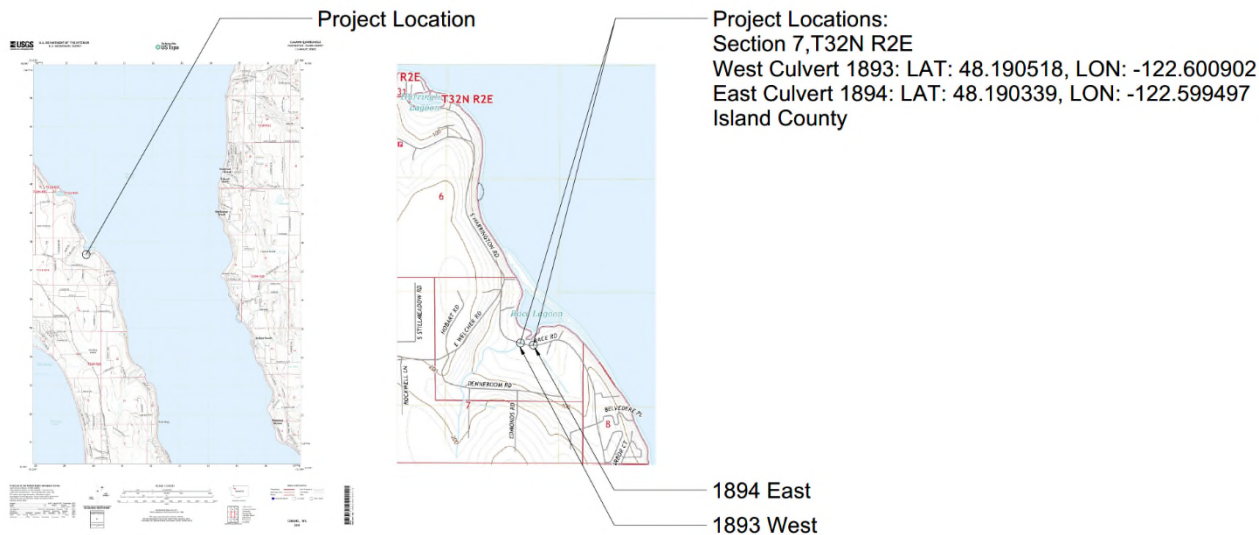


Figure 1 Vicinity map.



Figure 2 Race Lagoon estuary below Culvert West 1893.



Skagit Fish Enhancement Group; Race Lagoon Passage - Culverts #1893 & 1894 (#22-1089)
Attachment #500189, 1894 US Inlet (2).jpg

Figure 3 The inlet of the Eastern culvert looking downstream.



Figure 4 The inlet of the Western culvert looking downstream.



Skagit Fish Enhancement Group; Race Lagoon Passage - Culverts #1093 & 1884 (#22-1089)
Attachment #500187, 1893 DS Outlet (2).jpg

Figure 5 The outlet of the Western culvert.

2. Hydrology and Hydraulics

The initial design of the subject culverts is based on the Washington Department of Fish and Wildlife, WDFW, stream simulation conceptual geometry with a hydraulic design verification.

The BFW dimensions in this reach are as shown in the simple calculator following in the figure below which calculates a draft proposed culvert size or bridge span based on the stream width and using initially the Washington Department of Fish and Wildlife stream simulation and the side slopes beneath a bridge.

Race Road 1894 East Smaller			Culvert Geometry				Bridge Geometry					
			Culvert Stream Simulation Width	Additional Width Conditions for debris	Culvert Span Chosen	Use this Culvert Span	Depth to Cr invert from bot cord of bridge	Stream Bottom Width required	Side Slopes	Skew Angle	Span with no Skew	Bridge Span Length with Skew
US	Site	Bankfull width Measurements, feet	Average Bankfull width									
		6.5										
		6										
		5.5										
		10										
		12										
		12										
		13										

Figure 6 Preliminary width calculations for the east culvert.


Race Road 1893 West Larger			Culvert Geometry				Bridge						
Site	Bankfull width Measurements, feet	Average Bankfull width	Culvert Stream Simulation Width	Additional Width Conditions for debris	Culvert Span Chosen	Use this Culvert Span	Depth to Cr invert from bot cord of bridge	Stream Width required	Side Slopes	Skew Angle	Bridge Span with no Skew	Bridge Span Length with Skew	
Up stream	6 7.5 10.5 15 14 14												
													
Up stream			11.2	15.4	1.5	16.9	3	7.5	2.5	0	22.5	23	
	5 6 5.5 7 10.5												
	BFWc Grand Average		9.0										
			Climate Change Factor Adjusted Span				1.07						
Downstream			6.8	10.2	1.5	11.7	3	7.5	2.5	0	22.5	23	

Figure 7 Preliminary width calculations for the West culvert.

Given the geometry proposed, and including later described adjustments for climate change in the year 2080, the calculated culvert spans for the Eastern culvert and the Western culvert are 12.5 feet and 14 feet respectively.

Hydrology at the two stream crossings

The following section describes the hydrology of the subject reach and is based on the work by , Mastin, M.C., 2016, etal for ungaged catchments in Washington using regression analysis. In addition basin characteristics were delineated and reported using the USGS Streamstats on line software for that purpose, Version 4..

Due to unforeseen changes in the flow rates in the upper areas of the watershed upstream and required climate change scenarios from WDFW, the Washington Department of Fish and Wildlife document, WDFW, Incorporating Climate Change into the Design of Water Crossing Structures, 2016, the design flow rate value is calculated to be Q design with climate change 100 year event equal to Qd100cc East = 7.5 cfs and the Qd100 cc West = 14 cfs.

See the Hydrology section in the appendix for details.

Established Culvert Width

The USGS Stream Stats program referenced above estimates an average bankfull channel width of 8.0' and 10.5' respectively for culverts east and west, 1894 and 1893, (but notes that the parameters are outside of the suggested range and were extrapolated).

Then by using the WDFW Climate Change Model for channel width recommends an 7 percent increase in channel width for the 2080 timeframe at the site which increases the width to 8.56 feet and 11.2 feet respectively for the two culverts. During preliminary design for stream simulation methods this will require a culvert span of approximately 12.5' and 14'.

During the final design phase, a refined measurement and determination of the bank full width shall be completed. However, currently design is proceeding with these dimensions, and the preliminary design drawings reflect that.

The culvert material has been chosen as a concrete box culvert. The concrete sections will contain keyways and weldments and be placed on a compacted subgrade of gravel, and the stream simulation streambed will be constructed within the upturned U shaped precast concrete sections, upon completion of the stream bed construction the concrete traffic lids will be placed on the top, and the road fill will be compacted around the structure. After that the road will be constructed and replaced with asphalt surfacing.

Pebble Count at Site Reach

The following figure describes the pebble count sizing for the reaches at the two Race Lagoon tributary crossings. This pebble count describes the stream bed characteristics along a stream profile of approximately 600 lineal feet and was determined during the survey of the stream reach.

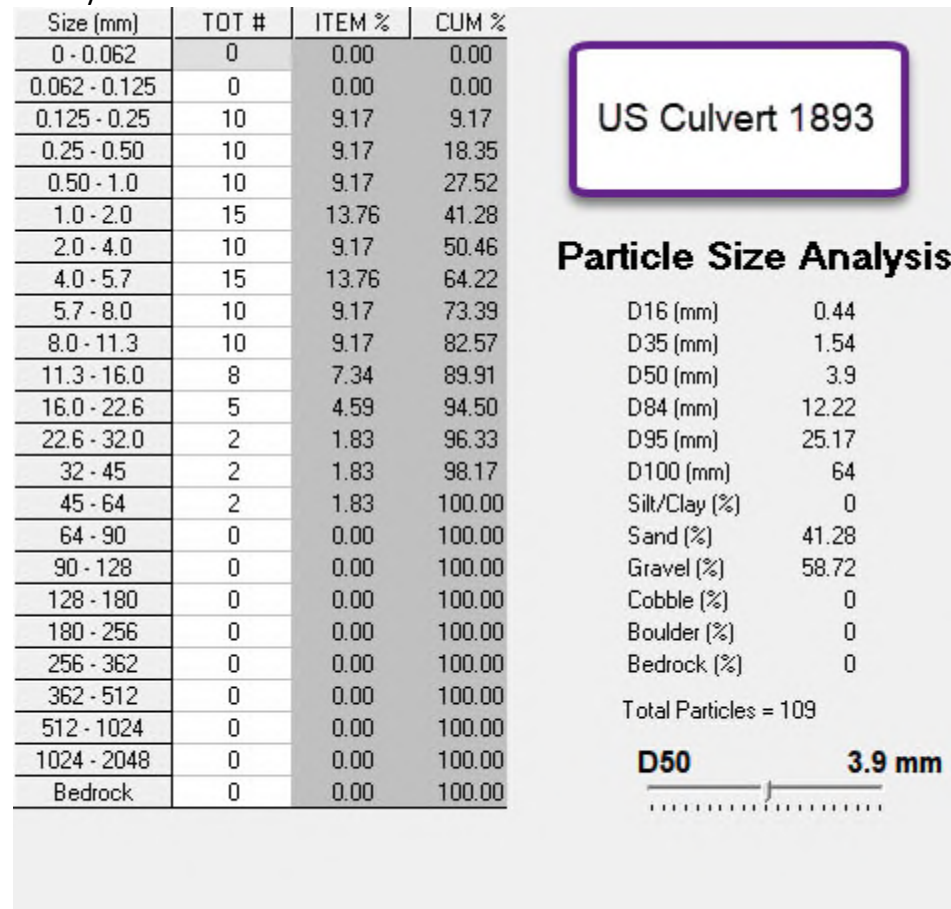


Figure 8 Race Lagoon Tributary 1893, pebble count data at the road crossing site showing the D5, D15, D84, D95 % finer diameters. This clearly shows a clayey silt base to the stream bed with fine gravel present locally in the riffle reaches.

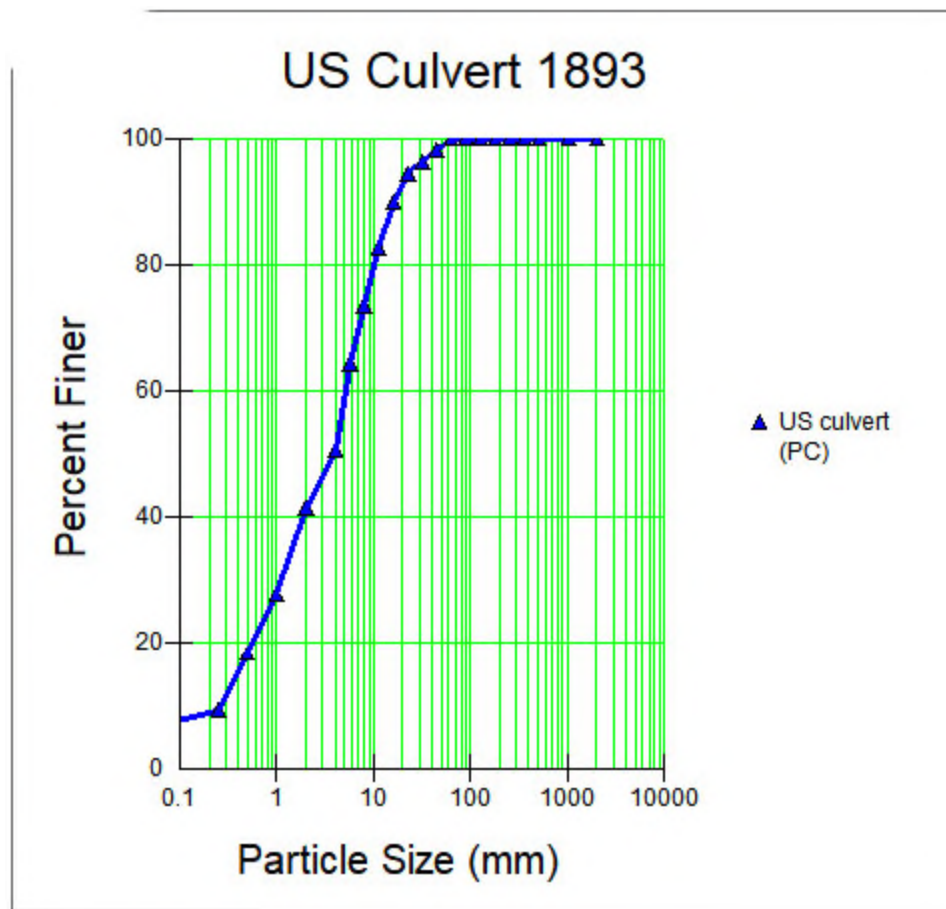


Figure 9 Race Lagoon Tributary 1893, sediment distribution curve at the road crossing site. Showing the clayey silt base to the stream bed.

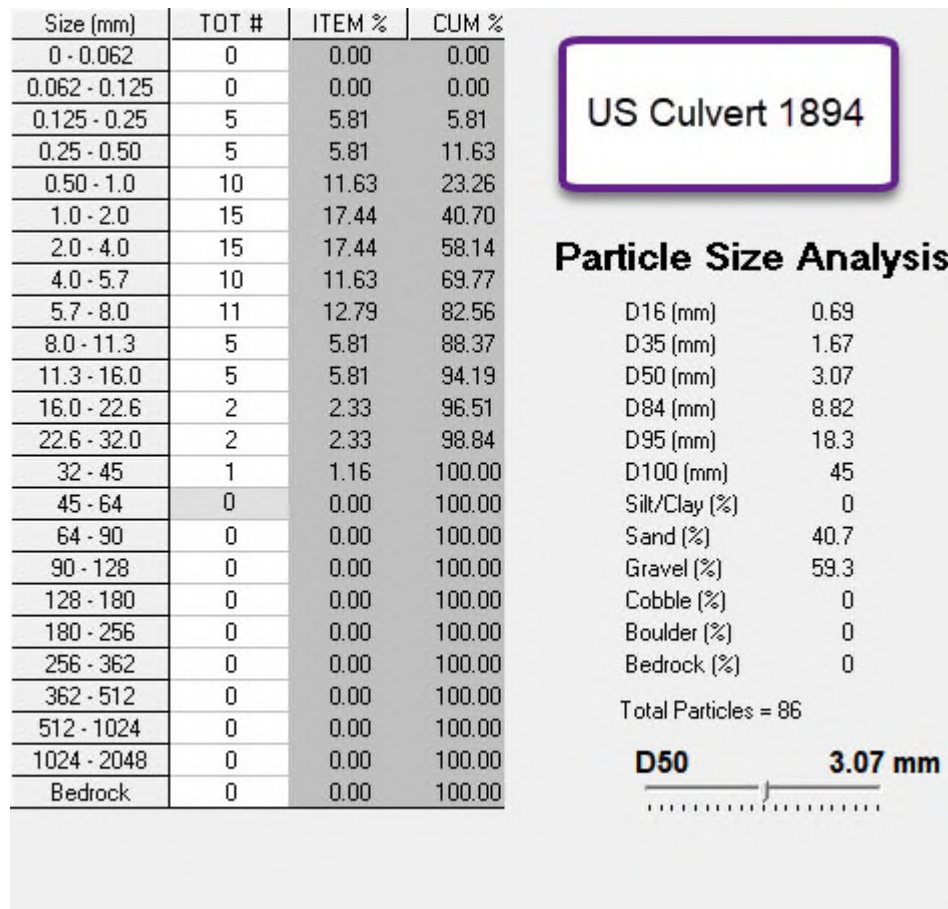


Figure 10 Race Lagoon Tributary 1894 East, pebble count data at the road crossing site showing the D5, D15, D84, D95 % finer diameters. This clearly shows a clayey silt base to the stream bed.

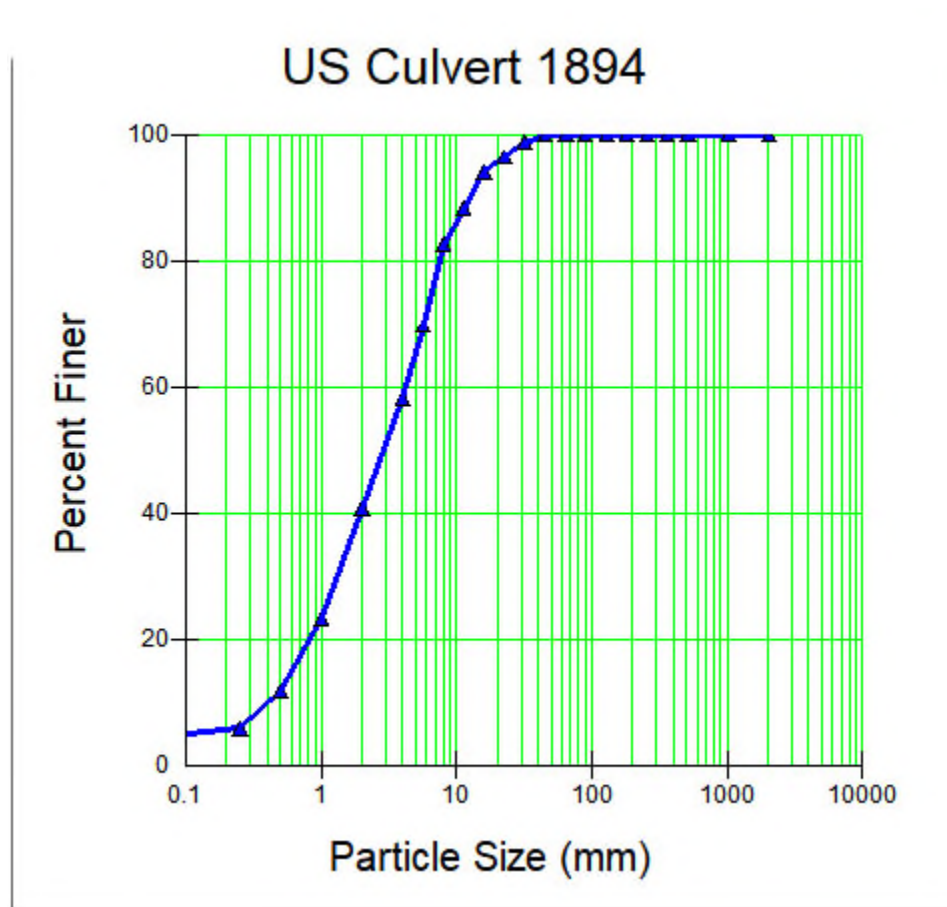


Figure 11 Race Lagoon Tributary 1894, sediment distribution curve at the road crossing site. Showing the clayey silt base to the stream bed.

3. Hydraulic Modeling for the crossing sites

Preliminary design hydraulic modeling was performed for the design of the stream crossings with an assumed low flow channel constructed in the stream simulation streambed of each culvert. A one-dimensional HEC-RAS model was prepared for this cross section and used to determine the water surface elevations, water velocities, Froude number, and stream energy values for tractive force evaluations and scour depths.

Flow contraction at the cross section as shown is not present due to the constructed size of the 2 culverts at the 2 tributaries.

Channel bed widths have been established in preliminary design initially by the WDFW stream simulation method established for culvert crossings. The bed width is established at 14' and 12.5' for a stream simulation approach design and the resultant construction contract documents will show the stream bed width as approximately this dimension. The ordinary High-Water Line, OHWL event, or Q 2-year return with climate change flow rate is noted to be 2 cfs and 8 cfs respectively in the East and West culverts. A low-flow stream shape will be incorporated into both the stream crossings at culvert East and West.

The following table was used to calculate and model the stream geometry in the HEC-RAS and in the U.S. Forest Service, USFS, Fish Xing software application shown in the appendix.

Name of Culvert	Return Interval (years)	Flow Rate (cfs)
Culvert West 1893	2	3.72
Culvert East 1894	2	1.99
Culvert West 1893	100	14
Culvert East 1894	100	7.5

Table 1 Stream flows shown for each culvert and return intervals used in the HECRAS Modeling and Fish Xing Modeling.

Site characteristics for the proposed culvert sites have been evaluated for tractive force and scour potential of sediment within the culvert and will result in the governing sizes of the gradation of streambed sediments within the culvert. This will be modeled using a triangular channel cross section with a low flow channel.

See the following screen shots for the results to HEC-RAS calculations. The stream cross section below the bridge is shown and then the resultant calculation follows.

The road cross section for each tributary is shown and is shown wrapped around the upstream face of each of the culverts in the screenshots. Note the exaggerated vertical scale.

The model includes the approximation for climate change of an additional 1.5 feet above the mean high higher water, MHHW, elevation for the highest estimated tide at Race Lagoon. The MHHW elevation is noted to be 9.05 feet NGVD88 plus an additional 1.5 feet provides the estimated elevation of the high tide in race Lagoon in the year 2080, with a 50% chance of occurrence, to be 10.55 feet. This elevation was used in the HECRAS model to consider if a tidal influence occurred at the culvert crossings. Also, whether or not a tidal prism inundated the far side of the road crossing into the upstream fields to the south.

The modeling indicates that no tidal prism crosses the road at either of the culvert crossings. However, Culvert West 1893 west shows a backwater characteristic due to the future high tides at the high flow 100 year return occurrence.

