Location Hydraulic Study
and
Preliminary Hydrology and Hydraulics Report
Haines Highway Milepost 3.5 to 25.3

ADOT&PF Project No. 68606 / SHAK-095-6(28)

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October 30, 2009

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2. Executive summary

This report presents design concepts for roadway embankment erosion protection along the Chilkat River; and, flood conveyance and fish passage at a number of culverts along tributary streams. Design features are in support of the Preliminary Engineering Report (PER) and are based on the 2009 design alignment provided by DOWL HKM. There is a companion Stream and Habitat Inventory (S&HI) prepared by Inter-Fluve, Inc. (Inter-Fluve, July, 2006) based on a 2006 version of the design alignment which provides a graphical overview of the project.

The proposed Haines Highway realignment project between mileposts 3.5 and 25.3 follows the Chilkat River and crosses 106 culvert locations. The highway embankment along the Chilkat River was conceptually designed for erosion and depth of scour protection. The analysis and design follow methods in the Highway Preconstruction Manual and Highway Drainage Manual and are presented in Section 4.

All culverts located in the field were evaluated in the field by rapid assessment methods and are summarized in tabular format in the appendices. A total of 28 culverts are discussed in greater detail in this report. Of these culvert crossings, eleven are either 48-inch diameter or larger, or of approximately equivalent size, along fish bearing streams with desirable upstream habitats. An additional four large culverts are located on the two active debris flows at MP 19 and 23. Geotechnical recommendations by DOWL HKM to accommodate debris flows consist of large box culverts to enable equipment access to clean out the occasional debris flow deposits. Details of the design are scheduled for the Draft DSR phase. Thirteen smaller pipes were identified that had fish presence and will require fish passage for the replacement culverts. Analysis and design of large culverts and culverts along fish bearing streams follow methods in the Highway Preconstruction Manual and Highway Drainage Manual and are presented in Sections 5 through 20. Analysis and design of the smaller fish pipes are discussed in Section 21.

A summary table of culverts considered in this report is presented on the following page.

Culvert Summary.

2009 Station	Proposed fish passage design method (MOA, 2001)	Proposed Culvert	
		size	type
Large culverts			
222+51	tier 1	6'-9"x4'-11"	pipe arch
319+13	tier 1	6'-9"x4'-11"	pipe arch
324+79	tier 1	7'-3"x5'-3"	pipe arch
483+18	tier 1	7'-3"x5'-3"	pipe arch
512+24	tier 1	14'-1"x6'-2"	alum box
589+12	tier 1	7'-3"x5'-3"	pipe arch
647+20	tier 1	8'-10"x6'-1"	pipe arch
652+70	tier 1	pending	pending
710+75	tier 1	12'-7"x8'-4"	pipe arch
865+88	tier 1	11'-7"x7'-5"	pipe arch
887+60	tier 1	9'-4"x6'-3"	pipe arch
962+06	Debris flow	pending	pending
973+30	Debris flow	pending	pending
1102+19	tier 1	7'-3"x5'-3"	pipe arch
1179+75	Debris flow	pending	pending
1187+25	Debris flow	pending	pending
Smaller Culverts			
228+95	tier 2 - no baffles	2’	cmp
240+38	tier 2 - no baffles	2’	cmp
245+19	tier 1	4’	cmp
248+45	tier 1	3’	cmp
292+90	tier 2 - baffled pipe	4’	cmp
314+72	tier 2 - no baffles	3’	cmp
366+36	tier 1	3'-6"x2'-5"	pipe arch
382+07	tier 2	3’	cmp
419+95	tier 2 - baffled pipe	3.5’	cmp
530+70	tier 1	3’	cmp
606+68	tier 2	2’	cmp
736+83 – option 1	tier 1	7'-4"x5'-4"	pipe arch
option 2	tier 2 - baffled pipe	3’	cmp
767+14	tier 2 - baffled pipe	3.5’	cmp

3. Introduction

The Haines Highway realignment study involves the Resurfacing, Rehabilitation and Restoration (3R) reconstruction of the highway between mileposts 3.5 and 25.3. This work is necessary to improve safety by bringing the highway into compliance with current design standards. Completion of this stretch will connect with previously constructed improvements for an improved highway between Haines and the border with Canada.

This study is a preliminary level hydrologic and hydraulic evaluation of the Chilkat River and tributary drainages that cross the Haines Highway between mileposts 3.5 and 25.3. Conceptual level designs and drawings for erosion protection along the highway embankment and preliminary design of fish passage and flood conveyance at larger culverts are included in this study. This report is submitted in support of the Preliminary Engineering Report (PER). This report was prepared in accordance with the Highway Preconstruction Manual (HPM) 1120.5 and the Alaska Highway Drainage Manual (HDM). Final designs will require detailed survey for each stream crossing and will be prepared and documented in a final design report to be submitted with Plans-in-Hand. This report provides information for preliminary design and environmental/permitting actions.

A companion Stream and Habitat Inventory Study (S&HI) was prepared by Inter-Fluve, Inc. (July 2006) which is included herein by reference for a graphical overview of the project.

3.1 Objective

The objective of this report is to characterize hydrologic and hydraulic conditions of the Chilkat River and tributary crossings of the highway. Further, conceptual level designs for typical erosion protection and passage of flood flows and fish through larger culverts were prepared for environmental/permitting actions. Full designs will be prepared at a later phase for submittal with the Plans-in-Hand.

3.1.1 Objective - Chilkat River

The Chilkat River is a large, dynamic, glacially fed river. There is a complex network of side channels between mileposts 10 and 19. Further, the Chilkat River discharges to the Lynn Canal which experiences 16.5-ft tidal fluctuations. No Federal Emergency Management Agency (FEMA) Flood Insurance Study for the project reach was identified. The Haines Highway follows the northeast bank of the river, with river flows along the embankment toe for long stretches of highway. In a number of locations, side channels impinge directly into the highway embankment then turn downstream at sharp angles.

The objective of this study along the Chilkat River and its side channels was to estimate the erosive forces acting on the proposed road embankment for conceptual design of bank revetments. Depths and locations of scour were investigated in the field and conceptually analyzed to aid in estimating depth of scour along the toe of the proposed embankment. The impacts on flood water surface elevations by the proposed project are approximately evaluated.

These objectives were approached through field investigations; interviews with Alaska Department of Transportation and Public Facilities (ADOT&PF) maintenance personnel and long time residents; and, conceptual level analysis and design. Design level analysis and modeling will be completed and documented at a later phase for the Plans-in-Hand submittal.

3.1.2 Objective - Tributaries

Between mileposts 3.5 and 25.3, 106 existing culvert crossings were located in the field. Eight culverts listed in the as-built drawings were not found in the field. An inventory of pipe size and general site conditions was made through a rapid assessment and tabulated (see Appendix Section 23.1).

Of the culverts found, fifteen crossings were identified for this Summary Hydraulic Report. Eleven of the existing crossings are comprised of either 48-inch or larger diameter pipes, or fish bearing streams with ample upstream habitats. An additional four large culverts are located along debris fans - flood runoff and fish passage design will be coordinated with geotechnical design in progress by DOWL HKM for passage of debris torrent sediments. In addition, thirteen smaller pipes are either included in the anadromous waters catalog (AWC) or were identified by Inter-Fluve or Alaska Department of Natural Resources, Office of Habitat Management and Permitting (OHMP) staff to have fish present. A brief narrative of each of these smaller pipes is included in this report. The associated analysis, designs and drawings were prepared to a conceptual level for inclusion in the Preliminary Engineering Report for environmental/permitting actions. Final designs and hydraulic reports will be prepared for submittal with the Plans-in-Hand.

3.2 Field Investigations

On October 5 through 10, 2005, Inter-Fluve conducted field investigations of the hydrologic and hydraulic conditions of the Chilkat River and tributary crossings. The field investigation included: 1) investigation of Chilkat River main stem and side channel scour and bank erosion conditions; 2) inventory and rapid assessment of existing culverts; 3) identification of culverts requiring more detailed study; and 4) cursory total station survey for conceptual design of a number of larger/fish bearing culverts. Conditions immediately following the flood of November 2005 were observed by Inter-Fluve staff and incorporated into the S&HI and this study. In response to design refinements and adjustments of the highway alignment, additional survey was collected in November 2008, May 2009 and October 2009 near Station 888+00 (S&HI station 908+00) and a number of proposed mitigation sites .

Details of the field investigation along the Chilkat River are provided in Section 4.2.

All culverts shown on the 1980 as-built drawings were searched for. A total of 109 crossings, including six with twin pipes, were located. Of the crossings shown on the as-built drawings, eight were not found. A rapid assessment of all found culverts was conducted. The rapid assessment included: size and condition of culvert, inlet/outlet conditions, height to stain line, degree of sedimentation/debris, and photo documentation of inlet/outlet conditions. An inventory of the culverts found in the field with a summary of rapid assessment results is included in a table in Appendix Section 23.1, along with those culverts listed on the as-built drawings that were not found. Based on height to stain line, the majority of the surveyed pipes appeared to be adequately sized. Further, interviews with ADOT&PF maintenance personnel indicated that except for flooding caused by hillside debris flows blocking culvert inlets, to date there has been satisfactory conveyance through the existing pipes. A large magnitude flood occurred during November 2005 and was reported to be as large a flood as recalled. Observations by Mark Sogge (Inter-Fluve, Haines) and Roger Ingledue (ADOT&PF Haines maintenance supervisor) indicate that all occurrences of road overtopping were the result of culverts plugged with sediment and debris (personal communication, March 8, 2006). No evidence of unobstructed pipes having insufficient conveyance capacity was reported.

In preparation for environmental and permitting actions, preliminary designs for flood conveyance and fish passage were prepared for eleven of the larger crossings and thirteen smaller fish bearing pipes identified for more intensive analysis. As noted above, study and design efforts at the four large culverts located along the two debris flows at MP 19 and 23 will be coordinated with geotechnical design during the design phase by DOWL HKM for passage of debris torrent sediments. Detailed site topographic survey, design and final Summary Hydraulic Report for each pipe will be prepared during a later phase and submitted with Plans-in-Hand.

Basic site survey data were collected at the fifteen large culverts identified for more detailed study. As survey coverage was unknown at the time and results of ongoing survey efforts would not be available within the timeframe of the preliminary phase of this study (October-November, 2005), Inter-Fluve used a total station survey gun and rod with prism to collect cursory relative location and elevation survey data including stream profile, typical cross section, culvert invert and crown elevations at the inlet and outlet and typical roadway elevations. The purpose of this survey data collection was to provide the essential site topographic data required to develop conceptual designs. Final design will require site-specific detailed topographic, cross section and profile survey data. The thirteen smaller fish pipes were identified after the field investigations and subsequently added to this study. Survey data from the additional thirteen smaller fish pipes were obtained from the ground based survey of the road embankment by ADOT&PF or Toner-Nordling surveyors (now DOWL HKM) or from the project LIDAR.

3.3 Hydrology - General Methods

3.3.1 Chilkat River

Hydrologic analysis methods for the Chilkat River are presented in Section 4.4.

3.3.2 Tributary Basins

Hydrologic analysis methods conducted in common for the tributary basins are included here, with tributary-specific information included in the individual tributary summaries.

3.3.2.1 Hydrology

Hydrologic analyses were performed for eleven streams with major crossings of the Haines Highway between mileposts 3.5 and 25.3. All streams flow through culverts under the Haines Highway shortly before entering the main stem of the Chilkat River or major Chilkat side channels. These streams have culverts at least 48 inches in diameter and/or contain significant fish habitat. Peak flow estimates for various return periods were estimated in order to analyze flood conveyance and fish passage conditions. As stated in the 2001 *Memorandum of Agreement between the Alaska Department of Fish and Game and the Alaska Department of Transportation and Public Facilities for the Design Permitting and Construction of Culverts for Fish Passage* (MOA),fish passage design flow is 40 percent of the 2-year peak flow. At this time, hydrologic analysis was not performed for the four streams that are located on debris fans. For these streams, flood runoff and fish passage design will be coordinated with geotechnical recommendations for conveyance of debris flow sediments.

The thirteen smaller fish pipes all drain areas ranging from 0.05- to 0.49-sq. mi. All are smaller than the 0.72-sq mi lower limit for the USGS regional regression estimates for flood runoff flows. Estimates of flows along the additional thirteen smaller fish pipe streams were extrapolated based on area weighting from neighboring larger basins. However, the high degree of variance in hydrologic predictions was suspected to incur unacceptable error. Therefore, an alternate approach was taken: while providing fish passage to meet MOA criteria, the flood conveyance of the proposed structures was verified to be either equal or greater to existing conditions. Details of this analysis are presented in Section 21 – Small Fish Culverts.

The eleven streams for which hydrologic analyses were performed originate in the Takshanuk Mountains northwest of Haines, AK. A map of the basin locations can be found in Figure 1. Basin sizes range from 0.47 mi^2 to 2.26 mi^2. Basin elevations range from sea level to over 5,000 feet. The watersheds are steep, with average watershed slopes ranging between 44 and 64 percent. Spruce-dominated forests with poorly-drained soils reach up to approximately 3,000 feet. Unforested alpine slopes characterize the higher elevations. Annual precipitation is approximately 60 inches, with most of the precipitation falling as snow in the winter months (Western Regional Climate Center). Seasonal hydrographs are unavailable for these basins; however, based on elevation and precipitation regimes, peak stream flows would be expected to result from spring and summer snowmelt with occasional peaks generated by rain and rain-on-snow events.

Debris flows dominate channel and valley morphology for some streams in this area; however, the eleven streams addressed in this section do not exhibit frequent debris flows.

Peak flows for various return periods were estimated for each of the eleven basins using USGS regional regression equations (Curran et al. 2003), the SCS Unit Hydrograph Method (SCS 1984), and the Rational Method. For the reasons discussed below, peak flow estimates generated from the regional regression equations are believed to be the most appropriate for stream crossing design purposes.

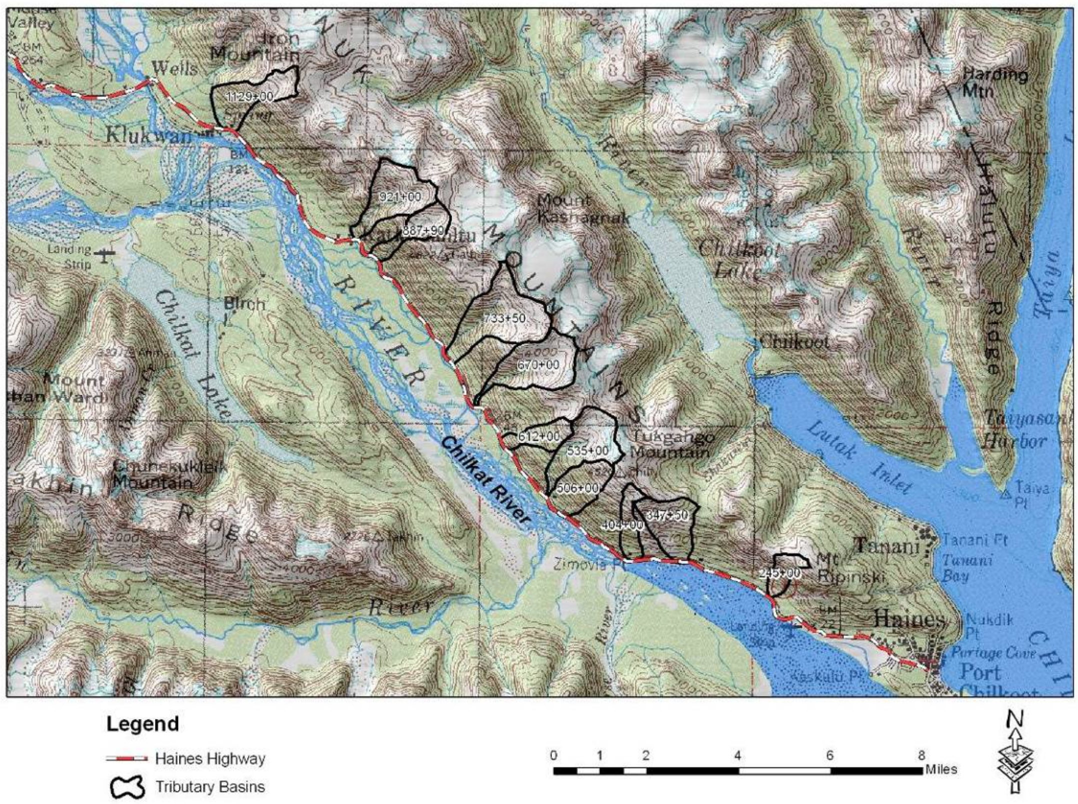


Figure 1. Map of Tributary Basins.

3.3.2.2 Regional Regression Analysis

The regression equations for southeast Alaska utilize drainage area (A), storage (ST), mean annual precipitation (P), and mean minimum January temperature (J) as predictor variables. Curran et al. (2003) used stream flow data from a total of 93 gaging stations to develop the regression equations. The equations and accuracy information are displayed in Table 3-1. Drainage area for each tributary basin was obtained by manually digitizing watershed boundaries on USGS 1:24,000 (7.5 minute) topographic maps in a Geographic Information System (GIS). Percent storage for each basin was obtained in GIS by digitizing surface water areas on the topographic maps. Mean minimum January temperature was obtained from values mapped by Jones and Fahl (1994). Values for basins located between isothermal lines were estimated through visual interpolation.

Mean annual precipitation values were obtained in GIS using a digitized version of the Jones and Fahl (1994) annual precipitation map - all of the basins fall within the 60 inch annual precipitation zone. **It should be noted, however, that this precipitation value is higher than actual annual precipitation measurements at Haines of 47.77 inches based on a period of record from June 1973 through December 2005 (Western Regional Climate Center).**

Table 3-1. USGS Regional Regression equations for estimating flood magnitude for various recurrence intervals. Equations are applicable to southeast Alaska (Curran et al. 2003).

Regression Equation for Specified Recurrence Interval (93 gaging stations)	Average standard error of prediction (percent)	Average equivalent years of record*
$Q_2 = 0.004119\ A^{0.8361}\ (ST+1)^{-0.3590}\ P^{\ 0.9110}\ (J+32)^{1.635}$	38	0.88
$Q_5 = 0.009024\ A^{0.8322}\ (ST+1)^{-0.3670}\ P^{\ 0.8128}\ (J+32)^{1.640}$	37	1.3
$Q_{10} = 0.01450\ A^{0.8306}\ (ST+1)^{-0.3691}\ P^{\ 0.7655}\ (J+32)^{1.622}$	37	1.8
$Q_{25} = 0.02522\ A^{0.8292}\ (ST+1)^{-0.3697}\ P^{\ 0.7165}\ (J+32)^{1.588}$	38	2.4
$Q_{50} = 0.03711\ A^{0.8286}\ (ST+1)^{-0.3693}\ P^{\ 0.6847}\ (J+32)^{1.559}$	40	2.8
$Q_{100} = 0.05364\ A^{0.8281}\ (ST+1)^{-0.3683}\ P^{\ 0.6556}\ (J+32)^{1.527}$	41	3.1
$Q_{200} = 0.07658\ A^{0.8276}\ (ST+1)^{-0.3669}\ P^{\ 0.6284}\ (J+32)^{1.495}$	43	3.4
$Q_{500} = 0.1209\ A^{0.8272}\ (ST+1)^{-0.3646}\ P^{\ 0.5948}\ (J+32)^{1.449}$	45	3.6

A=drainage area, in square miles; ST= area of lakes and ponds (storage), in percent; P=mean annual precipitation, in inches; J=mean minimum January temperature, in degrees Fahrenheit

Applicable range of variables: A: 0.720-571; ST: 0-26; P: 70-300; J: 0-32

**The number of years of systematic stream flow data that would have to be collected for a given site to estimate the stream flow statistic with accuracy equivalent to the estimate from the regression equation*

Basin characteristics for the eleven basins were within the range of values used to develop the regression equations with a number of exceptions. Three of the basins had drainage areas below the range; the smallest of which has a drainage area of 0.466 mi^2 compared to the range of 0.720 – 571 mi^2. According to the Jones and Fahl (1994) precipitation map, all of the basins have a mean annual precipitation of 60 inches, compared to the range of 70 – 300 inches. The violation of these criteria will affect the accuracy of the flow predictions. In general, the 11 tributary basins are smaller, lower elevation, drier, and warmer than the basins used to generate the regression equations. The study basins may exhibit proportionally larger peak flows than the basins used to generate the regression equations because of quicker times of concentration (less attenuation) due to high gradient and small size. Actual peak flow volumes could also be lower than those reported if precipitation levels are closer to the 47.77 inches measured at Haines, compared to the 60 inches reported by Jones and Fahl (1994).

Compared to the SCS Unit Hydrograph Method and the Rational Method, the regional regression equations are believed to represent the most appropriate flow estimates for design purposes. The regression estimates are included in Table 3-2. Estimates from the SCS and Rational Method are presented in Appendix, Section 23.2.

Table 3-2. Flow estimates for tributary basins using USGS Regional Regression Equations (Curran et al. 2003).

Station ID	Drainage Area (mi^2)	40% of 2-year flood[1]	Flow Estimate for Indicated Return Period (ft^3/second)							
			2	5	10	25	50	100	200	500
222+51	0.47	17	42	64	79	99	114	130	147	171
319+13	0.60	20	50	75	93	117	135	154	175	202
324+79	1.23	37	92	137	169	212	246	280	317	368
483+18	1.07	30	76	113	139	175	203	232	263	305
512+30	1.46	29	73	107	130	166	193	220	250	290
589+20	0.65	21	52	78	96	121	140	160	181	210
647+20	1.75	38	96	142	174	220	255	291	331	384
710+70	2.26	50	125	186	228	288	334	381	432	502
865+88	0.80	22	55	82	101	127	148	169	192	224
887+60	1.55	38	95	141	175	219	255	291	331	385
1102+19	1.26	29	73	109	135	170	198	227	258	301

[1] *Interim fish passage design flow (ADFG/ADOT&PF Memorandum of Agreement 2001)*

3.3.2.3 SCS Unit Hydrograph Method

The SCS (now NRCS-Natural Resources Conservation Service) Unit Hydrograph Method (SCS 1984) was also applied to these 11 basins. The SCS Method calculates the volume of runoff per area of the basin according to soil and land use conditions. Information on time of concentration of stream flow and initial abstraction of storm precipitation are then used to calculate a unit hydrograph, which is applied to the runoff volume to calculate peak flow rates (SCS 1984). The hydrologic soil group was obtained in GIS using the NRCS State Soil Geographic (STATSGO) layer (NRCS 1979). The hydrologic soil group and land use conditions were then used to determine runoff curve numbers, which for all the basins were estimated at a value of 79. Time of concentration was obtained using flow length and average watershed slope, according to the procedures described for the method. Flow lengths were obtained in GIS by measuring the flow path from the stream outlet to the watershed divide using digitized versions of the USGS 7.5 minute topographic maps. Average watershed slopes were obtained by performing map calculations on the 30-meter Digital Elevation Models (DEMs) for the basins.

Basin characteristics yielded values outside the range for the initial abstraction to precipitation ratio that is used in the model. This is due to high intensity storms and low permeability soils. These results suggest that conditions in the study basins are outside the range of basin characteristics used to develop the SCS Method, which is primarily geared towards lowland agricultural basins. Final runoff volumes were substantially higher than those predicted with the regional regression equations. For these reasons, the SCS Method values were considered unreasonable estimates and were not incorporated into the final estimates for design flow. SCS Method flow estimates can be found in Appendix, Section 23.2.

3.3.2.4 Rational Method

The Rational Method was also applied to the study basins. The rational method simply uses rainfall intensity, watershed area, and a runoff coefficient to predict peak flow levels. Rainfall intensities for the 1-hour storm were used due to the short times of concentration of the basins. A runoff coefficient of 0.25 was selected based on watershed slopes and hydrologic soil groups. The Rational Method is best suited for small urban catchments and results for larger, rural basins should be viewed with caution. Nevertheless, the peak flow estimates are similar to the regional regression estimates, though slightly lower on average. These values are not used as recommended design flows because of the violation of basin size criteria specified in the Alaska Highway Drainage Manual (ADOT&PF, 1995), but they do increase confidence in the regional regression estimates because of their similar magnitude. Rational Method flow estimates can be found in Appendix, Section 23.2.

4. Chilkat River

4.1 Introduction

The project reach extends from highway milepost 3.5 to 25.3. The highway runs roughly parallel with the Chilkat River, crossing at the Wells Bridge near milepost 25.

The Chilkat River is a large, glacial fed river. Drainage area at the Wells Bridge is 791-square miles. Near the Haines airport the drainage area increases to 1,602-square miles. The Chilkat River varies in width from about 1,000-ft up to 1.1-miles near the airport. Bed materials range from silt/sand at the mouth to gravel/cobble near the upstream end of the study area. The active river channels shift dramatically over a short time period. From the mouth to milepost 10 the main stem parallels and fronts much of the highway. From milepost 10 to 19 there are a number of side channels and back water sloughs near the highway. A map of the Chilkat River watershed is included in Figure 2.

This study addresses, at a conceptual level, erosion protection of the highway embankment adjacent to the Chilkat River or its side channels. Included are estimates of depths of scour through field investigations and analysis. Further, incorporation of habitat while providing engineered stability to the highway is addressed.

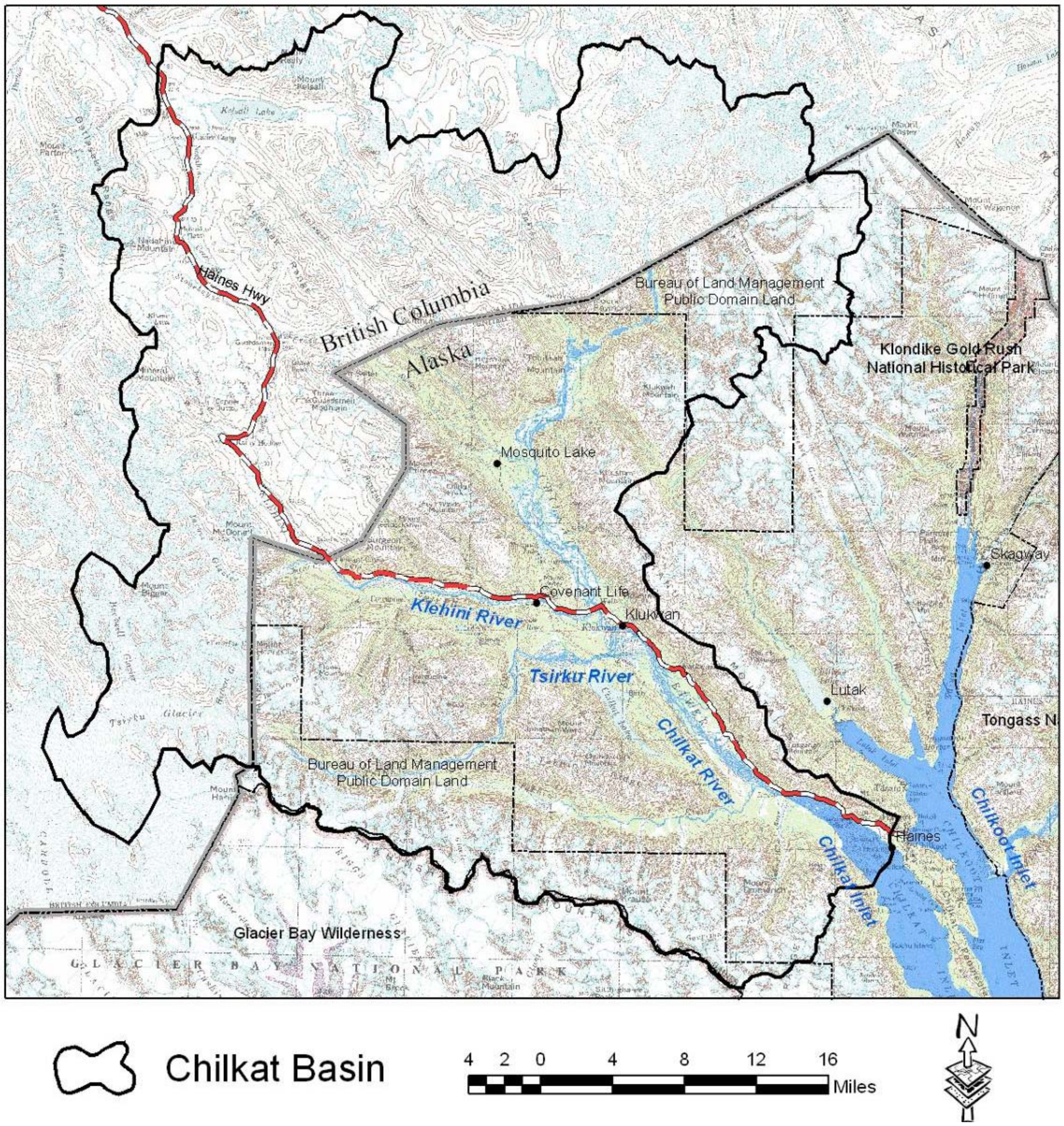


Figure 2. Map of the Chilkat Basin.

4.2 Chilkat River Field Investigations

Field investigations of the Chilkat River included visual inspection of existing roadway embankments, revetment and vegetation conditions, and estimates of existing scour depth conditions. Main areas of concern along the Chilkat River included reaches where the Chilkat River makes moderate to sharp bends, where points of land jut into the river and side channels of the Chilkat River impinge directly on the highway embankment.

4.2.1 Chilkat River Main Stem

Scour investigations were based on depth sounder measurements of scour holes along the main stem and side channels: An 18.5-ft jet boat was used to access portions of the main stem of the Chilkat River. An Eagle, SuperPro ID portable depth sounder was attached to the boat to estimate depths to bottom. The depth sounder readings were periodically compared against depths manually probed with a rod to develop a correction factor. Typical areas where river scour were expected to occur were investigated by slowly ferrying across the river, depth sounder readings were called out and noted on site aerial photos. These depth readings are likely accurate to no better than 1- to 2-ft. Reading distance from shore was visually estimated and likely accurate to no better than 5- to 10-ft. The objective was to gain an understanding of relative magnitude of scour at different river conditions.

ADF&G maintains a staff gage near highway Station 395+00 (S&HI station 418+00) as noted in Section 4.3.1. At the time of the boat based investigations, the staff gage read approximately 29.03-ft elevation. No river flow information is associated with elevation readings.

Depths measured on October 7, 2005 ranged from 2- to 3-ft along straight wide sections to as deep as 15.5-ft in areas of bends and obstructions. Specific areas noted to have deep scour holes include:

- Off a point of land near Station315+00 (S&HI station 338+00) scour depths range from 9- to 15.5-ft approximately 25-ft from shore.
- Near Station 394+00 (S&HI station 417+00), scour depths range from 8- to 14-ft with maximum depth about 30-ft from shore.
- Near Station 454+00 (S&HI station 477+00) above the lower ADF&G fish wheel flow depths are between 4.5 and 6.0-ft deep, evidence of little scouring along this locally straight reach.
- Near Station 462+00 (S&HI station 485+00) above the upper ADF&G fish wheel flow depths range from 6.0- to 9.5-ft. Flows impinge on the road embankment at the outside of a bend.

Scour conditions appeared to be localized at predictable locations, yet extend for several hundred feet in an upstream-downstream direction. It is anticipated that the location of scour holes will change dramatically in response to flood conditions and changes in channel plan form. It must be noted that scour holes typically reach their greatest depth at or shortly before a flood peak. As the flood recedes, bed load begins to deposit in the scour hole, reducing the depth observed following the flood. Thus, the maximum depth of scour during floods is typically greater than those observed following the flood. Maximum depths of scour during flooding vary dependent on a number of factors including magnitude of flood, rate of flow increase/decrease, debris, sediment and water temperature.

During the boat based investigations, visual observations were made of the existing riprap revetment and adjacent vegetative condition. In general, the existing rock along the main stem of the Chilkat River appeared to be performing satisfactorily for erosion protection. Woody vegetation growth was typically vigorous above a well-defined elevation on the bank and sporadic or absent below this elevation.

4.2.2 Chilkat River Side Channel

Side channels impinge directly on the highway and turn away at sharp angles; notably near stations: 640+00, 703+00, 751+00, 816+00 and 830+00 (S&HI stations 663+00, 724+00, 772+00, 837+00 and 851+00, respectively). Depth of scour at sharp bends along side channels impinging on the highway were also investigated by jet boat, where accessible, using the portable depth sounder. Areas inaccessible to the jet boat were investigated with the portable depth sounder and floating boom. The transducer was taped to a crab pot buoy which was attached to the end of a 14-ft long aluminum pruning saw handle. The 15-ft long depth sounder cable allowed readings to be taken from a wadeable depth along shore to a distance of about 15-ft into the channel. A guy line attached to the buoy was held from an upstream location to maintain the boom in position in areas of higher flow velocities. The boom was manually extended out from the bank and depth soundings read off and recorded. These depth readings are likely accurate to no better than 1- to 2-ft. Distance from shore was estimated in relation to reference marks along the pole and likely accurate to 1- to 3-ft. The objective was to gain an understanding of relative magnitude of scour at sharp bends.

Depths measured along the side channels on October 7 and 8, 2005 ranged from 4-ft along straight sections to as deep as 12-ft at sharp bends. Specific areas noted to have deep scour holes include:

- At a bend in the side channel near Station 623+00 (S&HI station 646+00) depths range from 4- to 9.5-ft.
- At a sharp bend in the side channel near Station 640+00 (S&HI station 663+00) depths range from 6- to 11-ft.
- Along a straight reach of the side channel from Station 672+00 to 699+00 (S&HI stations 693+00 and 720+00, respectively) depths range from 4- to 9.5-ft. Average depths appear to range from 5- to 6-ft.
- At a bend in the side channel near Station 703+00 (S&HI station 724+00) depths range from 6.5- to 11-ft. Deepest scour appears to occur approximately 10- to 15-ft off shore.
- At a bend in the side channel near Station 751+00 (S&HI station 772+00) depths range from 6- to 9-ft.
- At bends in a minor side channel near Stations 816+00 and 830+00 (S&HI stations 837+00 and 851+00, respectively) scour depths range from 6- to 11-ft deep.

Scour conditions appeared to be localized at predictable locations yet extend for a few hundred feet in the upstream-downstream direction. Commonly, vegetated banks opposite the highway dropped vertically 7- to 8-ft below water level to the stream bottom. Trees toppled into the channel are not uncommon along these locations. As noted earlier, scour holes typically reach their greatest depth at or shortly before a flood peak. As the flood recedes, bed load begins to deposit in the scour hole, reducing the depth observed following the flood. Depths of scour during floods are expected to be greater than those observed following the flood event.

Visual observations of riprap conditions along the side channels indicated that the majority of the existing rock was in satisfactory condition. Some erosion was noted along the bank where the rock was small, banks were steep, and flow impingement most likely. These areas were located at: 700+50-704+00, 750+00-752+00, and 777+00-779+00 (S&HI stations 721+50-725+00, 771+00-771+00, and 798+00-800+00, respectively). Areas of vegetated riprap generally appeared to be in satisfactory condition for erosion protection. Typically there is a distinct elevation of persistent vegetation with vigorous plant growth above and little to no plant growth below. These observable conditions provide useful guidelines for what is feasible for bioengineering solutions.

4.3 Hydraulic History

4.3.1 Tidal and Non-Tidal

Tidal range of the Lynn Canal at the Chilkat Inlet gage (6.9-miles southeast (true) of the Haines airport) is 16.5-ft between mean lower low water (MLLW) and mean higher high water (MHHW) (http://www.co-ops.nos.noaa.gov/benchmarks/9452421.html).

An inquiry was submitted to ADOT&PF surveyors regarding conversion from the tidal datum to land based elevation datum. The following response was provided (T. Reed, personal communication May 22, 2006):

> "ADOT&PF has benchmark ties to the NAVD 88 datum in the Haines area for the subject project. Based on other ADOT&PF survey work (specifically GPS ties to tidal benchmarks at Taiyasanka Harbor, AK station 9452434) in the area a conversion from tidal to NAVD 88 datum was determined to be NAVD 88 + 7.4-ft = MLLW tidal datum. MHHW tide elevation along the Chilkat Inlet is 16.76-ft (MLLW). This elevation converted to NAVD 88 is approximately 9.4-ft (NAVD 88). Based on existing conditions LIDAR topographic mapping, elevation 14.7-ft (NAVD 88) occurs along the Chilkat River sand flats at the downstream end of the Haines Airport, downstream of the project beginning. The lowest LIDAR elevation observed at the upper end of the runway is 17.3-ft NAVD88."

The extent of tidal influence along the Chilkat River was approximately estimated by extrapolating the HEC-RAS model developed for the scour hole at station 394+00 (S&HI station 417+00) to downstream from the airport. The most downstream cross section synthesized for the Station 394+00 (S&HI station 417+00) outcropping was copied downstream to the airport and also copied to 14,045-ft downstream of the airport to the end of the flats indicated on the USGS topographic map. The elevations of these cross sections were adjusted based on the LIDAR contour elevation (14-ft) at the airport and at the downstream end of the flats based on extrapolation of the lower LIDAR coverage. Though extremely approximate in nature, this provided a rough comparison of water surface elevations generated along the river with the one-dimensional HEC-RAS model and MHHW. From this modeling it was seen that the elevation of MHHW is lower than the flood water surface elevation for the 2- through 100-year events that were considered in the model. Therefore, high tide will not have a hydraulic affect on river during the 2-year or higher flows. Results of the approximate HEC-RAS model are shown in Appendix 23.5.1.

Fluctuations in the Chilkat River discharge and associated water surface elevations will affect the project and backwater many of the tributary crossings of the highway. Typical summer water level fluctuations are observed at a staff gage maintained and monitored by ADF&G near station 395+00 (S&HI station 418+00). The gage has been read for a period of record from 1994 through 2005 from June through September or October. The gage readings include only water surface elevation. The top of the piling elevation, 36.185-ft, was surveyed by ADOT&PF in 2005 with the associated staff gage elevations subsequently tied to that temporary bench mark elevation (M. Sogge, personal communication, Sept 2006). River water surface levels range from about 31.0- to 33.0-ft for June through July. Levels begin to decrease starting in August. In September the river levels range from an average low of about 29.0- to 31.5-ft. September minimum water levels are about 28.5-ft while maximum values are about 33.5-ft. These levels reflect the impact of fall rains. No river discharge measurements or calculations are associated with these stage data. A chart of these data are provided in Figure 3

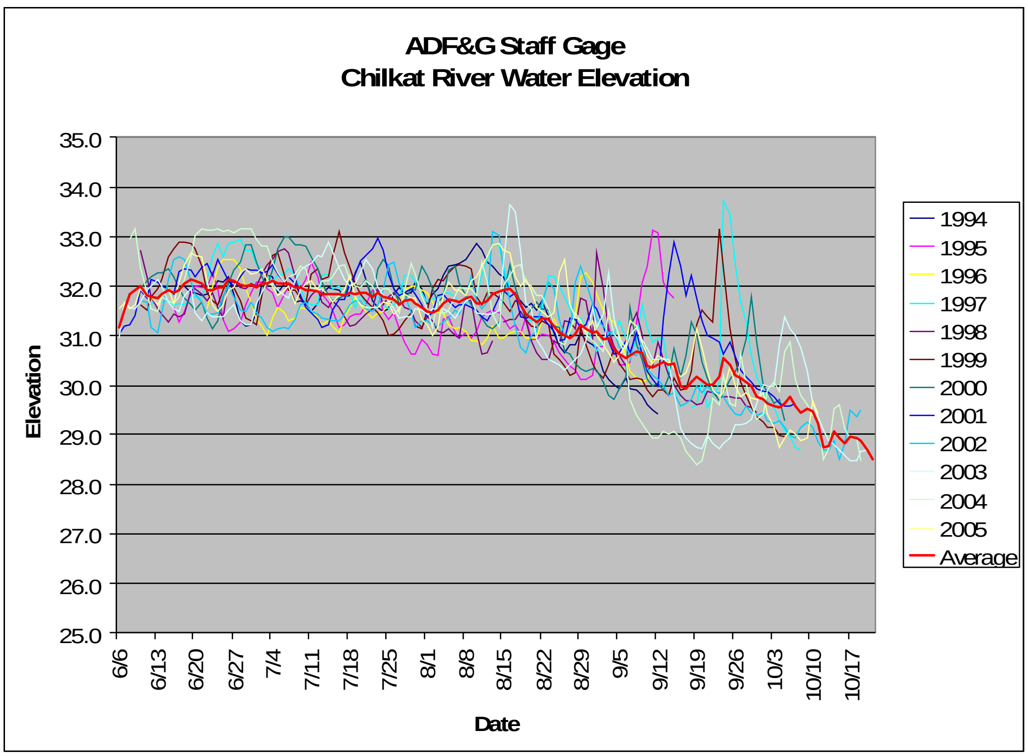


Figure 3. ADF&G staff gage readings near Sta 395+00

4.3.2 Navigation

Navigation is limited to recreational, commercial tour and ADF&G research jet boat use along the length of the project. In addition, commercial raft float trips are conducted from the Tsirku River through the Chilkat Bald Eagle Preserve to about milepost 15.

Recreational canoes, kayaks and rafts are also used along the river. The Chilkat River dynamically shifts its course with extensive gravel bars, shallow flow depths over riffles and extensive sand and silt flats. Other than tourism and sport and subsistence fishing, little commercial activity presently occurs along the Chilkat River. Therefore, no other navigational use is anticipated.

4.3.3 Confluence

The Chilkat River discharges to the Chilkat Inlet of Lynn Canal. Within the project reach, the Chilkat River has confluences with the Kicking Horse River, the Tahkin River, the Tsirku River and the Klehini River. All these rivers discharge into the Chilkat River from the southwest side, opposite the highway. No impact is foreseen to these confluences by the proposed action.

4.3.4 Mining

Approximately 500,000-cy of gravel was mined from the river near the Haines airport runway during the winter of 1990-91 for construction of the Haines airport. Otherwise, mining activity within the Chilkat River has not been identified to exist. No in stream mining of gravel material is reportedly planned for this project.

Iron, gold, copper, platinum and palladium deposits exist within the Chilkat River watershed along the project length. However, economics have not justified mining these deposits. No plans for mining these deposits are publicly available. (M. Sogge, personal communication)

4.3.5 Debris and Icing Problems

Debris load along the Chilkat River consists of large woody debris load typical of this scale of southeast Alaskan glacial rivers. This debris forms occasional logjams but has not been observed to have a significant impact on the Haines Highway.

The timing of ice-up of the Chilkat River depends on the severity of the winter. In general, there is a section of the river near the Tsirku River alluvial fan that remains open at least through November, but more often December. There have been many times around Christmas when the river has been observed to be open between 19 mile and the Wells Bridge. It is not uncommon for most of the river to freeze over in January and February. Channels of the river can open up in March, but the main breakup does not typically occur until the beginning of April. (M. Sogge, personal communication)

Glaciers occupy approximately 20 percent of the upper watershed (based on the 1:250,000 USGS map). Glaciers do not directly encroach into the project area. No glacial outburst flooding was recalled in the anecdotal record. USGS Atlas HA-455 (Post and Mayo, 1971) indicates no significant glacial outburst floods in the Chilkat River Basin. Glacial outburst flooding from the headwaters of the Tsirku River is implied by hatch pattern on Sheet 1 in the Post and Mayo report. However, there is no discussion of the Tsirku River in the report. The Tsirku River discharges into the Chilkat River opposite the village of Klukwan. Based on the anecdotal record and cursory reference in the Post and Mayo report, it is assumed that glacial outburst flooding has insignificant influence on flows along the Chilkat River.

4.3.6 Geomorphology

Geomorphology of the Chilkat River can be characterized as a large dynamic glacially fed river. The river is braided throughout the project length and the active flow path shifts significantly and dramatically over short time periods; typically in response to higher magnitude and longer duration flows. As an anecdotal example, along a side channel adjacent to the road near milepost 14, an exposed sand bar observed in 1999 by Inter-Fluve was absent and found to be replaced by a 12-ft deep scour hole during the October 2005 field investigation. The braided main stem is adjacent to the road or separated by a narrow band of forest from the Haines airport to milepost 10. From milepost 10 to 19, there is a complex system of side channels close to the road with the main river further from the road. Along the project length, the Klehini, Tsirku, Tahkin and Kicking Horse Rivers are tributary to the Chilkat River entering from the southwest side opposite the highway.

4.3.7 Bed Load

Based on ocular investigation, bed load varies in size from sands and silts near the downstream end, transitioning to gravels and cobbles at the Wells Bridge near milepost 25. Above the Wells Bridge, the Chilkat River widens with extensive sand bars noted.

4.3.8 Environmental

Environmental considerations along the Chilkat River include the presence of Chinook, coho, pink, chum and sockeye salmon, eulachon and bald eagles. Proposed bank revetments strive to maximize the use of habitat elements while maintaining engineered stability.

4.4 Hydrology

The Chilkat River originates in the Datlasaka and Kusawak Mountains of northwest coastal British Columbia, flows into northern southeast Alaska, and empties into the Chilkat Inlet branch of the Lynn Canal near Haines, AK. Total basin size is approximately 1,600 square miles; just over half (54 percent) lying within the United States. Major tributaries include the Kelsall River, the Klehini River, the Tsirku River, and the Takhin River. Elevations in the basin range from sea level at the mouth to approximately 9,000 feet in the headwaters of the Tsirku Basin. Precipitation is snow-dominated with summer rains common in the lower elevations. The higher elevations are covered with expansive glaciers. The main stem and major tributaries exhibit a glacial melt water hydrologic regime, with peak flows typically occurring in the early summer (snowmelt) or in late summer/early fall (rain plus snowmelt). Low flows typically occur during winter months. Occasional large peak flows result from rain-on-snow events.

Flood frequency analysis was conducted for five locations along the main stem Chilkat River. Flow estimates were made for various return periods in support of channel hydraulic assessments at various locations where the main stem Chilkat or major side channels flow adjacent to the Haines Highway. Flow estimates are for the entire Chilkat River and do not account for flow separation into branching channels.

Peak flow estimates for various return periods were estimated using a combination of USGS regional regression equations (Curran et al. 2003) and watershed expansion of nearby available gage data. Nearby gages used in the watershed expansion include the Klehini Gage (USGS Station #15056560) and the Upper Chilkat Gage (USGS #15056400).

4.4.1 Regional Regression Analysis

The regression equations for southeast Alaska utilize drainage area (A), storage (ST), mean annual precipitation (P), and mean minimum January temperature (J) as predictor variables. Curran et al. (2003) used stream flow data from a total of 93 gaging stations to develop the equations. The equations and accuracy information are displayed in Table 3-1. Basin delineations were performed manually in a Geographic Information System (GIS) using the USGS 1:250,000 topographical map (Skagway) and shaded relief images derived from 30-meter Digital Elevation Models (DEMs). Percent storage for each basin was obtained in GIS by digitizing surface water areas on topographic maps. Mean annual precipitation values were obtained in GIS using a digitized version of the Jones and Fahl (1994) annual precipitation map. Average precipitation values for each basin were weighted by the amount of area in each precipitation zone. Precipitation zones were not available for the Canadian portions of the basins; US data was therefore proportionally expanded into the Canadian portion. Mean minimum January temperature was obtained by geo-referencing and digitizing the temperature isothermal map in Jones and Fahl (1994). Average temperature values for each basin were weighted by the amount of area in each temperature zone. The regression estimates for the main stem Chilkat are included in Table 4-2.

4.4.2 Watershed Expansion Using Gage Data

Flow records are available for several years at two locations in the Chilkat Basin. These include the Upper Chilkat Gage (1962-1968) and the Klehini Gage (1982-1993). Curran et al. (2003) recommend a procedure for estimating peak flows where gage data is available. The method involves conducting Log Pearson III analysis on the gage data and weighting these results with those obtained using regional regression equations. Weighting is conducted according to the number of years of record of gage data and the Equivalent Years of Record (EYR) of the regression equation. This analysis was conducted by Curran et al. (2003) for many streams in Alaska, including the Klehini. The values for the Klehini included in Table 4-2 were obtained by expanding the reported Klehini values to the basins of interest.

Curran et al. (2003) performed stream flow analysis for stations with at least eight years of record and therefore did not perform analysis for the Upper Chilkat Gage, which has seven years of peak flow records. The procedure they describe, however, is suitable for stations with as few as five years of record due to the weighting with regression equations. Their procedure was therefore performed for the Upper Chilkat Gage location in order to obtain additional data points for final peak flow estimates.

A Log Pearson Type III analysis was first performed on the gage data following the methods described in Bulletin 17B of the IACW (1982). Instantaneous peaks were used for all years except one, where only the average daily peak was available. A weighted skew coefficient was obtained by weighting the derived station skew with the generalized skew for southeast Alaska using the procedures described in Curran et al. (2003). The values obtained through Log Pearson III analysis are included in Table 4-1. Regional regression analysis was then performed for the station location. The Log Pearson III values and the regression values were weighted using the following equation from Curran et al. (2003):

$$\log Q_{Twtd} = \frac{\log Q_{Tsta} N + \log Q_{Treg} EYR}{N + EYR}$$

where Q_{Twtd} is the weighted peak flow estimate, Q_{Tsta} is the value obtained from the Log Pearson III analysis with weighted skew, Q_{Treg} is the value obtained using the regional regression equation, N is the number of years of record of station data, and EYR is the Equivalent Years of Record for the regional regression equation. The weighted flow estimates for the Chilkat Gage location are included in Table 4-1.

Table 4-1. Results of flow calculations for the Upper Chilkat Gage location using Log Pearson Type III Analysis and USGS regional regression equations.

	Log Pearson III		Regional Regression		
Return Period	Q (ft^3/second)	Years of Record (Gage)	Q (ft^3/second)	Equivalent Years of Record[1]	Weighted Q (ft^3/second)
2	8,985	7	6,521	0.88	8,669
5	12,712	7	8,880	1.30	12,017
10	15,649	7	10,485	1.80	14,418
25	19,949	7	12,922	2.40	17,856
50	23,610	7	14,766	2.80	20,647
100	27,697	7	16,633	3.10	23,684
200	32,269	7	18,678	3.40	26,987

[1]*From Curran et al. (2003)*

4.4.3 Final Flow Estimates

In order to obtain final flood flow estimates, values from the following analyses were averaged: 1) regional regression, 2) watershed expansion using Klehini Gage, and 3) watershed expansion using Upper Chilkat Gage. All of these results are included in Table 4-2.

Table 4-2. Final flow estimates for locations along the lower mainstem Chilkat River. Values in cubic feet per second.

Return Period	Chilkat at Mouth ($1,602\ mi^2$)	Chilkat below Tahkin River ($1,526\ mi^2$)	Chilkat below Tsirku River ($1,364\ mi^2$)	Chilkat below Klehini River ($1,080\ mi^2$)	Chilkat above Klehini River ($791\ mi^2$)
2-Year					
Regional Regression	32,837	30,932	25,465	18,327	12,375
Klehini Expansion	40,106	38,204	34,148	27,038	19,803
Upper Chilkat Expansion	57,869	55,123	49,272	39,013	28,573
Average	43,604	41,420	36,295	28,126	20,250
5-Year					
Regional Regression	45,167	42,552	35,173	25,506	17,260
Klehini Expansion	47,327	45,081	40,296	31,906	23,368
Upper Chilkat Expansion	80,213	76,408	68,297	54,076	39,606
Average	57,569	54,681	47,922	37,163	26,745
10-Year					
Regional Regression	53,375	50,300	41,637	30,368	20,523
Klehini Expansion	51,839	49,380	44,138	34,948	25,596
Upper Chilkat Expansion	96,242	91,677	81,944	64,882	47,520
Average	67,152	63,786	55,906	43,399	31,213
25-Year					
Regional Regression	66,004	62,231	51,731	37,896	25,763
Klehini Expansion	57,537	54,807	48,989	38,789	28,409
Upper Chilkat Expansion	119,186	113,532	101,479	80,350	58,849
Average	80,909	76,856	67,399	52,345	37,674
50-Year					
Regional Regression	75,469	71,180	59,301	43,610	29,708
Klehini Expansion	61,485	58,568	52,351	41,451	30,359
Upper Chilkat Expansion	137,818	131,280	117,343	92,911	68,049
Average	91,591	87,010	76,332	59,324	42,705
100-Year					
Regional Regression	85,007	80,209	66,969	49,436	33,748
Klehini Expansion	65,434	62,330	55,713	44,113	32,308
Upper Chilkat Expansion	158,093	150,593	134,606	106,579	78,060
Average	102,845	97,710	85,763	66,710	48,039
200-Year					
Regional Regression	95,425	90,074	75,366	55,839	38,200
Klehini Expansion	69,382	66,091	59,075	46,775	34,258
Upper Chilkat Expansion	180,138	171,592	153,376	121,441	88,944
Average	114,982	109,252	95,939	74,685	53,801

4.5 Local input

The Haines area ADOT&PF maintenance supervisor, Roger Ingledue, was interviewed about existing conditions, past performance and areas of concern. In general, the existing Chilkat River and Haines Highway system was reported to be functioning satisfactorily. No flood overtopping of the road either by the Chilkat River main stem or side channels or tributary crossings along the project reach was reported. Overtopping of the road by some tributaries during the November 2005 flood was reported in cases where the culverts were blocked by debris or sediment. No problems with icing were recalled. And no problem areas of revetment erosion were noted.

A flood occurred in November, 2005 that caused sediment and debris accumulations in some tributaries that blocked culverts. Mr. Ingledue reported that flows overtopping the road during the November 2005 flood were a result of debris and sediment plugging the culvert. No overtopping was reported at culverts that were not obstructed. (Personal communication to Mark Sogge, Inter-Fluve, March 8, 2006)

4.6 Backwater

4.6.1 Main stem

No FEMA Flood Insurance Studies were located for the Chilkat River. Anecdotal information indicates that this stretch of highway has not been overtopped during the period of record, since about 1980. Reports of overtopping of the highway during the November 2005 flood were determined to be mountainside flows blocked by sediment and debris accumulations at culvert inlets and subsequently overtopping the road.

The hydraulic and geomorphic conditions of this river and system of side channels are extremely dynamic and complex. The Chilkat River is a braided sand, gravel and cobble bed river with rapidly changing active channels. An extensive sand flats area is located at the mouth where the sediment load deposits as the Chilkat River enters the tidal Lynn Canal. Existing data consists of LIDAR coverage along the highway corridor extending up to approximately one-third, but no more than 1,000-ft, across the active river. The LIDAR does not capture below water topography (bathymetry). The active river ranges from 1,000-ft to over a mile in width. USGS maps have a contour interval of 100-ft and are inadequate to extend the topographic coverage for the hydraulic analysis. Further, the USGS 1:63,360 topographic maps were created in 1954 and revised/inspected in 1977. In addition to the coarse resolution of the topography, it is impacted by isostatic rebound anecdotally reported to be approximately 0.9-inches/year as noted in Section 4.9. There is extremely limited availability of river flow-water surface elevation data for calibration of a hydraulic model.

Given the dynamic nature and complexity of the Chilkat River system and scale of the several miles of river paralleling the road; determination of a jurisdictional 100-year water surface elevation along the length of the project is beyond the scope of this study.

Therefore, an alternate approach was adopted for this conceptual level evaluation. This approximate approach is site specific to enable a semi-quantitative modeling approach for design values. In addition, the relative impact of the proposed action on water surface elevations can be approximated. For preliminary design of bank erosion protection and depth of scour, areas of greatest concern were considered. The area selected for this simplified approach was near Station 394+00 (S&HI station 417+00). A scour hole with depths to 15.5-ft is located at the outside of a bend in the river off a point of land. ADF&G maintains a seasonal staff gage near this location.

Model cross sections were approximately synthesized from the dearth of available data. The LIDAR surface topographic information was used in conjunction with depth sounder readings to approximate bathymetry. Active river width was approximated from the USGS topographic map with a southwest flood plain elevation assumed. Distance between sections was measured from the respective location of the sections superimposed on the LIDAR topography. Downstream boundary conditions were determined by normal depth calculations using a slope of 0.00066-ft/ft determined from the portion of LIDAR topography for the river. For this conceptual phase, values of Manning's n roughness coefficient were estimated based on engineering judgment. Values for the channel and overbank areas were 0.038 and 0.055, respectively.

To model proposed conditions, the existing conditions model was copied and modified to reflect a 2H:1V bank. Comparison of the existing and proposed conditions models indicates 0.02-ft of increase in elevation. However, it must be noted that the Chilkat River is dynamically changing location and bed form with corresponding changes in water surface elevations. Further, the model did not account for changes in cross sectional shape as silts/sands/gravels will transport and deposit in response to river flows.

As noted in Section 4.3.1, this model was used to approximately estimate the upstream limit of tidal influence. The downstream most cross section near station 394+00 (S&HI station 417+00) was copied to near the airport and the limit of the sand flats indicated on the USGS topographic map. Cross section elevations were adjusted based on LIDAR elevations at the airport and extrapolation to the edge of the sand flats. Low tide conditions were modeled using a normal depth as a downstream boundary condition. High tide conditions were modeled using MHHW converted to NAVD 88 project datum as a constant downstream water surface elevation boundary condition. The results of this approximate model indicated that high tide elevations are lower than river water surface elevations generated from the model using normal depth boundary conditions. Thus MHHW do not create a back water condition (hydraulic M1 curve) on river flows at the downstream end of the model below the Haines airport and do not impact the river hydraulics through the project reach.

Summary results from the modeling effort are included in Appendix 23.5.1.

4.6.2 Side Channels

A modeling approach similar to the main stem was taken for the side channels. Representative sites near Stations 640+00, 672+00 to 709+00, 749+00 and 792+00 (S&HI stations 663+00, 693+00, 730+00, 770+00, 813+00, respectively) were selected for evaluation. The LIDAR topographic data included the full side channel width at these locations. Boat and wading based depth sounding readings were used to synthesize below water portions of the cross section. Wading based depth soundings extended only partially across the side channel. Depths across the un-sounded width were extrapolated by assumption.

A range of flows were included in the model in an effort to determine the worst case condition for design of revetment and scour depth protection. As described in the preceding section, the river system is extremely dynamic and complex. The percent of flow diverting from the main Chilkat River along the side channel and flood plains is not known. Therefore, it is not possible to determine a return period event for the various flows.

Summary results from the modeling effort are included in Appendix 23.5.1.

4.7 Scour

As described in Section 4.2, areas where scour would be expected to occur were investigated using a portable depth sounder. These areas were accessed with a jet boat or by wading. These readings provide the scour conditions at the time of the field investigation; October 7 and 8, 2005. Floods typically form the deepest scour at or near the peak of the flood hydrograph. As the flood recedes, the scour hole begins to fill in with bed load. Therefore, maximum scour depth would be expected to be deeper than that measured in October.

4.7.1 Main Stem

Scour depths were observed using the jet boat and depth sounder. Locations of depth readings from the bank were noted by landmarks and visual estimates of distance from the bank. Readings and location were noted onto the project air photo. Main stem depths ranged from 2- to 3- feet in shallow straight riffles to scour holes with depths of 14- to 15.5-ft. Scour holes typically occurred at bends or points of land extending into the active flow path. Scour holes extended for several hundred feet in the upstream-downstream direction.

The Chilkat River system is highly dynamic with flow paths and channel geometry changing quickly and dramatically. As a result, the location, depth and mechanism of scour should be expected to change with scour depths in excess of observed values potentially occurring at nearly any location along the embankment.

4.7.2 Side Channels

Locations of scour holes along the side channels are likely to be more static in their location than those occurring within the main river channel. The scour holes were typically located at bends or local scour at obstructions. Observed scour depths ranged from 8- to 12-ft or more.

4.8 Hydraulic Design

4.8.1 Main Stem

Field observations and the results of the hydraulic modeling were used for conceptual design of road embankment protection. In the field it was noted that there was a distinct elevation on the bank of persistent woody vegetation. Woody vegetation was generally robust above this elevation. Below this elevation, the vegetation was either altogether absent or sporadic. This very obvious field indicator provides a guideline about the applicability of bioengineering techniques for erosion protection. Below this elevation rock is the most suitable material to provide the level of erosion protection required for the highway. Above this elevation, vegetation may provide a satisfactory measure for erosion protection. Non-living vegetation may be incorporated into the lower bank if properly designed for scour and stability of the road, road embankment, and materials. Concepts are shown in the drawings. Final design of these features will be completed at a later stage for submittal with Plans-in-Hand.

Rock to protect the lower bank was sized for flows up to the 100-year event based on bed tractive force, adjusted for increases if along a bend, using the moment stability method (Julien, 1995). The moment stability method accounts for the angularity and specific gravity of rock and provides results that compare well against conditions observed in the field. For relatively straight reaches an average rock size of 18-inches (sound and angular rock with a minimum specific gravity equal to 2.65) laid at a 2H:1V slope will be required. A layer of filter gravel (or fabric) will be required between the rock and the bank slope.

Scour depth is most accurately estimated from field observations. As noted in the preceding section, scour at bends and points of land jutting into the channel were observed in early October, 2005 to have depths to 15.5-ft. These depths will be greater during flood peaks. The observed scour holes occur in predictable isolated locations and tend to extend for several hundred feet in the upstream – downstream direction. Areas at higher risk of erosion include places where the river impinges the road embankment with flows turning at an angle or where land juts into the flow. Straight flow paths were observed to have flow depths of 3- to 6-ft deep with a relatively flat bed surface. However, the river is dynamic and continually changing flow path. Any portion of the road embankment may become subject to aggressive scour from river flows. Following project completion, monitoring and adaptive management of the road embankment is highly recommended.

From the hydraulic analysis, bed shears appear low enough that vegetation may perform satisfactorily for bank erosion protection above the field observed elevation of persistent woody vegetation. Basic concepts are included in the concept drawings. Details will be prepared at final design.

4.8.2 Side Channels

Similar to the main stem, field observations and the results of the hydraulic modeling were used for conceptual design of road embankment protection along the side channels of the Chilkat River. A distinct elevation of persistent woody vegetation was noted for side channels as well.

The side channels represent a complex network of flow paths. It was not possible without extensive topographic data and modeling efforts to determine the percentage of flow for each return period flood event that is conveyed along the side channels or flood plains. Therefore, a worst case condition, corresponding to bank full flow, was used as the design condition along the side channels. Flows greater than bank full are expected to spill onto the flood plain and dissipate the energy associated with the additional flow. Rock to protect the lower bank was sized for flows up to the worst case condition based on bed tractive force, and the moment stability method (Julien, 1995). A bend coefficient was used to account for greater shear forces along bends (FHWA, 1988). For sharp bends (e.g. Station 640+00 - S&HI station 663+00) the coefficient doubles the bed tractive force. The moment stability method accounts for the angularity of rock and provides results that compare well against conditions observed in the field. Average rock size of about 18-inch diameter will be required along straight reaches, below the tangent of bends. At moderate bends average rock size will need to be between 21- and 27-inches. At sharp bends with high tractive forces and turbulence, average rock size may need to be 30-inches and laid at 2.5H:1V or flatter. All rock is to be sound and angular with sizes based on a minimum specific gravity equal to 2.65. A layer of filter gravel (or fabric) will be required between the rock and the bank slope.

Scour depth is based on observations in the field. As noted in the preceding section, scour at bends and points of land jutting into the Chilkat side channels were observed in early October, 2005 to have depths to 11.5-ft. These depths will be greater during flood peaks. The scour holes occur in predictable isolated locations and tend to extend for a few hundred feet in the upstream – downstream direction. Areas at higher risk of erosion include outsides of bends. The severity of scour increases with tighter bends. Straight flow paths were observed to have flow depths of 4- to 6-ft deep with a relatively flat bed surface. Locations of scour are not expected to change from current locations. Fallen trees or debris accumulations will also initiate local scour. Following project completion, ongoing monitoring and adaptive management of the road embankment is highly recommended.

From the hydraulic analysis, bed shears appear low enough that vegetation may perform satisfactorily for bank erosion protection above the field observed elevation of persistent woody vegetation. Basic concepts are included in the concept drawings. Details will be prepared at final design.

4.9 23 CFR

An internet search turned up no indication that a FEMA Flood Insurance Study exists for the Chilkat River. Communication with Haines Borough Planner Scott Hansen indicated that no FEMA Flood Insurance Study (FIS) is known to exist for the Chilkat River system. An FIS for the immediate Haines area dating back to the 1970's is available but is likely obsolete as isostatic rebound is anecdotally reported to be approximately 0.9-inches/year (S. Hansen, email communication).

As described in Section 4.6, representative conditions at Station 394+00 (S&HI station 417+00) were modeled to compare estimated water surface elevations associated with existing and with project conditions. The existing conditions run was copied and modified to represent bank conditions. There is 0.02-ft of increase in water surface elevation for the with-project condition. However, it must be noted that the river changes dynamically with shifting bed forms. Changes in cross section and flow roughness by these natural processes are anticipated to cause greater changes in water surface elevations. Further, the dynamic shifting of the river bed and bar forms will likely adjust in response to roadway encroachment. A detailed analysis of this bed shifting and corresponding adjustements to water surface elevations is beyond the scope of this study.

Risks associated with the proposed action are considered to be similar in scale to those of the existing roadway. The road embankment is subject to forces of the Chilkat River and changes in channel form, such as scour depths and locations. The existing road is subject to much the same forces. Through field observations and design calculations similar or greater levels of protection are an objective. Following project implementation monitoring and maintenance are recommended.

4.10 Conclusion

The hydraulic features of the proposed action have been developed to a conceptual level in support of permitting and environmental activities. The design features will be revised as appropriate and final designs and report will be prepared for the Plans-in-Hand submittal.

Conceptual designs of revetments follow industry standard methods. Bioengineering has no nationally established engineering design methods. Design of vegetative erosion protection is based on current knowledge in the industry and Inter-Fluve's experience from 1983 to the present in this field. Further, reference reach conditions are used as a design template.

4.11 Riprap

Existing riprap was observed to be mostly stable and reported to be performing satisfactorily. Hydraulic analysis was used to preliminarily size rock for road embankment erosion protection as described in Section 4.8.

4.12 Flood Hazard Area

The project is not located within a defined flood hazard area.

5. Culvert Replacement at Station 222+51

5.1 Introduction

The unnamed tributary crossing the highway at station 222+51 (S&HI station 245+50) is comprised of an existing circular 48-inch corrugated metal pipe (CMP). The bottom of the pipe is rusted and the pipe should be replaced. At this Preliminary Engineering Report phase, the pipe was preliminarily designed based on Tier 1 stream simulation fish passage design [1] methods outlined in the MOA. Tier 1 methods were selected based on the high quality of upstream habitats. This project will replace the existing pipe with a larger 6'-9" by 4'-11" pipe arch to convey flood flows and provide fish passage.

5.2 Hydraulic History

This unnamed tributary crosses the Haines Highway at about elevation 21-ft. As described in Section 4.3.1, MHHW is at elevation 9.4-ft (NAVD 88) and based on approximate modeling, tidal backwater will not extend to this location.

Field indicators of Chilkat River backwater (i.e. deposition of fine sediments) were not seen to extend upstream along the tributary to the location of the existing culvert. Therefore, it is not likely that the culvert is impacted by backwater effects from frequently occurring Chilkat River flows. Large Chilkat River floods would be expected to have a backwater influence extending to the culvert.

No historical flood data are available for this tributary. Magnitude and water surface elevations for the flood of record are not known. High water marks for large flood events were not evident. No Flood Insurance Studies were identified for the Chilkat River or its tributaries, including this one.

A site visit was conducted on October 7, 2005. A rapid assessment and cursory site survey were conducted for this phase as described in Section 3.2. The existing culvert is a 48-inch CMP with no stream substrate material in the bottom of the pipe. The bottom of the pipe is rusted. The pipe should be replaced for longevity. From the site survey, the existing pipe is approximately 66-ft long at approximately 0.0215-ft/ft slope. A small amount of flow was observed. No flooding problems with the existing culvert were reported in the anecdotal record or indicators observed in the field.

The creek is too small for navigation. This project will not impact navigation. The confluence with the Chilkat River is approximately 1,000-ft downstream. No upstream

[1] As stated in the MOA - **Tier 1 stream simulation** fish passage design attempts to replicate natural stream channel conditions within the culvert. Culvert width at the ordinary high water (OHW) stage is 90-percent or greater than the channel width at OHW. Slope varies by no more than 1-percent from adjacent stream reaches. Substrate is placed within the culvert and designed to remain dynamically stable for flows up to the 50-year event and contain a sufficient volume of fines to limit subsurface flow. Culvert inverts are buried to 40-percent of the diameter for circular culverts or 20-percent of the rise for arch pipes. (ADFG and ADOT&PF, 2001)

confluences were observed in the vicinity. Therefore, no impacts to confluences are expected. This stream runs through a portion of the Southeast Road builder gravel pit upstream of the highway.

Reach scale geomorphic conditions were summarized in the Stream and Habitat Inventory (S&HI) from observations and simple tape measurements by hand. On the reach scale, the upstream channel is a 3-6' wide, E type channel with a substrate of mixed sand and organics. There is a small pool at the culvert inlet. Downstream of the culvert the stream winds along the toe of the road fill slope back to station 234+50. The upstream half of this reach is also an E type channel 3-6' wide with a sandy/organic substrate. Stream banks are grassy, woody debris is present and alder often overhangs the stream. The lower half of this reach is influenced by the river backwater, wider (6-10'), more open and 6-18" deep. Substrate is silt, sand, fine gravels and organic matter. Aquatic weeds shape the stream meander and banks are grassy or vegetated with alder and willow.

The S&HI indicates that this stream is used by coho as spawning and rearing habitat. Dolly Varden use this stream for rearing. The stream is listed in the Anadromous Waters Catalog as catalog number: 115-32-10250-2004.

5.3 Hydrology

The contributing basin has a drainage area of approximately 0.47 square miles and extends up to near the summit of Mount Ripinski (3,679 feet). The watershed is steep, with an average watershed slope of 63 percent. There is no perennial channel depicted on the USGS 7.5 minute topographical map. The perennial flow present on the valley floor may be largely contributed by seeps at the toe of the hill slope. There is very little storage in the basin and there are no glaciers. The watershed is largely undeveloped, with slight industrial use in the lower portion of the basin.

There is no known gage information for this stream. Peak flow estimates using regional regression equations ranged from 42 cfs for the 2-year event to 130 cfs for the 100-year flood. The fish passage design flow, which is 40 percent of the 2-year event, is 17 cfs. There is no local input to report for this basin.

5.4 Hydraulic Design

At this phase, preliminary design was completed in support of the Preliminary Engineering Report. Final designs will require detailed stream cross section and profile survey. Final culvert designs will be prepared and documented for submittal with the Plans-in-Hand.

A 6'-9" by 4'-11" pipe arch is recommended as the replacement at this crossing. This size pipe will satisfy requirements of the Tier 1 stream simulation design method for fish passage as stated in the MOA. This culvert will provide sufficient span to accommodate the 6.7-ft wide reference stream channel width averaged from cross sections 53 feet upstream and 45 feet downstream of the existing pipe measured by the Inter-Fluve survey

(October, 2005) and representative of stream conditions locally at the culvert. The culvert would be set at a slope to match the existing stream system. Stream substrate will be placed in the bottom of the pipe to fill a minimum of 20 percent of the rise. Concepts are shown in Section 23.3.

Existing and proposed conditions were modeled with HEC-RAS. Results of modeling indicate that the proposed culvert will pass the 50-year flood with headwater elevation to culvert rise ratio equal to 1.02.

Table 5-1. 222+51 Hydrologic and Hydraulic Summary

Drainage Area = 0.47-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs)	79	114	130
Flow depth at inlet (ft)	2.82	3.98	4.59
Hw/D	0.72	1.02	1.17

Note: Design was completed to preliminary level in support of the Preliminary Engineering Report based on cursory survey data collected by Inter-Fluve based on a relative horizontal and vertical datum. Final design will include site topographic survey.