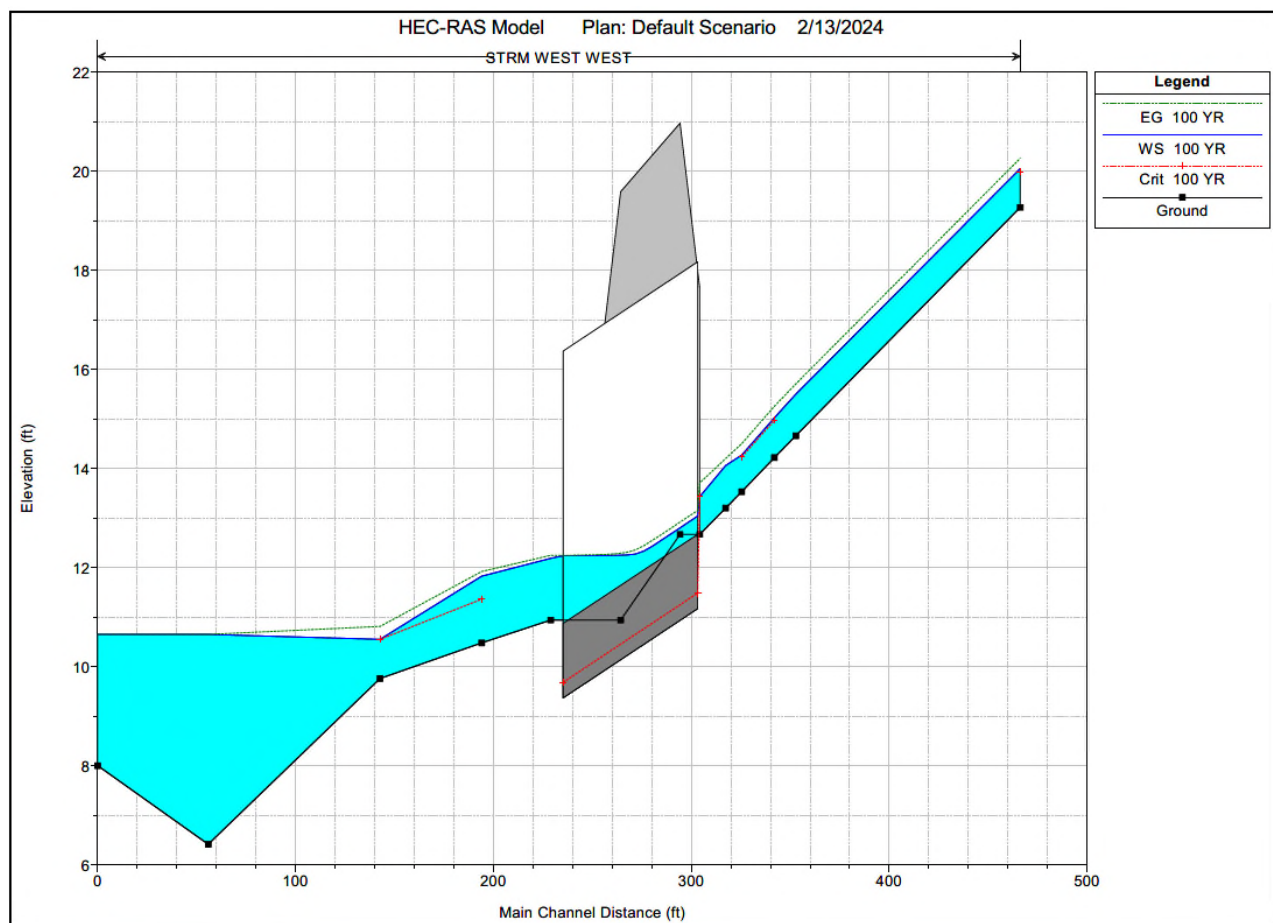


Figure 12 HECRAS output for Culvert West 1893, showing the 100 year water surface elevation in blue.

HEC-RAS Plan: Default Scenario River: STRM WEST Reach: WEST

Reach	River Sta	Profile	Q Total	W.S. Elev	Crit W.S.	Vel Chnl	Froude # Chl	Shear Chan	Power Chan
			(cfs)	(ft)	(ft)	(ft/s)		(lb/sq ft)	(lb/ft s)
WEST	1000	2 YR	3.72	19.67		2.37	0.74	0.71	1.68
WEST	1000	100 YR	14.00	20.05	19.99	3.65	0.86	1.40	5.11
WEST	999	2 YR	3.72	15.06		2.59	0.81	0.85	2.20
WEST	999	100 YR	14.00	15.50		3.66	0.83	1.38	5.05
WEST	998.6	2 YR	3.72	14.65	14.58	2.37	0.72	0.70	1.65
WEST	998.6	100 YR	14.00	15.02	14.97	3.86	0.89	1.56	6.02
WEST	998	2 YR	3.72	13.89	13.87	2.67	0.90	0.95	2.53
WEST	998	100 YR	14.00	14.27	14.24	3.89	0.91	1.59	6.17
WEST	997.9	2 YR	3.72	13.63		2.02	0.61	0.51	1.02
WEST	997.9	100 YR	14.00	14.06		3.02	0.68	0.93	2.82
WEST	997.7	2 YR	3.72	13.04	13.04	2.98	1.00	1.18	3.52
WEST	997.7	100 YR	14.00	13.43	13.43	4.19	1.00	1.87	7.83
WEST	996.48		Culvert						
WEST	996	2 YR	3.72	11.63		1.30	0.34	0.19	0.25
WEST	996	100 YR	14.00	12.19		1.98	0.39	0.37	0.73
WEST	995	2 YR	3.72	10.91	10.91	3.19	1.00	1.30	4.14
WEST	995	100 YR	14.00	11.83	11.36	2.44	0.45	0.55	1.33
WEST	994	2 YR	3.72	10.64		0.92	0.21	0.09	0.08
WEST	994	100 YR	14.00	10.55	10.55	4.09	1.01	1.81	7.41
WEST	993	2 YR	3.72	10.65		0.04	0.00	0.00	0.00
WEST	993	100 YR	14.00	10.65		0.16	0.02	0.00	0.00
WEST	992	2 YR	3.72	10.65		0.04	0.00	0.00	0.00
WEST	992	100 YR	14.00	10.65		0.15	0.02	0.00	0.00

Table 2 HECRAS tabular output for Culvert West 1893 for 100 year and 2 year return intervals.

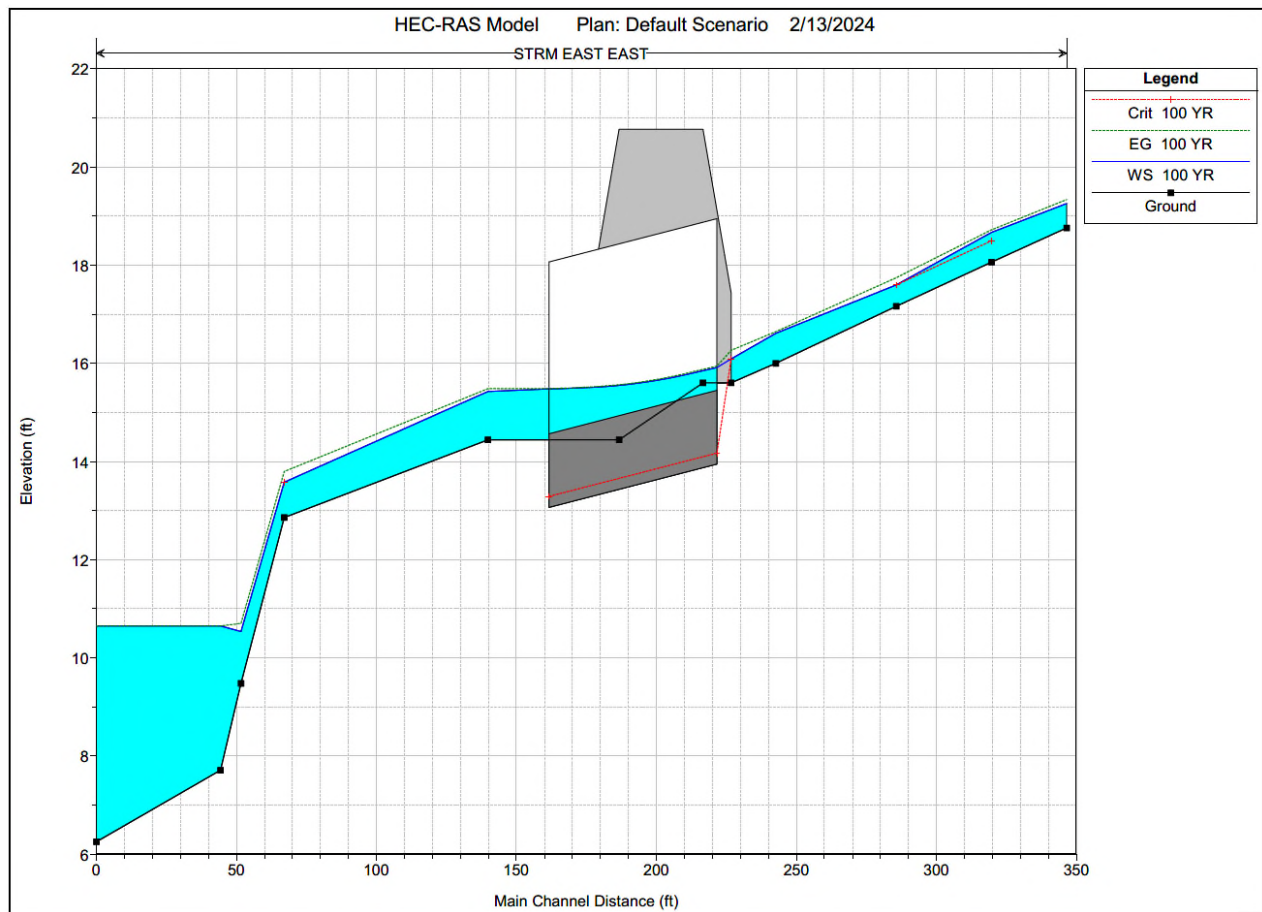


Figure 13 HECRAS output profile of water surface for the 100 year return interval at the Culvert East 1894.

HEC-RAS Plan: Default Scenario River: STRM EAST Reach: EAST

Reach	River Sta	Profile	Q Total (cfs)	W.S. Elev (ft)	Crit W.S. (ft)	Vel Chnl (ft/s)	Froude # Chl	Shear Chan (lb/sq ft)	Power Chan (lb/ft s)
EAST	1008	2 YR	1.99	19.00	18.97	1.80	0.77	0.50	0.90
EAST	1008	100 YR	7.50	19.25		2.28	0.74	0.67	1.51
EAST	1007.6	2 YR	1.99	18.39	18.27	1.20	0.44	0.20	0.24
EAST	1007.6	100 YR	7.50	18.67	18.50	1.79	0.50	0.38	0.67
EAST	1007	2 YR	1.99	17.37	17.37	2.26	1.01	0.81	1.83
EAST	1007	100 YR	7.50	17.60	17.60	3.07	1.00	1.22	3.74
EAST	1006	2 YR	1.99	16.32		1.07	0.41	0.16	0.18
EAST	1006	100 YR	7.50	16.61		1.52	0.43	0.27	0.41
EAST	1005	2 YR	1.99	15.83	15.83	2.42	1.00	0.89	2.17
EAST	1005	100 YR	7.50	16.09	16.09	3.39	1.00	1.40	4.76
EAST	1004.51		Culvert						
EAST	1004	2 YR	1.99	15.00		1.34	0.40	0.22	0.30
EAST	1004	100 YR	7.50	15.43		1.93	0.45	0.39	0.76
EAST	1003	2 YR	1.99	13.24	13.24	2.78	1.00	1.08	3.00
EAST	1003	100 YR	7.50	13.58	13.58	3.74	1.01	1.62	6.06
EAST	1002	2 YR	1.99	10.64		0.74	0.15	0.06	0.04
EAST	1002	100 YR	7.50	10.54		3.27	0.72	1.12	3.66
EAST	1001	2 YR	1.99	10.65		0.02	0.00	0.00	0.00
EAST	1001	100 YR	7.50	10.65		0.06	0.01	0.00	0.00
EAST	1000	2 YR	1.99	10.65		0.02	0.00	0.00	0.00
EAST	1000	100 YR	7.50	10.65		0.06	0.01	0.00	0.00

Table 3 HECRAS tabular output for the Culvert East 1894 for the 100 year and 2 year return intervals.

5. Construction Costs

Construction costs are estimated using professional judgement and experience in the current construction industry. At this phase of preliminary design costs are higher than anticipated bids will be due to the uncertainty of costs and inflation. These costs include an 8% annual inflation factor.

Race Road Culvert Replacements Construction Costs

Summary

Site West: 14' x 4.67' x 64' Concrete Box Culvert	\$1,031,417
Site East: 12.5' x 5.67' x 72' Concrete Box Culvert	\$1,090,146

Figure 14 Summary of estimated construction costs for the Race Lagoon Road crossings.

Chinook Engineering
Opinion of Probable Construction Costs



Race Road Culvert Replacements Construction Costs

Site West: 14' x 4.67' x 64' Concrete Box Culvert

Project Name: Race Road Culvert Replacements Construction Costs
 Chinook Project #: 22457
 Date: 02/07/24

Estimate By: Jay S. Kidder, PE
 Stream: Race Road Culvert Replacements

Annual Construction
 Inflation Factor Applied to
 Construction Total 8.00%

Description	Unit	Quantity	Cost	Amount	Sub Total
Mobilization / Site Preparation					
Mobilize	L.S.	1	\$65,000.00	\$65,000	
Access and Traffic control	L.S.	1	\$25,000.00	\$25,000	
Stream Bypass	L.S.	1	\$0.00	\$0	
Erosion Control	L.S.	1	\$5,000.00	\$5,000	
Dewater and foundation water contr	EA	2	\$4,000.00	\$8,000	
Fish Removal	L.S.	1	\$0.00	\$0	
Utilities 811, and Pothole & Replace	LS	1	\$15,000.00	\$15,000	
MOBILIZATION / SITE PREP SUB TOTAL					\$118,000
Excavation					
Grubbing and disposal on site	ACRES	0.11	\$10,000.00	\$1,148	
Tree falling stumps to remain	EA	0	\$650.00	\$0	
Excavation, Common, at culvert with end haul	C.Y.	1138	\$85.00	\$96,688	
Cut asphalt	LF	136	\$6.00	\$816	
Cut and demolish asphalt end haul	Ton	31	\$80.00	\$2,481	
EXCAVATION SUB TOTAL					\$101,132
Culvert Installation					
Culvert Base Precast Conc.	CY	63	\$2,300	\$144,474	
Culvert Traffic Slab top, Conc.	CY	36	\$2,300	\$81,778	
Culvert Ends, Conc.	CY	4	\$2,300	\$9,030	
Install, crane or large excav.	L.S.	1	\$18,000	\$18,000	
Culvert disposal	EA	1	\$2,000.00	\$2,000	
Culvert Weld tabs	EA	128	\$30	\$3,840	
Backfill against culvert, CSBC	CY	1340	\$85	\$113,904	
Subgrade & Compaction subgrade	C.Y.	69	\$85	\$5,843	
Geotextile	SY	142	\$9.50	\$1,351	
Quarry Spalls and ditching	Ton	60	\$150	\$9,000	
Fill Road base crushed gravel	C.Y.	141	\$110	\$15,507	
Resurface with HMA Class A	Ton	46	\$120	\$5,529	
BRIDGE INSTALLATION SUB TOTAL					\$410,255
Channel Work HPA Req'd					
Streambed Gravel, Fishmix grade	C.Y.	7	\$110.00	\$815	
Culvert backfill in barrel	C.Y.	117	\$110.00	\$12,833	
Culvert Habitat Boulders	Ton	32	\$110.00	\$3,520	
Revegetation	LS	1	\$4,000.00	\$4,000	
CHANNEL WORK SUBTOTAL					\$21,168
CONSTRUCTION TOTAL					\$702,600
Sales Tax	8.80%				\$61,829
Admin/Planning	8.00%				\$56,208
Permits	9.00%				\$63,234
Engineering Design	15.00%				\$105,390
Engineering Construction Manage.	6.00%				\$42,156
Soils Lab Testing		0	\$2,000.00		\$0
PROJECT TOTAL					\$1,031,417

Opinions of Probable Construction Cost

In providing opinions of probable construction cost, the Client understands that the Consultant (Chinook Engineering) has no control over the cost or availability of labor, equipment or materials, or over market condition or the Contractor's method of pricing, and the consultant's opinions of probable construction costs are made on the basis of the Consultant's professional judgment and experience. The Consultant makes no warranty, express or implied that the bids or the negotiated cost of the Work will not vary from the Consultant's opinion of probable construction cost.

Figure 15
 Construction cost
 estimate West
 1893 culvert
 crossing at Race
 Lagoon.

Chinook Engineering
Opinion of Probable Construction Costs
Race Road Culvert Replacements Construction Costs
Site East: 12.5' x 5.67' x 72' Concrete Box Culvert



Project Name: Race Road Culvert Replacements Construction Costs
Chinook Project #: 22457
Date: 02/07/24
Estimate By: Jay S. Kidder, PE
Stream: Race Road Culvert Replacements

Inflation Factor Applied to 8.00%

Description	Unit	Quantity	Cost	Amount	Sub Total
Mobilization / Site Preparation					
Mobilize	L.S.	1	\$65,000.00	\$65,000	
Access and Traffic control	L.S.	1	\$25,000.00	\$25,000	
Stream Bypass	L.S.	1	\$0.00	\$0	
Erosion Control	L.S.	1	\$5,000.00	\$5,000	
Dewater and foundation water contr	EA	2	\$4,000.00	\$8,000	
Fish Removal	L.S.	1	\$0.00	\$0	
Utilities 811, and Pothole & Replace	LS	1	\$15,000.00	\$15,000	
MOBILIZATION / SITE PREP SUB TOTAL					\$118,000
Excavation					
Grubbing and disposal on site	ACRES	0.11	\$10,000.00	\$1,148	
Tree falling stumps to remain	EA	0	\$650.00	\$0	
Excavation, Common, at culvert					
with end haul	C.Y.	1264	\$85.00	\$107,431	
Cut asphalt	LF	136	\$6.00	\$816	
Cut and demolish asphalt end haul	Ton	31	\$80.00	\$2,481	
EXCAVATION SUB TOTAL					\$111,876
Culvert Installation					
Culvert Base Precast Conc.	CY	71	\$2,300	\$162,533	
Culvert Traffic Slab top, Conc.	CY	40	\$2,300	\$92,000	
Culvert Ends, Conc.	CY	4	\$2,300	\$9,030	
Install, crane or large excav.	L.S.	1	\$18,000	\$18,000	
Culvert disposal	EA	1	\$2,000.00	\$2,000	
Culvert Weld tabs	EA	144	\$30	\$4,320	
Backfill against culvert, CSBC	CY	1485	\$85	\$126,194	
Subgrade & Compaction subgrade	C.Y.	69	\$85	\$5,843	
Geotextile	SY	142	\$9.50	\$1,351	
Quarry Spalls and ditching	Ton	60	\$150	\$9,000	
Fill Road base crushed gravel	C.Y.	150	\$110	\$16,541	
Resurface with HMA Class A	Ton	46	\$120	\$5,529	
BRIDGE INSTALLATION SUB TOTAL					\$452,341
Channel Work HPA Req'd					
Cut Roots and clean up	C.Y.	5	\$65.00	\$325	
Fish mix stream sed. and cobble	CY	15	\$110.00	\$1,650	
Excavation, Channel change	C.Y.	9	\$80.00	\$693	
Streambed Gravel, Fishmix grade	C.Y.	7	\$110.00	\$815	
Culvert backfill in barrel	C.Y.	124	\$110.00	\$13,689	
Culvert Habitat Boulders	Ton	32	\$110.00	\$3,520	
Revegetation	LS	1	\$4,000.00	\$4,000	
CHANNEL WORK SUBTOTAL					\$22,717
CONSTRUCTION TOTAL					\$761,329
Sales Tax	8.80%				\$61,829
Admin/Planning	8.00%				\$56,208
Permits	9.00%				\$63,234
Engineering Design	15.00%				\$105,390
Engineering Construction Manage.	6.00%				\$42,156
Soils Lab Testing		0	\$2,000.00		\$0
PROJECT TOTAL					\$1,090,146

Opinions of Probable Construction Cost

In providing opinions of probable construction cost, the Client understands that the Consultant (Chinook Engineering) has no control over the cost or availability of labor, equipment or materials, or over market condition or the Contractor's method of pricing, and the consultant's opinions of probable construction costs are made on the basis of the Consultant's professional judgment and experience. The Consultant makes no warranty, express or implied that the bids or the negotiated cost of the Work will not vary from the Consultant's opinion of probable construction cost.

Figure 16
Construction cost
estimate East
1894 culvert
crossing at Race
Lagoon.

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7. Appendices



860 Windrose Drive
Coupeville, WA 98239

Telephone (360) 672-5528

Memorandum

Date: January 8, 2024

From: Jay S. Kidder, P.E.

To: Alison Studley, Executive Director SFEG

Subject: Race Road Culvert Replacement Project
hydrology and Hydraulics memo together with fish
crossing and stream simulation dimensions

Hi Allison,

Please find attached a memo that presents the several design tools that I use to size culverts properly for fish passage. The results are shown attached. This may initiate discussions as to the actual size used in the design.

These tools include the Streamstats online program from the USGS to provide the best estimate of stream flow for the 2 watersheds, 1893, and 1894; an Excel spreadsheet that solves the stream simulation calculation for Washington state; the Washington State Department of Fish and Wildlife climate change modifier for culverts and stream crossings; and the U.S. Forest Service FishXng output.

I use these tools to design for culverts in the stream, starting with the bank full width measurements then use the spreadsheet for the appropriate size culvert replacement, which is then modified by the climate change increase for the year 2080, and then double check sizing using the U.S. Forest Service FishXng program. All the earlier culvert spans and barrier measurements are shown as well.

Give me a call if you need anything else such as revising the drawings again. My phone number is 360-672-5528.