5.5 23 CFR

There is no known FEMA Flood Insurance Study for the existing culvert. The proposed action includes a culvert larger in size and more hydraulically efficient than the existing culvert. Hydraulic analysis indicates that the upstream water surface elevations will be lower with the proposed culvert than currently exist. Risks of the proposed culvert are considered minimal. There is a reduction in upstream backwater effects and more efficient conveyance of flows through the pipe. There is less likelihood of debris blocking the culvert. The proposed culvert will improve stream process and provide more natural flood plain connectivity.

5.6 Conclusion

The hydraulic features of the proposed action are developed to a preliminary level at this phase in support of the Preliminary Engineering Report. Design will be completed for submittal with Plans-in-Hand. The proposed culvert is not expected to impact the flood plain or environment. The proposed culvert meets ADOT&PF's requirements for conveyance of the 50-year event. The proposed culvert was designed for fish passage using the Tier 1 method to simulate adjacent stream conditions. This provides favorable continuity of stream processes and passage of fish through the culvert from adjacent stream reaches.

The hydrologic and hydraulic summary for the proposed culvert are presented in Table 5-1.

5.7 Riprap

The culvert was designed to provide fish passage using Tier 1 stream simulation to maintain continuity of flow of water and sediment. No riprap is proposed at this time.

5.8 Station 222+51 – Existing conditions photos

Existing Culvert: 48-inch cmp
Catalog Number: 115-32-10250-2004
Fish Use: Rearing coho and Dolly Varden. Spawning coho
Description: This location was referenced as Station 245+50 in the S&HI. Based on hand measurements, upstream of the culvert the stream is a 3-6' wide, E type channel with a substrate of mixed sand and organics. There is a small pool at the culvert inlet. Downstream of the culvert the stream winds along the toe of the road fill slope back to (S&HI) station 234+50. The upstream half of this reach is also an E type channel 3-6' wide with a sandy/organic substrate. Stream banks are grassy, woody debris is present and alder often overhangs the stream. The lower half of this reach is influenced by the river backwater, wider (6-10'), more open and 6-18" deep. Substrate is silt, sand, fine gravels and organic matter. Aquatic weeds shape the stream meander and banks are grassy or vegetated with alder and willow.




6. Culvert Replacement at Station 319+13

6.1 Introduction

The unnamed tributary crossing the highway at station 319+13 (S&HI Station 342+00) is comprised of an existing circular 36-inch corrugated metal pipe (CMP). The bottom of the pipe is rusted with the outlet unraveled. It is recommended that the pipe be replaced. At this Preliminary Engineering Report phase, the pipe was preliminarily designed based on Tier 1 stream simulation methods outlined in the MOA. Tier 1 methods were selected based on the high quality of upstream habitats. This project will replace the existing pipe with a larger 6'-9" by 4'-11" pipe arch to convey flood flows and provide fish passage.

6.2 Hydraulic History

This unnamed tributary crosses the Haines Highway at about elevation 26.5-ft. As described in Section 4.3.1, MHHW is at elevation 9.4-ft (NAVD 88) and based on approximate modeling tidal backwater will not extend to this location.

Field indicators of Chilkat River backwater (i.e. deposition of fine sediments) extend upstream along the tributary to the location of the existing culvert. Therefore, the culvert is impacted by frequently occurring Chilkat River backwater effects.

No historical flood data are available for this tributary. Magnitude and water surface elevations for the flood of record are not known. High water marks for large flood events were not evident. No Flood Insurance Studies were identified for the Chilkat River or its tributaries, including this one.

A site visit was conducted on October 7, 2005. A rapid assessment and cursory site survey were conducted for this phase as described in Section 3.2. The existing culvert is a 36-inch CMP with no sediment in the bottom of the pipe. The bottom of the pipe is rusted with a section of the outlet unraveled. The pipe should be replaced for longevity. From the site survey, the existing pipe is approximately 53-ft long at approximately 0.0137-ft/ft slope. The outlet is perched approximately 0.25- to 0.6-ft above the scour pool water surface. The pool is about 1.1-ft deep. A small amount of flow was observed.

The creek is too small for navigation. This project will not impact navigation. The confluence with the Chilkat River is approximately 290-ft downstream. No upstream confluences were observed in the vicinity. No impacts to confluences are expected. No mining occurs on this stream.

Reach scale geomorphic conditions were summarized in the Stream and Habitat Inventory (S&HI) based on observations and simple tape measurements by hand. Upstream of the culvert the complex channel of the stream meanders among alder roots and downfall. On the reach scale, the upstream channel is 1-3' wide with a substrate of gravel and organics. Depth is 6-8" and overhanging cover is dense. Periodically, hillside processes deliver sediments to this site. No problems with conveyance through the existing culvert were reported in the anecdotal record or indicators observed in the field. The downstream end of the culvert is perched 3-4” and unraveled. The stream meanders along the road back to station 316+50 before entering the Chilkat River. The river backwaters the stream and deposits silt over the gravel bed. On the reach scale, the downstream channel is 4-6’ wide and 3-4” deep. It lies in an old flood channel of the river. Stream banks are grass covered.

The S&HI indicates that this stream is used by coho and Dolly Varden as rearing habitat. The stream is not listed in the Anadromous Waters Catalog.

6.3 Hydrology

The contributing basin has a drainage area of approximately 0.6 square miles. The basin extends up to Seven Mile Saddle, which connects into the Shakasevi drainage on the east side of the divide. The high point of the basin is at 3,904 feet at the summit of an unnamed peak. The watershed has an average slope of 42 percent. The USGS 7.5 minute topographical map depicts a perennial stream channel that is believed to be within the contributing area for the culvert. The bulk of the perennial flow present on the valley floor may be largely contributed by seeps at the toe of the hill slope and possibly by hyporheic flow from the main stem Chilkat. There is virtually no storage in the basin and there are no glaciers. The watershed is undeveloped.

There is no known gage information for this stream. Peak flow estimates using regional regression equations ranged from 50 cfs for the 2-year event to 154 cfs for the 100-year flood. The fish passage design flow, which is 40 percent of the 2-year event, is 20 cfs. There is no local input to report for this basin.

6.4 Hydraulic Design

At this phase, preliminary design was completed in support of the Preliminary Engineering Report. Final designs will require detailed stream cross section and profile survey. Final culvert designs will be prepared and documented for submittal with the Plans-in-Hand.

A 6’-9” by 4’-11” pipe arch is recommended as the replacement at this crossing to satisfy requirements of the Tier 1 (stream simulation) design method for fish passage as stated in the MOA. This culvert will provide sufficient span to accommodate the 5.1-ft wide reference stream channel measured 17 feet upstream of the culvert by the Inter-Fluve survey (October, 2005) and representative of stream conditions locally at the culvert. November, 2008 survey measured 4 to 5 ft wide channel widths approximately 100 feet downstream of the culvert. The culvert would be set at a slope to match the existing stream system. Stream substrate will be placed in the bottom of the pipe to fill a minimum of 20-percent of the rise. Concepts are shown in Section 23.3.

Existing and proposed conditions were modeled with HEC-RAS. Results of modeling indicate that the proposed culvert will pass the 50-year flood with headwater elevation to culvert rise ratio equal to 1.16.

Table 6-1. 319+13 Hydrologic and Hydraulic Summary

Drainage Area = 0.60-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs)	93	135	154
Flow depth at inlet (ft)	3.36	4.54	5.09
Hw/D	0.86	1.16	1.30

Note: Design was completed to preliminary level in support of the Preliminary Engineering Report based on cursory survey data collected by Inter-Fluve based on a relative horizontal and vertical datum. Final design will include site topographic survey.

6.5 23 CFR

There is no known FEMA Flood Insurance Study for the existing culvert. The proposed action includes a culvert larger in size and more hydraulically efficient than the existing culvert. Hydraulic analysis indicates that the upstream water surface elevations will be lower with the proposed culvert than currently exist. Risks of the proposed culvert are considered minimal. There is a reduction in upstream backwater effects and more efficient conveyance of flows through the pipe. There is less likelihood of debris blocking the culvert. The proposed culvert will improve stream process and provide more natural flood plain connectivity.

6.6 Conclusion

The hydraulic features of the proposed action are developed to a preliminary level at this phase in support of the Preliminary Engineering Report. Design will be completed for submittal with Plans-in-Hand. The proposed culvert is not expected to impact the flood plain or environment. The proposed culvert was designed for fish passage using the Tier 1 method to simulate adjacent stream conditions. This provides favorable continuity of stream processes and passage of fish through the culvert from adjacent stream reaches.

The hydrologic and hydraulic summary for the proposed culvert are presented in Table 6-1.

6.7 Riprap

The culvert was designed using Tier 1 stream simulation to maintain continuity of flow of water and sediment. No riprap is proposed at this time.

6.8 Station 319+13 – Existing conditions photos

Existing Culvert: 36-inch cmp
Fish Use: Rearing coho and Dolly Varden
Description: This location was referenced as Station 342+00 in the S&HI. Based on hand measurements, upstream of the culvert the complex channel of the stream meanders among alder roots and downfall. The stream is 1-3' wide with a substrate of gravel and organics. Depth is 6-8" and overhanging cover is dense. The downstream end of the culvert is perched 3-4" and unraveled. The stream meanders along the road back to station 316+50 before entering the Chilkat River. The river backwaters the stream and deposits silt over the gravel bed. The stream is 4-6' wide and 3-4" deep. It lies in an old flood channel of the river. Stream banks are grass covered.

7. Culvert Replacement at Station 324+79

7.1 Introduction

The unnamed tributary crossing the highway at station 324+79 (S&HI station 347+50) is comprised of an existing circular 48-inch corrugated metal pipe (CMP). The pipe bottom is rusted and the inlet is damaged; the pipe should be replaced. At this Preliminary Engineering Report phase, the pipe was conceptually designed based on Tier 1 stream simulation methods outlined in the MOA. Tier 1 methods were selected based on the high quality of upstream habitats. This project will replace the existing pipe with a larger 7'-3" by 5'-3" pipe arch to convey flood flows without overtopping the road and provide fish passage.

7.2 Hydraulic History

This unnamed tributary crosses the Haines Highway at about elevation 28-ft. As described in Section 4.3.1, MHHW is at elevation 9.4-ft (NAVD 88 and based on approximate modeling tidal backwater will not extend to this location.

Field indicators of Chilkat River backwater (i.e. deposition of fine sediments) extend upstream along the tributary to the location of the existing culvert. Therefore, the culvert is impacted by frequently occurring Chilkat River backwater effects.

No historical flood data are available for this tributary. Water surface elevations for flood of record are not known. High water marks for large flood events were not evident. No Flood Insurance Studies were identified for the Chilkat River or its tributaries, including this one.

A site visit was conducted on October 7, 2005. A rapid assessment and cursory site survey were conducted for this phase as described in Section 3.2. The existing culvert is a 48-inch CMP with no stream substrate material observed in the bottom of the pipe. The pipe bottom is rusted and the inlet is damaged. The pipe should be replaced for longevity. From the site survey, the existing pipe is approximately 60-ft long laid at approximately 0.0194-ft/ft slope. The rim of the downstream scour pool is 1.2-ft higher than the culvert outlet invert and 0.03-ft lower than the culvert inlet effectively backwatering most of the pipe length. No flow was observed. No flooding problems with the existing culvert were reported in the anecdotal record or indicators observed in the field.

The creek is too small for navigation. This project will not impact navigation. The confluence with the Chilkat River is approximately 350-ft downstream. No upstream confluences were observed in the vicinity. No impacts to confluences are expected. No mining occurs on this stream.

Reach scale geomorphic conditions were summarized in the Stream and Habitat Inventory (S&HI) from observations and simple tape measurements by hand. The culvert appears to be fairly recently replaced yet the bottom of the pipe is rusted. , On the reach scale, the upstream channel is a 1-2' wide E type channel with a fine silt and gravel substrate. The stream drains a swamp fed by numerous springs along the toe of the mountain. The culvert outlet empties into a short section of gravel bottomed stream with a width of 2-3' and grassy banks. The stream then turns into a 3-6' wide backwatered slough with a silt substrate. Springs feed this section of the stream.

The S&HI indicates that this stream is used by coho and Dolly Varden as rearing habitat. The stream is listed in the Anadromous Waters Catalog as catalog number: 115-32-10250-2014.

7.3 Hydrology

The contributing basin has a drainage area of approximately 1.23 square miles. The basin extends up to Seven Mile Saddle, which connects into the Shakasevi drainage on the east side of the divide. The high point of the basin is at 4,088 feet on the ridge leading north to Tukgahgo Mountain. The watershed has an average slope of 55 percent. The USGS 7.5 minute topographical map depicts two perennial stream channels that have their confluence 150 meters upstream of the culvert. Some of the perennial flow present on the valley floor may possibly be from hyporheic flow from the main stem Chilkat. There is virtually no storage in the basin and no glaciers. A pack trail heading to Seven mile Saddle follows the eastern edge of the basin; otherwise, the watershed is undeveloped.

There is no known gage information for this stream. Peak flow estimates using regional regression equations ranged from 92 cfs for the 2-year event to 280 cfs for the 100-year flood. The fish passage design flow, which is 40 percent of the 2-year event, is 37 cfs. Hydraulic analysis for the existing pipe indicates that the 2-year event will over top the road. Given that the anecdotal record of culverts along the Haines Highway has not identified this culvert to be a problem, the flows from the hydrology estimates are suspected to be too large and in error. This is the only tributary with estimated flows being suspiciously high. Therefore, an alternate approach was taken where the hydraulic capacity of the existing culvert was used to back calculate the flow that meets design criteria (HW/D < 1.5). In addition, the culvert configuration required to provide fish passage was analyzed to confirm that the flood conveyance was equal to or greater than existing conditions.

For existing conditions the flow corresponding to a HW/D ~ 1.5 is approximately 169-cfs (10-year event predicted flow). Prorating the predicted flows to the ADOT&PF criteria of HW/D < 1.5 for the 50-year design event would approximate the Q2-yr ~ 63-cfs, Q10-yr ~ 116-cfs, Q50-yr ~ 169-cfs and Q100-yr ~ 192-cfs. These flows are approximately 70-percent of the estimates using regional regression equations. As noted in Section 3, precipitation values recorded in Haines are 80-percent of regional regression values providing a possible explanation for this reduction in flows. The corresponding fish passage flow is roughly 25-cfs. Based on this hydrology and hydraulic analysis, a 7'-3"x5'-3" pipe arch would be required to prevent overtopping of the road. This is a significantly larger pipe than the existing structure which has not been reported in the anecdotal record to be a problem. The hydrology remains suspect and will be further scrutinized during final design.

There is no local input to report for this basin.

7.4 Hydraulic Design

At this phase, preliminary design was completed in support of the Preliminary Engineering Report. Final designs will require detailed stream cross section and profile survey. Final culvert designs will be prepared and documented for submittal with the Plans-in-Hand.

A 7'-3" by 5'-3" pipe arch is recommended as the replacement at this crossing to provide sufficient flood conveyance for the estimated stream flows and prevent overtopping of the road by the estimated 50-year flow. This size pipe will satisfy requirements of the Tier 1 stream simulation design method for fish passage as stated in the MOA. This culvert will provide sufficient span to accommodate the average 6.9-ft wide reference stream channel width measured 20 feet upstream and 42 feet downstream of the culvert by the Inter-Fluve survey (October, 2005) and representative of stream conditions locally at the culvert. The culvert would be set at a slope to match the existing stream system. Stream substrate will be placed in the bottom of the pipe to fill a minimum of 20-percent of the rise. Concepts are shown in Section 23.3.

Existing and proposed conditions were modeled with HEC-RAS. Results of modeling indicate that the proposed culvert will provide greater conveyance capacity than currently exists. Results of modeling indicate that the proposed culvert will pass the 50-year flood with headwater elevation to culvert rise ratio equal to 1.08.

Table 7-1. 324+79 Hydrologic and Hydraulic Summary

Drainage Area = 1.23-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs)	116	169	192
Flow depth at inlet (ft)	3.34	4.22	5.09
Hw/D	0.85	1.08	1.30

Notes:

1. Design was completed to preliminary level in support of the Preliminary Engineering Report based on cursory survey data collected by Inter-Fluve based on a relative horizontal and vertical datum. Final design will include site topographic survey.
2. Through the hydraulic analysis a 7.25'x5.25' pipe arch is required to prevent the estimated 50-year flood from overtopping the road. This is a significantly larger pipe than the existing structure which has not been reported in the anecdotal record to be a problem. The hydrology remains suspect and will be further scrutinized during final design.

7.5 23 CFR

There is no known FEMA Flood Insurance Study for the existing culvert. The proposed action includes a culvert larger in size and more hydraulically efficient than the existing culvert. Hydraulic analysis indicates that the upstream water surface elevations will be lower with the proposed culvert than currently exist. Risks of the proposed culvert are considered minimal. There is a reduction in upstream backwater effects and more efficient conveyance of flows through the pipe. There is less likelihood of debris blocking the culvert. The proposed culvert will improve stream process and provide more natural flood plain connectivity.

7.6 Conclusion

The hydraulic features of the proposed action are developed to a preliminary level at this phase in support of the Preliminary Engineering Report. Design will be completed for submittal with Plans-in-Hand. The proposed culvert is not expected to impact the flood plain or environment. The proposed culvert meets ADOT&PF's requirements for conveyance of the 50-year event. The proposed culvert was designed for fish passage using the Tier 1 method to simulate adjacent stream conditions. This provides favorable continuity of stream processes and passage of fish through the culvert from adjacent stream reaches.

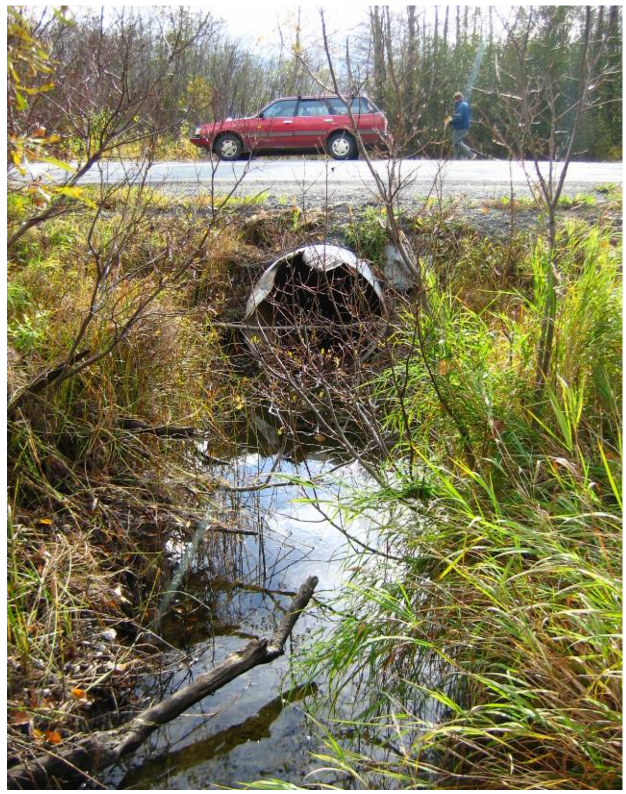
The hydrologic and hydraulic summary for the proposed culvert are presented in Table 7-1.

7.7 Riprap

The culvert was designed using Tier 1 stream simulation to maintain continuity of flow of water and sediment. No riprap is proposed at this time.

7.8 Station 324+79 – Existing conditions photos

Existing Culvert: 48-inch cmp
Catalog Number: 115-32-10250-2014
Fish Use: Rearing coho and Dolly Varden
Description: This location was referenced as Station 347+50 in the S&HI. The culvert appears to be fairly recently replaced. Based on hand measurements, upstream of the culvert the stream is a 1-2' wide E type channel with a fine silt and gravel substrate. The stream drains a swamp fed by numerous springs along the toe of the mountain. The culvert outlet empties into a short section of gravel bottomed stream with a width of 2-3' and grassy banks. The stream then turns into a 3-6' wide backwatered slough with a silt substrate. Springs feed this section of the stream.



8. Culvert Replacement at Station 483+18

8.1 Introduction

The unnamed tributary crossing the highway at station 483+18 (S&HI station 506+25) is comprised of an existing circular 48-inch corrugated metal pipe (CMP) with a rusted bottom and outlet apron. It is recommended that the pipe be replaced. At this Preliminary Engineering Report phase, the pipe was preliminarily designed based on Tier 1 stream simulation methods outlined in the MOA. Tier 1 methods were selected based on the high quality of upstream habitats. This project will replace the existing pipe with a larger 7'-3" by 5'-3" pipe arch to convey flood flows and provide fish passage.

8.2 Hydraulic History

This unnamed tributary crosses the Haines Highway at about elevation 35-ft. As described in Section 4.3.1, MHHW is at elevation 9.4-ft (NAVD 88) and based on approximate modeling tidal backwater will not extend to this location.

Field indicators of Chilkat River backwater (i.e. deposition of fine sediments) extend upstream along the tributary to the location of the existing culvert. Therefore, the culvert is impacted by frequently occurring Chilkat River backwater effects.

No historical flood data are available for this tributary. Water surface elevations for the flood of record are not known. High water marks for large flood events were not evident. No Flood Insurance Studies were identified for the Chilkat River or its tributaries, including this one.

A site visit was conducted on October 7, 2005. A rapid assessment and cursory site survey were conducted for this phase as described in Section 3.2. The existing culvert is a 48-inch CMP with no stream substrate material observed in the bottom of the pipe. The bottom of the pipe and outlet apron is rusted. The pipe should be replaced for longevity. From the site survey, the existing pipe is approximately 65-ft long laid at approximately 0.0091-ft/ft slope. The outlet of the downstream scour pool is 0.13-ft lower than the culvert outlet invert. Low flows appear able to backwater the culvert outlet invert. No flooding problems with the existing culvert were reported in the anecdotal record or indicators observed in the field.

The creek is too small for navigation. This project will not impact navigation. The confluence with the Chilkat River is approximately 125-ft downstream. No upstream confluences were observed in the vicinity. No impacts to confluences are expected. No mining occurs on this stream.

Reach scale geomorphic conditions were summarized in the Stream and Habitat Inventory (S&HI) from observations and simple tape measurements by hand. On the reach scale, the upstream channel is about 8' wide and flows over a silt/organic substrate. The stream is backwatered by the Chilkat River and had a depth of 6-8" at the time of the survey. Banks are muddy and grassy, with willow and alder growing close to the water on one side. The culvert empties into a 30’ diameter pool with a depth of 3’. Banks are silty up to the level of frequent river backwater and then formed of grass and young willow/alder. Substrate is silt. Downstream of the pool the channel is 10’ wide but terminates abruptly at a sandbar about 125’ from the road. A small trickle flows over the sandbar and into an isolated pool. Fish access is dependent on the river water level.

The S&HI indicates that this stream is used by coho and Dolly Varden as rearing habitat. The stream is listed in the Anadromous Waters Catalog as catalog number: 115-32-10250-2024.

8.3 Hydrology

The contributing basin has a drainage area of approximately 1.07 square miles. The basin extends up to a ridge leading northeast toward Tukgahgo Mountain. The high point of the basin is at 4,490 feet. The watershed has an average slope of 57 percent. The USGS 7.5 minute topographical map depicts a single perennial stream channel with its headwaters at a small lake. A portion of the perennial flow present on the valley floor may be contributed by seeps at the toe of the hill slope and possibly by hyporheic flow from the main stem Chilkat. There is very little storage in the basin and there are no glaciers. The watershed is undeveloped.

There is no known gage information for this stream. Peak flow estimates using regional regression equations ranged from 76 cfs for the 2-year event to 232 cfs for the 100-year flood. The fish passage design flow, which is 40 percent of the 2-year event, is 30 cfs. There is no local input to report for this basin.

8.4 Hydraulic Design

At this phase, preliminary design was completed in support of the Preliminary Engineering Report. Final designs will require detailed stream cross section and profile survey. Final culvert designs will be prepared and documented for submittal with the Plans-in-Hand.

By Tier 1 methods, a 7’-4” by 5’-4” pipe arch would be required to accommodate stream width at this crossing. This size pipe will satisfy requirements of the Tier 1 stream simulation design method for fish passage as stated in the MOA. This culvert will provide sufficient span to accommodate the 8-ft wide reference stream channel width measured 104 feet upstream of the existing culvert by the Inter-Fluve survey (October, 2005) and representative of stream conditions locally at the culvert. The culvert would be set at a slope to match the existing stream system. Stream substrate will be placed in the bottom of the pipe arch to fill a minimum of 20-percent of the rise. Concepts are shown in Section 23.3.

Existing and proposed conditions were modeled with HEC-RAS. Results of modeling indicate that the proposed culvert will provide greater conveyance capacity than currently exists. The proposed culvert will pass the 50-year flood with headwater elevation to culvert rise ratio equal to 1.29.

Table 8-1. 483+18 Hydrologic and Hydraulic Summary

Drainage Area = 1.07-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs)	139	203	232
Flow depth at inlet (ft)	3.92	5.49	6.41
Hw/D	0.92	1.29	1.51

Note: Design was completed to preliminary level in support of the Preliminary Engineering Report based on cursory survey data collected by Inter-Fluve based on a relative horizontal and vertical datum. Final design will include site topographic survey.

8.5 23 CFR

There is no known FEMA Flood Insurance Study for the existing culvert. The proposed action includes a culvert larger in size and more hydraulically efficient than the existing culvert. Hydraulic analysis indicates that the upstream water surface elevations will be lower with the proposed culvert than currently exist. Risks of the proposed culvert are considered minimal. There is a reduction in upstream backwater effects and more efficient conveyance of flows through the pipe. There is less likelihood of debris blocking the culvert. The proposed culvert will improve stream process and provide more natural flood plain connectivity.

8.6 Conclusion

The hydraulic features of the proposed action are developed to a preliminary level at this phase in support of the Preliminary Engineering Report. Design will be completed for submittal with Plans-in-Hand. The proposed culvert is not expected to impact the flood plain or environment.

The hydrologic and hydraulic summary for the proposed culvert are presented in Table 8-1.

8.7 Riprap

The culvert was designed using Tier 1 stream simulation to maintain continuity of flow of water and sediment. No riprap is proposed at this time.

8.8 Station 483+18– Existing conditions photos

Existing Culvert: 48-inch cmp
Catalog Number: 115-32-10250-2024
Fish Use: Rearing coho and Dolly Varden
Description: This location was referenced as Station 506+25 in the S&HI. Based on hand measurements, upstream of the culvert the stream is about 8' wide and flows over a silt/organic substrate. The stream is backwatered by the Chilkat River and had a depth of 6-8" at the time of the survey. Banks are muddy and grassy, with willow and alder growing close to the water on one side. The culvert empties into a 30' diameter pool with a depth of 3'. Banks are silty up to the level of frequent river backwater and then formed of grass and young willow/alder. Substrate is silt. Downstream of the pool the channel is 10' wide but terminates abruptly at a sandbar about 125' from the road. A small trickle flows over the sandbar and into an isolated pool. Fish access is dependent on the river water level.




9. Culvert Replacement at Station 512+24

9.1 Introduction

This tributary is referred to locally as 10-Mile Creek. The tributary crosses the highway at station 512+24 (S&HI station 535+50) near a hydroelectric plant. The existing crossing is comprised of one 24-inch and one 36-inch circular corrugated metal pipes (CMP). At this Preliminary Engineering Report phase, the replacement pipe was preliminarily designed to meet Tier 1 stream simulation fish passage design methods outlined in the MOA. Tier 1 methods were selected based on the high quality of upstream habitats. This project will replace the existing pipes with one larger 14'-1" by 6'-2" aluminum box culvert to convey flood flows, provide fish passage and meet site cover restrictions.

9.2 Hydraulic History

10-Mile Creek crosses the Haines Highway at about elevation 37-ft. As described in Section 4.3.1, MHHW is at elevation 9.4-ft (NAVD 88) and based on approximate modeling tidal backwater will not extend to this location.

10-Mile Creek discharges into 10-Mile Slough, then enters the main stem of the Chilkat River approximately 800-ft downstream of the culverts. Field indicators of Chilkat River backwater (i.e. deposition of fine sediments) extend upstream along 10-Mile Slough to the confluence with 10-Mile Creek. The culverts appear to be above the Chilkat River backwater. Therefore, it appears that the new culvert will not be impacted by frequently occurring Chilkat River backwater effects.

No historical flood data are available for this tributary. Magnitude and water surface elevations for the flood of record are not known. High water marks for large flood events were not evident. No Flood Insurance Studies were identified for the Chilkat River or its tributaries, including this one.

A site visit was conducted on October 7, 2005. A rapid assessment and cursory site survey were conducted for this phase as described in Section 3.2. The existing culverts are one 24-inch and one-36-inch diameter circular CMP. The majority of the flows pass through the 36-inch pipe. Approximately 0.6-ft of material was measured in the bottom of the 36-inch pipe. No perching of the pipe or formation of a scour pool was observed. From survey measurements on the 36-inch CMP, the length is approximately 73-ft long at approximately 0.0087-ft/ft slope. No flooding problems with the existing culvert were reported in the anecdotal record or indicators observed in the field.

The creek is too small for navigation. This project will not impact navigation. The confluence with the Chilkat River is approximately 800-ft downstream of the culverts. The confluence with 10-Mile Slough is approximately 100-ft downstream. No upstream confluences were observed in the vicinity. No impacts to confluences are expected. No mining occurs on this stream.

Reach scale, geomorphic conditions were summarized in the Stream and Habitat Inventory (S&HI) from observations and simple tape measurements by hand. On the reach scale, the upstream channel is about 15’ wide and flows in riffles over ideal spawning gravels. The banks are well vegetated and overhang the stream. A run of the river hydroelectric plant is upstream. Downstream of the culverts, the stream varies in width from 15-20’, the bottom is gravel and the stream is heavily utilized by spawning salmon. Stream banks are fully vegetated with grasses. Further downstream the stream meanders through a wide, old river channel that is frequently backwatered by the river.

The S&HI indicates that this stream is used by coho and Dolly Varden as rearing habitat. Pink and chum use this stream for spawning habitat. The stream is listed in the Anadromous Waters Catalog as catalog number: 115-32-10250-2028-3002.

9.3 Hydrology

10-Mile Creek has a drainage area of approximately 1.46 square miles. The high point of the basin is at 4,441 feet at the summit of Tukgahgo Mountain. The watershed has an average slope of 44 percent. The USGS 7.5 minute topographical map depicts a perennial stream channel that is fed by several lakes in the upper basin. This storage comprises just under 2 percent of the basin area. Glaciers on the north side of Tukgahgo Mountain lie within the basin but comprise less than 5 percent of the basin area. The basin is narrow at the outlet, with little more than 500 hundred feet of stream channel between the culvert and the toe of the hill slope. A small hydroelectric operation is located on the stream at the hill slope toe and a small staging area is located on the north side of the stream upstream of the culvert. The hydropower plant is a run-of-the-river facility and does not impact the flow hydrograph (J. Floreski, personal communication to M. Sogge, March 2006). The remainder of the watershed is undeveloped.

There is no known gage information for this stream. Peak flow estimates using regional regression equations ranged from 73 cfs for the 2-year event to 220 cfs for the 100-year flood. The fish passage design flow, which is 40 percent of the 2-year event, is 29 cfs. There is no local input to report for this basin.

9.4 Hydraulic Design

At this phase, preliminary design was completed in support of the Preliminary Engineering Report. Final designs will require detailed stream cross section and profile survey. Final culvert designs will be prepared and documented for submittal with the Plans-in-Hand.

By Tier 1 methods, a 14’-1” by 6’-2” aluminum box culvert would be required to accommodate stream width at this crossing and to meet site cover restrictions. This size pipe will satisfy requirements of the Tier 1 stream simulation design method for fish passage as stated in the MOA. This culvert will provide sufficient span to accommodate the 15.3-ft wide reference stream channel width measured 30 feet upstream of the culvert by the Inter-Fluve survey (October, 2005) and representative of stream conditions locally at the culvert. The culvert would be set at a slope to match the existing stream system. Stream substrate will be placed in the bottom of the pipe to fill a minimum of 20-percent of the rise. Concepts are shown in Section 23.3.

Existing and proposed conditions were modeled with HEC-RAS. Results of modeling indicate that the proposed culvert will pass the 50-year flood with headwater elevation to culvert rise ratio equal to 0.79.

Table 9-1. 512+24 Hydrologic and Hydraulic Summary

Drainage Area = 1.46-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs)	130	193	220
Flow depth at inlet (ft)	2.78	3.51	3.77
Hw/D	0.63	0.79	0.85

Note: Design was completed to preliminary level in support of the Preliminary Engineering Report based on cursory survey data collected by Inter-Fluve based on a relative horizontal and vertical datum. Final design will include site topographic survey.

9.5 23 CFR

There is no known FEMA Flood Insurance Study for the existing culvert. The proposed action includes a culvert larger in size and more hydraulically efficient than the existing culvert. Hydraulic analysis indicates that the upstream water surface elevations will be lower with the proposed culvert than currently exist. Risks of the proposed culvert are considered minimal. There is a reduction in upstream backwater effects and more efficient conveyance of flows through the pipe. There is less likelihood of debris blocking the culvert. The proposed culvert will improve stream process and provide more natural flood plain connectivity.

9.6 Conclusion

The hydraulic features of the proposed action are developed to a preliminary level at this phase in support of the Preliminary Engineering Report. Design will be completed for submittal with Plans-in-Hand. The proposed culvert is not expected to impact the flood plain or environment. The proposed culvert meets ADOT&PF’s requirements for conveyance of the 50-year event. The proposed culvert was designed for fish passage using the Tier 1 method to simulate adjacent stream conditions. This provides favorable continuity of stream processes and passage of fish through the culvert from adjacent stream reaches.

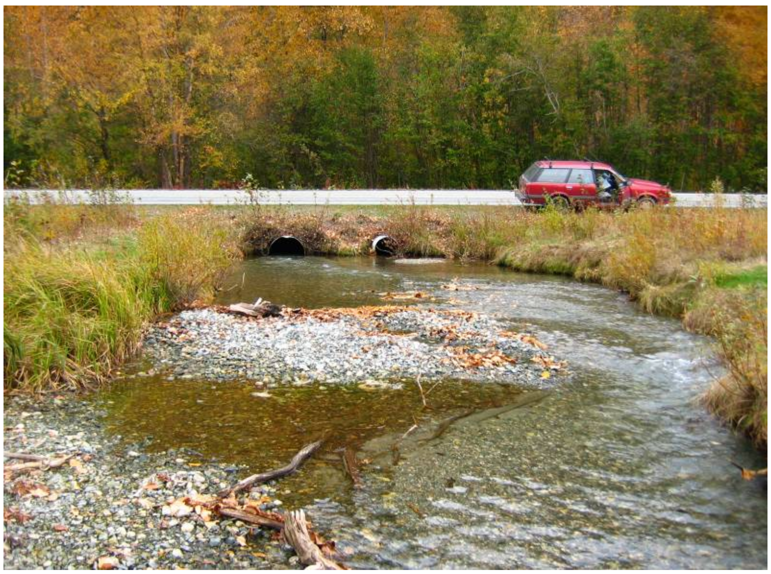
The hydrologic and hydraulic summary for the proposed culvert are presented in Table 9-1.

9.7 Riprap

The culvert was designed using Tier 1 stream simulation to maintain continuity of flow of water and sediment. No riprap is proposed at this time.

9.8 Station 512+24 – Existing conditions photos

Existing Culverts: 30-inch cmp, 24-inch cmp
Catalog Number: 115-32-10250-2028-3002
Fish Use: Rearing coho and Dolly Varden. Spawning pink and chum
Description: This location was referenced as Station 535+50 in the S&HI. Based on hand measurements, upstream of the culverts the stream is about 15' wide and flows in riffles over ideal spawning gravels. The banks are well vegetated and overhang the stream. A hydroelectric plant is upstream. Downstream of the culverts the stream varies in width from 15-20', the bottom is gravel and the stream is heavily utilized by spawning salmon. Stream banks are fully vegetated with grasses. Further downstream the stream meanders through a wide, old river channel that is frequently backwatered by the river.



10. Culvert Replacement at Station 589+12

10.1 Introduction

The unnamed tributary crossing the highway at station 589+12 (S&HI station 612+40) is comprised of two existing circular 24-inch corrugated metal pipes (CMP). The bottoms of the pipes are rusted and the pipes should be replaced. At this Preliminary Engineering Report phase, the replacement pipe was preliminarily designed based on Tier 1 stream simulation methods outlined in the MOA. Tier 1 methods were selected based on the high quality of upstream habitats. This project will replace the existing pipes with a larger 7'-3" by 5'-3" pipe arch to convey flood flows and provide fish passage.

10.2 Hydraulic History

This unnamed tributary crosses the Haines Highway at about elevation 44-ft. As described in Section 4.3.1, MHHW is at elevation 9.4-ft (NAVD 88) and based on approximate modeling tidal backwater will not extend to this location.

This tributary discharges into a major side channel of the Chilkat River approximately 45 feet downstream of the culvert. Field indicators of Chilkat River backwater (i.e. deposition of fine sediments) extend upstream along the tributary to the location of the existing culvert. The culvert is impacted by frequently occurring Chilkat River backwater effects.

No historical flood data are available for this tributary. Magnitude and water surface elevations for the flood of record are not known. High water marks for large flood events were not evident. No Flood Insurance Studies were identified for the Chilkat River or its tributaries, including this one.

A site visit was conducted on October 7, 2005. A rapid assessment and cursory site survey were conducted for this phase as described in Section 3.2. The existing culverts are two 24-inch CMPs with no stream substrate material observed in the bottom of the pipes. The bottoms of the pipes are rusted and the pipes should be replaced for longevity. From the site survey, the two pipes are approximately 63-ft long at an average slope of 0.006-ft/ft. The pipes are higher than the adjacent streambed. No flow was observed. No flooding problems with the existing culvert were reported in the anecdotal record or indicators observed in the field.

The creek is too small for navigation. This project will not impact navigation. The confluence with a side channel of the Chilkat River is 45 feet downstream. No upstream confluences were observed in the vicinity. Therefore, no impacts to confluences are expected. No mining occurs on this stream.

Reach scale geomorphic conditions were summarized in the Stream and Habitat Inventory (S&HI) based on observations and simple tape measurements by hand. On the reach scale the upstream channel averages 2' wide E type channel with a very low gradient. It is infrequently backwatered by the Chilkat River. The banks are thickly vegetated with grasses and the substrate is a blend of organics and silt. The stream leads into a broad wetland. Downstream of the culvert the stream banks are bare sand and the stream is heavily backwatered by the river. The substrate is silt/gravel and there is no cover.

The S&HI indicates that this stream is used by coho, Dolly Varden and cutthroat as rearing habitat. The stream is listed as catalog number: 115-32-10250-2032.

10.3 Hydrology

The contributing basin has a drainage area of approximately 0.65 square miles. The basin extends up to 4,035 feet. The watershed has an average slope of 49 percent. The USGS 7.5 minute topographical map does not depict a perennial stream channel. The perennial flow present on the valley floor is likely contributed by seeps at the toe of the hillslope as well as by hyporheic flow from a side channel of the mainstem Chilkat. There is virtually no storage in the basin and there are no glaciers. The watershed is undeveloped.

There is no known gage information for this stream. Peak flow estimates using regional regression equations ranged from 52 cfs for the 2-year event to 160 cfs for the 100-year flood. The fish passage design flow, which is 40 percent of the 2-year event, is 21 cfs. There is no local input to report for this basin.

10.4 Hydraulic Design

At this phase, preliminary design was completed in support of the Preliminary Engineering Report. Final designs will require detailed stream cross section and profile survey. Final culvert designs will be prepared and documented for submittal with the Plans-in-Hand.

A 6’-9 by 4’-11” pipe arch is recommended as the replacement at this crossing. This size pipe will satisfy requirements of the Tier 1 stream simulation design method for fish passage as stated in the MOA. This culvert will provide sufficient span to accommodate the 5.9-ft wide reference stream channel width measured 35 feet upstream of the culvert by the Inter-Fluve survey (October, 2005) and representative of stream conditions locally at the culvert. The culvert would be set at a slope to match the existing stream system. Stream substrate will be placed in the bottom of the pipe to fill a minimum of 20-percent of the rise. Concepts are shown in Section 23.3.

Existing and proposed conditions were modeled with HEC-RAS. Results of modeling indicate that the proposed culvert will pass the 50-year flood with headwater elevation to culvert rise ratio equal to 1.05.

Table 10-1. 589+12 Hydrologic and Hydraulic Summary

Drainage Area = 0.65-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs)	96	140	160
Flow depth at inlet (ft)	3.36	4.40	4.92
Hw/D	0.80	1.05	1.17

Note: Design was completed to preliminary level in support of the Preliminary Engineering Report based on cursory survey data collected by Inter-Fluve based on a relative horizontal and vertical datum. Final design will include site topographic survey.

10.5 23 CFR

There is no known FEMA Flood Insurance Study for the existing culvert. The proposed action includes a culvert larger in size and more hydraulically efficient than the existing culvert. Hydraulic analysis indicates that the upstream water surface elevations will be lower with the proposed culvert than currently exist. Risks of the proposed culvert are considered minimal. There is a reduction in upstream backwater effects and more efficient conveyance of flows through the pipe. There is less likelihood of debris blocking the culvert. The proposed culvert will improve stream process and provide more natural flood plain connectivity.

10.6 Conclusion

The hydraulic features of the proposed action are developed to a preliminary level at this phase in support of the Preliminary Engineering Report. Design will be completed for submittal with Plans-in-Hand. The proposed culvert is not expected to impact the flood plain or environment. The proposed culvert was designed for fish passage using the Tier 1 method to simulate adjacent stream conditions. This provides favorable continuity of stream processes and passage of fish through the culvert from adjacent stream reaches.

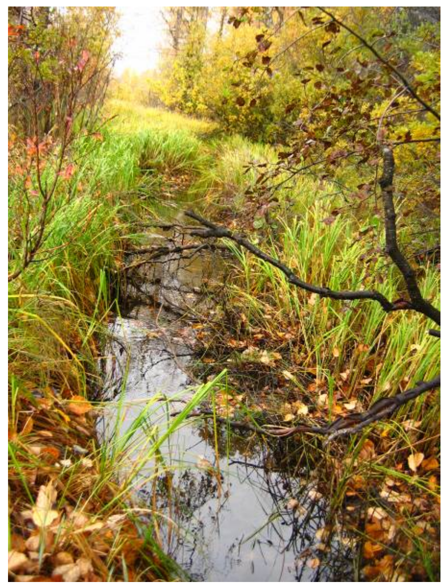
The hydrologic and hydraulic summary for the proposed culvert are presented in Table 10-1.

10.7 Riprap

The culvert was designed using Tier 1 stream simulation to maintain continuity of flow of water and sediment. No riprap is proposed at this time.

10.8 Station 580+12 – Existing conditions photos

Existing Culverts: 2 - 24-inch cmps
Catalog Number: 115-32-10250-2032
Fish Use: Rearing coho, Dolly Varden and cutthroat
Description: This location was referenced as Station 612+40 in the S&HI. Based on hand measurements, upstream of the culverts the stream is a 2’ wide E type channel with a very low gradient. It is infrequently backwatered by the Chilkat River. The banks are thickly vegetated with grasses and the substrate is a blend of organics and silt. The stream leads into a broad swamp. Downstream of the culvert the stream banks are bare sand and the stream is heavily backwatered by the river. The substrate is silt/gravel and there is no cover.



11. Culvert Replacement at Station 647+20

11.1 Introduction

This tributary is referred to locally as 13-Mile Creek. The tributary crossing of the highway at station 647+20 (S&HI station 670+00) is comprised of two existing circular 36-inch corrugated metal pipes (CMP). The bottoms of the pipes are stained. To provide fish passage and accommodate potential flows and debris loads these pipes should be replaced with a larger pipe arch. At this Preliminary Engineering Report phase, the replacement pipe was preliminarily designed based on Tier 1 stream simulation methods outlined in the MOA. Tier 1 methods were selected based on the good quality of upstream habitats. This project will replace the existing pipe with a larger 8'-10" by 6'-1" pipe arch to convey potential flood flows and provide fish passage.

The proposed highway alignment closely follows the existing alignment. Though this culvert is located on a debris flow fan, the volume of sediment observed to have deposited at the road following a flood in November 2005 is anticipated to either pass through a culvert inline with the approach stream alignment or can be managed by periodic maintenance operations. The larger impact of debris flow events at this site appears to be the dynamic history of the stream changing course and the point where the stream meets the road. The replacement culvert is sized to pass anticipated flood flows and provide fish passage.

11.2 Hydraulic History

This unnamed tributary currently crosses the Haines Highway at about elevation 48-ft As described in Section 4.3.1, MHHW is at elevation 9.4-ft (NAVD) 88 and based on approximate modeling, tidal backwater will not extend to this location.

This tributary discharges into a major side channel of the Chilkat River approximately 700 feet downstream of the culvert. Field indicators of Chilkat River backwater (deposition of fine sediments) extend upstream along the tributary to the location of the existing culvert. The culvert appears to be impacted by frequently occurring Chilkat River backwater effects.

No historical flood data are available for this tributary. Water surface elevations for flood of record are not known. High water marks for large flood events were not evident. No Flood Insurance Studies were identified for the Chilkat River or its tributaries, including this one.

A site visit was conducted on October 7, 2005. A rapid assessment and cursory site survey of the existing culverts were conducted for this phase as described in Section 3.2. Detailed survey of the tributary between the culverts and Chilkat River side channel was conducted in November 2008. The existing culverts are two 36-inch CMP with no material in the bottom of the pipes. Measurements on one pipe, as a typical condition, indicates a length of approximately 59-ft long at approximately 0.016-ft/ft slope. Flow was observed along the creek. No flooding problems with the existing culverts were reported in the anecdotal record or indicators observed in the field.

Following the November 2005 flood, the stream occupied a new channel uphill of the road. The stream currently encounters the road at Station 652+70 and splits, with the majority of flows going towards Haines to the 647+20 culvert, the remainder of flows go north and pass the highway through a 24-inch CMP at station 655+35. Flood conveyance of 13-Mile Creek past the highway can be improved by adding a culvert at station 652+70,routing the stream along the downhill side of the road and returning to the existing stream approximately 30 feet downstream of the existing culvert. This new culvert will be designed in conjunction with a mitigation concept at a later phase. The existing culvert at 647+20 will be replaced to pass overland flows and accommodate the full tributary flows should debris flows move the stream back into its alignment prior to the November 2005 flood.

The creek is too small for navigation. This project will not impact navigation. The confluence with the side channel of the Chilkat River is approximately 700 feet downstream. No upstream confluences were observed in the vicinity. Therefore, no impacts to confluences are expected. No mining occurs on this stream.

Reach scale geomorphic conditions were summarized in the Stream and Habitat Inventory (S&HI). Upstream of the culverts the stream splits almost immediately. The majority of flows follow a branch which runs in a roadside ditch up to near station 652+70 where it turns up the hill from the road. The section along the road is an E type channel 2’ wide and +1’ deep. The banks are vegetated with grasses that frequently overhang the full width of the stream. Substrate is gravel. The major branch of the stream is gravel bottomed and meanders away from the road in a stable bed where the stream broadens and winds through established forest with well forested banks. Downstream, the culverts empty into a broad 15’ by 20’ pool that leads into a reach scale average 4-8’ wide E-channel backwatered at times by a beaver dam and the influence of a side channel of the river. The stream empties into the river near station 641+00. The stream banks are predominantly grass, with some willow. At times, the stream flows directly along the toe of the road fill. The lower section of the stream is much less well vegetated that the upper portion.

The S&HI indicates that this stream is used by coho and Dolly Varden as rearing habitat. This stream is used by pink salmon as spawning habitat. The stream is listed as catalog number: 115-32-10250-2040.

11.3 Hydrology

This stream has a drainage area of approximately 1.75 square miles. The high point of the basin is at 5,265 feet at the summit of an unnamed peak. The watershed has an average slope of 53 percent. The USGS 7.5 minute topographical map depicts a perennial stream channel with several branches midway up the basin. The southern branch is fed by lakes in the upper basin. This storage comprises less than 1 percent of the basin area. A small glacier is depicted on the southeast side of the basin (map data is circa 1991) but the current status of this glacier is unknown. The basin is narrow at the outlet, with only a couple of hundred feet of stream channel between the culvert and the toe of the hill slope. The watershed is undeveloped.

There is no known gage information for this stream. Peak flow estimates using regional regression equations ranged from 96 cfs for the 2-year event to 291 cfs for the 100-year flood. The fish passage design flow, which is 40 percent of the 2-year event, is 38 cfs. There is no local input to report for this basin.

11.4 Hydraulic Design

This stream occasionally experiences debris flows which shift the location of the stream. The flood of November 2005 caused a shift of alignment with the stream currently encountering the road near station 652+70. A new culvert is proposed for Station 652+70 in conjunction with proposed mitigation and to convey the tributary flows. However, the potential for the stream to reoccupy the pre-November 2005 flood alignment - which is tributary to the existing culverts - is anticipated to occur within the service life of the culvert. Therefore, it is recommended that this culvert be sized to convey all flows from this tributary. The moderate volume of sediment observed to have deposited at station 652+70 from the November 2005 flood is anticipated to be conveyed through the proposed pipe arch. If necessary, periodic maintenance may be required to clear deposited sediments. At a minimum, a culvert at this location is required to convey overland flows collected by the roadside ditch.

At this phase, preliminary design was completed in support of the Preliminary Engineering Report. Final culvert designs will be prepared and documented for submittal with the Plans-in-Hand.

A 8'-10 by 6'-1" pipe arch is recommended as the replacement at this crossing. This size pipe will satisfy requirements of the Tier 1 stream simulation design method for fish passage as stated in the MOA. This culvert will provide sufficient span to accommodate the downstream channel which varies in width from 8.5 to 9.3 feet measured by the Inter-Fluve survey (November, 2008) and representative of stream conditions locally at the culvert. The culvert would be set at a slope to match the existing stream system. Stream substrate will be placed in the bottom of the pipe to fill a minimum of 20 percent of the rise. Concepts are shown in Section 23.3.

Existing and proposed conditions were modeled with HEC-RAS. Results of modeling indicate that the proposed culvert will pass the 50-year flood with headwater elevation to culvert rise ratio equal to 1.15.

Table 11-1. 647+20 Hydrologic and Hydraulic Summary

Drainage Area = 1.75-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs) full tributary flow	174	255	291
Flow depth at inlet (ft)	4.06	5.58	6.20
Hw/D	0.84	1.15	1.28

Note: Design was completed to preliminary level in support of the Preliminary Engineering Report based on site survey data collected by DOWL HKM and Inter-Fluve based on a project horizontal and vertical datum.

11.5 23 CFR

There is no known FEMA Flood Insurance Study for the existing culvert. The proposed action includes a culvert larger in size and more hydraulically efficient than the existing culverts. The location of the tributary is dynamic therefore it is assumed that during its service life this culvert will once again need to convey full tributary flows. Hydraulic analysis of full tributary flows indicates that the upstream water surface elevations will be lower with the proposed culvert than currently exist. Risks of the proposed culvert are considered minimal. There is a reduction in upstream backwater effects and more efficient conveyance of flows through the pipe. There is less likelihood of debris blocking the culvert. Volumes of sediment deposition near the road are considered to be moderate enough that they will pass through the proposed culvert or can be managed with periodic maintenance. The proposed culvert will improve stream process and provide more natural flood plain connectivity.

11.6 Conclusion

The hydraulic features of the proposed action are developed to a preliminary level at this phase in support of the Preliminary Engineering Report. Design will be completed for submittal with Plans-in-Hand. The proposed culvert is not expected to impact the flood plain or environment. The proposed culvert was designed for fish passage using the Tier 1 method to simulate adjacent stream conditions. This provides favorable continuity of stream processes and passage of fish through the culvert from adjacent stream reaches.

The hydrologic and hydraulic summary for the proposed culvert are presented in Table 11-1.

11.7 Riprap

The culvert was designed using Tier 1 stream simulation to maintain continuity of flow of water and sediment. No riprap is proposed at this time.

11.8 Station 647+20 – Existing conditions photos

Existing Culverts: 2 – 36-inch cmp
Catalog Number: 115-32-10250-2040
Fish Use: Rearing coho and Dolly Varden. Spawning pink salmon
Description: This location was referenced as Station 670+00 in the S&HI. Based on hand measurements, upstream of the culverts the stream splits almost immediately. The minor branch runs in a roadside ditch up to near (S&HI) station 680+30 where it turns away from the road. The section along the road is an E type channel 2' wide and +1' deep. The banks are vegetated with grasses that frequently overhang the full width of the stream. Substrate is gravel. Where it cuts away from the road, this section of the stream broadens and winds through established forest. The major branch of the stream is gravel bottomed and meanders away from the road in a stable bed with well forested banks. Downstream, the culverts empty into a broad 15' by 20' pool that leads into a 4-8' wide E-channel backwatered at times by a beaver dam and the influence of a side channel of the river. The stream joins the river near (S&HI) station 668+40. The stream banks are predominantly grass, with some willow. At times, the stream flows directly along the toe of the road fill. The lower section of the stream is much less well vegetated than the upper portion.





12. Culvert Installation at Station 652+70

In addition to replacing the culvert at Station 647+20, a new culvert crossing will be installed at 652+70 to provide fish passage and conveyance of floods and debris along 13-Mile Creek.

12.1 Introduction

This tributary is referred to locally as 13-Mile Creek. The existing culvert crossing of the highway for this tributary is located at station 647+20 (S&HI station 670+00). A flood in November 2005 relocated the creek alignment to impinge the highway at station 652+70. At the highway, flows split to both the north and the south along the roadside ditch. It is proposed to place a culvert at station to convey flow and debris across the highway into a mitigation channel to be constructed and connect to the existing stream exiting the station 647+20 culvert. The mitigation channel is under development and will have an effect on the hydraulics through the proposed culvert. Considering that the proposed 8’-10” by 6’-1” pipe arch culvert at station 647+20 was designed to convey full stream flows and meet Tier 1 stream simulation criteria; it is anticipated a similar structure will be required at this site.

12.2 Conclusion

A 8’-10” by 6’-1” pipe arch culvert designed to convey full stream flows and meet Tier 1 stream simulation criteria is proposed for station 652+70.

13. Culvert Replacement at Station 710+75

13.1 Introduction

This tributary is referred to locally as 14-Mile Creek. The tributary crosses the highway at station 710+75 (S&HI station 731+00) near a local unimproved boat ramp. The crossing is comprised of two 36-inch circular corrugated metal pipes (CMP). The bottoms of the pipes are rusted and the pipes should be replaced. At this Preliminary Engineering Report phase, the replacement pipe was preliminarily designed to meet Tier 1 stream simulation fish passage methods as outlined in the MOA and site cover restrictions. Tier 1 methods were selected based on the high quality of upstream habitats. This project will replace the existing pipes with a larger 12'-7" by 8'-4" pipe arch to convey flood flows, provide fish passage and meet site cover restrictions.

13.2 Hydraulic History

14-Mile Creek crosses the Haines Highway at about elevation 49.5-ft. As described in Section 4.3.1, MHHW is at elevation 9.4-ft (NAVD 88) and based on approximate modeling tidal backwater will not extend to this location.

14-Mile Creek flows 150-ft from the culvert outlet before entering a side channel of the Chilkat River. The culvert is actively backwatered and frequently submerged by flows along this side channel

No historical flood data are available for this tributary. Magnitude and water surface elevations for the flood of record are not known. High water marks for large flood events were not evident. No Flood Insurance Studies were identified for the Chilkat River or its tributaries, including this one.

A site visit was conducted on October 8, 2005. A rapid assessment and cursory site survey were conducted for this phase as described in Section 3.2. The existing culverts are two 36-inch diameter circular CMP pipes. Both culverts are at similar elevations and at the time of the survey were nearly submerged by backwater from the Chilkat River side channel. The pipes were clear of debris. The bottoms of the pipes are rusted and the pipes should be replaced for longevity. From the site survey, the pipes are approximately 94-ft long, laid at approximately 0.017-ft/ft slope. Though the culverts were observed to be nearly submerged by backwater, no problems of flooding over the road with the existing culverts were reported in the anecdotal record or indicators observed in the field.

The creek at the culverts and upstream is too small for navigation. The culvert replacement will not impact navigation at the culverts and upstream. No upstream confluences were observed in the vicinity. The confluence with a side channel of the Chilkat River is approximately 150-ft downstream of the culverts. An unimproved boat launch ramp is located immediately downstream of the culverts to provide access to the side channel of the Chilkat River. Maintaining the existing launch conditions, removal of the launch and restoration of the stream and relocation or improvement of the launch facilities are currently under consideration. No other impacts to confluences are expected. No mining occurs on this stream.

Reach scale geomorphic conditions were summarized in the Stream and Habitat Inventory (S&HI) based on observations and simple tape measurements by hand. On the reach scale, the upstream channel is 8-10' wide and leads into a vegetated meadow. Stream banks are stable and vegetated with grasses and willow. The substrate is loose silt and organic matter. There is some backwatering by the river. The outlets of the culverts are nearly submerged even at low river levels and empty into a large, deep pool that acts as both a rearing area for fish and a boat launch site. The pool empties into the river via a short channel. There is some overhanging vegetation on one side of the pool. Substrate is sand and silt.

The S&HI indicates that this stream is used by coho and Dolly Varden as spawning and rearing habitat. Pink and chum use this stream for spawning habitat. The stream is listed in the Anadromous Waters Catalog as catalog number: 115-32-10250-2044.

13.3 Hydrology

14-Mile Creek has a drainage area of approximately 2.26 square miles, the largest of the tributary basins. The high point of the basin is at 5,664 feet at the summit of an unnamed peak. The watershed has an average slope of 51 percent. The USGS 7.5 minute topographical map depicts a perennial stream with two major forks extending to the headwaters. Each branch is fed by lakes in the upper basin. Lake storage comprises less than 1 percent of the basin area. Expansive glaciers cover the east side of the divide, but no glaciers are located on the west side in the basin area. The stream enters the Chilkat side channel further south than depicted on the USGS map. Flow on the valley floor is likely supplemented by hill slope seeps and possibly by hyporheic flow from the Chilkat side channel. The watershed is undeveloped.

There is no known gage information for this stream. Peak flow estimates using regional regression equations ranged from 125 cfs for the 2-year event to 381 cfs for the 100-year flood. The fish passage design flow, which is 40 percent of the 2-year event, is 50 cfs. There is no local input to report for this basin.

13.4 Hydraulic Design

At this phase, preliminary design was completed in support of the Preliminary Engineering Report. Final designs will require detailed stream cross section and profile survey. Final culvert designs will be prepared and documented for submittal with the Plans-in-Hand.

A 12'-7" by 8'-4" pipe arch is recommended as the replacement to accommodate stream width at this crossing and to meet site cover restrictions. This size pipe will satisfy requirements of the Tier 1 stream simulation design method for fish passage as stated in the MOA. This culvert will provide sufficient span to accommodate the 14-ft wide reference stream channel width measured 18 feet upstream of the culvert by the Inter-

Fluve survey (October, 2005)) and representative of stream conditions locally at the culvert. The culvert would be set at a slope to match the existing stream system. Stream substrate will be placed in the bottom of the pipe arch to fill a minimum of 20-percent of the rise. Concepts are shown in Section 23.3.

Existing and proposed conditions were modeled with HEC-RAS. Model boundary conditions assumed normal flow depth based on downstream gradient (slope = 0.002-ft/ft) with no backwater by the Chilkat River. Results of modeling indicate that the proposed culvert will pass the 50-year flood with headwater elevation to culvert rise ratio equal to 0.71.

Table 13-1. 710+75 Hydrologic and Hydraulic Summary

Drainage Area = 2.26-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs)	228	334	381
Flow depth at inlet (ft)	3.09	4.76	5.34
Hw/D	0.46	0.71	0.80

Note: Design was completed to preliminary level in support of the Preliminary Engineering Report based on cursory survey data collected by Inter-Fluve based on a relative horizontal and vertical datum. Final design will include site topographic survey.

13.5 23 CFR

There is no known FEMA Flood Insurance Study for the existing culvert. The proposed action includes a culvert larger in size and more hydraulically efficient than the existing culvert. Hydraulic analysis indicates that the upstream water surface elevations will be lower with the proposed culvert than currently exist. Risks of the proposed culvert are considered minimal. There is a reduction in upstream backwater effects and more efficient conveyance of flows through the pipe. There is less likelihood of debris blocking the culvert. The proposed culvert will improve stream process and provide more natural flood plain connectivity.

13.6 Conclusion

The hydraulic features of the proposed action are developed to a preliminary level at this phase in support of the Preliminary Engineering Report. Design will be completed for submittal with Plans-in-Hand. The proposed culvert is not expected to impact the flood plain or environment. The proposed culvert meets ADOT&PF's requirements for conveyance of the 50-year event. The proposed culvert was designed for fish passage using the Tier 1 method to simulate adjacent stream conditions. Tier 1 methods were selected based on the high quality of upstream habitats. This provides favorable continuity of stream processes and passage of fish through the culvert from adjacent stream reaches.

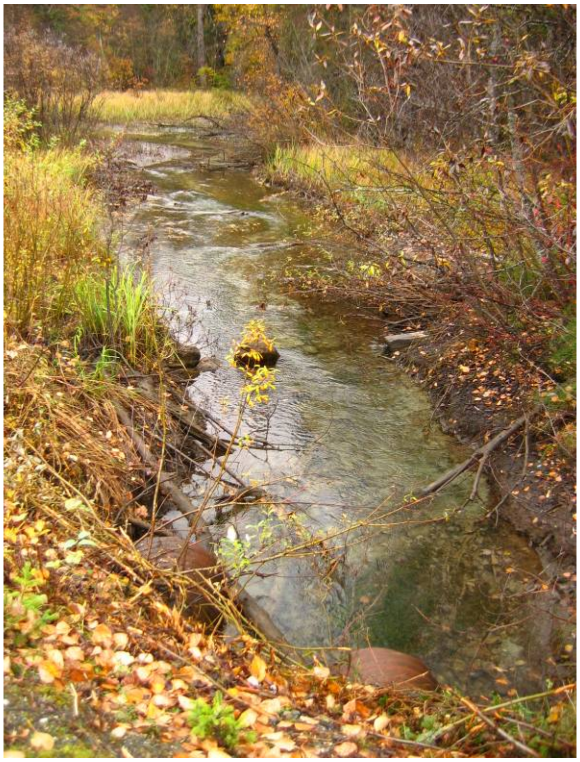
The hydrologic and hydraulic summary for the proposed culvert are presented in Table 13-1.

13.7 Riprap

The culvert was designed using Tier 1 stream simulation to maintain continuity of flow of water and sediment. This stream has a very flat gradient and low energy. No riprap is proposed at this time.

13.8 Station 710+75 – Existing conditions photos

Existing Culverts: 2 – 36-inch cmp
Catalog Number: 115-32-10250-2044
Fish Use: Rearing and spawning coho and Dolly Varden
Description: This location was referenced as Station 731+00 in the S&HI. Based on hand measurements, upstream of the culverts the stream is 8-10' wide and leads into a vegetated meadow. Stream banks are stable and vegetated with grasses and willow. The substrate is loose silt and organic matter. There is some backwatering by the river. The outlets of the culverts are nearly submerged even at low river levels and empty into a large, deep pool that acts as both a rearing area for fish and a boat launch site. The pool empties into the river via a short channel. There is some overhanging vegetation on one side of the pool. Substrate is sand and silt.



14. Culvert Replacement at Station 865+88

14.1 Introduction

This tributary, locally referred to as 17-Mile Creek, crosses the highway at station 865+88 (S&HI station 886+00). The crossing is comprised of an existing 6'-1"x4'7" pipe arch. The bottom of the pipe is stained and rusted and the pipe should be replaced for longevity. At this Preliminary Engineering Report phase, the pipe was preliminarily designed to meet Tier 1 stream simulation fish passage methods and site cover restrictions. Tier 1 methods were selected based on the high quality of upstream habitats and ground water source. The stream immediately above the road is ponded through an excavated area along the road embankment with a free flowing reach immediately upstream that is an average of 12.6-ft wide. This project will replace the existing pipe with a larger 11'-7" by 7'-5" pipe arch to convey flood flows, provide fish passage and site cover restrictions. The location of the culvert will be moved to approximately station 869+00 to accommodate a new stream alignment as one component of project mitigation.

14.2 Hydraulic History

17-Mile Creek crosses the Haines Highway at about elevation 67-ft. As described in Section 4.3.1, MHHW is at elevation 9.4-ft (NAVD 88) and based on approximate modeling tidal backwater will not extend to this location. This tributary flows approximately 60-ft to a minor side channel of the Chilkat River. The culvert experiences some backwater by flows along this side channel

No historical flood data are available for this tributary. Magnitude and water surface elevations for the flood of record are not known. High water marks for large flood events were not evident. No Flood Insurance Studies were identified for the Chilkat River or its tributaries, including this one.

A site visit was conducted on October 8, 2005. A rapid assessment and cursory site survey were conducted for this phase as described in Section 3.2. The existing culvert is a 6'-1"x4'7" pipe arch. The outlet is perched about 0.25-ft above the water surface elevation in the downstream scour pool. The pipe appears to have no accumulated sediment in the bottom. The pipe is approximately 72-ft long laid at approximately 0.015-ft/ft slope. No flooding problems with the existing culvert were reported in the anecdotal record or indicators observed in the field.

The creek is too small for navigation. This project will not impact navigation. The confluence with a minor side channel of the Chilkat River is approximately 60-ft downstream. No upstream confluences were observed in the vicinity. No impacts to confluences are expected. No mining occurs on this stream.

Reach scale geomorphic conditions were summarized in the Stream and Habitat Inventory (S&HI). The stream upstream of the culvert is a man-made complex consisting of two distinct branches. The main branch is a spring fed channel that runs along the toe of the road embankment up to station 871+75 where it ends in a beaver dam or man-made berm. From observations and simple tape measurements by hand, the lower half of this channel is excavated and consistently 8-10' wide and forms a slow moving pool 1-2' deep. The steep banks are vegetated with overhanging grasses. Several springs feed into the channel from under the bank on the mountain side The upper half of the channel is a 2-3' wide riffle winding through boulders and thickly vegetated with grasses. The second branch of the complex feeds into the main branch about 100' upstream of the culvert inlet. This branch is fed by a series of springs, as well as a mountain stream, and rises in a series of pools and riffles up to a chum salmon incubation box facility operated by the Northern Southeast Regional Aquaculture Association. The stream substrate is gravel/cobble and the banks are well vegetated. Downstream the culvert outlet empties into a large pool used as a holding area for adult chum salmon. Pool substrate is silt covered gravel. A short channel connects the pool to a minor side channel of the Chilkat River.

The S&HI indicates that this stream is used by coho and Dolly Varden as rearing habitat. Chum and coho use this stream as spawning habitat. The stream is listed in the Anadromous Waters Catalog as catalog number: 115-32-10250-2060-3002.

14.3 Hydrology

This stream has a drainage area of approximately 0.8 square miles. The high point of the basin is at 5,608 feet at the summit of an unnamed peak. The watershed has an average slope of 57 percent. The USGS 7.5 minute topographical map depicts a perennial stream that branches midway up the basin. There is virtually no storage in the basin and there are no glaciers. The man-made channel running along the road is fed by hill slope seeps and possibly by hyporheic flow from the Chilkat side channel. The watershed is undeveloped.

There is no known gage information for this stream. Peak flow estimates using regional regression equations ranged from 55 cfs for the 2-year event to 169 cfs for the 100-year flood. The fish passage design flow, which is 40 percent of the 2-year event, is 22 cfs. There is no local input to report for this basin.

14.4 Hydraulic Design

At this phase, preliminary design was completed in support of the Preliminary Engineering Report. Final designs will require detailed stream cross section and profile survey. Final culvert designs will be prepared and documented for submittal with the Plans-in-Hand.

A 11'-7" by 7'-5" pipe arch would be required to accommodate stream width for Tier 1 stream simulation fish passage per the MOA at this crossing and meet site cover restrictions. This culvert will provide sufficient span to accommodate the 12.6-ft wide reference stream channel width measured along a free flowing reach approximately 105 feet upstream of the existing culvert by the Inter-Fluve survey (October, 2005) and representative of stream conditions locally at the culvert under the relocated mitigation channel conditions. The culvert would be set at a slope to match the existing stream system. Stream substrate will be placed in the bottom of the pipe to fill a minimum of 20-percent of the rise. Concepts are shown in Section 23.3.

Existing and proposed conditions were modeled with HEC-RAS. Results of modeling indicate that the proposed culvert will pass the 50-year flood with headwater elevation to culvert rise equal to 0.43.

Table 14-1. 865+88 Hydrologic and Hydraulic Summary

Drainage Area = 0.80-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs)	101	148	169
Flow depth at inlet (ft)	1.61	2.11	2.33
HW/D	0.33	0.43	0.47

Note: Design was completed to preliminary level in support of the Preliminary Engineering Report based on cursory survey data collected by Inter-Fluve based on a relative horizontal and vertical datum. Final design will include site topographic survey.

14.5 23 CFR

There is no known FEMA Flood Insurance Study for the existing culvert. The proposed action includes a culvert larger in size and more hydraulically efficient than the existing culvert. Hydraulic analysis indicates that the upstream water surface elevations will be lower with the proposed culvert than currently exist. Risks of the proposed culvert are considered minimal. There is a reduction in upstream backwater effects and more efficient conveyance of flows through the pipe. There is less likelihood of debris blocking the culvert. The proposed culvert and proposed channel relocation for mitigation will improve stream process and provide more natural flood plain connectivity.

14.6 Conclusion

The hydraulic features of the proposed action are developed to a preliminary level at this phase in support of the Preliminary Engineering Report. Design will be completed for submittal with Plans-in-Hand. The proposed culvert is not expected to impact the flood plain or environment. The proposed culvert meets ADOT&PF's requirements for conveyance of the 50-year event. The proposed culvert was designed for fish passage using the Tier 1 method to simulate adjacent stream conditions. This provides favorable continuity of stream processes and passage of fish through the culvert from adjacent stream reaches.

The hydrologic and hydraulic summary for the proposed culvert are presented in Table 14-1.

14.7 Riprap

The culvert was designed to provide fish passage using Tier 1 stream simulation to maintain continuity of flow of water and sediment. No riprap is proposed at this time.

14.8 Station 865+88 – Existing conditions photos

Existing Culvert: 6'-1" x 4'-7" pipe arch
Catalog Number: 115-32-10250-3002
Fish Use: Rearing coho and Dolly Varden. Spawning chum and coho
Description: This location was referenced as Station 886+00 in the S&HI. The stream upstream of the culvert is a man-made complex consisting of two distinct branches. The main branch is a spring fed channel that runs up to 2009 station 871+75 where it ends in a beaver dam or man-made berm. Based on hand measurements, the lower half of this channel is excavated with a consistent 8-10' width and forms a slow moving pool 1-2' deep. The steep banks are vegetated with overhanging grasses. Several springs feed into the channel from under the bank on the mountain side The upper half of the channel is a 2-3' wide riffle winding through boulders and thickly vegetated with grasses. The second branch of the complex feeds into the main branch about 100' upstream of the culvert inlet. This branch is fed by a series of springs, as well as a mountain stream, and rises in a series of pools and riffles up to a chum salmon incubation box facility operated by the Northern Southeast Regional Aquaculture Association. The stream substrate is gravel/cobble and the banks are well vegetated. Downstream, the culvert outlet empties into a large pool used as a holding area for adult chum salmon. The pipe is perched 4". Pool substrate is silt covered gravel. A short channel connects the pool to a side channel of the Chilkat River.