Thank you,
Jay Kidder

<https://chinookengineering.sharepoint.com/sites/RaceRoadCulvertReplacements1893-1894/Shared Documents/BOD/Fish Crossing and Stream Simulation Memo.docx>

Crossing Report for Race Road Large West 1893

Project: Hydraulics and FishXing

Table 1. Project Summary for Hydraulics and FishXing

File Name	Crossing Name	Stream Name	Culvert Length	QLP	QHP	% Passable
Race Road large West	Race Road Large West	unnamed	56 ft	4.3 cfs	16.5 cfs	100.0%
small Race Road.xng	Race Road Small Culvert	unnamed	74 ft	2.3 cfs	8.9 cfs	100.0%

Crossing Location Information

Crossing Name: Race Road Large West 1893

Stream Name: unnamed

Road: Race Road

FishXing V3.0 2006

Biological Data

Fish Length: 8 cm
Minimum Water Depth: 0.1 ft
Prolonged Swimming Speed: 5.1 ft/s
Prolonged Time to Exhaustion: 20 min
Prolonged Notes:
Oncorhynchus tshawytscha
Chinook salmon
Length: 71.35 to 84.79 cm
Temp: 12.5 Deg C
Speed Range: 4.1 - 6.43 ft/s
Fish Body Depth: 0.06 ft

Burst Swimming Speed: 5.3 ft/s
Burst Time to Exhaustion: 10 s
Burst Notes:
Oncorhynchus tshawytscha
Chinook salmon
Length: 50.8 to 96.5 cm
Temp: 18.9 to 19.4 Deg C
Fish Body Depth: 0.06 ft
Fish Metrics Calculated

Leaping Speed: 16.8 ft/s
Velocity Reduction Factors:
Inlet: 1.00
Barrel: 1.00
Outlet: 1.00

Crossing Installation Data

Culvert Type: 13 X 7 ft Box
Material: Concrete
Installation: Embedded
Countersunk Depth: 2.3 ft
Natural Bottom Roughness Coefficient: 0.05
Culvert Length: 56 ft
Culvert Slope: 3.36%
Culvert Roughness Coefficient: 0.013
Natural Bottom Roughness Coefficient: 0.05
Inlet Invert Elevation: 12.31 ft
Outlet Invert Elevation: 10.43 ft
Inlet Headloss Coefficient (Ke): 0.7

FishXing V3.0 2006

Design Flows

Low Passage Flow: 4.3 cfs

High Passage Flow: 16.5 cfs

Tailwater Information

Tailwater Option: Tailwater Channel Cross-Section

Channel Bottom Slope: 3.4%

Outlet-Pool Bottom Elevation: 10.43 ft

Table 2. Tailwater Cross Section Data.

Station (ft)	Elevation (ft)	Roughness Coefficient
0.00	18.00	0.055
4.00	10.43	
18.00	10.43	
22.00	18.00	

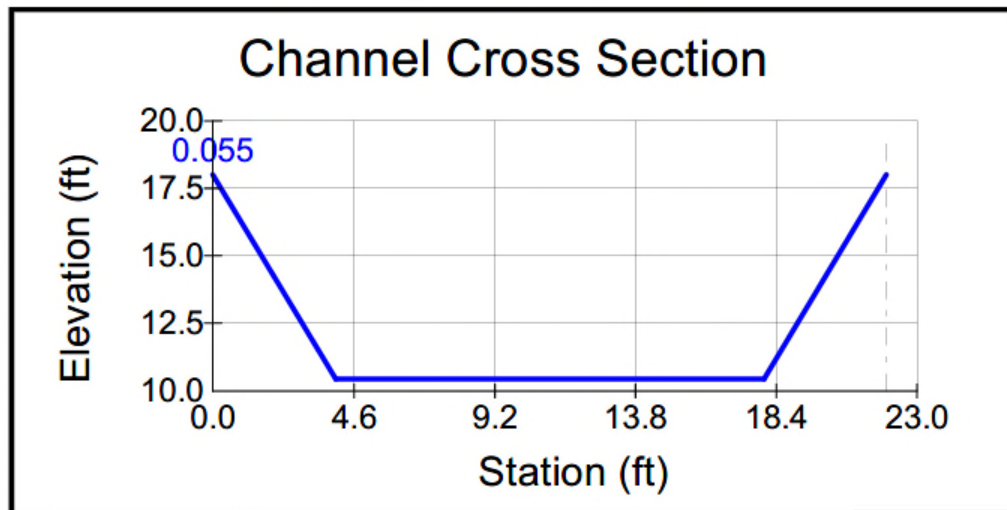


Figure 1. Channel Cross Section at Tailwater Crest.

FishXing V3.0 2006

Table 3. Tailwater Rating Table Information.

Discharge (cfs)	Tailwater Elevation (ft)	Wetted Perimeter (ft)	Cross-Sect. Area (sq. ft)	Composite Roughness Coefficient
0.0	10.4	0.00	0.00	0.000
0.8	10.5	14.16	0.98	0.055
3.6	10.6	14.38	2.39	0.055
7.8	10.7	14.61	3.82	0.055
13.1	10.8	14.84	5.25	0.055
19.4	10.9	15.06	6.70	0.055
26.7	11.0	15.29	8.15	0.055
34.8	11.1	15.52	9.62	0.055
43.8	11.2	15.74	11.09	0.055
53.5	11.3	15.97	12.58	0.055
63.9	11.4	16.19	14.08	0.055
75.0	11.5	16.42	15.58	0.055
86.8	11.6	16.65	17.10	0.055
99.2	11.7	16.87	18.63	0.055
112.2	11.8	17.10	20.17	0.055
125.8	11.9	17.33	21.72	0.055
140.0	12.0	17.55	23.28	0.055
154.8	12.1	17.78	24.85	0.055
170.1	12.2	18.00	26.44	0.055
186.0	12.3	18.23	28.03	0.055
202.4	12.4	18.46	29.63	0.055
219.3	12.5	18.68	31.24	0.055
236.7	12.6	18.91	32.87	0.055
254.6	12.7	19.13	34.50	0.055
273.0	12.8	19.36	36.15	0.055
291.9	12.9	19.59	37.80	0.055
311.3	13.0	19.81	39.47	0.055
331.1	13.1	20.04	41.15	0.055
351.4	13.2	20.27	42.83	0.055
372.2	13.3	20.49	44.53	0.055
393.4	13.4	20.72	46.24	0.055
415.1	13.5	20.94	47.96	0.055
437.2	13.6	21.17	49.69	0.055
459.7	13.7	21.40	51.43	0.055
482.7	13.8	21.62	53.18	0.055
506.1	13.9	21.85	54.94	0.055
530.0	14.0	22.08	56.71	0.055
554.2	14.1	22.30	58.50	0.055
578.9	14.2	22.53	60.29	0.055
604.0	14.3	22.75	62.09	0.055
629.6	14.4	22.98	63.91	0.055
655.5	14.5	23.21	65.73	0.055
681.9	14.6	23.43	67.57	0.055
708.7	14.7	23.66	69.41	0.055
735.9	14.8	23.89	71.27	0.055
763.5	14.9	24.11	73.14	0.055
791.5	15.0	24.34	75.02	0.055
819.9	15.1	24.56	76.90	0.055

FishXing V3.0 2006

Discharge (cfs)	Tailwater Elevation (ft)	Wetted Perimeter (ft)	Cross-Sect. Area (sq. ft)	Composite Roughness Coefficient
848.7	15.2	24.79	78.80	0.055
877.9	15.3	25.02	80.71	0.055
907.5	15.4	25.24	82.63	0.055
937.5	15.5	25.47	84.56	0.055
968.0	15.6	25.69	86.50	0.055
998.8	15.7	25.92	88.46	0.055
1030.0	15.8	26.15	90.42	0.055
1061.6	15.9	26.37	92.39	0.055
1093.6	16.0	26.60	94.37	0.055
1126.0	16.1	26.83	96.37	0.055
1158.8	16.2	27.05	98.37	0.055
1192.0	16.3	27.28	100.39	0.055
1225.6	16.4	27.50	102.41	0.055
1259.6	16.5	27.73	104.45	0.055
1294.0	16.6	27.96	106.50	0.055
1328.7	16.7	28.18	108.55	0.055
1363.9	16.8	28.41	110.62	0.055
1399.4	16.9	28.64	112.70	0.055
1435.4	17.0	28.86	114.79	0.055
1471.7	17.1	29.09	116.89	0.055
1508.5	17.2	29.31	119.00	0.055
1545.6	17.3	29.54	121.12	0.055
1583.1	17.4	29.77	123.25	0.055
1621.0	17.5	29.99	125.39	0.055
1659.4	17.6	30.22	127.54	0.055
1698.1	17.7	30.45	129.71	0.055
1737.1	17.8	30.67	131.88	0.055
1776.6	17.9	30.90	134.07	0.055
1816.5	18.0	31.12	136.26	0.055

FishXing V3.0 2006

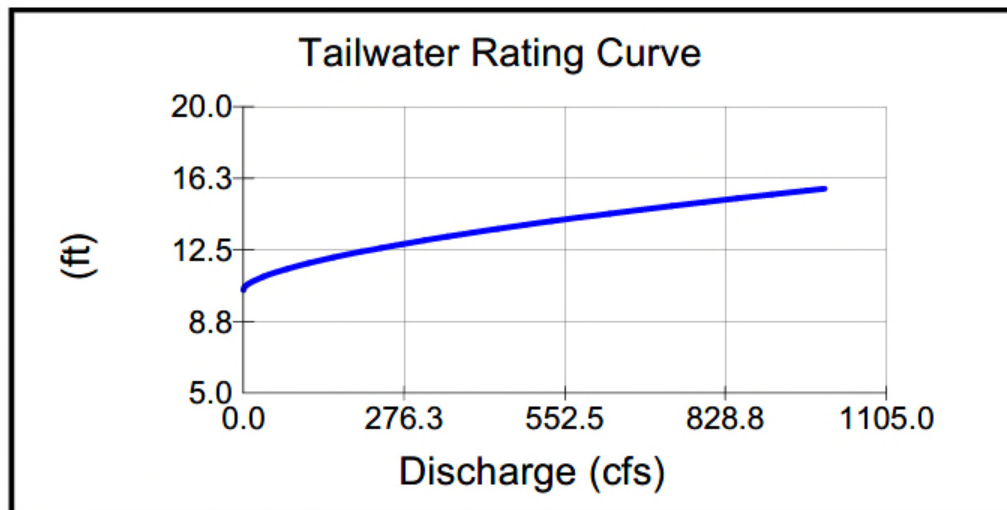


Figure 2. Tailwater Rating Curve

Table 4. Fish Passage Summary.

Fish Passage Summary	
Low Passage Design Flow	4.30 cfs
High Passage Design Flow	16.50 cfs
Percent of Flows Passable	100.0 %
Passable Flow Range	4.30 to 16.50 cfs
Depth Barrier	None
Leap Barriers	None
Velocity Barrier	None
Pool Depth Barrier	None

Table 5. Culvert Summary for 4.30 cfs.

Summary for Q = 4.30 cfs	
Normal Depth (ft)	0.19
Critical Depth (ft)	0.15
Headwater Depth (ft)	0.36
HW/D	0.08
Inlet Velocity (ft/s)	2.32
Tailwater Depth (ft)	0.19
Outlet Water Surface Drop (ft)	0.00
Prolonged Swim Time (min)	0.28
Burst Swim Time (s)	0.00
Barrier Code	NONE

FishXing V3.0 2006

Table 6. Culvert Profiles for 4.30 cfs.

Dist Down Culvert (ft)	Profiles for Q = 4.30 cfs				
	Depth (ft)	Velocity Average (ft/s)	Velocity Occupied (ft/s)	Swim Mode	Barrier Type
0	0.36	0.00	0.00	Prolonged	NONE
3	0.19	2.32	2.31	Prolonged	
5	0.19	1.78	1.77	Prolonged	
8	0.19	1.78	1.77	Prolonged	
11	0.19	1.78	1.77	Prolonged	
14	0.19	1.78	1.77	Prolonged	
17	0.19	1.78	1.77	Prolonged	
20	0.19	1.78	1.77	Prolonged	
23	0.19	1.78	1.77	Prolonged	
26	0.19	1.78	1.77	Prolonged	
29	0.19	1.78	1.77	Prolonged	
32	0.19	1.78	1.77	Prolonged	
35	0.19	1.78	1.77	Prolonged	
38	0.19	1.78	1.77	Prolonged	
41	0.19	1.78	1.77	Prolonged	
44	0.19	1.78	1.77	Prolonged	
47	0.19	1.78	1.77	Prolonged	
50	0.19	1.78	1.77	Prolonged	
53	0.19	1.78	1.77	Prolonged	
56	0.19	1.77	1.77		

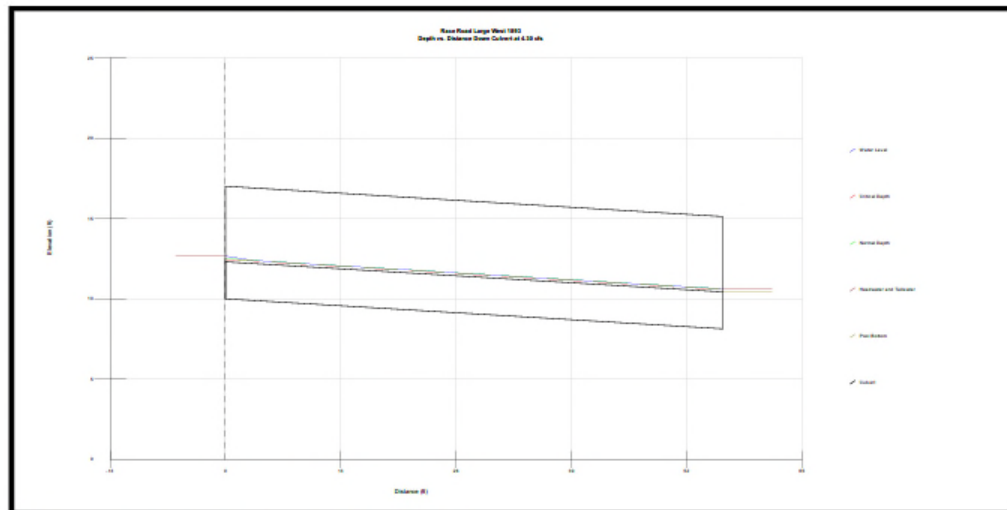


Figure 3. Water Surface Profile at 4.3 cfs

FishXing V3.0 2006

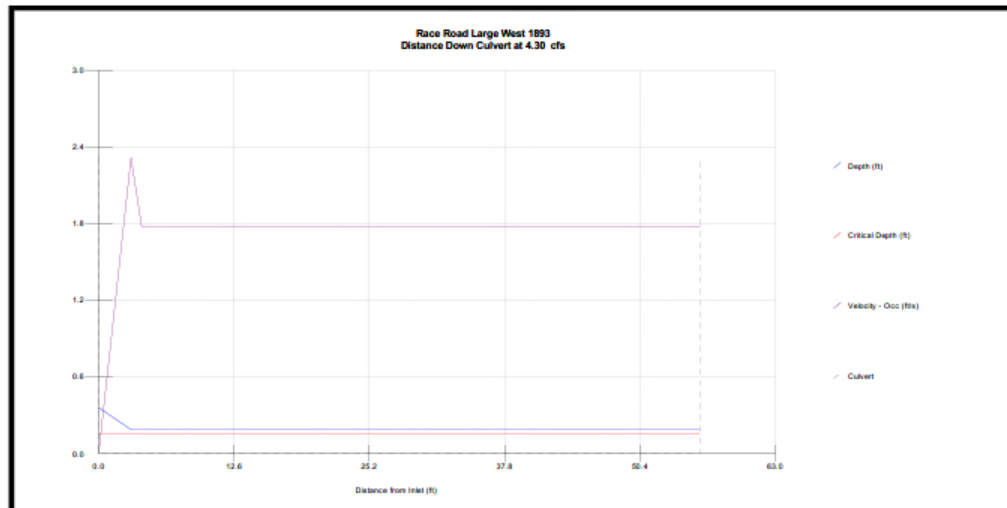


Figure 4. Culvert Profiles at 4.3 cfs

Table 7. Culvert Summary for 16.5 cfs.

Summary for Q = 16.50 cfs	
Normal Depth (ft)	0.42
Critical Depth (ft)	0.37
Headwater Depth (ft)	0.72
HW/D	0.15
Inlet Velocity (ft/s)	3.96
Tailwater Depth (ft)	0.42
Outlet Water Surface Drop (ft)	0.00
Prolonged Swim Time (min)	0.45
Burst Swim Time (s)	0.00
Barrier Code	NONE

FishXing V3.0 2006

Table 8. Culvert Profiles for 16.5 cfs.

Dist Down Culvert (ft)	Profiles for Q = 16.50 cfs				
	Depth (ft)	Velocity Average (ft/s)	Velocity Occupied (ft/s)	Swim Mode	Barrier Type
0	0.72	0.00	0.00	Prolonged	NONE
3	0.42	3.96	3.95	Prolonged	
5	0.42	3.04	3.03	Prolonged	
8	0.42	3.04	3.03	Prolonged	
11	0.42	3.04	3.03	Prolonged	
14	0.42	3.04	3.03	Prolonged	
17	0.42	3.04	3.03	Prolonged	
20	0.42	3.04	3.03	Prolonged	
23	0.42	3.04	3.03	Prolonged	
26	0.42	3.04	3.03	Prolonged	
29	0.42	3.04	3.03	Prolonged	
32	0.42	3.04	3.03	Prolonged	
35	0.42	3.04	3.03	Prolonged	
38	0.42	3.04	3.03	Prolonged	
41	0.42	3.04	3.03	Prolonged	
44	0.42	3.04	3.03	Prolonged	
47	0.42	3.04	3.03	Prolonged	
50	0.42	3.04	3.03	Prolonged	
53	0.42	3.04	3.03	Prolonged	
56	0.42	3.00	2.99		

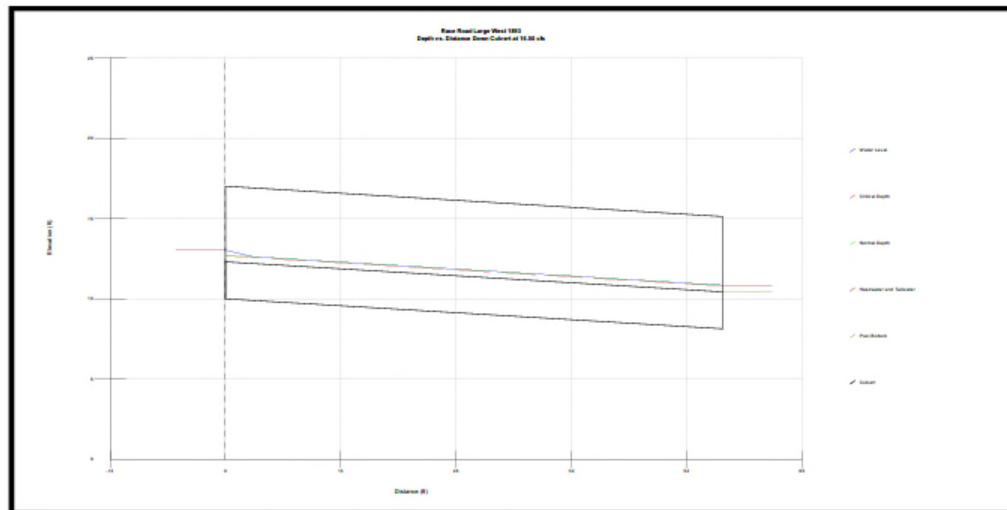


Figure 5. Water Surface Profile at 16.5 cfs

FishXing V3.0 2006

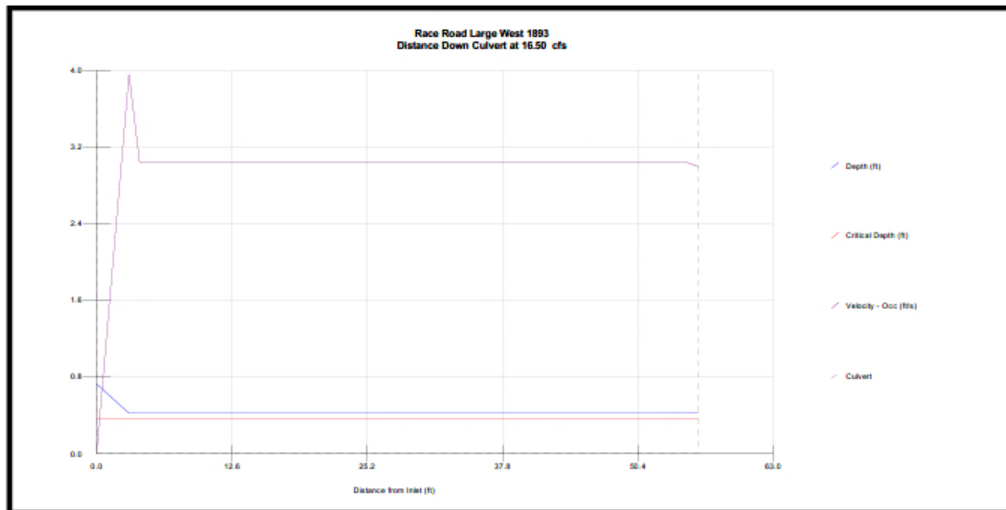


Figure 6. Culvert Profiles at 16.5 cfs

Table 9. Culvert Summary for 2 cfs.

Summary for Q = 2.00 cfs	
Normal Depth (ft)	0.12
Critical Depth (ft)	0.09
Headwater Depth (ft)	0.26
HW/D	0.05
Inlet Velocity (ft/s)	1.71
Tailwater Depth (ft)	0.11
Outlet Water Surface Drop (ft)	0.00
Prolonged Swim Time (min)	0.25
Burst Swim Time (s)	0.00
Barrier Code	NONE

FishXing V3.0 2006

Table 10. Culvert Profiles for 2 cfs.