15. Culvert Replacement at Station 887+60

15.1 Introduction

This tributary, locally known as Horse Farm Creek, crosses the new highway alignment approximately at station 895+75 (S&HI station 917+00) near a private grass airstrip. The existing crossing is comprised of two 36-inch circular corrugated metal pipes (CMP) along a stream averaging 4 to 6 feet wide. The highway will be realigned with the new crossing at (2009) station 887+60 approximately 1,000 feet downstream of the existing crossing. The stream at the new location is approximately 9 feet wide about 125 feet upstream of the confluence with Eighteen Mile Slough, a minor side channel of the Chilkat River. At this Preliminary Engineering Report phase, the replacement pipe was preliminarily designed to meet Tier 1 stream simulation fish passage methods and site cover restrictions. Tier 1 methods were selected based on the heavy utilization of high quality upstream habitats. This project will place a 9'-4" by 6'-3" pipe arch at the stream crossing of the new highway alignment to convey flood flows and provide fish passage. The existing pipes may be removed and the stream day lighted as part of project mitigation.

15.2 Hydraulic History

Horse Farm Creek will cross the new Haines Highway location at about elevation 65-ft. As described in Section 4.3.1, MHHW is at elevation 9.4-ft (NAVD 88) and based on approximate modeling tidal backwater will not extend to this location. The new highway alignment is approximately 70 feet upstream of the confluence of, and is backwatered by, Eighteen Mile Slough, a minor side channel of the Chilkat River.

No historical flood data are available for this tributary. Magnitude and water surface elevations for the flood of record are not known. High water marks for large flood events were not evident. This reach of Horse Farm Creek is directly backwatered by Eighteen Mile Slough. No Flood Insurance Studies were identified for the Chilkat River or its tributaries, including this one.

During a flood in November 2005, a significant volume of sand was deposited at the existing culvert and along the stream. During a site visit in May 2008 the sand was observed to have largely been transported from the system.

A site visit of the existing culverts was conducted on October 8, 2005. A rapid assessment and cursory site survey of the existing culverts were conducted for this phase as described in Section 3.2. The existing culverts are two 36-inch diameter circular CMPs. Both culverts are at similar elevations and at the time of the survey were nearly submerged. Approximately 0.8- to 1.4-ft of material was measured in the bottom of the 36-inch pipes. The bottoms of the pipes are rusted and - should this road be kept in service for access to private property – the pipes should be replaced for longevity. A decision on access and fate of this culvert has not been made at this time. Therefore, a replacement pipe to provide access has not been designed at this time. From the site survey, the pipes are approximately 58-ft long and average 0.015-ft/ft slope. The culverts were observed to have no scour pool or be perched. No flooding problems with the existing culvert were reported in the anecdotal record or indicators observed in the field. The proposed highway alignment is located downstream approximately 1,000 feet. Additional survey in this area was collected in November 2008 and May 2009. The current design alignment is similar to that shown in the companion 2006 Stream and Habitat Inventory (S&HI).

The creek is too small for navigation. This project will not impact navigation. The confluence with Eighteen Mile Slough, a minor side channel of the Chilkat River, is approximately 70 feet downstream of the proposed highway alignment. No upstream confluences were observed in the vicinity. No impacts to confluences are expected. No mining occurs on this stream.

Reach scale geomorphic conditions were summarized in the Stream and Habitat Inventory (S&HI) from observations and simple tape measurements by hand. The channel upstream of the existing highway crossing is a fast 4-6% continuous riffle with a rocky substrate. The stream is 4-6’ wide and meanders through a young forest. Downstream of the culverts the stream meanders along the existing road, intersecting the new alignment centerline at station 887+60. The roughly 1200’ of stream between the culvert outlet and the confluence with Eighteen Mile Slough can be approximately divided by habitat type into three reaches. The first 400’ section, measured from the culvert outlet downstream, is a 4-6’ wide E-channel composed primarily of riffles, with a substrate of gravel. Although it is of similar width, the second 400’ section is flatter in gradient and more complex, composed of riffles combined with numerous deep pools associated with the root structures of well established vegetation. The substrate of this reach is more silt/organic, although the November 2005 flood did deposit a good deal of gravel. The downstream reach connecting to the slough widens to a maximum width of 15’ and is subject to backwatering when the Chilkat River is high. The stream substrate is silt, and the banks are steep and well vegetated. Two small streams draining adjacent wetlands enter Horse Farm Creek from the west.

The S&HI indicates that this stream is used by coho and Dolly Varden as spawning and rearing habitat. Pink and coho use this stream for spawning habitat. The stream is listed in the Anadromous Waters Catalog as catalog number: 115-32-10250-2060-3001.

15.3 Hydrology

This stream has a drainage area of approximately 1.55 square miles. The high point of the basin is at 5,621 feet at the summit of an unnamed peak. The watershed is steep, with an average slope of 64 percent. The USGS 7.5 minute topographical map depicts a perennial stream with 3 branches midway up the basin. There is virtually no storage and there are no glaciers. The lower 500 meters of stream channel flows along the eastern edge of the large Nineteen-Mile Debris Fan and possibly loses flow to this feature. There is a small airstrip adjacent to the lower portion of the stream downstream of the existing culvert and upstream of the proposed crossing, but no development within the drainage area contributing to the culvert itself.

There is no known gage information for this stream. Peak flow estimates using regional regression equations ranged from 95 cfs for the 2-year event to 291 cfs for the 100-year flood. The fish passage design flow, which is 40 percent of the 2-year event, is 38 cfs. There is no local input to report for this basin.

15.4 Hydraulic Design

At this phase, preliminary design was completed in support of the Preliminary Engineering Report. Basic topographic data at the new alignment stream crossing was surveyed in November 2008. Final culvert designs will be prepared and documented for submittal with the Plans-in-Hand.

A 9'-4" by 6'-3" pipe arch is recommended for the stream crossing of the proposed highway alignment. This size pipe will satisfy site cover restrictions and requirements of the Tier 1 stream simulation design method for fish passage as stated in the MOA. This culvert will provide sufficient span to accommodate the 8.3-ft wide reference stream channel width measured along a free flowing reach approximately 90 feet upstream of the new highway crossing by the Inter-Fluve survey (November 2008) and is representative of stream conditions locally to the new crossing. The culvert would be set at a slope to match the existing stream system. Stream substrate will be placed in the bottom of the pipe to fill a minimum of 20-percent of the rise. Concepts are shown in Section 23.3.

Existing and proposed conditions were modeled with HEC-RAS. Results of modeling indicate that the proposed culvert will pass the 50-year flood with headwater elevation to culvert rise ratio equal to 1.17.

Table 15-1. 887+60 Hydrologic and Hydraulic Summary

Drainage Area = 1.55-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs)	175	255	291
Flow depth at inlet (ft)	4.06	5.86	6.65
Hw/D	0.81	1.17	1.33

Note: Design was completed to preliminary level in support of the Preliminary Engineering Report based on basic topographic survey data collected November 2008 and based on project horizontal and vertical datum. Final design may require additional site topographic survey.

15.5 23 CFR

There is no known FEMA Flood Insurance Study for the existing culvert. The proposed action includes a culvert to be placed where none currently exists. Hydraulic modeling based on total station topography indicate that water surface elevations for the 50- and 100-year events will increase by nearly 1.62 and 2.26 feet, respectively. The site survey and, LIDAR topography and aerial photography indicate that adjacent land uses is low-lying undeveloped forest and wetland. The 100-year water surface elevation at the inlet of the proposed culvert is 72.2 feet, 4.8 feet lower than the end of the nearby runway. Increases in water surface elevations are not expected to encroach onto the nearby air strip. Risks of the proposed culvert are considered minimal.

15.6 Conclusion

The hydraulic features of the proposed action are developed to a preliminary level at this phase in support of the Preliminary Engineering Report. Design will be completed for submittal with Plans-in-Hand. The proposed culvert is not expected to impact the flood plain or environment.

The hydrologic and hydraulic summary for the proposed culvert are presented in Table 15-1.

15.7 Riprap

No riprap is proposed at this time.

15.8 Station 887+60 – Existing conditions photos

Existing Culverts: 2 – 36-inch cmp
Catalog Number: 115-32-10250-2060-3001
Fish Use: Rearing coho and Dolly Varden. Spawning pink and coho
Description: The existing location of stream crossing of the highway was referenced as Station 917+00 in the S&HI. Upstream of the culverts the stream is a fast 4-6% continuous riffle with a rocky substrate. The stream is 4-6' wide and meanders through a young forest. Downstream of the culverts the stream meanders along the existing road, intersecting the new alignment centerline at (2009) station 887+60. The roughly 1200' of stream between the culvert outlet and the confluence with Eighteen Mile Slough can be approximately divided by habitat type into three reaches. The first 400' section, measured from the culvert outlet downstream, is a 4-6' wide E-channel composed primarily of riffles, with a substrate of gravel. Although it is of similar width, the second 400' section is flatter in gradient and more complex, composed of riffles combined with numerous deep pools associated with the root structures of well established vegetation. The substrate of this reach is more silt/organic, although the November 2005 flood did deposit a good deal of gravel. The downstream reach connecting to the slough widens to a maximum width of 15' and is subject to backwatering when the Chilkat River is high. The stream substrate is silt, and the banks are steep and well vegetated. Two small streams draining adjacent wetlands enter Horse Farm Creek from the west.

Station 917+00 – Existing conditions photos (cont'd)

16. Culvert Replacement at Station 962+06

16.1 Introduction

This tributary is located along a debris flow at highway station 962+06 (S&HI station 983+25). The existing crossing is comprised of an 8'-2" by 5'-9" pipe arch. The replacement culvert will be a large box culvert designed for flood conveyance and to facilitate equipment access for clearing of debris flow sediments.

16.2 Conclusion

The replacement culvert will be a large box culvert designed for flood conveyance and to facilitate equipment access for clearing of debris flow sediments.

16.3 Station 962+06 – Existing conditions photos

Existing Culvert: 8'– 2" x 5'– 9" pipe arch
Fish Use: Rearing coho and Dolly Varden
Description: This location was referenced as Station 983+25 in the S&HI. This stream is part of the 19 mile slide area and is subject to alteration by the periodic influx and mechanical removal of large quantities of slide material. This material consists of fine decomposed rock and gravels mixed with cobbles. The stream above the culvert runs in an open ditch along the road back to (2009) station 958+00. No vegetation is present yet numerous juvenile fish were seen in the stream. The stream turns away from the road and runs toward the mountain for about 75' before any upstream movement of fish is prevented by a barrier falls. Downstream of the culvert the stream is braided and open until it intersects the woods several hundred feet below the pipe. The substrate is slide material and initially there is little vegetation. Once the stream enters the woods it is a 2-3' wide fast riffle until it empties into a series of riverside pools fed by upwelling water.

17. Culvert Replacement at Station 973+30

The crossing structure at this site will consist of a large box culvert to facilitate removal of deposited sediment using equipment.

17.1 Introduction

This tributary is located along a debris flow at highway station 973+30 (S&HI station 994+50). The crossing is comprised of a 9'-9" by 6'-9" pipe arch. The replacement culvert will be a large box culvert designed for flood conveyance and to facilitate equipment access for clearing of debris flow sediments.

17.2 Conclusion

The replacement culvert will be a large box culvert designed for flood conveyance and to facilitate equipment access for clearing of debris flow sediments.

17.3 Station 973+30– Existing conditions photos

Existing Culvert: 9'– 9" x 5'– 9" pipe arch
Fish Use: Unknown
Description: This location was referenced as Station 994+50 in the S&HI. The stream above the culvert of this 19 mile slide stream is very unstable and often excavated by heavy equipment. Substrate is mobile slide material. Some vegetation is beginning to be established on the banks. Fish passage above the culvert is blocked by a headcut upstream 200'. Downstream of the culvert the stream is initially a braided riffle with little sign of viable fish habitat. Two hundred feet downstream of the culvert outlet the stream becomes a steep cascade through boulders until it enters the river.

18. Culvert Replacement at Station 1102+19

18.1 Introduction

This tributary is locally referred to as 21-1/2 Mile Creek and crosses the highway at station 1102+19 (S&HI station 1123+25). The crossing, immediately downriver of the turn off to the village of Klukwan, is comprised of an existing circular 36-inch corrugated metal pipe (CMP). At this Preliminary Engineering Report phase, the pipe was preliminarily designed based on Tier 1 stream simulation methods outlined in the MOA. Tier 1 methods were selected based on fair to good upstream habitats and to provide continuity of flow, sediment and debris through the pipe. This project will replace the existing pipe with a larger 7'-3" by 5'-3" pipe arch to convey flood flows and provide fish passage.

18.2 Hydraulic History

This unnamed tributary crosses the Haines Highway at about elevation 117-ft. As described in Section 4.3.1, MHHW is at elevation 9.4-ft (NAVD 88) and based on approximate modeling tidal backwater will not extend to this location. The low flow water level in adjacent reaches of the Chilkat River are at approximately elevation 108-ft. It is unlikely that Chilkat River flows will have a backwater impact extending to the culvert location.

No historical flood data are available for this tributary. Magnitude and water surface elevations for the flood of record are not known. High water marks for large flood events were not evident. No Flood Insurance Studies were identified for the Chilkat River or its tributaries, including this one.

A site visit was conducted on October 8, 2005. A rapid assessment and cursory site survey were conducted for this phase as described in Section 3.2. The existing culvert is a 36-inch CMP with no stream substrate material in the bottom of the pipe. From the site survey, the existing pipe is approximately 66-ft long at approximately 0.057-ft/ft slope. The tributary streambed slope is 0.038-ft/ft upstream and 0.007-ft/ft downstream of the culvert. A small amount of flow was observed. No flooding problems with the existing culvert were reported in the anecdotal record or indicators observed in the field.

The creek is too small for navigation. This project will not impact navigation. The confluence with the Chilkat River is approximately 1,500-ft downstream. No upstream confluences were observed in the vicinity. Therefore, no impacts to confluences are expected. No mining occurs on this stream.

Reach scale geomorphic conditions were summarized in the Stream and Habitat Inventory (S&HI) from observations and simple tape measurements by hand. The channel upstream of the existing highway crossing is 1-2' wide and composed of riffle habitat. The stream runs alongside the road up to (2009) station 1107+00 before the channel turns away from the road. For the first 150' above the culvert the stream lies away from the toe of the road fill slope and cover is provided by adjacent willow and alder. The stream then runs tight along the toe and the banks are vegetated with grasses. Downstream of the culvert the stream flows through a manipulated habitat with patches of willow and grasses beginning to be established. For both portions of the stream the substrate is small gravel.

The S&HI indicates that this stream is used by coho and Dolly Varden as rearing habitat. Chum and coho use this stream for spawning habitat. The stream is listed in the Anadromous Waters Catalog as catalog number: 115-32-10250-2070.

18.3 Hydrology

This stream has a drainage area of approximately 1.26 square miles. The high point of the basin is at 5,477 feet on a ridge leading north toward Iron Mountain. The watershed has an average slope of 54 percent. The USGS 7.5 minute topographical map depicts a single perennial stream channel extending only one third of the way up the basin. There is no storage and there are no glaciers. The lower 1,000 yards of stream flows along the eastern edge of the large Twenty-three mile debris fan and likely loses flow to this feature. There is a water tank in the lower portion of the basin that supplies the village of Klukwan. Otherwise, the watershed is undeveloped.

There is no known gage information for this stream. Peak flow estimates using regional regression equations ranged from 73 cfs for the 2-year event to 227 cfs for the 100-year flood. The fish passage design flow, which is 40 percent of the 2-year event, is 29 cfs. There is no local input to report for this basin.

18.4 Hydraulic Design

At this phase, preliminary design was completed in support of the Preliminary Engineering Report. Final designs will require detailed stream cross section and profile survey. Final culvert designs will be prepared and documented for submittal with the Plans-in-Hand.

A 7’-3” by 5’-3” pipe arch is recommended as the replacement at this crossing. This size pipe will satisfy requirements of the Tier 1 stream simulation design method for fish passage as stated in the MOA. This culvert will provide sufficient span to accommodate the 6.6-ft wide reference stream channel width measured 60 feet upstream of the culvert by the Inter-Fluve survey (October, 2005) and is representative of stream conditions locally at the culvert. The culvert would be set at a slope to match the existing stream system. Stream substrate will be placed in the bottom of the pipe to fill a minimum of 20-percent of the rise. Concepts are shown in Section 23.3.

Existing and proposed conditions were modeled with HEC-RAS. Results of modeling indicate that the proposed culvert will pass the 50-year flood with headwater elevation to culvert rise ratio equal to 1.46.

Table 18-1. 1102+19 Hydrologic and Hydraulic Summary

Drainage Area = 1.26-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs)	135	198	227
Flow depth at inlet (ft)	4.55	6.15	6.81
Hw/D	1.08	1.46	1.62

Note: Design was completed to preliminary level in support of the Preliminary Engineering Report based on cursory survey data collected by Inter-Fluve based on a relative horizontal and vertical datum. Final design will include site topographic survey.

18.5 23 CFR

There is no known FEMA Flood Insurance Study for the existing culvert. The proposed action includes a culvert larger in size and more hydraulically efficient than the existing culvert than currently exist. Risks of the proposed culvert are considered minimal. There is a reduction in upstream backwater effects and more efficient conveyance of flows through the pipe. There is less likelihood of debris blocking the culvert. The proposed culvert will improve stream process and provide more natural flood plain connectivity.

18.6 Conclusion

The hydraulic features of the proposed action are developed to a preliminary level at this phase in support of the Preliminary Engineering Report. Design will be completed for submittal with Plans-in-Hand. The proposed culvert is not expected to impact the flood plain or environment. The proposed culvert meets ADOT&PF's requirements for conveyance of the 50-year event. The proposed culvert was designed for fish passage using the Tier 1 method to simulate adjacent stream conditions. This provides favorable continuity of stream processes and passage of fish through the culvert from adjacent stream reaches.

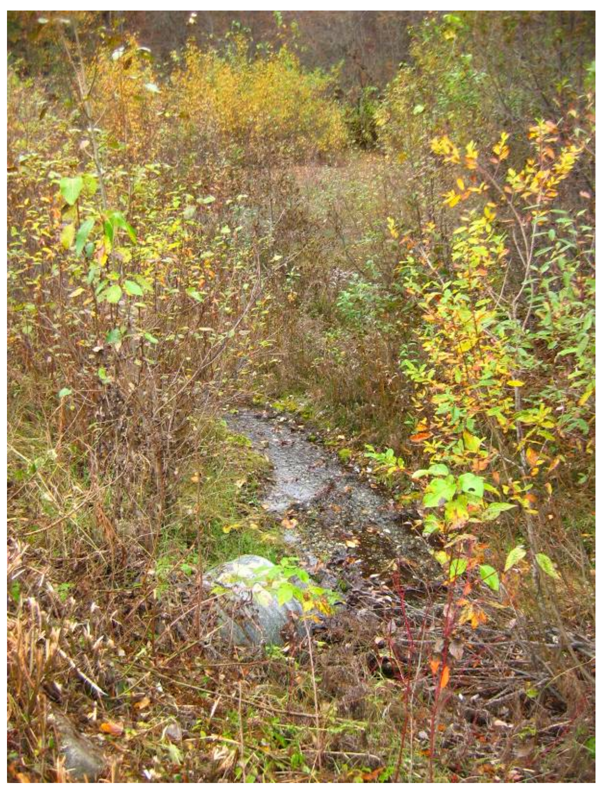
The hydrologic and hydraulic summary for the proposed culvert are presented in Table 18-1.

18.7 Riprap

The culvert was designed using Tier 1 stream simulation to maintain continuity of flow of water and sediment. No riprap is proposed at this time.

18.8 Station 1102+19 – Existing conditions photos

Existing Culvert: 36-inch cmp
Catalog Number: 115-32-10250-2070
Fish Use: Rearing coho and Dolly Varden. Spawning chum and coho
Description: This location was referenced as Station 1123+25 in the S&HI. Based on hand measurements, upstream of the culverts the stream is 1-2' wide and composed of riffle habitat. The stream runs alongside the road up to (2009) station 1107+00 before the channel turns away from the road. For the first 150' above the culvert the stream lies away from the toe of the road fill slope and cover is provided by adjacent willow and alder. The stream then runs tight along the toe and the banks are vegetated with grasses. Downstream of the culvert the stream flows through a manipulated habitat with patches of willow and grasses beginning to be established. For both portions of the stream the substrate is small gravel.



19. Culvert Replacement at Station 1179+75

The crossing structure at this site will consist of a large box culvert to facilitate removal of deposited sediment using equipment.

19.1 Introduction

This tributary is located along a debris flow at highway station 1179+75. The crossing is comprised of a corrugated metal pipe (CMP) about 13-ft in diameter. The replacement culvert will be a large box culvert designed for flood conveyance and to facilitate equipment access for clearing of debris flow sediments.

19.2 Conclusion

The replacement culvert will be a large box culvert designed for flood conveyance and to facilitate equipment access for clearing of debris flow sediments.

20. Culvert Replacement at Station 1187+25

The crossing structure at this site will consist of a large box culvert to facilitate removal of deposited sediment using equipment.

20.1 Introduction

This tributary is located along a debris flow at highway station 1187+25 (approximate S&HI station 1208+25). The crossing is comprised of an 8'-2" by 5'-9" pipe arch. The replacement culvert will be a large box culvert designed for flood conveyance and to facilitate equipment access for clearing of debris flow sediments.

20.2 Conclusion

The replacement culvert will be a large box culvert designed for flood conveyance and to facilitate equipment access for clearing of debris flow sediments.

20.3 Station 1187+25 – Existing conditions photos

Existing Culvert: 8'-2" x 5'-9" pipe arch

21. Small Fish Culverts

21.1 Introduction

Following completion of the field investigations and submittal of the preliminary draft H&H report (November 2005), a number of smaller pipes with fish present were identified. These pipes were either included in the Anadromous Waters Catalog or seen to have fish present by Inter-Fluve or OHMP staff. These pipes are all 36-inches or less in diameter, two sites have double 24-inch CMPs, and are not required to have a hydraulic summary report. However, culvert replacements may require ADF&G Title 16 Fish Habitat Permits. At the request of ADOT&PF, discussion of these culverts and recommendation of design method and culvert size were subsequently added to this report. Therefore, each of these smaller pipes with fish present are identified, existing conditions discussed, H&H analysis/preliminary design presented and size of pipe to meet fish passage and flood conveyance requirements discussed. This section describes methods for providing fish passage and providing flood conveyance equal to or greater than the existing culverts.

21.2 Hydraulic History

Through the anecdotal record and interviews with ADOT&PF maintenance personnel, no culverts were identified that had problems with icing or conveyance of flood flows through unobstructed pipes. Therefore, it is assumed that existing conditions of each pipe discussed below are performing satisfactorily.

21.3 Hydrology

No stream gaging data were identified or known to be available for these streams. Furthermore, the basins range in size from 0.05- to 0.49-sq. mi, all of which fall below the 0.72 sq. mi. threshold to be appropriately evaluated using USGS regression equations for this region. Initially, peak flow estimates were obtained by applying flow per unit area values from neighboring basins. Subsequent hydraulic analysis suggested that these flow estimates were unrealistically large in comparison to the size of the culverts and anecdotal reports of satisfactory flood conveyance. An alternate approach was therefore applied, whereby the discharge associated with a HW/D ratio of 1.5 was loosely approximated as a surrogate for the 50-year flow. Fish passage flows estimated from forty percent of the 2-year USGS regression flow estimate were then prorated based on the ratio of this surrogate and USGS regression estimated 50-year event. In most cases the fish passage flow estimated with this approach had a favorable comparison to the stainline observed on the culvert, an indicator of a frequently occurring flow. Tier 1 stream simulation or Tier 2 FISHPASS program design [2] fish passage designs were

[2] Tier 2 FISHPASS program design. This method uses the ADF&G FISHPASS software to determine hydraulic conditions passable by species and age class (size) of fish with sufficiently deep and slow flow to enable fish to pass the full length of culvert within their swimming capabilities (ADF&G and ADOT&PF MOA, 2001).

developed. Lastly, the culvert hydraulic capacity was checked to ensure that flood conveyance equaled or exceeded existing conditions.

21.4 Hydraulic Design

Existing hydraulic capacity was calculated using Federal Highway Administration's HY-8 culvert hydraulic analysis software.

Fish passage was based on Tier 1 stream simulation or Tier 2 FISHPASS program design methods based on recommendations and discussion with ADOT&PF and agency personnel. Tier 2 calculations utilized ADF&G's FISHPASS program for baffled and unbaffled pipes. Design fish were selected as either adults or juvenile Coho or Cutthroat through prior discussion and agreement with ADOT&PF and Agency personnel. A summary of design method used and design fish for Tier 2 applications is included in the culvert summary shown in Appendix 23.4.

A new culvert that would meet fish passage criteria was identified and then resized if necessary to provide equal or greater conveyance capacity than the existing structure. Hydraulic analysis was completed using FHWA HY-8. A comparison of hydraulic capacity for the existing and proposed culverts at each site is presented in Appendix 23.5.3.

Four of the smaller fish pipes are recommended to be integrated with stream improvements during a mitigation phase. These measures will improve fish passage and aquatic habitat (e.g. spawning and rearing). Fish passage and hydraulics of these culverts will be revised at the mitigation phase to incorporate these stream enhancements.

A summary discussion of each site follows.

<u>Station 228+95 (S&HI station 252+00)</u>. Tier 2 FISHPASS no baffles
The existing pipe is a 24-inch CMP with a rusted bottom. Elevation is approximately 22-ft. Upstream and downstream conditions are described in the companion Stream and Habitat Inventory (S&HI) and summarized in the following paragraph. Fish passage is designed using Tier 2 FISHPASS methods given the relatively flat gradient and observed ability of fish to pass the existing culvert. FISHPASS analysis indicates that juvenile Coho are able to pass the existing culvert. Therefore, the culvert replacement can be of similar type and elevation as the existing culvert - hydraulic capacity would remain unchanged.

As stated in the S&HI:

> Catalog Number: 115-32-10250-2006
> Stream Name: Schnabel Creek
> Fish Use: Rearing coho, Dolly Varden and cutthroat
> Description: Based on observations and hand measurements, upstream of the culvert the stream is 1-2' wide and 1' deep. The stream banks are thickly vegetated with grasses that tend to grow over most of the stream surface. Substrate is organic matter over gravel. The stream runs along the toe of the Southeast Road Builders' fill,

crossing the access driveway at station 269+00 and then connecting to the artificial ponds near S&HI station 260+50. The downstream end of the culvert is submerged in a small pool, with a 2-3' wide E type channel forming almost immediately at the outlet and meandering through the wetlands to connect to another stream. The outlet channel has a very low gradient, a silty bottom and low, vertical banks vegetated with marigolds, sedges and willows.

<u>Station 240+38 (S&HI station 263+50)</u>. Tier 2 FISHPASS no baffles
The existing pipe is a 24-inch CMP with a rusted bottom. Elevation is approximately 22-ft. Upstream and downstream conditions are described in the companion S&HI and summarized in the following paragraph. Fish passage is designed using Tier 2 FISHPASS methods given the relatively flat gradient and observed ability of fish to pass the existing culvert. FISHPASS analysis indicates that juvenile Coho are able to pass the existing culvert. Therefore, the culvert replacement can be of similar type and elevation as the existing culvert - hydraulic capacity would remain unchanged.

As stated in the S&HI:
Catalog Number: 115-32-10250-2006-3003
Stream Name: none, listed as tributary to Schnabel Creek
Fish Use: Rearing coho, Dolly Varden and cutthroat
Description: Although the ADFG Catalog lists this stream as a tributary to Schnabel Creek, it is actually a separate system fed by a wetland and spring complex cut off from the upper reaches of Schnabel Creek by the driveway at station 263+60. Upstream of the culvert the inlet stream flows from both directions along the toe of the road embankment. Flow is dispersed through a broad wetland area with little in the way of a defined channel. Based on observations and hand measurements, depth is usually less than 0.5' over a saturated organic base. Downstream of the culvert outlet is a 10' by 15' pool, with a depth of 3'. The pool leads into a 2' wide, 1' deep silt bottomed channel that meanders through willow and alder root systems. This channel winds roughly parallel to the road, swinging tight to the existing embankment toe between S&HI stations 260+50 and 261+00.

<u>Station 245+19 (S&HI station 268+00)</u>. Tier 1 stream simulation
The existing pipe is a 36-inch CMP with a rusted bottom. Elevation is approximately 23-ft. Upstream and downstream conditions are described in the companion S&HI and summarized in the following paragraph. Fish passage is designed using Tier 1 stream simulation methods given good upstream habitats which include wetlands. Based on hand measurements of the existing stream, the representative channel is approximately 2-ft wide. In order to incorporate stream substrate material to Tier 1 standards and provide equal or greater conveyance to what exists, a 4-ft diameter CMP will be required.

As stated in the S&HI:
Catalog Number: 115-32-10250-2008
Stream Name: Waterfall Creek

Fish Use: Rearing coho, Chinook and Dolly Varden. Coho Spawning
Description: The ADFG catalog lists this pipe as the primary conduit of Waterfall Creek. This is no longer the case. The culvert at station S&HI station 275+66 now passes the majority of the flow that leads from the waterfall the creek is named for. Based on observations and hand measurements, upstream of the inlet there is a short, 2'wide, shallow stream segment leading into an emergent marsh. The stream substrate is organic matter over gravel. The outlet stream is a short, 2' wide, 0.7' deep section leading into the main stream that flows from the S&HI station 275+66 culvert. The stream banks are well vegetated with grasses.

Station 248+45 (S&HI station 271+40). Tier 1 stream simulation
The existing pipe is a 24-inch CMP with a rusted bottom. Elevation is approximately 22-ft. Upstream and downstream conditions are described in the companion S&HI and summarized in the following paragraph. Fish passage is designed using Tier 1 methods given excellent upstream habitats which include wetlands. Based on hand measurements of the existing stream the representative channel is approximately 3-ft wide. In order to incorporate stream substrate material to Tier 1 standards and provide equal or greater conveyance to what exists, a 3-ft diameter CMP will be required.

As stated in the S&HI:

Catalog Number: 115-32-10250-2008-3005
Stream Name: none listed, tributary to Waterfall Creek
Fish Use: Rearing coho, Dolly Varden, Chinook and cutthroat
Description: Upstream of the culvert the stream disperses immediately into thickly vegetated marsh in a broad remnant channel. Based on observations and hand measurements, there are a number of pools with depth of up to 3'. The pools are fed in part by a small mountain stream about 100' from the road. However, the majority of the flow comes from the stream and wetland complex that stretches ahead on line up to the waterfall near S&HI station 305+40. Downstream of the culvert the stream meanders along the road to S&HI station 273+00 before turning toward the river. The stream flows through a marsh in a defined channel, with the banks composed of thick vegetation. Substrate is organic; depth is 0.5 - 1'.

Station 292+90 (S&HI station 316+00). Tier 2 FISHPASS baffles
The existing crossing is two 24-inch CMPs with rusted bottoms. Elevation is approximately 26-ft. Upstream and downstream conditions are described in the companion S&HI and summarized in the following paragraph. Of note, upstream of the culverts is a gravel lined pool that was excavated following heavy sedimentation during the November 2005 flood. The pool is approximately 15-ft by 35-ft, and presently bare of vegetation. A few redds were observed during the October field investigations, prior to the November 2005 flood, thus fish have been seen to utilize upstream habitats and passage is to be provided. Fish passage was designed by Tier 2 FISHPASS methods given the poor quality of upstream habitats. The Tier 2 culvert was then analyzed for

conveyance capacity using HY-8 to exceed existing conditions. A 4-ft diameter CMP is required with baffles to a height of 0.6-ft.

As stated in the S&HI:

> Fish Use: Rearing coho, cutthroat, Chinook and Dolly Varden. Spawning redds present
>
> Description: Upstream of the culvert there is a large, shallow, gravel bottomed pool excavated after the November 2005 flood. Based on observations and hand measurements, this pool is fed primarily by a 4' wide cascade that passes through a culvert in the adjacent driveway. Another mountain stream near S&HI station 321+00 provides another 10% of the flow. All fish habitat above the culvert has been scoured to gravel. Redds were present in this section in October 2005. This stream is used for a small hydropower system. Downstream of the culvert is a 10' wide gravel bottomed plunge pool with redds present (October 2005) at the tailout. The stream then flows directly to the river in a 6-10' wide, rocky cascade channel, the lower end of which is influenced by the river backwater.

<u>Station 314+72 (S&HI station 337+70)</u>. Tier 2 FISHPASS no baffles
The existing pipe is a 24-inch CMP with a rusted bottom. Elevation is approximately 28-ft. Upstream and downstream conditions are described in the companion S&HI and summarized in the following paragraph. Of note, upstream of the culverts is a gravel lined pool that was excavated following heavy sedimentation during the November 2005 flood. The pool is approximately 10- by 30-ft, and presently bare of vegetation. Some habitat value was noted during the October 2005 field investigations, prior to the November 2005 flood, thus fish passage is to be provided. Fish passage was designed by Tier 2 FISHPASS methods given the limited value of upstream habitats. The Tier 2 culvert was then analyzed for conveyance capacity using HY-8 to exceed existing conditions. A 3-ft diameter CMP is required to meet Tier 2 FISHPASS criteria.

As stated in the S&HI:

> Fish Use: Rearing coho and Dolly Varden below culvert outlet
>
> Description: Based on observations and hand measurements, upstream of the culvert there is a 10' by 30' pool created by ditch cleaning activity in the spring of 2006. This shallow pool is fed by a stream cascading down the cut slope adjacent to the pool. The inlet stream averages 4' wide and 0.1' deep and is well defined further upstream. Downstream of the culvert is an 8' diameter plunge pool 1.5' deep. The culvert was not perched in late May of 2006. The stream meanders the 140' to the Chilkat River through an 8' wide, high banked channel. The channel banks are thickly vegetated with alder and cottonwood. The stream meanders within this channel, with width varying from 1-3', and depth 0.2' to 0.8'. It is composed of pools and riffles over gravel.

<u>Station 366+36 (S&HI station 389+25)</u>. Tier 1 stream simulation
The existing pipe is a 24-inch CMP with a rusted bottom. Elevation is approximately 30-ft. Upstream and downstream conditions are described in the companion S&HI and

summarized in the following paragraph. There is excellent juvenile rearing habitat upstream of the culvert. Therefore, fish passage was designed by Tier 1 stream simulation methods. Based on hand measurements in the S&HI and approximations from the project survey, channel width was assumed to be 4 feet wide. A 42 inch by 29 inch pipe arch was selected. Substrate will be placed in the culvert to 6-inch depth with slope set to accommodate adjacent stream slopes.

As stated in the S&HI:

> Fish Use: Rearing coho, cutthroat and Dolly Varden
> Description: Upstream of the culvert the 2-4' wide stream provides 40' of excellent rearing habitat for juvenile fish after it cascades down the hillside. Substrate is gravel and the cover is dense. Downstream of the culvert the stream runs through a channel incised in a river deposited sandbar and empties directly into the Chilkat River.

<u>Station 382+07 (S&HI station 405+00)</u>. Tier 2 FISHPASS no baffles
The existing pipe is a 36-inch CMP with a rusted bottom. Elevation is approximately 30-ft. Upstream of the culvert is an extensive wetland that could provide excellent rearing habitat. The outlet of the existing culvert is perched, discharging directly to the Chilkat River. Periodic fish passage is enabled when the Chilkat River levels are sufficiently high to back water the culvert. The existing pipe meets Tier 2 FISHPASS fish passage requirements when the tailwater is 0.75-ft or greater over the outlet invert. Therefore, the culvert replacement can be of similar type and elevation as the existing culvert - hydraulic capacity would remain unchanged. The dynamic nature of the Chilkat River poses more risk to a constructed fish passage channel downstream of the culvert than is desirable. Therefore, the proposed culvert will have an outlet condition similar to existing; with periodic fish passage during Chilkat River high flow conditions backwatering the culvert.

As stated in the S&HI:

> Catalog Number: 115-32-10250-2016
> Stream Name: Lily Pad Creek
> Fish Use: Rearing coho and Dolly Varden
> Description: Based on observations and hand measurements, upstream of the culvert the first 50' of the stream consists of a 2' wide E type channel. The stream then disperses into a swamp and loses any defined channel. At the downstream end of the culvert the stream plunges directly onto a sandbar. There is an intermittent pool and shallow exit stream over the sandbar. Rearing fish access to the swamp is controlled by the river water level.

<u>Station 419+95 (S&HI station 443+00)</u>. Tier 2 baffles
The existing pipe is two 24-inch CMPs with rusted bottoms. Elevation is approximately 39-ft. Upstream and downstream conditions are described in the companion S&HI and summarized in the following paragraph. Of note, upstream of the culverts is a gravel lined pool at the toe of a steep cascade. Fish passage was designed by Tier 2 FISHPASS

methods given the poor quality of upstream habitats. The Tier 2 culvert was then analyzed for conveyance capacity using HY-8 to exceed existing conditions. A 3.5-ft diameter CMP is required with baffles to a height of 0.6-ft.

As stated in the S&HI:

Fish Use: Rearing coho, cutthroat, steelhead and Dolly Varden. Possible spawning
Description: Based on observations and hand measurements, upstream of the culverts there is a 20' diameter gravel lined pool fed by a quickly steepening, 3-5' wide, rocky cascade/step pool section of stream. The culverts empty into a 6-8' diameter plunge pool. The active culvert is perched 4-6". The stream below the outlet pool is composed of riffles interspersed with step pools and is 3-6' wide. Substrate is small rocks and gravel. Mature vegetation overhangs the stream.

Station 530+70 (S&HI station 554+00). Tier 1 stream simulation
The existing pipe is a 24-inch CMP with a rusted bottom. Elevation is approximately 40-ft. Upstream of the culvert is 10-1/2 Mile Pond that could provide excellent rearing habitat. Fish passage is designed using Tier 1 stream simulation methods given excellent upstream habitats. Based on hand measurements of existing stream the representative channel is approximately 2-ft wide. In order to incorporate stream substrate material to Tier 1 standards and provide equal or greater conveyance to what exists, a 3-ft diameter CMP will be required.

As stated in the S&HI:

Catalog Number:115-32-10250-2028-0010 (Pond is catalogued, stream not identified)
Stream Name: 10 1/2 Mile Pond, outlet stream
Fish Use: Coho and steelhead rearing
Description: Although this creek is not specifically shown on the ADF&G catalogue maps, it is directly connected to the 10 ½ Mile Pond. Based on observations and hand measurements, upstream of the culvert is a 15' stream that then disperses into the pond. The stream is 2-3' wide and 0.3'deep. Stream substrate is organic, and vegetation grows throughout. Below the culvert outlet the stream runs for 6' in a 2' wide, 0.2' deep channel, then disperses into a 10-20' wide wetland full of grasses and willows. Flow in this wetland is visible, depth is 0.8 to 1.3'. There are some open water areas. This wetland continues along the road for about 175', then becomes more channelized (3' wide, 0.3' deep) and turns away from the road. Near station 551+00 the stream broadens to 8-10' wide. Many fish were noted to be present (June 2006).

Station 606+68 (S&HI station 630+00). Tier 2 FISHPASS no baffles
The existing pipe is a 24-inch CMP with a rusted bottom. Elevation is approximately 45-ft. The outlet of the existing culvert is perched, discharging directly to the Chilkat River. Periodic fish passage is enabled when the Chilkat River levels are sufficiently high to backwater the culvert. The existing pipe meets Tier 2 FISHPASS fish passage requirements when the tailwater is 0.6-ft or greater over the outlet invert. Therefore, the culvert replacement can be of similar type and elevation as the existing culvert -

hydraulic capacity would remain unchanged. The dynamic nature of the Chilkat River poses more risk to a constructed fish passage channel downstream of the culvert than is desirable. Therefore, the proposed culvert will have an outlet condition similar to existing; with periodic fish passage during Chilkat River high flow conditions backwatering the culvert.

As stated in the S&HI:

Fish Use: Rearing cutthroat and Dolly Varden

Description: The flood of November 2005 directed approximately two-thirds of the flow from the waterfall at S&HI station 629+50 towards this culvert. The rest of the flow exits through the culvert at S&HI station 612+50. Based on observations and hand measurements, above the culvert inlet the stream divides into a 6-8' wide, 1-2' riffle, pool, glide complex running through an established alder and birch forest. The stream substrate is silt and organics for the first 100', then changes to recently deposited alluvial material. The culvert empties directly into the Chilkat River and is perched at low water.

<u>Station 736+83 (S&HI station 757+50)</u>. Either Tier 1 stream simulation or Tier 2 FISHPASS

The existing pipe is a 24-inch CMP with a rusted bottom. Elevation is approximately 57-ft. Upstream of the culvert is a pool and stream system that could provide excellent rearing habitat. The outlet of the existing culvert is perched, and discharges to a side channel of the Chilkat River with a surveyed width of about 8-ft wide – possibly a result of human disturbance. Based on preliminary methods either a 7'-4" by 5'4" pipe arch for Tier 1 stream simulation design method or 3-ft diameter CMP for Tier 2 FISHPASS design method is likely to be required. This area is recommended for mitigation opportunities. The proposed replacement culvert will be integrated into a fish passage channel to connect the pipe to the Chilkat River for a greater range of flows.

As stated in the S&HI:

Fish Use: Rearing coho, Chinook and Dolly Varden

Description: Based on observations and hand measurements, upstream of the culvert there is a small waterfall fed pool that extends about 50' back on line. The stream branch leading to north is 5-8' wide and 0.3' deep for the first 35', where the main flow enters as a waterfall. This 35' riffle section is shallow, littered with organic debris, and has a gravel substrate. The water extends in a roadside ditch up to S&HI station 760+00 where there is another small waterfall. This reach is an 8' wide, 0.8' deep pool. Standing water with little flow extends another 100' ahead on line. Fish are present throughout. Downstream, the perched culvert empties into a silty channel backwatered by the river. Grass grows on the banks above the river level, but bare silt is exposed lower down. There is no cover. The river gravel bars near the outlet are actively used for spawning.

<u>Station 767+14 (S&HI station 788+00)</u>. Tier 2 FISHPASS baffles

The existing pipe is one 36-inch CMP with a rusted bottom. Elevation is approximately 56-ft. Upstream and downstream conditions are described in the companion S&HI and summarized in the following paragraph. Of note, upstream of the culvert is a small stream that drains from the hill side. The outlet of the pipe is perched to a side channel of the Chilkat River. Given the poor quality of upstream habitats, the proposed culvert will have an outlet condition similar to existing; with periodic fish passage during Chilkat River high flow conditions backwatering the culvert. Fish passage was designed by Tier 2 FISHPASS methods for high river flow conditions given the poor quality of upstream habitats. The Tier 2 culvert was then analyzed for conveyance capacity using HY-8 to exceed existing conditions. A 3.5-ft diameter CMP is required with baffles to a height of 0.6-ft.

As stated in the S&HI:

> Fish Use: Rearing coho, Chinook and Dolly Varden. Possible redd observed (October, 2005)
> Description: The culvert is fed by two mountain streams that join together about 20' upstream of the inlet. One of the streams runs 100' back on line in a shallow, 2-3'wide, gravel bottomed roadside ditch which ends in a waterfall. The second branch runs for a distance of 120' away from the road and along the toe of the mountain before turning upslope as a waterfall. This 120' of stream is composed of 2-3' wide pool/riffle habitat with rock and gravel substrate. It is well vegetated. The culvert outlet empties directly into the river.

21.5 23 CFR

There is no known FEMA Flood Insurance Study for any of these existing culverts. The proposed action for each site includes replacement with a culvert that provides fish passage to either Tier 1 stream simulation or Tier 2 FISHPASS requirements and has flow capacity equal to or greater than the existing pipe. Risks of the proposed culverts are considered less than the existing structures. There is a reduction in upstream backwater effects and more efficient conveyance of flows through the pipes. There is less likelihood of sediment or debris blocking the culverts. The proposed culverts will improve stream process and provide more natural flood plain connectivity.

21.6 Conclusion

The hydraulic features of the proposed action are developed to a preliminary level at this phase in support of the Preliminary Engineering Report. Design will be completed for submittal with Plans-in-Hand. The proposed culverts were designed for fish passage using the Tier 1 stream simulation or Tier 2 FISHPASS method based on prior discussion and agreement with ADOT&PF and agency personnel. This provides favorable continuity of stream processes and passage of fish through the culvert from adjacent stream reaches. The proposed culverts will meet or exceed the conveyance of existing structures. The proposed culverts are not expected to impact the flood plain or environment.

The hydraulic summary for the proposed culvert are presented in Appendix 23.5.3.

21.7 Riprap

The culverts were designed using Tier 1 or Tier 2 stream simulation to maintain continuity of flow of water and sediment. Each culvert was designed to provide equal or greater flood capacity than currently exists. At this preliminary phase, the reduction in flow restriction is assumed to reduce any scour potential that may exist. Therefore, no riprap is proposed at this time.

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23. Appendices:

23.1 Culvert Inventory Table

Haines Highway - MP 3-25 Culvert Inventory

Legend
S&HI stationing
Multiple pipes
Big fish pipe
Small fish pipe

as-built summary field

Notes: reference to 'emergent wetland' areas is used loosely by non-botanist and does not necessarily comply with strict wetland definition
Stainline height above invert refers to low point of metal culvert; does not reference accumulations of material within pipe

Criteria used for determining if waters of the U.S.: drains stream, waterfall, or hillslope seeps; drains wetland or connected to wetland with evidence of flowing water; fish present.
If notes indicate lack of channel (downstream or upstream), then did not consider a Water of the U.S.

count	As-built	Centerline stationing			QA'd	Culvert	Culv Size	Culvert	As-Built	Eng. Survey	Height to Stainline at:			Waters of	Upstream	Inlet	Outlet	Downstream
09	Station	Design 9/2005	S&HI June/06	Design 10/2009		Size (in)		Length (ft)	Comment		inlet(ft)[1]	outlet(ft)[1]	fish bearing	the U.S.	conditions	Conditions	Conditions	conditions
	Haines Highway MP 4 - 12.77 As-Builts																	
1	212+58	212+50	212+53	189+51	dm	24	24	70			0.3			N	drains ditch; no water present	clear of debris/sediment at inlet; crimping of inlet from maintenance; gravel present in barrel 0.2 ft	opens to voids in large riprap	discharges to ditch
2	219+08	218+80	218+92	195+90	dm	24	24	74						N	drains ditch; no water present	partially obstructed by grass/debris; pipe invert filled 0.25-0.5 ft with gravel/sediment	could not locate; either hidden by riprap, sand dunes, or veg.	u/s of airport berm
3	235+52	234+90	235+12	212+10	dm	24	24	60			0.5	1		N	flowing water present discharge from u/s pipe to short open channel into road culvert	undamaged; slight sediment and veg obstruction	invert perched 0.8 ft abv channel ws; outlet damaged but open	discharges to Chilkat trib/slough. Mostly runoff or GW drainage.
4	237+51	236+87	237+09	214+07	dm	24	24	60			1			N		inlet and barrel clear of debris/ sediment; bottom 0.2-0.3 ft rusted out	perched 0.45 ft abv scour pool ws	scour pool = 6 ft wide x 7 ft long x 1.4 ft depth. Trickle of water.
5	246+02	245+30	245+52	222+51	dm	48	48	SeeSurv.		Yes	1		Yes	Y	juvenile salmonids present	undamaged; clear of debris/sediment	slight damage; backwatered 50-66% of barrel	scour pool = 15 ft wide x 20 ft long x 1-1.5 ft depth; pool backfilled with fines; metal debris (55 gal drum and outlet apron) in outlet pool
6	252+55	251+75	251+96	228+95	dm	24	24	60			0.75			N	drains ditch @ SE Road Builders	undamaged; partially obstructed by grass	could not locate; likely covered by veg and backwater at wet meadow/wetland complex	discharges to wet meadow/wetland complex
7	263+93	263+20	263+40	240+38	dm	24	24	60			0.65			Y		undamaged; clear of debris/sediment; flowing water present	backwatered from wetland area	discharges to wet meadow/wetland complex
8	268+75	268+00	268+20	245+19	dm	36	36	60			0.65			Y		undamaged; some veg on streambed	no scour hole; outlet damaged, no perching	discharges to standing water in wetland area
9	272+00	271+25	271+45	248+45	dm	24	24	58			1.1		YES - S&HI	Y	drains wetland area (rushes)	undamaged	undamaged	discharges to standing water in wetland area; no scour pool; juvenile salmonids present
10	316+46	315+71	315+91	292+90	dm	24	24	50			0.7		YES - S&HI	Y	clean gravels <= 0.25 ft	inlet slightly crimped; flowing water present; drains stream (hydropower plant upstream)	outlet moderately crimped; backwatered 0.45 ft to stainline	flowing water
11	316+50	315+75	315+95	292+94	dm	24	24	50			0.7		YES - S&HI	Y	clean gravels <= 0.25 ft	inlet slightly crimped; flowing water present; drains stream (hydropower plant upstream)	outlet slightly crimped; backwatered 0.45 ft to stainline	flowing water
12	322+19	321+44	321+64	298+62	dm	24	24	56			0.4	0.6		Y	drains flowing water in ditch supplied from small cascades on adjacent hillslope	inlet slightly crimped	freefall discharge to Chilkat	discharges direct to Chilkat
13	323+54	322+80	32300	299+97	dm	24	24	56			0.5 (rust line 1 ft)			Y	drains flowing water in ditch supplied from hillslope seeps	undamaged; flowing water	silt in outlet from Chilkat backwater; discharges to Chilkat bank; perched	discharges direct to Chilkat
14	331+30	could not locate	could not locate		dm	24	24	56						N/A				
15	338+30	337+50	337+70	314+72		24		52			1.2	0.5			Drains stream and ditch. Cascade 12' from inlet.	culvert slightly crushed; flowing water present; bottom 0.5' filled with gravel	Slightly damaged but fully open	discharges into 10' by 10' pool, which connect to a 140' channel feeding into the Chilkat River
16	342+73	341+92	342+12	319+13		36	36	SeeSurv.		Yes	see survey data		Yes	Y	water present	undamaged; stainline may be from Chilkat backflow	damaged; stainline may be from Chilkat backflow	water present
17	348+30	could not locate	could not locate		48"?	24	24	48						N/A				
18	348+57	347+58	347+77	324+79	MB	48	48	SeeSurv.		Yes	see survey data		YES - S&HI	Y	drains stream	inlet crimped; backwatered	undamaged; backwatered	small channel backwatered by Chilkat
19	373+55	372+00	372+20	349+25	dm	24	24	56			1 (rust line)			N	rel. dry forested area; drains wet drainage ditch	inlet crushed and covered with grasses	undamaged; 0.5 ft of silt	drains to rocklined outfall
20	390+09	389+25	389+30	366+36	dm	24	24	56			0.5		YES - S&HI	Y	drains stream (4 ft wide x 1 ft depth x 30 ft to hillslope); flowing water	inlet slightly crimped	outlet slightly crimped	silt lined channel (3 to 6 ft wide x 1.5 ft depth)
21	392+69	391+75	391+91	368+94	dm	24	24					0.3 (rust line 0.5)	YES - S&HI	Y	drains pool below waterfall	inlet crimped; flowing water present; slight debris obstruction	undamaged	discharges through silt deposits along Chilkat
22	396+07	395+20	395+34	372+37	dm	24	24	56				0.6 (rust line)		n	drains damp meadow area	obstructed by silt and veg; slightly crimped	freefall discharge to Chilkat; full of silt	
23	405+81	404+90	405+04	382+07	dm	36	36	56		No			YES - S&HI	Y				
24	427+27	426+30	426+52	403+57	dm	24	24	64			0.1	0.1		N	small dry forested hillslope	damaged; dry	damaged; clear of silt; discharges to steep grass bank at Chilkat	discharges direct to Chilkat bank

Haines Highway - MP 3-25 Culvert Inventory

S&HI stationing
Multiple pipes
Big fish pipe
Small fish pipe

as-built summary field

Notes: reference to 'emergent wetland' areas is used loosely by non-botanist and does not necessarily comply with strict wetland definition
Stainline height above invert refers to low point of metal culvert; does not reference accumulations of material within pipe

Criteria used for determining if waters of the U.S.: drains stream, waterfall, or hillslope seeps; drains wetland or connected to wetland with evidence of flowing water; fish present.
If notes indicate lack of channel (downstream or upstream), then did not consider a Water of the U.S.

count 09	As-built Station	Centerline stationing Design 9/2005	S&HI June/06	Design 10/2009	QA'd	Culvert Size (in)	Culv Size	Culvert Length (ft)	As-Built Comment	Eng. Survey	Height to Stainline at: inlet(ft)[1]	outlet(ft)[1]	fish bearing	Waters of the U.S.	Upstream conditions	Inlet Conditions	Outlet Conditions	Downstream conditions
25	431+39	430+40	430+60	407+65	dm	24	24	58			no stainline/no rust line	no stainline/no rust line		N	dry ditch at hillslope toe	slightly bent; clear; dry	crimped at top; freefall 0.5 ft to Chilkat bank	discharges direct to Chilkat bank
26	434+51	433+50	433+70	410+72	dm	24	24				0.3 (rust line)	0.3 (rust line)		N	ditchline maintained to drain 'dry' grassy area	crimped; phone line cable exposed at inlet	freefall discharge to Chilkat bank; silt extends 5 ft into pipe to meet rustline elev	discharges direct to Chilkat bank
27	443+80	442+72	442+98	419+95	dm	24	24					0.5 (rust line)	YES - S&HI	Y	steep boulder cascade stream	torn, crimped, and crushed; inlet located at 15 ft diam pool below steep boulder cascade; flowing water	perched 0.5 ft; scour pool = 8 ft long x 12 ft wide x 1.5-2 ft depth	cobble / small boulder stream
28	443+84	442+76	443+02	419+99	dm	24	24					0.6 (rust line)	YES - S&HI	Y	steep boulder cascade stream	torn, crimped, and crushed; inlet located at 15 ft diam pool below steep boulder cascade; flowing water	perched 0.5 ft; scour pool = 8 ft long x 12 ft wide x 1.5-2 ft depth	cobble / small boulder stream
29	457+01	456+00	456+23	433+00	dm	24	24				0.4 (rust line)	0.4		Y	drains damp ditchline immediately below steep cascade (4 x 1 ft seep)	1 ft diam rock at inlet (slight obstruction); inlet slightly crimped	slight silt/organics obstruction	shallow channel approx 10 ft to top of Chilkat bank; no siltation
30	473+16	471+80	472+09	449+03	dm	24	24	58				0.1		N	drains rocky hillslope below switchback driveway; dry	torn and crushed	clear; discharges to riprapped Chilkat bank	discharges direct to Chilkat bank
31	477+44	476+10	476+41	453+34	dm	24	24	62				0.2		Y	drains small waterfall 50 ft upditch; hillslope mostly dry	moderately crushed; flowing water	3 ft freefall to Chilkat riprap bank; pipe outlet located at Chilkat bank veg line	discharges direct to Chilkat bank
32	486+74	485+35	485+73	462+55	dm	24	24	52			1.2	0.3 (rust line)		Y	drains small waterfalls	0.3 ft sediment in inlet	1 ft freefall to Chilkat bank	discharges direct to Chilkat bank
33	493+85	491+50	491+90	468+70	dm	24	24	60			no stainline (rust line = 0.7 ft)	0.8 (rust line)		N	drains damp forested area	undamaged; no water present	pipe outlet located at Chilkat bank veg line	discharges to Chilkat sandbar at wood debris elev. Drainage pipe; no defined channel upstream; discharge dumps onto gravel bar.
34	497+63	502+00	502+38	479+18	dm	24	24	60						N		obstructed by veg and organic debris; no water present	undamaged; 0.8 ft blocked by debris	
35	507+36	506+00	506+37	483+18	dm	48	48	SeeSurv.		Yes	see survey data	see survey data	YES - S&HI	Y	drains stream that drains wetland complex; juvenile salmonids observed	sheet flow at inlet apron (fish passage barrier); debris blocking passage inside pipe	drains into large outlet pool; undamaged; clear of debris	juvenile salmonids observed; imperceptive flow; no surface connection with Chilkat at d/s end
36	536+86	535+08	535+49	512+24	dm	24	24	SeeSurv.		Yes	see survey data	see survey data	Yes	Y	flowing stream; redds located just upstream of inlet; juvenile salmonids and a dolly varden adult observed	undamaged	undamaged	many pink carcasses; drains into flowing stream with good spawning gravels; long slough to Chilkat confluence
37	536+91	535+15	535+56	512+32	dm	36	36	SeeSurv.		Yes	see survey data	see survey data	Yes	Y	flowing stream; redds located just upstream of inlet; juvenile salmonids and a dolly varden adult observed	undamaged	undamaged	many pink carcasses; drains into flowing stream with good spawning gravels; long slough to Chilkat confluence
38	542+31	540+60	541+00	517+67	dm	24	24	60				0.4 & 1		Y	drains emergent wetland	inlet base rusted out; veg obstructing inlet	backwatered by Chilkat	discharges to wetland area; perched
39	548+88	547+00	547+50	524+10	dm	24	24	60						Y	drains flat emergent wetland/wet meadow area	0.5 ft obstructed by silt and organics	obstructed by veg; 0.5 ft open pipe; 1.5 ft obstructed by silt/organics	no defined channel
40	555+36	553+60	554+06	530+70	dm	24	24	60			0.5 (rust line)			Y		torn; obstructed by silt and emergent veg; trickle of flowing water present	0.9 ft silt/organics; encroaching veg	discharges to emergent wetland
41	564+41	562+70	563+14	539+77	dm	24	24				0.3			N	drains roadside ditch/ gen'l dry forested area	slightly torn; clear of debris	unraveled 0.5 ft; gravel deposition in outlet	drains to wet roadside ditch
42	571+31	569+60	570+02	546+65	dm	24	24	58				0.8 (rust line)		N	drains mostly dry forested area	obstructed by alders, grass, sediment	d/s berm approx. 0.8 ft causing rust line @ 0.8 ft	drains to flat wet meadow/emergent area
43	581+53	579+75	580+25	556+84	dm	24	24	56			no stainline	no stainline		N	drains dry hillslope and roadside ditch	water stains in base of corrugations	slight berm at outlet; no stainline	grasses laid flat
44	593+79	591+98	592+40	569+06	dm	24	24	60			rustline 0.4-ft ***WIDE*** (convert to H)	1 (backwatered by river?)		N	drains dry forested area	rust line 0.4 ft wide; 0.3 ft obstructed by organic debris	backwatered by Chilkat (?)	drains to standing water
45	596+62	594+80	595+25	571+88	dm	24	24	60			0.2	0.7 (rust line)		N	drains dry hillslope and roadside ditch	slightly crimped; invert above upstream sump	0.3 ft organic matter	drains to roadside ditch/emergent wetland
46	601+08	599+30	599+72	576+36	dm	24	24	54			0.4 (rust line)	1 (rust line)		Y	drains dry hillslope and small emergent wetland area		berm of organics 0.7 ft	drains to pond/emergent wetland
47	604+50	602+70	603+14	579+78	dm	24	24	60			1	1.5 (rust line)		Y	drains emergent wetland	undamaged; water level 0.2 ft	undamaged	drains to pond/emergent wetland; channel = 1.5 ft wide x 0.5 ft depth; water 0.5 ft deep

Haines Highway - MP 3-25 Culvert Inventory

S&HI stationing
Multiple pipes
Big fish pipe
Small fish pipe

as-built summary field

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Criteria used for determining if waters of the U.S.: drains stream, waterfall, or hillslope seeps; drains wetland or connected to wetland with evidence of flowing water; fish present.
If notes indicate lack of channel (downstream or upstream), then did not consider a Water of the U.S.

count 09	As-built Station	Centerline stationing Design 9/2005	S&HI June/06	Design 10/2009	QA'd	Culvert Size (in)	Culv Size	Culvert Length (ft)	As-Built Comment	Eng. Survey	Height to Stainline at: inlet(ft)[1]	outlet(ft)[1]	fish bearing	Waters of the U.S.	Upstream conditions	Inlet Conditions	Outlet Conditions	Downstream conditions
48	613+80	612+10	612+47	589+12	mb	24	24	SeeSurv.		Yes	entire pipe stained	entire pipe stained	Yes	Y	juvenile salmonids observed	perched above inlet pool	perched	dominated by glacial silt from Chilkat
49	613+85	612+20	612+57	589+22	mb	24	24	SeeSurv.		Yes	entire pipe stained	entire pipe stained	Yes	Y	juvenile salmonids observed	undamaged; see survey for additional info	1.5 ft cascade to ws of outlet pool	dominated by glacial silt from Chilkat
50	621+37	619+30	619+53	596+17	dm	24	24	58			0.7	0.3		Y	drains emergent wetland	0.3 ft veg/silt	undamaged; 0.1 ft organics	drains to emergent wetland
51	631+88	629+81	630+04	606+68	dm	24	24	64			1.1	1		Y	drains stream = 6 ft wide x 1 ft depth with lots of small woody debris	sides bent inward (vertical orientation); flowing water present	perched 1 ft above toe of stream bank; middle of outlet located at Chilkat bank veg line	discharges direct to Chilkat bank
52	651+18	648+25	648+47	625+12	dm	24	24	60			1.2 (backwater?)			Y	drains emergent wetland	obstructed by organics	0.8 ft berm of organics; discharges to sump; surrounding ground is above pipe crown	no outlet channel
53	667+57	665+50	665+42	642+37	dm	24	24	66			0.7			Y	drains small stream (dry) from ephemeral swamp area; channel 2 ft wide x 0.75 ft deep	inlet crimped	fully rusted; 1.5 ft freefall to channel bottom; scour pool (wet) = 10 ft wide x 5 ft long (recessed)	discharges direct to Chilkat side-channel
54	672+37	670+32	670+25	647+16	mb	36	36	SeeSurv.		Yes			YES - S&HI	Y		perched		Fairly active flow - see SH&I
55	672+47	670+41	670+34	647+26	mb	36	36	SeeSurv.		Yes	see survey data	see survey data	YES - S&HI	Y	stream (see survey data)	see survey data	entire pipe stained	stream (see survey data)
	Haines Highway MP 12.5 - 25.3 As-Builts																	
56	680+80	678+45	677+70	655+35	dm	24	24	52			0.2 ft moss line			N	drains sump from low depression/swale	crimped; moss line 0.2 ft	0.2 ft organics in outlet	no d/s channel
57	690+50	688+30	686+09	665+04	dm	24	24	54						N		slightly crimped; crown is below surrounding grade; 3 ft diam sump down to pipe inlet; 0.4 ft material in inlet	buried by silt to 0.75 ft above crown (by Chilkat river); 1 ft diam exit hole.	discharges direct to Chilkat bank
58	695+20	694+00	691+46	670+70	mb	24	24	66						N	drains meadow area	90% plugged; dry	100% plugged; non-functional	discharges direct to Chilkat bank
59				681+50		18	18	unknown							Drains ditch	intact and dry; filled with 0.5' organics	Not found	would discharge directly into river
60	711+18	709+00	706+48	685+71	mb	24	24	54						N	drains road ditch	clear of debris; no stainline; no water present	80% plugged; 1.2 ft silt in outlet	discharges direct to Chilkat bank
61	718+78	718+00	715+44	694+68	mb	24	24	58						N	drains road ditch at hillslope base	clear of debris; no stainline; no water present	damaged from riprap; 100% plugged with silt; located at Chilkat bank	discharges direct to Chilkat bank
62	729+50	727+30	724+80	704+04	mb	24	24	56						N	drains road ditch at hillslope base	clear of debris; no stainline; no water present	outlet filled with 1.6 ft sand from Chilkat backflow	discharges direct to Chilkat bank
63	733+96	731+70	729+25	708+49	mb	24	24	60			0.9			N		clear of debris but debris encroaching; no water present	stainline covers entire pipe (backwater effect); filled with 1 ft sediment (sand and gravels); no water present	discharges into road ditch that connects with oultet pool of 734 culvert. Fairly dry; road maint.
64	735+80	733+60	731+46	710+70	mb	36	36	See surv.		Yes	entire inlet stained (backwater effect)	entire inlet stained (backwater effect)	YES - S&HI	Y	drains stream	clear of debris; see survey data	clear of debris; see survey data	discharges to backwater slough of Chilkat
65	735+86	733+68	731+52	710+76	mb	36	36	See surv.		Yes	entire inlet stained (backwater effect)	entire inlet stained (backwater effect)	YES - S&HI	Y	drains stream	clear of debris; see survey data	clear of debris; see survey data	discharges to backwater slough of Chilkat
66	26+30	755+08	752+69	731+92	mb	24	24	72						N	drains road ditch/swale	filled with organics 0.5 ft	could not locate; buried with Chilkat sediment	if not buried would discharge direct to Chilkat bank
67	31+07	759+97	757+62	736+83	mb	24	24	60			0.7	0.6	YES - S&HI	Y	drains ditch fed by hillslope waterfall	clear of debris; flowing water; avg chan width = 7 ft	clear of debris; freefall 0.7 ft to outlet pool ws	outlet pool depth 0.7 ft; avg chan width 4 ft; channel incised through silt prior to entering Chilkat
68	34+12	763+00	760+70	739+85	mb	24	24	72			0.7	0.7		y	drains ditch at base of hillslope	filled with 0.1 ft sediment; flowing water present	clear of debris	discharges direct to Chilkat side channel bank
69	35+88	764+72	762+46	741+64	mb	24	24	64			0.7	1.2		Y	drains road ditch fed by hillslope seeps/falls	filled with sediment 0.1 ft	filled with sediment 0.4 ft; 15% plugged	discharges direct to Chilkat bank
70	36+92	765+80	763+55	742+72	mb	24	24	62						Y	hillslope waterfall nearly at inlet; 1.5 ft riffle (cobbles) to river level	filled with sediment 0.8 ft; culvert half filled with water; inlet pool = 3 ft wide x 3 ft long x 0.3 depth	filled with sediment 0.7 ft	discharges direct to Chilkat bank

Haines Highway - MP 3-25 Culvert Inventory

S&HI stationing
Multiple pipes
Big fish pipe
Small fish pipe

as-built   summary field

Notes: reference to 'emergent wetland' areas is used loosely by non-botanist and does not necessarily comply with strict wetland definition
Stainline height above invert refers to low point of metal culvert; does not reference accumulations of material within pipe

Criteria used for determining if waters of the U.S.: drains stream, waterfall, or hillslope seeps; drains wetland or connected to wetland with evidence of flowing water; fish present.
If notes indicate lack of channel (downstream or upstream), then did not consider a Water of the U.S.

count	As-built	Centerline stationing			QA'd	Culvert	Culv Size	Culvert	As-Built	Eng. Survey	Height to Stainline at:			Waters of	Upstream	Inlet	Outlet	Downstream
09	Station	Design 9/2005	S&HI June/06	Design 10/2009		Size (in)		Length (ft)	Comment		inlet(ft)[1]	outlet(ft)[1]	fish bearing	the U.S.	conditions	Conditions	Conditions	conditions
71	39+79	768+60	766+33	745+50	mb	24	24	58			0.8			Y	upstream channel = 5 ft wide x 0.3 ft depth	clear of debris; flowing water present	clear of debris; 1/3 fileld with Chilkat backwater; no obvious stainline	discharges direct to Chilkat bank
72	48+50	778+40	776+04	755+29	mb	24	24	62						N		clear of debris; no stainline; no water present	does not reach river; plugged with silt	30 ft of river bank between outlet and Chilkat. Appears to be a cross drainage ditch; really no defined channel.
73	61+38	790+28	788+00	767+14	mb	36	36	52			1	1.4	YES - S&HI	Y	upstream channel fed by hillslope waterfall; upstream channel 4.5 ft avg width	filled with sediment 0.3 ft; flowing water present	filled with sediment (Chilkat silt) 0.2 ft	discharges direct to Chilkat bank
74	65+16	793+88	791+60	770+74	mb	24	24	52						Y	drains wall-based slough/wetland	clear of debris; stain covers entire pipe (backwater effects); 1/2 full of water	clear of debris; 1/3 full of standing water; water depth in pipe 1 ft; stainline covers entire outlet (backwater effects)	outlet pool = 4.5 ft wide x 25 ft long x 1.2 ft depth; juvenile salmonids present
75	83+28	811+97	809+68	788+83	mb	24	24	50						N	drains roadside ditch at base of hillslope	filled with sediment 0.3 ft; 15% plugged; no water present	90% buried with Chilkat silt	6 ft of river bank between outlet and Chilkat braid
76	89+55	818+00	815+70	794+86	mb	24	24	50						Y	drains south end of wetland complex	filled with organic sediment 0.6 ft; 80% plugged	could not locate; buried or under water	discharges into large wetland complex
77	94+00	823+00	820+80	800+00	mb	24	24	52						Y	standing water; drains wetland area	filled with sediment 0.5 ft; only 1.5 ft width open	could not locate; buried	discharges into large wetland complex
78	119+15	847+77	845+54	824+68	mb	24	24	50						N	drains roadside ditch/swale at hillslope base	filled with sediment 0.6 ft; inlet top bent; 10% plugged; no water present	filled with sediment 0.4 ft; 15% plugged	no well-defined channel
79	130+05	858+55	856+36	835+52	mb	24	24	52						N		filled with sediment 0.2 ft; open width 1.8 ft; 25% plugged with organics; no water present	filled with sediment 0.7 ft; 20% plugged; no water present	
80	136+02	864+51	862+33	841+48	mb	24	24	52						N		filled with sediment 0.4 ft; 1.5 ft width open; 25% plugged; no water present	filled with sediment 0.2 ft; 10% plugged; no water present	
81	138+70	867+10	864+92	844+10	mb	24	24	64			0.1			N	drains road ditch	clear of debris/sediment; no water present	filled with sand 1 ft; 50% plugged	
82	152+23	880+00	877+89	857+45	mb	36	36	98			1.7	2.5 (backwater effects)		Y	stagnate pool at inlet 15 ft x 15 ft x 1 ft depth	filled with organic sediment 0.4 ft; backwatered; standing water present	small amount of flowing water;	60 ft from outlet to Chilkat braid. Silty muck
83	160+50	888+25	886+29	865+88	mb	6'-1"x4'-7"	6'-1"x4'-7"	See surv.		Yes	see survey data	see survey data	Yes	Y	drains roadside ditch (2-15 ft width) created by excavation for road fill; ditch filled with 2 ft organicy silt; ditch supplied by high gradient stream (egg boxes)	good condition; see survey data	clear of sediment; small drop to outlet pool water surface; see survey data	short distance to Chilkat braid (<50 ft); adult chum present; redds observed at outlet
84	168+10	895+91	894+36	873+49	mb	24	24	68						Y	u/s bfw = 12 ft; backwatered; water present but no discernable flow; connects with 887+70 ditch	filled with 0.8 ft sediment; 1 ft width open; barely functional	filled with sediment 1.4 ft	small stagnate pool near outlet 3 ft x 3 ft; dead and dying juvenile coho present
85	187+25	915+15	911+92	890+91	mb	24	24	56			0.4	0.2		Y		clear of debris/sediment; flowing water draining ditchline	0.6 ft freefall to cobble riffle; 3.5 ft long riffle to pool; pool 0.8 ft depth; fish passage barrier at this flow	20 ft to confluence with Chilkat tributary
86	193+85	921+16	916+81	887+60	mb	36	36 (2)	See surv.	Stream realignment	Yes	see survey data	see survey data	Yes	Y	stream appears near bankfull	2 36 inch culverts; water level near stainline; appears to be spring fed system	gradient steepens above inlet pool; see survey data	E channel; see survey data
87		921+21	916+81	887+60	mb	36		see surv.		Yes			YES - S&HI	Y		One of two see above		
88	199+90	927+54	921+66	900+76	dm	24	24	60			none			N	drains roadside ditch	inlet slightly crimped; no stainline	undamaged; scour hole = 3 ft long x 3.5 ft wide x 0.7 ft depth	falls away steeply; filled with organic debris (leaves)
89	207+36	933+10	927+22	906+00	dm	24	24	62			none			N	drains roadside ditch	80% crimped; no stainline	15-20% plugged with organics; no scour pool	no d/s channel; slight swale
90	223+41	949+02	943+08	921+91	dm	24	24	52			none			N	drains roadside ditch	slightly crimped; no stainline; slight gravel build-up	slightly crimped; no scour pool	no discernable channel
91	239+38	965+08	959+14	937+97	dm	24	24	68			none			N	drains roadside ditch	inlet torn and crimped; no stainline; clear of debris/sediment	could not locate; buried by leaves, wood, or gravel	no discernable channel
92		973+53	967+58	946+42		18	18				none				drains roadside ditch, no flow	filled 0.7' with sand/organics, in good condition	outlet is buried by road widening fill material	
93	263+52	989+18	983+24	962+06	mb	8'-2"x5'-9"	8'-2"x5'-9"	see surv.		Yes	see survey data	see survey data	YES - S&HI	Y	debris flow; stream flowing in from south (re-routed to prevent frequent culvert plugging)	silt and cobble base (debris flow material); see survey data	see survey data	debris flow path
94	270+68	could not locate	could not locate			8'-2"x5'-9"		60						N/A				

Haines Highway - MP 3-25 Culvert Inventory

S&HI stationing
Multiple pipes
Big fish pipe
Small fish pipe

as-built summary field

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Stainline height above invert refers to low point of metal culvert; does not reference accumulations of material within pipe

Criteria used for determining if waters of the U.S.: drains stream, waterfall, or hillslope seeps; drains wetland or connected to wetland with evidence of flowing water; fish present.
If notes indicate lack of channel (downstream or upstream), then did not consider a Water of the U.S.

count	As-built	Centerline stationing			QA'd	Culvert	Culv Size	Culvert	As-Built	Eng. Survey	Height to Stainline at:			Waters of	Upstream	Inlet	Outlet	Downstream
09	Station	Design 9/2005	S&HI June/06	Design 10/2009		Size (in)		Length (ft)	Comment		inlet(ft)[1]	outlet(ft)[1]	fish bearing	the U.S.	conditions	Conditions	Conditions	conditions
95	274+68	1000+33	994+50	973+30	mb	9'-9"x6'-9"	9'-9"x6'-9"	see surv.		Yes	see survey data	see survey data	Unknown - S&HI	Y	debris flow; stream flowing in from north (re-routed to prevent frequent culvert plugging); main slide path to south	silt and cobble/boulder base (debris flow material; see survey data	see survey data	debris flow path
96	277+96	1003+55	997+82	976+60	dm	36	36	52			0.4			Y	drains north end of 21 mile fan and ditch	inlet slightly torn and crimped; slight gravel accumulation	slight obstruction by sapling; filled with sand 0.3 ft	discharges to road side drainate channel with cobble substrate
97	299+51	1025+15	1019+52	998+31	dm	24	24	48						n		80% filled with gravel from upstream headcut	d/s channel aggraded to above pipe crown; pressure flow has maintained a 1 x 2 ft opening	
98	309+20	1034+85	1029+22	1008+00	dm	36	36	54				0.5		Y	along relic debris flow channel; 50 x 75 ft excavated (trap) area at base of debris flow path	slightly crimped; nearly plugged by sediment	filled with sediment to 0.2 ft	discharges to Chilkat along 15 ft channel (filled with salmon bones)
99	321+76	1047+37	1041+78	1020+52	dm	24	24	60						N	possibly a relic debris flow path	obstructed by wood waste; area above possibly relic debris flow path	d/s channel aggraded to pipe crown; scour has kept outlet clear	no defined channel; 30 ft to Chilkat
100	339+68	1065+33	1059+68	1038+52	dm	24	24	60			0.6			Y	drains small waterfall area; active flow	Recent pipe; obstructed by veg and sediment	free discharge to Chilkat riprap bank	discharges direct to Chilkat bank
101	343+46	1069+11	1063+49	1042+32	dm	24	24	62			0.7			N	drains roadside ditch; wet but no flow	filled with debris 0.4 ft; slightly crimped; sump at inlet; excavated ditchline above crown	free discharge to Chilkat riprap bank	discharges direct to Chilkat bank
102	346+00	1071+64	1066+02	1044+85	dm	24	24	54			0.85	0.2		Y	adjacent ditch is wet seep; flowing water present	filled with gravel 0.5 ft; flowing water present	clear of debris; perched 0.1-0.2 ft; discharges to moderately steep channel to Chilkat; no Chilkat silt dep.	mod steep channel section to Chilkat
103	348+24	1073+85	1068+21	1047+05	dm	24	24	54				0.7		Y		filled with debris 1 ft; slightly crimped	filled with sediment 0.6 ft	short channel to top of Chilkat bank above siltation. Flowing water; a number of seeps.
104	350+43	1075+92	1070+30	1049+14	dm	24	24	62			0.6	0.2		Y		some gravel accumulation; flowing water present	clear of debris, has end section	mod steep channel to top of Chilkat bank; no siltation. Flowing water; a number of seeps.
105	352+50	1077+95	1072+31	1051+16	dm	24	24	56			1.1 stainline (0.3 rust line)			Y		rust line 0.3 ft; flowing water present; slight sediment accumulation	outlet apron direct to Chilkat bank	discharges direct to Chilkat bank approx 5 ft above veg line. Flowing water; a number of seeps. GW coming out of hillside.
106	355+09	1080+50	1074+92	1053+75	dm	24	24	64			0.5 (rust line)			Y	small waterfall u/s of inlet	inlet crimped; flowing water present	discharges to Chilkat riprap bank	discharges direct to Chilkat bank
107	360+08	1085+00	1079+88	1058+72	dm	24	24	52		could not locate				y				
108	372+75	1098+16	1092+52	1071+35	dm	24	24	50			0.8	0.9	no access - S&HI	Y		filled with gravel 0.25 ft; water depth 0.3 ft above gravel	no outlet apron	steep channel. Active water flow.
109	380+94	1106+38	1100+68	1079+57	dm	24	24	56			0.2			Y	small waterfall direct to inlet	slightly crimped; filled with gravel 0.1-0.2 ft	1/2 filled with gravel and rock	discharges to waterfall to Chilkat River
110	383+11	1108+56	1102+85	1081+75	dm	24	24	54			0.3			Y	active flow from seeps	undamaged and clear of debris; flowing water present	obstructed by organics - no adequate flushing flow	discharges to steep cascade (1:1) to Chilkat
111	397+60	1123+05	1117+35	1096+25	dm	24	24	54				0.2		Y	drains waterfall/seeps aloing debris flow path	obstructed by rocks and veg to 1.6 ft; undamaged	undamaged; clear of debris	discharges to steep bank waterfall 1.8 ft to gully
112	403+58	1129+00	1123+25	1102+19		36	36	see surv.		Yes	see survey data	see survey data	YES - S&HI	Y	small stream; very little flow	good condition; see survey data	good condition; see survey data	small channel; area has been heavily altered
113	403+62					36		66						Y				paired with 1129 culvert
114	418+59	could not locate	could not locate			36		64						N/A				
115	420+79	could not locate	could not locate			36		60						N/A				
116	454+17	could not locate	could not locate			24		56						N/A				
117	466+88	1192+33	1186+58	1165+44	dm	24	24	62			none	none		N	drains roadside ditch (dry)	good condition; no stainline	moss in bottom 0.3 ft; no stainline	no defined d/s channel
118	472+18	1197+66	1191+92	1170+78	dm	24	24	64						N	drains ditch (dry)	crimped; 50% obstructed; inlet perched 0.5 ft above ditch	some organics in bottom; good condition; possibly a recent extension; no stainline	
119	476+64	could not locate	could not locate			24		60						N/A				
120	480+47	1206+60	1200+73	1179+75		About 13'	About 13'	see surv.		Yes	see survey data	see survey data	Unknown - S&HI	Y	large debris flow path; stream and debris flow path to north of inlet; excavated sediment trap at base of debris path; see survey data	concrete base; flowing water present; sheet flow over inlet apron; approx half of width with silt/cobble debris flow material; machinery able to drive through to clear culvert; see survey data	concrete base; approx half of width with silt/cobble debris flow material	debris path; see survey data

Haines Highway - MP 3-25 Culvert Inventory

S&HI stationing
Multiple pipes
Big fish pipe
Small fish pipe

as-built summary field

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count	As-built	Centerline stationing			QA'd	Culvert	Culv Size	Culvert	As-Built	Eng. Survey	Height to Stainline at:				Upstream	Inlet	Outlet	Downstream
09	Station	Design 9/2005	S&HI June/06	Design 10/2009		Size (in)		Length (ft)	Comment		inlet(ft)[1]	outlet(ft)[1]	fish bearing	Waters of the U.S.	conditions	Conditions	Conditions	conditions
121	488+60	1214+20	1208+26	1187+25		8'-2"x5'-9"	8'-2"x5'-9"	see surv.		Yes	see survey data	see survey data	Unknown - S&HI	Y	large sediment trap excavated u/s of inlet; large headcut at base of debris flow path; see survey data	partially obstructed with fill material from maintenance; no water present	perched; no water present; see survey data	debris path; see survey data
122	511+95	could not locate	could not locate			24		56						N/A				
123	536+93	not surveyed	not surveyed			24	24	54						N				floopplain relief only
124	537+89	1263+00	1259+44	1238+45	dm	24	24	58			none			N		no slope; north end slightly crimped; no stainline; pipe likely to equalize floodplain flood waters on either side of road embankment		

23.2 *Hydrology - Table of flow estimates for tributary basins.*

Flow estimates include those obtained by: 1) USGS regional regression equations, 2) SCS Unit Hydrograph Method, and 3) the Rational Method. The estimates from the USGS regional regression estimates are the recommended flow estimates for flood conveyance and fish passage design assessments.