Dist Down Culvert (ft)	Profiles for Q = 2.00 cfs				
	Depth (ft)	Velocity Average (ft/s)	Velocity Occupied (ft/s)	Swim Mode	Barrier Type
0	0.26	0.00	0.00	Prolonged	NONE
3	0.12	1.71	1.70	Prolonged	
5	0.12	1.31	1.30	Prolonged	
8	0.12	1.31	1.30	Prolonged	
11	0.12	1.31	1.30	Prolonged	
14	0.12	1.31	1.30	Prolonged	
17	0.12	1.31	1.30	Prolonged	
20	0.12	1.31	1.30	Prolonged	
23	0.12	1.31	1.30	Prolonged	
26	0.12	1.31	1.30	Prolonged	
29	0.12	1.31	1.30	Prolonged	
32	0.12	1.31	1.30	Prolonged	
35	0.12	1.31	1.30	Prolonged	
38	0.12	1.31	1.30	Prolonged	
41	0.12	1.31	1.30	Prolonged	
44	0.12	1.31	1.30	Prolonged	
47	0.12	1.31	1.30	Prolonged	
50	0.12	1.31	1.30	Prolonged	
53	0.12	1.31	1.30	Prolonged	
56	0.11	1.37	1.37		

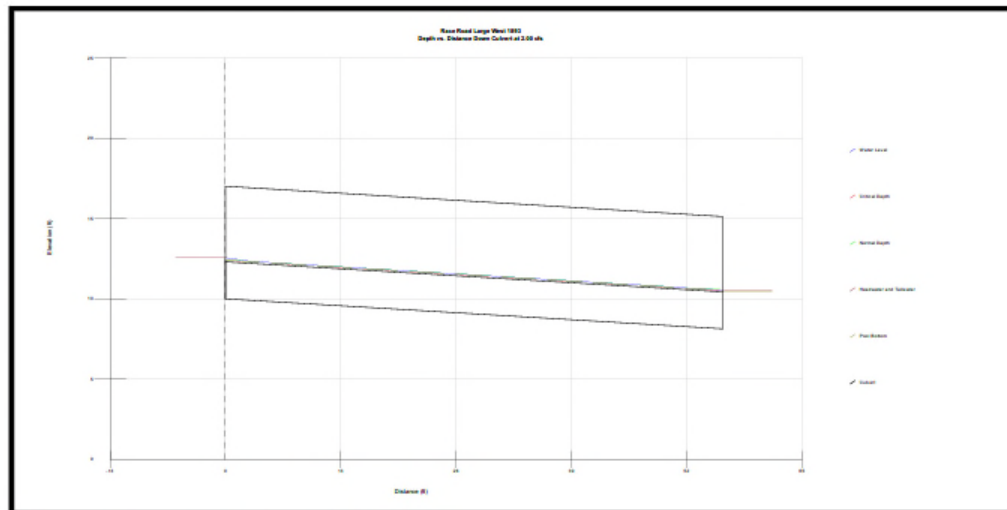


Figure 7. Water Surface Profile at 2 cfs

FishXing V3.0 2006

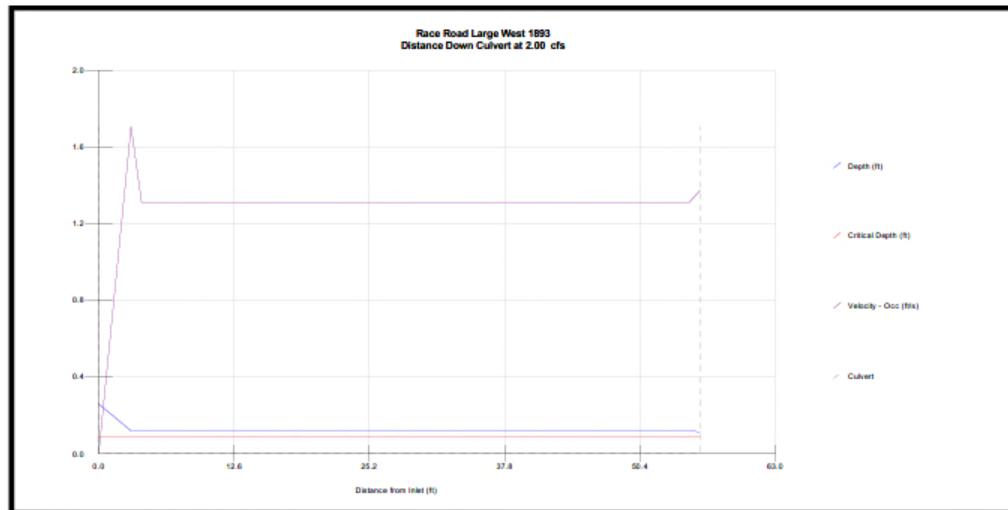


Figure 8. Culvert Profiles at 2 cfs

FishXing V3.0 2006

Table 11. Culvert Rating Table.

Q total (cfs)	Depth Min (ft)	V(occ) Max (ft/s)	Depth TW (ft)	Outlet WS Drop (ft)	Depth Pool (ft)	Barrier Type
0.0	0.00	0.00	-10.43	10.43	-10.43	Depth
0.8	0.07	1.20	0.07	0.00	0.07	Depth
1.6	0.10	1.65	0.10	0.00	0.10	Depth
2.5	0.13	1.85	0.13	0.00	0.13	NONE
3.3	0.16	2.08	0.16	0.00	0.16	NONE
4.30	0.19	2.32	0.19	0.00	0.19	NONE
5.1	0.21	2.48	0.21	0.00	0.21	NONE
5.9	0.23	2.64	0.23	0.00	0.23	NONE
6.8	0.24	2.77	0.25	0.00	0.25	NONE
7.6	0.26	2.90	0.27	0.00	0.27	NONE
8.4	0.28	3.03	0.28	0.00	0.28	NONE
9.2	0.29	3.14	0.30	0.00	0.30	NONE
10.0	0.31	3.25	0.31	0.00	0.31	NONE
10.9	0.32	3.35	0.33	0.00	0.33	NONE
11.7	0.34	3.45	0.34	0.00	0.34	NONE
12.5	0.35	3.54	0.36	0.00	0.36	NONE
13.3	0.37	3.64	0.37	0.00	0.37	NONE
14.1	0.38	3.72	0.39	0.00	0.39	NONE
15.0	0.39	3.81	0.40	0.00	0.40	NONE
15.8	0.41	3.89	0.41	0.00	0.41	NONE
16.50	0.42	3.96	0.42	0.00	0.42	NONE
17.3	0.43	4.04	0.44	0.00	0.44	NONE
18.1	0.44	4.11	0.45	0.00	0.45	NONE
19.0	0.45	4.18	0.46	0.00	0.46	NONE
19.8	0.47	4.26	0.47	0.00	0.47	NONE
20.6	0.48	4.32	0.49	0.00	0.49	NONE
21.4	0.49	4.39	0.50	0.00	0.50	NONE
22.2	0.50	4.46	0.51	0.00	0.51	NONE
23.1	0.51	4.52	0.52	0.00	0.52	NONE
23.9	0.52	4.59	0.53	0.00	0.53	NONE
24.8	0.53	4.65	0.54	0.00	0.54	NONE

FishXing V3.0 2006

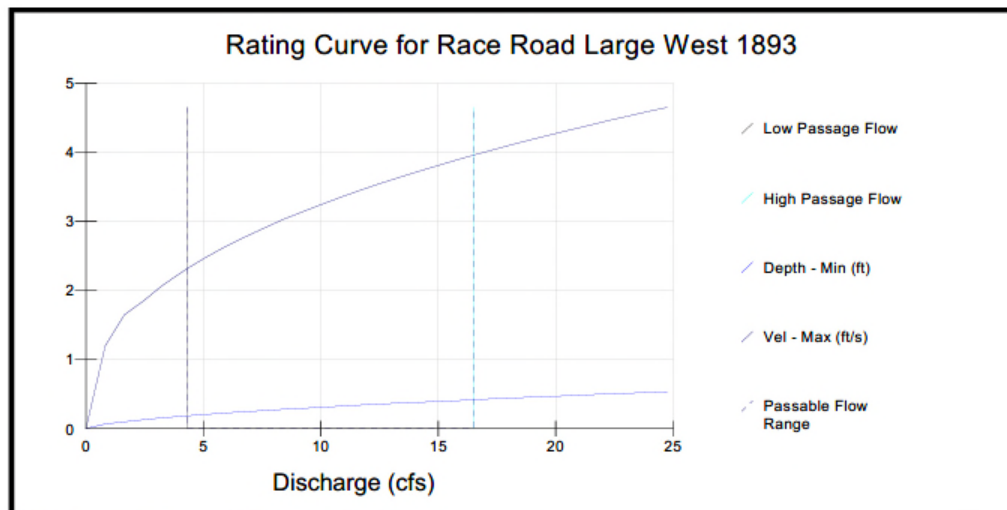


Figure 9. Culvert Rating Curve

Barrier Codes

V = Strict Velocity Barrier
 EB = Fish Exhausted at Burst Speed
 Long = Fish Exhausted at Prolonged Speed
 Leap = Excessive leap at outlet
 Drop = Excessive drop at outlet
 Depth = Too shallow for substantial distance
 Pool = Leap Pool too shallow
 NONE = Not a barrier

FishXing V3.0 2006

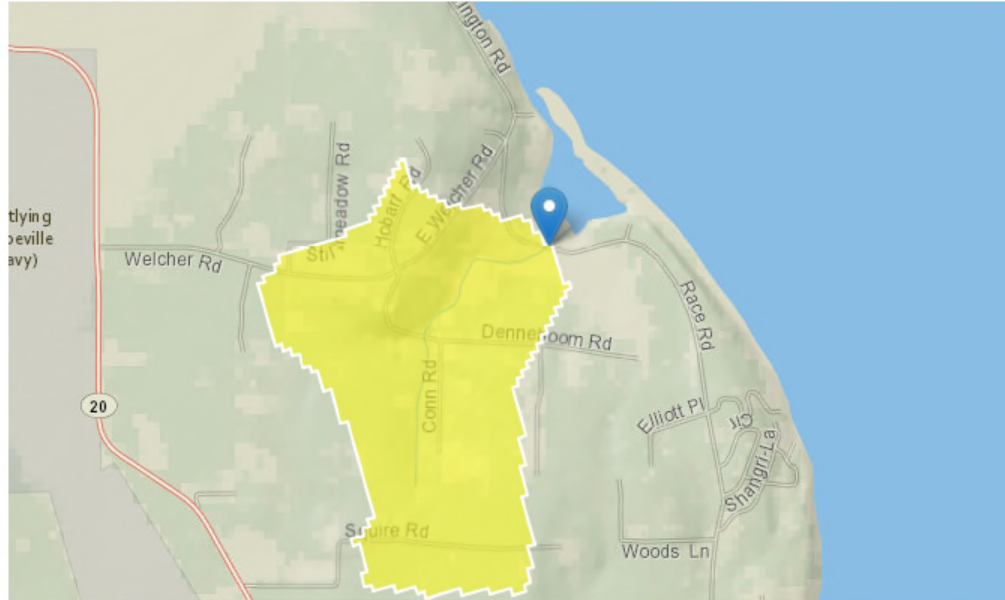
Stream Crossing Race Road at 1893

Region ID: WA

Workspace ID: WA20220310234322184000

Clicked Point (Latitude, Longitude): 48.19047, -122.60091

Time: 2022-03-10 15:43:49 -0800



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.56	square miles
PRECPRIS10	Basin average mean annual precipitation for 1981 to 2010 from PRISM	21.4	inches
PRECIP	Mean Annual Precipitation	20	inches
BSLDEM30M	Mean basin slope computed from 30 m DEM	6.26	percent
CANOPY_PCT	Percentage of drainage area covered by canopy as described in OK SIR 2009_5267	69.1	percent

Parameter Code	Parameter Description	Value	Unit
ELEV	Mean Basin Elevation	196	feet
ELEVMAX	Maximum basin elevation	347	feet
MINBELEV	Minimum basin elevation	21.2	feet
NFSL30	North-Facing Slopes Greater Than 30 Percent	0	percent
RELIEF	Maximum - minimum elevation	325	feet
SLOP30_30M	Percent area with slopes greater than 30 percent from 30-meter DEM.	0	percent

Peak-Flow Statistics Parameters [Peak Region 3 2016 5118]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.56	square miles	0.08	2610
PRECPRIS10	Mean Annual Precip PRISM 1981 2010	21.4	inches	33.2	168

Peak-Flow Statistics Disclaimers [Peak Region 3 2016 5118]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report [Peak Region 3 2016 5118]

Statistic	Value	Unit
50-percent AEP flood	3.72	ft ³ /s
20-percent AEP flood	6.14	ft ³ /s
10-percent AEP flood	7.87	ft ³ /s
4-percent AEP flood	10.2	ft ³ /s
2-percent AEP flood	12	ft ³ /s
1-percent AEP flood	14	ft ³ /s
0.5-percent AEP flood	16	ft ³ /s

Statistic	Value	Unit
0.2-percent AEP flood	18.8	ft ³ /s

Peak-Flow Statistics Citations

Mastin, M.C., Konrad, C.P., Veilleux, A.G., and Tecca, A.E., 2016, Magnitude, frequency, and trends of floods at gaged and ungaged sites in Washington, based on data through water year 2014 (ver 1.1, October 2016): U.S. Geological Survey Scientific Investigations Report 2016-5118, 70 p. (<http://dx.doi.org/10.3133/sir20165118>)

Low-Flow Statistics Parameters [Low Flow Western 2 var 2012 5078]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.56	square miles	0.1	48.9
PRECIP	Mean Annual Precipitation	20	inches	25.1	143

Low-Flow Statistics Disclaimers [Low Flow Western 2 var 2012 5078]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Low-Flow Statistics Flow Report [Low Flow Western 2 var 2012 5078]

Statistic	Value	Unit
7 Day 10 Year Low Flow	0.0171	ft ³ /s

Low-Flow Statistics Citations

Curran, C.A., Eng, Ken, and Konrad, C.P., 2012, Analysis of low flows and selected methods for estimating low-flow characteristics at partial-record and ungaged stream sites in western Washington: U.S. Geological Survey Scientific Investigations Report 2012-5078, 46 p. (<http://pubs.usgs.gov/sir/2012/5078/>)

Bankfull Statistics Parameters [99.2 Percent (0.553 square miles) Pacific Mountain System D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.56	square miles	6.1776	8079.9147

Bankfull Statistics Parameters [99.2 Percent (0.553 square miles) Pacific Border P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.56	square miles	6.169878	3938.976756

Bankfull Statistics Parameters [99.2 Percent (0.553 square miles) USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.56	square miles	0.07722	59927.7393

Bankfull Statistics Parameters [Pac Maritime Mtn CastroJackson 2001]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.56	square miles	54.8	3093

Bankfull Statistics Disclaimers [99.2 Percent (0.553 square miles) Pacific Mountain System D Bieger 2015]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Bankfull Statistics Flow Report [99.2 Percent (0.553 square miles) Pacific Mountain System D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	10.5	ft
Bieger_D_channel_depth	0.842	ft
Bieger_D_channel_cross_sectional_area	11.9	ft^2

Bankfull Statistics Disclaimers [99.2 Percent (0.553 square miles) Pacific Border P Bieger 2015]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Bankfull Statistics Flow Report [99.2 Percent (0.553 square miles) Pacific Border P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	8.5	ft
Bieger_P_channel_cross_sectional_area	9.95	ft^2
Bieger_P_channel_depth	0.779	ft

Bankfull Statistics Flow Report [99.2 Percent (0.553 square miles) USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	10.1	ft
Bieger_USA_channel_depth	1.07	ft
Bieger_USA_channel_cross_sectional_area	12.5	ft^2

Bankfull Statistics Disclaimers [Pac Maritime Mtn CastroJackson 2001]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Bankfull Statistics Flow Report [Pac Maritime Mtn CastroJackson 2001]

Statistic	Value	Unit
Bankfull Width	9.66	ft
Bankfull Depth	0.526	ft
Bankfull Area	9.29	ft^2
Bankfull Streamflow	61.7	ft^3/s

Bankfull Statistics Citations

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G., 2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p.

(https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_campaign=PDFCoverPages)

Castro, J.M, and Jackson, P.L. Castro, J.M, and Jackson, P.L., 2001, Bankfull Discharge Recurrence Intervals and Regional Hydraulic Geometry Relationships: Patterns in the Pacific Northwest, USA, Journal of the American Water Resources Association, Volume 37, No. 5, 14 p. (<https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1752-1688.2001.tb03636.x>)

Future Projections for Climate-Adapted Culvert Design

Project Name: Race road fish passage cu

Stream Name: Unnamed West culvert 186

Street Name: Race road

Culvert coordinates: 48.1906, -122.6009

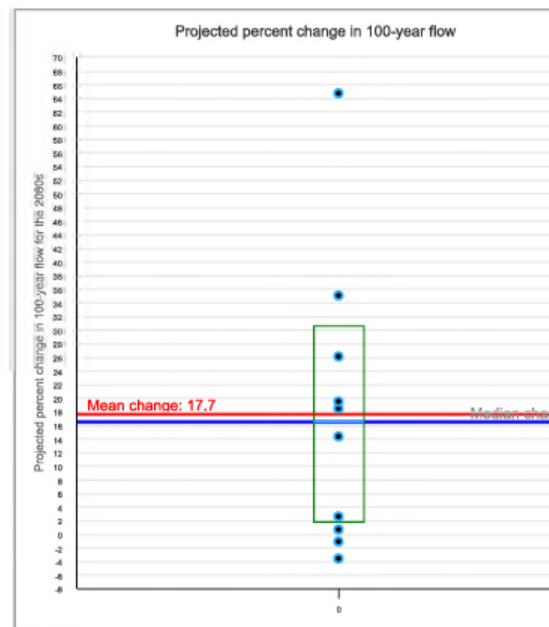
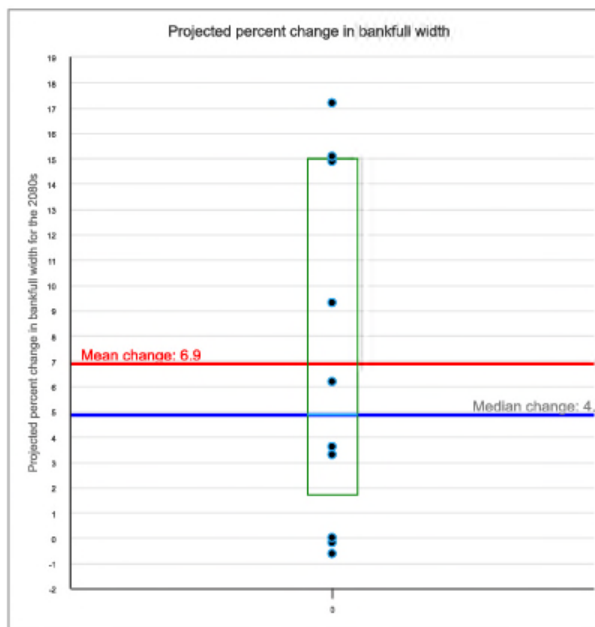
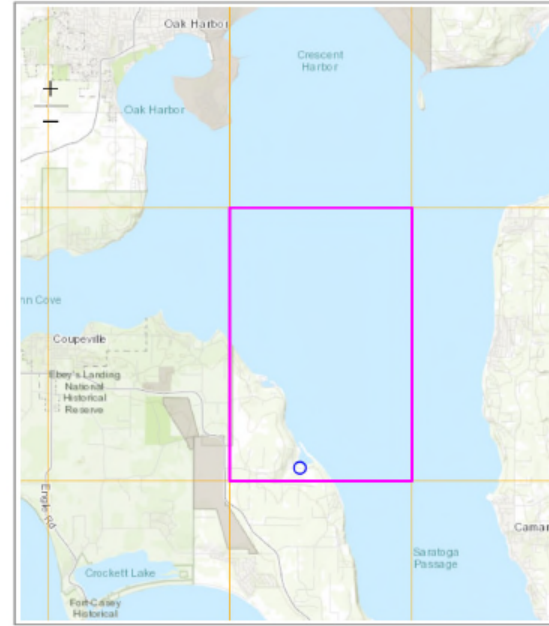
Grid ID: 48.21875_-122.59375

Ecoregion: Pacific Maritime Mountains

Projected mean percent change in bankfull flow:
 2040s: 9.9% 2080s: 14.7%

Projected mean percent change in bankfull width:
 2040s: 4.7% 2080s: 6.9%

Projected mean percent change in 100-year flood:
 2040s: 8.8% 2080s: 17.7%



The Washington Department of Fish and Wildlife makes no guarantee concerning the data's content, accuracy, precision, or completeness. WDFW makes no warranty of fitness for a particular purpose and assumes no liability for the data represented here.



Washington Department of Fish and Wildlife

Fish Passage & Diversion Screening Inventory Database Report Cover Sheet

The following report is extracted from the Washington Department of Fish and Wildlife's (WDFW) Fish Passage and Diversion Screening Inventory Database (FPDSI). WDFW makes every attempt to keep these reports in sync with FPDSI; however, the dynamic nature of the data and workflows associated with maintaining the database may result in short-term differences.

Users are encouraged to contact WDFW to discuss appropriate use of the data and how we can assist with fish passage barrier removal or inventory. Please visit the Fish Passage web site for contact information at: <https://wdfw.wa.gov/species-habitats/habitat-recovery/fish-passage/about>

Disclaimers:

- Data presented here represent a snapshot observation of conditions in a dynamic environment that is subject to change. Fish passage data are also collected from a variety of agencies and sources. Therefore, WDFW makes no guarantee concerning the data's content, accuracy, completeness, or the results obtained from use of the data. WDFW assumes no liability for the data represented here.
- These data are not an attempt to provide you with an official agency response as to the impacts of your project on fish and wildlife.
- Note that some fish passage features, habitats or species may occur in areas not currently known to the WDFW Fish Passage division, and may not be reflected in this database. A lack of data does not necessarily indicate that a feature, habitat, or species are not present.
- Unauthorized attempts to alter or modify these data are strictly prohibited.
- Bankfull width measurements included in these reports should not be used for fish passage crossing design. They are solely for assessment purposes.
- The barrier status reported in this document is based on the swimming abilities of adult salmonids. Passabilities are a qualitative value, and should not be interpreted as a quantitative calculation. Please see page 1-4 of the Fish Passage Inventory, Assessment and Prioritization Manual for further clarification: <https://wdfw.wa.gov/publications/02061>
- EXIF data presented with Image Reports may be erroneous due to camera battery failures and resetting of camera clock functions.

Abbreviations:

Most abbreviations in this report are defined in the Quick Reference Tables of the Fish Passage Inventory, Assessment, and Prioritization Manual. Additional commonly used abbreviations are defined as follows:

NFB = no potential salmonid use, **BB** = both banks, **LB** = left bank looking downstream, **RB** = right bank looking downstream, **US** or **U/S** = upstream, **DS** or **D/S** = downstream, **WSDrop** = water surface drop, **BFW** = bankfull width, **OHW** = ordinary high water, **SLW** = scour line width, **CMP** = corrugated metal pipe, **Q₉₀** = fish passage flow, **V&D** = Velocity and Depth, **ROW** = Right of Way

The FPDSI database often uses default values such as '-99.99' or '-999' to represent null values.

WDFW Fish Passage and Diversion Screening Inventory Database

Site Description Report

Site ID 609593

Project

☐ Mitigated

Geographic Coordinates

Latitude (WGS 84): 48.190567
 Longitude (WGS 84): -122.600867
 East (NAD 83 HARN): 1,127,853.5
 North (NAD 83 HARN): 1,048,934.0

Waterbody

Stream: unnamed
 Tributary To: Race Lagoon
 WRIA: 06
 River Mile: -999.99
 Fish Use Potential: Yes
 FUP Criteria: Physical

General Location

Road Name: Race Rd
 Mile Post: -999.99
 County: Island
 WDFW Region: 4

Owner

Type: County
 Name: Island County

PI Species

☐ Sockeye ☒ Chinook ☒ Sea Run Cutthroat
☐ Pink ☒ Coho ☒ Resident Trout
☒ Chum ☒ Steelhead ☐ Bull Trout

Associated Features

☒ Culvert ☐ Dam ☐ Natural Barrier ☐ Diversion
☐ Non-Culvert Xing ☐ Other ☐ Fishway

Location/Directions

Site Comments

7/17/2023

These data represent a snapshot of the Washington Department of Fish and Wildlife's current records. Due to the ongoing nature of assessment and inventory of these features, these data may not accurately represent conditions on the ground, and are subject to change.

USGS Data Disclaimer: Unless otherwise stated, all data, metadata and related materials are considered to satisfy the quality standards relative to the purpose for which the data were collected. Although these data and associated metadata have been reviewed for accuracy and completeness and approved for release by the U.S. Geological Survey (USGS), no warranty expressed or implied is made regarding the display or utility of the data for other purposes, nor on all computer systems, nor shall the act of distribution constitute any such warranty.

USGS Software Disclaimer: This software has been approved for release by the U.S. Geological Survey (USGS). Although the software has been subjected to rigorous review, the USGS reserves the right to update the software as needed pursuant to further analysis and review. No warranty, expressed or implied, is made by the USGS or the U.S. Government as to the functionality of the software and related material nor shall the fact of release constitute any such warranty. Furthermore, the software is released on condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from its authorized or unauthorized use.

USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.7.0

StreamStats Services Version: 1.2.22

NSS Services Version: 2.1.2

Race Road Culvert and Bridge Calculator 1893				
Values From Streamstats		cfs		
	Return Yr	Value		
	2	3.72		
	5	6.14		
	10	7.87		
	25	10.2		
	50	12		
	100	14		
	200	16		
	500	18.8		
Bieger BFW, feet		10.5 feet		
Climate change Factors ¹				
	Year factors		Increased Values	
	2040	2080	2040	2080
% increase in BFW Flow (2 year)	9.9	14.7	4.1	4.3 cfs
% increase in BFW Width	4.7	6.9	11.0	11.2 feet
% increase in 100 year Flood	8.8	17.7	15.2	16.5 cfs

¹ WDFW, web-based analysis. Culverts and Climate Change, changes in bank full width and flow rates in culverts in Washington state. Developed in conjunction with University of Washington 2021.
<https://geodataservices.wdfw.wa.gov/hp/culvert-app/#aboutTab>

Where; PlI in the Prediction Interval limit lower, Plu is the Prediction Interval limit upper, and AESp is the Avergae Standard error of Prediction.

References;

Mastin, M.C., Konrad, C.P., Veilleux, A.G., and Tecca, A.E.,2016, Magnitude, frequency, and trends of floods at gaged and ungaged sites in Washington, based on data through water year 2014 (ver 1.1, October 2016): U.S. Geological Survey Scientific Investigations Report 2016–5118, 70 p.

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p.

Castro, J.M, and Jackson, P.L.Castro, J.M, and Jackson, P.L., 2001, Bankfull Discharge Recurrence Intervals and Regional Hydraulic Geometry Relationships: Patterns in the Pacific Northwest, USA, Journal of the American Water Resources Association, Volume 37, No. 5, 14 p.

WDFW Fish Passage and Diversion Screening Inventory Database

Level A Culvert Assessment Report

Site ID: 609593	Stream: unnamed	WRIA: 06
Latitude: 48.190567	Tributary To: Race Lagoon	Fish Use Potential: Yes
Longitude: -122.600867		

Data Source: Skagit Fisheries Enhancement Group
Field Crew: George;Matthews;PM Review Date: 3/5/2020

Culvert Details								Level A Parameters					
ID	Shape	Material	Span	Rise	Length	WDIC	Apron	WSDrop	Location	Countersunk	Backwater	Slope (%)	Sediment
1.1	RND	CST	0.85	0.85	18.60	0.05	NO	0.17	Inlet	No	No	3.08	
All dimensions in meters													

Channel Description	
Toe Width (m):	<input type="text"/>
Average Width (m):	<input type="text" value="1.17"/>
Culvert/Stream Width Ratio:	<input type="text" value="0.73"/>
Plunge Pool	
Length (m):	<input type="text" value="2.10"/>
Max Depth (m):	<input type="text" value="0.43"/>
OHW Width (m):	<input type="text" value="2.40"/>
Road	
Fill Depth (m):	<input type="text" value="2.00"/>



Assessment Results	
Tidal Influence: <input type="text" value="Yes"/>	Tidegate Present: <input type="text" value="No"/>
Barrier: <input type="text" value="Unknown"/>	Passability (%): <input type="text" value="Unknown"/>
Reason: <input type="text" value="insufficient Data"/>	Method: <input type="text" value="Level A"/>
Fishway Present: <input type="text" value="No"/>	Recheck: <input type="text"/>

Comments
Tidal influence, Level T required

Potential Habitat Gain		
Survey Type: <input type="text"/>	Spawning (sq m): <input type="text"/>	Length (m): <input type="text"/>
Significant Reach: <input type="text" value="Unknown"/>	Rearing (sq m): <input type="text"/>	PI Total: <input type="text"/>

7/17/2023

These data represent a snapshot of the Washington Department of Fish and Wildlife's current records. Due to the ongoing nature of assessment and inventory of these features, these data may not accurately represent conditions on the ground, and are subject to change.

WDFW Fish Passage and Diversion Screening Inventory Database

Level A Culvert Assessment Report

Site ID: 609593	Stream: unnamed	WRIA: 06
Latitude: 48.190567	Tributary To: Race Lagoon	Fish Use Potential: Yes
Longitude: -122.600867		

Data Source: Skagit Fisheries Enhancement Group
Field Crew: George;Matthews;PM Review Date: 3/5/2020

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1.1	RND	CST	0.85	0.85	18.60	0.05	NO	0.17	Inlet	No	No	3.08	
All dimensions in meters													

Channel Description	
Toe Width (m):	<input type="text"/>
Average Width (m):	<input type="text" value="1.17"/>
Culvert/Stream Width Ratio:	<input type="text" value="0.73"/>
Plunge Pool	
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Max Depth (m):	<input type="text" value="0.43"/>
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Road	
Fill Depth (m):	<input type="text" value="2.00"/>



Assessment Results	
Tidal Influence: <input type="text" value="Yes"/>	Tidegate Present: <input type="text" value="No"/>
Barrier: <input type="text" value="Unknown"/>	Passability (%): <input type="text" value="Unknown"/>
Reason: <input type="text" value="insufficient Data"/>	Method: <input type="text" value="Level A"/>
Fishway Present: <input type="text" value="No"/>	Recheck: <input type="text"/>

Comments
Tidal influence, Level T required

Potential Habitat Gain		
Survey Type: <input type="text"/>	Spawning (sq m): <input type="text"/>	Length (m): <input type="text"/>
Significant Reach: <input type="text" value="Unknown"/>	Rearing (sq m): <input type="text"/>	PI Total: <input type="text"/>

7/17/2023

These data represent a snapshot of the Washington Department of Fish and Wildlife's current records. Due to the ongoing nature of assessment and inventory of these features, these data may not accurately represent conditions on the ground, and are subject to change.

WDFW Fish Passage and Diversion Screening Inventory Database

Image Report - Active

Site ID: 609593		
Latitude: 48.190567	Stream: unnamed	WRIA: 06
Longitude: -122.600867	Tributary To: Race Lagoon	Fish Use Potential: Yes

Associated Features

- | | | | |
|---|--------------------------------|--|------------------------------------|
| <input checked="" type="checkbox"/> Culvert | <input type="checkbox"/> Dam | <input type="checkbox"/> Natural Barrier | <input type="checkbox"/> Diversion |
| <input type="checkbox"/> Non-Culvert Xing | <input type="checkbox"/> Other | <input type="checkbox"/> Fishway | |



Image Name: 609593_1.jpg, Date/Time: 03/05/2020 10:41



Image Name: 609593_2.jpg, Date/Time: 03/05/2020 10:49

7/17/2023

These data represent a snapshot of the Washington Department of Fish and Wildlife's current records. Due to the ongoing nature of assessment and inventory of these features, these data may not accurately represent conditions on the ground, and are subject to change.

Correction Analysis Form

Site Information (measurements in feet)

Project Name: **Island Co. Culvert Prioritization – Area 2** SRFB Project #: **19-1343** Date: **9/24/21**
Culvert #**1893**

Bankfull Width (outside influence of culvert): **5.9' u.s., 8.8' d.s.** Utilities Crossing: ☒ Yes ☐ No ☐ Unknown

Road Fill at Culvert Invert: **8.9' outlet IE to road surface** Road Width: **31.5' shoulder to shoulder**

Road Description/Condition (mainline, spur road, driveway/access): **2 lane county road**

Evaluator Information

Evaluator Name: **Tom Slocum, PE**

Affiliation: **Whidbey Island Conservation District**

Mailing Address: **PO Box 490**

City: **Coupeville**

State: **WA**

Zip: **98239**

Telephone:

FAX:

Cell: **360 899-6041**

E-mail: **tom@skagitcd.org**

Upstream Habitat/Channel Description

Channel Slope (outside of culvert influence): **3.9%**

Re-grade Potential (streambed US – streambed DS in feet): **2.30**

Dominant Substrate: ☐ Sand (<1/5") ☒ Gravel (1/5"–3") ☐ Cobble (3"–12") ☐ Boulder (>12") ☐ Bedrock

Additional Upstream Information, Habitat Description, Other Site Conditions or Concerns, Including Potential Re-Grade Impacts Relative to Channel Stability And Habitat:

The channel u.s. of the culvert crossing is a straightened, excavated ditch thorough dense blackberry thicket with no in-channel habitat features for at least 60 feet upstream of the crossing. The channel intersects the road ditch 5' u.s. of culvert.

Downstream Habitat/Channel Description

Channel Slope: **1.5%** (outside of culvert influence)

Additional Downstream Information, Habitat Description, Other Site Conditions or Concerns:

The channel is a straightened ditch for 20 feet d.s. of the culvert crossing, then enters a less-impacted, more natural channel that runs through rose and hawthorne hedges to Race Lagoon. Tidal elevations were not measured. The stream is classified as Type F. See the profile drawing.

Correction Options and Preferred Alternative

Options to Consider – Provide up to Three Site-Appropriate Correction Alternatives.

Option 1: **60' x 14' diameter bottomless arch culvert, per Stream Simulation design.**

Option 2: **60' x 13' x 7' high 3-sided concrete box culvert, per Stream Simulation design**

Option 3: **25' x 26' prefabricated concrete bridge**

Preferred Alternative - Provide a 1- or 2-paragraph Recommendation for this Site. Include any Site-Specific Concerns that Will Need to be Addressed During Design and Construction:

Option 1 is simplest and cheapest to construct, but depending on tidal elevations, may be susceptible to salt-water corrosion. Tidal elevations need to be determined to verify this. The bridge option likely would be unfavorable to Island Count DPW due to maintenance requirements. All options may require some degree of relocating water and phone utility lines, depending on the locations (be determined).

Cost Estimates

Rough Cost Estimate* - Attach Detailed Cost Breakdown Using the Appropriate Cost Estimate Template, Provided Separately.

Option 1: **\$368,200**

Option 2: **\$566,500**

Option 3: \$484,000

*This is a rough approximation of project costs; actual costs may vary depending on specifications identified during final design.

Correction Analysis Form Instructions

This will be completed for projects determined to be of potential high benefit to fish resources based on the information provided in Barrier Evaluation Form and Expanded Barrier Evaluation Form. The completed forms will be used to develop a prioritized list of projects to be presented to SRFB for potential funding.

Site Information

Project Name—This is the landowner's last name followed by the creek name. If more than one site per landowner is evaluated on the same creek, designate each site with a letter, e.g. Franklin-Boulder Creek A.

RCO/SRFB Project Number—This will be provided by PRISM database.

Bankfull Width—The stream width measured perpendicular to flow at the stage at which water begins to overflow into the active flood plain. Bankfull width requires a floodplain or a bench not present in many channels. In those cases, use ordinary high water. Ordinary high water is where the regular stream flow makes a line on the bank marking soil or vegetation with a character distinct from that of the abutting upland. Also defined as the lowest point at which perennial vegetation grows on the stream bank. Enter the average of several bankfull width measurements taken up and/or downstream of the culvert, outside the influence of the culvert.

Utilities Crossing—Include any water, gas, phone or electrical utilities at the crossing to be affected by project construction.

Road Fill at Downstream End—Measure height of material from top of culvert to top of fill at downstream end.

Road Width—Measurement should include shoulders.

Road Description/Condition—Provide a brief description of the road surface, use, condition, etc.

Evaluator Information

Provide contact information for the people completing the Correction Analysis Form.

Upstream Habitat and Channel Description

Channel Slope—This is measured outside of the culvert influence.

Re-grade Potential—Subtract the downstream streambed elevation from the upstream streambed elevation at the site.

Dominant Substrate—Identify the size category most prominent in the substrate.

Additional Information—Provide any additional upstream information that may be important to the project.

Downstream Habitat and Channel Description

Channel Slope—This is measured outside of the culvert influence.

Additional Information—Provide any additional upstream information that may be important to the project.

Correction Options and Preferred Alternative

Options to Consider—The purpose of this section is to provide the sponsor some guidance on the intended fix. Most small forest landowner projects should be relatively straightforward; however each site is different.

Preferred Alternative—Describe the recommended correction and site-specific concerns to be addressed during design and construction.

Cost Estimates

Rough cost estimate—Provide estimated costs for correction options listed above. Costs should be based on cost estimate templates, provided separately, for culverts, bottomless arch culverts, and bridges. Attach the corresponding completed template for each estimate. These represent approximate costs; actual costs may vary depending on specifications identified during final project design.

CULVERT EVALUATION FIELD FORM (LEVEL A)									
Site ID: ¹	1893	Culvert #: ²	1.1	Date: ³	3/5/20	Old ID: ⁴			
SKCO ID: ⁵		Org: ⁶	SFFCA	Crew: ⁷	EM, JG	Stream: ⁸			
PHOTOS TAKEN: ⁹ <input checked="" type="checkbox"/> US Culv <input type="checkbox"/> US Channel <input checked="" type="checkbox"/> DS Culv <input type="checkbox"/> DS Channel <input type="checkbox"/> Road Right <input type="checkbox"/> Road Left <input checked="" type="checkbox"/> Other									
ROAD DESCRIPTION									
Road Surface Type: ¹⁰	CS	<input checked="" type="checkbox"/> A	GR	Other	Road Width (including shoulders): ¹⁴	8.87	meters		
Temporary Access Needed? ¹¹	Yes	<input checked="" type="checkbox"/> No	Unknown		Road Fill Depth: ¹⁵ (B-D)	1.95	meters		
In-Road Utilities: ¹²	<input checked="" type="checkbox"/> Yes	No	Unknown		US Road Prism Depth: ¹⁶ (A-E)	2.245	meters		
Overhead Utilities/Crossings: ¹³	Yes	<input checked="" type="checkbox"/> No	Unknown		DS Road Prism Depth: ¹⁷ (B-F)	2.88	meters		
Road Notes: ¹⁸									
CULVERT DESCRIPTION									
Culvert Shape: ¹⁹	<input checked="" type="checkbox"/> BOX	ARCH	SQSH	ELL	Other	Length of Culvert: ²⁸	18.63	meters	
Culvert Material: ²⁰	PCC	CPC	<input checked="" type="checkbox"/> CST	SST	SPA	MRY	Culvert Span: ²⁹	0.85	meters
	CAL	SPS	PVC	TMB	Other		Rise of Culvert: ³⁰	use 3/4" for rise	meters
Number of Baffles: ²¹ (if > 0, fill out fishway form)	NA					Culvert Slope: ³¹	$\frac{(US\ Invert^E - DS\ Invert^F)}{Length^S} \times 100$ %		
Baffle Type: ²²	Concrete	Metal	Wood			Water Depth: ³²	5.25 m	meters	
	Plastic	Rock	Other			Hydraulic Drop: ³³	17 cm	19 cm	meters
Apron? ²³	US	DS	<input checked="" type="checkbox"/> No			Drop Location: ³⁴	<input checked="" type="checkbox"/> Inlet	<input type="checkbox"/> Outlet	<input checked="" type="checkbox"/> Interior
Gate? ²⁴	US	DS	<input checked="" type="checkbox"/> No			Plunge Pool Description (N/A if no Hydraulic Drop)			
Fishway? ²⁵ (if yes, fill out fishway form)	YES	<input checked="" type="checkbox"/> No				Plunge Pool Length: ³⁵	2.1	meters	
Countersunk? ²⁶	YES	<input checked="" type="checkbox"/> No				Maximum Depth: ³⁶	0.43	meters	
Backwatered? ²⁷	YES	<input checked="" type="checkbox"/> No				Scour Line Width: ³⁷	2.4	meters	
Culvert Notes: ³⁸ (if multiple culverts at site, indicate defining features of each) SLIGHTLY CRUSHED AT UP STREAM END TOTALLY RUSTED OUT AT BOTTOM, no inverts taken APPROX SURFACE ELEVATION IS 19cm DS 19cm 1m in culvert									
CHANNEL DESCRIPTION									
Channel Width: ³⁹	1.17m					Culvert Span ÷ Channel Width: ⁴⁰ (29÷39)			
Channel Notes: ⁴¹									
BARRIER STATUS ⁴² (Circle one below)									
Passable ⁴³	Barrier Reason ⁴⁴					Level B Analysis Required ⁴⁵			
	Drop > .24 M <input checked="" type="checkbox"/> Slope >= 1%					Backwatered <input type="checkbox"/> Slope < 1% <input type="checkbox"/> Culvert Width < 75% <input type="checkbox"/>			
Barrier Notes: ⁴⁶									

CULVERT EVALUATION FIELD FORM (LEVEL A): CALCULATIONS

Site ID: 1893

Culvert #: 1.1

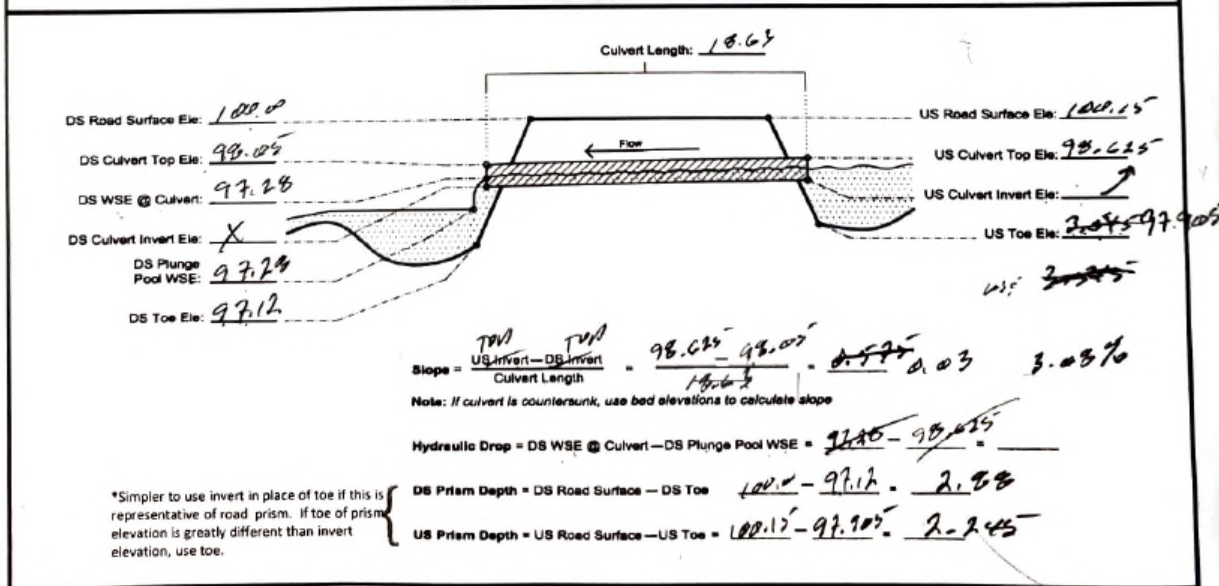
Date: 3-5-2024

FS	IH	BS	EL	NOTE
	101.45	1.45	100.00	BEACH MARK
3.325	"		96.125	US WSE
4.46	"		96.99	inlet WSE
4.17	"		97.25	DS WSE
4.23	"		97.12	DS TIDE
1.45	"	1.45	100.00	BS
3.545			97.905	US TIDE

ENTER FINAL MEASUREMENTS HERE

US Road Shoulder: ^A	1.30 / 100.12	DS Road Shoulder: ^B	1.45 / 100	220-1000 (BM)
US Culvert Top: ^C	2.825 / 99.62	DS Culvert Top: ^D	3.40 / 99.05	
US Culvert Invert: ^E	RUSTED OUT	DS Culvert Invert: ^F	RUSTED OUT	

SCHEMATIC OF CULVERT MEASUREMENTS



1900 - 100 in SWE 1000

12

Crossing Report for Race Road Small Culvert to East 1894

Project: Hydraulics and FishXing

Table 1. Project Summary for Hydraulics and FishXing

File Name	Crossing Name	Stream Name	Culvert Length	QLP	QHP	% Passable
small Race Road.xng	Race Road	unnamed	74 ft	2 cfs	8.55 cfs	100.0%

Crossing Location Information

Crossing Name: Race Road Small Culvert to East 1894

Stream Name: unnamed

Road: Race Road

FishXing V3.0 2006

Design Flows

Low Passage Flow: 2.3 cfs

High Passage Flow: 8.9 cfs

Tailwater Information

Tailwater Option: Tailwater Channel Cross-Section

Channel Bottom Slope: 3%

Outlet-Pool Bottom Elevation: 13.67 ft

Table 2. Tailwater Cross Section Data.