	Culvert Station										
Return Period	**222+51 (0.47mi^2)**	**319+13 (0.6 mi^2)**	**324+79 (1.23mi^2)**	**483+18 (1.07 mi^2)**	**512+24 (1.46 mi^2)**	**589+12 (0.65 mi^2)**	**647+20 (1.75 mi^2)**	**710+75 92.26 mi^2)**	**865+88 (0.8 mi^2)**	**887+60 (1.55 mi^2)**	**1102+19 (1.26 mi^2)**
2-Year											
Regional Regression	42	50	92	76	73	52	96	125	55	95	73
SCS Unit Hydrograph Method	119	141	304	333	397	196	471	637	294	558	496
Rational Method	37	48	98	86	117	52	140	181	64	124	101
5-Year											
Regional Regression	64	75	137	113	107	78	142	186	82	141	109
SCS Unit Hydrograph Method	250	295	628	603	714	358	851	1,137	451	857	693
Rational Method	47	60	124	108	147	66	177	228	81	156	127
10-Year											
Regional Regression	79	93	169	139	130	96	174	228	101	175	135
SCS Unit Hydrograph Method	274	323	689	670	793	398	946	1,263	531	1,009	817
Rational Method	56	71	147	129	175	78	210	272	96	186	152
25-Year											
Regional Regression	99	117	212	175	166	121	220	288	127	219	170
SCS Unit Hydrograph Method	357	422	898	905	1,070	537	1,276	1,704	677	1,286	1,041
Rational Method	64	82	169	147	201	90	241	312	110	213	174
50-Year											
Regional Regression	114	135	246	203	193	140	255	334	148	255	198
SCS Unit Hydrograph Method	429	507	1,079	1,003	1,187	596	1,416	1,890	760	1,445	1,169
Rational Method	69	88	180	158	215	96	258	333	118	228	186
100-Year											
Regional Regression	130	154	280	232	220	160	291	381	169	291	227
SCS Unit Hydrograph Method	471	556	1,183	1,120	1,325	665	1,580	2,109	833	1,583	1,281
Rational Method	74	95	196	171	234	104	280	362	128	247	202

23.3 Drawings

State of Alaska Department of Transportation and Public Facilities

Haines Highway - MP 3.5 to MP 25.3
Hydrology and Hydraulic Summary
Chilkat River and Select Tributaries

STATE OF ALASKA VICINITY MAP

SHEET INDEX

DRAFT
NOT FOR CONSTRUCTION

NO.	BY	DATE	REVISION DESCRIPTION

RP	DM	DM,MS
DRAWN	DESIGNED	CHECKED
DM	10/28/09	
APPROVED	DATE	PROJECT

State of Alaska Department of Transportation and Public Facilities – Haines, Alaska
Haines Highway – MP 3.5 to 25.3

Prepared By: Inter-Fluve, Inc.

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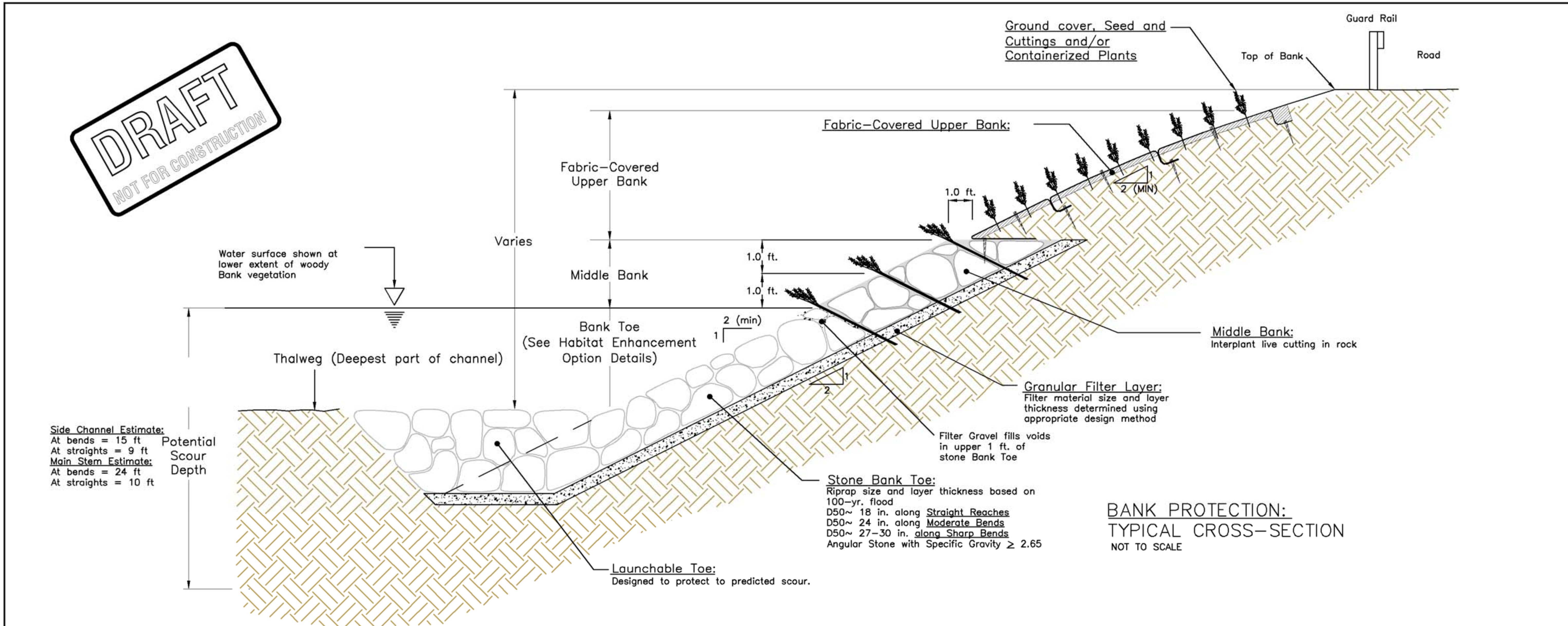
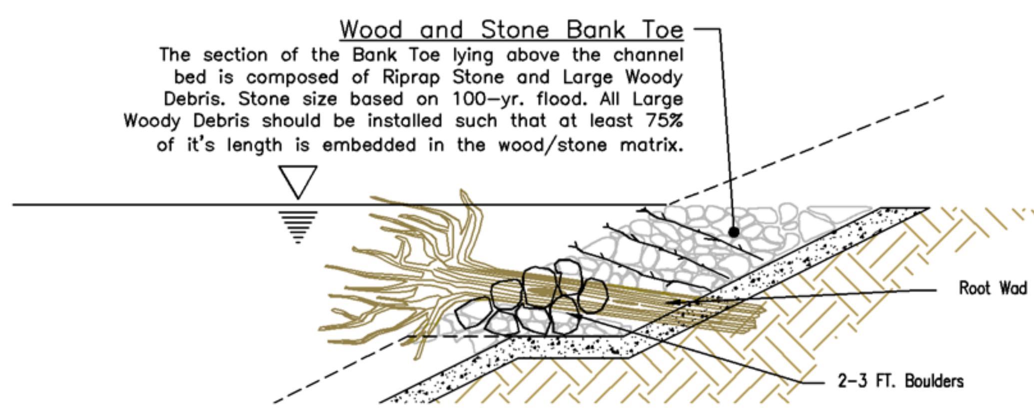
Hood River, OR 97031
541.386.9003
www.interfluve.com

Hydrology and Hydraulics Vicinity Map and Sheet Index

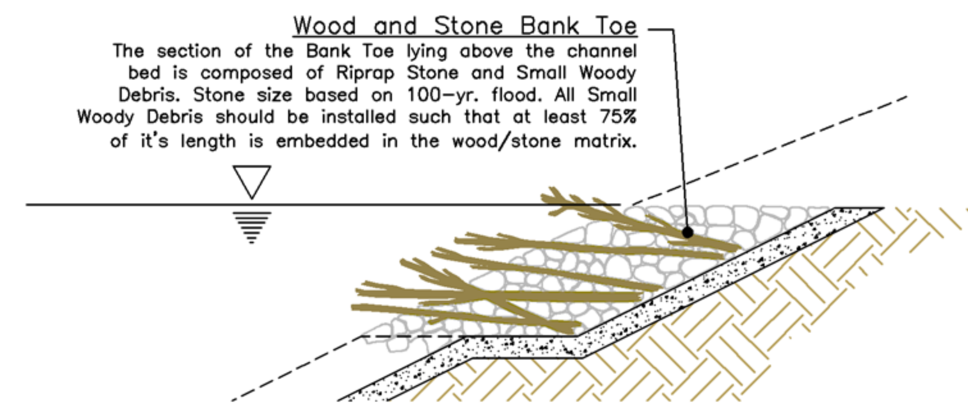
SHEET 1 OF 13



BANK PROTECTION:
TYPICAL CROSS-SECTION
NOT TO SCALE



1. LARGE WOODY DEBRIS



2. SMALL WOODY DEBRIS

BANK TOE HABITAT ENHANCEMENT OPTIONS
These options recommended only along straight reaches, not at outside of bends.

NO.	BY	DATE	REVISION DESCRIPTION

RP DRAWN	DM DESIGNED	DM,MS CHECKED
DM APPROVED	10/28/09 DATE	PROJECT

State of Alaska Department of Transportation and Public Facilities – Haines, Alaska
Haines Highway – MP 3.5 to 25.3

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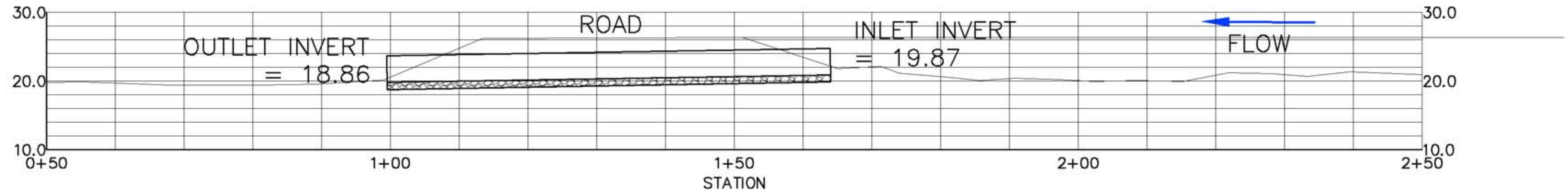
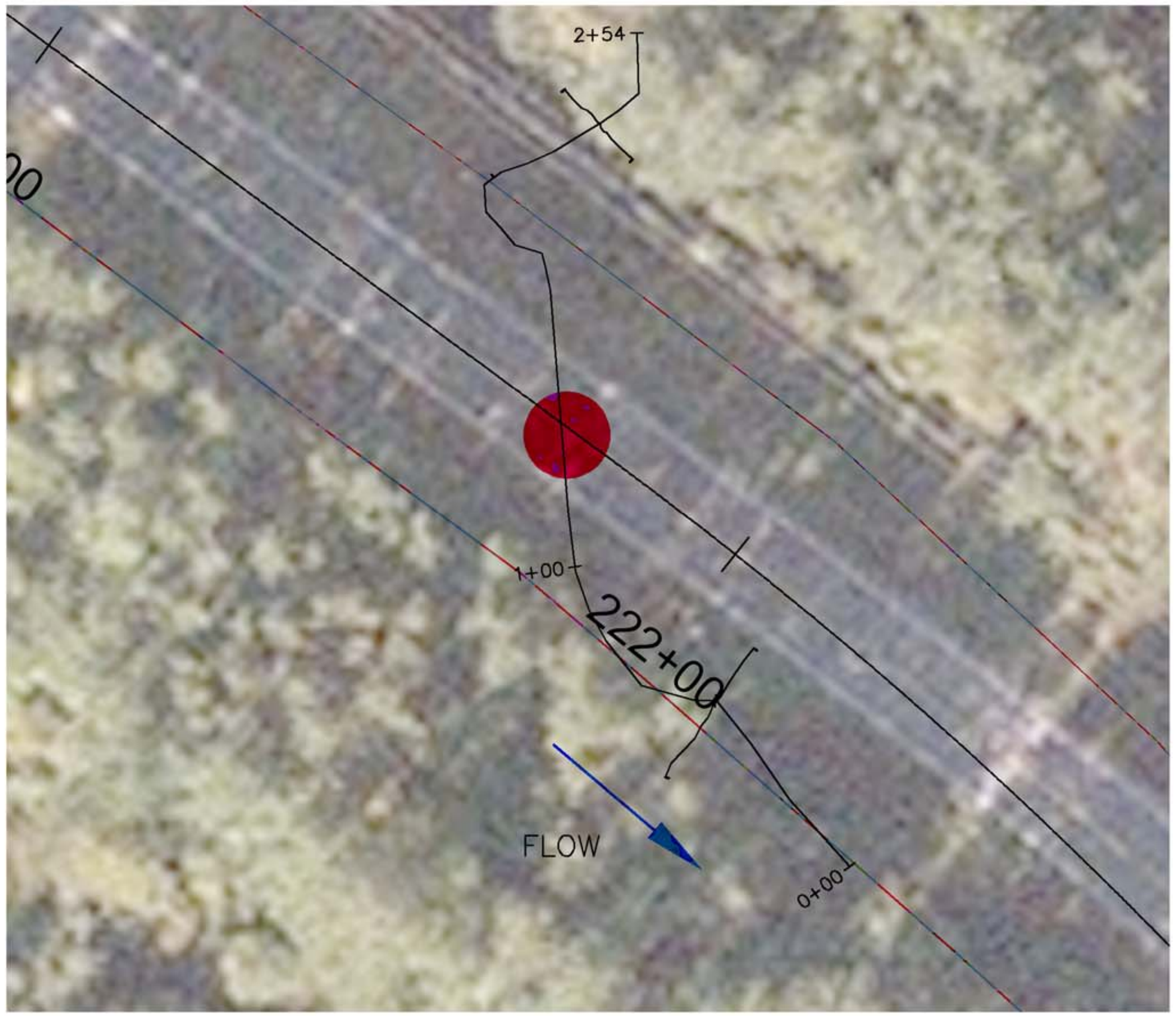
Chilkat River – Biotechnical Bank Protection Concepts

SHEET 2 OF 13



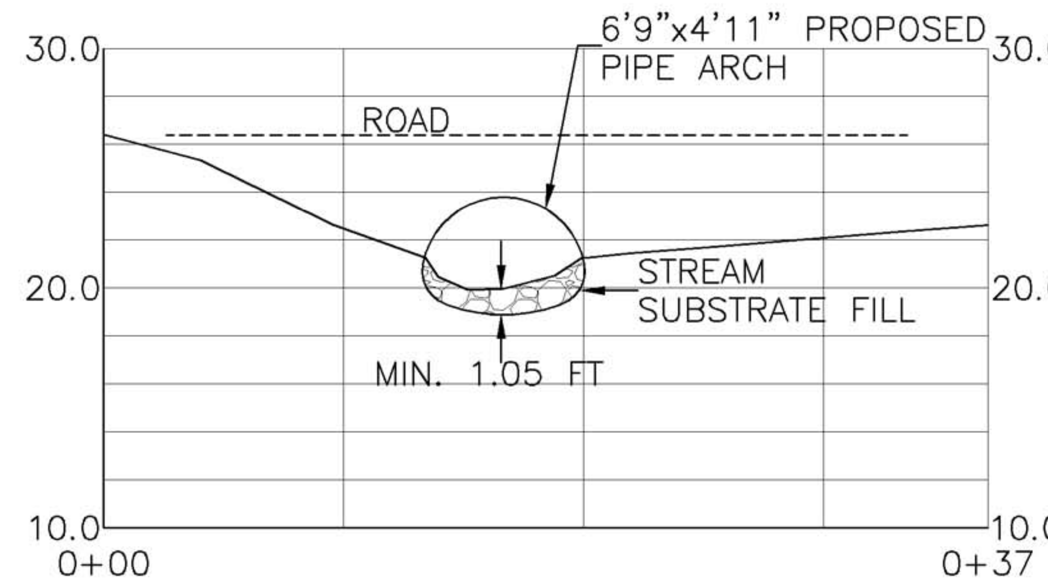
CHANNEL PROFILE



PLAN VIEW

0 40 80

SCALE IN FEET



REPRESENTATIVE SECTION VIEW

DRAFT
NOT FOR CONSTRUCTION

NOTE:
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DRAWN	DESIGNED	CHECKED
DM	10/28/09	
APPROVED	DATE	PROJECT

State of Alaska Department of Transportation and Public Facilities – Haines, Alaska
Haines Highway – MP 3.5 to 25.3

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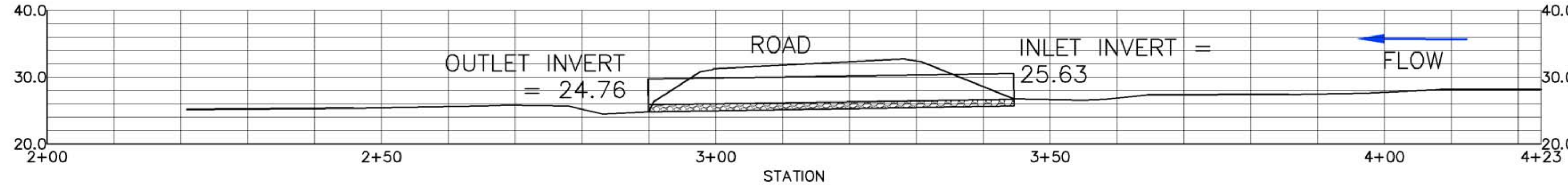
Hood River, OR 97031
541.386.9003
www.interfluve.com

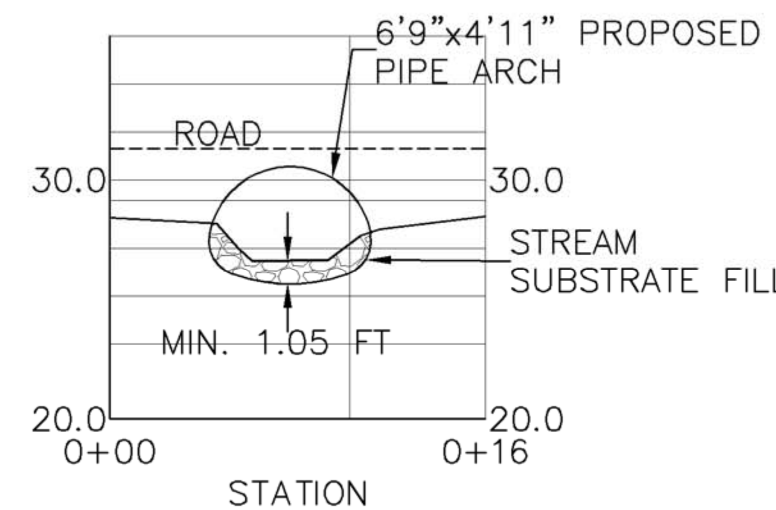
Culvert Analysis STA 222+51
Plan View, Section and Profile

SHEET
3 OF 13



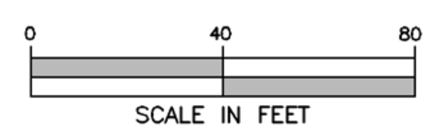
CHANNEL PROFILE

PLAN VIEW



REPRESENTATIVE SECTION VIEW

DRAFT
NOT FOR CONSTRUCTION



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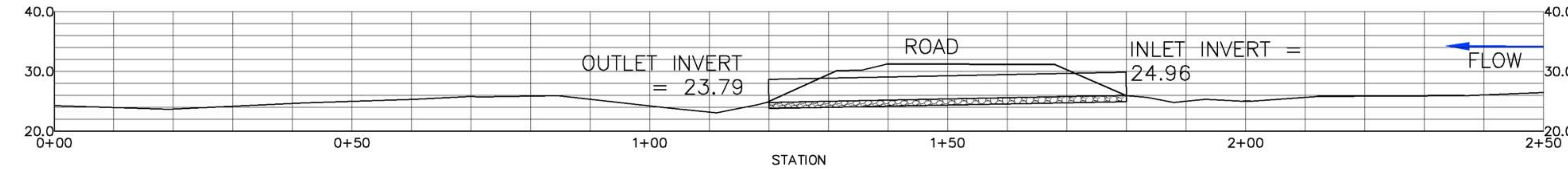
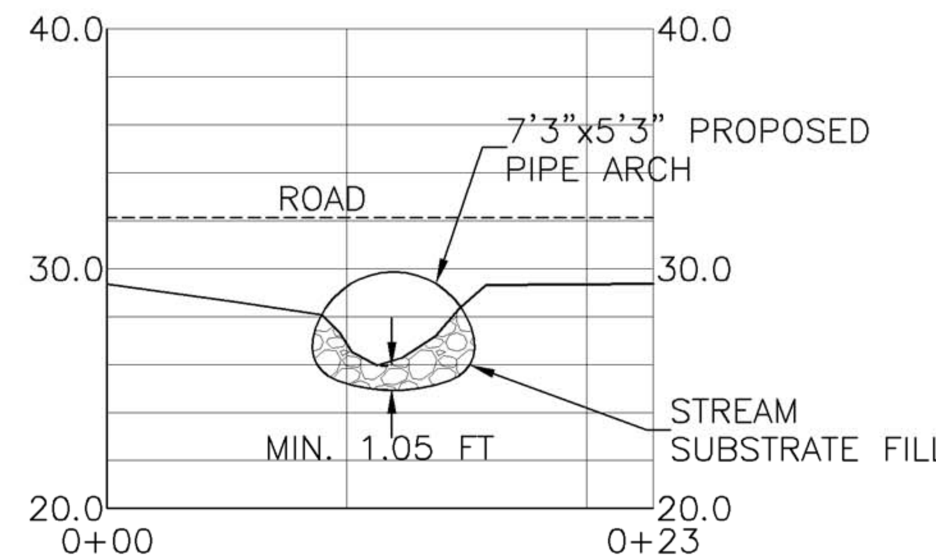
Culvert Analysis STA 319+13
Plan View, Section and Profile

SHEET
4 OF 13



CHANNEL PROFILE

PLAN VIEW



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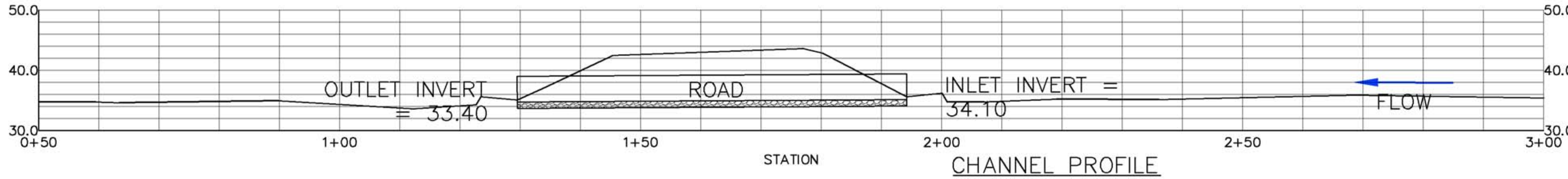
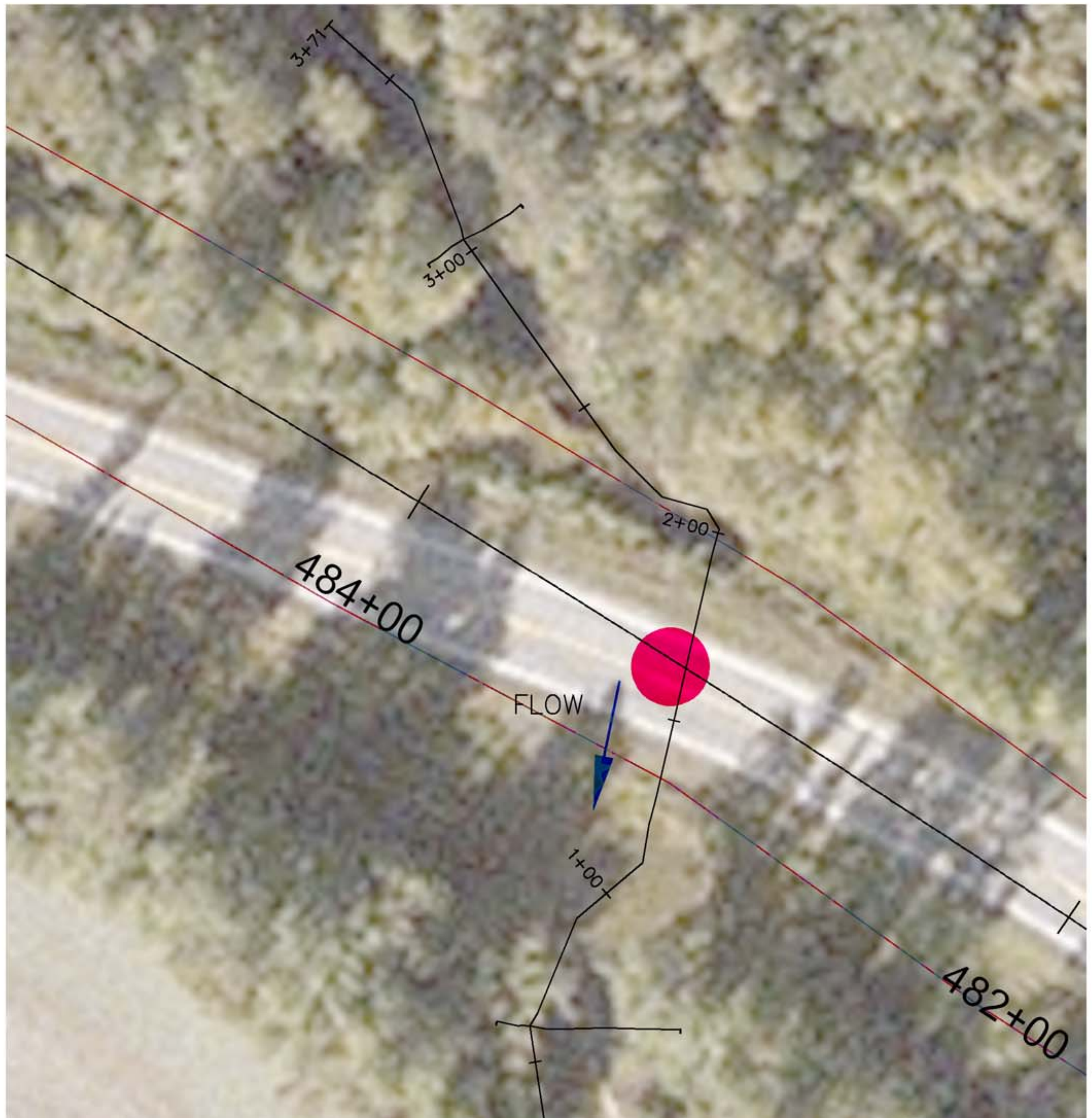
Culvert Analysis STA 324+79
Plan View, Section and Profile

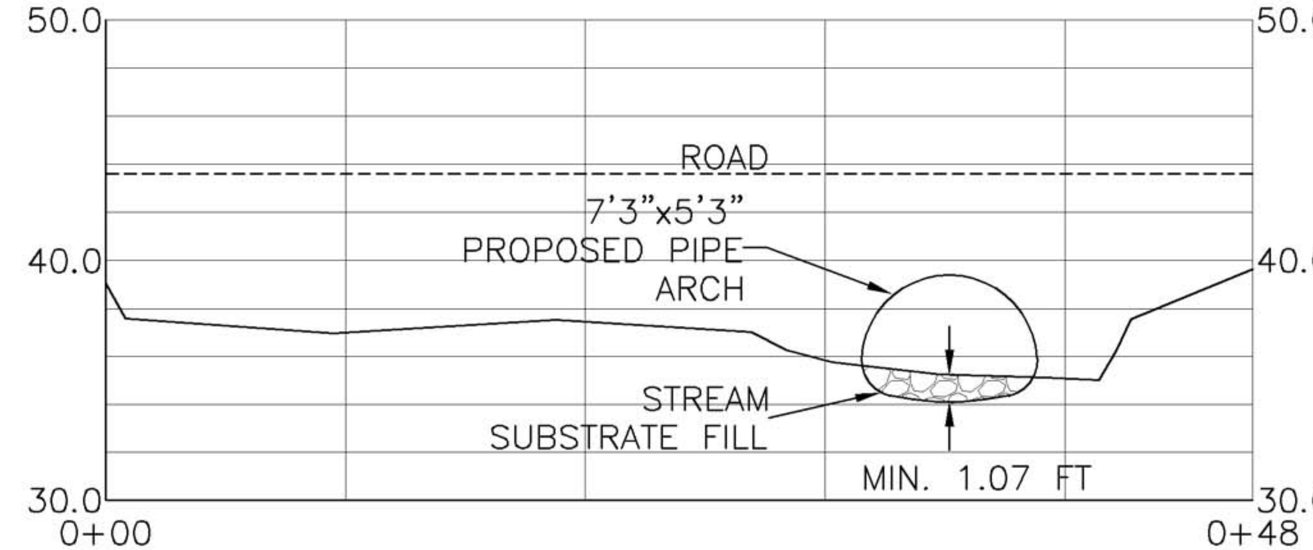
SHEET 5 OF 13



CHANNEL PROFILE



PLAN VIEW



REPRESENTATIVE SECTION VIEW

SCALE IN FEET (0, 40, 80)

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Haines Highway – MP 3.5 to 25.3

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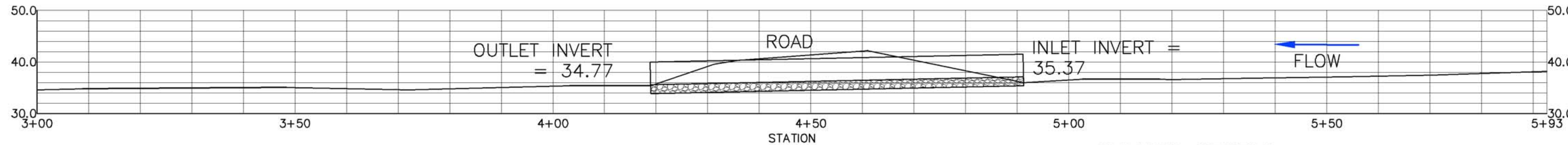
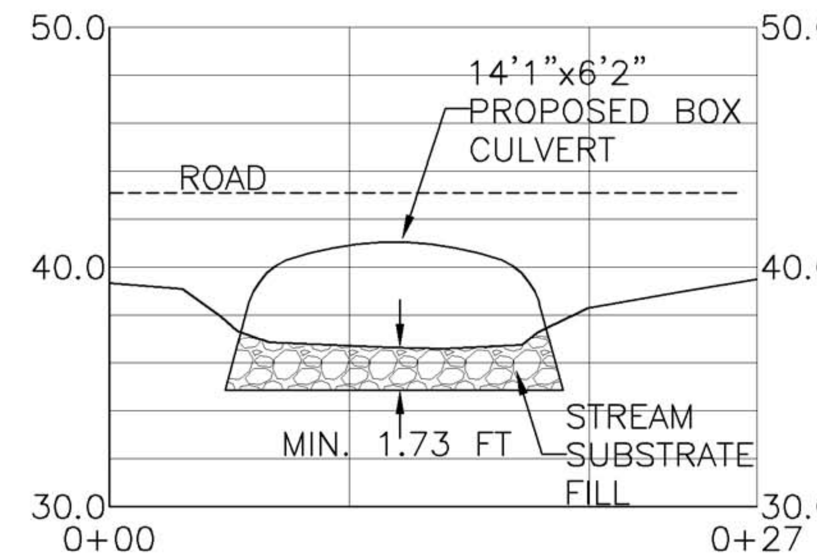
Culvert Analysis STA 483+18
Plan View, Section and Profile

SHEET 6 OF 13



CHANNEL PROFILE

PLAN VIEW



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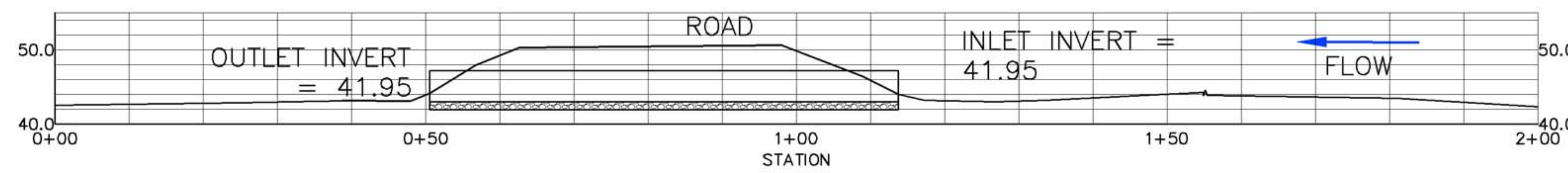
Culvert Analysis STA 512+24
Plan View, Section and Profile

SHEET
7 OF 13



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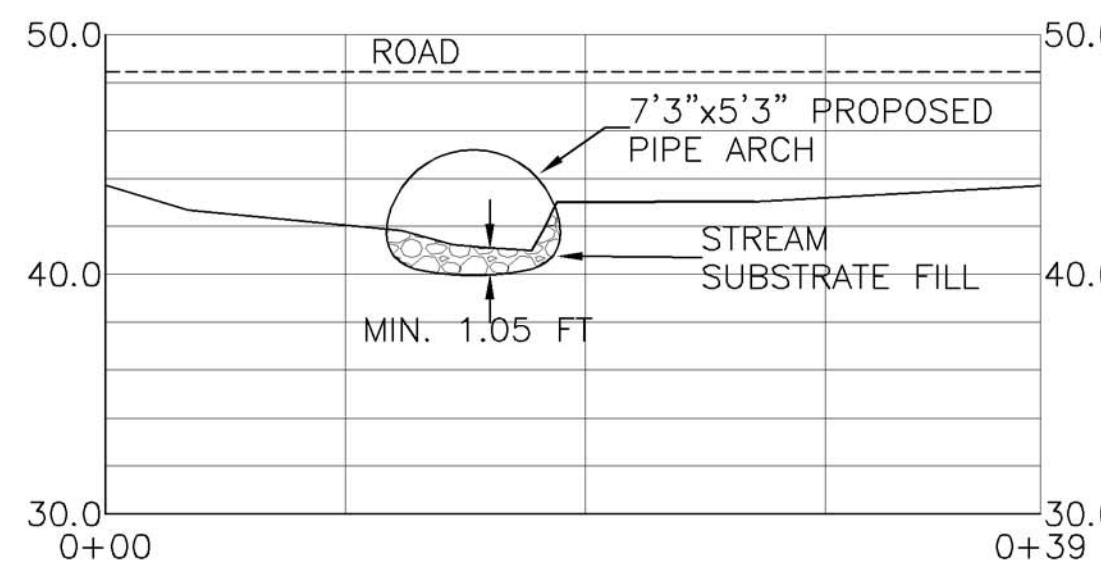

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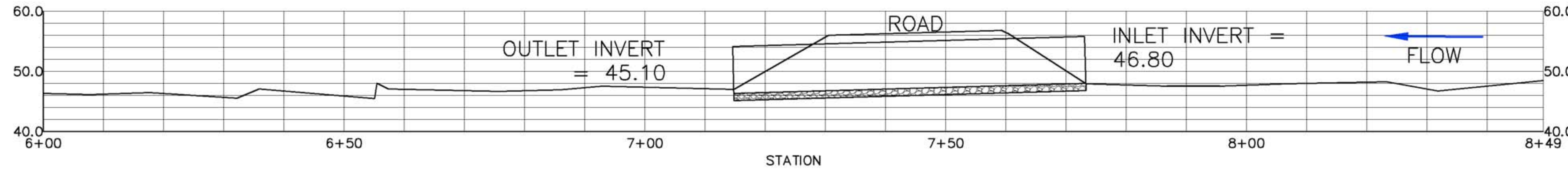
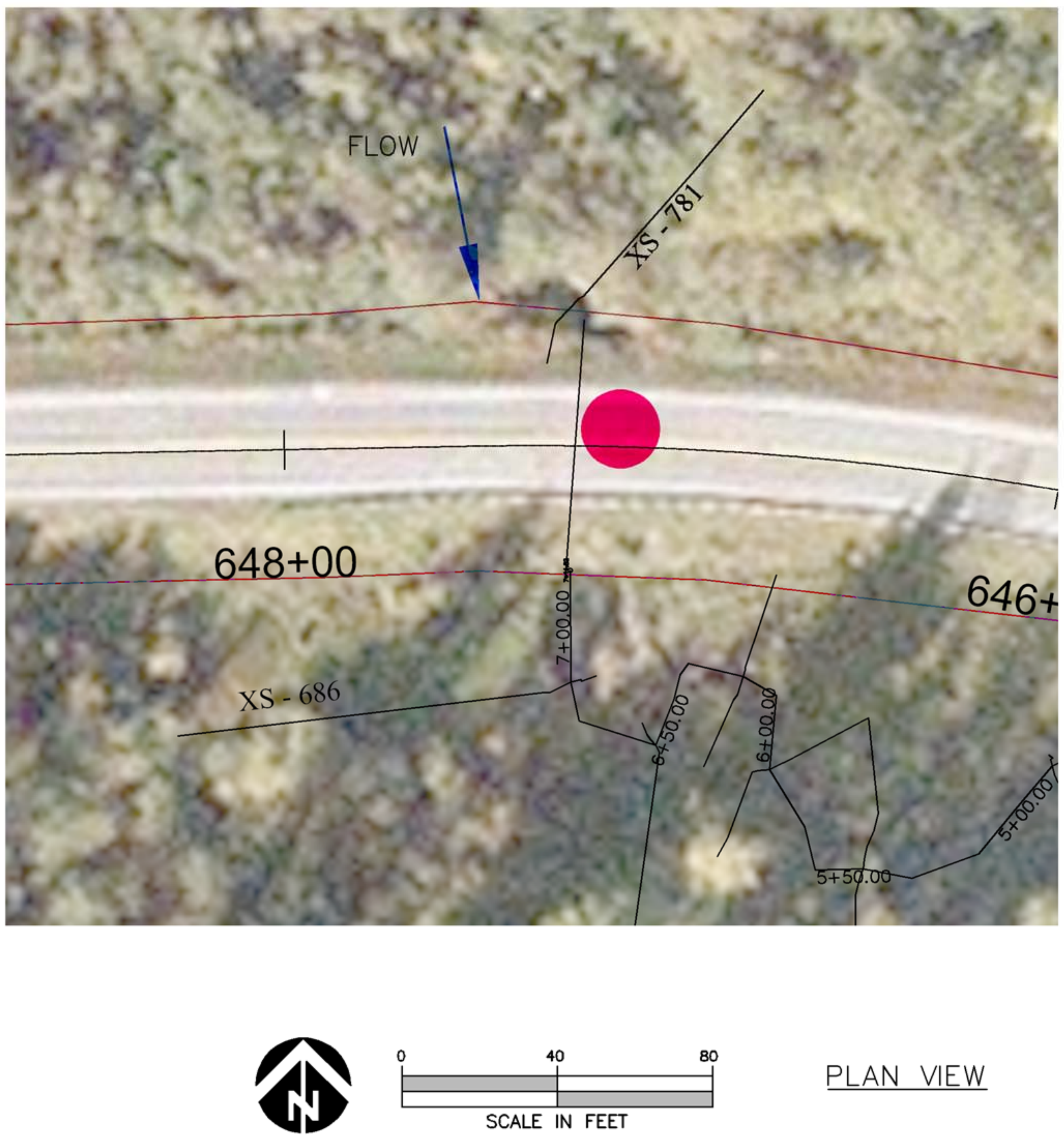
Culvert Analysis STA 589+12
Plan View, Section and Profile

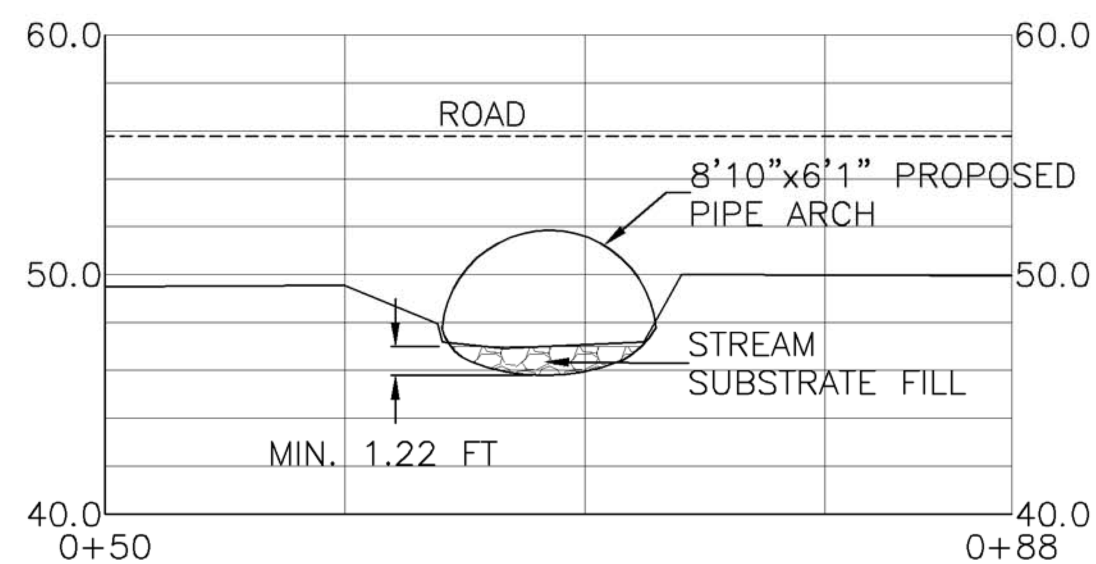
SHEET 8 OF 13



CHANNEL PROFILE



PLAN VIEW



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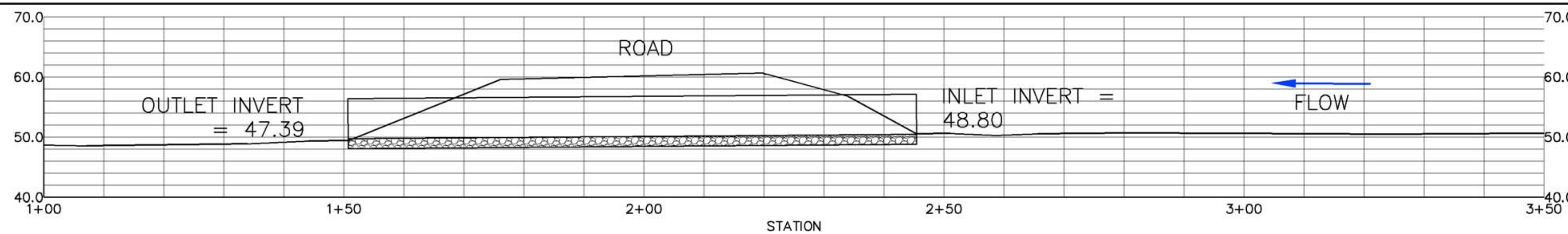
Culvert Analysis STA 647+20
Plan View, Section and Profile

SHEET 9 OF 13



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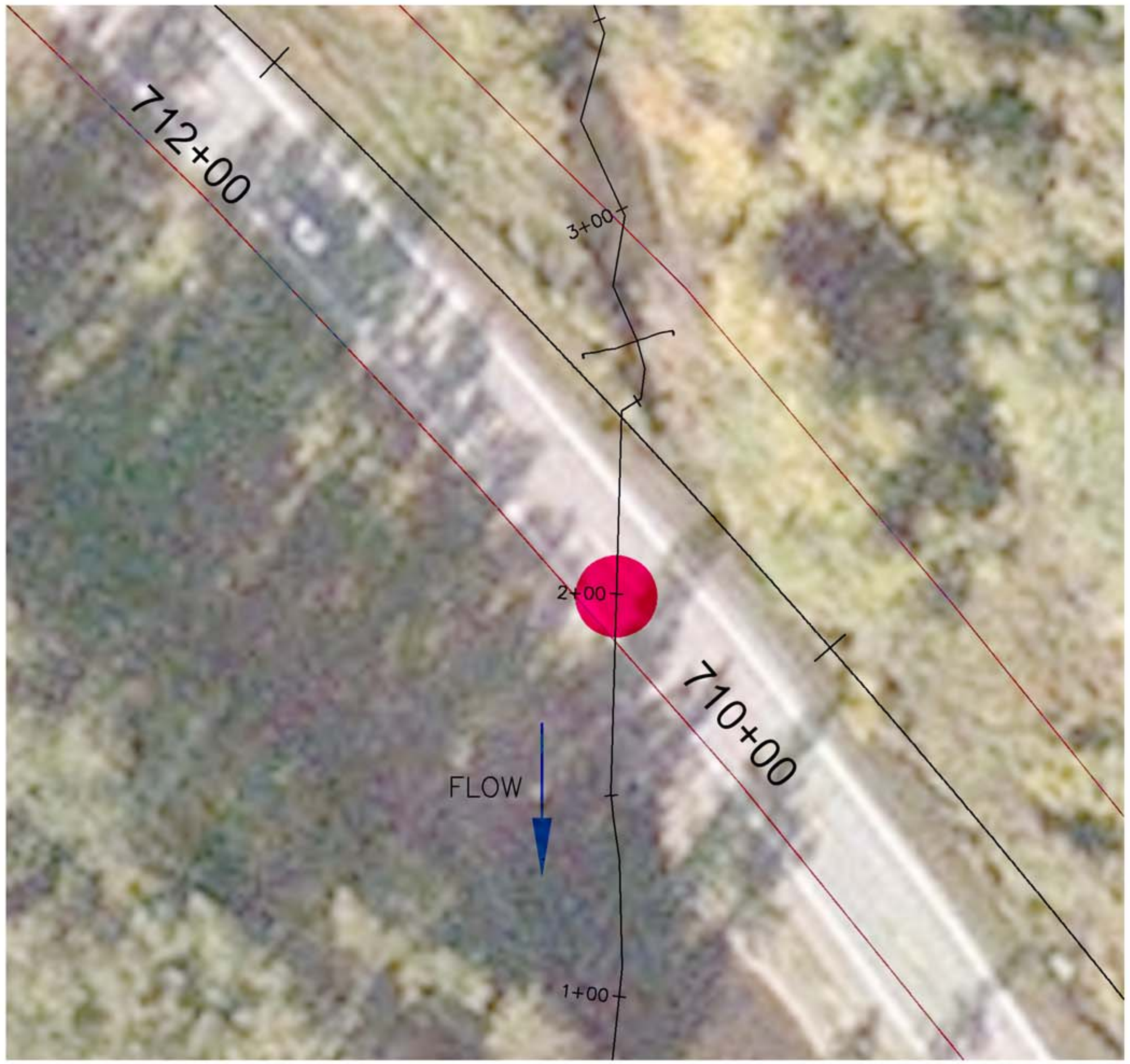

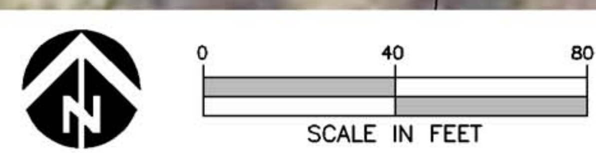

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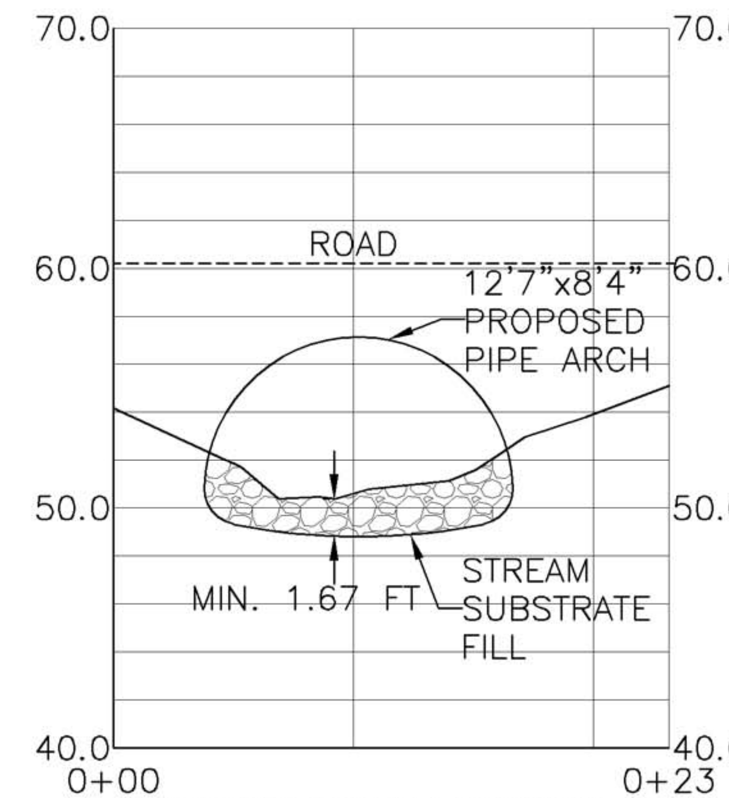

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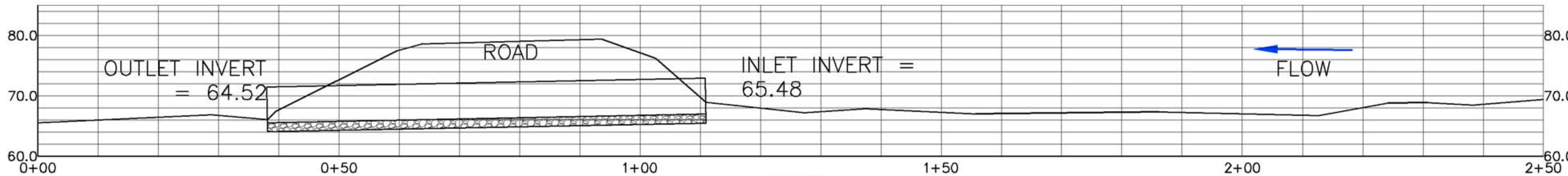
Culvert Analysis STA 710+75
Plan View, Section and Profile

SHEET 10 OF 13



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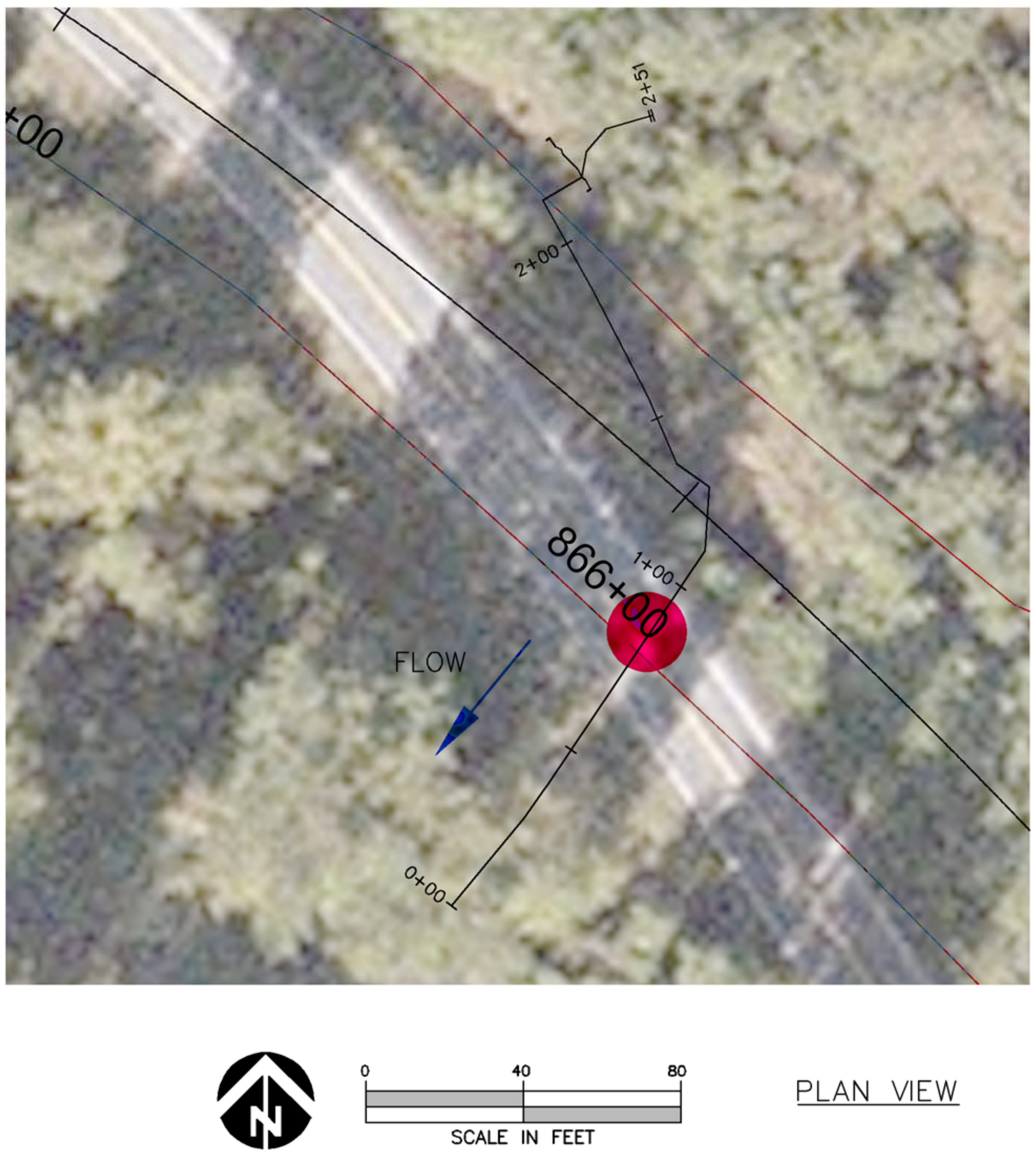

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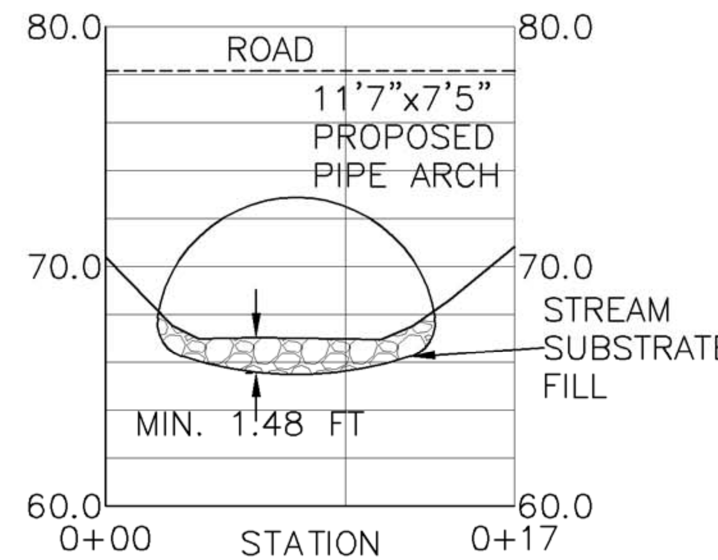

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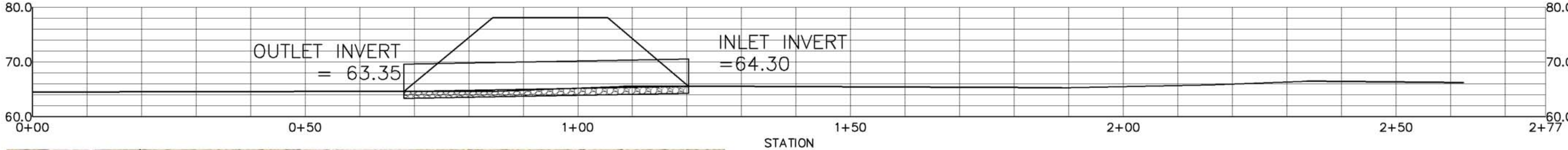
Culvert Analysis STA 865+88
Plan View, Section and Profile

SHEET
11 OF 13



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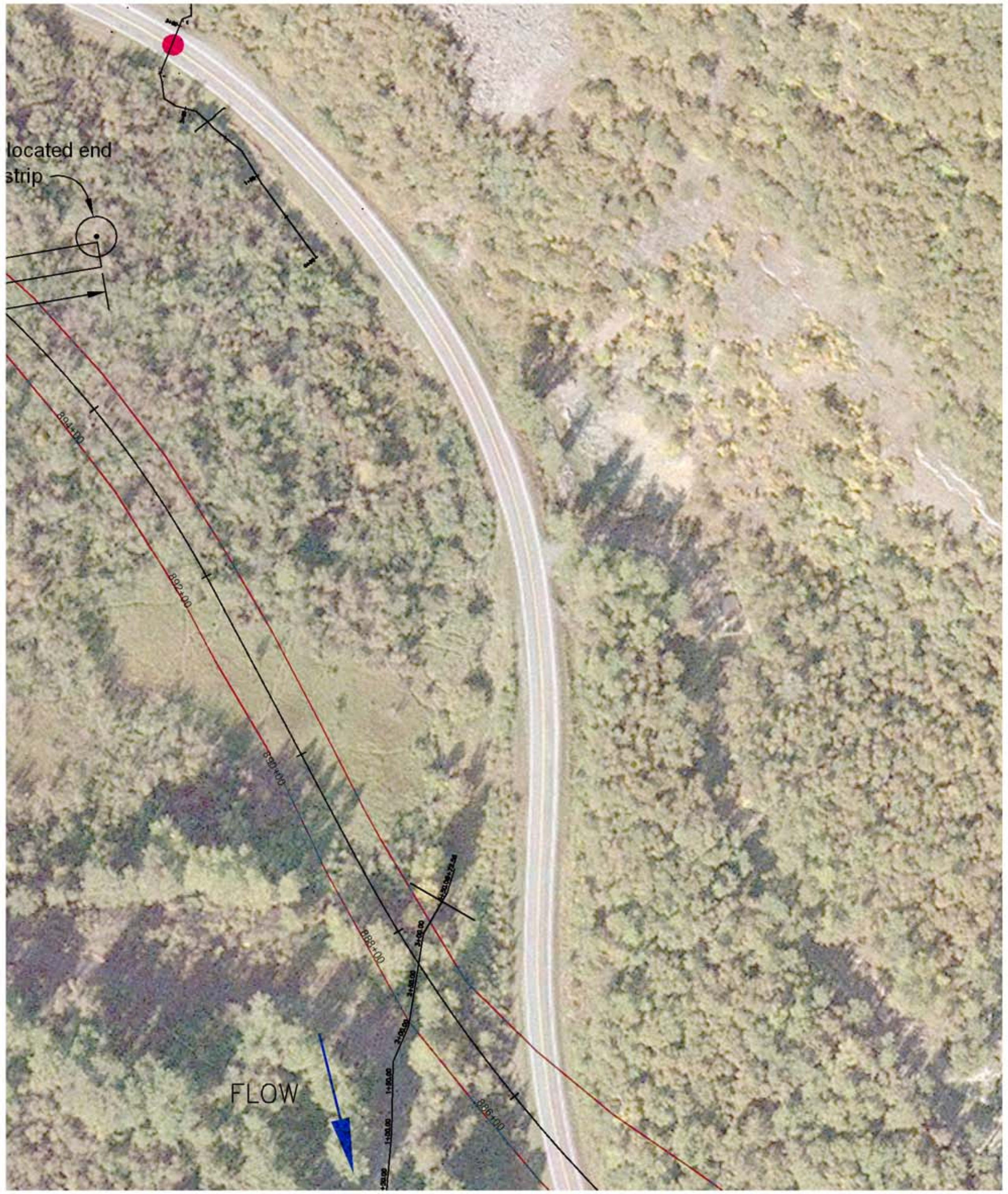

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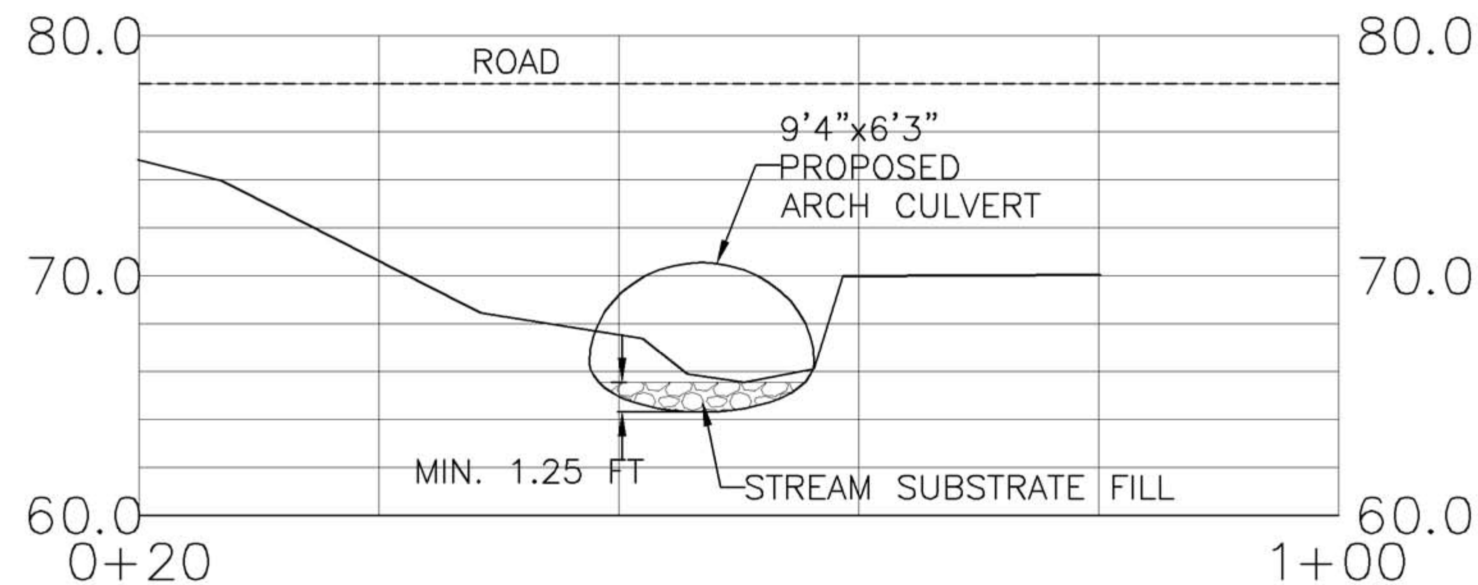