Station (ft)	Elevation (ft)	Roughness Coefficient
0.00	16.00	0.055
1.00	14.00	
8.50	14.00	
9.50	16.00	

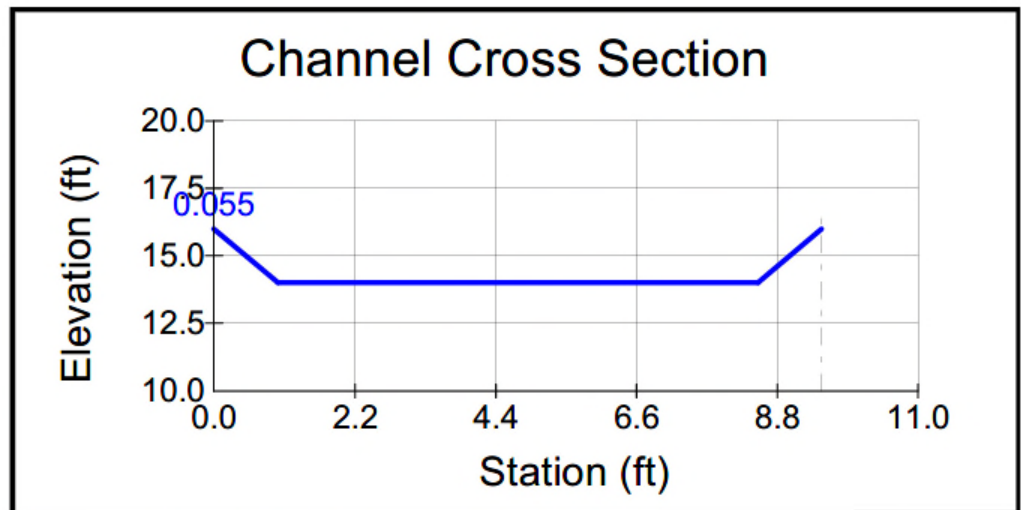


Figure 1. Channel Cross Section at Tailwater Crest.

FishXing V3.0 2006

Table 3. Tailwater Rating Table Information.

Discharge (cfs)	Tailwater Elevation (ft)	Wetted Perimeter (ft)	Cross-Sect. Area (sq. ft)	Composite Roughness Coefficient
0.0	14.0	0.00	0.00	0.000
0.7	14.1	7.72	0.75	0.055
2.4	14.2	7.95	1.52	0.055
4.6	14.3	8.17	2.29	0.055
7.4	14.4	8.39	3.08	0.055
10.6	14.5	8.62	3.87	0.055
14.3	14.6	8.84	4.68	0.055
18.4	14.7	9.07	5.49	0.055
22.9	14.8	9.29	6.32	0.055
27.7	14.9	9.51	7.15	0.055
32.8	15.0	9.74	8.00	0.055
38.3	15.1	9.96	8.85	0.055
44.1	15.2	10.18	9.72	0.055
50.2	15.3	10.41	10.59	0.055
56.5	15.4	10.63	11.48	0.055
63.2	15.5	10.85	12.37	0.055
70.1	15.6	11.08	13.28	0.055
77.3	15.7	11.30	14.19	0.055
84.8	15.8	11.52	15.12	0.055
92.5	15.9	11.75	16.06	0.055
100.5	16.0	11.97	17.00	0.055

FishXing V3.0 2006

Table 8. Culvert Profiles for 8.9 cfs.

Dist Down Culvert (ft)	Profiles for Q = 8.90 cfs				
	Depth (ft)	Velocity Average (ft/s)	Velocity Occupied (ft/s)	Swim Mode	Barrier Type
0	0.74	0.00	0.00	Prolonged	NONE
3	0.63	2.64	2.64	Prolonged	
6	0.63	2.03	2.02	Prolonged	
10	0.63	2.03	2.02	Prolonged	
14	0.63	2.03	2.02	Prolonged	
18	0.63	2.03	2.02	Prolonged	
22	0.63	2.03	2.02	Prolonged	
26	0.63	2.03	2.02	Prolonged	
30	0.64	1.99	1.98	Prolonged	
34	0.64	1.97	1.97	Prolonged	
38	0.65	1.96	1.95	Prolonged	
42	0.66	1.94	1.94	Prolonged	
46	0.66	1.92	1.91	Prolonged	
50	0.67	1.89	1.89	Prolonged	
54	0.68	1.86	1.85	Prolonged	
58	0.70	1.82	1.82	Prolonged	
62	0.71	1.78	1.78	Prolonged	
66	0.73	1.74	1.73	Prolonged	
70	0.75	1.69	1.68	Prolonged	
74	0.78	1.64	1.63		

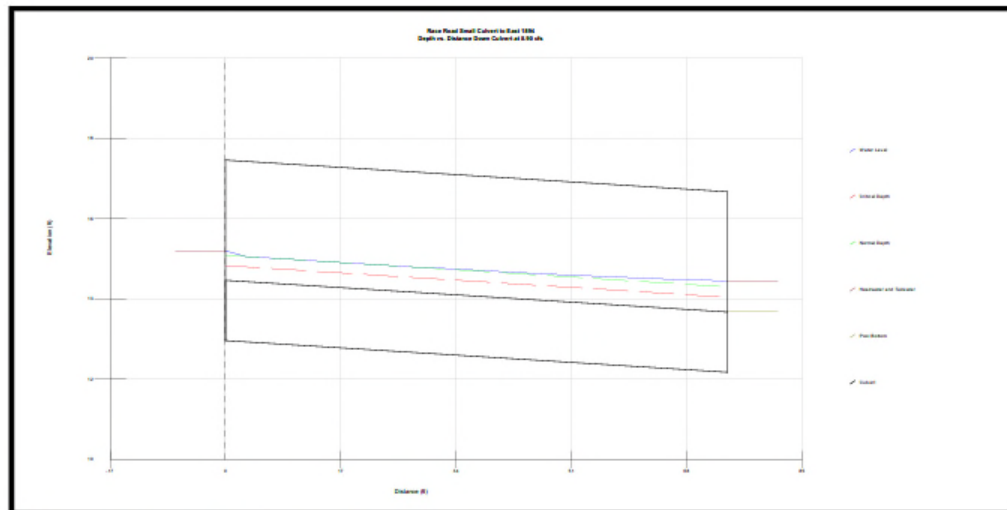


Figure 5. Water Surface Profile at 8.9 cfs

FishXing V3.0 2006

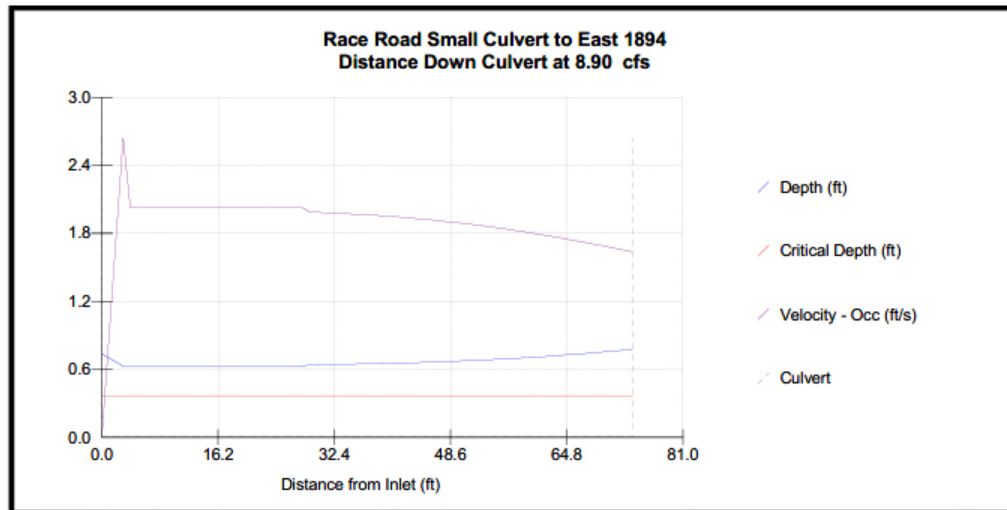


Figure 6. Culvert Profiles at 8.9 cfs

Table 9. Culvert Summary for 1 cfs.

Summary for Q = 1.00 cfs	
Normal Depth (ft)	0.17
Critical Depth (ft)	0.09
Headwater Depth (ft)	0.19
HW/D	0.06
Inlet Velocity (ft/s)	1.11
Tailwater Depth (ft)	0.45
Outlet Water Surface Drop (ft)	0.00
Prolonged Swim Time (min)	0.28
Burst Swim Time (s)	0.00
Barrier Code	Depth

FishXing V3.0 2006

Table 10. Culvert Profiles for 1 cfs.

Dist Down Culvert (ft)	Profiles for Q = 1.00 cfs				
	Depth (ft)	Velocity Average (ft/s)	Velocity Occupied (ft/s)	Swim Mode	Barrier Type
0	0.19	0.00	0.00	Prolonged	Depth
3	0.17	1.11	1.10	Prolonged	Depth
6	0.17	0.85	0.84	Prolonged	Depth
10	0.17	0.85	0.84	Prolonged	Depth
14	0.17	0.85	0.84	Prolonged	Depth
18	0.17	0.85	0.84	Prolonged	Depth
22	0.17	0.85	0.84	Prolonged	Depth
26	0.17	0.85	0.84	Prolonged	Depth
30	0.17	0.85	0.84	Prolonged	Depth
34	0.17	0.85	0.84	Prolonged	Depth
38	0.17	0.82	0.82	Prolonged	Depth
42	0.18	0.78	0.78	Prolonged	Depth
46	0.20	0.72	0.72	Prolonged	Depth
50	0.22	0.64	0.64	Prolonged	
54	0.25	0.57	0.56	Prolonged	
58	0.29	0.50	0.49	Prolonged	
62	0.32	0.44	0.44	Prolonged	
66	0.36	0.39	0.39	Prolonged	
70	0.40	0.35	0.35	Prolonged	
74	0.45	0.32	0.32		

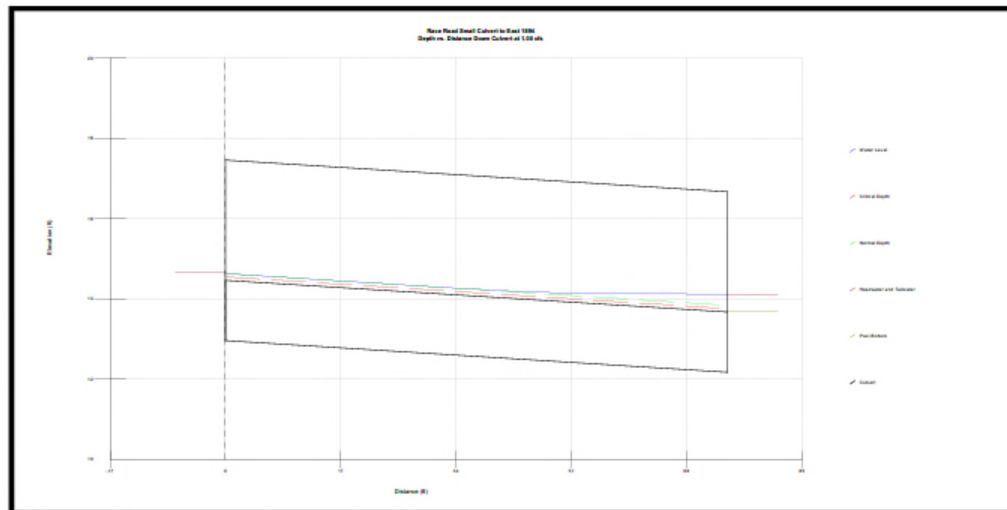


Figure 7. Water Surface Profile at 1 cfs

FishXing V3.0 2006

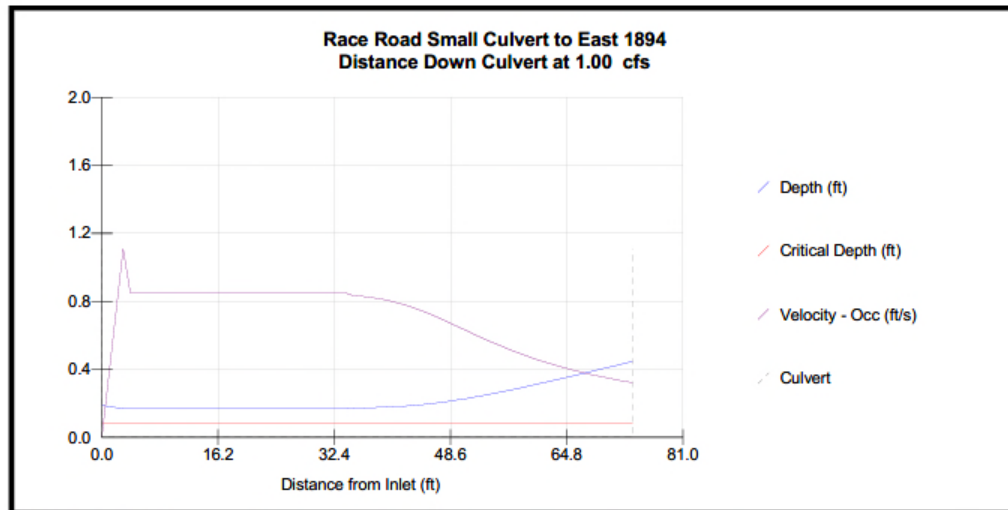


Figure 8. Culvert Profiles at 1 cfs

FishXing V3.0 2006

Table 11. Culvert Rating Table.

Q total (cfs)	Depth Min (ft)	V(occ) Max (ft/s)	Depth TW (ft)	Outlet WS Drop (ft)	Depth Pool (ft)	Barrier Type
0.00	0.00	0.00	-13.67	13.67	-13.67	Drop; Depth; P
0.44	0.10	0.80	0.39	0.00	0.39	Depth
0.88	0.16	1.05	0.44	0.00	0.44	Depth
1.32	0.20	1.24	0.47	0.00	0.47	Depth
1.76	0.24	1.39	0.49	0.00	0.49	NONE
2.30	0.28	1.54	0.53	0.00	0.53	NONE
2.74	0.31	1.66	0.55	0.00	0.55	NONE
3.18	0.34	1.76	0.57	0.00	0.57	NONE
3.62	0.36	1.85	0.59	0.00	0.59	NONE
4.06	0.39	1.94	0.61	0.00	0.61	NONE
4.50	0.42	2.02	0.63	0.00	0.63	NONE
4.94	0.44	2.09	0.64	0.00	0.64	NONE
5.38	0.46	2.16	0.66	0.00	0.66	NONE
5.82	0.49	2.23	0.67	0.00	0.67	NONE
6.26	0.51	2.30	0.69	0.00	0.69	NONE
6.70	0.53	2.36	0.71	0.00	0.71	NONE
7.14	0.55	2.42	0.72	0.00	0.72	NONE
7.58	0.57	2.48	0.74	0.00	0.74	NONE
8.02	0.59	2.54	0.75	0.00	0.75	NONE
8.46	0.61	2.59	0.76	0.00	0.76	NONE
8.90	0.63	2.64	0.78	0.00	0.78	NONE
9.34	0.65	2.69	0.79	0.00	0.79	NONE
9.78	0.66	2.74	0.80	0.00	0.80	NONE
10.22	0.68	2.79	0.82	0.00	0.82	NONE
10.66	0.70	2.84	0.83	0.00	0.83	NONE
11.10	0.72	2.88	0.84	0.00	0.84	NONE
11.54	0.73	2.93	0.85	0.00	0.85	NONE
11.98	0.75	2.97	0.87	0.00	0.87	NONE
12.42	0.77	3.01	0.88	0.00	0.88	NONE
12.86	0.78	3.05	0.89	0.00	0.89	NONE
13.35	0.80	3.10	0.90	0.00	0.90	NONE

FishXing V3.0 2006

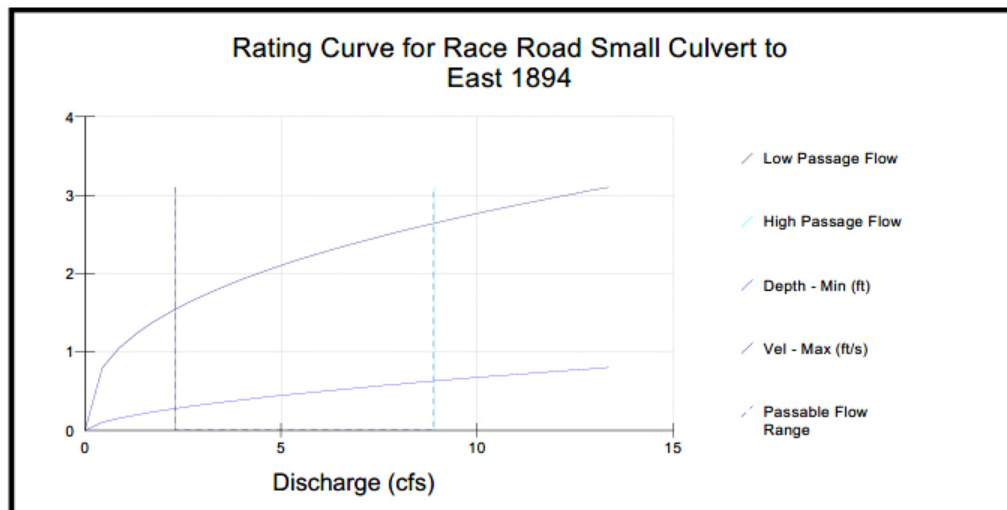


Figure 9. Culvert Rating Curve

Barrier Codes

V = Strict Velocity Barrier
 EB = Fish Exhausted at Burst Speed
 Long = Fish Exhausted at Prolonged Speed
 Leap = Excessive leap at outlet
 Drop = Excessive drop at outlet
 Depth = Too shallow for substantial distance
 Pool = Leap Pool too shallow
 NONE = Not a barrier

FishXing V3.0 2006

Table 3. Tailwater Rating Table Information.

Discharge (cfs)	Tailwater Elevation (ft)	Wetted Perimeter (ft)	Cross-Sect. Area (sq. ft)	Composite Roughness Coefficient
0.0	14.0	0.00	0.00	0.000
0.7	14.1	7.72	0.75	0.055
2.4	14.2	7.95	1.52	0.055
4.6	14.3	8.17	2.29	0.055
7.4	14.4	8.39	3.08	0.055
10.6	14.5	8.62	3.87	0.055
14.3	14.6	8.84	4.68	0.055
18.4	14.7	9.07	5.49	0.055
22.9	14.8	9.29	6.32	0.055
27.7	14.9	9.51	7.15	0.055
32.8	15.0	9.74	8.00	0.055
38.3	15.1	9.96	8.85	0.055
44.1	15.2	10.18	9.72	0.055
50.2	15.3	10.41	10.59	0.055
56.5	15.4	10.63	11.48	0.055
63.2	15.5	10.85	12.37	0.055
70.1	15.6	11.08	13.28	0.055
77.3	15.7	11.30	14.19	0.055
84.8	15.8	11.52	15.12	0.055
92.5	15.9	11.75	16.06	0.055
100.5	16.0	11.97	17.00	0.055

FishXing V3.0 2006

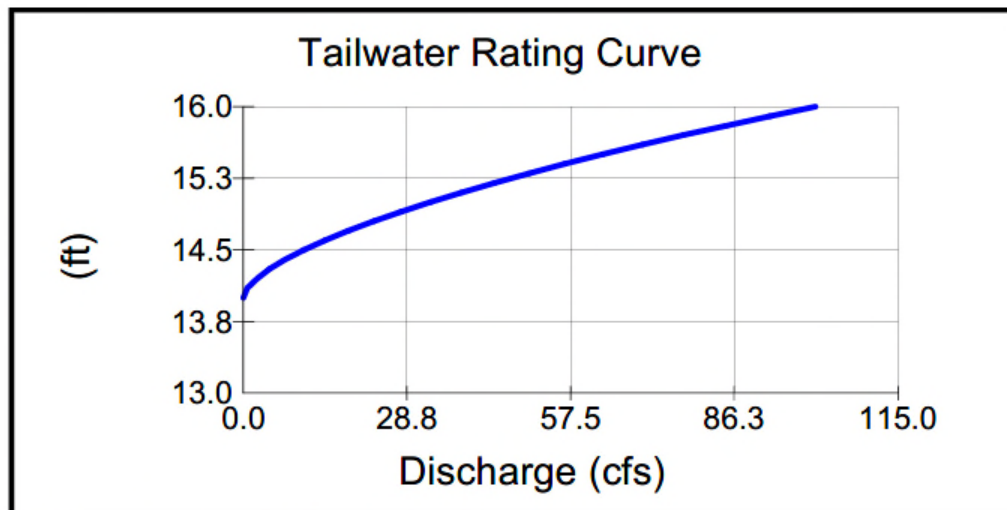


Figure 2. Tailwater Rating Curve

Table 4. Fish Passage Summary.

Fish Passage Summary	
Low Passage Design Flow	2.30 cfs
High Passage Design Flow	8.90 cfs
Percent of Flows Passable	100.0 %
Passable Flow Range	2.30 to 8.90 cfs
Depth Barrier	None
Outlet Drop Barriers	None
Velocity Barrier	None
Pool Depth Barrier	None

Table 5. Culvert Summary for 2.30 cfs.

Summary for Q = 2.30 cfs	
Normal Depth (ft)	0.28
Critical Depth (ft)	0.15
Headwater Depth (ft)	0.31
HW/D	0.10
Inlet Velocity (ft/s)	1.54
Tailwater Depth (ft)	0.53
Outlet Water Surface Drop (ft)	0.00
Prolonged Swim Time (min)	0.30
Burst Swim Time (s)	0.00
Barrier Code	NONE

FishXing V3.0 2006

Table 6. Culvert Profiles for 2.30 cfs.

Dist Down Culvert (ft)	Profiles for Q = 2.30 cfs				
	Depth (ft)	Velocity Average (ft/s)	Velocity Occupied (ft/s)	Swim Mode	Barrier Type
0	0.31	0.00	0.00	Prolonged	NONE
3	0.28	1.54	1.54	Prolonged	
6	0.28	1.18	1.16	Prolonged	
10	0.28	1.18	1.16	Prolonged	
14	0.28	1.18	1.16	Prolonged	
18	0.28	1.18	1.16	Prolonged	
22	0.28	1.18	1.16	Prolonged	
26	0.28	1.18	1.16	Prolonged	
30	0.28	1.18	1.16	Prolonged	
34	0.29	1.15	1.15	Prolonged	
38	0.29	1.13	1.12	Prolonged	
42	0.30	1.09	1.09	Prolonged	
46	0.31	1.05	1.04	Prolonged	
50	0.33	0.99	0.98	Prolonged	
54	0.36	0.92	0.92	Prolonged	
58	0.39	0.85	0.85	Prolonged	
62	0.42	0.79	0.78	Prolonged	
66	0.45	0.73	0.72	Prolonged	
70	0.49	0.67	0.67	Prolonged	
74	0.53	0.62	0.62		

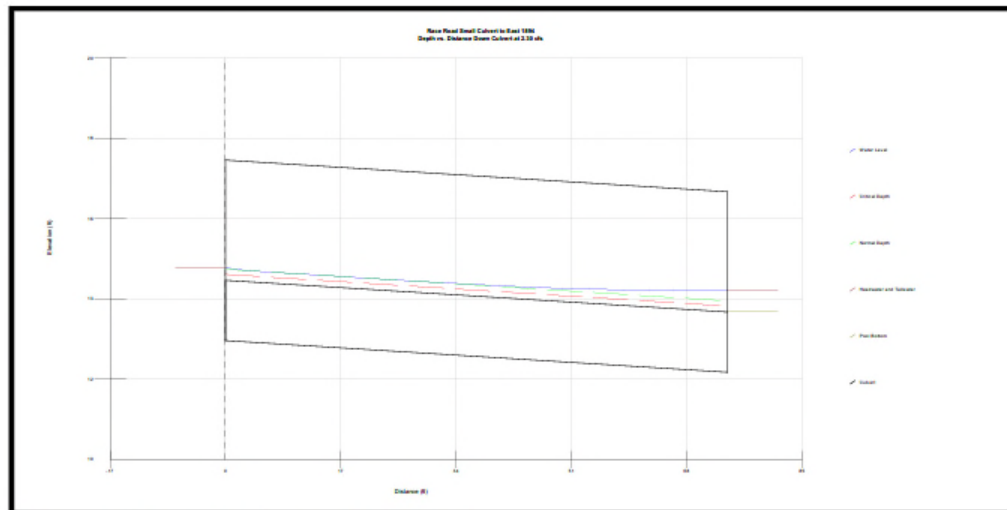


Figure 3. Water Surface Profile at 2.3 cfs

FishXing V3.0 2006

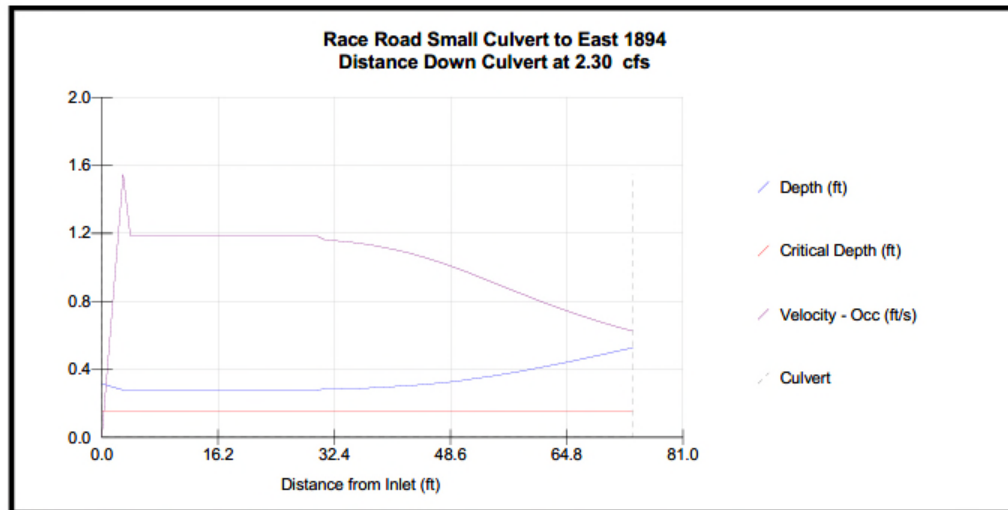


Figure 4. Culvert Profiles at 2.3 cfs

Table 7. Culvert Summary for 8.9 cfs.

Summary for Q = 8.90 cfs	
Normal Depth (ft)	0.63
Critical Depth (ft)	0.37
Headwater Depth (ft)	0.74
HW/D	0.25
Inlet Velocity (ft/s)	2.64
Tailwater Depth (ft)	0.78
Outlet Water Surface Drop (ft)	0.00
Prolonged Swim Time (min)	0.39
Burst Swim Time (s)	0.00
Barrier Code	NONE

FishXing V3.0 2006

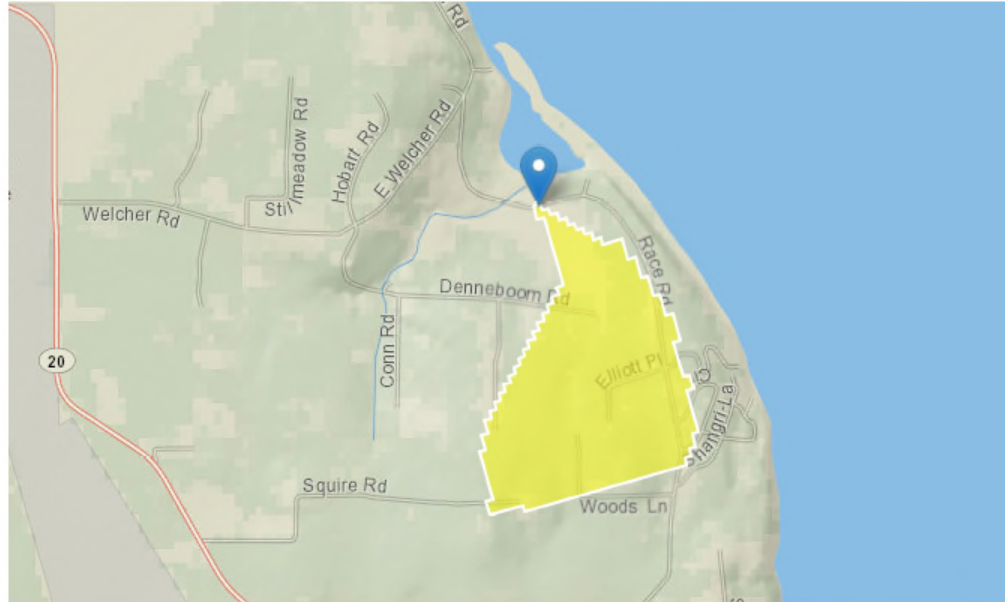
Race Road Culvert Stream Stats at 1894 SE Culvert

Region ID: WA

Workspace ID: WA20220311000053870000

Clicked Point (Latitude, Longitude): 48.19019, -122.59897

Time: 2022-03-10 16:01:20 -0800



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.28	square miles
PRECPRIS10	Basin average mean annual precipitation for 1981 to 2010 from PRISM	21.4	inches
PRECIP	Mean Annual Precipitation	20.1	inches
BSLDEM30M	Mean basin slope computed from 30 m DEM	7.95	percent
CANOPY_PCT	Percentage of drainage area covered by canopy as described in OK SIR 2009_5267	75.5	percent

Parameter Code	Parameter Description	Value	Unit
ELEV	Mean Basin Elevation	179	feet
ELEVMAX	Maximum basin elevation	344	feet
MINBELEV	Minimum basin elevation	26.2	feet
NFSL30	North-Facing Slopes Greater Than 30 Percent	0	percent
RELIEF	Maximum - minimum elevation	317	feet
SLOP30_30M	Percent area with slopes greater than 30 percent from 30-meter DEM.	0	percent

Peak-Flow Statistics Parameters [Peak Region 3 2016 5118]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.28	square miles	0.08	2610
PRECPRIS10	Mean Annual Precip PRISM 1981 2010	21.4	inches	33.2	168

Peak-Flow Statistics Disclaimers [Peak Region 3 2016 5118]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report [Peak Region 3 2016 5118]

Statistic	Value	Unit
50-percent AEP flood	1.99	ft ³ /s
20-percent AEP flood	3.3	ft ³ /s
10-percent AEP flood	4.23	ft ³ /s
4-percent AEP flood	5.49	ft ³ /s
2-percent AEP flood	6.44	ft ³ /s
1-percent AEP flood	7.5	ft ³ /s
0.5-percent AEP flood	8.55	ft ³ /s

Statistic	Value	Unit
0.2-percent AEP flood	10.1	ft ³ /s

Peak-Flow Statistics Citations

Mastin, M.C., Konrad, C.P., Veilleux, A.G., and Tecca, A.E., 2016, Magnitude, frequency, and trends of floods at gaged and ungaged sites in Washington, based on data through water year 2014 (ver 1.1, October 2016): U.S. Geological Survey Scientific Investigations Report 2016-5118, 70 p. (<http://dx.doi.org/10.3133/sir20165118>)

Low-Flow Statistics Parameters [Low Flow Western 2 var 2012 5078]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.28	square miles	0.1	48.9
PRECIP	Mean Annual Precipitation	20.1	inches	25.1	143

Low-Flow Statistics Disclaimers [Low Flow Western 2 var 2012 5078]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Low-Flow Statistics Flow Report [Low Flow Western 2 var 2012 5078]

Statistic	Value	Unit
7 Day 10 Year Low Flow	0.00766	ft ³ /s

Low-Flow Statistics Citations

Curran, C.A., Eng, Ken, and Konrad, C.P., 2012, Analysis of low flows and selected methods for estimating low-flow characteristics at partial-record and ungaged stream sites in western Washington: U.S. Geological Survey Scientific Investigations Report 2012-5078, 46 p. (<http://pubs.usgs.gov/sir/2012/5078/>)

Bankfull Statistics Parameters [37.0 Percent (0.103 square miles) Pacific Mountain System D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.28	square miles	6.1776	8079.9147

Bankfull Statistics Parameters [37.0 Percent (0.103 square miles) Pacific Border P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.28	square miles	6.169878	3938.976756

Bankfull Statistics Parameters [37.0 Percent (0.103 square miles) USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.28	square miles	0.07722	59927.7393

Bankfull Statistics Parameters [58.0 Percent (0.162 square miles) Pac Maritime Mtn CastroJackson 2001]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.28	square miles	54.8	3093

Bankfull Statistics Disclaimers [37.0 Percent (0.103 square miles) Pacific Mountain System D Bieger 2015]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Bankfull Statistics Flow Report [37.0 Percent (0.103 square miles) Pacific Mountain System D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	7.97	ft
Bieger_D_channel_depth	0.687	ft
Bieger_D_channel_cross_sectional_area	7.59	ft^2

Bankfull Statistics Disclaimers [37.0 Percent (0.103 square miles) Pacific Border P Bieger 2015]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Bankfull Statistics Flow Report [37.0 Percent (0.103 square miles) Pacific Border P

Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	6.27	ft
Bieger_P_channel_cross_sectional_area	6.08	ft^2
Bieger_P_channel_depth	0.62	ft

Bankfull Statistics Flow Report [37.0 Percent (0.103 square miles) USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	7.91	ft
Bieger_USA_channel_depth	0.919	ft
Bieger_USA_channel_cross_sectional_area	8.59	ft^2

Bankfull Statistics Disclaimers [58.0 Percent (0.162 square miles) Pac Maritime Mtn CastroJackson 2001]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Bankfull Statistics Flow Report [58.0 Percent (0.162 square miles) Pac Maritime Mtn CastroJackson 2001]

Statistic	Value	Unit
Bankfull Width	7.17	ft
Bankfull Depth	0.402	ft
Bankfull Area	5.57	ft^2
Bankfull Streamflow	38.8	ft^3/s

Bankfull Statistics Citations

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G., 2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p.
https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_campaign=PDFCoverPages
Castro, J.M, and Jackson, P.L. Castro, J.M, and Jackson, P.L., 2001, Bankfull Discharge Recurrence Intervals and Regional Hydraulic Geometry Relationships: Patterns in the

Pacific Northwest, USA, Journal of the American Water Resources Association, Volume 37, No. 5, 14 p. (<https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1752-1688.2001.tb03636.x>)

USGS Data Disclaimer: Unless otherwise stated, all data, metadata and related materials are considered to satisfy the quality standards relative to the purpose for which the data were collected. Although these data and associated metadata have been reviewed for accuracy and completeness and approved for release by the U.S. Geological Survey (USGS), no warranty expressed or implied is made regarding the display or utility of the data for other purposes, nor on all computer systems, nor shall the act of distribution constitute any such warranty.

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USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.7.0

StreamStats Services Version: 1.2.22

NSS Services Version: 2.1.2

Flows for design small 1894 east				
Values From Streamstats		cfs		
	Return Year	Value		
	2	1.99		
	5	3.3		
	10	4.23		
	25	5.49		
	50	6.44		
	100	7.55		
	200	8.55		
	500	10.1		
Bieger BFW, feet		7.97 feet		
Climate change Factors ¹				
	Year factors		Increased Values	
	2040	2080	2040	2080
% increase in BFW Flow (2 year)	9.9	14.7	2.2	2.3 cfs
% increase in BFW Width	4.7	6.9	8.3	8.5 feet
% increase in 100 year Flood	8.8	17.7	8.2	8.9 cfs

¹ WDFW, web-based analysis. Culverts and Climate Change, changes in bank full width and flow rates in culverts in Washington state. Developed in conjunction with University of Washington 2021.
<https://geodataservices.wdfw.wa.gov/hp/culvert-app/#aboutTab>

Where; PlI in the Prediction Interval limit lower, Plu is the Prediction Interval limit upper, and AESp is the Average Standard error of Prediction.

References;

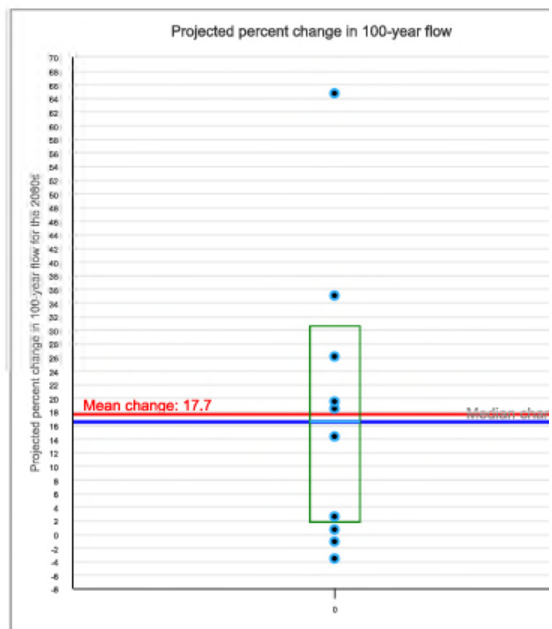
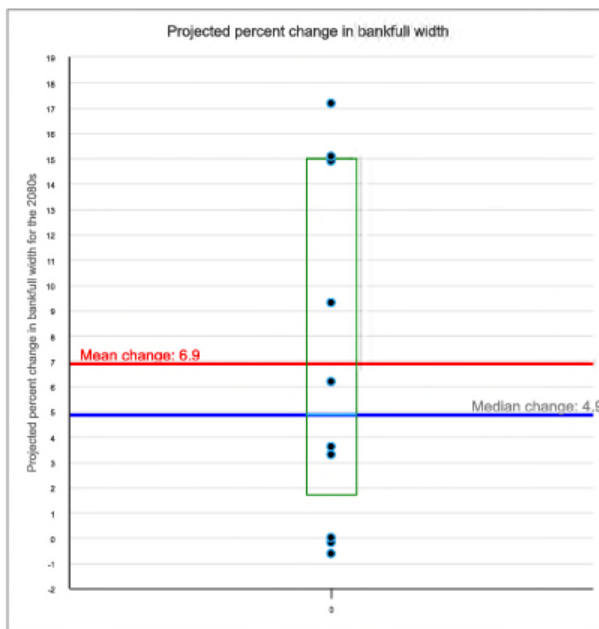
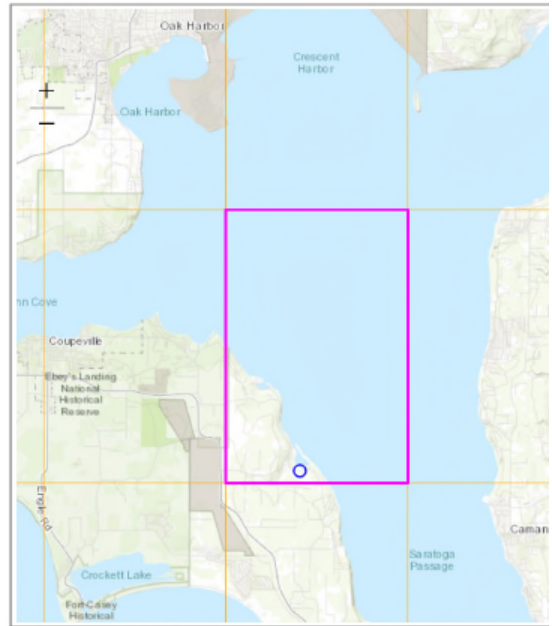
Mastin, M.C., Konrad, C.P., Veilleux, A.G., and Tecca, A.E.,2016, Magnitude, frequency, and trends of floods at gaged and ungaged sites in Washington, based on data through water year 2014 (ver 1.1, October 2016): U.S. Geological Survey Scientific Investigations Report 2016–5118, 70 p.

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p.

Castro, J.M, and Jackson, P.L.Castro, J.M, and Jackson, P.L., 2001, Bankfull Discharge Recurrence Intervals and Regional Hydraulic Geometry Relationships: Patterns in the Pacific Northwest, USA, Journal of the American Water Resources Association, Volume 37, No. 5, 14 p.

Future Projections for Climate-Adapted Culvert Design

Project Name: Race Road Fish Passage C
Stream Name: unnamed Tributary to Race
Street Name: Race Road
Culvert coordinates: 48.1904, -122.5995
Grid ID 48.21875_-122.59375
Ecoregion Pacific Maritime Mountains
Projected mean percent change in bankfull flow:
 2040s: 9.9% 2080s: 14.7%
Projected mean percent change in bankfull width:
 2040s: 4.7% 2080s: 6.9%
Projected mean percent change in 100-year flood:
 2040s: 8.8% 2080s: 17.7%



The Washington Department of Fish and Wildlife makes no guarantee concerning the data's content, accuracy, precision, or completeness. WDFW makes no warranty of fitness for a particular purpose and assumes no liability for the data represented here.

Race Road 1894 East Smaller			Culvert Geometry				Bridge Geometry						
Site	Bankfull width Measurements, feet	Average Bankfull width	Culvert Stream Simulation Width	Additional Width Conditions for debris	Culvert Span Chosen	Use this Culvert Span	Depth to Cr invert from bot cord of bridge	Stream Bottom Width required	Side Slopes	Skew Angle	Bridge Span with no Skew	Bridge Span Length with Skew	
US	6.5 6 5.5 8 12 9												
Up stream DS	5 4 6 5 3 3.5	7.8	11.4	1.5	12.9	12.9	5	12	2	0	32	32	
		BFWc Grand Average		6.1	BFWc Grand Average Span Width								
				Climate Change Factor Adjusted Span		1.3							
Downstream		4.41666667	7.3	1.5	8.8	8.8	5	12	2	0	32	32	

Race Road 1893 West Larger			Culvert Geometry				Bridge						
Site	Bankfull width Measurements, feet	Average Bankfull width	Culvert Stream Simulation Width	Additional Width Conditions for debris	Culvert Span Chosen	Use this Culvert Span	Depth to Cr invert from bot cord of bridge	Stream Bottom Width required	Side Slopes	Skew Angle	Bridge Span with no Skew	Bridge Span Length with Skew	
Up stream	6 7.5 10.5												
Up stream	5 6 5.5 7 10.5	8.0	11.6	1.5	13.1	13.1	3	7.5	2.5	0	22.5	23	
		BFWc Grand Average		7.4	BFWc Grand Average								
				Climate Change Factor Adjusted Span		1.3							
Downstream			6.8	10.2	1.5	11.7	3	7.5	2.5	0	22.5	23	



Washington Department of Fish and Wildlife

Fish Passage & Diversion Screening Inventory Database Report Cover Sheet

The following report is extracted from the Washington Department of Fish and Wildlife's (WDFW) Fish Passage and Diversion Screening Inventory Database (FPDSI). WDFW makes every attempt to keep these reports in sync with FPDSI; however, the dynamic nature of the data and workflows associated with maintaining the database may result in short-term differences.