REPRESENTATIVE SECTION VIEW

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0 100 200
SCALE IN FEET

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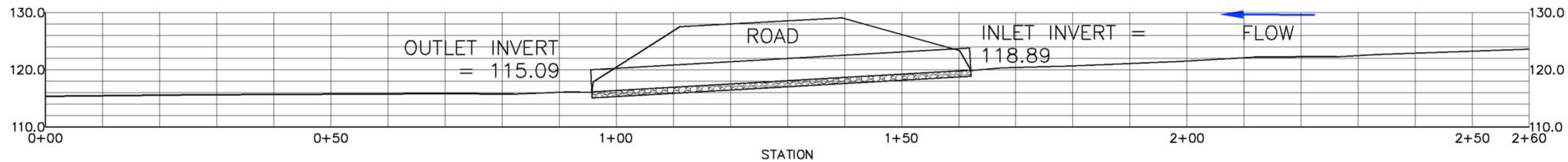
Culvert Analysis STA 887+60
Plan View, Section and Profile

SHEET
12 OF 13



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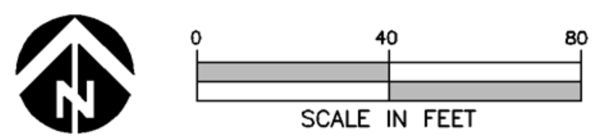

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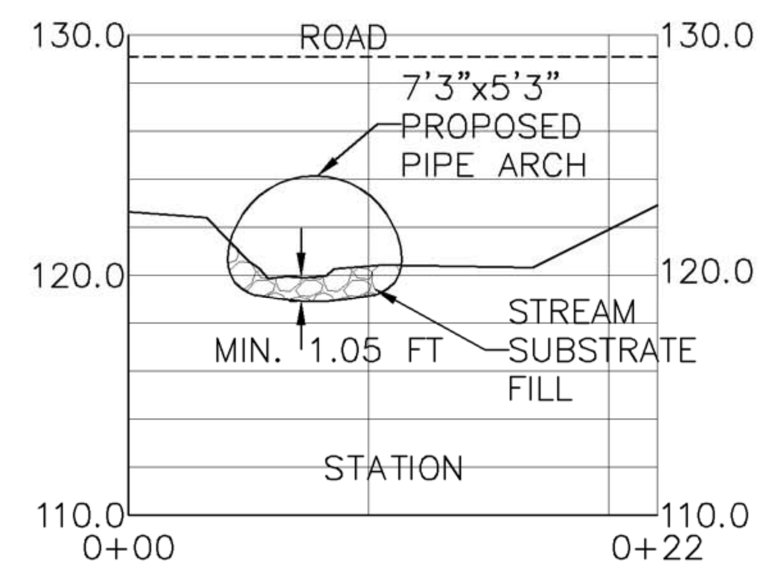

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Culvert Analysis STA 1102+19
Plan View, Section and Profile

SHEET 13 OF 13

23.4 Culvert Summary

Haines Hwy H&H report - Culvert summary

October 30, 2009

Ref: Handbook of Steel Drainage & Highway Construction Products, 1983, AIS

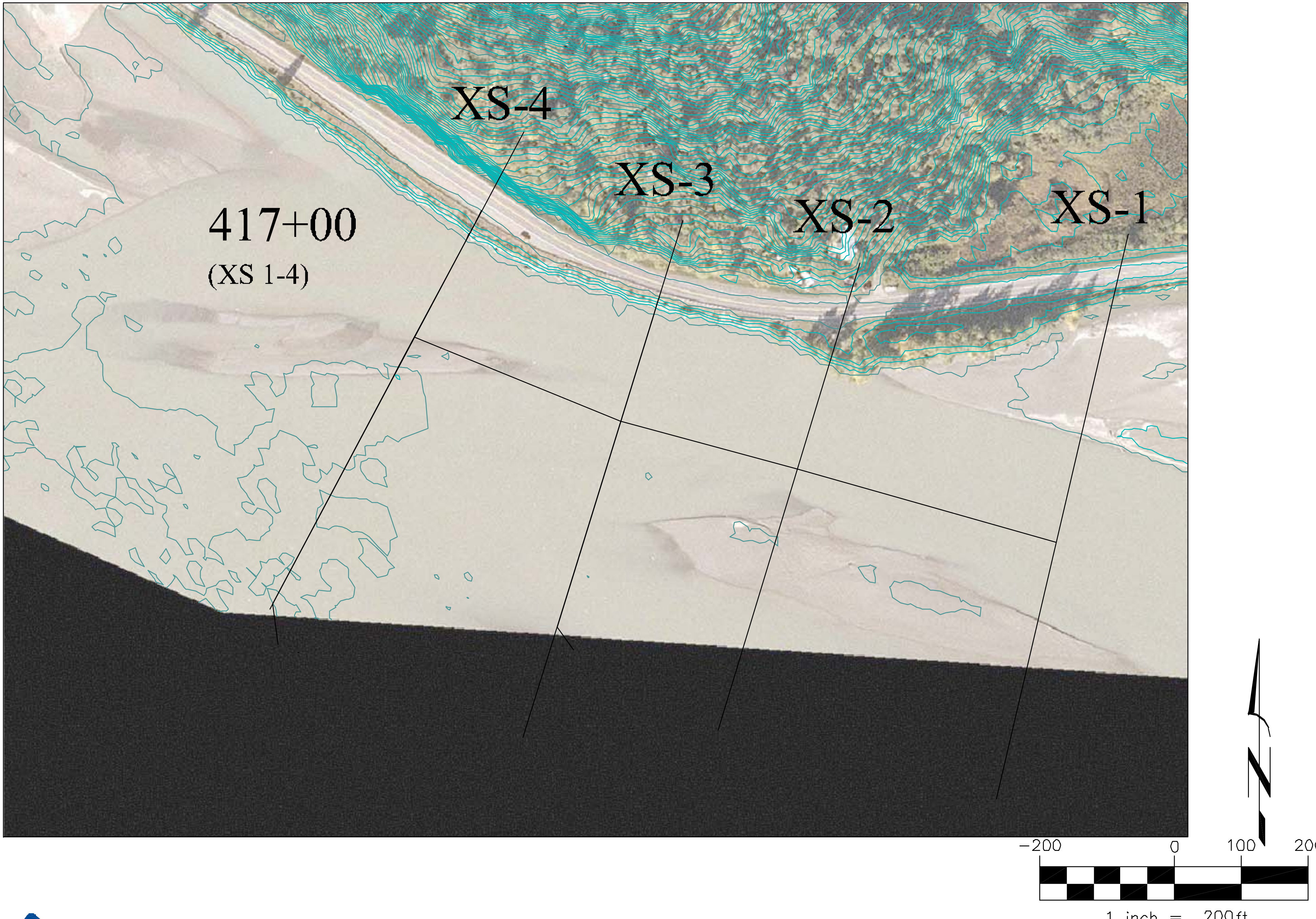
0.20*rise (pipe arch)

Station	Station	Prop. Road	~ Cover (ft)	cover (H 20 Live load)			Length	Pipe Invert - (Preliminary design)			min bury	bury	50-yr	Proposed design										
S&HI - 2006	2009	CL elev	based on prop rd elev	min (in)	max (ft)	Table	(ft)	inlet	outlet	datum	depth	depth	HW/d	method	Design fish	justification	Wch	Dch	- method	Comment	span	rise	size	type
245+50	222+51	29.14	4.35	12	17	HC-8	85	19.87	18.86	~dot&pf datum	0.98	1.05	1.02	tier 1		habitat	6.0		total station		6.75	4.92	6'-9"x4'-11"	pipe arch
342+00	319+13	31.39*	**	12	17	HC-8	65	25.63	24.76	~dot&pf datum	0.98	1.05	1.16	tier 1		habitat	4.6		total station		6.75	4.92	6'-9"x4'-11"	pipe arch
347+50	324+79	32.11	1.90	12	17	HC-8	63	24.96	23.79	~dot&pf datum	0.98	1.05	1.08	tier 1		habitat	6.3		total station		7.25	5.25	7'-3"x5'-3"	pipe arch
506+25	483+18	42.28	2.93	12	17	HC-8	67	34.10	33.40	~dot&pf datum	1.07	1.05	1.29	tier 1		habitat	7.2		total station		7.25	5.25	7'-3"x5'-3"	pipe arch
535+25	512+24	43.14	1.61	16.9	5	T1-31	64	35.37	34.77	~dot&pf datum	1.23	1.73	<1.0	tier 1		habitat	13.8		total station		14.083	6.167	14'-1"x6'-2"	alum box
														--			--		--				--	--
612+50	589+12	50.12	2.92	12	17	HC-8	64	41.95	41.95	dot&pf	1.07	1.05	1.05	tier 1		habitat	5.3		total station		7.25	5.25	7'-3"x5'-3"	pipe arch
														--			--		--				--	--
670+00	647+20	56.45	3.56	18	13	HC-11	59	46.8	45.1	dot&pf	1.22	1.22	1.15	tier 1		habitat, sediment & de	8.5-9.3		total station		8.83	6.083	8'-10"x6'-1"	pipe arch
														--			--		--				--	--
731+00	710+75	61.34*	**	24	6	HC-11	98	48.8	47.39	dot&pf	1.67	1.67	<1.0	tier 1		habitat	14.0		total station		12.58	8.33	12'-7"x8'-4"	pipe arch
														--			--		--				--	--
886+00	865+88	76.49	4.58	24	16	HC-8	72	64.48	63.52	dot&pf	2.48	2.48	<1.0	tier 1		habitat	12.6		total station		11.58	7.42	11'-7"x7'-5"	pipe arch
908+50	887+60	77.97	7.42	18	12	HC-11	65	64.3	63.35	dot&pf	1.25	1.25	1.17	tier 1	juv coho	habitat	8.3		total station		9.33	6.25	9'-4"x6'-3"	pipe arch
														--			--		--				--	--
983+25	962+06						debris flow							debris flow					total station				debris flow	
994+50	973+30						debris flow							debris flow					total station				debris flow	
1123+25	1102+19	128.74	4.60	12	17	HC-8	90	118.89	115.09	dot&pf	1.05	1.05	1.46	tier 1		habitat	6.0		total station		7.25	5.25	7'-3"x5'-3"	pipe arch
1200+60	1179+75						debris flow							debris flow					total station				debris flow	
1208+20	1187+25						debris flow							debris flow					total station				debris flow	
Smaller fish pipes												**comment 1**	**comment 2**											
252+00	228+95	28.82	4.53	12	99	HC-1	63	22.29	21.43	dot&pf	0		no baffles	tier 2 (no bfl)	juv coho	Lo S, FISHPASS	*3.0*	*1.0*	*hand- d/s*		2	2	2	cmp
263+50	240+38	28.24	3.58	12	99	HC-1	66	22.66	21.49	dot&pf	0		no baffles	tier 2 (no bfl)	juv coho	Lo S, FISHPASS	*2.0*	*1.0*	*hand- d/s*		2	2	2	cmp
268+90	245+19	28.22	2.58	12	62	HC-1	61	21.64	20.11	dot&pf	1.6			tier 1			2.0	0.7	hand- d/s	4ft: Q(t1)>Q(ex)	4	4	4	cmp
271+40	248+45	27.42	3.15	12	66	HC-1	64	21.27	21.00	dot&pf	1.2			tier 1			3.0	1.0	hand- d/s	3ft: Q(t1)>Q(ex)	3	3	3	cmp
316+00	292+90	29.50*	**	12	62	HC-1	60	27.23	25.55	dot&pf	0	u/s pool excvt'd after 11/05	0.15D baffles	tier 2 - baffled pipe	Adult (& juv) coho	BW~12-ft	flooded		DOT	4ft: Q(t1)>Q(ex)	4	4	4	cmp
														--			--		--				--	--
337+70	314+72	30.83*	**	12	66	HC-1	56	28.20	27.33	dot&pf	0	u/s pool excvt'd after 11/05	no baffles - Juv p	tier 2 (no bfl)	Adult (& juv) coho	BW~10-ft	4.3	0.8	hand- d/s	3ft: Q(t1)>Q(ex)	3	3	3	cmp
389+30	366+36	30.78*	**	12	10	HC-7	56	30.98	29.23	dot&pf	0.5	excellent u/s rearing habitat		tier 1		good u/s habitat	4.0		hand		3.5	2.42	3'-6"x2'-5"	pipe arch
405+00	382+07	30.76*	**				81	30.50	30.47	dot&pf		exist pipe meets fish pass with TW > 0.75-ft	Outlet perched to active Chilkat	tier 2		Perched to Chilkat	3.5		DOT survey	Large, high quality wetland	3	3	3	cmp
443+00	419+95	41.62*	**	12	57	HC-1	65	40.38	38.75	dot&pf	0		0.15D baffles	tier 2 - baffled pipe	juv coho	BW~10-ft	9.0		hand- d/s		3.5	3.5	3.5	cmp
														--		--	--		--				--	--
554+00	530+70	43.55	1.79	12	66	HC-1	63	38.76	37.71	dot&pf	1.2			tier 1			2.0	0.2	hand	3ft: Q(t1)>Q(ex)	3	3	3	cmp
630+00	606+68	51.00	3.19	12	99	HC-1	63	45.81	45.36	dot&pf	0	exist pipe meets fish pass with TW > 0.6-ft		tier 2	juv coho or cutthroat	Perched to Chilkat	< 8'-10'		hand		2	2	2	cmp
757+50	736+83	70.73	9.03	12	17-34	HC-8	77	56.45	53.43	dot&pf	1.07	incorp into mitigation ch	**option 1**	tier 1		BW~6.8-ft			hand		7.25	5.25	7'-4"x5'-4"	pipe arch
757+50		70.73	11.28	12	66	HC-1	77	57.52	54.50	dot&pf	0	incorp into mitigation ch	**option 2**	tier 2 - baffled pipe	Adult & juv coho	3ft: Q(t1)>Q(ex)				3ft: Q(t1)>Q(ex)	3	3	3	cmp
787+50	767+14	60.95*	**	12	57	HC-1	71	56.72	55.16	dot&pf	0	exist pipe meets fish pass with TW > **0.75**-ft	0.15D baffles	tier 2 - baffled pipe		Perched to Chilkat & poor u/s habitats	3.0		hand		3.5	3.5	3.5	cmp

Note: * Road CL and culvert elevations are pending adjustments to meet cover requirements

23.5 Hydraulic Output

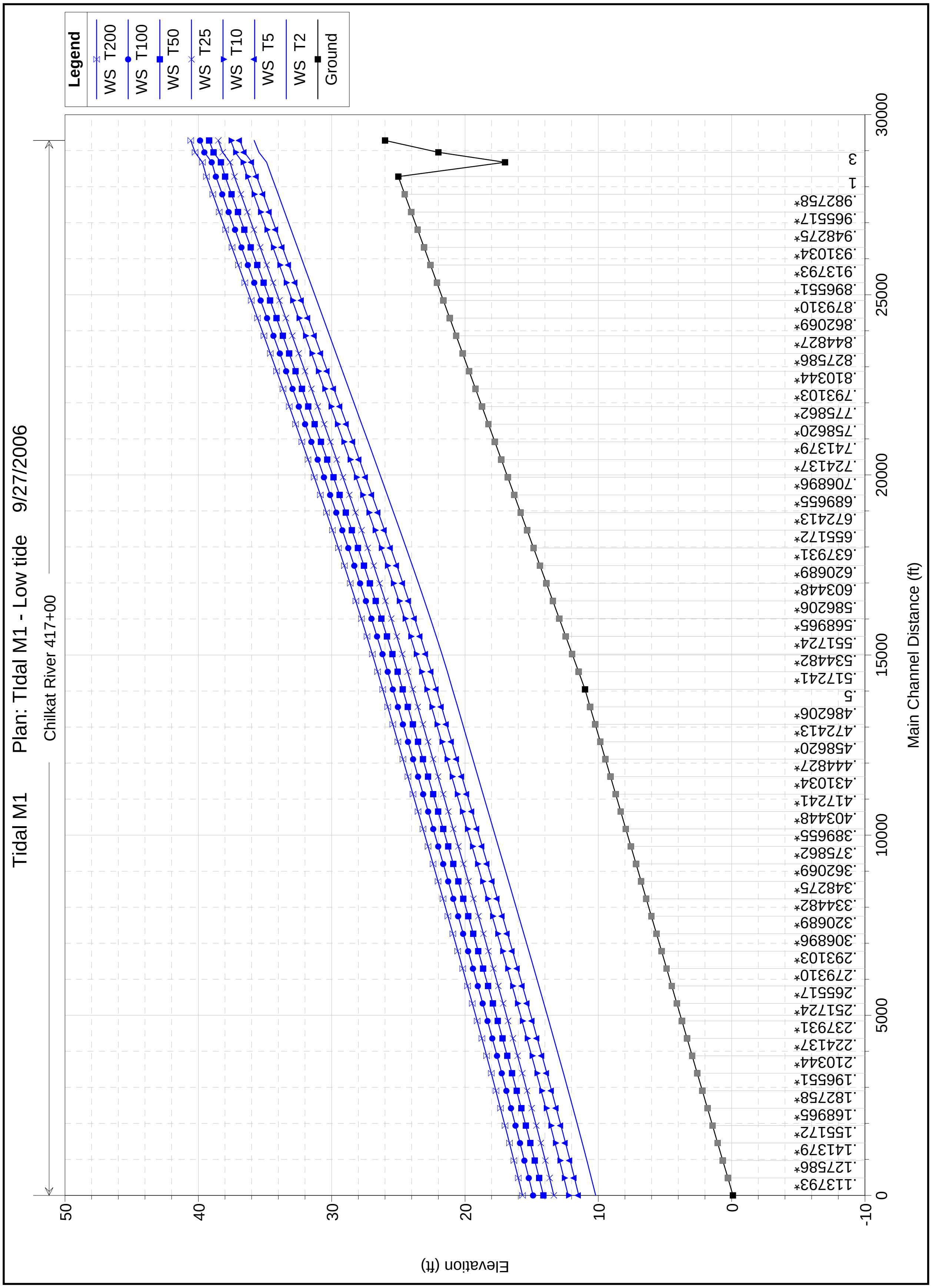
23.5.1 Hydraulic Output – Chilkat River



Haines Highway – HEC–RAS Schematic

S&HI Station 417+00

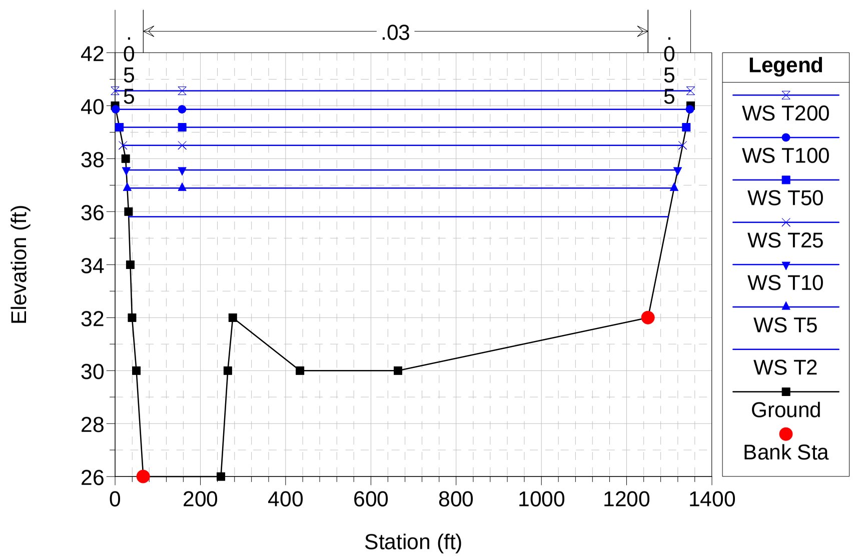
inter·fluve, inc.
1020 Wasco Street, Suite I
Hood River, OR 97031
541.386.4591
www.interfluve.com



Tidal M1 Plan: TIdal M1 - Low tide 9/27/2006
Chilkat River 417+00
Legend
WS T200
WS T100
WS T50
WS T25
WS T10
WS T5
WS T2
Ground
Elevation (ft)
Main Channel Distance (ft)

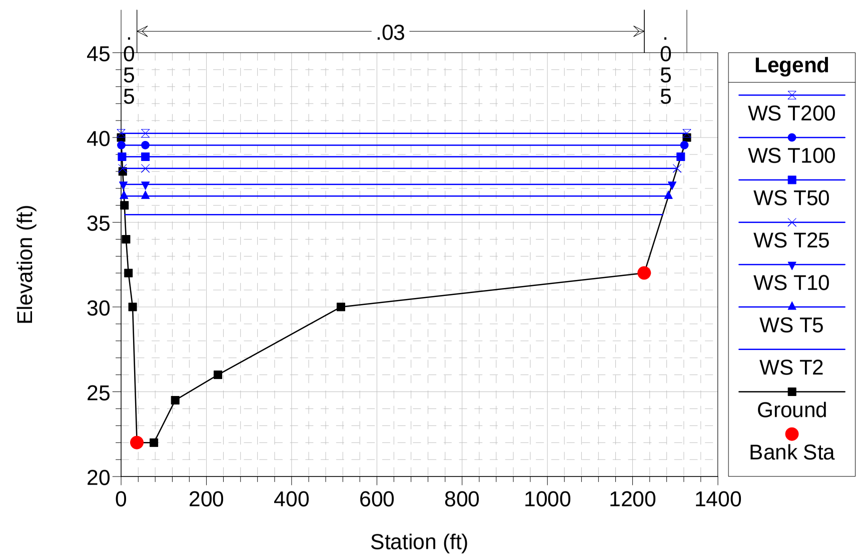
Tidal M1 Plan: TIdal M1 - Low tide 9/27/2006

River = Chilkat River Reach = 417+00 RS = 4 2-points added for typical average depth = 4-ft



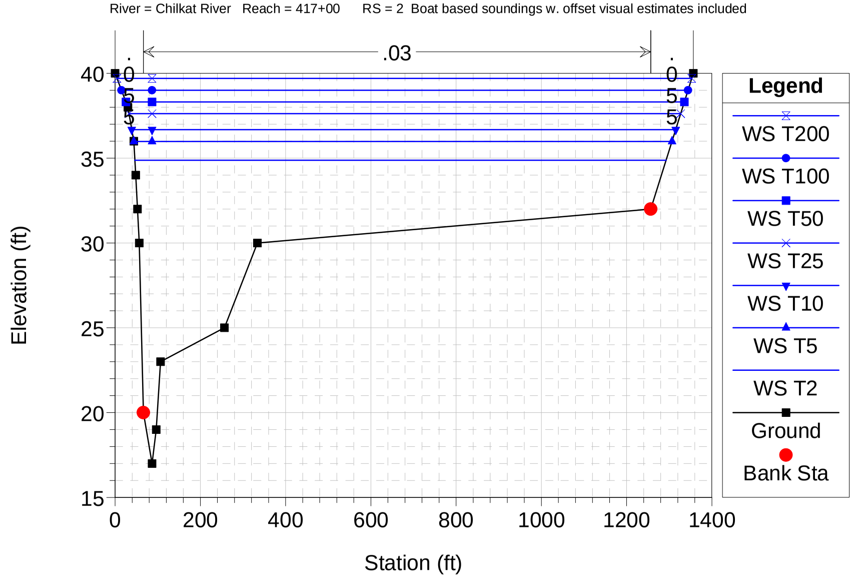
Tidal M1 Plan: TIdal M1 - Low tide 9/27/2006

River = Chilkat River Reach = 417+00 RS = 3 Boat based soundings w. offset visual estimates included



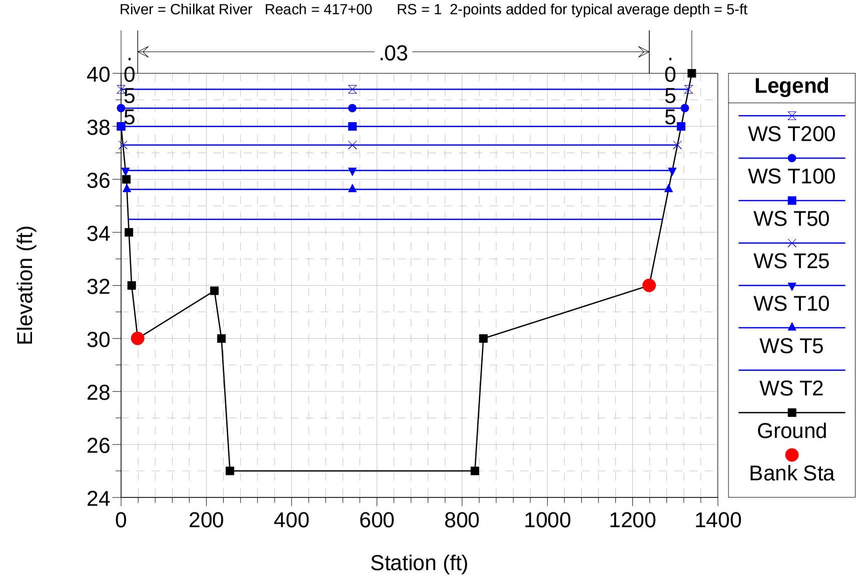
Tidal M1 Plan: TIdal M1 - Low tide 9/27/2006

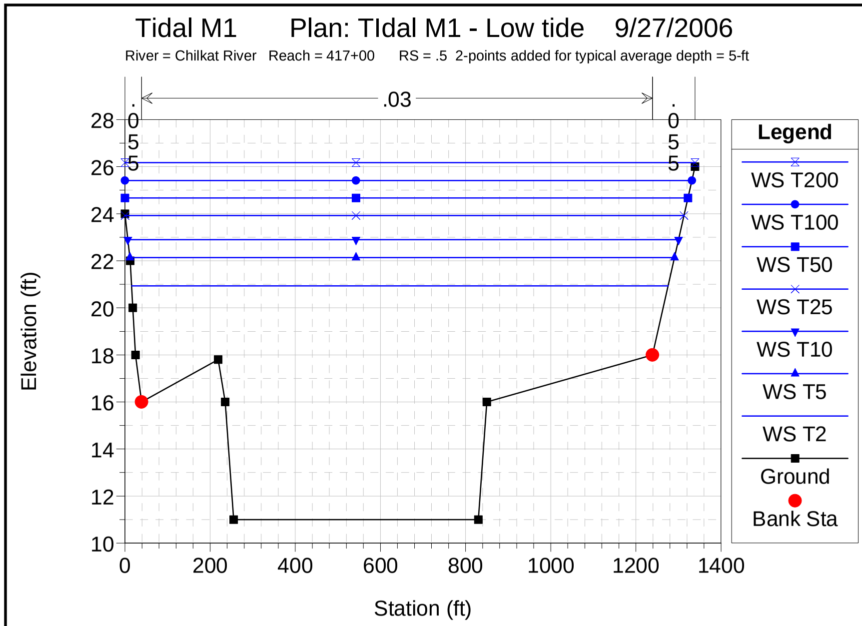
River = Chilkat River Reach = 417+00 RS = 2 Boat based soundings w. offset visual estimates included

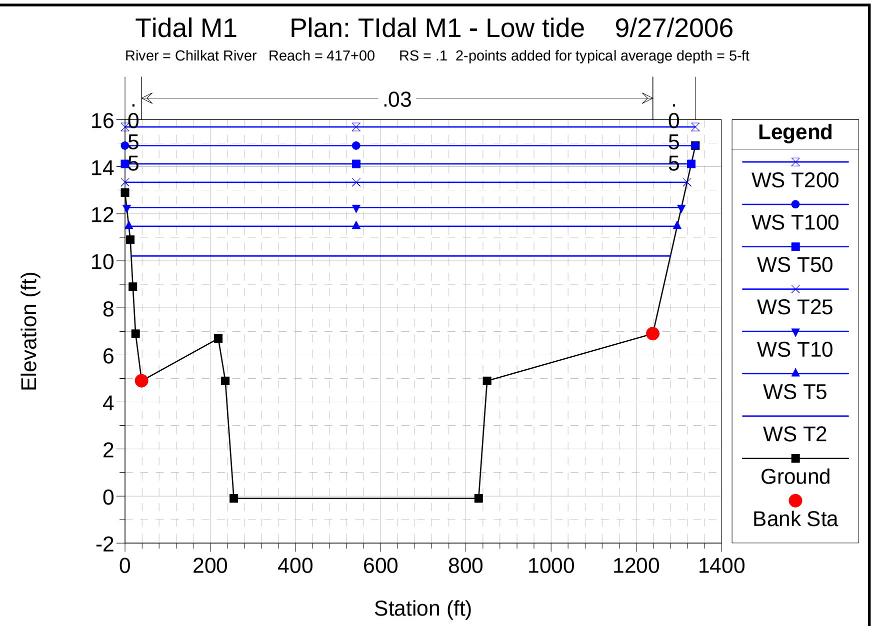


Tidal M1 Plan: TIdal M1 - Low tide 9/27/2006

River = Chilkat River Reach = 417+00 RS = 1 2-points added for typical average depth = 5-ft

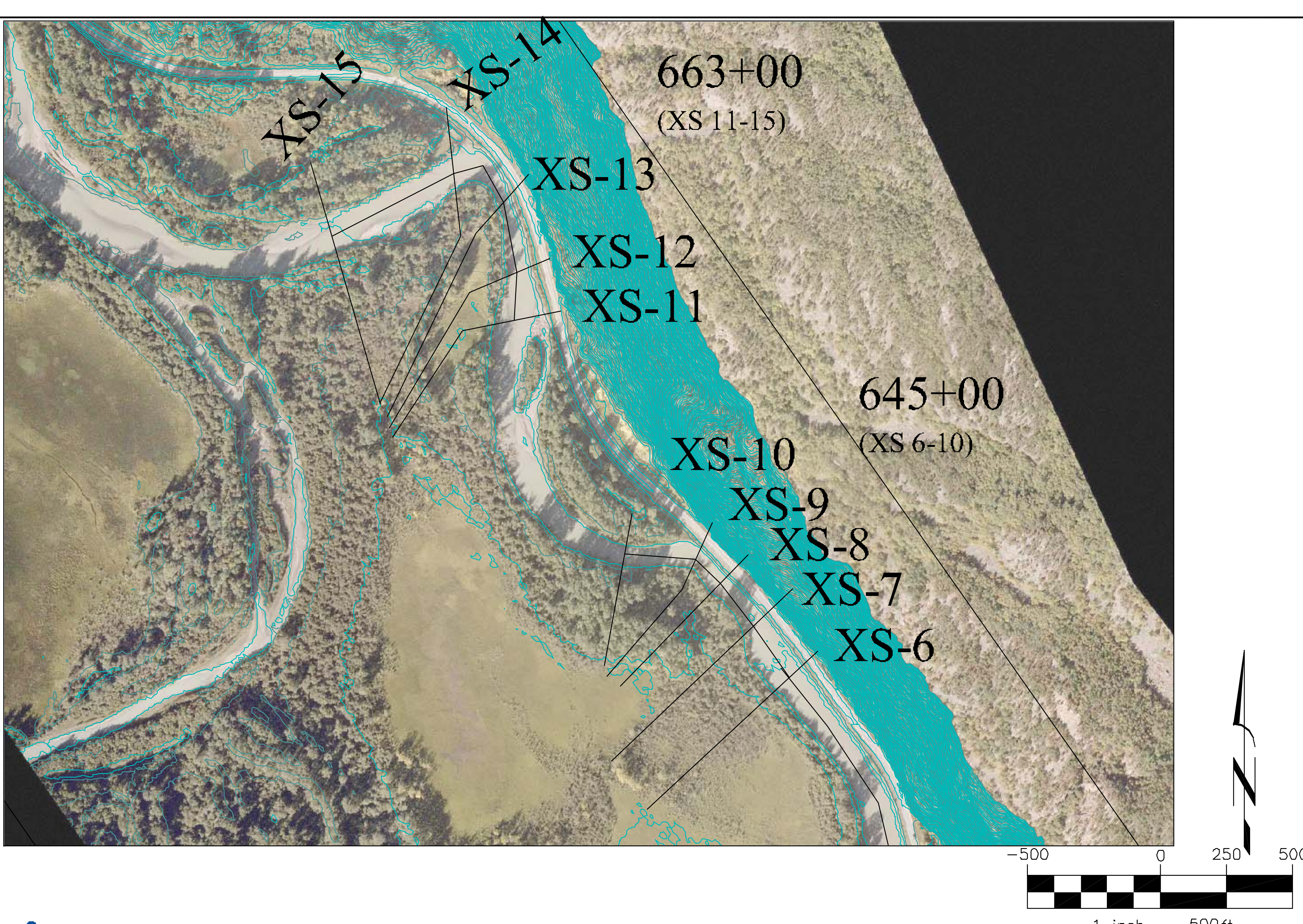



Tidal M1 Plan: TIdal M1 - Low tide 9/27/2006
River = Chilkat River Reach = 417+00 RS = .5 2-points added for typical average depth = 5-ft
.03
Elevation (ft)
Station (ft)
Legend
WS T200
WS T100
WS T50
WS T25
WS T10
WS T5
WS T2
Ground
Bank Sta


Tidal M1 Plan: TIdal M1 - Low tide 9/27/2006
River = Chilkat River Reach = 417+00 RS = .1 2-points added for typical average depth = 5-ft
.03
Elevation (ft)
Station (ft)
Legend
WS T200
WS T100
WS T50
WS T25
WS T10
WS T5
WS T2
Ground
Bank Sta

HEC-RAS Plan: TIdalM1Lo River: Chilkat River Reach: 417+00

Reach	River Sta	Profile	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
417+00	.1	T2	42300.00		-0.10	10.20	5.84	10.56	0.000664	10.30	7.31	4.80	8914.86	1265.64	1200.00	0.31	0.30
417+00	.1	T5	55300.00		-0.10	11.47	6.91	11.91	0.000664	11.57	8.57	5.34	10528.34	1287.01	1200.00	0.32	0.36
417+00	.1	T10	64200.00		-0.10	12.26	7.36	12.76	0.000664	12.36	9.37	5.67	11558.89	1301.94	1200.00	0.33	0.39
417+00	.1	T25	77100.00		-0.10	13.33	7.93	13.91	0.000665	13.43	10.44	6.10	12963.40	1319.31	1200.00	0.33	0.43
417+00	.1	T50	87100.00		-0.10	14.12	8.35	14.75	0.000664	14.22	11.22	6.40	14003.47	1329.13	1200.00	0.34	0.46
417+00	.1	T100	97500.00		-0.10	14.89	8.78	15.58	0.000664	14.99	12.00	6.69	15038.15	1338.83	1200.00	0.34	0.50
417+00	.1	T200	108700.00		-0.10	15.69	9.23	16.43	0.000664	15.79	12.79	6.98	16100.49	1338.90	1200.00	0.34	0.53
417+00	.5	T2	42300.00	14044.99	11.00	20.93		21.33	0.000790	9.93	6.94	5.06	8450.33	1259.98	1200.00	0.34	0.34
417+00	.5	T5	55300.00	14044.99	11.00	22.14		22.63	0.000789	11.14	8.14	5.63	9978.27	1278.97	1200.00	0.35	0.40
417+00	.5	T10	64200.00	14044.99	11.00	22.90		23.45	0.000789	11.90	8.90	5.97	10954.01	1293.20	1200.00	0.35	0.44
417+00	.5	T25	77100.00	14044.99	11.00	23.92		24.56	0.000788	12.92	9.93	6.42	12291.90	1312.45	1200.00	0.36	0.49
417+00	.5	T50	87100.00	14044.99	11.00	24.67		25.37	0.000787	13.67	10.68	6.73	13276.50	1322.28	1200.00	0.36	0.52
417+00	.5	T100	97500.00	14044.99	11.00	25.41		26.17	0.000786	14.41	11.42	7.04	14259.53	1331.54	1200.00	0.37	0.56
417+00	.5	T200	108700.00	14044.99	11.00	26.17		27.00	0.000785	15.17	12.18	7.34	15277.96	1338.90	1200.00	0.37	0.60
417+00	1	T2	42300.00	28279.06	25.00	34.49		34.95	0.000983	9.49	6.50	5.41	7898.19	1253.21	1200.00	0.37	0.40
417+00	1	T5	55300.00	28279.06	25.00	35.62		36.18	0.000983	10.62	7.63	6.01	9320.42	1270.57	1200.00	0.38	0.47
417+00	1	T10	64200.00	28279.06	25.00	36.33		36.96	0.000983	11.33	8.34	6.38	10226.35	1282.61	1200.00	0.39	0.51
417+00	1	T25	77100.00	28279.06	25.00	37.29		38.02	0.000982	12.29	9.30	6.86	11467.69	1300.63	1200.00	0.40	0.57
417+00	1	T50	87100.00	28279.06	25.00	37.99		38.79	0.000982	12.99	10.00	7.20	12382.67	1313.75	1200.00	0.40	0.61
417+00	1	T100	97500.00	28279.06	25.00	38.68		39.56	0.000982	13.68	10.69	7.52	13295.25	1322.45	1200.00	0.41	0.65
417+00	1	T200	108700.00	28279.06	25.00	39.40		40.34	0.000981	14.40	11.40	7.85	14241.21	1331.37	1200.00	0.41	0.70
417+00	2	T2	42300.00	28679.06	17.00	34.88		35.53	0.001835	17.88	5.39	6.52	6589.87	1246.25	1190.00	0.49	0.62
417+00	2	T5	55300.00	28679.06	17.00	35.98		36.75	0.001685	18.98	6.49	7.07	7972.23	1262.50	1190.00	0.49	0.68
417+00	2	T10	64200.00	28679.06	17.00	36.68		37.52	0.001617	19.68	7.19	7.41	8856.30	1275.86	1190.00	0.49	0.72
417+00	2	T25	77100.00	28679.06	17.00	37.62		38.57	0.001542	20.62	8.14	7.86	10071.71	1294.11	1190.00	0.49	0.78
417+00	2	T50	87100.00	28679.06	17.00	38.31		39.34	0.001498	21.31	8.83	8.18	10969.52	1310.02	1190.00	0.49	0.82
417+00	2	T100	97500.00	28679.06	17.00	39.00		40.10	0.001462	22.00	9.51	8.49	11870.48	1328.87	1190.00	0.49	0.87
417+00	2	T200	108700.00	28679.06	17.00	39.70		40.89	0.001428	22.70	10.21	8.80	12813.35	1348.31	1190.00	0.49	0.91
417+00	3	T2	42300.00	28954.06	22.00	35.45		35.93	0.001094	13.45	6.29	5.58	7716.34	1261.50	1190.00	0.39	0.43
417+00	3	T5	55300.00	28954.06	22.00	36.54		37.14	0.001095	14.54	7.38	6.21	9099.48	1277.21	1190.00	0.40	0.50
417+00	3	T10	64200.00	28954.06	22.00	37.23		37.90	0.001093	15.23	8.07	6.59	9986.54	1287.18	1190.00	0.41	0.55
417+00	3	T25	77100.00	28954.06	22.00	38.17		38.94	0.001089	16.17	9.01	7.08	11203.05	1300.72	1190.00	0.42	0.61
417+00	3	T50	87100.00	28954.06	22.00	38.86		39.71	0.001085	16.86	9.70	7.42	12100.49	1310.66	1190.00	0.42	0.66
417+00	3	T100	97500.00	28954.06	22.00	39.54		40.46	0.001082	17.54	10.38	7.75	12996.76	1320.50	1190.00	0.42	0.70
417+00	3	T200	108700.00	28954.06	22.00	40.25		41.24	0.001079	18.25	11.08	8.09	13927.56	1327.10	1190.00	0.43	0.75
417+00	4	T2	42300.00	29284.06	26.00	35.81		36.37	0.001425	9.81	5.81	6.04	7160.78	1265.78	1184.00	0.44	0.52
417+00	4	T5	55300.00	29284.06	26.00	36.89		37.57	0.001377	10.89	6.89	6.65	8536.97	1282.71	1184.00	0.45	0.59
417+00	4	T10	64200.00	29284.06	26.00	37.57		38.33	0.001350	11.57	7.58	7.02	9420.53	1293.62	1184.00	0.45	0.64
417+00	4	T25	77100.00	29284.06	26.00	38.51		39.36	0.001321	12.51	8.51	7.50	10634.26	1312.96	1184.00	0.45	0.70
417+00	4	T50	87100.00	29284.06	26.00	39.19		40.13	0.001303	13.19	9.19	7.84	11534.99	1329.90	1184.00	0.46	0.75
417+00	4	T100	97500.00	29284.06	26.00	39.86		40.88	0.001286	13.86	9.87	8.17	12440.35	1346.71	1184.00	0.46	0.79
417+00	4	T200	108700.00	29284.06	26.00	40.56		41.66	0.001267	14.56	10.57	8.49	13384.57	1350.10	1184.00	0.46	0.84



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541.386.4591
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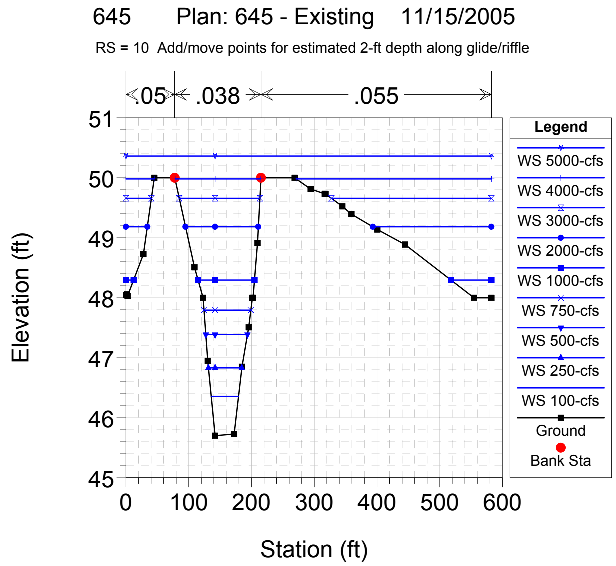
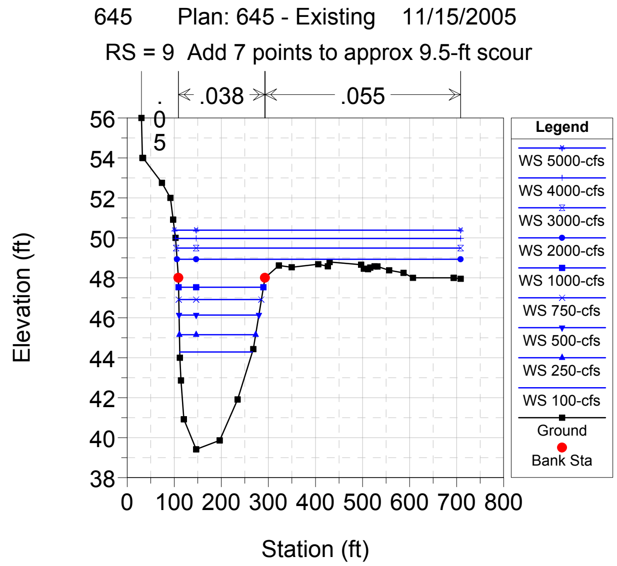
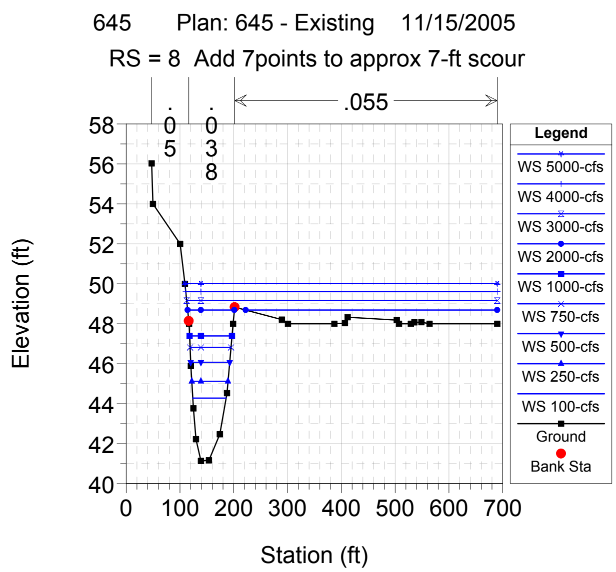
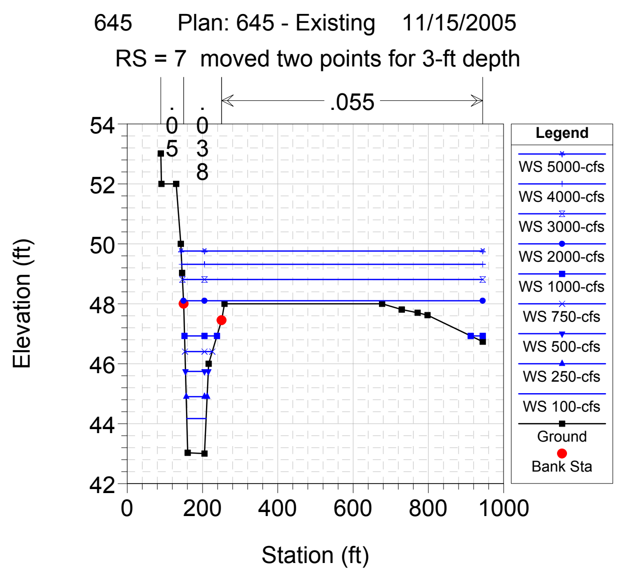
Haines Highway – HEC–RAS Schematic

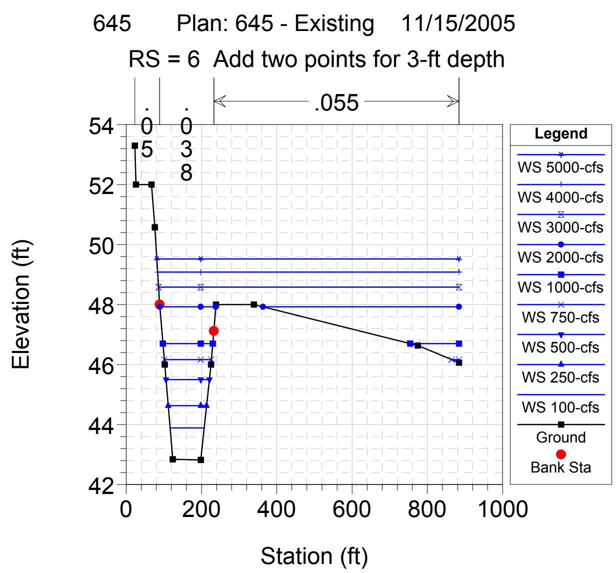
S&HI Stations 645+00 and 663+00


645 Plan: 645 - Existing 11/15/2005
RS = 10 Add/move points for estimated 2-ft depth along glide/riffle
.05
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Bank Sta


645 Plan: 645 - Existing 11/15/2005
RS = 9 Add 7 points to approx 9.5-ft scour
.05
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Bank Sta

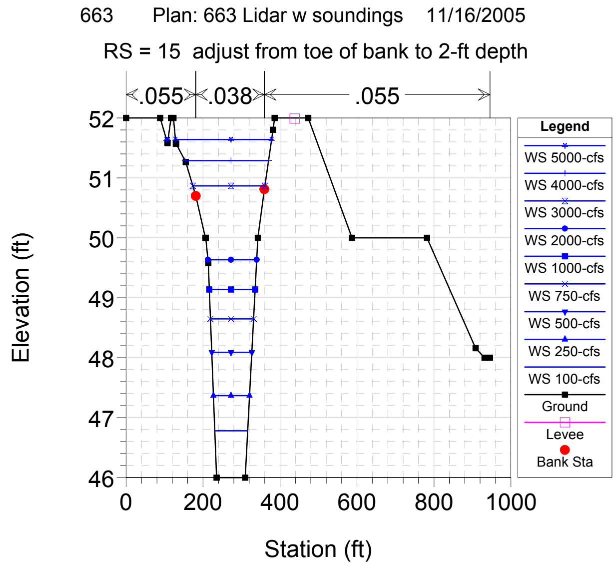

645 Plan: 645 - Existing 11/15/2005
RS = 8 Add 7points to approx 7-ft scour
.05
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Bank Sta

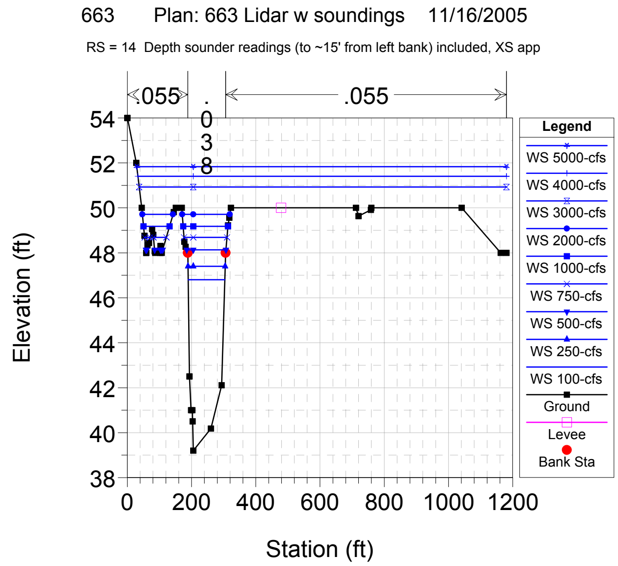

645 Plan: 645 - Existing 11/15/2005
RS = 7 moved two points for 3-ft depth
.05
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Bank Sta

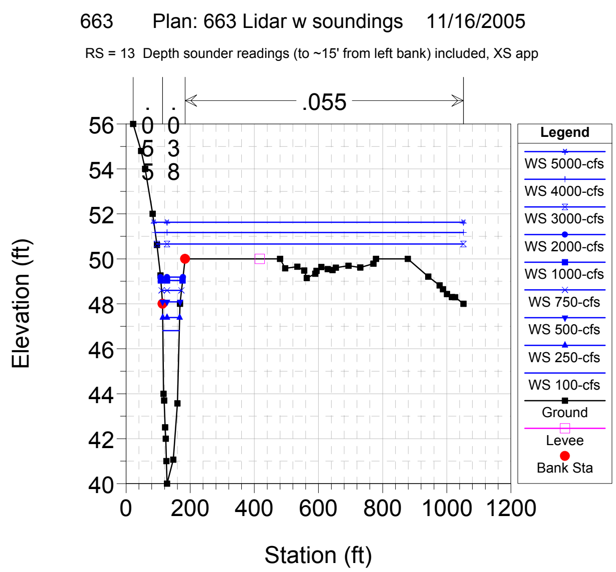

645 Plan: 645 - Existing 11/15/2005
RS = 6 Add two points for 3-ft depth
.05
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Bank Sta

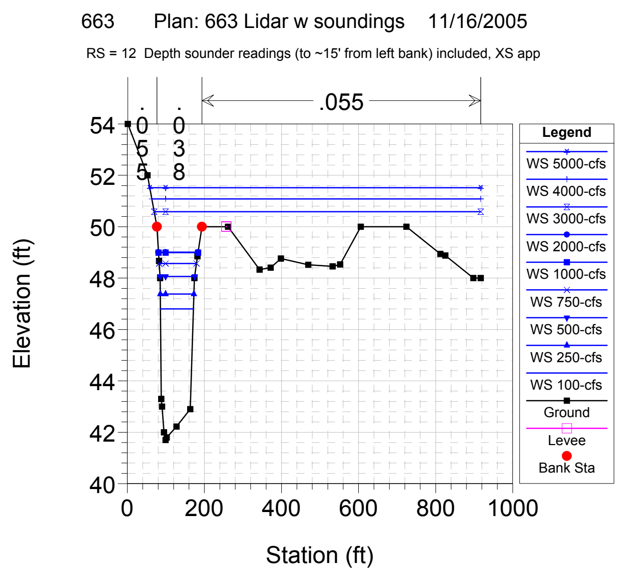
HEC-RAS Plan: 645 River: Chilkat Reach: 645+00

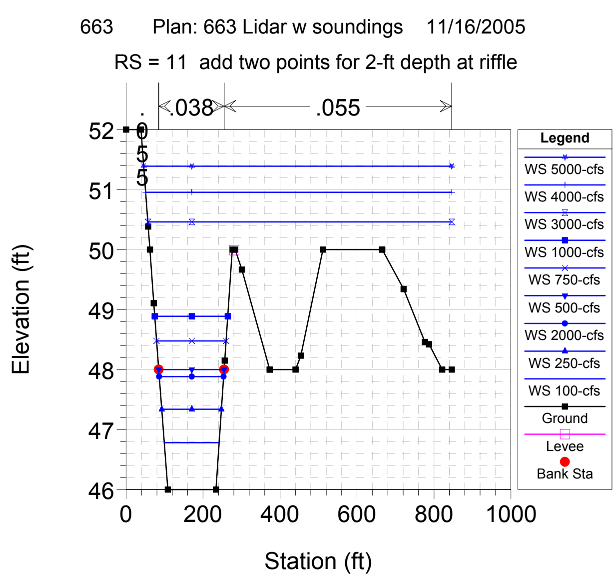
Reach	River Sta	Profile	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
645+00	6	100-cfs	100.00		42.82	43.89	43.21	43.91	0.000901	1.07	0.96	1.14	87.39	90.61	90.61	0.21	0.05
645+00	6	250-cfs	250.00		42.82	44.63	43.52	44.67	0.000901	1.81	1.56	1.57	158.75	101.94	101.94	0.22	0.09
645+00	6	500-cfs	500.00		42.82	45.50	43.90	45.56	0.000901	2.68	2.19	1.98	252.78	115.18	115.18	0.24	0.12
645+00	6	750-cfs	750.00		42.82	46.17	44.22	46.24	0.000901	3.35	2.66	2.25	334.36	144.77	125.15	0.24	0.15
645+00	6	1000-cfs	1000.00		42.82	46.70	44.50	46.79	0.000902	3.88	3.03	2.45	440.47	261.92	132.42	0.25	0.17
645+00	6	2000-cfs	2000.00		42.82	47.92	45.39	48.04	0.000901	5.10	3.98	2.94	1012.20	669.79	143.67	0.26	0.22
645+00	6	3000-cfs	3000.00		42.82	48.58	46.11	48.70	0.000901	5.76	4.62	3.25	1525.76	798.19	144.18	0.27	0.26
645+00	6	4000-cfs	4000.00		42.82	49.08	47.04	49.21	0.000901	6.26	5.13	3.48	1926.51	800.62	144.18	0.27	0.29
645+00	6	5000-cfs	5000.00		42.82	49.52	47.62	49.66	0.000900	6.70	5.57	3.67	2279.87	802.76	144.18	0.27	0.31
645+00	7	100-cfs	100.00	236.00	43.00	44.17		44.22	0.001945	1.17	1.08	1.80	55.43	51.40	51.40	0.31	0.13
645+00	7	250-cfs	250.00	236.00	43.00	44.90		45.01	0.002282	1.90	1.70	2.64	94.69	55.68	55.68	0.36	0.24
645+00	7	500-cfs	500.00	236.00	43.00	45.74		45.93	0.002566	2.74	2.37	3.48	143.53	60.58	60.58	0.40	0.37
645+00	7	750-cfs	750.00	236.00	43.00	46.40		46.65	0.003067	3.40	2.57	4.02	186.45	72.49	72.49	0.44	0.48
645+00	7	1000-cfs	1000.00	236.00	43.00	46.93		47.23	0.003490	3.93	2.65	4.38	231.11	117.87	86.05	0.47	0.57
645+00	7	2000-cfs	2000.00	236.00	43.00	48.10		48.51	0.003772	5.10	3.39	5.37	558.59	794.66	100.79	0.51	0.79
645+00	7	3000-cfs	3000.00	236.00	43.00	48.81		49.07	0.002473	5.81	4.10	4.93	1122.16	797.56	100.79	0.43	0.62
645+00	7	4000-cfs	4000.00	236.00	43.00	49.32		49.55	0.002071	6.32	4.61	4.88	1529.81	799.51	100.79	0.40	0.59
645+00	7	5000-cfs	5000.00	236.00	43.00	49.76		49.97	0.001852	6.76	5.05	4.90	1883.74	801.09	100.79	0.38	0.58
645+00	8	100-cfs	100.00	440.00	41.14	44.28		44.29	0.000122	3.14	2.21	0.73	136.98	61.85	61.85	0.09	0.02
645+00	8	250-cfs	250.00	440.00	41.14	45.12		45.14	0.000282	3.98	2.84	1.31	191.40	67.36	67.36	0.14	0.05
645+00	8	500-cfs	500.00	440.00	41.14	46.07		46.13	0.000462	4.93	3.56	1.94	258.15	72.56	72.56	0.18	0.10
645+00	8	750-cfs	750.00	440.00	41.14	46.81		46.90	0.000584	5.67	4.12	2.39	313.24	76.10	76.10	0.21	0.15
645+00	8	1000-cfs	1000.00	440.00	41.14	47.39		47.52	0.000698	6.25	4.54	2.79	358.30	78.88	78.88	0.23	0.19
645+00	8	2000-cfs	2000.00	440.00	41.14	48.68		48.91	0.001105	7.54	5.46	3.96	726.58	554.68	84.94	0.30	0.37
645+00	8	3000-cfs	3000.00	440.00	41.14	49.16		49.47	0.001521	8.02	5.91	4.90	1001.40	577.63	85.50	0.36	0.55
645+00	8	4000-cfs	4000.00	440.00	41.14	49.61		49.96	0.001721	8.47	6.35	5.47	1259.50	579.36	85.50	0.38	0.67
645+00	8	5000-cfs	5000.00	440.00	41.14	50.01		50.39	0.001837	8.87	6.76	5.89	1493.68	580.93	85.50	0.40	0.76
645+00	9	100-cfs	100.00	570.00	39.42	44.29		44.29	0.000005	4.87	3.39	0.19	523.85	154.33	154.33	0.02	0.00
645+00	9	250-cfs	250.00	570.00	39.42	45.15		45.15	0.000015	5.73	4.08	0.38	660.19	161.87	161.87	0.03	0.00
645+00	9	500-cfs	500.00	570.00	39.42	46.14		46.14	0.000030	6.72	4.86	0.61	824.09	169.52	169.52	0.05	0.01
645+00	9	750-cfs	750.00	570.00	39.42	46.91		46.92	0.000042	7.49	5.46	0.78	957.73	175.51	175.51	0.06	0.01
645+00	9	1000-cfs	1000.00	570.00	39.42	47.53		47.54	0.000055	8.11	5.92	0.94	1067.29	180.27	180.27	0.07	0.02
645+00	9	2000-cfs	2000.00	570.00	39.42	48.93		48.96	0.000105	9.51	7.20	1.48	1546.00	602.69	183.91	0.10	0.05
645+00	9	3000-cfs	3000.00	570.00	39.42	49.49		49.55	0.000171	10.07	7.76	1.98	1885.56	604.41	183.91	0.13	0.08
645+00	9	4000-cfs	4000.00	570.00	39.42	49.97		50.05	0.000231	10.55	8.24	2.40	2175.78	605.88	183.91	0.15	0.12
645+00	9	5000-cfs	5000.00	570.00	39.42	50.39		50.49	0.000287	10.97	8.66	2.76	2430.04	608.08	183.91	0.17	0.15
645+00	10	100-cfs	100.00	838.00	45.70	46.36	46.36	46.63	0.026149	0.66	0.55	4.22	23.71	43.47	43.47	1.01	0.89
645+00	10	250-cfs	250.00	838.00	45.70	46.83	46.83	47.28	0.022378	1.13	0.88	5.36	46.68	53.18	53.18	1.01	1.22
645+00	10	500-cfs	500.00	838.00	45.70	47.39	47.39	48.00	0.020146	1.69	1.20	6.27	79.75	66.26	66.26	1.01	1.51
645+00	10	750-cfs	750.00	838.00	45.70	47.79	47.79	48.54	0.018992	2.09	1.46	6.91	108.58	74.61	74.61	1.01	1.72
645+00	10	1000-cfs	1000.00	838.00	45.70	48.30	48.30	48.96	0.014408	2.60	1.66	6.57	165.05	166.57	89.98	0.90	1.49
645+00	10	2000-cfs	2000.00	838.00	45.70	49.18	49.18	49.82	0.011832	3.48	2.08	6.92	387.97	339.08	116.06	0.85	1.53
645+00	10	3000-cfs	3000.00	838.00	45.70	49.66	49.66	50.34	0.011885	3.96	2.33	7.48	569.99	423.86	128.42	0.86	1.73
645+00	10	4000-cfs	4000.00	838.00	45.70	49.98	49.98	50.75	0.012843	4.28	2.50	8.15	718.85	492.86	136.85	0.91	2.00
645+00	10	5000-cfs	5000.00	838.00	45.70	50.36	50.36	51.10	0.010787	4.66	2.88	8.19	939.47	582.35	137.32	0.85	1.93


663 Plan: 663 Lidar w soundings 11/16/2005
RS = 15 adjust from toe of bank to 2-ft depth
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Levee
Bank Sta


663 Plan: 663 Lidar w soundings 11/16/2005
RS = 14 Depth sounder readings (to ~15' from left bank) included, XS app
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Levee
Bank Sta

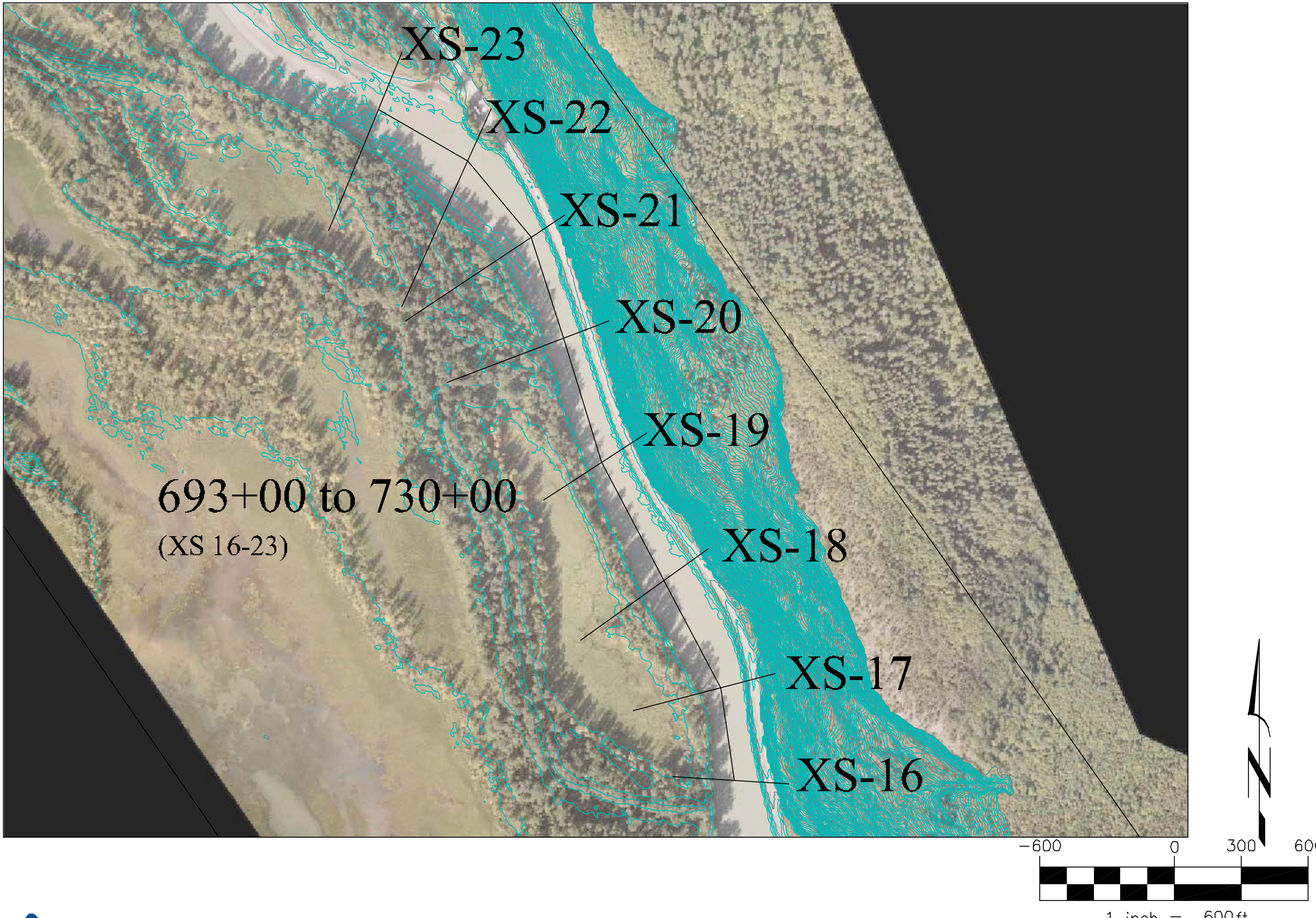

663 Plan: 663 Lidar w soundings 11/16/2005
RS = 13 Depth sounder readings (to ~15' from left bank) included, XS app
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Levee
Bank Sta


663 Plan: 663 Lidar w soundings 11/16/2005
RS = 12 Depth sounder readings (to ~15' from left bank) included, XS app
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Levee
Bank Sta


663 Plan: 663 Lidar w soundings 11/16/2005
RS = 11 add two points for 2-ft depth at riffle
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 2000-cfs
WS 250-cfs
WS 100-cfs
Ground
Levee
Bank Sta

HEC-RAS Plan: 663 w sndgs River: Chilkat Reach: 663+00

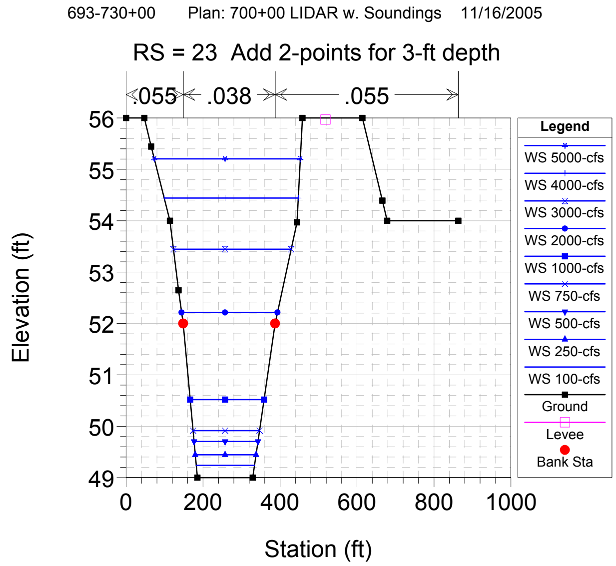
Reach	River Sta	Profile	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
663+00	11	100-cfs	100.00		46.00	46.78	46.27	46.80	0.000902	0.78	0.73	0.95	104.71	142.68	142.68	0.20	0.04
663+00	11	250-cfs	250.00		46.00	47.34	46.49	47.37	0.000901	1.34	1.21	1.33	187.74	155.22	155.22	0.21	0.07
663+00	11	500-cfs	500.00		46.00	48.00	46.77	48.04	0.000900	2.00	1.74	1.69	295.24	170.09	170.08	0.23	0.10
663+00	11	750-cfs	750.00		46.00	48.48	47.00	48.54	0.000901	2.48	2.21	1.99	378.79	180.77	170.08	0.24	0.12
663+00	11	1000-cfs	1000.00		46.00	48.89	47.21	48.97	0.000900	2.89	2.62	2.23	455.22	190.00	170.08	0.24	0.15
663+00	11	2000-cfs	2000.00		46.00	47.88	47.88	48.70	0.017813	1.88	1.64	7.27	275.28	167.43	167.43	1.00	1.83
663+00	11	3000-cfs	3000.00		46.00	50.46	48.40	50.57	0.000900	4.46	4.20	3.05	1548.17	790.02	170.08	0.26	0.24
663+00	11	4000-cfs	4000.00		46.00	50.95	48.87	51.07	0.000901	4.95	4.69	3.29	1939.03	795.70	170.08	0.27	0.26
663+00	11	5000-cfs	5000.00		46.00	51.39	49.29	51.52	0.000900	5.39	5.13	3.49	2286.53	800.71	170.08	0.27	0.29
663+00	12	100-cfs	100.00	181.00	41.70	46.80	42.61	46.80	0.000008	5.10	4.17	0.28	357.17	85.69	85.69	0.02	0.00
663+00	12	250-cfs	250.00	181.00	41.70	47.38	43.01	47.39	0.000033	5.68	4.67	0.61	407.26	87.29	87.29	0.05	0.01
663+00	12	500-cfs	500.00	181.00	41.70	48.07	43.43	48.08	0.000088	6.37	5.20	1.07	467.86	89.93	89.93	0.08	0.03
663+00	12	750-cfs	750.00	181.00	41.70	48.57	43.78	48.60	0.000158	6.87	5.31	1.46	514.39	96.88	96.88	0.11	0.05
663+00	12	1000-cfs	1000.00	181.00	41.70	48.99	44.08	49.04	0.000233	7.29	5.42	1.80	557.08	102.74	102.74	0.14	0.08
663+00	12	2000-cfs	2000.00	181.00	41.70	49.01	45.10	49.21	0.000925	7.31	5.43	3.58	558.80	102.98	102.98	0.27	0.30
663+00	12	3000-cfs	3000.00	181.00	41.70	50.59	45.96	50.69	0.000515	8.89	6.30	2.96	1787.24	847.03	116.85	0.21	0.20
663+00	12	4000-cfs	4000.00	181.00	41.70	51.08	46.71	51.19	0.000567	9.38	6.79	3.26	2207.90	853.06	116.85	0.22	0.23
663+00	12	5000-cfs	5000.00	181.00	41.70	51.52	47.38	51.64	0.000602	9.82	7.23	3.50	2582.39	858.39	116.85	0.23	0.26
663+00	13	100-cfs	100.00	450.00	40.00	46.80	41.42	46.81	0.000015	6.80	4.72	0.42	240.90	51.03	51.03	0.03	0.00
663+00	13	250-cfs	250.00	450.00	40.00	47.39	42.14	47.40	0.000068	7.39	5.17	0.92	271.15	52.47	52.47	0.07	0.02
663+00	13	500-cfs	500.00	450.00	40.00	48.08	42.96	48.12	0.000189	8.08	5.64	1.62	308.32	55.11	54.66	0.12	0.06
663+00	13	750-cfs	750.00	450.00	40.00	48.59	43.58	48.67	0.000346	8.59	5.74	2.22	338.23	61.97	58.78	0.16	0.12
663+00	13	1000-cfs	1000.00	450.00	40.00	49.04	44.08	49.15	0.000512	9.04	5.84	2.74	366.83	67.89	62.34	0.20	0.17
663+00	13	2000-cfs	2000.00	450.00	40.00	49.19	45.60	49.63	0.001926	9.19	5.88	5.35	377.17	69.91	63.55	0.39	0.66
663+00	13	3000-cfs	3000.00	450.00	40.00	50.66	46.84	50.90	0.001160	10.66	6.76	4.57	1372.13	956.19	70.12	0.31	0.46
663+00	13	4000-cfs	4000.00	450.00	40.00	51.17	47.91	51.39	0.001106	11.17	7.28	4.69	1866.31	961.31	70.12	0.31	0.47
663+00	13	5000-cfs	5000.00	450.00	40.00	51.62	49.10	51.82	0.001057	11.62	7.73	4.77	2299.87	965.79	70.12	0.30	0.48
663+00	14	100-cfs	100.00	724.00	39.20	46.81	40.15	46.81	0.000001	7.61	5.96	0.15	678.98	114.01	114.01	0.01	0.00
663+00	14	250-cfs	250.00	724.00	39.20	47.40	40.55	47.41	0.000006	8.20	6.46	0.33	747.67	115.83	115.83	0.02	0.00
663+00	14	500-cfs	500.00	724.00	39.20	48.13	41.06	48.14	0.000018	8.93	7.08	0.60	836.15	147.28	117.64	0.04	0.01
663+00	14	750-cfs	750.00	724.00	39.20	48.69	41.42	48.70	0.000032	9.49	7.63	0.83	930.93	191.32	117.64	0.05	0.01
663+00	14	1000-cfs	1000.00	724.00	39.20	49.18	41.73	49.19	0.000045	9.98	8.12	1.03	1031.68	220.24	117.64	0.06	0.02
663+00	14	2000-cfs	2000.00	724.00	39.20	49.71	42.66	49.76	0.000142	10.51	8.66	1.92	1155.19	243.29	117.64	0.11	0.07
663+00	14	3000-cfs	3000.00	724.00	39.20	50.93	43.40	50.99	0.000149	11.73	9.88	2.14	2456.52	1143.35	117.64	0.12	0.09
663+00	14	4000-cfs	4000.00	724.00	39.20	51.41	44.03	51.48	0.000189	12.21	10.35	2.49	3002.37	1147.44	117.64	0.14	0.12
663+00	14	5000-cfs	5000.00	724.00	39.20	51.83	44.62	51.92	0.000221	12.63	10.78	2.77	3487.66	1151.06	117.64	0.15	0.14
663+00	15	100-cfs	100.00	1238.00	46.00	46.78	46.38	46.82	0.002558	0.78	0.73	1.60	62.41	85.50	85.50	0.33	0.12
663+00	15	250-cfs	250.00	1238.00	46.00	47.37	46.69	47.44	0.002369	1.37	1.22	2.18	114.94	93.88	93.88	0.35	0.18
663+00	15	500-cfs	500.00	1238.00	46.00	48.09	47.08	48.20	0.002162	2.09	1.79	2.68	186.78	104.27	104.27	0.35	0.24
663+00	15	750-cfs	750.00	1238.00	46.00	48.65	47.41	48.79	0.002119	2.65	2.20	3.04	246.87	112.22	112.22	0.36	0.29
663+00	15	1000-cfs	1000.00	1238.00	46.00	49.14	47.68	49.31	0.002046	3.14	2.55	3.29	303.87	119.27	119.27	0.36	0.32
663+00	15	2000-cfs	2000.00	1238.00	46.00	49.63	48.59	50.10	0.004841	3.63	2.87	5.49	364.61	126.85	126.85	0.57	0.87
663+00	15	3000-cfs	3000.00	1238.00	46.00	50.87	49.31	51.33	0.004311	4.87	3.09	5.44	552.40	187.47	178.43	0.54	0.83
663+00	15	4000-cfs	4000.00	1238.00	46.00	51.29	49.95	51.92	0.004989	5.29	3.51	6.37	637.33	217.08	178.43	0.60	1.09
663+00	15	5000-cfs	5000.00	1238.00	46.00	51.64	50.64	52.44	0.005609	5.64	3.87	7.20	720.44	253.85	178.43	0.65	1.35