Users are encouraged to contact WDFW to discuss appropriate use of the data and how we can assist with fish passage barrier removal or inventory. Please visit the Fish Passage web site for contact information at: <https://wdfw.wa.gov/species-habitats/habitat-recovery/fish-passage/about>

Disclaimers:

- Data presented here represent a snapshot observation of conditions in a dynamic environment that is subject to change. Fish passage data are also collected from a variety of agencies and sources. Therefore, WDFW makes no guarantee concerning the data's content, accuracy, completeness, or the results obtained from use of the data. WDFW assumes no liability for the data represented here.
- These data are not an attempt to provide you with an official agency response as to the impacts of your project on fish and wildlife.
- Note that some fish passage features, habitats or species may occur in areas not currently known to the WDFW Fish Passage division, and may not be reflected in this database. A lack of data does not necessarily indicate that a feature, habitat, or species are not present.
- Unauthorized attempts to alter or modify these data are strictly prohibited.
- Bankfull width measurements included in these reports should not be used for fish passage crossing design. They are solely for assessment purposes.
- The barrier status reported in this document is based on the swimming abilities of adult salmonids. Passabilities are a qualitative value, and should not be interpreted as a quantitative calculation. Please see page 1-4 of the Fish Passage Inventory, Assessment and Prioritization Manual for further clarification: <https://wdfw.wa.gov/publications/02061>
- EXIF data presented with Image Reports may be erroneous due to camera battery failures and resetting of camera clock functions.

Abbreviations:

Most abbreviations in this report are defined in the Quick Reference Tables of the Fish Passage Inventory, Assessment, and Prioritization Manual. Additional commonly used abbreviations are defined as follows:

NFB = no potential salmonid use, **BB** = both banks, **LB** = left bank looking downstream, **RB** = right bank looking downstream, **US** or **U/S** = upstream, **DS** or **D/S** = downstream, **WSDrop** = water surface drop, **BFW** = bankfull width, **OHW** = ordinary high water, **SLW** = scour line width, **CMP** = corrugated metal pipe, **Q₉₅** = fish passage flow, **V&D** = Velocity and Depth, **ROW** = Right of Way

The FPDSI database often uses default values such as '-99.99' or '-999' to represent null values.

WDFW Fish Passage and Diversion Screening Inventory Database

Site Description Report

Site ID 609594

Project

☐ Mitigated

Geographic Coordinates

Latitude (WGS 84):	48.1903825
Longitude (WGS 84):	-122.5995231
East (NAD 83 HARN):	1,128,179.5
North (NAD 83 HARN):	1,048,858.0

Waterbody

Stream:	unnamed
Tributary To:	Race Lagoon
WRIA:	06
River Mile:	-999.99
Fish Use Potential:	Unknown
FUP Criteria:	

General Location

Road Name:	Race Rd
Mile Post:	-999.99
County:	Island
WDFW Region:	4

Owner

Type:	County
Name:	Island County

PI Species

<input type="checkbox"/> Sockeye	<input type="checkbox"/> Chinook	<input type="checkbox"/> Sea Run Cutthroat
<input type="checkbox"/> Pink	<input type="checkbox"/> Coho	<input type="checkbox"/> Resident Trout
<input type="checkbox"/> Chum	<input type="checkbox"/> Steelhead	<input type="checkbox"/> Bull Trout

Associated Features

<input checked="" type="checkbox"/> Culvert	<input type="checkbox"/> Dam	<input type="checkbox"/> Natural Barrier	<input type="checkbox"/> Diversion
<input type="checkbox"/> Non-Culvert Xing	<input type="checkbox"/> Other	<input type="checkbox"/> Fishway	

Location/Directions

Site Comments

7/17/2023

These data represent a snapshot of the Washington Department of Fish and Wildlife's current records. Due to the ongoing nature of assessment and inventory of these features, these data may not accurately represent conditions on the ground, and are subject to change.

WDFW Fish Passage and Diversion Screening Inventory Database

Level A Culvert Assessment Report

Site ID: 609594	Stream: unnamed	WRIA: 06
Latitude: 48.1903825	Tributary To: Race Lagoon	Fish Use Potential: Unknown
Longitude: -122.5995231		

Data Source: Skagit Fisheries Enhancement Group
Field Crew: Matthews;JJ;PM Review Date: 2/27/2020

Culvert Details										Level A Parameters			
ID	Shape	Material	Span	Rise	Length	WDIC	Apron	WSDrop	Location	Countersunk	Backwater	Slope (%)	Sediment
1.1	RND	CST	0.50	0.55	23.10	0.10	NO	0.00		No	No	0.97	

All dimensions in meters

Channel Description Toe Width (m): <input type="text"/> Average Width (m): <input type="text" value="1.80"/> Culvert/Stream Width Ratio: <input type="text" value="0.28"/> Plunge Pool Length (m): <input type="text" value="0.00"/> Max Depth (m): <input type="text" value="-99.99"/> OHW Width (m): <input type="text" value="-999.99"/> Road Fill Depth (m): <input type="text" value="1.10"/>	
--	--

Assessment Results Barrier: <input type="text" value="Unknown"/> Reason: <input type="text" value="Level B Require"/>	Tidal Influence: <input type="text" value="No"/> Passability (%): <input type="text" value="Unknown"/> Fishway Present: <input type="text" value="No"/>	Tidegate Present: <input type="text" value="No"/> Method: <input type="text" value="Level A"/> Recheck: <input type="text" value="LB"/>
--	---	---

Comments

Potential Habitat Gain Survey Type: <input type="text"/> Significant Reach: <input type="text" value="Unknown"/>	Spawning (sq m): <input type="text"/> Rearing (sq m): <input type="text"/>	Length (m): <input type="text"/> PI Total: <input type="text"/>
---	---	--

7/17/2023

These data represent a snapshot of the Washington Department of Fish and Wildlife's current records. Due to the ongoing nature of assessment and inventory of these features, these data may not accurately represent conditions on the ground, and are subject to change.

WDFW Fish Passage and Diversion Screening Inventory Database
Image Report - Active

Site ID: 609594	Stream: unnamed	WRIA: 06
Latitude: 48.1903825	Tributary To: Race Lagoon	Fish Use Potential: Unknown
Longitude: -122.5995231		

Associated Features

- | | | | |
|---|--------------------------------|--|------------------------------------|
| <input checked="" type="checkbox"/> Culvert | <input type="checkbox"/> Dam | <input type="checkbox"/> Natural Barrier | <input type="checkbox"/> Diversion |
| <input type="checkbox"/> Non-Culvert Xing | <input type="checkbox"/> Other | <input type="checkbox"/> Fishway | |



Image Name: 609594_1.jpg, Date/Time: 02/27/2020 12:45



Image Name: 609594_2.jpg, Date/Time: 02/27/2020 12:41

7/17/2023

These data represent a snapshot of the Washington Department of Fish and Wildlife's current records. Due to the ongoing nature of assessment and inventory of these features, these data may not accurately represent conditions on the ground, and are subject to change.

Correction Analysis Form

Site Information (measurements in feet)

Project Name: *Island Co. Culvert Prioritization – Area 2* SRFB Project #: *19-1343* Date: *9/24/21*
Culvert #*1894*

Bankfull Width (outside influence of culvert): *3.3' u.s., 4.6' d.s.* Utilities Crossing: ☒ Yes ☐ No ☐ Unknown

Road Fill at Culvert Invert: *5.2' outlet IE to road surface* Road Width: *27' shoulder to shoulder*

Road Description/Condition (mainline, spur road, driveway/access): *2 lane county road*

Evaluator Information

Evaluator Name: **Tom Slocum, PE**

Affiliation: **Whidbey Island Conservation District**

Mailing Address: **PO Box 490**

City: **Coupeville**

State: **WA**

Zip: **98239**

Telephone:

FAX:

Cell: **360 899-6041**

E-mail: **tom@skagitcd.org**

Upstream Habitat/Channel Description

Channel Slope (outside of culvert influence): *0.8%* Re-grade Potential (streambed US – streambed DS in feet): *0.9*

Dominant Substrate: ☐ Sand (<1/5") ☒ Gravel (1/5"–3") ☐ Cobble (3"–12") ☐ Boulder (>12") ☐ Bedrock

Additional Upstream Information, Habitat Description, Other Site Conditions or Concerns, Including Potential Re-Grade Impacts Relative to Channel Stability And Habitat:

Straightened, excavated channel through dense rose bush and hawthorne thickets with no in-channel habitat features. Intersects road ditch 5' u.s. of culvert.

Downstream Habitat/Channel Description

Channel Slope: *3.7%* (outside of culvert influence)

Additional Downstream Information, Habitat Description, Other Site Conditions or Concerns:

Excavated channel for 28 feet d.s. of culvert, where two, 12" diam. CPP culverts across a private access lane create a passage barrier. Tidal elevation was not measured. Stream is classified improbably as Type F. See the profile drawing.

Correction Options and Preferred Alternative

Options to Consider – Provide up to Three Site-Appropriate Correction Alternatives.

Option 1: **60 LF x 7-ft diameter pipe arch culvert per No Slope design**

Option 2: **60 LF x 7.5-ft diameter bottomless arch culvert per No Slope design**

Option 3: **60 LF x 7-ft wide x 4-ft high concrete box culvert, per No Slope design**

Preferred Alternative - Provide a 1- or 2-paragraph Recommendation for this Site. Include any Site-Specific Concerns that Will Need to be Addressed During Design and Construction:

Option 1 is simplest to construct, but depending on tidal elevations, may be susceptible to salt-water corrosion. Tidal elevations need to be determined to verify this. If salt water corrosion will be excessive, then Option 3 (concrete box culvert) would be the preferred alternative. All options may require some degree of relocating water and phone utility lines, depending on the locations (be determined).

Cost Estimates

Rough Cost Estimate* - Attach Detailed Cost Breakdown Using the Appropriate Cost Estimate Template, Provided Separately.

Option 1: \$271,900

Option 2: \$279,500

Option 3: \$340,000

*This is a rough approximation of project costs; actual costs may vary depending on specifications identified during final design.

CULVERT EVALUATION FIELD FORM (LEVEL A)									
Site ID: ¹	1894	Culvert #: ²	1.1	Date: ³	2/27/20	Old ID: ⁴			
SKCO ID: ⁵		Org: ⁶	SFEG	Crew: ⁷	PM, EMS	Stream: ⁸			
PHOTOS TAKEN: ⁹ <input checked="" type="checkbox"/> US Culv <input checked="" type="checkbox"/> US Channel <input checked="" type="checkbox"/> DS Culv <input checked="" type="checkbox"/> DS Channel <input checked="" type="checkbox"/> Road Right <input checked="" type="checkbox"/> Road Left <input checked="" type="checkbox"/> Other									
ROAD DESCRIPTION									
Road Surface Type: ¹⁰	CS	<input checked="" type="checkbox"/> A	GR	Other	Road Width (including shoulders): ¹⁴	22.25	8-10	meters	
Temporary Access Needed? ¹¹	Yes	No	<input checked="" type="checkbox"/> Unknown		Road Fill Depth: ¹⁵ (B-D)	1.078		meters	
In-Road Utilities: ¹²	<input checked="" type="checkbox"/> Yes	No	Unknown		US Road Prism Depth: ¹⁶ (A-E)	1.485		meters	
Overhead Utilities/Crossings: ¹³	Yes	<input checked="" type="checkbox"/> No	Unknown		DS Road Prism Depth: ¹⁷ (B-F)	1.538		meters	
Road Notes: ¹⁸ power box near road									
CULVERT DESCRIPTION									
Culvert Shape: ¹⁹	<input checked="" type="checkbox"/> RND	<input checked="" type="checkbox"/> BOX	<input checked="" type="checkbox"/> ARCH	<input checked="" type="checkbox"/> SQSH	<input checked="" type="checkbox"/> ELL	Other	Length of Culvert: ²⁸	22.25	23.14
Culvert Material: ²⁰	PCC	CPC	<input checked="" type="checkbox"/> CST	SST	SPA	MRY	Culvert Span: ²⁹	0.46	0.50
	CAL	SPS	PVC	TMB	Other		Rise of Culvert: ³⁰	0.55	
Number of Baffles: ²¹ (If > 0, fill out fishway form)	NA						Culvert Slope: ³¹ $\left(\frac{\text{US Invert} - \text{DS Invert}}{\text{Length}} \right) \times 100$	0.97	%
Baffle Type: ²²	Concrete	<input checked="" type="checkbox"/> Metal	Wood				Water Depth: ³²	0.105	meters
	Plastic	Rock	Other				Hydraulic Drop: ³³	0.0	meters
Apron? ²³	US	DS	<input checked="" type="checkbox"/> No				Drop Location: ³⁴	NA	Inlet Outlet Interior
Gate? ²⁴	US	DS	<input checked="" type="checkbox"/> No				Plunge Pool Description (N/A if no Hydraulic Drop)		
Fishway? ²⁵ (If yes, fill out fishway form)	YES	<input checked="" type="checkbox"/> No					Plunge Pool Length: ³⁵		meters
Countersunk? ²⁶	YES	<input checked="" type="checkbox"/> No					Maximum Depth: ³⁶		meters
Backwatered? ²⁷	YES	<input checked="" type="checkbox"/> No					Scour Line Width: ³⁷		meters
Culvert Notes: ³⁸ (If multiple culverts at site, indicate defining features of each) Land owner says sewer crossing approx 30 meters North of 1894 private culvert DS • GNSS location: 48.19024460, -122.59939769 • US neighbor is Engineer @ Penn Cove Shellfish • DS neighbor is Rod Scherence (360) 809-7669 RodScherence@gmail.com									
CHANNEL DESCRIPTION									
Channel Width: ³⁹	Span 1.1m	BFW 1.8m					Culvert Span ÷ Channel Width: ⁴⁰ (29÷39)		
Channel Notes: ⁴¹									
BARRIER STATUS ⁴² (Circle one below)									
Passable ⁴³	Barrier Reason ⁴⁴				Level B Analysis Required ⁴⁵				
	Drop > .24 M		Slope >= 1%		Backwatered	Slope < 1%		Culvert Width < 75%	
Barrier Notes: ⁴⁶ Slope is close to Level A barrier criteria									

CULVERT EVALUATION FIELD FORM (LEVEL A): CALCULATIONS

Site ID: 1894 Culvert #: 1.1 Date: 2/27/20

Site ID: 1894 Culvert #: 1.1 Date: 2/27/20

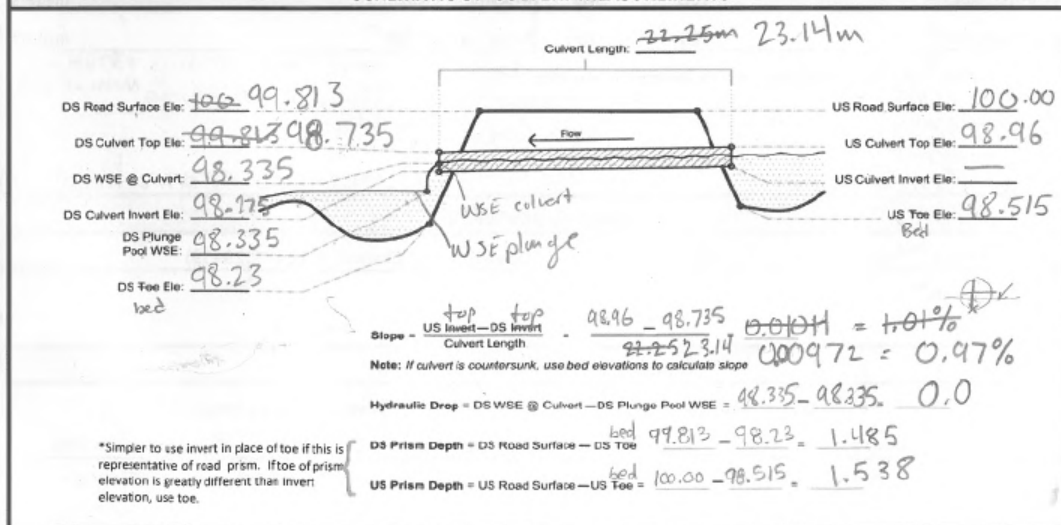
Site ID: 1894 Culvert #: 1.1 Date: 2/27/20

[illegible]

ENTER FINAL MEASUREMENTS HERE -99.813

US Road Shoulder: ^A	1.38	100.00	DS Road Shoulder: ^S	1.38	156.7	100.00
US Culvert Top: ^C	2.42	98.96	DS Culvert Top: ^D	2.645		98.735
US Culvert Invert: ^E	— see notes		DS Culvert Invert: ^F	3.105		98.275

SCHEMATIC OF CULVERT MEASUREMENTS



LEVEL B HYDRAULIC ANALYSIS FIELD FORM (3/18/2019)

1 Site ID 1894
 2 Culvert Number 1.1
 5 Datum Elevation 100.00
 6 Datum Location US road (on white mark)

3 Crew EM, PM, JJ
 4 Date 2/27/20

7 CULVERT MEASUREMENTS

	IH	RH	VD +/-	ELEV
Upstream Invert	101.38	(see notes)		
Upstream Culvert Bed		2.865		98.515
Downstream Invert		3.105		98.275
Downstream Culvert Bed		3.15		98.23

IH = Instrument Height; RH = Rod Height; VD = Vertical Distance (for equipment that measures incline); ELEV = Elevation (relative to Datum Elevation). Formulas on reverse side.

8 Culvert Roughness ☐ concrete ☐ smooth ☐ paved invert
 corrugation: ☒ 0.5" x 2.67" ☐ 1" x 3" ☐ 2" x 6" ☐ other _____
 9 Sediment Through Length of Pipe? ☐ yes ☒ no ☐ unknown

10 DOWNSTREAM CONTROL CROSS-SECTION

	STA	IH	RH	VD +/-	ELEV	DEP	WSE	SUB
Top LB	0.00	101.38	2.59		98.79			F
Toe LB	0.68		3.045		98.285	0.04	98.325	
Bed 1	0.88		3.155		98.225	0.10	98.315	
Bed 2	1.08		3.160		98.220	0.10	98.32	
Bed 3	1.28		3.11		98.285	0.06	98.325	
Toe RB	1.47		3.085		98.290	0.04	98.33	
Top RB	2.05		2.87		98.51			

10 Avg. WSE 0.323m

STA = Station; DEP = Water Depth; WSE = Water Surface Elevation; SUB = Dominant Substrate (F = Fines, C = Gravels/Cobbles/Bedrock, B = Boulders, W = Wood)

	IH	RH	VD +/-	WSE
12 Water Surface Downstream of X-Section:	101.38	3.265		98.115

13 Distance from X-section 7.7 m
 => cant go 15m down because there is another culvert

Correction Analysis Form Instructions

This will be completed for projects determined to be of potential high benefit to fish resources based on the information provided in Barrier Evaluation Form and Expanded Barrier Evaluation Form. The completed forms will be used to develop a prioritized list of projects to be presented to SRFB for potential funding.

Site Information

Project Name—This is the landowner's last name followed by the creek name. If more than one site per landowner is evaluated on the same creek, designate each site with a letter, e.g. Franklin-Boulder Creek A.

RCO/SRFB Project Number—This will be provided by PRISM database.

Bankfull Width—The stream width measured perpendicular to flow at the stage at which water begins to overflow into the active flood plain. Bankfull width requires a floodplain or a bench not present in many channels. In those cases, use ordinary high water. Ordinary high water is where the regular stream flow makes a line on the bank marking soil or vegetation with a character distinct from that of the abutting upland. Also defined as the lowest point at which perennial vegetation grows on the stream bank. Enter the average of several bankfull width measurements taken up and/or downstream of the culvert, outside the influence of the culvert.

Utilities Crossing—Include any water, gas, phone or electrical utilities at the crossing to be affected by project construction.

Road Fill at Downstream End—Measure height of material from top of culvert to top of fill at downstream end.

Road Width—Measurement should include shoulders.

Road Description/Condition—Provide a brief description of the road surface, use, condition, etc.

Evaluator Information

Provide contact information for the people completing the Correction Analysis Form.

Upstream Habitat and Channel Description

Channel Slope—This is measured outside of the culvert influence.

Re-grade Potential—Subtract the downstream streambed elevation from the upstream streambed elevation at the site.

Dominant Substrate—Identify the size category most prominent in the substrate.

Additional Information—Provide any additional upstream information that may be important to the project.

Downstream Habitat and Channel Description

Channel Slope—This is measured outside of the culvert influence.

Additional Information—Provide any additional upstream information that may be important to the project.

Correction Options and Preferred Alternative

Options to Consider—The purpose of this section is to provide the sponsor some guidance on the intended fix. Most small forest landowner projects should be relatively straightforward; however each site is different.

Preferred Alternative—Describe the recommended correction and site-specific concerns to be addressed during design and construction.

Cost Estimates

Rough cost estimate—Provide estimated costs for correction options listed above. Costs should be based on cost estimate templates, provided separately, for culverts, bottomless arch culverts, and bridges. Attach the corresponding completed template for each estimate. These represent approximate costs; actual costs may vary depending on specifications identified during final project design.

SITE IDENTIFICATION FIELD FORM (1/15/09)

¹Site ID: 1894 GPS Position Taken: ☒ Yes ☐ No
²Latitude: 48.19024460 ³Longitude: -122.59939769
⁴Identifying Group: SFEG ⁵Road Name: Race Rd
⁶Milepost: _____ ⁷County: Island County
⁸Location/Directions: Take Hwy 20 south, Turn Left on W Melcher Rd, Turn Right on RACE Rd. 0.3 miles
⁹Stream Name: WDFW reach code 17110019-002374 ¹⁰WRIA #: 6
¹¹Tributary To: Race Lagoon ¹²River Mile: —
¹³Fish Use Potential: ☐ Yes ☐ No ☐ Unknown
¹⁴Fish Use Criteria: ☐ Mapped ☐ Physical ☐ Biological ☐ Other
¹⁵Species: ☐ Chinook ☐ Chum ☐ Sockeye ☐ Coho ☐ Pink ☐ Steelhead
☐ Resident Cutthroat/Rainbow Trout ☐ Searun Cutthroat
☐ Bull/Dolly Varden Trout
¹⁶Feature Type: ☒ Culvert ☐ Fishway ☐ Dam ☐ Gravity Diversion
☐ Pump Diversion ☐ Other ☐ Non Culvert Crossing ☐ Natural Barrier
¹⁷Site Comments: _____

¹⁸OWNER INFORMATION

Type: ☐ Federal ☐ State ☒ County ☐ City ☐ Tribal ☐ Private ☐ Other
 Name: Island County
 Street Address: _____
 Mailing Address: _____
 City: _____ State: _____ Zip: _____
 Phone #: _____
 Contact Name & Phone#: _____