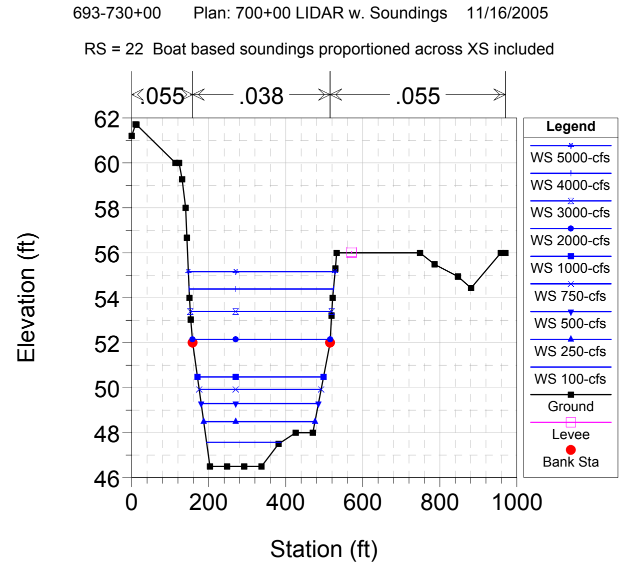


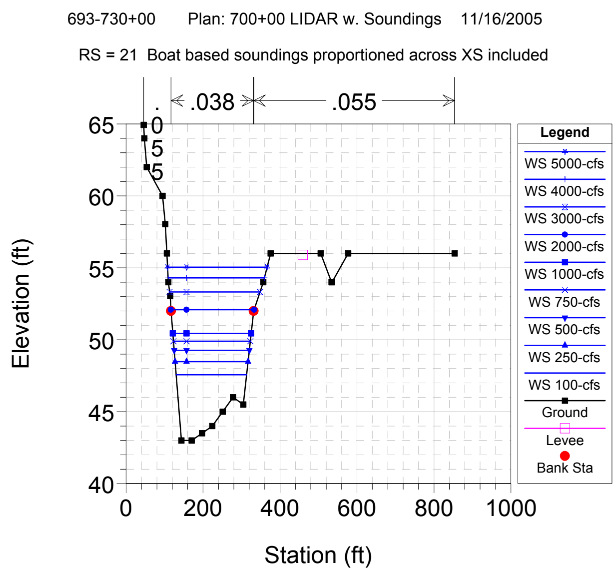
inter·fluve, inc.
1020 Wasco Street, Suite I
Hood River, OR 97031
541.386.4591
www.interfluve.com

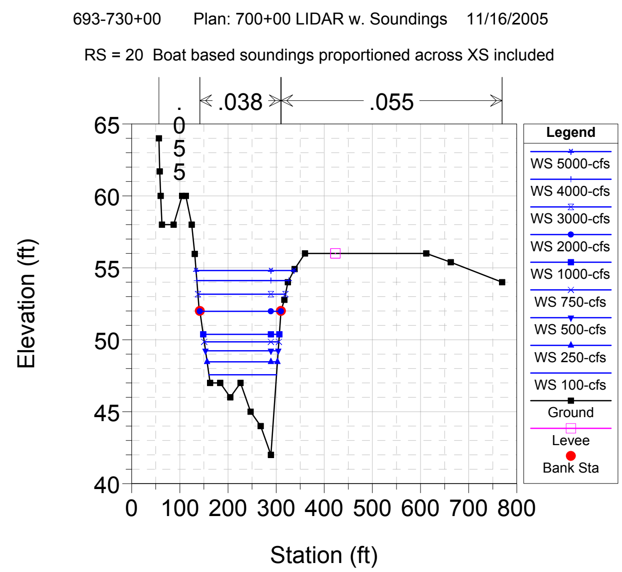
Haines Highway – HEC–RAS Schematic

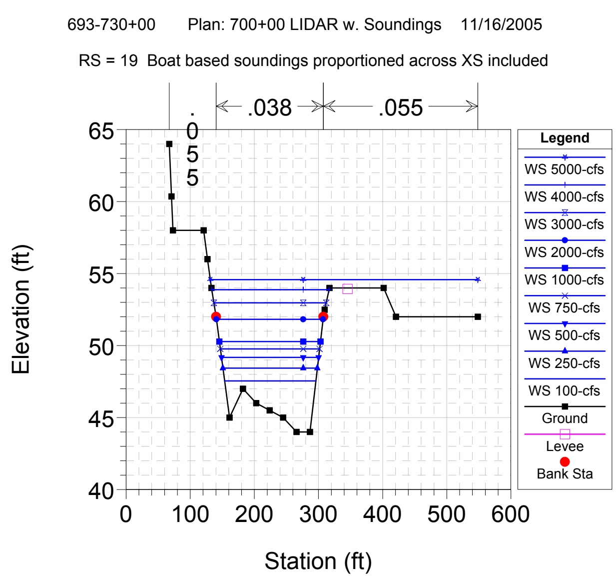
S&HI Station 693+00 to 730+00

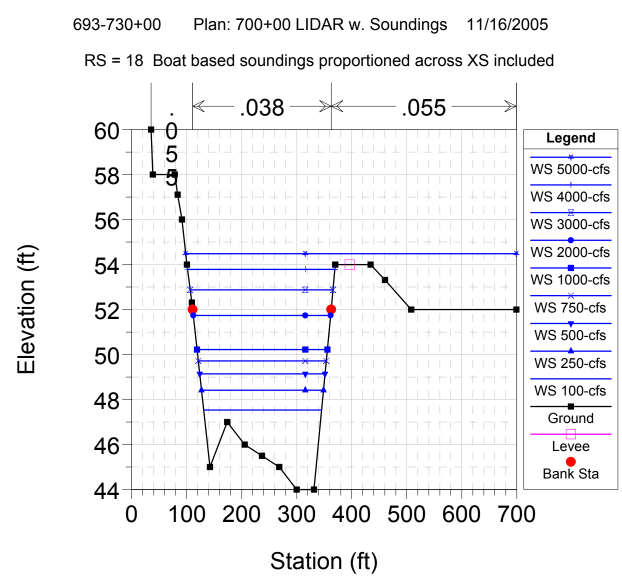

693-730+00 Plan: 700+00 LIDAR w. Soundings 11/16/2005
RS = 23 Add 2-points for 3-ft depth
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Levee
Bank Sta

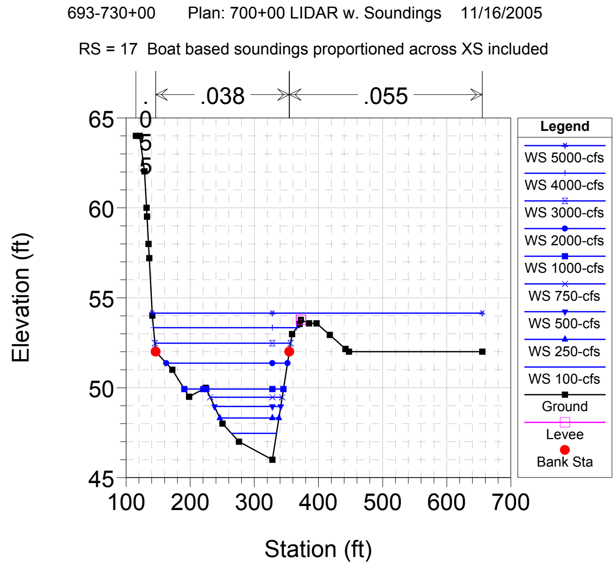

693-730+00 Plan: 700+00 LIDAR w. Soundings 11/16/2005
RS = 22 Boat based soundings proportioned across XS included
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Levee
Bank Sta

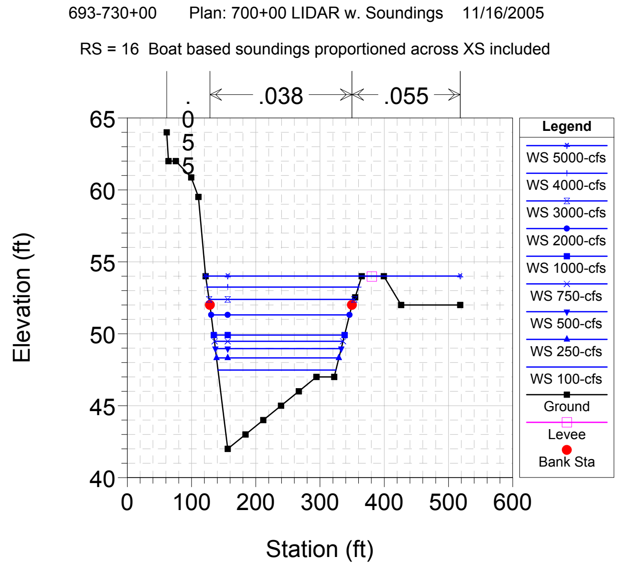

693-730+00 Plan: 700+00 LIDAR w. Soundings 11/16/2005
RS = 21 Boat based soundings proportioned across XS included
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Levee
Bank Sta

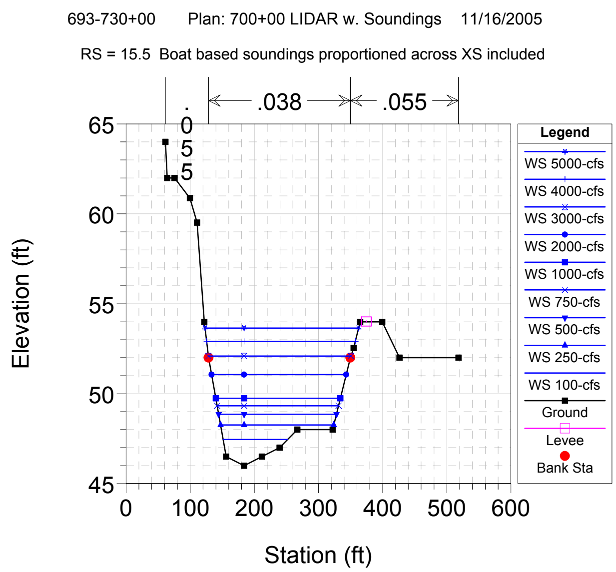

693-730+00 Plan: 700+00 LIDAR w. Soundings 11/16/2005
RS = 20 Boat based soundings proportioned across XS included
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Levee
Bank Sta


693-730+00 Plan: 700+00 LIDAR w. Soundings 11/16/2005
RS = 19 Boat based soundings proportioned across XS included
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Levee
Bank Sta


693-730+00 Plan: 700+00 LIDAR w. Soundings 11/16/2005
RS = 18 Boat based soundings proportioned across XS included
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Levee
Bank Sta


693-730+00 Plan: 700+00 LIDAR w. Soundings 11/16/2005
RS = 17 Boat based soundings proportioned across XS included
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Levee
Bank Sta


693-730+00 Plan: 700+00 LIDAR w. Soundings 11/16/2005
RS = 16 Boat based soundings proportioned across XS included
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Levee
Bank Sta

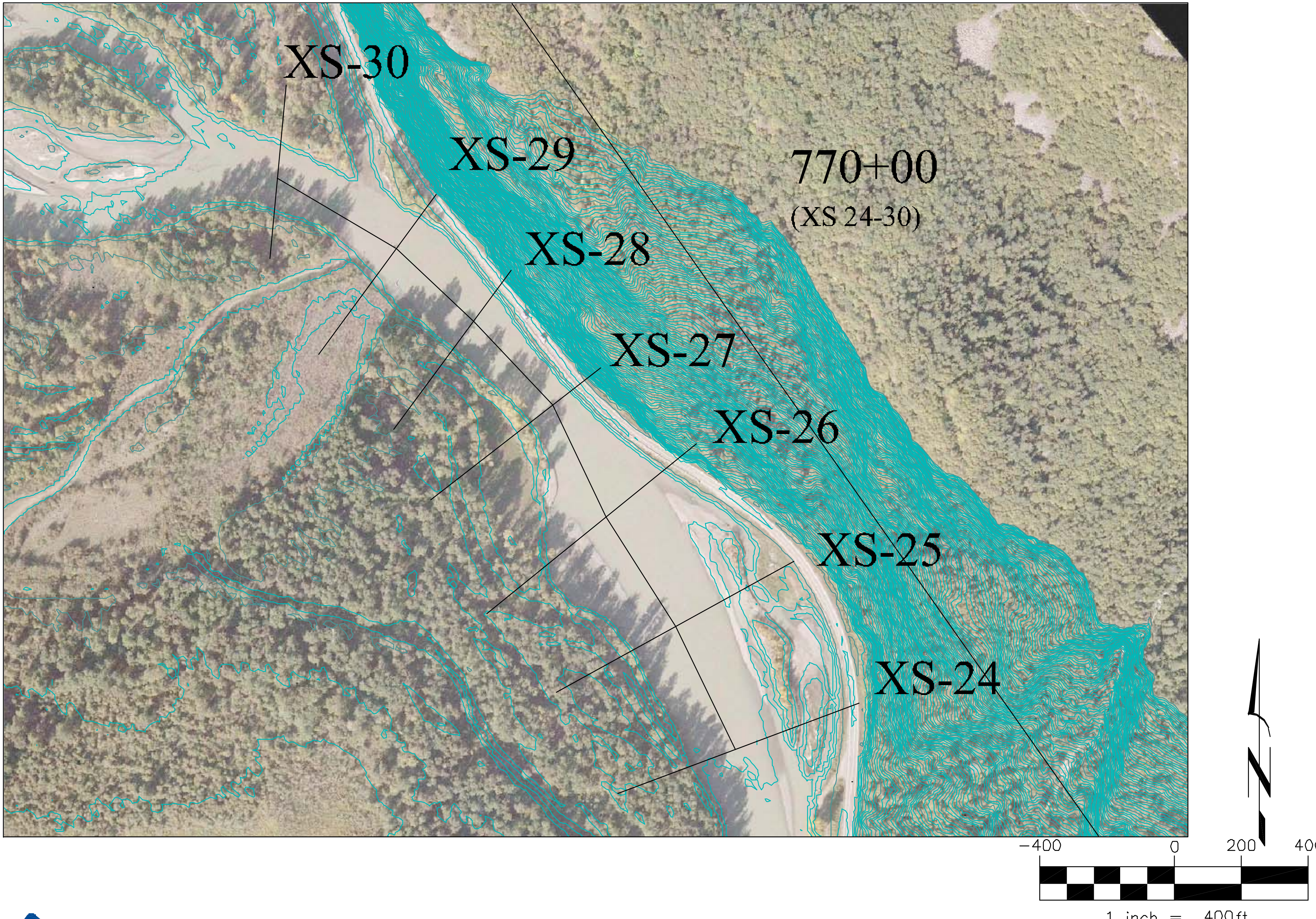

693-730+00 Plan: 700+00 LIDAR w. Soundings 11/16/2005
RS = 15.5 Boat based soundings proportioned across XS included
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Levee
Bank Sta

HEC-RAS Plan: 700 bathym River: Chilkat Reach: 700+00

Reach	River Sta	Profile	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
700+00	15.5	100-cfs	100.00		46.00	47.45	46.73	47.47	0.000901	1.45	0.91	1.10	91.02	100.41	100.41	0.20	0.05
700+00	15.5	250-cfs	250.00		46.00	48.27	47.07	48.29	0.000901	2.27	1.12	1.26	197.73	176.59	176.59	0.21	0.06
700+00	15.5	500-cfs	500.00		46.00	48.86	47.46	48.90	0.000901	2.86	1.66	1.64	304.45	183.63	183.63	0.22	0.09
700+00	15.5	750-cfs	750.00		46.00	49.33	47.76	49.39	0.000901	3.33	2.08	1.91	393.07	189.28	189.28	0.23	0.12
700+00	15.5	1000-cfs	1000.00		46.00	49.75	48.14	49.82	0.000900	3.75	2.43	2.12	472.14	194.18	194.18	0.24	0.14
700+00	15.5	2000-cfs	2000.00		46.00	51.06	48.74	51.18	0.000901	5.06	3.52	2.71	738.19	209.84	209.84	0.25	0.20
700+00	15.5	3000-cfs	3000.00		46.00	52.10	49.23	52.25	0.000901	6.10	4.35	3.12	961.45	222.21	220.98	0.26	0.24
700+00	15.5	4000-cfs	4000.00		46.00	52.91	49.68	53.10	0.000902	6.91	5.17	3.50	1147.13	231.74	220.98	0.27	0.29
700+00	15.5	5000-cfs	5000.00		46.00	53.65	50.07	53.88	0.000901	7.65	5.90	3.82	1320.59	239.36	220.98	0.28	0.33
700+00	16	100-cfs	100.00	500.00	42.00	47.48	43.22	47.48	0.000009	5.48	2.55	0.21	467.46	183.54	183.54	0.02	0.00
700+00	16	250-cfs	250.00	500.00	42.00	48.32	43.76	48.32	0.000022	6.32	3.28	0.40	624.39	190.49	190.49	0.04	0.00
700+00	16	500-cfs	500.00	500.00	42.00	48.96	44.32	48.97	0.000049	6.96	3.82	0.67	747.76	195.79	195.79	0.06	0.01
700+00	16	750-cfs	750.00	500.00	42.00	49.47	44.73	49.48	0.000075	7.47	4.24	0.88	848.93	200.03	200.03	0.08	0.02
700+00	16	1000-cfs	1000.00	500.00	42.00	49.91	45.07	49.93	0.000098	7.91	4.61	1.07	938.00	203.68	203.68	0.09	0.03
700+00	16	2000-cfs	2000.00	500.00	42.00	51.31	46.04	51.35	0.000171	9.31	5.72	1.63	1230.35	215.25	215.25	0.12	0.06
700+00	16	3000-cfs	3000.00	500.00	42.00	52.39	46.75	52.45	0.000222	10.39	6.64	2.04	1468.05	225.96	220.98	0.14	0.09
700+00	16	4000-cfs	4000.00	500.00	42.00	53.25	47.39	53.34	0.000263	11.25	7.49	2.41	1665.44	235.17	220.98	0.16	0.12
700+00	16	5000-cfs	5000.00	500.00	42.00	54.01	47.79	54.12	0.000283	12.01	8.26	2.67	2061.60	396.15	220.98	0.16	0.14
700+00	17	100-cfs	100.00	917.00	46.00	47.46	46.95	47.51	0.002580	1.46	0.82	1.74	57.64	70.41	70.41	0.34	0.13
700+00	17	250-cfs	250.00	917.00	46.00	48.31	47.37	48.37	0.001634	2.31	1.39	1.96	127.53	92.02	92.02	0.29	0.14
700+00	17	500-cfs	500.00	917.00	46.00	48.95	47.84	49.06	0.002014	2.95	1.84	2.63	190.09	103.20	103.20	0.34	0.23
700+00	17	750-cfs	750.00	917.00	46.00	49.47	48.18	49.61	0.002156	3.47	2.19	3.05	245.66	112.20	112.20	0.36	0.29
700+00	17	1000-cfs	1000.00	917.00	46.00	49.93	48.48	50.09	0.002736	3.93	2.04	3.28	304.99	149.72	149.72	0.40	0.35
700+00	17	2000-cfs	2000.00	917.00	46.00	51.37	49.42	51.57	0.002082	5.37	2.91	3.63	551.09	189.24	189.24	0.37	0.38
700+00	17	3000-cfs	3000.00	917.00	46.00	52.47	50.25	52.70	0.001708	6.47	3.72	3.87	776.13	211.74	208.47	0.35	0.39
700+00	17	4000-cfs	4000.00	917.00	46.00	53.34	50.76	53.61	0.001510	7.34	4.58	4.18	962.82	223.52	208.47	0.34	0.43
700+00	17	5000-cfs	5000.00	917.00	46.00	54.15	51.21	54.35	0.001014	8.15	5.40	3.82	1677.42	514.68	208.47	0.29	0.34
700+00	18	100-cfs	100.00	1461.00	44.00	47.54	44.60	47.54	0.000012	3.54	2.13	0.22	455.55	214.33	214.33	0.03	0.00
700+00	18	250-cfs	250.00	1461.00	44.00	48.42	45.03	48.42	0.000024	4.42	2.92	0.39	647.12	221.74	221.74	0.04	0.00
700+00	18	500-cfs	500.00	1461.00	44.00	49.14	45.52	49.15	0.000046	5.14	3.56	0.62	810.01	227.85	227.85	0.06	0.01
700+00	18	750-cfs	750.00	1461.00	44.00	49.72	45.83	49.73	0.000064	5.72	4.05	0.80	943.30	232.73	232.73	0.07	0.02
700+00	18	1000-cfs	1000.00	1461.00	44.00	50.22	46.06	50.23	0.000079	6.22	4.48	0.94	1060.91	236.96	236.96	0.08	0.02
700+00	18	2000-cfs	2000.00	1461.00	44.00	51.74	46.75	51.77	0.000126	7.74	5.73	1.40	1429.86	249.74	249.74	0.10	0.04
700+00	18	3000-cfs	3000.00	1461.00	44.00	52.88	47.23	52.92	0.000156	8.88	6.81	1.75	1720.22	259.65	251.97	0.12	0.07
700+00	18	4000-cfs	4000.00	1461.00	44.00	53.78	47.63	53.85	0.000183	9.78	7.72	2.05	1959.13	267.81	251.97	0.13	0.09
700+00	18	5000-cfs	5000.00	1461.00	44.00	54.48	47.99	54.55	0.000185	10.48	8.42	2.19	2763.08	600.97	251.97	0.13	0.10
700+00	19	100-cfs	100.00	2058.00	44.00	47.55	44.77	47.55	0.000026	3.55	2.13	0.33	303.65	142.31	142.31	0.04	0.00
700+00	19	250-cfs	250.00	2058.00	44.00	48.43	45.32	48.44	0.000053	4.43	2.93	0.58	432.16	147.29	147.29	0.06	0.01
700+00	19	500-cfs	500.00	2058.00	44.00	49.17	45.83	49.19	0.000103	5.17	3.58	0.92	542.83	151.44	151.44	0.09	0.02
700+00	19	750-cfs	750.00	2058.00	44.00	49.77	46.17	49.79	0.000143	5.77	4.09	1.18	633.31	154.76	154.76	0.10	0.04
700+00	19	1000-cfs	1000.00	2058.00	44.00	50.28	46.44	50.31	0.000175	6.28	4.52	1.40	712.99	157.62	157.62	0.12	0.05
700+00	19	2000-cfs	2000.00	2058.00	44.00	51.82	47.24	51.88	0.000277	7.82	5.79	2.08	962.71	166.28	166.28	0.15	0.10
700+00	19	3000-cfs	3000.00	2058.00	44.00	52.97	47.82	53.07	0.000343	8.97	6.91	2.60	1159.03	175.27	167.30	0.17	0.15
700+00	19	4000-cfs	4000.00	2058.00	44.00	53.88	48.34	54.03	0.000401	9.88	7.82	3.05	1322.67	183.05	167.30	0.19	0.19
700+00	19	5000-cfs	5000.00	2058.00	44.00	54.58	48.81	54.74	0.000410	10.58	8.52	3.27	1861.52	417.18	167.30	0.20	0.21
700+00	20	100-cfs	100.00	2637.00	42.00	47.56	43.73	47.56	0.000032	5.56	2.02	0.35	283.63	140.49	140.49	0.04	0.00
700+00	20	250-cfs	250.00	2637.00	42.00	48.47	44.52	48.47	0.000061	6.47	2.83	0.61	413.12	146.20	146.20	0.06	0.01
700+00	20	500-cfs	500.00	2637.00	42.00	49.24	45.23	49.25	0.000113	7.24	3.49	0.95	527.63	151.08	151.08	0.09	0.02
700+00	20	750-cfs	750.00	2637.00	42.00	49.85	45.72	49.87	0.000152	7.85	4.01	1.21	621.58	154.96	154.96	0.11	0.04
700+00	20	1000-cfs	1000.00	2637.00	42.00	50.38	46.21	50.41	0.000184	8.38	4.45	1.42	704.37	158.30	158.30	0.12	0.05
700+00	20	2000-cfs	2000.00	2637.00	42.00	51.98	47.38	52.05	0.000280	9.98	5.73	2.07	965.82	168.43	168.43	0.15	0.10
700+00	20	3000-cfs	3000.00	2637.00	42.00	53.17	47.98	53.27	0.000336	11.17	6.92	2.57	1175.23	182.02	168.56	0.17	0.14

HEC-RAS Plan: 700 bathym River: Chilkat Reach: 700+00 (Continued)

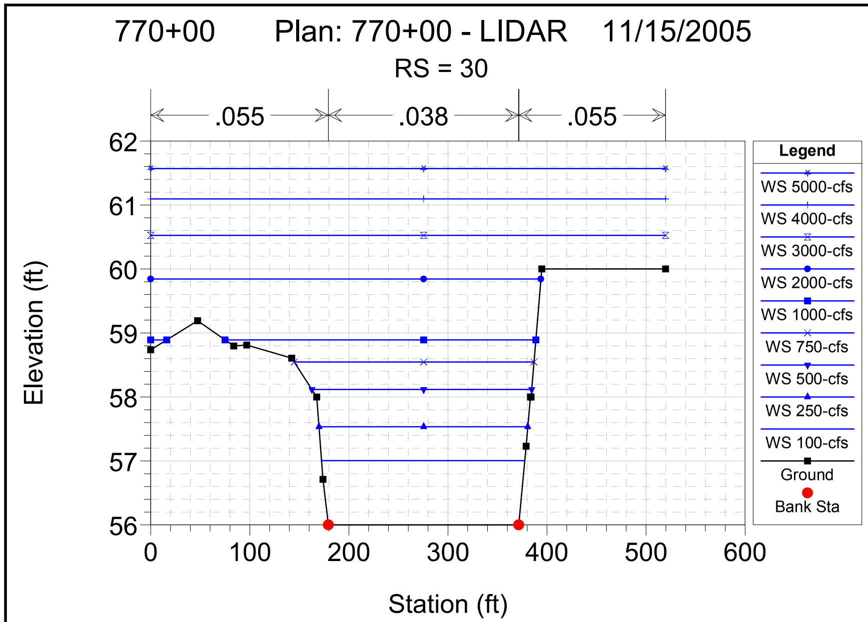
Reach	River Sta	Profile	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
700+00	20	4000-cfs	4000.00	2637.00	42.00	54.12	48.49	54.26	0.000387	12.12	7.87	3.01	1351.54	190.93	168.56	0.19	0.19
700+00	20	5000-cfs	5000.00	2637.00	42.00	54.81	48.97	55.00	0.000453	12.81	8.56	3.44	1489.07	203.13	168.56	0.21	0.24
700+00	21	100-cfs	100.00	3113.00	43.00	47.57	43.61	47.57	0.000005	4.57	3.10	0.18	567.90	183.27	183.27	0.02	0.00
700+00	21	250-cfs	250.00	3113.00	43.00	48.48	43.99	48.48	0.000012	5.48	3.89	0.34	738.14	189.76	189.76	0.03	0.00
700+00	21	500-cfs	500.00	3113.00	43.00	49.27	44.39	49.27	0.000028	6.27	4.56	0.56	889.95	195.37	195.37	0.05	0.01
700+00	21	750-cfs	750.00	3113.00	43.00	49.90	44.71	49.91	0.000041	6.90	5.08	0.74	1014.47	199.85	199.85	0.06	0.01
700+00	21	1000-cfs	1000.00	3113.00	43.00	50.44	44.98	50.46	0.000054	7.44	5.52	0.89	1124.03	203.71	203.71	0.07	0.02
700+00	21	2000-cfs	2000.00	3113.00	43.00	52.09	45.90	52.12	0.000095	9.09	6.84	1.36	1469.86	216.15	214.78	0.09	0.04
700+00	21	3000-cfs	3000.00	3113.00	43.00	53.32	46.45	53.37	0.000123	10.32	8.07	1.73	1746.21	234.92	214.78	0.11	0.06
700+00	21	4000-cfs	4000.00	3113.00	43.00	54.31	46.89	54.37	0.000148	11.31	9.06	2.05	1985.85	250.27	214.78	0.12	0.08
700+00	21	5000-cfs	5000.00	3113.00	43.00	55.05	47.31	55.13	0.000176	12.05	9.80	2.36	2174.76	258.76	214.78	0.13	0.11
700+00	22	100-cfs	100.00	3557.00	46.50	47.57	46.76	47.58	0.000250	1.07	0.90	0.58	173.73	193.42	193.42	0.11	0.01
700+00	22	250-cfs	250.00	3557.00	46.50	48.49	46.97	48.50	0.000159	1.99	1.40	0.62	405.37	289.05	289.05	0.09	0.01
700+00	22	500-cfs	500.00	3557.00	46.50	49.29	47.23	49.30	0.000147	2.79	2.11	0.78	642.33	304.44	304.44	0.09	0.02
700+00	22	750-cfs	750.00	3557.00	46.50	49.93	47.43	49.94	0.000142	3.43	2.65	0.89	840.39	316.72	316.72	0.10	0.02
700+00	22	1000-cfs	1000.00	3557.00	46.50	50.48	47.62	50.49	0.000140	3.98	3.11	0.98	1017.21	327.30	327.30	0.10	0.03
700+00	22	2000-cfs	2000.00	3557.00	46.50	52.15	48.22	52.17	0.000141	5.65	4.46	1.26	1590.87	357.81	356.63	0.10	0.04
700+00	22	3000-cfs	3000.00	3557.00	46.50	53.39	48.59	53.43	0.000140	6.89	5.70	1.47	2041.90	367.31	356.63	0.11	0.05
700+00	22	4000-cfs	4000.00	3557.00	46.50	54.39	48.91	54.44	0.000144	7.89	6.71	1.67	2413.56	374.77	356.63	0.11	0.06
700+00	22	5000-cfs	5000.00	3557.00	46.50	55.16	49.21	55.21	0.000157	8.66	7.47	1.87	2701.53	380.95	356.63	0.12	0.07
700+00	23	100-cfs	100.00	4016.00	49.00	49.24	49.24	49.36	0.036322	0.24	0.23	2.83	35.40	151.64	151.64	1.03	0.53
700+00	23	250-cfs	250.00	4016.00	49.00	49.45	49.45	49.66	0.028268	0.45	0.43	3.72	67.25	158.15	158.15	1.00	0.75
700+00	23	500-cfs	500.00	4016.00	49.00	49.70	49.70	50.03	0.023980	0.70	0.66	4.58	109.29	166.36	166.36	0.99	0.98
700+00	23	750-cfs	750.00	4016.00	49.00	49.91	49.91	50.33	0.022173	0.91	0.84	5.17	144.96	173.02	173.02	1.00	1.16
700+00	23	1000-cfs	1000.00	4016.00	49.00	50.52	50.11	50.76	0.006884	1.52	1.33	3.92	255.18	192.13	192.13	0.60	0.57
700+00	23	2000-cfs	2000.00	4016.00	49.00	52.21	50.70	52.37	0.001853	3.21	2.62	3.20	626.88	249.21	239.06	0.35	0.30
700+00	23	3000-cfs	3000.00	4016.00	49.00	53.44	51.18	53.60	0.001127	4.44	3.85	3.22	968.82	305.98	239.06	0.29	0.27
700+00	23	4000-cfs	4000.00	4016.00	49.00	54.44	51.60	54.61	0.000891	5.44	4.85	3.34	1295.67	348.47	239.06	0.27	0.27
700+00	23	5000-cfs	5000.00	4016.00	49.00	55.20	51.98	55.39	0.000822	6.20	5.61	3.54	1573.30	379.55	239.06	0.26	0.29



Haines Highway – HEC–RAS Schematic

S&HI Station 770+00

inter·fluve, inc.
1020 Wasco Street, Suite I
Hood River, OR 97031
541.386.4591
www.interfluve.com


770+00 Plan: 770+00 - LIDAR 11/15/2005
RS = 30
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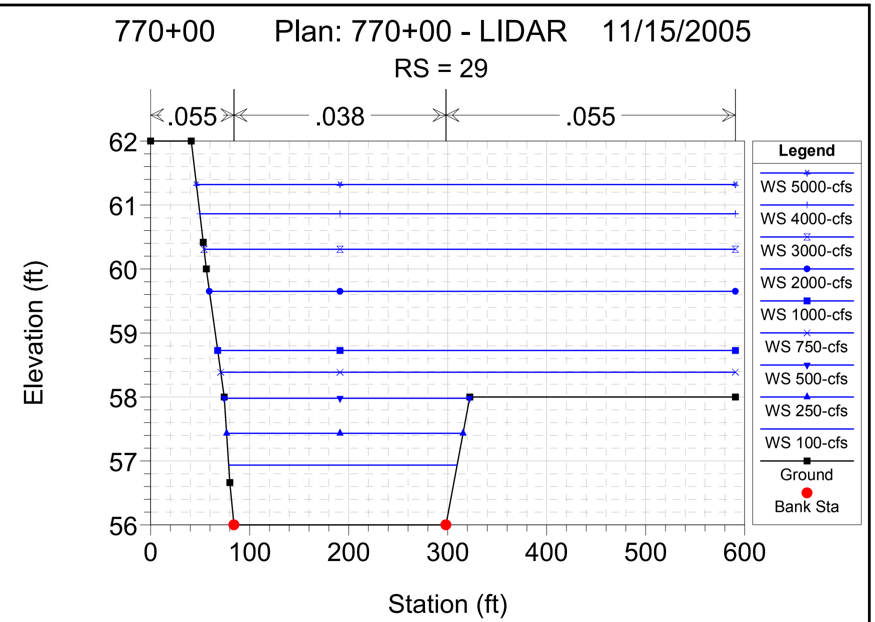
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Bank Sta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Station (ft)
Legend
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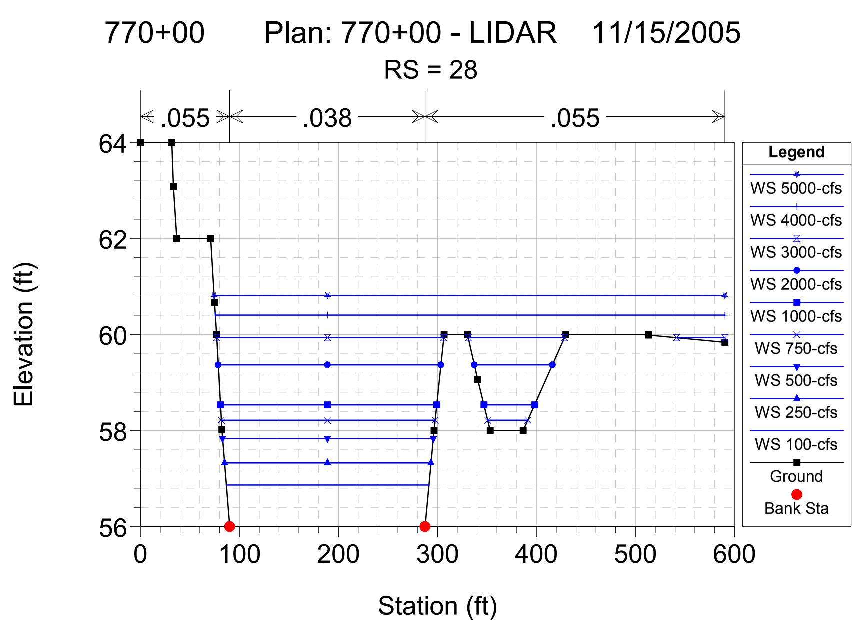
WS 100-cfs
Ground
Bank Sta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Station (ft)
Legend
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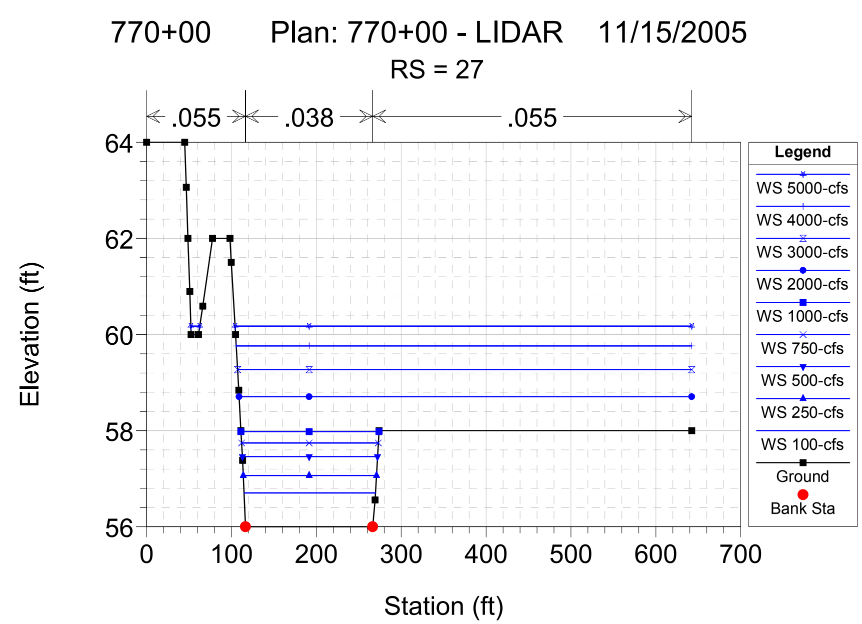
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Bank Sta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Station (ft)
Legend
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WS 1000-cfs
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WS 500-cfs
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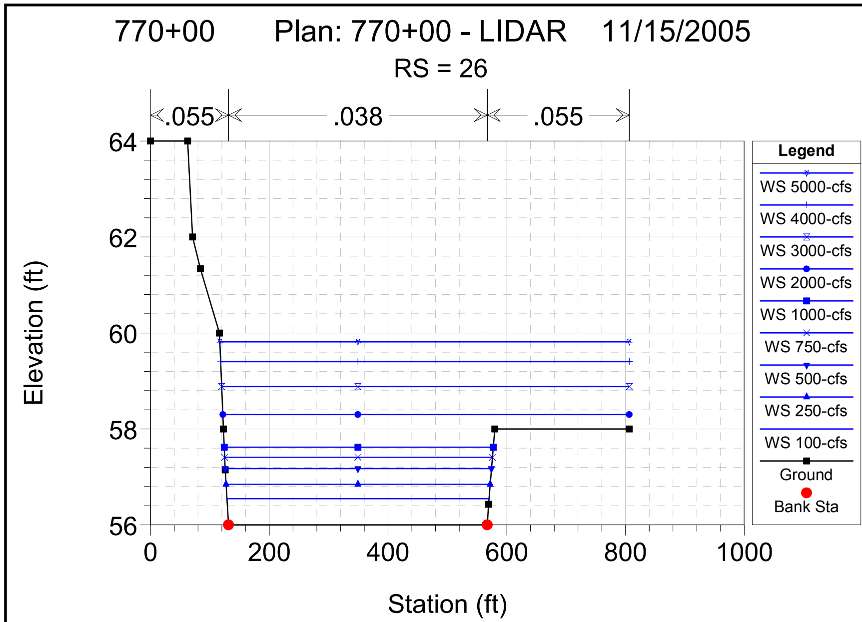
WS 100-cfs
Ground
Bank Sta


770+00 Plan: 770+00 - LIDAR 11/15/2005
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Elevation (ft)
Station (ft)
Legend
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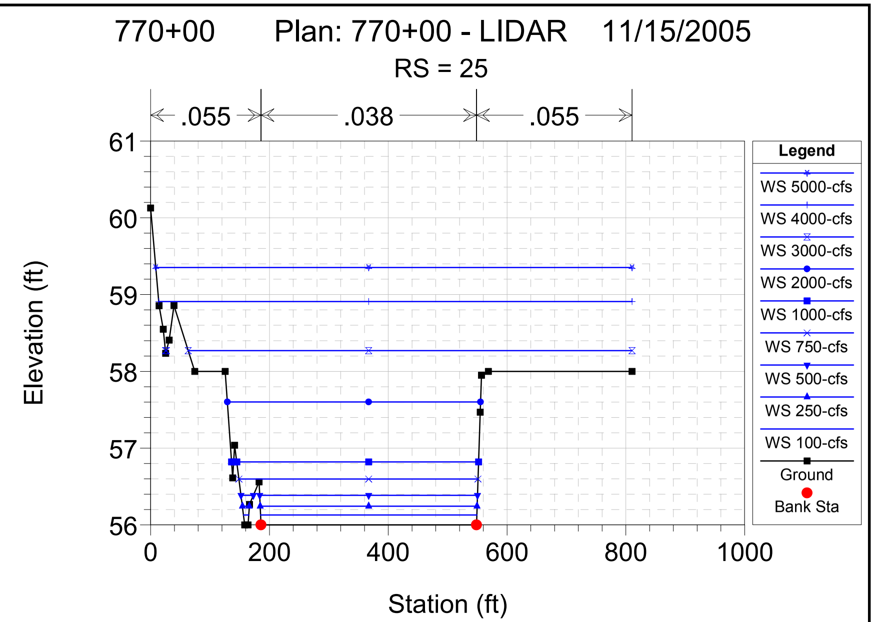
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Bank Sta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Station (ft)
Legend
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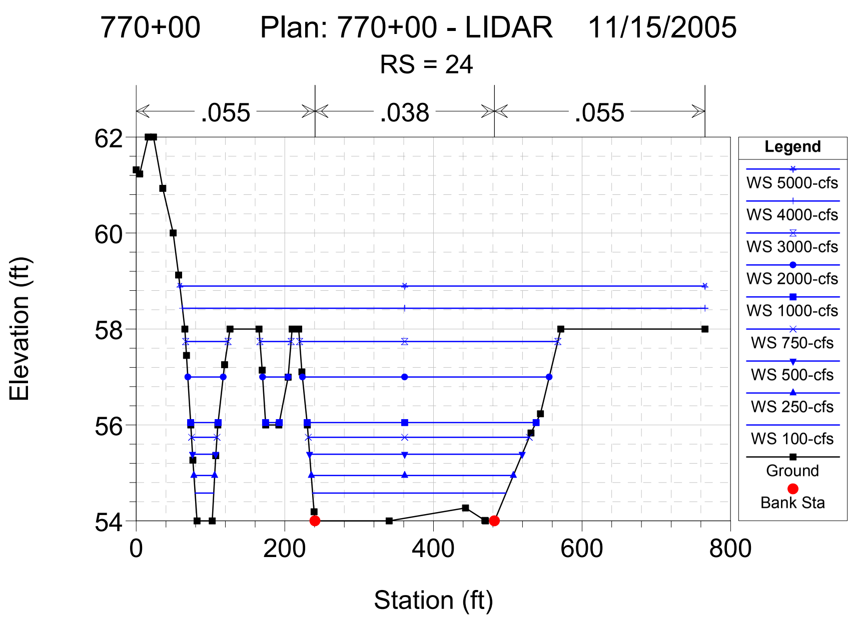
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Bank Sta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Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
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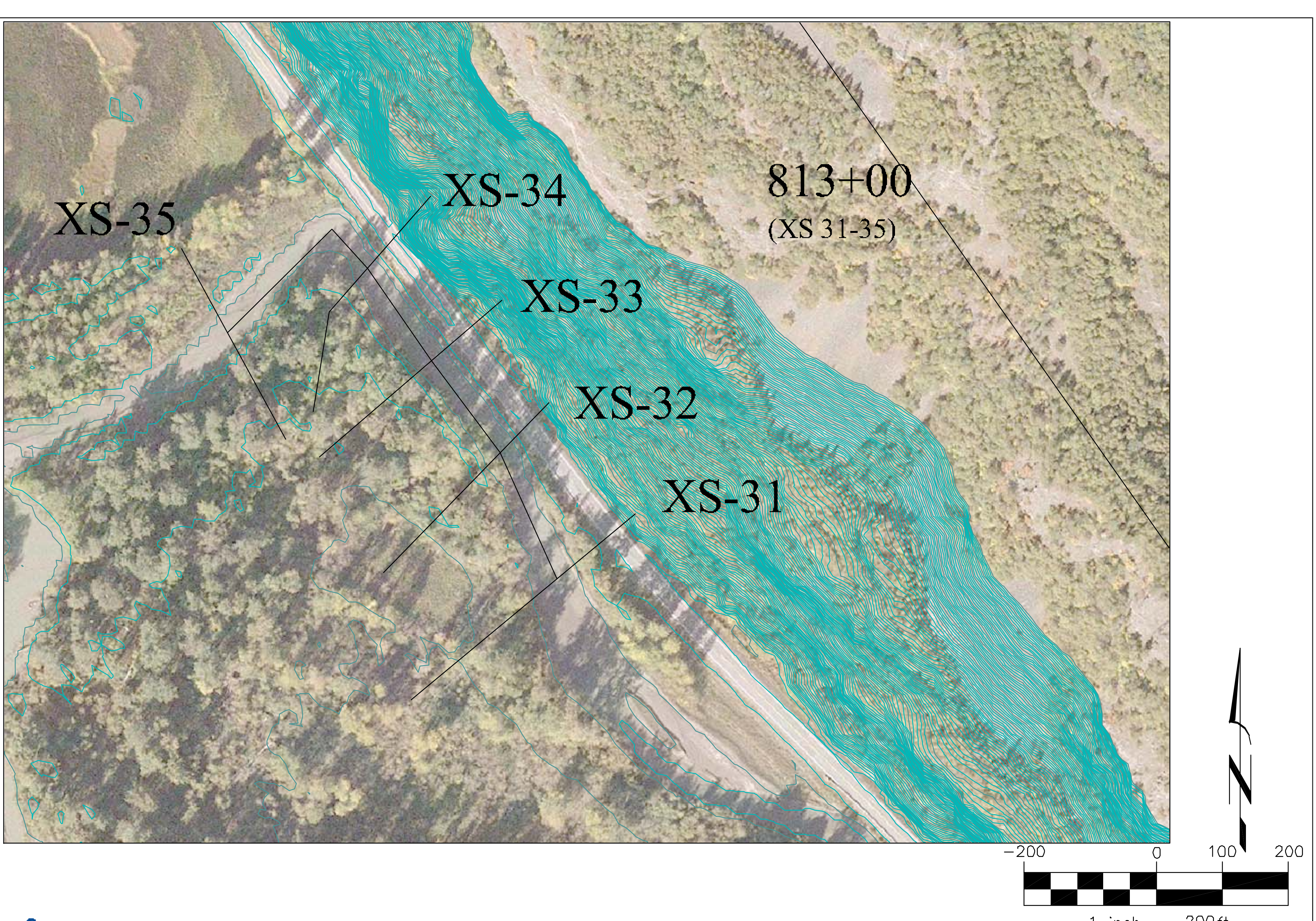
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Bank Sta

HEC-RAS Plan: 770 LIDAR River: Chilkat Reach: 770+00

Reach	River Sta	Profile	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
770+00	24	100-cfs	100.00		54.00	54.58	54.22	54.59	0.000902	0.58	0.51	0.75	140.85	285.28	241.56	0.18	0.03
770+00	24	250-cfs	250.00		54.00	54.95	54.37	54.96	0.000901	0.95	0.87	1.07	248.63	299.88	241.56	0.20	0.05
770+00	24	500-cfs	500.00		54.00	55.39	54.54	55.42	0.000901	1.39	1.32	1.41	385.05	317.32	241.56	0.22	0.07
770+00	24	750-cfs	750.00		54.00	55.74	54.69	55.78	0.000901	1.74	1.67	1.65	499.65	331.42	241.56	0.23	0.09
770+00	24	1000-cfs	1000.00		54.00	56.05	54.82	56.10	0.000901	2.05	1.97	1.85	603.64	363.52	241.56	0.23	0.11
770+00	24	2000-cfs	2000.00		54.00	57.00	55.26	57.08	0.000900	3.00	2.93	2.40	974.70	414.23	241.56	0.25	0.16
770+00	24	3000-cfs	3000.00		54.00	57.74	55.62	57.84	0.000901	3.74	3.66	2.79	1292.48	446.59	241.56	0.26	0.21
770+00	24	4000-cfs	4000.00		54.00	58.43	55.93	58.56	0.000901	4.43	4.36	3.13	1713.72	703.39	241.56	0.26	0.25
770+00	24	5000-cfs	5000.00		54.00	58.90	56.25	59.04	0.000900	4.90	4.82	3.35	2041.28	706.86	241.56	0.27	0.27
770+00	25	100-cfs	100.00	407.00	56.00	56.13	56.13	56.20	0.044458	0.13	0.13	2.11	47.88	372.86	362.68	1.03	0.36
770+00	25	250-cfs	250.00	407.00	56.00	56.24	56.24	56.36	0.033779	0.24	0.24	2.80	90.47	376.87	362.68	1.00	0.51
770+00	25	500-cfs	500.00	407.00	56.00	56.38	56.38	56.58	0.029101	0.38	0.38	3.53	144.53	387.26	362.68	1.00	0.70
770+00	25	750-cfs	750.00	407.00	56.00	56.60	56.50	56.77	0.014831	0.60	0.60	3.38	228.81	402.35	362.68	0.77	0.55
770+00	25	1000-cfs	1000.00	407.00	56.00	56.82	56.61	56.98	0.008984	0.82	0.82	3.25	319.27	410.45	362.68	0.63	0.46
770+00	25	2000-cfs	2000.00	407.00	56.00	57.60		57.76	0.003680	1.60	1.60	3.25	647.77	426.17	362.68	0.45	0.37
770+00	25	3000-cfs	3000.00	407.00	56.00	58.27		58.44	0.002538	2.27	2.27	3.40	1018.33	748.76	362.68	0.40	0.36
770+00	25	4000-cfs	4000.00	407.00	56.00	58.91		59.06	0.001699	2.91	2.91	3.28	1514.20	796.83	362.68	0.34	0.31
770+00	25	5000-cfs	5000.00	407.00	56.00	59.35		59.50	0.001489	3.35	3.35	3.38	1869.56	801.80	362.68	0.33	0.31
770+00	26	100-cfs	100.00	794.00	56.00	56.55		56.55	0.000255	0.55	0.55	0.42	240.23	441.38	435.54	0.10	0.01
770+00	26	250-cfs	250.00	794.00	56.00	56.85		56.85	0.000374	0.85	0.85	0.68	371.97	444.90	435.54	0.13	0.02
770+00	26	500-cfs	500.00	794.00	56.00	57.17		57.19	0.000498	1.17	1.17	0.97	519.07	448.74	435.54	0.16	0.04
770+00	26	750-cfs	750.00	794.00	56.00	57.41		57.43	0.000609	1.41	1.41	1.21	624.74	451.08	435.54	0.18	0.05
770+00	26	1000-cfs	1000.00	794.00	56.00	57.62		57.65	0.000680	1.62	1.62	1.41	719.42	453.17	435.54	0.19	0.07
770+00	26	2000-cfs	2000.00	794.00	56.00	58.30		58.36	0.000823	2.30	2.30	1.95	1097.38	684.37	435.54	0.23	0.12
770+00	26	3000-cfs	3000.00	794.00	56.00	58.88		58.96	0.000803	2.88	2.88	2.24	1497.83	686.38	435.54	0.23	0.14
770+00	26	4000-cfs	4000.00	794.00	56.00	59.40		59.49	0.000771	3.40	3.40	2.46	1853.99	688.17	435.54	0.23	0.16
770+00	26	5000-cfs	5000.00	794.00	56.00	59.81		59.92	0.000788	3.81	3.81	2.68	2138.51	689.59	435.54	0.24	0.19
770+00	27	100-cfs	100.00	1163.00	56.00	56.70		56.72	0.000930	0.70	0.70	0.94	107.12	154.88	149.91	0.20	0.04
770+00	27	250-cfs	250.00	1163.00	56.00	57.07		57.10	0.001435	1.07	1.07	1.55	163.90	156.96	149.91	0.26	0.10
770+00	27	500-cfs	500.00	1163.00	56.00	57.46		57.54	0.002012	1.46	1.46	2.26	225.76	159.25	149.91	0.33	0.18
770+00	27	750-cfs	750.00	1163.00	56.00	57.74		57.86	0.002489	1.74	1.74	2.82	271.26	161.12	149.91	0.38	0.27
770+00	27	1000-cfs	1000.00	1163.00	56.00	57.98		58.15	0.002887	1.98	1.98	3.31	309.45	162.67	149.91	0.41	0.36
770+00	27	2000-cfs	2000.00	1163.00	56.00	58.71		58.93	0.002914	2.71	2.71	4.10	688.64	533.38	149.91	0.44	0.49
770+00	27	3000-cfs	3000.00	1163.00	56.00	59.27		59.50	0.002657	3.27	3.27	4.44	989.60	535.16	149.91	0.43	0.54
770+00	27	4000-cfs	4000.00	1163.00	56.00	59.76		60.01	0.002460	3.76	3.76	4.69	1254.14	536.77	149.91	0.43	0.58
770+00	27	5000-cfs	5000.00	1163.00	56.00	60.17		60.44	0.002406	4.17	4.17	4.97	1476.99	548.51	149.91	0.43	0.63
770+00	28	100-cfs	100.00	1507.00	56.00	56.87		56.87	0.000266	0.87	0.87	0.58	174.35	204.70	197.38	0.11	0.01
770+00	28	250-cfs	250.00	1507.00	56.00	57.33		57.34	0.000398	1.33	1.33	0.94	269.47	208.59	197.38	0.14	0.03
770+00	28	500-cfs	500.00	1507.00	56.00	57.83		57.86	0.000537	1.83	1.83	1.36	376.37	212.87	197.38	0.18	0.06
770+00	28	750-cfs	750.00	1507.00	56.00	58.22		58.26	0.000636	2.22	2.22	1.68	466.22	256.48	197.38	0.20	0.09
770+00	28	1000-cfs	1000.00	1507.00	56.00	58.54		58.59	0.000707	2.54	2.54	1.93	550.45	269.65	197.38	0.21	0.11
770+00	28	2000-cfs	2000.00	1507.00	56.00	59.37		59.48	0.001033	3.37	3.37	2.82	788.57	303.60	197.38	0.27	0.22
770+00	28	3000-cfs	3000.00	1507.00	56.00	59.93		60.11	0.001325	3.93	3.93	3.55	969.21	375.37	197.38	0.32	0.33
770+00	28	4000-cfs	4000.00	1507.00	56.00	60.41		60.65	0.001568	4.41	4.41	4.16	1203.85	514.69	197.38	0.35	0.43
770+00	28	5000-cfs	5000.00	1507.00	56.00	60.82		61.10	0.001671	4.82	4.82	4.56	1415.43	515.97	197.38	0.37	0.50
770+00	29	100-cfs	100.00	1823.00	56.00	56.94		56.94	0.000172	0.94	0.94	0.49	208.31	230.71	214.17	0.09	0.01
770+00	29	250-cfs	250.00	1823.00	56.00	57.43		57.44	0.000256	1.43	1.43	0.79	324.77	238.79	214.17	0.12	0.02
770+00	29	500-cfs	500.00	1823.00	56.00	57.98		58.00	0.000342	1.98	1.98	1.14	457.64	247.69	214.17	0.14	0.04
770+00	29	750-cfs	750.00	1823.00	56.00	58.39		58.41	0.000382	2.39	2.39	1.36	663.66	519.76	214.17	0.16	0.06
770+00	29	1000-cfs	1000.00	1823.00	56.00	58.73		58.76	0.000389	2.73	2.73	1.50	840.59	522.83	214.17	0.16	0.07
770+00	29	2000-cfs	2000.00	1823.00	56.00	59.65		59.70	0.000457	3.65	3.65	1.98	1327.57	531.19	214.17	0.18	0.10
770+00	29	3000-cfs	3000.00	1823.00	56.00	60.31		60.38	0.000521	4.31	4.31	2.36	1678.55	536.60	214.17	0.20	0.14

HEC-RAS Plan: 770 LIDAR River: Chilkat Reach: 770+00 (Continued)

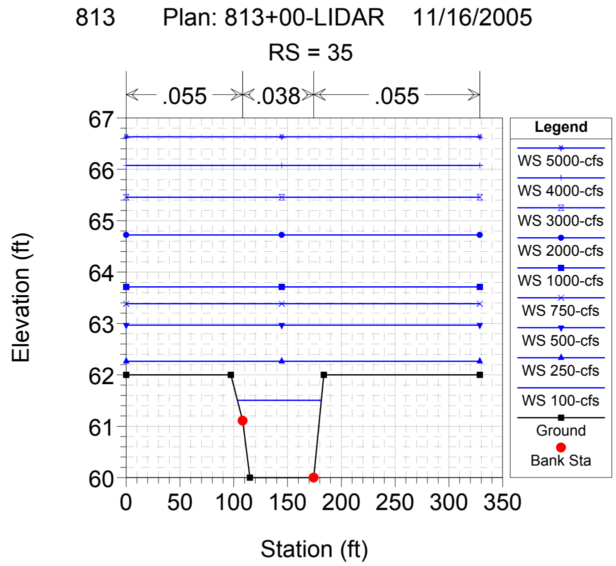
Reach	River Sta	Profile	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
770+00	29	4000-cfs	4000.00	1823.00	56.00	60.86		60.95	0.000569	4.86	4.86	2.68	1977.45	540.83	214.17	0.21	0.17
770+00	29	5000-cfs	5000.00	1823.00	56.00	61.32		61.42	0.000622	5.32	5.32	2.97	2225.05	544.34	214.17	0.23	0.21
770+00	30	100-cfs	100.00	2236.00	56.00	57.01		57.01	0.000169	1.01	1.01	0.51	199.99	205.14	192.13	0.09	0.01
770+00	30	250-cfs	250.00	2236.00	56.00	57.54		57.55	0.000253	1.54	1.54	0.83	310.26	210.79	192.13	0.12	0.02
770+00	30	500-cfs	500.00	2236.00	56.00	58.12		58.14	0.000344	2.12	2.12	1.20	434.98	221.90	192.13	0.14	0.05
770+00	30	750-cfs	750.00	2236.00	56.00	58.55		58.58	0.000414	2.55	2.55	1.48	534.45	242.02	192.13	0.16	0.07
770+00	30	1000-cfs	1000.00	2236.00	56.00	58.89		58.94	0.000478	2.89	2.89	1.73	630.45	329.87	192.13	0.18	0.09
770+00	30	2000-cfs	2000.00	2236.00	56.00	59.84		59.93	0.000639	3.84	3.84	2.43	994.40	393.87	192.13	0.22	0.15
770+00	30	3000-cfs	3000.00	2236.00	56.00	60.53		60.64	0.000750	4.53	4.53	2.93	1328.63	519.66	192.13	0.24	0.21
770+00	30	4000-cfs	4000.00	2236.00	56.00	61.10		61.23	0.000798	5.10	5.10	3.27	1624.97	519.66	192.13	0.26	0.25
770+00	30	5000-cfs	5000.00	2236.00	56.00	61.57		61.73	0.000852	5.57	5.57	3.59	1871.53	519.66	192.13	0.27	0.30

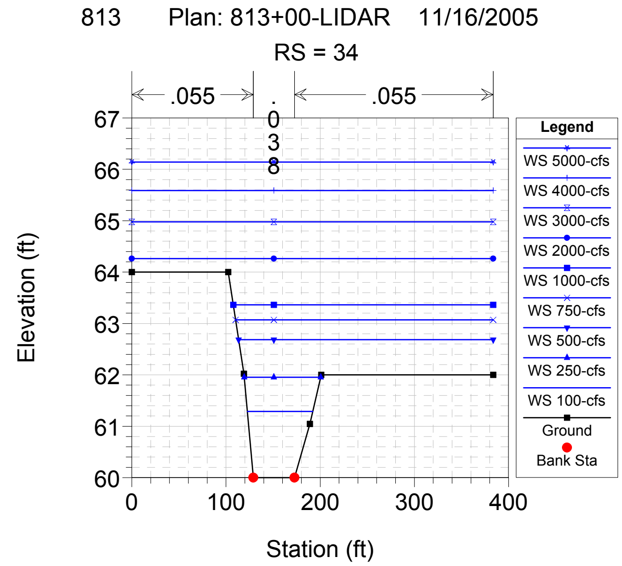


Haines Highway – HEC-RAS Schematic

S&HI Station 813+00

inter·fluve, inc.
1020 Wasco Street, Suite I
Hood River, OR 97031
541.386.4591
www.interfluve.com


813 Plan: 813+00-LIDAR 11/16/2005
RS = 35
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Bank Sta


813 Plan: 813+00-LIDAR 11/16/2005
RS = 34
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
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WS 4000-cfs
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WS 750-cfs
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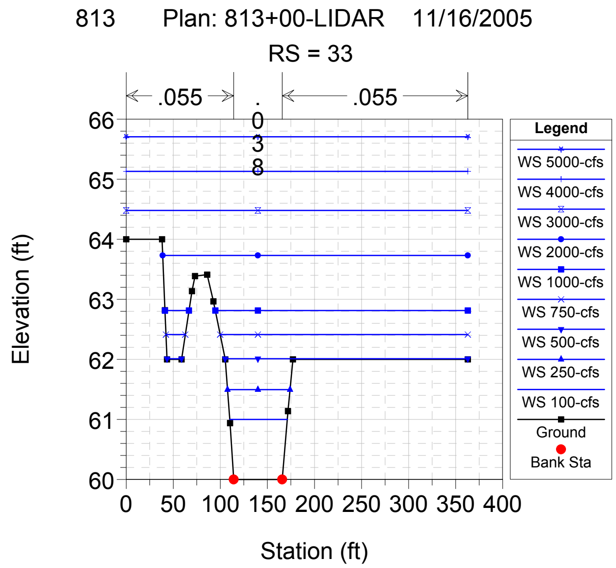
WS 250-cfs
WS 100-cfs
Ground
Bank Sta


813 Plan: 813+00-LIDAR 11/16/2005
RS = 33
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.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
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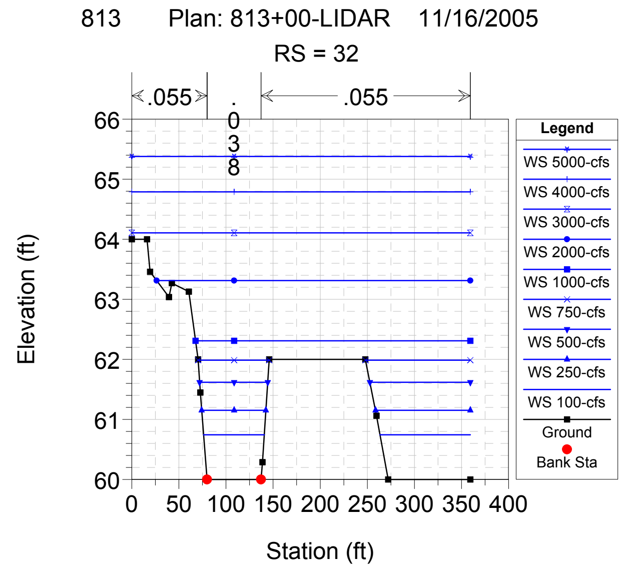
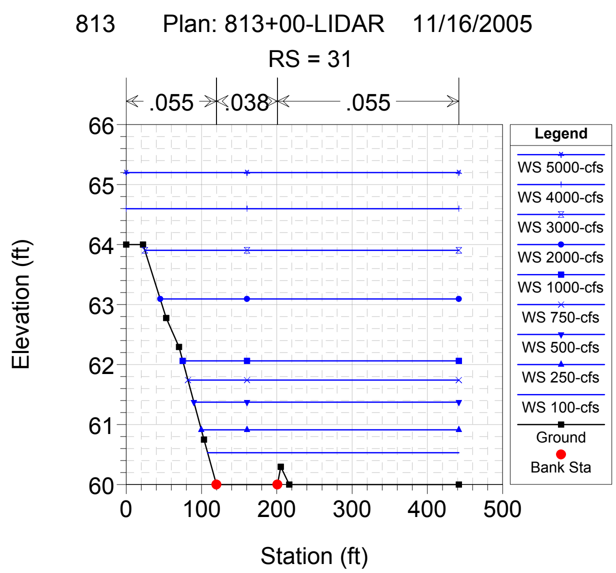
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Bank Sta


813 Plan: 813+00-LIDAR 11/16/2005
RS = 32
.055
.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Bank Sta


813 Plan: 813+00-LIDAR 11/16/2005
RS = 31
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.038
.055
Elevation (ft)
Station (ft)
Legend
WS 5000-cfs
WS 4000-cfs
WS 3000-cfs
WS 2000-cfs
WS 1000-cfs
WS 750-cfs
WS 500-cfs
WS 250-cfs
WS 100-cfs
Ground
Bank Sta

HEC-RAS Plan: 813 LIDAR River: Chilkat Reach: 813+00

Reach	River Sta	Profile	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
813+00	31	100-cfs	100.00		60.00	60.53	60.15	60.54	0.000901	0.53	0.53	0.77	171.75	333.76	80.92	0.19	0.03
813+00	31	250-cfs	250.00		60.00	60.91	60.28	60.92	0.000901	0.91	0.91	1.10	300.43	342.10	80.92	0.20	0.05
813+00	31	500-cfs	500.00		60.00	61.37	60.44	61.39	0.000900	1.37	1.37	1.45	460.20	351.95	80.92	0.22	0.08
813+00	31	750-cfs	750.00		60.00	61.74	60.58	61.77	0.000901	1.74	1.74	1.70	591.74	359.85	80.92	0.23	0.10
813+00	31	1000-cfs	1000.00		60.00	62.06	60.69	62.10	0.000900	2.06	2.06	1.90	708.19	366.71	80.92	0.23	0.12
813+00	31	2000-cfs	2000.00		60.00	63.09	61.09	63.15	0.000901	3.09	3.09	2.49	1101.13	396.63	80.92	0.25	0.17
813+00	31	3000-cfs	3000.00		60.00	63.90	61.42	63.98	0.000900	3.90	3.90	2.91	1431.83	417.03	80.92	0.26	0.22
813+00	31	4000-cfs	4000.00		60.00	64.60	61.72	64.70	0.000901	4.60	4.60	3.25	1736.04	441.79	80.92	0.27	0.26
813+00	31	5000-cfs	5000.00		60.00	65.20	61.99	65.31	0.000901	5.20	5.20	3.52	2001.32	441.79	80.92	0.27	0.29
813+00	32	100-cfs	100.00	209.00	60.00	60.74		60.76	0.001222	0.74	0.74	1.12	113.37	160.32	57.37	0.23	0.06
813+00	32	250-cfs	250.00	209.00	60.00	61.15		61.19	0.001740	1.15	1.15	1.79	180.50	168.88	57.37	0.29	0.13
813+00	32	500-cfs	500.00	209.00	60.00	61.62		61.69	0.002180	1.62	1.62	2.52	261.91	178.96	57.37	0.35	0.22
813+00	32	750-cfs	750.00	209.00	60.00	61.99		62.08	0.002436	1.99	1.99	3.05	328.87	186.69	57.37	0.38	0.30
813+00	32	1000-cfs	1000.00	209.00	60.00	62.31		62.45	0.003099	2.31	2.31	3.80	421.50	291.70	57.37	0.44	0.45
813+00	32	2000-cfs	2000.00	209.00	60.00	63.31		63.48	0.002502	3.31	3.31	4.34	721.98	332.96	57.37	0.42	0.52
813+00	32	3000-cfs	3000.00	209.00	60.00	64.11		64.30	0.002216	4.11	4.11	4.72	994.85	359.39	57.37	0.41	0.57
813+00	32	4000-cfs	4000.00	209.00	60.00	64.79		65.00	0.002034	4.79	4.79	5.01	1240.06	359.39	57.37	0.40	0.61
813+00	32	5000-cfs	5000.00	209.00	60.00	65.38		65.62	0.001953	5.38	5.38	5.31	1452.26	359.39	57.37	0.40	0.66
813+00	33	100-cfs	100.00	383.00	60.00	61.00		61.05	0.002276	1.00	1.00	1.87	56.29	61.02	51.61	0.33	0.14
813+00	33	250-cfs	250.00	383.00	60.00	61.50		61.64	0.003579	1.50	1.50	3.06	87.88	66.35	51.61	0.44	0.33
813+00	33	500-cfs	500.00	383.00	60.00	62.01	61.39	62.33	0.005503	2.01	2.01	4.62	125.49	273.31	51.61	0.57	0.69
813+00	33	750-cfs	750.00	383.00	60.00	62.41		62.73	0.004907	2.41	2.41	4.93	237.69	283.60	51.61	0.56	0.74
813+00	33	1000-cfs	1000.00	383.00	60.00	62.81		63.07	0.003722	2.81	2.81	4.75	353.07	293.81	51.61	0.50	0.65
813+00	33	2000-cfs	2000.00	383.00	60.00	63.73		64.00	0.003286	3.73	3.73	5.39	637.42	324.13	51.61	0.49	0.77
813+00	33	3000-cfs	3000.00	383.00	60.00	64.48		64.77	0.002948	4.48	4.48	5.77	898.61	362.90	51.61	0.48	0.82
813+00	33	4000-cfs	4000.00	383.00	60.00	65.13		65.43	0.002643	5.13	5.13	5.98	1134.86	362.90	51.61	0.47	0.85
813+00	33	5000-cfs	5000.00	383.00	60.00	65.71		66.02	0.002476	5.71	5.71	6.21	1343.71	362.90	51.61	0.46	0.88
813+00	34	100-cfs	100.00	554.00	60.00	61.29		61.32	0.001149	1.29	1.29	1.57	73.26	69.51	43.70	0.24	0.09
813+00	34	250-cfs	250.00	554.00	60.00	61.95		62.03	0.001600	1.95	1.95	2.44	123.42	81.21	43.70	0.31	0.20
813+00	34	500-cfs	500.00	554.00	60.00	62.68		62.77	0.001361	2.68	2.68	2.79	310.10	270.16	43.70	0.30	0.23
813+00	34	750-cfs	750.00	554.00	60.00	63.07		63.17	0.001446	3.07	3.07	3.14	414.99	273.41	43.70	0.32	0.28
813+00	34	1000-cfs	1000.00	554.00	60.00	63.36		63.47	0.001577	3.36	3.36	3.49	495.45	275.88	43.70	0.33	0.33
813+00	34	2000-cfs	2000.00	554.00	60.00	64.26		64.44	0.001962	4.26	4.26	4.55	773.85	383.62	43.70	0.39	0.52
813+00	34	3000-cfs	3000.00	554.00	60.00	64.98		65.18	0.001947	4.98	4.98	5.03	1047.78	383.62	43.70	0.40	0.60
813+00	34	4000-cfs	4000.00	554.00	60.00	65.59		65.81	0.001930	5.59	5.59	5.41	1281.67	383.62	43.70	0.40	0.67
813+00	34	5000-cfs	5000.00	554.00	60.00	66.14		66.39	0.001905	6.14	6.14	5.72	1494.05	383.62	43.70	0.41	0.73
813+00	35	100-cfs	100.00	855.00	60.00	61.50		61.52	0.000414	1.50	1.45	1.02	101.99	78.01	66.11	0.15	0.04
813+00	35	250-cfs	250.00	855.00	60.00	62.27		62.30	0.000542	2.27	2.21	1.54	230.14	328.74	66.11	0.18	0.07
813+00	35	500-cfs	500.00	855.00	60.00	62.97		63.00	0.000486	2.97	2.91	1.76	461.31	328.74	66.11	0.18	0.09
813+00	35	750-cfs	750.00	855.00	60.00	63.38		63.43	0.000547	3.38	3.33	2.04	597.63	328.74	66.11	0.20	0.11
813+00	35	1000-cfs	1000.00	855.00	60.00	63.71		63.76	0.000609	3.71	3.66	2.29	705.40	328.74	66.11	0.21	0.14
813+00	35	2000-cfs	2000.00	855.00	60.00	64.72		64.81	0.000772	4.72	4.67	3.03	1037.31	328.74	66.11	0.25	0.22
813+00	35	3000-cfs	3000.00	855.00	60.00	65.46		65.57	0.000910	5.46	5.40	3.63	1278.92	328.74	66.11	0.28	0.31
813+00	35	4000-cfs	4000.00	855.00	60.00	66.08		66.23	0.001018	6.08	6.02	4.13	1482.86	328.74	66.11	0.30	0.38
813+00	35	5000-cfs	5000.00	855.00	60.00	66.63		66.82	0.001102	6.63	6.58	4.55	1665.84	328.74	66.11	0.31	0.45

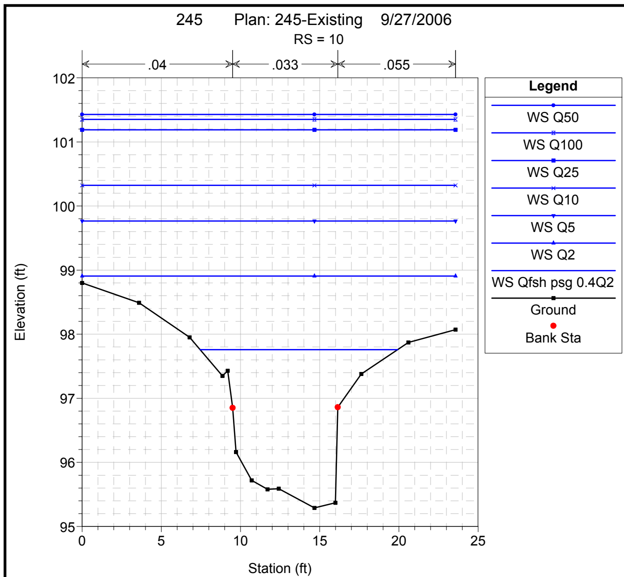
23.5.2 Hydraulic Output – Tributaries

Conversion from relative datum: As described in Section 3.2 cursory survey was collected as part of Inter-Fluve's October 2005 field investigations. These survey data were used for the preliminary HEC-RAS hydraulic modeling shown in this appendix. Approximate conversions to ADOT&PF datum was obtained by comparing elevations of features at each site surveyed by Inter-Fluve and ADOT&PF or Toner-Nordling. The approximate datum conversion is noted below. Subtract the elevation difference noted in the table from the Inter-Fluve survey and models for stations noted in the table to obtain approximate ADOT&PF elevations. Elevations for culverts not noted in the table are based on ADOT&PF datum. Design level survey of stream cross sections, topography, bathymetry and profiles – based on ADOT&PF project datum - will be required at all culverts to finalize designs for submittal at Plans-in-Hand.

Culvert (2009 Stationing)	Datum conversion elevation difference (IFI interim datum) – (elevation difference) ~ (ADOT&PF datum)
222+51	74.42-ft
319+13	68.83-ft
324+79	69.17-ft
483+18	57.63-ft
512+24	57.88-ft

Tributary 222+51 HEC-RAS

Companion 2006 Stream and Habitat Inventory (S&HI) station 245+50
Model based on relative datum. Subtract 74.42-ft for approximate conversion to ADOT&PF project datum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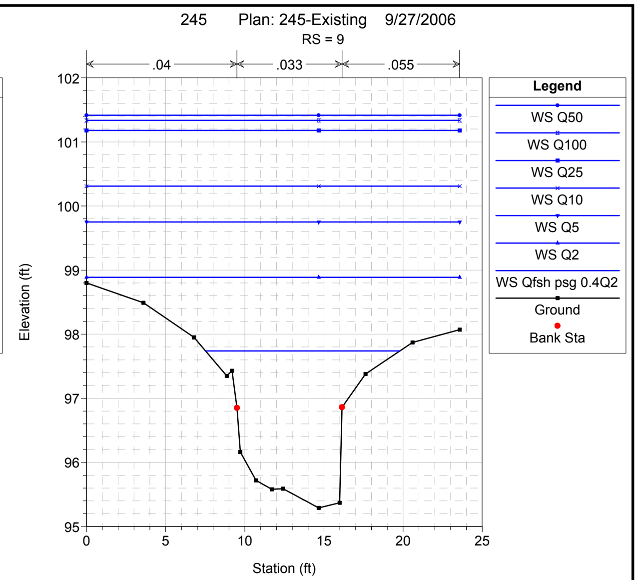
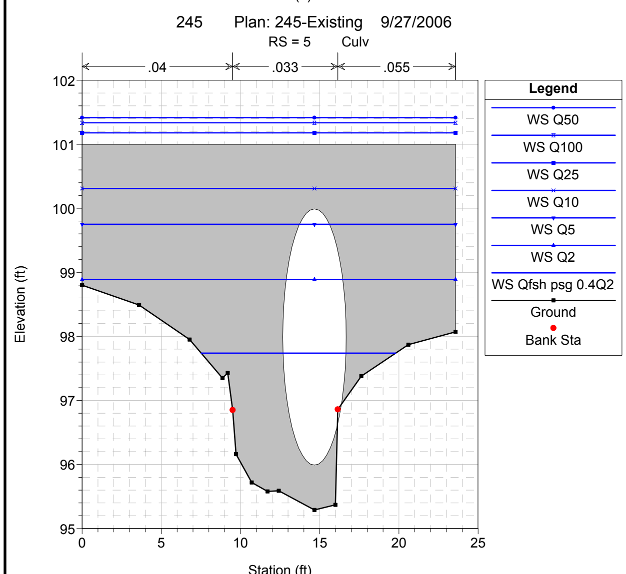
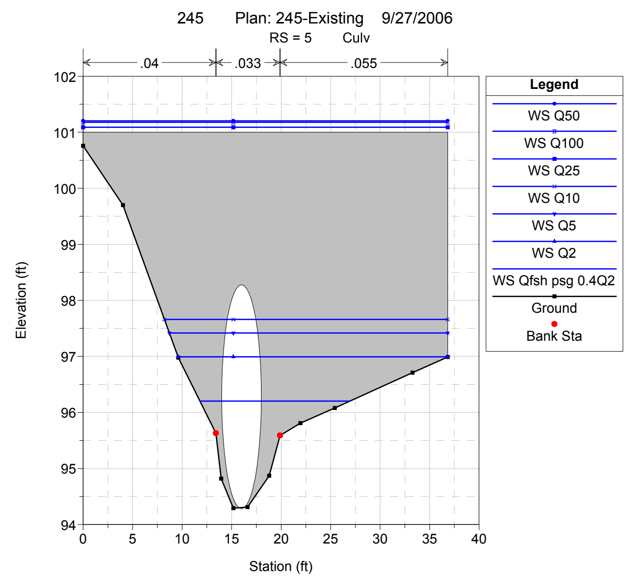
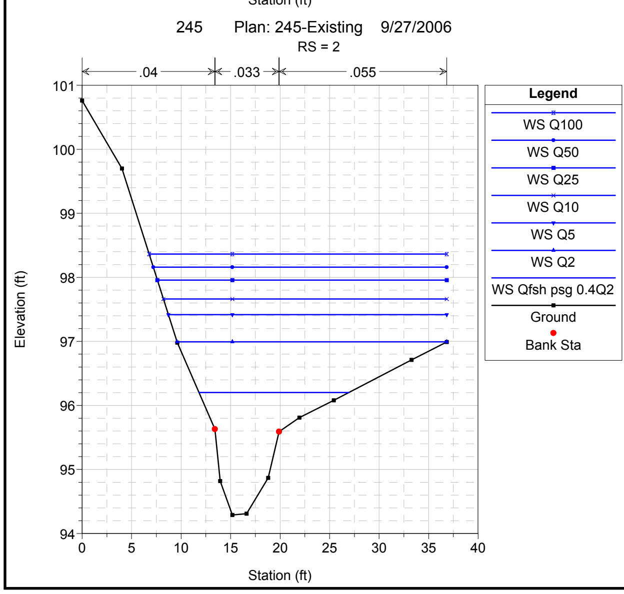
RS = 10
.04
.033
.055
Elevation (ft)
Station (ft)
Legend
WS Q50
WS Q100
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfsh psg 0.4Q2
Ground
Bank Sta


245 Plan: 245-Existing 9/27/2006
RS = 9
.04
.033
.055
Elevation (ft)
Station (ft)
Legend
WS Q50
WS Q100
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfsh psg 0.4Q2
Ground
Bank Sta


245 Plan: 245-Existing 9/27/2006
RS = 5 Culv
.04
.033
.055
Elevation (ft)
Station (ft)
Legend
WS Q50
WS Q100
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfsh psg 0.4Q2
Ground
Bank Sta


245 Plan: 245-Existing 9/27/2006
RS = 5 Culv
.04
.033
.055
Elevation (ft)
Station (ft)
Legend
WS Q50
WS Q100
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfsh psg 0.4Q2
Ground
Bank Sta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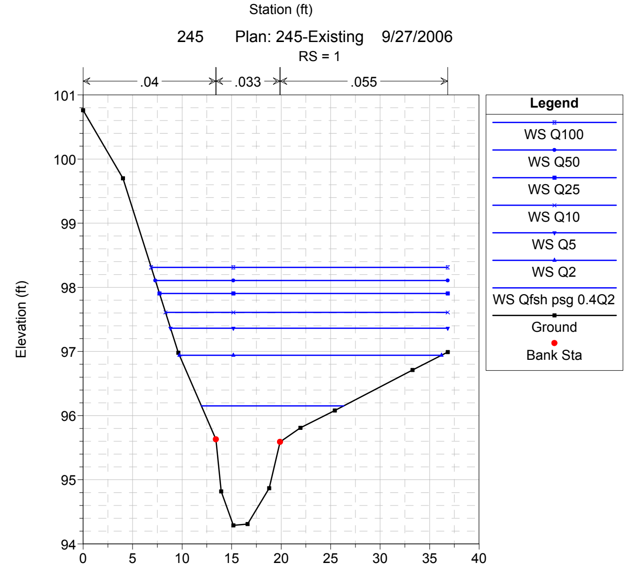
RS = 2
.04
.033
.055
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfsh psg 0.4Q2
Ground
Bank Sta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RS = 1
.04
.033
.055
Elevation (ft)
Station (ft)
Legend
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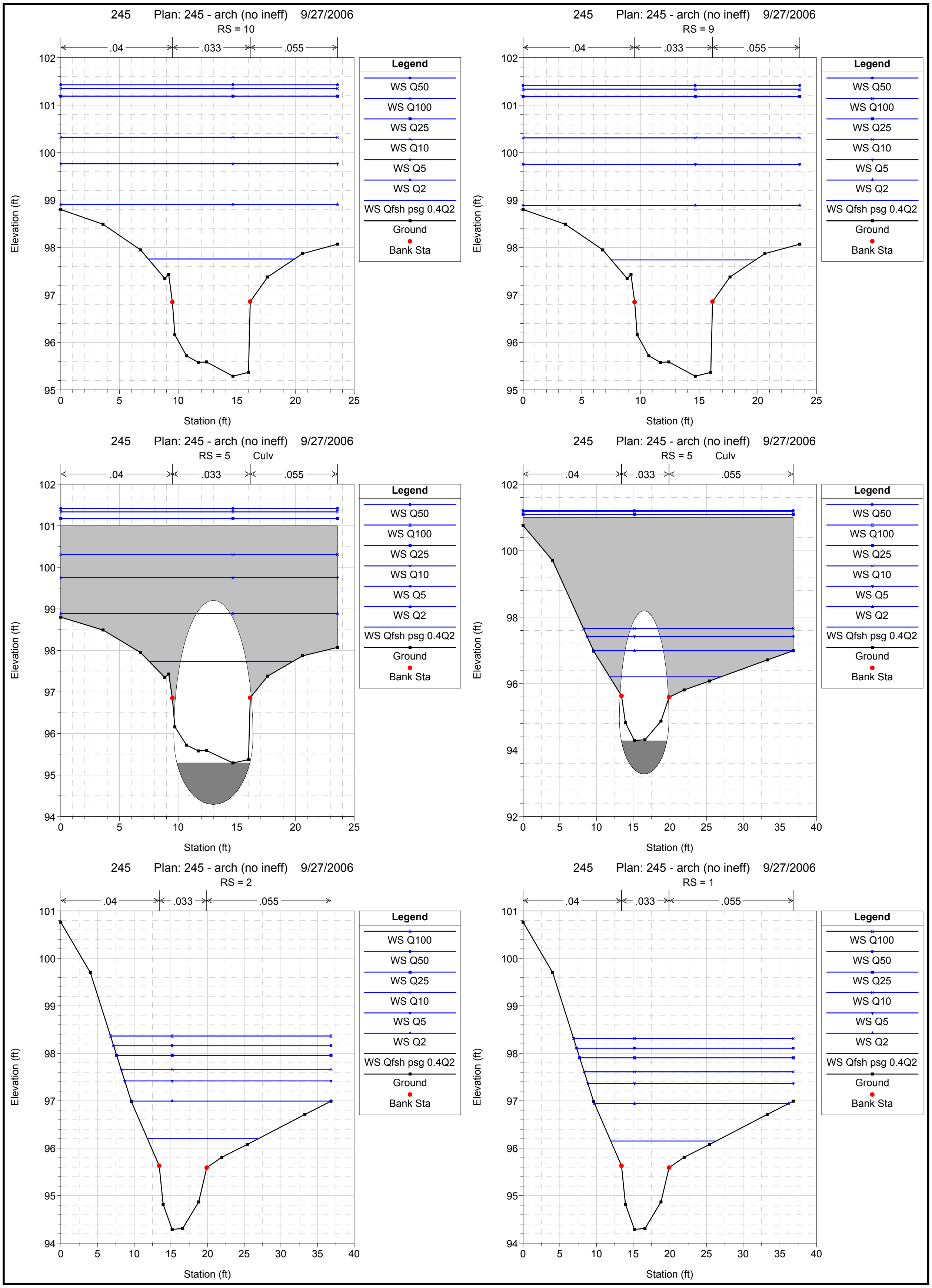
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfsh psg 0.4Q2
Ground
Bank Sta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RS = 10
.04
.033
.055
Legend
WS Q50
WS Q100
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfsh psg 0.4Q2
Ground
Bank Sta
Elevation (ft)
Station (ft)
245 Plan: 245 - arch (no ineff) 9/27/2006
RS = 9
245 Plan: 245 - arch (no ineff) 9/27/2006
RS = 5 Culv
245 Plan: 245 - arch (no ineff) 9/27/2006
RS = 5 Culv
245 Plan: 245 - arch (no ineff) 9/27/2006
RS = 2
245 Plan: 245 - arch (no ineff) 9/27/2006
RS = 1

HEC-RAS River: Trib 245 Reach: 245

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
245	1	Lo	Arch -noinef	5.00		94.29	95.37	94.81	95.39	0.001001	1.08	0.76	1.11	4.51	5.97	5.97	0.22	0.04
245	1	Lo	245-Ex	5.00		94.29	95.37	94.81	95.39	0.001001	1.08	0.76	1.11	4.51	5.97	5.97	0.22	0.04
245	1	Lo	Arch -noinef	10.00		94.29	95.78	95.01	95.81	0.001001	1.49	1.10	1.40	7.32	8.67	6.48	0.24	0.06
245	1	Lo	245-Ex	10.00		94.29	95.78	95.01	95.81	0.001001	1.49	1.10	1.40	7.32	8.67	6.48	0.24	0.06
245	1	Qfsh psg 0.4Q2	Arch -noinef	17.00		94.29	96.15	95.23	96.20	0.001001	1.86	1.47	1.70	11.61	14.40	6.48	0.25	0.08
245	1	Qfsh psg 0.4Q2	245-Ex	17.00		94.29	96.15	95.23	96.20	0.001001	1.86	1.47	1.70	11.61	14.40	6.48	0.25	0.08
245	1	Lo	Arch -noinef	30.00		94.29	96.62	95.54	96.68	0.001002	2.33	1.94	2.05	20.06	21.57	6.48	0.26	0.11
245	1	Lo	245-Ex	30.00		94.29	96.62	95.54	96.68	0.001002	2.33	1.94	2.05	20.06	21.57	6.48	0.26	0.11
245	1	Q2	Arch -noinef	42.00		94.29	96.94	95.79	97.00	0.001000	2.65	2.26	2.26	27.68	26.48	6.48	0.27	0.13
245	1	Q2	245-Ex	42.00		94.29	96.94	95.79	97.00	0.001000	2.65	2.26	2.26	27.68	26.48	6.48	0.27	0.13
245	1	Q5	Arch -noinef	64.00		94.29	97.36	96.22	97.44	0.001001	3.07	2.68	2.54	39.36	28.02	6.48	0.27	0.15
245	1	Q5	245-Ex	64.00		94.29	97.36	96.22	97.44	0.001001	3.07	2.68	2.54	39.36	28.02	6.48	0.27	0.15
245	1	Q10	Arch -noinef	79.00		94.29	97.61	96.43	97.69	0.001001	3.32	2.93	2.69	46.29	28.52	6.48	0.28	0.16
245	1	Q10	245-Ex	79.00		94.29	97.61	96.43	97.69	0.001001	3.32	2.93	2.69	46.29	28.52	6.48	0.28	0.16
245	1	Q25	Arch -noinef	99.00		94.29	97.90	96.66	97.99	0.001001	3.61	3.22	2.87	54.79	29.13	6.48	0.28	0.18
245	1	Q25	245-Ex	99.00		94.29	97.90	96.66	97.99	0.001001	3.61	3.22	2.87	54.79	29.13	6.48	0.28	0.18
245	1	Q50	Arch -noinef	114.00		94.29	98.11	96.80	98.20	0.001002	3.82	3.43	2.99	60.72	29.54	6.48	0.28	0.19
245	1	Q50	245-Ex	114.00		94.29	98.11	96.80	98.20	0.001002	3.82	3.43	2.99	60.72	29.54	6.48	0.28	0.19
245	1	Q100	Arch -noinef	130.00		94.29	98.31	96.98	98.41	0.001001	4.02	3.63	3.10	66.80	29.96	6.48	0.29	0.20
245	1	Q100	245-Ex	130.00		94.29	98.31	96.98	98.41	0.001001	4.02	3.63	3.10	66.80	29.96	6.48	0.29	0.20
245	2	Lo	Arch -noinef	5.00	49.00	94.29	95.42		95.43	0.000840	1.13	0.79	1.04	4.80	6.07	6.07	0.21	0.04
245	2	Lo	245-Ex	5.00	49.00	94.29	95.42		95.43	0.000840	1.13	0.79	1.04	4.80	6.07	6.07	0.21	0.04
245	2	Lo	Arch -noinef	10.00	49.00	94.29	95.83		95.86	0.000862	1.54	1.15	1.34	7.75	9.32	6.48	0.22	0.05
245	2	Lo	245-Ex	10.00	49.00	94.29	95.83		95.86	0.000862	1.54	1.15	1.34	7.75	9.32	6.48	0.22	0.05
245	2	Qfsh psg 0.4Q2	Arch -noinef	17.00	49.00	94.29	96.20		96.24	0.000879	1.91	1.52	1.63	12.36	15.16	6.48	0.23	0.07
245	2	Qfsh psg 0.4Q2	245-Ex	17.00	49.00	94.29	96.20		96.24	0.000879	1.91	1.52	1.63	12.36	15.16	6.48	0.23	0.07
245	2	Lo	Arch -noinef	30.00	49.00	94.29	96.67		96.73	0.000893	2.38	1.99	1.97	21.20	22.36	6.48	0.25	0.10
245	2	Lo	245-Ex	30.00	49.00	94.29	96.67		96.73	0.000893	2.38	1.99	1.97	21.20	22.36	6.48	0.25	0.10
245	2	Q2	Arch -noinef	42.00	49.00	94.29	96.99		97.05	0.000900	2.70	2.31	2.18	29.09	27.26	6.48	0.25	0.12
245	2	Q2	245-Ex	42.00	49.00	94.29	96.99		97.05	0.000900	2.70	2.31	2.18	29.09	27.26	6.48	0.25	0.12
245	2	Q5	Arch -noinef	64.00	49.00	94.29	97.42		97.48	0.000910	3.13	2.74	2.45	40.85	28.13	6.48	0.26	0.14
245	2	Q5	245-Ex	64.00	49.00	94.29	97.42		97.48	0.000910	3.13	2.74	2.45	40.85	28.13	6.48	0.26	0.14
245	2	Q10	Arch -noinef	79.00	49.00	94.29	97.66		97.74	0.000919	3.37	2.98	2.61	47.80	28.63	6.48	0.27	0.15
245	2	Q10	245-Ex	79.00	49.00	94.29	97.66		97.74	0.000919	3.37	2.98	2.61	47.80	28.63	6.48	0.27	0.15
245	2	Q25	Arch -noinef	99.00	49.00	94.29	97.96		98.04	0.000928	3.67	3.28	2.79	56.32	29.24	6.48	0.27	0.17
245	2	Q25	245-Ex	99.00	49.00	94.29	97.96		98.04	0.000928	3.67	3.28	2.79	56.32	29.24	6.48	0.27	0.17
245	2	Q50	Arch -noinef	114.00	49.00	94.29	98.16		98.24	0.000934	3.87	3.48	2.92	62.28	29.65	6.48	0.28	0.18
245	2	Q50	245-Ex	114.00	49.00	94.29	98.16		98.24	0.000934	3.87	3.48	2.92	62.28	29.65	6.48	0.28	0.18
245	2	Q100	Arch -noinef	130.00	49.00	94.29	98.36		98.45	0.000937	4.07	3.68	3.03	68.39	30.07	6.48	0.28	0.19
245	2	Q100	245-Ex	130.00	49.00	94.29	98.36		98.45	0.000938	4.07	3.68	3.03	68.38	30.07	6.48	0.28	0.19
245	5			Culvert														
245	9	Lo	Arch -noinef	5.00	121.00	95.29	95.77	95.77	95.92	0.026851	0.48	0.29	3.12	1.60	5.44	5.44	1.01	0.46
245	9	Lo	245-Ex	5.00	121.00	95.29	96.94	95.77	96.94	0.000147	1.65	1.35	0.56	8.96	6.90	6.63	0.08	0.01
245	9	Lo	Arch -noinef	10.00	121.00	95.29	95.95	95.95	96.18	0.024210	0.66	0.45	3.83	2.61	5.86	5.86	1.01	0.61
245	9	Lo	245-Ex	10.00	121.00	95.29	97.32	95.95	97.33	0.000252	2.03	1.73	0.87	11.85	8.21	6.63	0.12	0.02
245	9	Qfsh psg 0.4Q2	Arch -noinef	17.00	121.00	95.29	96.15	96.15	96.46	0.022221	0.86	0.61	4.43	3.84	6.33	6.33	1.00	0.74
245	9	Qfsh psg 0.4Q2	245-Ex	17.00	121.00	95.29	97.74	96.15	97.76	0.000339	2.45	2.15	1.16	16.13	12.28	6.63	0.14	0.04
245	9	Lo	Arch -noinef	30.00	121.00	95.29	96.67	96.43	96.94	0.010352	1.38	1.09	4.18	7.18	6.56	6.56	0.70	0.56
245	9	Lo	245-Ex	30.00	121.00	95.29	98.37	96.43	98.40	0.000373	3.08	2.78	1.44	26.50	19.29	6.63	0.15	0.05
245	9	Q2	Arch -noinef	42.00	121.00	95.29	97.07	96.65	97.35	0.007521	1.78	1.48	4.27	9.91	7.36	6.63	0.62	0.54
245	9	Q2	245-Ex	42.00	121.00	95.29	98.89	96.65	98.92	0.000340	3.60	3.30	1.54	37.62	23.58	6.63	0.15	0.05
245	9	Q5	Arch -noinef	64.00	121.00	95.29	97.68	97.01	97.99	0.005310	2.39	2.09	4.51	15.44	11.74	6.63	0.55	0.53
245	9	Q5	245-Ex	64.00	121.00	95.29	99.75	97.01	99.78	0.000260	4.46	4.16	1.58	57.97	23.58	6.63	0.14	0.05
245	9	Q10	Arch -noinef	79.00	121.00	95.29	98.11	97.25	98.40	0.003956	2.82	2.52	4.41	21.66	17.75	6.63	0.49	0.48
245	9	Q10	245-Ex	79.00	121.00	95.29	100.31	97.25	100.34	0.000225	5.02	4.72	1.60	71.13	23.58	6.63	0.13	0.05
245	9	Q25	Arch -noinef	99.00	121.00	95.29	98.75	97.57	98.95	0.002330	3.46	3.16	3.93	34.27	22.94	6.63	0.39	0.35
245	9	Q25	245-Ex	99.00	121.00	95.29	101.18	97.57	101.20	0.000173	5.89	5.59	1.57	91.63	23.58	6.63	0.12	0.05
245	9	Q50	Arch -noinef	114.00	121.00	95.29	99.27	97.79	99.41	0.001476	3.98	3.68	3.46	46.55	23.58	6.63	0.32	0.26
245	9	Q50	245-Ex	114.00	121.00	95.29	101.42	97.79	101.45	0.000193	6.13	5.83	1.70	97.24	23.58	6.63	0.12	0.05
245	9	Q100	Arch -noinef	130.00	121.00	95.29	99.88	98.04	99.99	0.000932	4.59	4.29	3.05	61.05	23.58	6.63	0.26	0.19
245	9	Q100	245-Ex	130.00	121.00	95.29	101.34	98.04	101.38	0.000266	6.05	5.75	1.98	95.33	23.58	6.63	0.15	0.07

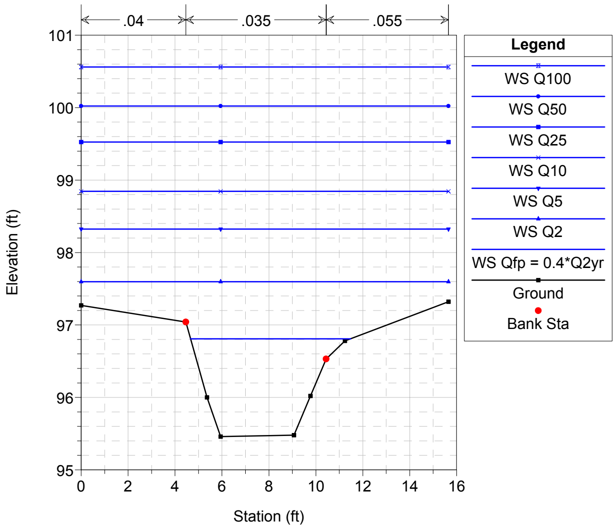
HEC-RAS River: Trib 245 Reach: 245 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
245	10	Lo	Arch -noinef	5.00	178.00	95.29	96.17		96.19	0.001802	0.88	0.62	1.27	3.92	6.35	6.35	0.29	0.06
245	10	Lo	245-Ex	5.00	178.00	95.29	96.95		96.95	0.000144	1.66	1.36	0.56	9.01	6.93	6.63	0.08	0.01
245	10	Lo	Arch -noinef	10.00	178.00	95.29	96.45		96.50	0.002247	1.16	0.89	1.74	5.74	6.47	6.47	0.33	0.10
245	10	Lo	245-Ex	10.00	178.00	95.29	97.34		97.35	0.000245	2.05	1.75	0.86	11.97	8.26	6.63	0.11	0.02
245	10	Qfsh psg 0.4Q2	Arch -noinef	17.00	178.00	95.29	96.74		96.82	0.002752	1.45	1.16	2.22	7.65	6.59	6.59	0.36	0.16
245	10	Qfsh psg 0.4Q2	245-Ex	17.00	178.00	95.29	97.76		97.78	0.000328	2.47	2.17	1.15	16.37	12.47	6.63	0.14	0.03
245	10	Lo	Arch -noinef	30.00	178.00	95.29	97.13		97.27	0.003349	1.84	1.54	2.92	10.37	7.57	6.63	0.41	0.25
245	10	Lo	245-Ex	30.00	178.00	95.29	98.40		98.42	0.000360	3.11	2.81	1.43	26.92	19.42	6.63	0.15	0.05
245	10	Q2	Arch -noinef	42.00	178.00	95.29	97.47		97.64	0.003349	2.18	1.88	3.33	13.17	9.72	6.63	0.43	0.30
245	10	Q2	245-Ex	42.00	178.00	95.29	98.91		98.94	0.000330	3.62	3.32	1.53	38.09	23.58	6.63	0.15	0.05
245	10	Q5	Arch -noinef	64.00	178.00	95.29	98.02		98.22	0.003043	2.73	2.43	3.77	19.99	16.36	6.63	0.43	0.35
245	10	Q5	245-Ex	64.00	178.00	95.29	99.77		99.79	0.000256	4.48	4.18	1.57	58.32	23.58	6.63	0.14	0.05
245	10	Q10	Arch -noinef	79.00	178.00	95.29	98.38		98.58	0.002544	3.09	2.79	3.78	26.69	19.35	6.63	0.40	0.34
245	10	Q10	245-Ex	79.00	178.00	95.29	100.32		100.35	0.000223	5.03	4.73	1.59	71.44	23.58	6.63	0.13	0.05
245	10	Q25	Arch -noinef	99.00	178.00	95.29	98.90		99.07	0.001845	3.61	3.31	3.61	37.97	23.58	6.63	0.35	0.29
245	10	Q25	245-Ex	99.00	178.00	95.29	101.19		101.21	0.000171	5.90	5.60	1.56	91.86	23.58	6.63	0.12	0.05
245	10	Q50	Arch -noinef	114.00	178.00	95.29	99.36		99.49	0.001308	4.07	3.77	3.31	48.77	23.58	6.63	0.30	0.24
245	10	Q50	245-Ex	114.00	178.00	95.29	101.43		101.46	0.000192	6.14	5.84	1.70	97.51	23.58	6.63	0.12	0.05
245	10	Q100	Arch -noinef	130.00	178.00	95.29	99.94		100.04	0.000878	4.65	4.35	2.99	62.39	23.58	6.63	0.25	0.18
245	10	Q100	245-Ex	130.00	178.00	95.29	101.35		101.39	0.000263	6.06	5.76	1.97	95.69	23.58	6.63	0.14	0.07

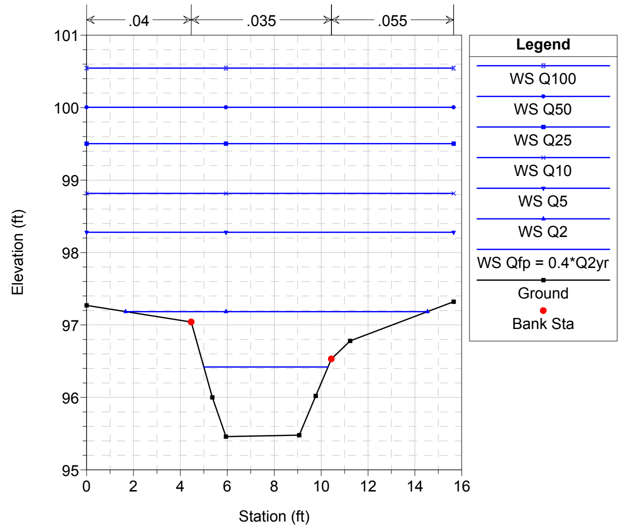
Tributary 319+13 HEC-RAS

Companion 2006 Stream and Habitat Inventory (S&HI) station 342+00
Model based on relative datum. Subtract 68.83-ft for approximate conversion to ADOT&PF project datum

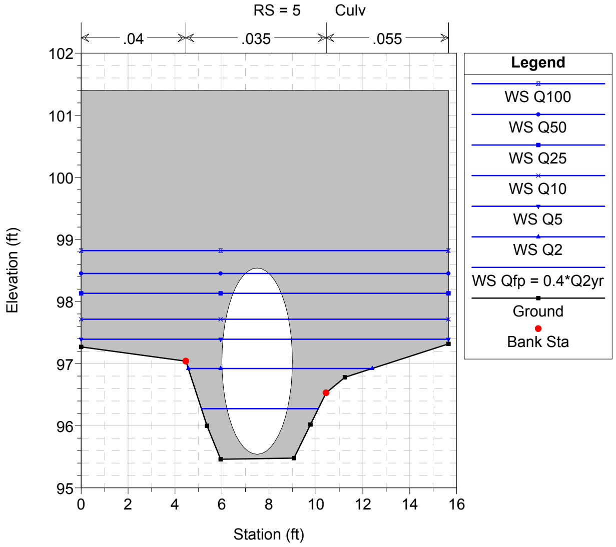
342 Plan: 342 - Existing 8/16/2006
RS = 10



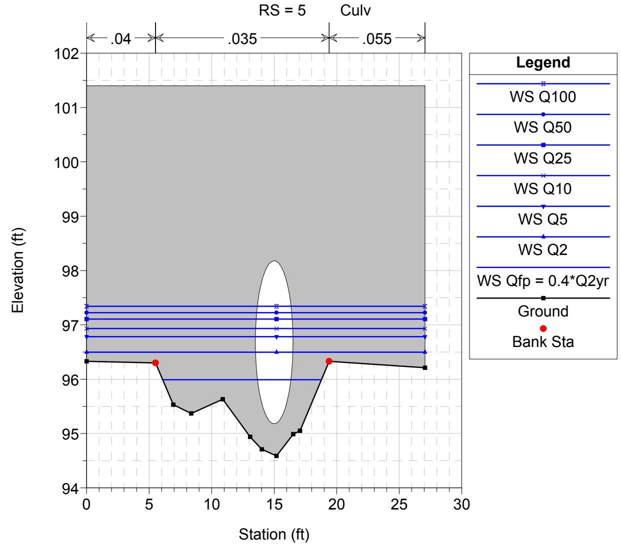
342 Plan: 342 - Existing 8/16/2006
RS = 9



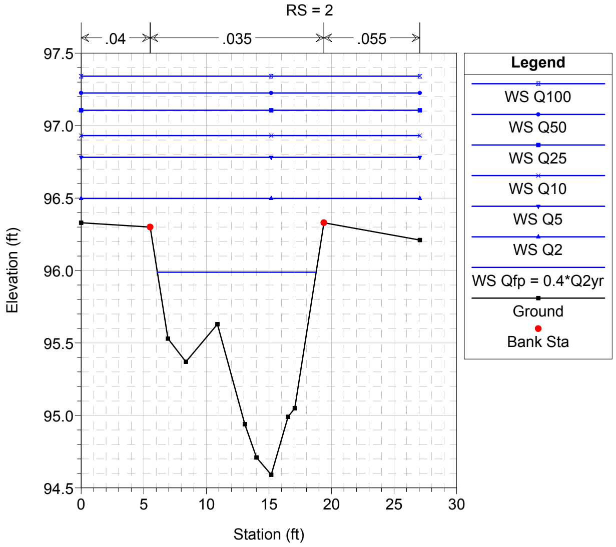
342 Plan: 342 - Existing 8/16/2006
RS = 5 Culv



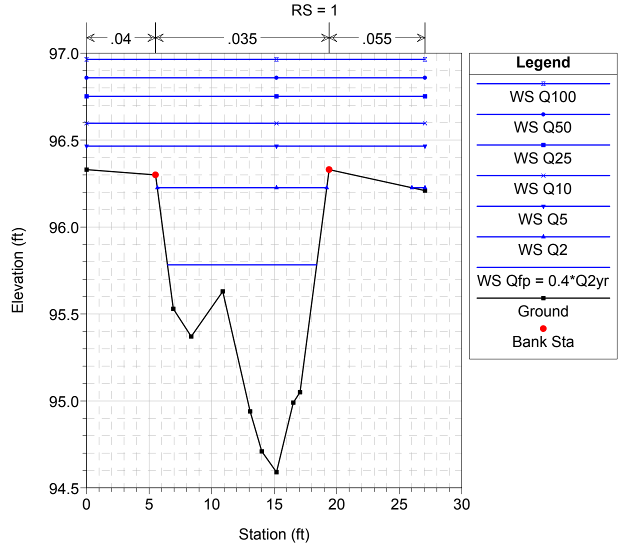
342 Plan: 342 - Existing 8/16/2006
RS = 5 Culv

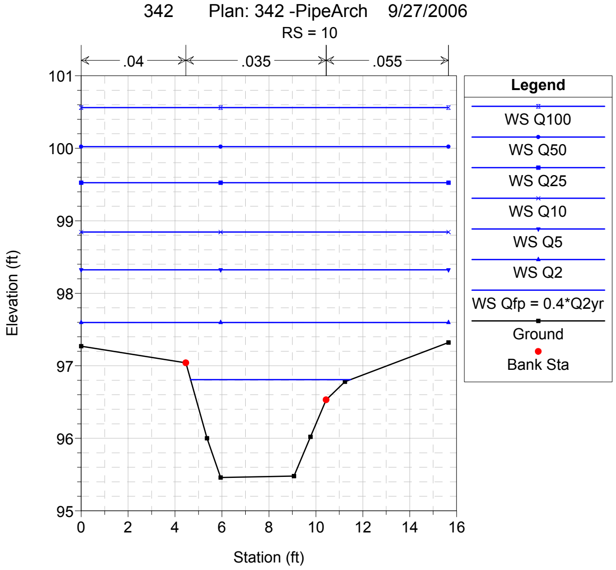


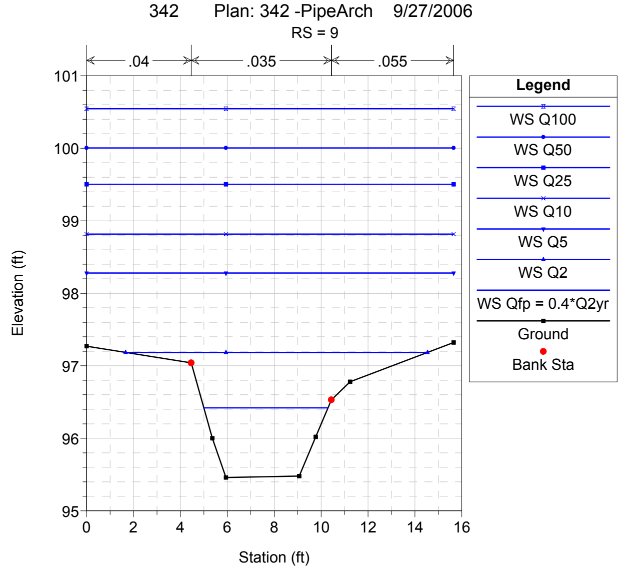
342 Plan: 342 - Existing 8/16/2006
RS = 2

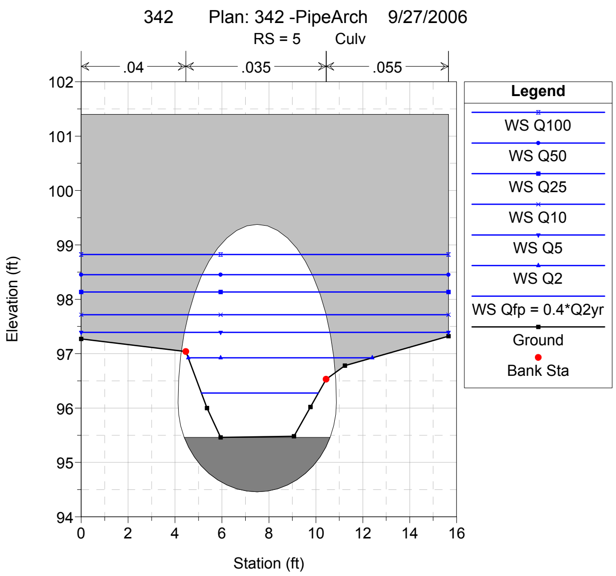


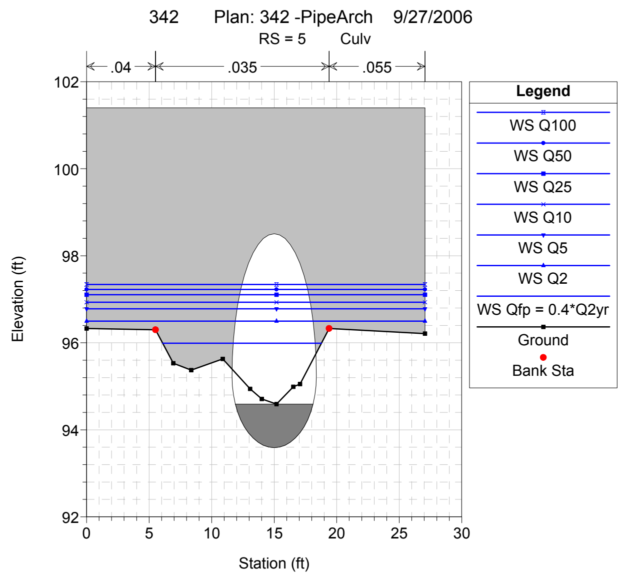
342 Plan: 342 - Existing 8/16/2006
RS = 1

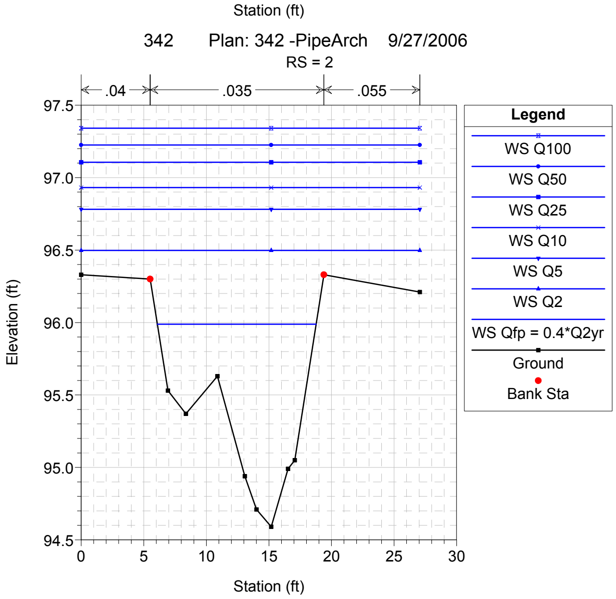


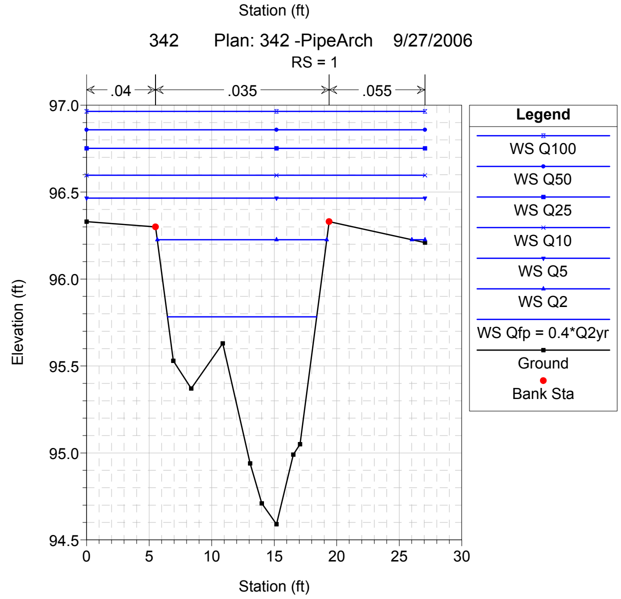

342 Plan: 342 -PipeArch 9/27/2006
RS = 10
.04
.035
.055
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp = 0.4*Q2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
95
96
97
98
99
100
101
0
2
4
6
8
10
12
14
16


342 Plan: 342 -PipeArch 9/27/2006
RS = 9
.04
.035
.055
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp = 0.4*Q2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
95
96
97
98
99
100
101
0
2
4
6
8
10
12
14
16


342 Plan: 342 -PipeArch 9/27/2006
RS = 5 Culv
.04
.035
.055
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp = 0.4*Q2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
94
95
96
97
98
99
100
101
102
0
2
4
6
8
10
12
14
16


342 Plan: 342 -PipeArch 9/27/2006
RS = 5 Culv
.04
.035
.055
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp = 0.4*Q2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
92
94
96
98
100
102
0
5
10
15
20
25
30


342 Plan: 342 -PipeArch 9/27/2006
RS = 2
.04
.035
.055
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp = 0.4*Q2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
94.5
95.0
95.5
96.0
96.5
97.0
97.5
0
5
10
15
20
25
30


342 Plan: 342 -PipeArch 9/27/2006
RS = 1
.04
.035
.055
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp = 0.4*Q2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
94.5
95.0
95.5
96.0
96.5
97.0
0
5
10
15
20
25
30

HEC-RAS River: Trib 342 Reach: 342

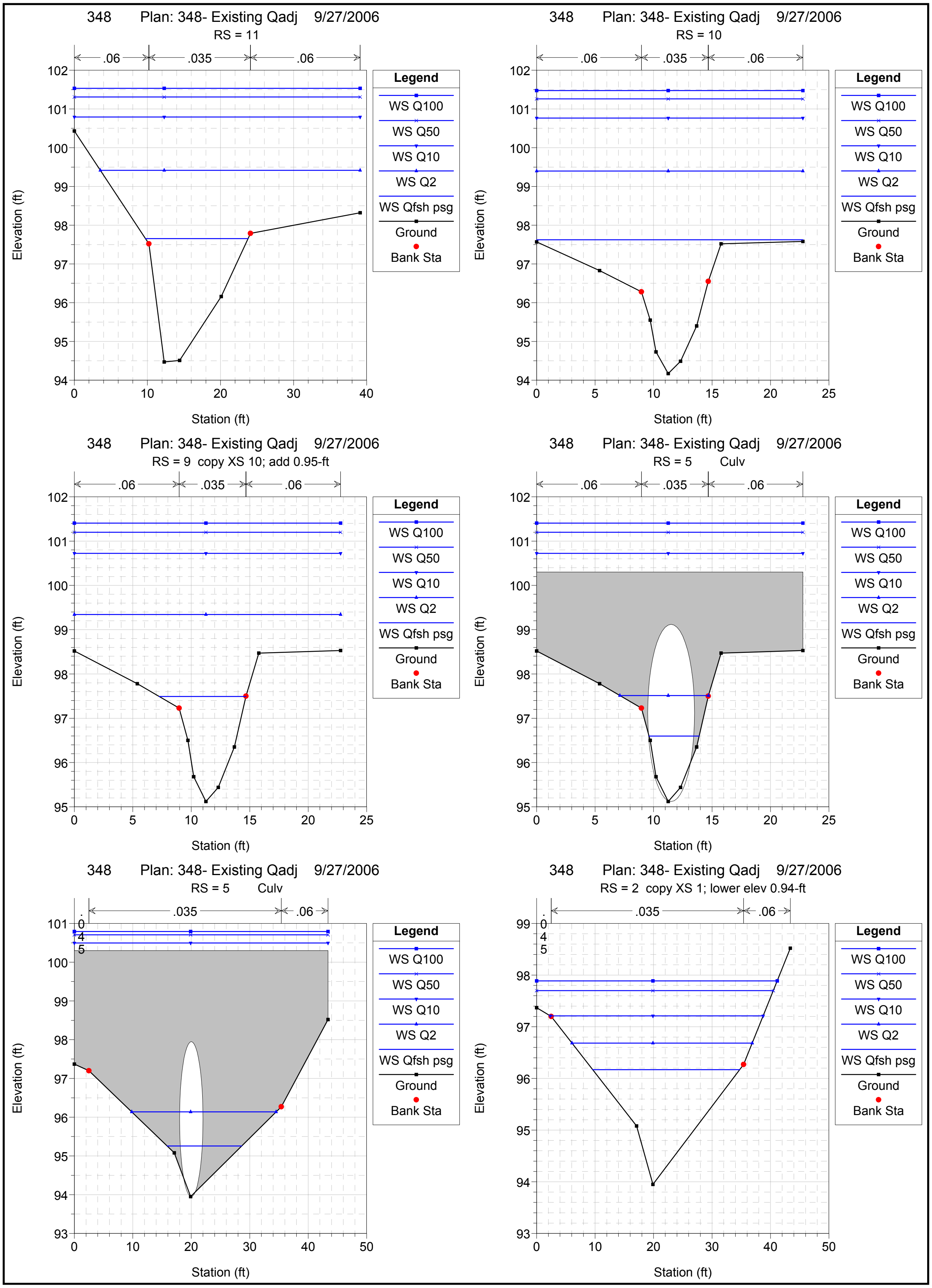
Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
342	1	Lo	342-Sim	10.00		94.59	95.55	95.35	95.64	0.010703	0.96	0.41	2.39	4.19	10.09	10.09	0.65	0.27
342	1	Lo	342-Ex	10.00		94.59	95.55	95.35	95.64	0.010703	0.96	0.41	2.39	4.19	10.09	10.09	0.65	0.27
342	1	Qfp = 0.4*Q2yr	342-Sim	20.00		94.59	95.78	95.64	95.92	0.010703	1.19	0.57	2.94	6.80	11.93	11.93	0.69	0.37
342	1	Qfp = 0.4*Q2yr	342-Ex	20.00		94.59	95.78	95.64	95.92	0.010703	1.19	0.57	2.94	6.80	11.93	11.93	0.69	0.37
342	1	Lo	342-Sim	30.00		94.59	95.95	95.79	96.13	0.010719	1.36	0.71	3.39	8.86	12.54	12.54	0.71	0.45
342	1	Lo	342-Ex	30.00		94.59	95.95	95.79	96.13	0.010719	1.36	0.71	3.39	8.86	12.54	12.54	0.71	0.45
342	1	Lo	342-Sim	40.00		94.59	96.10	95.92	96.31	0.010701	1.51	0.82	3.73	10.73	13.08	13.08	0.73	0.52
342	1	Lo	342-Ex	40.00		94.59	96.10	95.92	96.31	0.010701	1.51	0.82	3.73	10.73	13.08	13.08	0.73	0.52
342	1	Q2	342-Sim	50.00		94.59	96.23	96.03	96.48	0.010708	1.64	0.92	4.02	12.46	14.60	13.55	0.74	0.58
342	1	Q2	342-Ex	50.00		94.59	96.23	96.03	96.48	0.010708	1.64	0.92	4.02	12.46	14.60	13.55	0.74	0.58
342	1	Q5	342-Sim	75.00		94.59	96.47	96.37	96.79	0.010709	1.88	1.14	4.62	18.08	27.06	13.87	0.76	0.72
342	1	Q5	342-Ex	75.00		94.59	96.47	96.37	96.79	0.010709	1.88	1.14	4.62	18.08	27.06	13.87	0.76	0.72
342	1	Q10	342-Sim	93.00		94.59	96.60	96.53	96.96	0.010705	2.01	1.27	4.97	21.64	27.06	13.87	0.78	0.80
342	1	Q10	342-Ex	93.00		94.59	96.60	96.53	96.96	0.010705	2.01	1.27	4.97	21.64	27.06	13.87	0.78	0.80
342	1	Q25	342-Sim	117.00		94.59	96.75	96.69	97.16	0.010716	2.16	1.42	5.37	25.83	27.06	13.87	0.79	0.90
342	1	Q25	342-Ex	117.00		94.59	96.75	96.69	97.16	0.010716	2.16	1.42	5.37	25.83	27.06	13.87	0.79	0.90
342	1	Q50	342-Sim	135.00		94.59	96.86	96.79	97.30	0.010712	2.27	1.53	5.63	28.72	27.06	13.87	0.80	0.97
342	1	Q50	342-Ex	135.00		94.59	96.86	96.79	97.30	0.010712	2.27	1.53	5.63	28.72	27.06	13.87	0.80	0.97
342	1	Q100	342-Sim	154.00		94.59	96.96	96.88	97.44	0.010710	2.37	1.63	5.89	31.58	27.06	13.87	0.81	1.04
342	1	Q100	342-Ex	154.00		94.59	96.96	96.88	97.44	0.010710	2.37	1.63	5.89	31.58	27.06	13.87	0.81	1.04
342	2	Lo	342-Sim	10.00	22.00	94.59	95.73		95.77	0.003570	1.14	0.53	1.61	6.19	11.74	11.74	0.39	0.11
342	2	Lo	342-Ex	10.00	22.00	94.59	95.73		95.77	0.003570	1.14	0.53	1.61	6.19	11.74	11.74	0.39	0.11
342	2	Qfp = 0.4*Q2yr	342-Sim	20.00	22.00	94.59	95.99		96.06	0.004077	1.40	0.74	2.14	9.33	12.68	12.68	0.44	0.18
342	2	Qfp = 0.4*Q2yr	342-Ex	20.00	22.00	94.59	95.99		96.06	0.004063	1.40	0.74	2.14	9.34	12.68	12.68	0.44	0.18
342	2	Lo	342-Sim	30.00	22.00	94.59	96.18		96.28	0.004458	1.59	0.89	2.53	11.86	13.39	13.39	0.47	0.23
342	2	Lo	342-Ex	30.00	22.00	94.59	96.18		96.28	0.004457	1.59	0.89	2.53	11.86	13.39	13.39	0.47	0.23
342	2	Lo	342-Sim	40.00	22.00	94.59	96.35		96.47	0.004611	1.76	1.02	2.82	14.89	27.06	13.87	0.49	0.28
342	2	Lo	342-Ex	40.00	22.00	94.59	96.35		96.47	0.004610	1.76	1.02	2.82	14.89	27.06	13.87	0.49	0.28
342	2	Q2	342-Sim	50.00	22.00	94.59	96.50		96.63	0.004267	1.91	1.17	2.97	18.95	27.06	13.87	0.48	0.30
342	2	Q2	342-Ex	50.00	22.00	94.59	96.50		96.63	0.004260	1.91	1.17	2.97	18.97	27.06	13.87	0.48	0.29
342	2	Q5	342-Sim	75.00	22.00	94.59	96.78		96.94	0.004055	2.19	1.45	3.35	26.64	27.06	13.87	0.49	0.35
342	2	Q5	342-Ex	75.00	22.00	94.59	96.78		96.94	0.004062	2.19	1.45	3.35	26.62	27.06	13.87	0.49	0.35
342	2	Q10	342-Sim	93.00	22.00	94.59	96.93		97.12	0.004225	2.34	1.60	3.65	30.70	27.06	13.87	0.51	0.40
342	2	Q10	342-Ex	93.00	22.00	94.59	96.93		97.12	0.004228	2.34	1.60	3.65	30.69	27.06	13.87	0.51	0.40
342	2	Q25	342-Sim	117.00	22.00	94.59	97.11		97.33	0.004461	2.52	1.78	4.02	35.43	27.06	13.87	0.53	0.47
342	2	Q25	342-Ex	117.00	22.00	94.59	97.11		97.32	0.004465	2.52	1.78	4.02	35.41	27.06	13.87	0.53	0.47
342	2	Q50	342-Sim	135.00	22.00	94.59	97.22		97.47	0.004627	2.63	1.89	4.27	38.63	27.06	13.87	0.55	0.52
342	2	Q50	342-Ex	135.00	22.00	94.59	97.22		97.47	0.004631	2.63	1.89	4.27	38.61	27.06	13.87	0.55	0.52
342	2	Q100	342-Sim	154.00	22.00	94.59	97.34		97.61	0.004787	2.75	2.01	4.52	41.78	27.06	13.87	0.56	0.57
342	2	Q100	342-Ex	154.00	22.00	94.59	97.34		97.61	0.004791	2.75	2.01	4.52	41.77	27.06	13.87	0.56	0.57
342	5			Culvert														
342	9	Lo	342-Sim	10.00	77.00	95.46	96.09	96.09	96.36	0.025408	0.63	0.53	4.14	2.42	4.59	4.59	1.00	0.76
342	9	Lo	342-Ex	10.00	77.00	95.46	97.14	96.09	97.16	0.000647	1.68	1.36	1.19	9.18	11.69	5.98	0.18	0.05
342	9	Qfp = 0.4*Q2yr	342-Sim	20.00	77.00	95.46	96.42	96.42	96.80	0.023537	0.96	0.76	4.98	4.02	5.30	5.30	1.01	0.98
342	9	Qfp = 0.4*Q2yr	342-Ex	20.00	77.00	95.46	97.91	96.42	97.93	0.000385	2.45	2.14	1.24	21.00	15.65	5.98	0.15	0.04
342	9	Lo	342-Sim	30.00	77.00	95.46	96.67	96.67	97.15	0.021856	1.21	0.96	5.54	5.45	6.12	5.66	1.00	1.13
342	9	Lo	342-Ex	30.00	77.00	95.46	98.59	96.67	98.61	0.000278	3.13	2.81	1.27	31.57	15.65	5.98	0.13	0.04
342	9	Lo	342-Sim	40.00	77.00	95.46	96.90	96.90	97.44	0.019710	1.44	1.15	5.90	6.99	7.65	5.86	0.97	1.21
342	9	Lo	342-Ex	40.00	77.00	95.46	99.29	96.90	99.31	0.000210	3.83	3.51	1.28	42.48	15.65	5.98	0.12	0.04
342	9	Q2	342-Sim	50.00	77.00	95.46	97.18	97.13	97.68	0.014403	1.72	1.41	5.75	9.71	12.87	5.98	0.85	1.08
342	9	Q2	342-Ex	50.00	77.00	95.46	100.31	97.13	100.32	0.000130	4.85	4.53	1.19	58.44	15.65	5.98	0.10	0.03
342	9	Q5	342-Sim	75.00	77.00	95.46	98.28	97.56	98.45	0.002794	2.82	2.50	3.72	26.70	15.65	5.98	0.41	0.37
342	9	Q5	342-Ex	75.00	77.00	95.46	101.83	97.56	101.85	0.000108	6.37	6.05	1.32	82.29	15.65	5.98	0.09	0.03
342	9	Q10	342-Sim	93.00	77.00	95.46	98.82	97.73	98.97	0.001974	3.36	3.04	3.56	35.10	15.65	5.98	0.36	0.32
342	9	Q10	342-Ex	93.00	77.00	95.46	102.16	97.73	102.18	0.000139	6.70	6.38	1.55	87.38	15.65	5.98	0.11	0.05
342	9	Q25	342-Sim	117.00	77.00	95.46	99.50	97.93	99.64	0.001441	4.04	3.73	3.48	45.86	15.65	5.98	0.32	0.29
342	9	Q25	342-Ex	117.00	77.00	95.46	102.51	97.93	102.55	0.000184	7.05	6.73	1.85	92.91	15.65	5.98	0.13	0.07
342	9	Q50	342-Sim	135.00	77.00	95.46	100.00	98.07	100.14	0.001211	4.54	4.23	3.47	53.71	15.65	5.98	0.30	0.27
342	9	Q50	342-Ex	135.00	77.00	95.46	102.74	98.07	102.78	0.000220	7.28	6.96	2.06	96.44	15.65	5.98	0.14	0.08

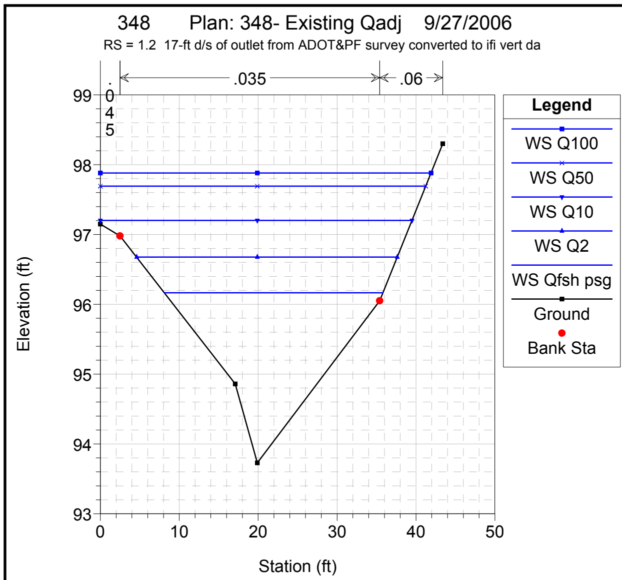
HEC-RAS River: Trib 342 Reach: 342 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
342	9	Q100	342-Sim	154.00	77.00	95.46	100.55	98.20	100.68	0.001029	5.09	4.77	3.47	62.18	15.65	5.98	0.28	0.26
342	9	Q100	342-Ex	154.00	77.00	95.46	102.97	98.20	103.03	0.000257	7.51	7.19	2.28	100.12	15.65	5.98	0.15	0.10
342	10	Lo	342-Sim	10.00	90.00	95.46	96.42		96.52	0.005847	0.96	0.76	2.48	4.03	5.30	5.30	0.50	0.24
342	10	Lo	342-Ex	10.00	90.00	95.46	97.15		97.17	0.000632	1.69	1.37	1.18	9.29	11.93	5.98	0.18	0.05
342	10	Qfp = 0.4*Q2yr	342-Sim	20.00	90.00	95.46	96.81		96.97	0.006377	1.35	1.07	3.21	6.33	6.82	5.78	0.55	0.37
342	10	Qfp = 0.4*Q2yr	342-Ex	20.00	90.00	95.46	97.92		97.94	0.000381	2.46	2.14	1.24	21.08	15.65	5.98	0.15	0.04
342	10	Lo	342-Sim	30.00	90.00	95.46	97.11		97.31	0.006383	1.65	1.33	3.69	8.80	10.76	5.98	0.56	0.45
342	10	Lo	342-Ex	30.00	90.00	95.46	98.59		98.61	0.000277	3.13	2.82	1.27	31.63	15.65	5.98	0.13	0.04
342	10	Lo	342-Sim	40.00	90.00	95.46	97.38	96.90	97.59	0.005468	1.92	1.60	3.86	12.57	15.65	5.98	0.54	0.47
342	10	Lo	342-Ex	40.00	90.00	95.46	99.29		99.31	0.000210	3.83	3.51	1.28	42.52	15.65	5.98	0.12	0.04
342	10	Q2	342-Sim	50.00	90.00	95.46	97.60	97.13	97.81	0.004843	2.14	1.82	3.96	16.03	15.65	5.98	0.52	0.47
342	10	Q2	342-Ex	50.00	90.00	95.46	100.31		100.32	0.000130	4.85	4.53	1.19	58.46	15.65	5.98	0.10	0.03
342	10	Q5	342-Sim	75.00	90.00	95.46	98.32		98.49	0.002599	2.86	2.55	3.63	27.40	15.65	5.98	0.40	0.35
342	10	Q5	342-Ex	75.00	90.00	95.46	101.83		101.85	0.000108	6.37	6.06	1.32	82.31	15.65	5.98	0.09	0.03
342	10	Q10	342-Sim	93.00	90.00	95.46	98.85		98.99	0.001901	3.39	3.07	3.51	35.56	15.65	5.98	0.35	0.31
342	10	Q10	342-Ex	93.00	90.00	95.46	102.16		102.18	0.000139	6.70	6.38	1.55	87.41	15.65	5.98	0.11	0.05
342	10	Q25	342-Sim	117.00	90.00	95.46	99.52		99.66	0.001412	4.06	3.75	3.46	46.18	15.65	5.98	0.31	0.28
342	10	Q25	342-Ex	117.00	90.00	95.46	102.51		102.55	0.000184	7.05	6.74	1.85	92.95	15.65	5.98	0.13	0.07
342	10	Q50	342-Sim	135.00	90.00	95.46	100.02		100.16	0.001194	4.56	4.25	3.46	53.98	15.65	5.98	0.30	0.27
342	10	Q50	342-Ex	135.00	90.00	95.46	102.74		102.78	0.000220	7.28	6.96	2.06	96.48	15.65	5.98	0.14	0.08
342	10	Q100	342-Sim	154.00	90.00	95.46	100.56		100.69	0.001018	5.10	4.78	3.45	62.40	15.65	5.98	0.28	0.26
342	10	Q100	342-Ex	154.00	90.00	95.46	102.97		103.03	0.000257	7.51	7.20	2.28	100.17	15.65	5.98	0.15	0.10

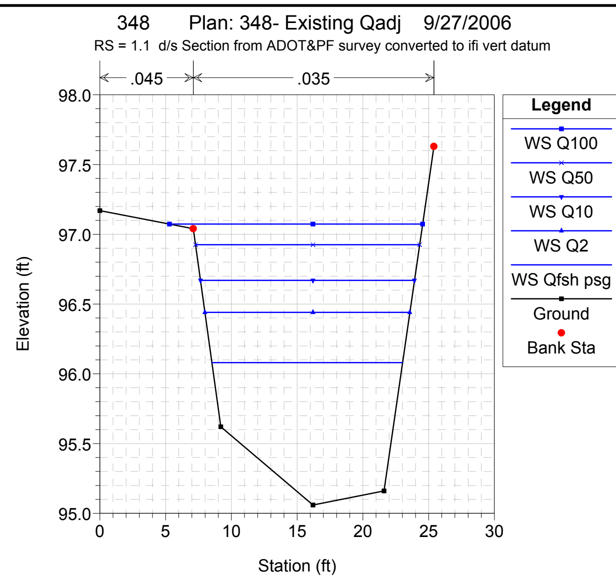
Tributary 324+79 HEC-RAS

Companion 2006 Stream and Habitat Inventory (S&HI) station 347+50
Model based on relative datum. Subtract 69.17-ft for approximate conversion to ADOT&PF project datum

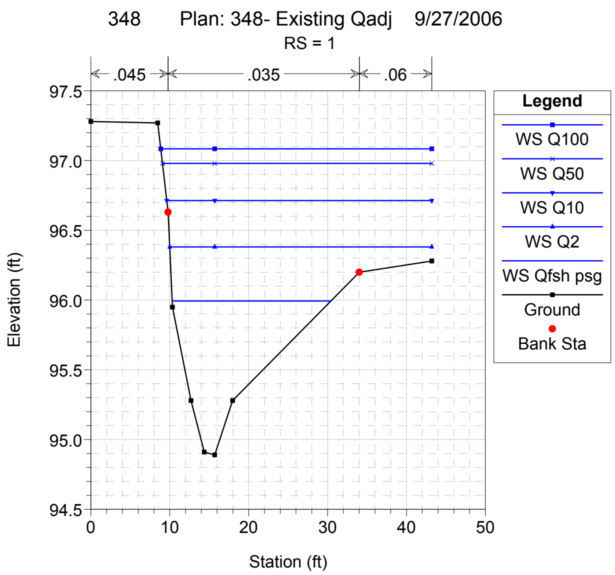

348 Plan: 348- Existing Qadj 9/27/2006
RS = 11
.06 .035 .06
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
WS Q10
WS Q2
WS Qfsh psg
Ground
Bank Sta
348 Plan: 348- Existing Qadj 9/27/2006
RS = 10
348 Plan: 348- Existing Qadj 9/27/2006
RS = 9 copy XS 10; add 0.95-ft
348 Plan: 348- Existing Qadj 9/27/2006
RS = 5 Culv
348 Plan: 348- Existing Qadj 9/27/2006
RS = 5 Culv
348 Plan: 348- Existing Qadj 9/27/2006
RS = 2 copy XS 1; lower elev 0.94-ft



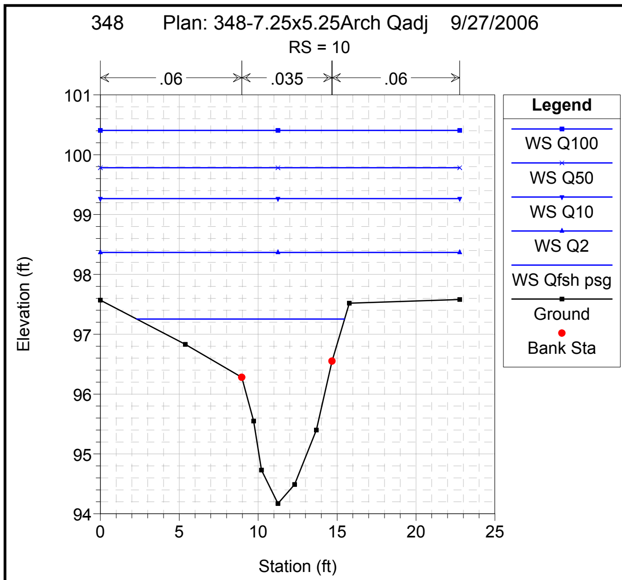
348 Plan: 348- Existing Qadj 9/27/2006
RS = 1.2 17-ft d/s of outlet from ADOT&PF survey converted to ifi vert da
.045
.035
.06
Legend
WS Q100
WS Q50
WS Q10
WS Q2
WS Qfsh psg
Ground
Bank Sta
Elevation (ft)
Station (ft)

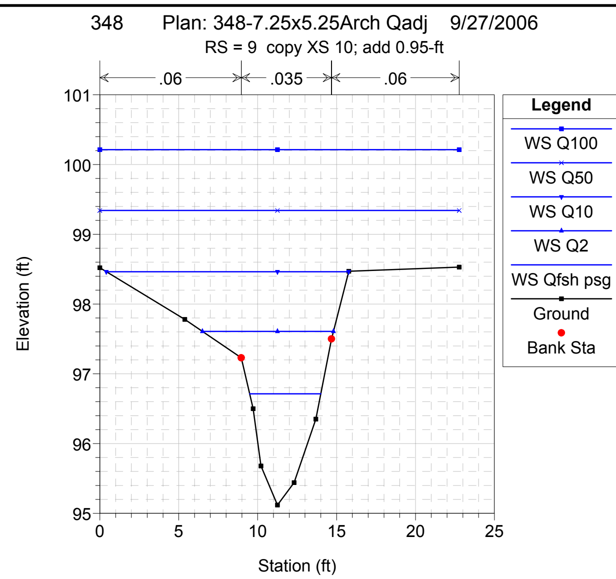


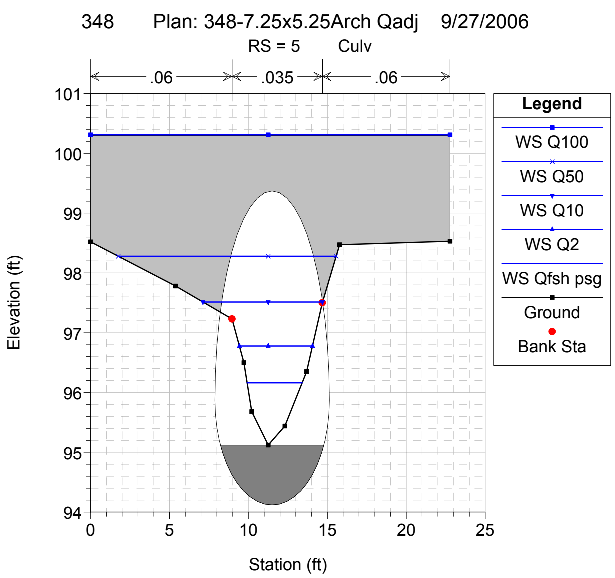
348 Plan: 348- Existing Qadj 9/27/2006
RS = 1.1 d/s Section from ADOT&PF survey converted to ifi vert datum
.045
.035
Legend
WS Q100
WS Q50
WS Q10
WS Q2
WS Qfsh psg
Ground
Bank Sta
Elevation (ft)
Station (ft)

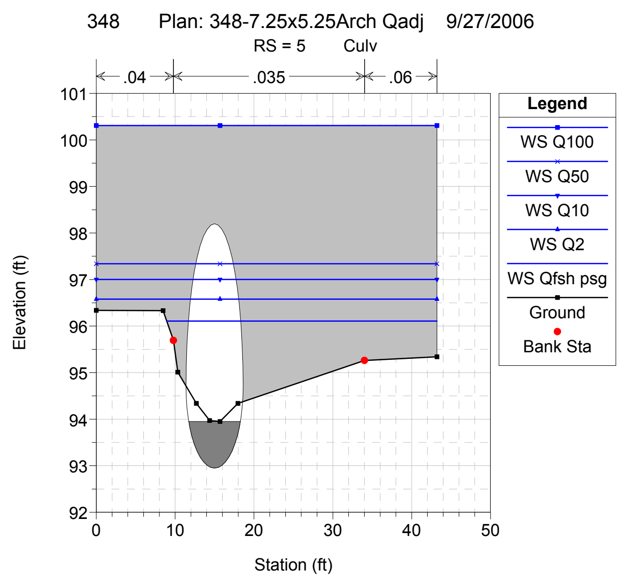


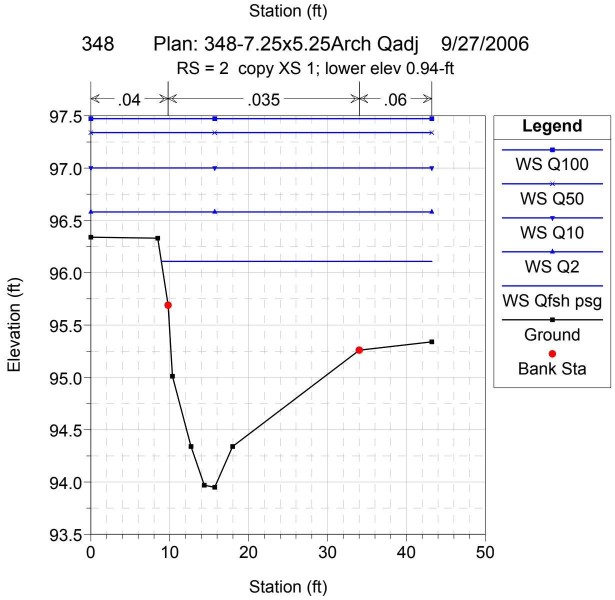
348 Plan: 348- Existing Qadj 9/27/2006
RS = 1
.045
.035
.06
Legend
WS Q100
WS Q50
WS Q10
WS Q2
WS Qfsh psg
Ground
Bank Sta
Elevation (ft)
Station (ft)

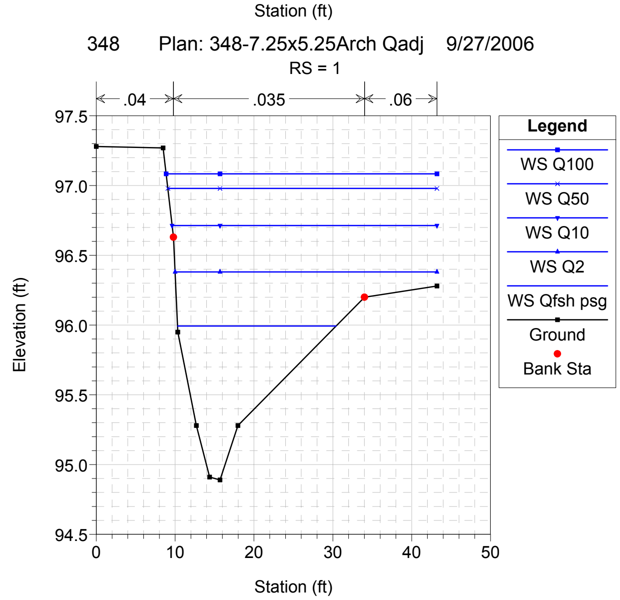

348 Plan: 348-7.25x5.25Arch Qadj 9/27/2006
RS = 10
.06
.035
.06
Legend
WS Q100
WS Q50
WS Q10
WS Q2
WS Qfsh psg
Ground
Bank Sta
Elevation (ft)
Station (ft)


348 Plan: 348-7.25x5.25Arch Qadj 9/27/2006
RS = 9 copy XS 10; add 0.95-ft
.06
.035
.06
Legend
WS Q100
WS Q50
WS Q10
WS Q2
WS Qfsh psg
Ground
Bank Sta
Elevation (ft)
Station (ft)


348 Plan: 348-7.25x5.25Arch Qadj 9/27/2006
RS = 5 Culv
.06
.035
.06
Legend
WS Q100
WS Q50
WS Q10
WS Q2
WS Qfsh psg
Ground
Bank Sta
Elevation (ft)
Station (ft)


348 Plan: 348-7.25x5.25Arch Qadj 9/27/2006
RS = 5 Culv
.04
.035
.06
Legend
WS Q100
WS Q50
WS Q10
WS Q2
WS Qfsh psg
Ground
Bank Sta
Elevation (ft)
Station (ft)


348 Plan: 348-7.25x5.25Arch Qadj 9/27/2006
RS = 2 copy XS 1; lower elev 0.94-ft
.04
.035
.06
Legend
WS Q100
WS Q50
WS Q10
WS Q2
WS Qfsh psg
Ground
Bank Sta
Elevation (ft)
Station (ft)


348 Plan: 348-7.25x5.25Arch Qadj 9/27/2006
RS = 1
.04
.035
.06
Legend
WS Q100
WS Q50
WS Q10
WS Q2
WS Qfsh psg
Ground
Bank Sta
Elevation (ft)
Station (ft)

HEC-RAS River: 348 Trib Reach: 348

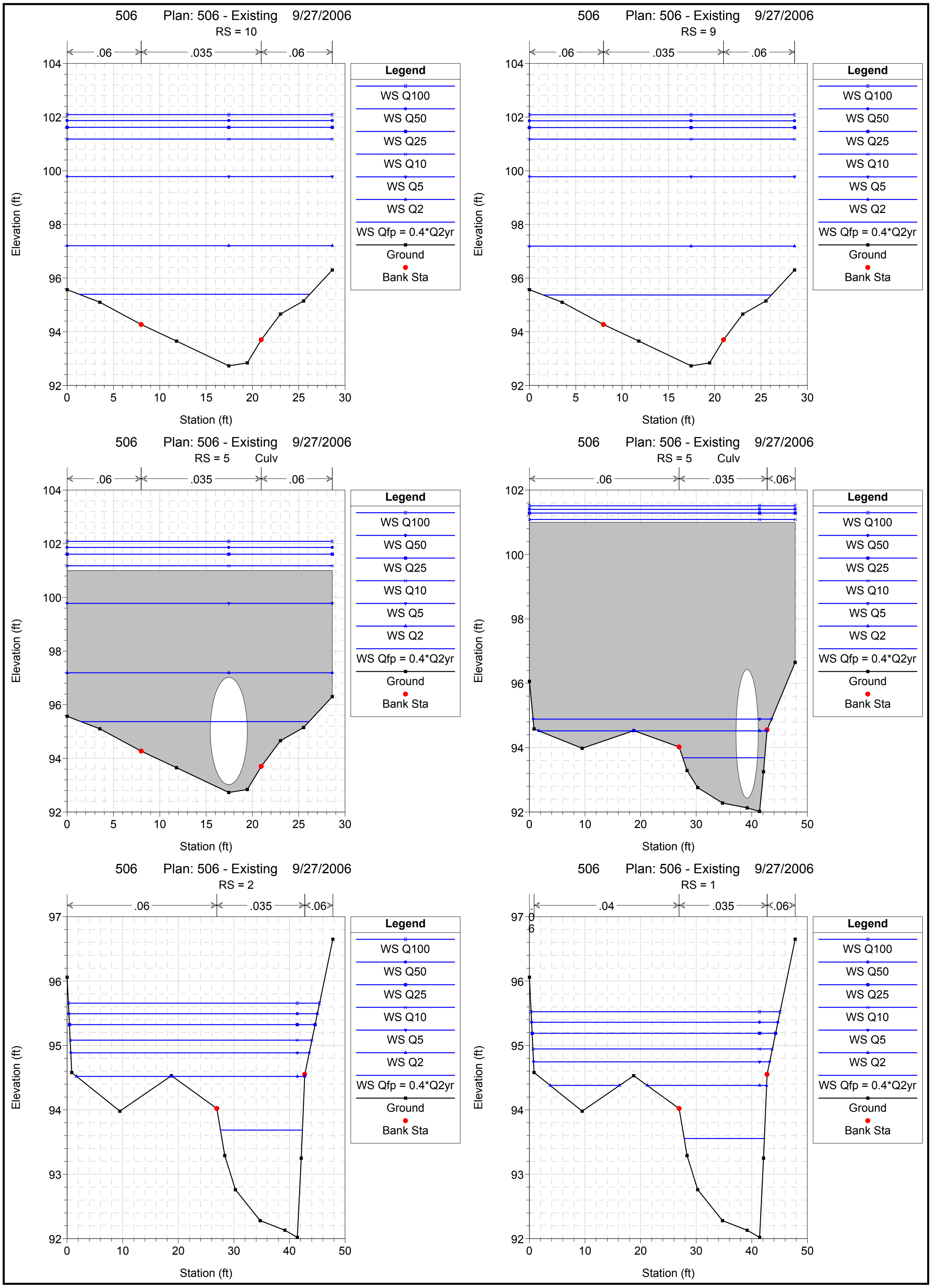
Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
348	1	Qfsh psg	348-7.25Qadj	25.00		94.89	95.99	95.79	96.08	0.008009	1.10	0.51	2.42	10.33	20.09	20.09	0.60	0.25
348	1	Qfsh psg	348exQadj	25.00		94.89	95.99	95.79	96.08	0.008009	1.10	0.51	2.42	10.33	20.09	20.09	0.60	0.25
348	1	Q2	348-7.25Qadj	63.00		94.89	96.38	96.16	96.54	0.008010	1.49	0.80	3.24	20.51	33.21	24.03	0.64	0.39
348	1	Q2	348exQadj	63.00		94.89	96.38	96.16	96.54	0.008010	1.49	0.80	3.24	20.51	33.21	24.03	0.64	0.39
348	1	Q10	348-7.25Qadj	116.00		94.89	96.71	96.49	96.96	0.008001	1.82	1.12	4.05	31.60	33.59	24.24	0.67	0.55
348	1	Q10	348exQadj	116.00		94.89	96.71	96.49	96.96	0.008001	1.82	1.12	4.05	31.60	33.59	24.24	0.67	0.55
348	1	Q50	348-7.25Qadj	169.00		94.89	96.98	96.73	97.30	0.008000	2.09	1.39	4.66	40.61	34.13	24.24	0.70	0.68
348	1	Q50	348exQadj	169.00		94.89	96.98	96.72	97.30	0.008000	2.09	1.39	4.66	40.61	34.14	24.24	0.70	0.68
348	1	Q100	348-7.25Qadj	192.00		94.89	97.08	96.81	97.43	0.008001	2.19	1.49	4.89	44.17	34.35	24.24	0.71	0.73
348	1	Q100	348exQadj	192.00		94.89	97.08	96.82	97.43	0.008001	2.19	1.49	4.89	44.18	34.35	24.24	0.71	0.73
348	1.1	Qfsh psg	348exQadj	25.00	13.10	95.06	96.08		96.16	0.004020	1.02	0.77	2.23	11.23	14.50	14.50	0.45	0.19
348	1.1	Q2	348exQadj	63.00	13.10	95.06	96.44		96.66	0.007680	1.38	1.07	3.78	16.65	15.58	15.58	0.65	0.49
348	1.1	Q10	348exQadj	116.00	13.10	95.06	96.67	96.57	97.18	0.014375	1.61	1.25	5.71	20.30	16.28	16.28	0.90	1.07
348	1.1	Q50	348exQadj	169.00	13.10	95.06	96.93	96.93	97.66	0.017362	1.87	1.44	6.88	24.55	17.05	17.05	1.01	1.48
348	1.1	Q100	348exQadj	192.00	13.10	95.06	97.07	97.07	97.85	0.016686	2.01	1.55	7.08	27.14	19.25	17.44	1.00	1.53
348	1.2	Qfsh psg	348exQadj	25.00	28.10	93.73	96.17		96.18	0.000316	2.44	1.13	0.81	30.90	27.70	27.29	0.13	0.02
348	1.2	Q2	348exQadj	63.00	28.10	93.73	96.68		96.71	0.000633	2.95	1.48	1.37	46.40	33.03	30.81	0.20	0.06
348	1.2	Q10	348exQadj	116.00	28.10	93.73	97.20		97.25	0.000804	3.47	1.91	1.83	65.41	39.50	32.90	0.23	0.09
348	1.2	Q50	348exQadj	169.00	28.10	93.73	97.69		97.76	0.000777	3.96	2.40	2.10	85.20	41.24	32.90	0.24	0.11
348	1.2	Q100	348exQadj	192.00	28.10	93.73	97.88		97.95	0.000772	4.15	2.58	2.20	93.03	41.91	32.90	0.24	0.12
348	2	Qfsh psg	348-7.25Qadj	25.00	48.00	93.95	96.11		96.11	0.000148	2.16	1.46	0.65	42.96	34.28	24.24	0.10	0.01
348	2	Qfsh psg	348exQadj	25.00	48.10	93.95	96.17		96.19	0.000558	2.22	1.00	0.99	25.19	25.14	25.14	0.17	0.03
348	2	Q2	348-7.25Qadj	63.00	48.00	93.95	96.58		96.60	0.000343	2.63	1.93	1.20	61.41	43.21	24.24	0.15	0.04
348	2	Q2	348exQadj	63.00	48.10	93.95	96.68		96.72	0.000983	2.73	1.34	1.60	39.64	30.82	29.35	0.24	0.08
348	2	Q10	348-7.25Qadj	116.00	48.00	93.95	97.00		97.04	0.000558	3.05	2.35	1.75	79.61	43.21	24.24	0.20	0.08
348	2	Q10	348exQadj	116.00	48.10	93.95	97.21		97.28	0.001196	3.26	1.70	2.07	57.36	36.42	32.90	0.28	0.12
348	2	Q50	348-7.25Qadj	169.00	48.00	93.95	97.34		97.40	0.000719	3.39	2.69	2.17	94.22	43.21	24.24	0.23	0.12
348	2	Q50	348exQadj	169.00	48.10	93.95	97.70		97.78	0.001070	3.75	2.18	2.31	76.53	40.49	32.90	0.28	0.14
348	2	Q100	348-7.25Qadj	192.00	48.00	93.95	97.47		97.55	0.000778	3.52	2.82	2.33	99.93	43.21	24.24	0.24	0.13
348	2	Q100	348exQadj	192.00	48.10	93.95	97.89		97.98	0.001039	3.94	2.37	2.41	84.19	41.15	32.90	0.28	0.15
348	5			Culvert														
348	9	Qfsh psg	348-7.25Qadj	25.00	111.00	95.12	96.71	96.71	97.21	0.025040	1.59	0.98	5.67	4.41	4.51	4.51	1.01	1.21
348	9	Qfsh psg	348exQadj	25.00	111.10	95.12	97.49	96.71	97.63	0.004077	2.37	1.48	2.95	8.67	7.41	5.71	0.43	0.29
348	9	Q2	348-7.25Qadj	63.00	111.00	95.12	97.61	97.61	98.33	0.019952	2.49	1.59	6.85	9.59	8.30	5.72	0.96	1.52
348	9	Q2	348exQadj	63.00	111.10	95.12	99.34	97.61	99.41	0.000943	4.22	3.33	2.43	39.40	22.77	5.72	0.24	0.15
348	9	Q10	348-7.25Qadj	116.00	111.00	95.12	98.46	98.46	99.26	0.013401	3.34	2.45	7.48	19.67	15.36	5.72	0.84	1.57
348	9	Q10	348exQadj	116.00	111.10	95.12	100.72	98.48	100.79	0.000684	5.60	4.71	2.61	70.86	22.77	5.72	0.21	0.15
348	9	Q50	348-7.25Qadj	169.00	111.00	95.12	99.34	99.04	99.85	0.006794	4.22	3.33	6.53	39.38	22.77	5.72	0.63	1.08
348	9	Q50	348exQadj	169.00	111.10	95.12	101.20	99.04	101.31	0.000977	6.08	5.19	3.33	81.71	22.77	5.72	0.26	0.24
348	9	Q100	348-7.25Qadj	192.00	111.00	95.12	100.21	99.18	100.50	0.003052	5.09	4.20	5.11	59.25	22.77	5.72	0.44	0.61
348	9	Q100	348exQadj	192.00	111.10	95.12	101.41	99.18	101.54	0.001079	6.29	5.39	3.59	86.41	22.77	5.72	0.27	0.28
348	10	Qfsh psg	348-7.25Qadj	25.00	128.00	94.17	97.25		97.30	0.000975	3.08	2.19	1.87	15.95	13.17	5.72	0.22	0.10
348	10	Qfsh psg	348exQadj	25.00	128.10	94.17	97.62		97.65	0.000520	3.45	2.56	1.52	21.89	22.77	5.72	0.17	0.06
348	10	Q2	348-7.25Qadj	63.00	128.00	94.17	98.37		98.44	0.000977	4.20	3.30	2.46	38.84	22.77	5.72	0.24	0.15
348	10	Q2	348exQadj	63.00	128.10	94.17	99.40		99.43	0.000287	5.23	4.33	1.60	62.30	22.77	5.72	0.14	0.06
348	10	Q10	348-7.25Qadj	116.00	128.00	94.17	99.27		99.37	0.001111	5.10	4.20	3.09	59.32	22.77	5.72	0.27	0.22
348	10	Q10	348exQadj	116.00	128.10	94.17	100.76		100.80	0.000316	6.59	5.70	2.02	93.42	22.77	5.72	0.15	0.09
348	10	Q50	348-7.25Qadj	169.00	128.00	94.17	99.78		99.93	0.001441	5.61	4.72	3.80	71.04	22.77	5.72	0.31	0.33
348	10	Q50	348exQadj	169.00	128.10	94.17	101.26		101.33	0.000487	7.09	6.20	2.65	104.70	22.77	5.72	0.19	0.14
348	10	Q100	348-7.25Qadj	192.00	128.00	94.17	100.41		100.54	0.001119	6.24	5.34	3.63	85.28	22.77	5.72	0.28	0.29
348	10	Q100	348exQadj	192.00	128.10	94.17	101.47		101.55	0.000553	7.30	6.41	2.88	109.56	22.77	5.72	0.20	0.17
348	11	Qfsh psg	348exQadj	25.00	161.10	94.47	97.65		97.67	0.000259	3.18	1.92	0.96	26.12	14.04	13.57	0.12	0.03
348	11	Q2	348exQadj	63.00	161.10	94.47	99.42		99.43	0.000139	4.95	3.64	1.07	77.30	35.55	13.90	0.10	0.03
348	11	Q10	348exQadj	116.00	161.10	94.47	100.79		100.81	0.000126	6.32	5.01	1.27	129.32	39.10	13.90	0.10	0.03

HEC-RAS River: 348 Trib Reach: 348 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
348	11	Q50	348exQadj	169.00	161.10	94.47	101.31		101.34	0.000180	6.84	5.53	1.62	149.51	39.10	13.90	0.12	0.05
348	11	Q100	348exQadj	192.00	161.10	94.47	101.53		101.57	0.000199	7.06	5.75	1.75	158.22	39.10	13.90	0.13	0.06

Tributary 483+18 HEC-RAS

Companion 2006 Stream and Habitat Inventory (S&HI) station 506+25
Model based on relative datum. Subtract 57.63-ft for approximate conversion to ADOT&PF project datum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RS = 10
.06
.035
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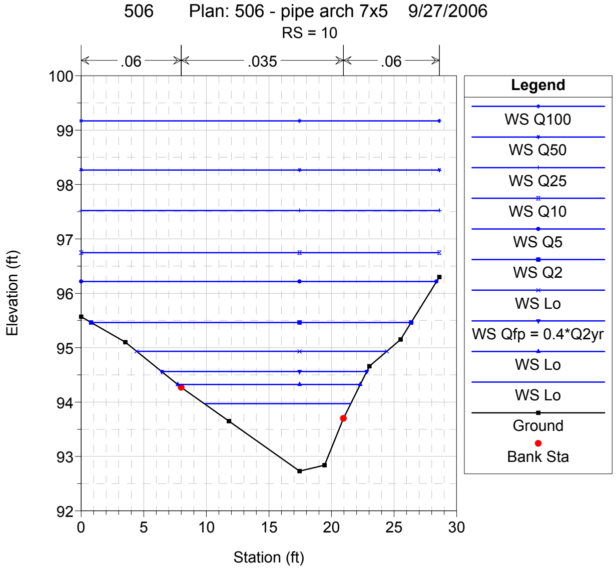
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp = 0.4*Q2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
506 Plan: 506 - Existing 9/27/2006
RS = 9
.06
.035
.06
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp = 0.4*Q2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
506 Plan: 506 - Existing 9/27/2006
RS = 5 Culv
.06
.035
.06
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp = 0.4*Q2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
506 Plan: 506 - Existing 9/27/2006
RS = 5 Culv
.06
.035
.06
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp = 0.4*Q2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
506 Plan: 506 - Existing 9/27/2006
RS = 2
.06
.035
.06
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp = 0.4*Q2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
506 Plan: 506 - Existing 9/27/2006
RS = 1
.04
.035
.06
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp = 0.4*Q2yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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RS = 10
.06
.035
.06
Elevation (ft)
Station (ft)
Legend
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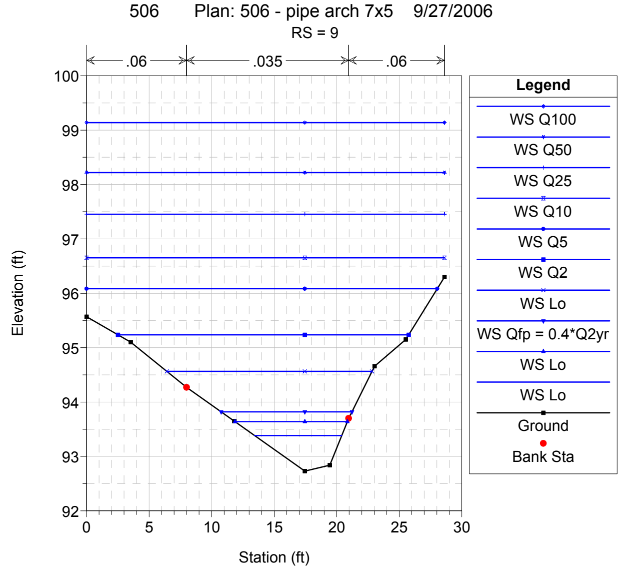
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Lo
WS Qfp = 0.4*Q2yr
WS Lo
WS Lo
Ground
Bank Sta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RS = 9
.06
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.06
Elevation (ft)
Station (ft)
Legend
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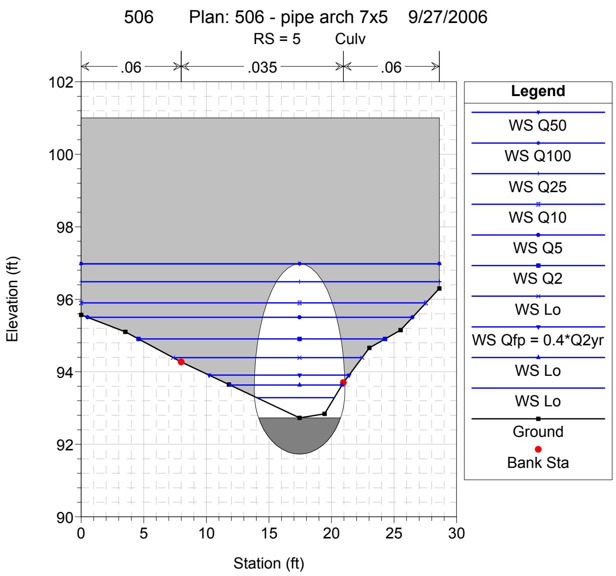
WS Q25
WS Q10
WS Q5
WS Q2
WS Lo
WS Qfp = 0.4*Q2yr
WS Lo
WS Lo
Ground
Bank Sta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RS = 5 Culv
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Elevation (ft)
Station (ft)
Legend
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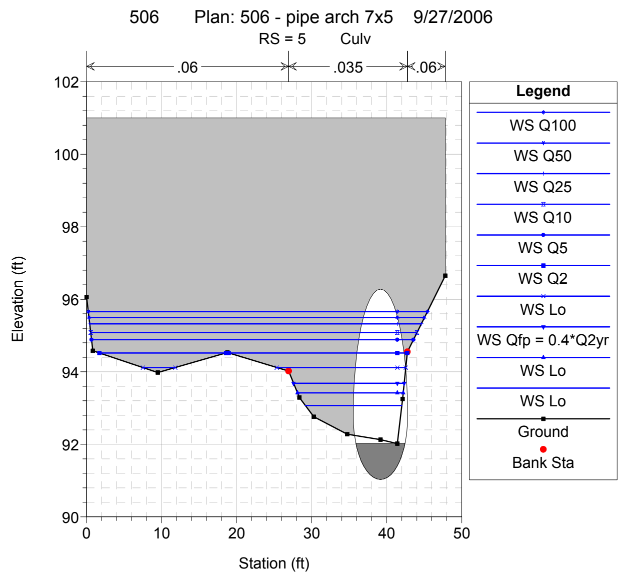
WS Q10
WS Q5
WS Q2
WS Lo
WS Qfp = 0.4*Q2yr
WS Lo
WS Lo
Ground
Bank Sta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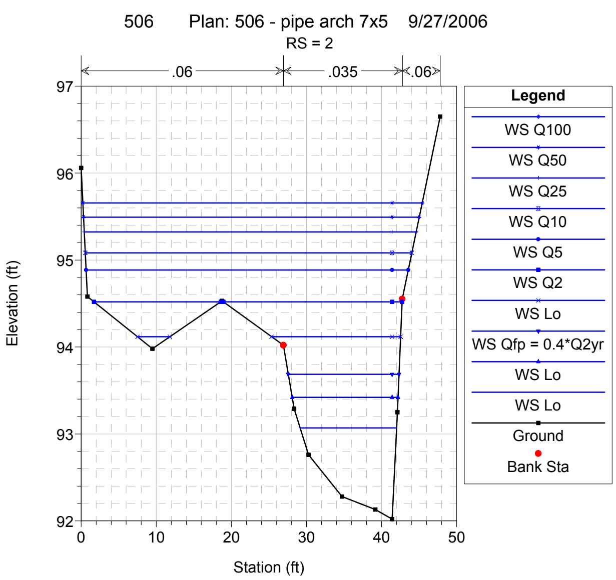
RS = 5 Culv
.06
.035
.06
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Lo
WS Qfp = 0.4*Q2yr
WS Lo
WS Lo
Ground
Bank Sta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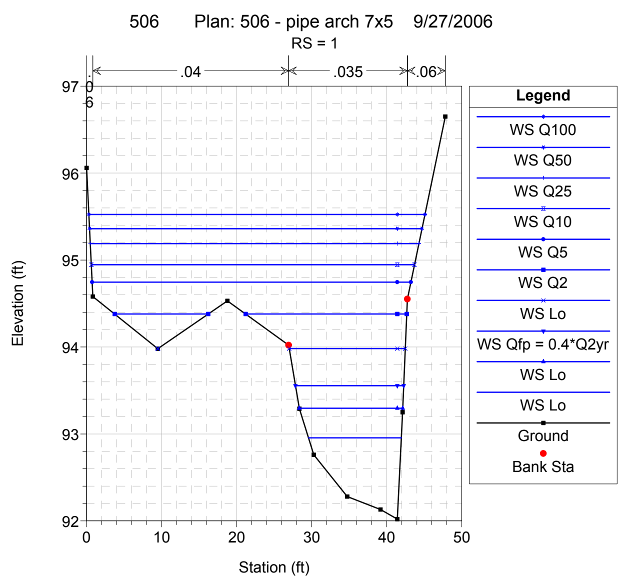
RS = 2
.06
.035
.06
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Lo
WS Qfp = 0.4*Q2yr
WS Lo
WS Lo
Ground
Bank Sta


506 Plan: 506 - pipe arch 7x5 9/27/2006
RS = 1
.04
.035
.06
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Lo
WS Qfp = 0.4*Q2yr
WS Lo
WS Lo
Ground
Bank Sta

HEC-RAS River: 506 Trib Reach: 506

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
506	1	Lo	506-parch	10.00		92.02	92.95	92.56	92.98	0.002001	0.93	0.61	1.32	7.55	12.37	12.37	0.30	0.07
506	1	Lo	506-Ex	10.00		92.02	92.95	92.56	92.98	0.002001	0.93	0.61	1.32	7.55	12.37	12.37	0.30	0.07
506	1	Lo	506-parch	20.00		92.02	93.30	92.76	93.34	0.002001	1.28	0.87	1.66	12.01	13.79	13.79	0.31	0.10
506	1	Lo	506-Ex	20.00		92.02	93.30	92.76	93.34	0.002001	1.28	0.87	1.66	12.01	13.79	13.79	0.31	0.10
506	1	Qfp = 0.4*Q2yr	506-parch	30.00		92.02	93.56	92.91	93.61	0.002002	1.54	1.09	1.91	15.67	14.43	14.43	0.32	0.13
506	1	Qfp = 0.4*Q2yr	506-Ex	30.00		92.02	93.56	92.91	93.61	0.002002	1.54	1.09	1.91	15.67	14.43	14.43	0.32	0.13
506	1	Lo	506-parch	50.00		92.02	93.98	93.15	94.06	0.002001	1.96	1.43	2.27	22.06	15.54	15.47	0.33	0.16
506	1	Lo	506-Ex	50.00		92.02	93.98	93.15	94.06	0.002001	1.96	1.43	2.27	22.06	15.54	15.47	0.33	0.16
506	1	Q2	506-parch	76.00		92.02	94.38	93.41	94.48	0.002002	2.36	1.80	2.62	31.77	33.94	15.74	0.34	0.20
506	1	Q2	506-Ex	76.00		92.02	94.38	93.41	94.48	0.002002	2.36	1.80	2.62	31.77	33.94	15.74	0.34	0.20
506	1	Q5	506-parch	113.00		92.02	94.75	93.71	94.87	0.002004	2.73	2.15	2.95	46.54	42.47	15.82	0.35	0.24
506	1	Q5	506-Ex	113.00		92.02	94.75	93.71	94.87	0.002004	2.73	2.15	2.95	46.54	42.47	15.82	0.35	0.24
506	1	Q10	506-parch	139.00		92.02	94.95	93.89	95.08	0.002000	2.93	2.35	3.13	55.10	43.06	15.82	0.36	0.26
506	1	Q10	506-Ex	139.00		92.02	94.95	93.89	95.08	0.002000	2.93	2.35	3.13	55.10	43.06	15.82	0.36	0.26
506	1	Q25	506-parch	175.00		92.02	95.19	94.24	95.33	0.002001	3.17	2.60	3.34	65.65	43.79	15.82	0.37	0.29
506	1	Q25	506-Ex	175.00		92.02	95.19	94.24	95.33	0.002001	3.17	2.60	3.34	65.65	43.79	15.82	0.37	0.29
506	1	Q50	506-parch	203.00		92.02	95.36	94.56	95.51	0.002000	3.34	2.77	3.48	73.19	44.30	15.82	0.37	0.31
506	1	Q50	506-Ex	203.00		92.02	95.36	94.56	95.51	0.002000	3.34	2.77	3.48	73.19	44.30	15.82	0.37	0.31
506	1	Q100	506-parch	232.00		92.02	95.52	94.69	95.69	0.002002	3.50	2.93	3.62	80.51	44.79	15.82	0.37	0.33
506	1	Q100	506-Ex	232.00		92.02	95.52	94.69	95.69	0.002002	3.50	2.93	3.62	80.51	44.79	15.82	0.37	0.33
506	2	Lo	506-parch	10.00	70.00	92.02	93.07		93.09	0.001181	1.05	0.70	1.11	9.00	12.85	12.85	0.23	0.05
506	2	Lo	506-Ex	10.00	70.00	92.02	93.07		93.09	0.001181	1.05	0.70	1.11	9.00	12.85	12.85	0.23	0.05
506	2	Lo	506-parch	20.00	70.00	92.02	93.42		93.45	0.001326	1.40	0.97	1.46	13.74	14.10	14.10	0.26	0.08
506	2	Lo	506-Ex	20.00	70.00	92.02	93.42		93.45	0.001326	1.40	0.97	1.46	13.74	14.10	14.10	0.26	0.08
506	2	Qfp = 0.4*Q2yr	506-parch	30.00	70.00	92.02	93.69		93.73	0.001420	1.67	1.19	1.71	17.57	14.74	14.74	0.28	0.10
506	2	Qfp = 0.4*Q2yr	506-Ex	30.00	70.00	92.02	93.69		93.73	0.001420	1.67	1.19	1.71	17.57	14.74	14.74	0.28	0.10
506	2	Lo	506-parch	50.00	70.00	92.02	94.12		94.18	0.001499	2.10	1.55	2.07	24.54	21.48	15.61	0.29	0.13
506	2	Lo	506-Ex	50.00	70.00	92.02	94.12		94.18	0.001499	2.10	1.55	2.07	24.54	21.48	15.61	0.29	0.13
506	2	Q2	506-parch	76.00	70.00	92.02	94.52		94.61	0.001545	2.50	1.93	2.41	37.04	40.69	15.81	0.31	0.17
506	2	Q2	506-Ex	76.00	70.00	92.02	94.52		94.61	0.001545	2.50	1.93	2.41	37.04	40.69	15.81	0.31	0.17
506	2	Q5	506-parch	113.00	70.00	92.02	94.89		95.00	0.001653	2.87	2.29	2.79	52.52	42.89	15.82	0.33	0.21
506	2	Q5	506-Ex	113.00	70.00	92.02	94.89		95.00	0.001652	2.87	2.29	2.79	52.53	42.89	15.82	0.32	0.21
506	2	Q10	506-parch	139.00	70.00	92.02	95.08		95.21	0.001757	3.06	2.49	3.04	61.03	43.47	15.82	0.34	0.25
506	2	Q10	506-Ex	139.00	70.00	92.02	95.08		95.21	0.001758	3.06	2.49	3.04	61.03	43.47	15.82	0.34	0.25
506	2	Q25	506-parch	175.00	70.00	92.02	95.32		95.47	0.001880	3.30	2.73	3.35	71.53	44.19	15.82	0.36	0.29
506	2	Q25	506-Ex	175.00	70.00	92.02	95.32		95.47	0.001880	3.30	2.73	3.35	71.53	44.19	15.82	0.36	0.29
506	2	Q50	506-parch	203.00	70.00	92.02	95.49		95.65	0.001956	3.47	2.90	3.55	79.09	44.69	15.82	0.37	0.32
506	2	Q50	506-Ex	203.00	70.00	92.02	95.49		95.65	0.001956	3.47	2.90	3.55	79.09	44.69	15.82	0.37	0.32
506	2	Q100	506-parch	232.00	70.00	92.02	95.66		95.83	0.002026	3.64	3.06	3.75	86.41	45.18	15.82	0.38	0.35
506	2	Q100	506-Ex	232.00	70.00	92.02	95.66		95.83	0.002026	3.64	3.06	3.75	86.41	45.18	15.82	0.38	0.35
506	5			Culvert														
506	9	Lo	506-parch	10.00	135.00	92.73	93.38	93.38	93.59	0.025747	0.65	0.40	3.61	2.77	6.96	6.96	1.01	0.62
506	9	Lo	506-Ex	10.00	135.00	92.73	94.32	93.38	94.33	0.000394	1.59	0.95	0.80	12.78	14.55	12.96	0.14	0.02
506	9	Lo	506-parch	20.00	135.00	92.73	93.64	93.64	93.91	0.023084	0.91	0.53	4.16	4.81	8.98	8.98	1.00	0.75
506	9	Lo	506-Ex	20.00	135.00	92.73	94.89	93.64	94.91	0.000313	2.16	1.53	0.98	22.45	19.55	12.96	0.14	0.03
506	9	Qfp = 0.4*Q2yr	506-parch	30.00	135.00	92.73	93.82	93.82	94.15	0.021972	1.09	0.64	4.59	6.56	10.46	10.20	1.01	0.85
506	9	Qfp = 0.4*Q2yr	506-Ex	30.00	135.00	92.73	95.37	93.82	95.39	0.000264	2.64	2.01	1.08	32.99	24.60	12.96	0.13	0.03
506	9	Lo	506-parch	50.00	135.00	92.73	94.56	94.11	94.72	0.004505	1.83	1.20	3.16	16.59	16.41	12.96	0.51	0.33
506	9	Lo	506-Ex	50.00	135.00	92.73	96.21	94.11	96.22	0.000194	3.48	2.84	1.17	55.64	28.37	12.96	0.12	0.03
506	9	Q2	506-parch	76.00	135.00	92.73	95.24	94.38	95.36	0.002184	2.51	1.87	2.96	29.81	23.24	12.96	0.38	0.25
506	9	Q2	506-Ex	76.00	135.00	92.73	97.19	94.38	97.21	0.000144	4.46	3.83	1.23	83.83	28.62	12.96	0.11	0.03
506	9	Q5	506-parch	113.00	135.00	92.73	96.08	94.69	96.19	0.001172	3.35	2.72	2.78	52.22	28.04	12.96	0.30	0.19
506	9	Q5	506-Ex	113.00	135.00	92.73	99.78	94.69	99.79	0.000050	7.05	6.41	1.02	157.84	28.62	12.96	0.07	0.02
506	9	Q10	506-parch	139.00	135.00	92.73	96.65	94.90	96.75	0.000857	3.92	3.29	2.70	68.37	28.62	12.96	0.26	0.17
506	9	Q10	506-Ex	139.00	135.00	92.73	101.18	94.90	101.19	0.000039	8.45	7.81	1.02	197.92	28.62	12.96	0.06	0.02
506	9	Q25	506-parch	175.00	135.00	92.73	97.45	95.16	97.54	0.000598	4.72	4.09	2.61	91.34	28.62	12.96	0.23	0.15
506	9	Q25	506-Ex	175.00	135.00	92.73	101.61	95.16	101.63	0.000052	8.88	8.25	1.22	210.37	28.62	12.96	0.07	0.03
506	9	Q50	506-parch	203.00	135.00	92.73	98.22	95.35	98.29	0.000432	5.49	4.85	2.49	113.20	28.62	12.96	0.20	0.13
506	9	Q50	506-Ex	203.00	135.00	92.73	101.86	95.35	101.89	0.000063	9.13	8.50	1.38	217.57	28.62	12.96	0.08	0.03

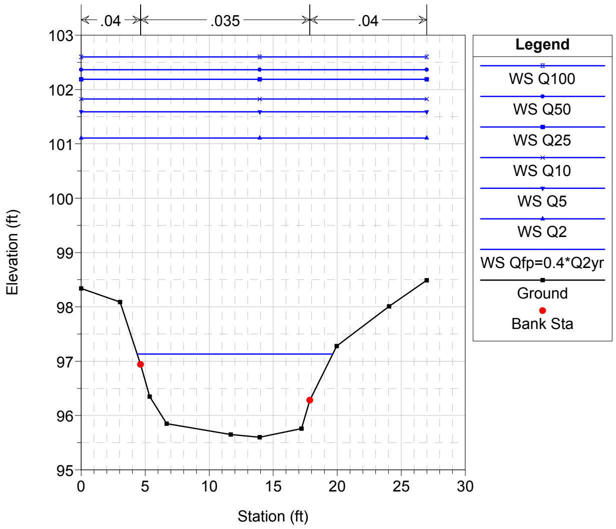
HEC-RAS River: 506 Trib Reach: 506 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
506	9	Q100	506-parch	232.00	135.00	92.73	99.14	95.54	99.20	0.000306	6.41	5.77	2.35	139.49	28.62	12.96	0.17	0.11
506	9	Q100	506-Ex	232.00	135.00	92.73	102.09	95.54	102.11	0.000075	9.36	8.72	1.53	223.91	28.62	12.96	0.09	0.04
506	10	Lo	506-parch	10.00	245.00	92.73	93.97		93.99	0.001324	1.24	0.73	1.23	8.20	11.69	11.11	0.25	0.06
506	10	Lo	506-Ex	10.00	245.00	92.73	94.36		94.37	0.000342	1.63	0.99	0.77	13.38	14.86	12.96	0.14	0.02
506	10	Lo	506-parch	20.00	245.00	92.73	94.32		94.36	0.001550	1.59	0.96	1.60	12.85	14.58	12.96	0.29	0.09
506	10	Lo	506-Ex	20.00	245.00	92.73	94.93		94.94	0.000290	2.20	1.56	0.96	23.12	19.91	12.96	0.13	0.03
506	10	Qfp = 0.4*Q2yr	506-parch	30.00	245.00	92.73	94.56		94.62	0.001635	1.83	1.20	1.90	16.55	16.38	12.96	0.31	0.12
506	10	Qfp = 0.4*Q2yr	506-Ex	30.00	245.00	92.73	95.40		95.41	0.000251	2.67	2.03	1.06	33.71	24.89	12.96	0.13	0.03
506	10	Lo	506-parch	50.00	245.00	92.73	94.93		95.02	0.001775	2.20	1.57	2.37	23.29	20.00	12.96	0.33	0.17
506	10	Lo	506-Ex	50.00	245.00	92.73	96.23		96.25	0.000189	3.50	2.86	1.16	56.25	28.42	12.96	0.12	0.03
506	10	Q2	506-parch	76.00	245.00	92.73	95.46		95.56	0.001428	2.73	2.10	2.58	35.38	25.57	12.96	0.31	0.18
506	10	Q2	506-Ex	76.00	245.00	92.73	97.21		97.23	0.000142	4.48	3.84	1.22	84.28	28.62	12.96	0.11	0.03
506	10	Q5	506-parch	113.00	245.00	92.73	96.22		96.31	0.000978	3.49	2.85	2.62	55.94	28.39	12.96	0.27	0.17
506	10	Q5	506-Ex	113.00	245.00	92.73	99.78		99.80	0.000050	7.05	6.42	1.02	157.99	28.62	12.96	0.07	0.02
506	10	Q10	506-parch	139.00	245.00	92.73	96.75		96.84	0.000767	4.02	3.38	2.60	71.14	28.62	12.96	0.25	0.16
506	10	Q10	506-Ex	139.00	245.00	92.73	101.18		101.19	0.000039	8.45	7.82	1.02	198.04	28.62	12.96	0.06	0.02
506	10	Q25	506-parch	175.00	245.00	92.73	97.52		97.60	0.000563	4.79	4.16	2.56	93.28	28.62	12.96	0.22	0.14
506	10	Q25	506-Ex	175.00	245.00	92.73	101.62		101.64	0.000051	8.89	8.25	1.22	210.54	28.62	12.96	0.07	0.03
506	10	Q50	506-parch	203.00	245.00	92.73	98.27		98.34	0.000417	5.54	4.90	2.46	114.59	28.62	12.96	0.20	0.12
506	10	Q50	506-Ex	203.00	245.00	92.73	101.87		101.89	0.000063	9.14	8.51	1.37	217.77	28.62	12.96	0.08	0.03
506	10	Q100	506-parch	232.00	245.00	92.73	99.17		99.24	0.000300	6.44	5.81	2.33	140.47	28.62	12.96	0.17	0.11
506	10	Q100	506-Ex	232.00	245.00	92.73	102.09		102.12	0.000075	9.36	8.73	1.53	224.15	28.62	12.96	0.09	0.04

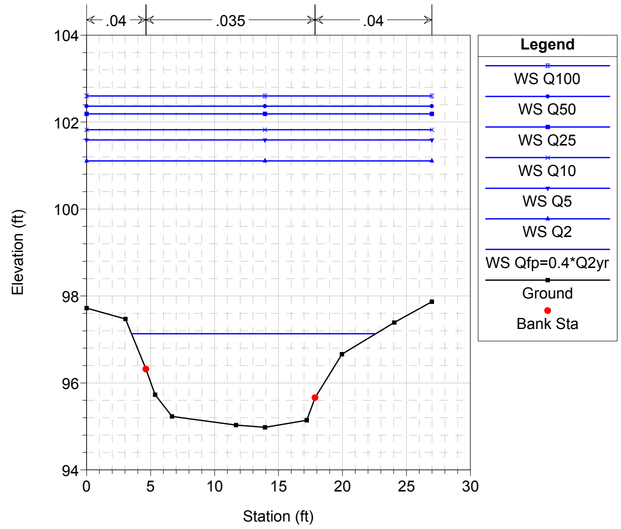
Tributary 512+24 HEC-RAS

Companion 2006 Stream and Habitat Inventory (S&HI) station 535+50
Model based on relative datum. Subtract 57.88-ft for approximate conversion to ADOT&PF project datum

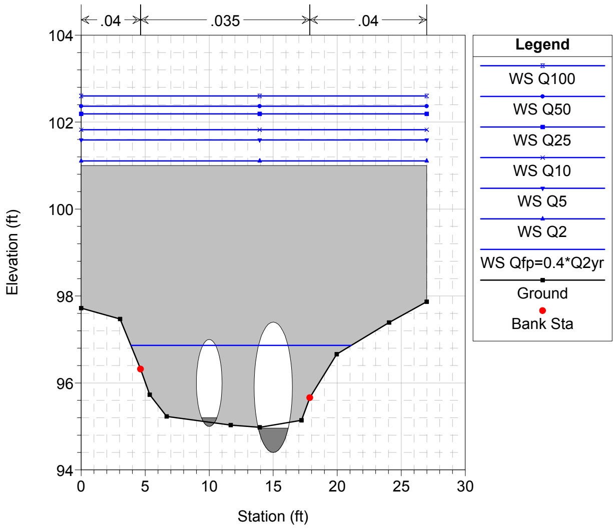
534 Plan: 10-Mile Existing 9/27/2006
RS = 10



534 Plan: 10-Mile Existing 9/27/2006
RS = 9



534 Plan: 10-Mile Existing 9/27/2006
RS = 5 Culv



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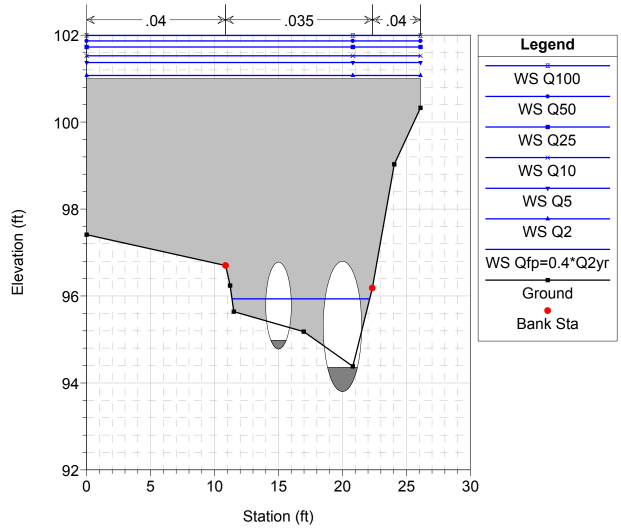

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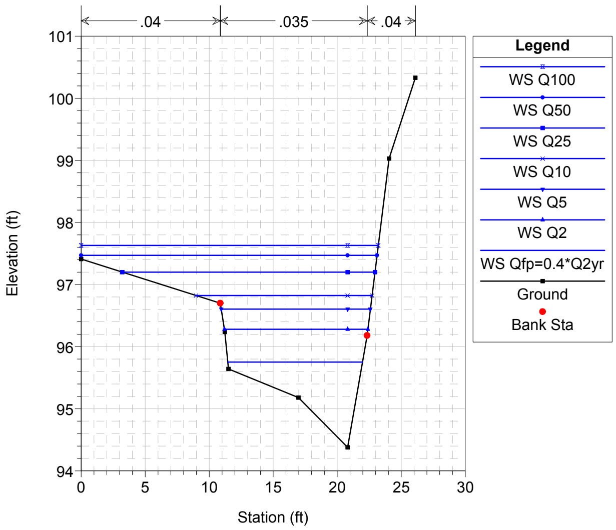

534 Plan: 10-Mile Existing 9/27/2006
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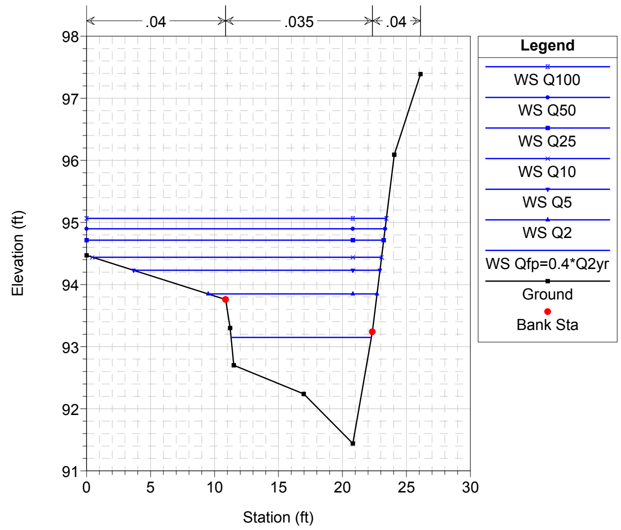

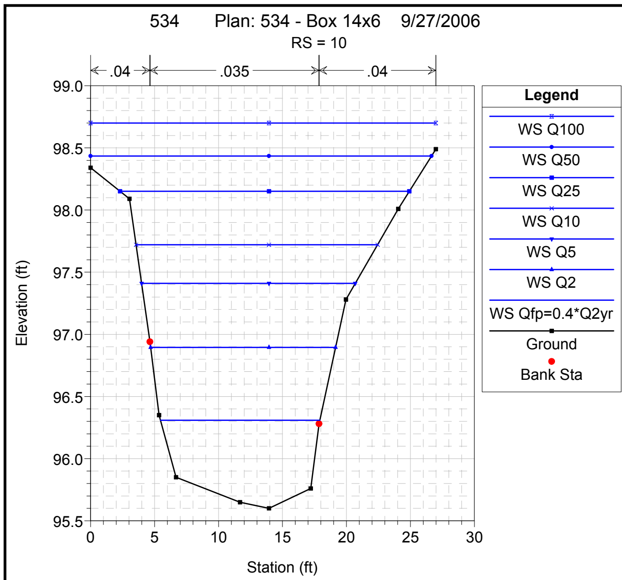
534 Plan: 534 - Box 14x6 9/27/2006
RS = 10
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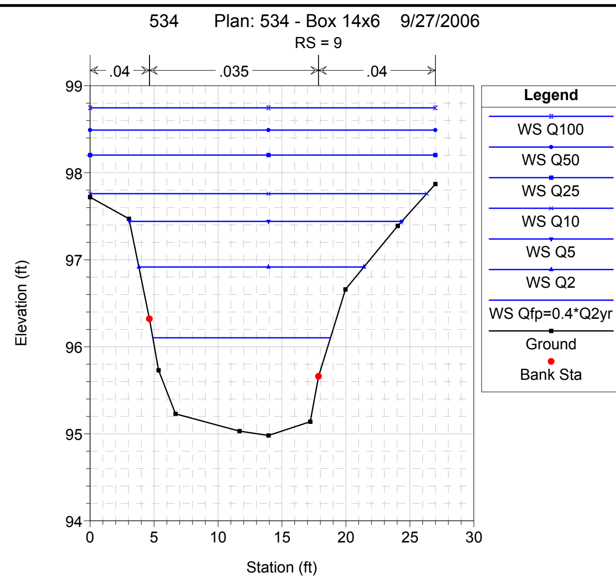
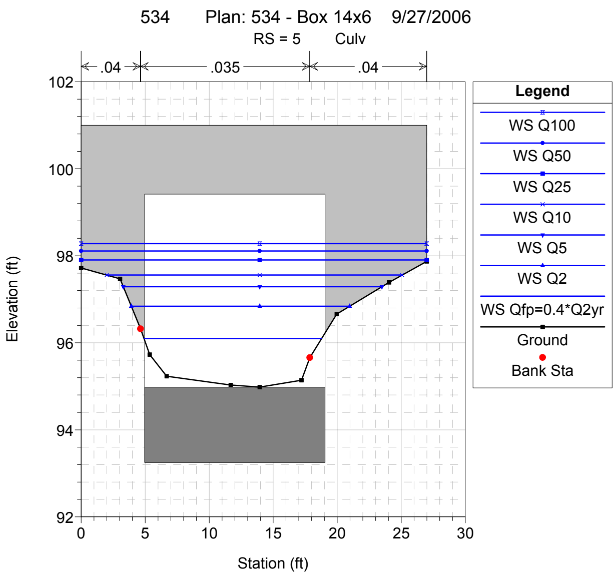
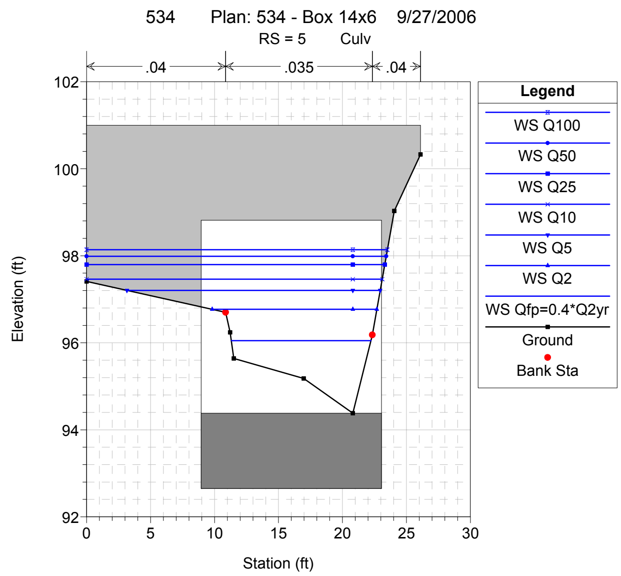
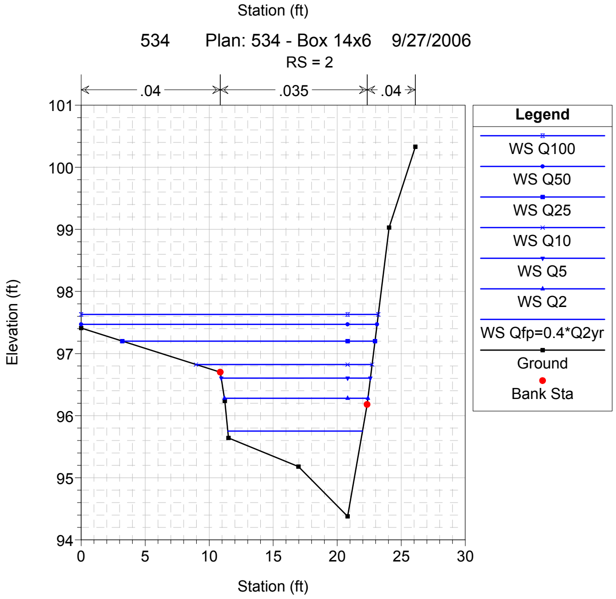
.035
.04
Elevation (ft)
Station (ft)
99.0
98.5
98.0
97.5
97.0
96.5
96.0
95.5
0
5
10
15
20
25
30
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp=0.4*Q2yr
Ground
Bank Sta


534 Plan: 534 - Box 14x6 9/27/2006
RS = 9
.04
.035
.04
Elevation (ft)
Station (ft)
99
98
97
96
95
94
0
5
10
15
20
25
30
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp=0.4*Q2yr
Ground
Bank Sta


534 Plan: 534 - Box 14x6 9/27/2006
RS = 5 Culv
.04
.035
.04
Elevation (ft)
Station (ft)
102
100
98
96
94
92
0
5
10
15
20
25
30
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp=0.4*Q2yr
Ground
Bank Sta


534 Plan: 534 - Box 14x6 9/27/2006
RS = 5 Culv
.04
.035
.04
Elevation (ft)
Station (ft)
102
100
98
96
94
92
0
5
10
15
20
25
30
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp=0.4*Q2yr
Ground
Bank Sta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.035
.04
Elevation (ft)
Station (ft)
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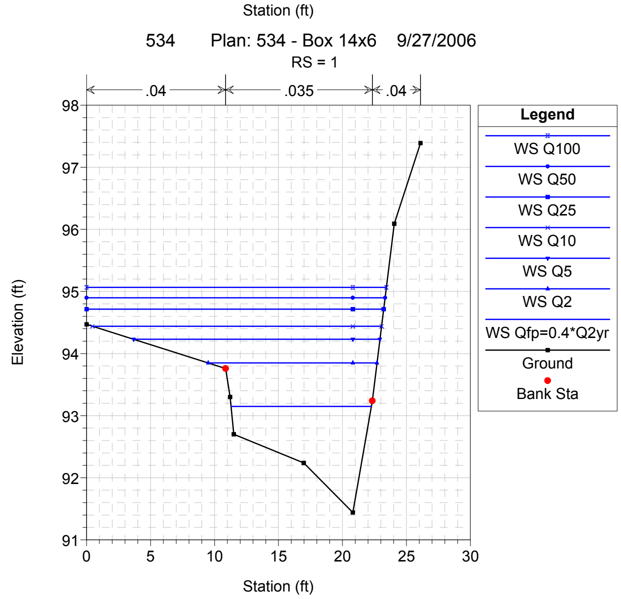
100
99
98
97
96
95
94
0
5
10
15
20
25
30
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp=0.4*Q2yr
Ground
Bank Sta


534 Plan: 534 - Box 14x6 9/27/2006
RS = 1
.04
.035
.04
Elevation (ft)
Station (ft)
98
97
96
95
94
93
92
91
0
5
10
15
20
25
30
Legend
WS Q100
WS Q50
WS Q25
WS Q10
WS Q5
WS Q2
WS Qfp=0.4*Q2yr
Ground
Bank Sta

HEC-RAS River: 10-Mile Ck Reach: 534

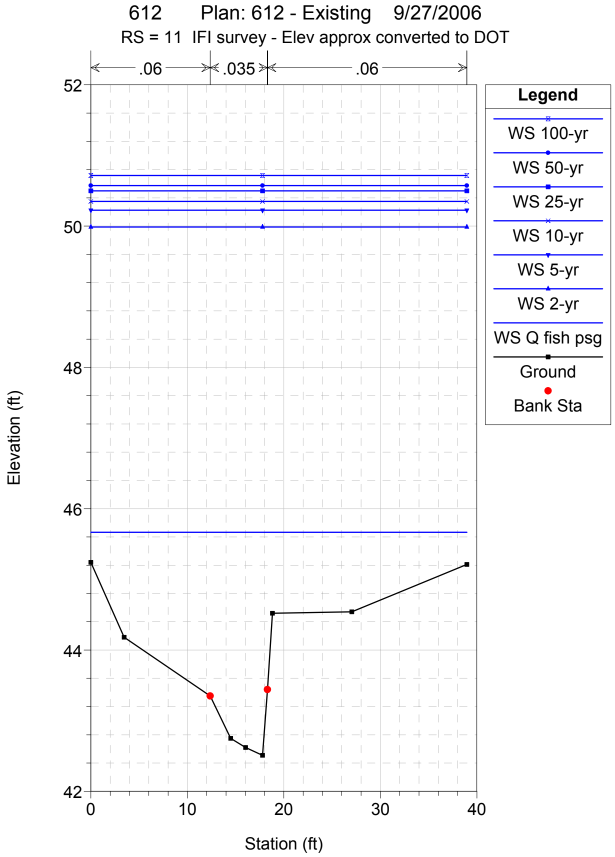
Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
534	1	Lo	534-box	10.00		91.44	92.68	92.40	92.74	0.006006	1.24	0.50	1.98	5.05	10.14	10.14	0.49	0.18
534	1	Lo	10Mi - Ex	10.00		91.44	92.68	92.40	92.74	0.006006	1.24	0.50	1.98	5.05	10.14	10.14	0.49	0.18
534	1	Lo	534-box	20.00		91.44	92.95	92.67	93.05	0.006000	1.51	0.74	2.53	7.89	10.70	10.70	0.52	0.25
534	1	Lo	10Mi - Ex	20.00		91.44	92.95	92.67	93.05	0.006000	1.51	0.74	2.53	7.89	10.70	10.70	0.52	0.25
534	1	Qfp=0.4*Q2yr	534-box	29.00		91.44	93.15	92.81	93.28	0.006006	1.71	0.91	2.89	10.02	10.96	10.96	0.53	0.31
534	1	Qfp=0.4*Q2yr	10Mi - Ex	29.00		91.44	93.15	92.81	93.28	0.006006	1.71	0.91	2.89	10.02	10.96	10.96	0.53	0.31
534	1	Lo	534-box	50.00		91.44	93.52	93.09	93.71	0.006006	2.08	1.25	3.53	14.17	11.45	11.28	0.56	0.42
534	1	Lo	10Mi - Ex	50.00		91.44	93.52	93.09	93.71	0.006006	2.08	1.25	3.53	14.17	11.45	11.28	0.56	0.42
534	1	Q2	534-box	73.00		91.44	93.85	93.34	94.11	0.006004	2.41	1.56	4.07	18.07	13.20	11.46	0.57	0.52
534	1	Q2	10Mi - Ex	73.00		91.44	93.85	93.34	94.11	0.006004	2.41	1.56	4.07	18.07	13.20	11.46	0.57	0.52
534	1	Q5	534-box	107.00		91.44	94.23	93.67	94.57	0.006002	2.79	1.94	4.71	24.25	19.26	11.46	0.60	0.64
534	1	Q5	10Mi - Ex	107.00		91.44	94.23	93.69	94.57	0.006002	2.79	1.94	4.71	24.25	19.26	11.46	0.60	0.64
534	1	Q10	534-box	130.00		91.44	94.44	93.89	94.82	0.006010	3.00	2.15	5.04	28.65	22.60	11.46	0.61	0.71
534	1	Q10	10Mi - Ex	130.00		91.44	94.44	93.89	94.82	0.006011	3.00	2.15	5.04	28.65	22.60	11.46	0.61	0.71
534	1	Q25	534-box	166.00		91.44	94.71	94.26	95.14	0.006002	3.27	2.43	5.46	34.99	23.22	11.46	0.62	0.80
534	1	Q25	10Mi - Ex	166.00		91.44	94.71	94.26	95.14	0.006002	3.27	2.43	5.46	34.99	23.22	11.46	0.62	0.80
534	1	Q50	534-box	193.00		91.44	94.90	94.53	95.36	0.006001	3.46	2.61	5.73	39.24	23.33	11.46	0.63	0.86
534	1	Q50	10Mi - Ex	193.00		91.44	94.90	94.53	95.36	0.006001	3.46	2.61	5.73	39.24	23.33	11.46	0.63	0.86
534	1	Q100	534-box	220.00		91.44	95.07	94.69	95.56	0.006009	3.63	2.78	5.98	43.20	23.43	11.46	0.63	0.92
534	1	Q100	10Mi - Ex	220.00		91.44	95.07	94.68	95.56	0.006009	3.63	2.78	5.98	43.20	23.43	11.46	0.63	0.92
534	2	Lo	534-box	10.00	186.00	94.38	95.34	95.34	95.55	0.027269	0.96	0.41	3.68	2.72	6.60	6.60	1.01	0.65
534	2	Lo	10Mi - Ex	10.00	186.00	94.38	95.34	95.34	95.55	0.027269	0.96	0.41	3.68	2.72	6.60	6.60	1.01	0.65
534	2	Lo	534-box	20.00	186.00	94.38	95.61	95.61	95.87	0.025530	1.23	0.49	4.06	4.93	9.99	9.99	1.02	0.74
534	2	Lo	10Mi - Ex	20.00	186.00	94.38	95.61	95.61	95.87	0.025530	1.23	0.49	4.06	4.93	9.99	9.99	1.02	0.74
534	2	Qfp=0.4*Q2yr	534-box	29.00	186.00	94.38	95.75	95.75	96.07	0.024355	1.37	0.61	4.53	6.40	10.51	10.51	1.02	0.86
534	2	Qfp=0.4*Q2yr	10Mi - Ex	29.00	186.00	94.38	95.75	95.75	96.07	0.024355	1.37	0.61	4.53	6.40	10.51	10.51	1.02	0.86
534	2	Lo	534-box	50.00	186.00	94.38	96.03	96.03	96.47	0.022092	1.65	0.86	5.35	9.35	10.88	10.88	1.02	1.08
534	2	Lo	10Mi - Ex	50.00	186.00	94.38	96.03	96.03	96.47	0.022092	1.65	0.86	5.35	9.35	10.88	10.88	1.02	1.08
534	2	Q2	534-box	73.00	186.00	94.38	96.28	96.28	96.84	0.020825	1.90	1.09	6.02	12.14	11.20	11.14	1.02	1.26
534	2	Q2	10Mi - Ex	73.00	186.00	94.38	96.28	96.28	96.84	0.020825	1.90	1.09	6.02	12.14	11.20	11.14	1.02	1.26
534	2	Q5	534-box	107.00	186.00	94.38	96.61	96.61	97.32	0.019382	2.23	1.39	6.77	15.85	11.64	11.39	1.01	1.48
534	2	Q5	10Mi - Ex	107.00	186.00	94.38	96.61	96.61	97.32	0.019382	2.23	1.39	6.77	15.85	11.64	11.39	1.01	1.48
534	2	Q10	534-box	130.00	186.00	94.38	96.82	96.82	97.60	0.017672	2.44	1.60	7.09	18.54	13.75	11.46	0.99	1.55
534	2	Q10	10Mi - Ex	130.00	186.00	94.38	96.82	96.82	97.60	0.017672	2.44	1.60	7.09	18.54	13.75	11.46	0.99	1.55
534	2	Q25	534-box	166.00	186.00	94.38	97.20	97.20	97.98	0.013654	2.82	1.97	7.17	24.83	19.73	11.46	0.90	1.48
534	2	Q25	10Mi - Ex	166.00	186.00	94.38	97.20	97.20	97.98	0.013654	2.82	1.97	7.17	24.83	19.73	11.46	0.90	1.48
534	2	Q50	534-box	193.00	186.00	94.38	97.47	97.47	98.21	0.011253	3.09	2.24	7.09	30.70	23.11	11.46	0.83	1.39
534	2	Q50	10Mi - Ex	193.00	186.00	94.38	97.47	97.47	98.21	0.011253	3.09	2.24	7.09	30.70	23.11	11.46	0.83	1.39
534	2	Q100	534-box	220.00	186.00	94.38	97.63	97.63	98.41	0.010979	3.25	2.40	7.34	34.44	23.21	11.46	0.83	1.45
534	2	Q100	10Mi - Ex	220.00	186.00	94.38	97.63	97.63	98.41	0.010979	3.25	2.40	7.34	34.44	23.21	11.46	0.83	1.45
534	5			Culvert														
534	9	Lo	534-box	10.00	261.00	94.98	95.56	95.38	95.62	0.005905	0.58	0.45	1.88	5.32	11.94	11.94	0.50	0.16
534	9	Lo	10Mi - Ex	10.00	261.00	94.98	96.09	95.38	96.10	0.000439	1.11	0.93	0.83	12.21	13.86	12.95	0.15	0.02
534	9	Lo	534-box	20.00	261.00	94.98	95.89	95.56	95.96	0.003914	0.91	0.74	2.13	9.43	13.18	12.70	0.44	0.18
534	9	Lo	10Mi - Ex	20.00	261.00	94.98	96.66	95.56	96.68	0.000349	1.68	1.48	1.00	20.65	15.82	13.22	0.15	0.03
534	9	Qfp=0.4*Q2yr	534-box	29.00	261.00	94.98	96.10	95.69	96.19	0.003575	1.12	0.94	2.38	12.33	13.89	12.96	0.43	0.20
534	9	Qfp=0.4*Q2yr	10Mi - Ex	29.00	261.00	94.98	97.13	95.69	97.15	0.000280	2.15	1.94	1.08	28.84	19.10	13.22	0.14	0.03
534	9	Lo	534-box	50.00	261.00	94.98	96.53	95.93	96.64	0.003055	1.55	1.34	2.78	18.49	15.32	13.22	0.42	0.25
534	9	Lo	10Mi - Ex	50.00	261.00	94.98	98.65	95.93	98.67	0.000089	3.67	3.47	0.90	66.79	26.99	13.22	0.08	0.02
534	9	Q2	534-box	73.00	261.00	94.98	96.92	96.16	97.06	0.002693	1.94	1.73	3.10	24.87	17.59	13.22	0.42	0.28
534	9	Q2	10Mi - Ex	73.00	261.00	94.98	101.11	96.16	101.11	0.000025	6.13	5.92	0.68	132.94	26.99	13.22	0.05	0.01
534	9	Q5	534-box	107.00	261.00	94.98	97.44	96.46	97.61	0.002233	2.46	2.25	3.37	35.08	21.29	13.22	0.40	0.30
534	9	Q5	10Mi - Ex	107.00	261.00	94.98	101.59	96.46	101.60	0.000041	6.61	6.40	0.92	145.98	26.99	13.22	0.06	0.02
534	9	Q10	534-box	130.00	261.00	94.98	97.76	96.62	97.93	0.002023	2.78	2.57	3.50	42.64	26.31	13.22	0.38	0.31
534	9	Q10	10Mi - Ex	130.00	261.00	94.98	101.83	96.62	101.84	0.000054	6.85	6.64	1.07	152.37	26.99	13.22	0.07	0.02
534	9	Q25	534-box	166.00	261.00	94.98	98.20	96.89	98.38	0.001727	3.22	3.02	3.59	54.62	26.99	13.22	0.36	0.31
534	9	Q25	10Mi - Ex	166.00	261.00	94.98	102.19	96.89	102.21	0.000073	7.21	7.00	1.29	162.16	26.99	13.22	0.09	0.03
534	9	Q50	534-box	193.00	261.00	94.98	98.49	97.08	98.67	0.001620	3.51	3.30	3.70	62.33	26.99	13.22	0.36	0.32
534	9	Q50	10Mi - Ex	193.00	261.00	94.98	102.37	97.08	102.39	0.000090	7.39	7.18	1.46	166.95	26.99	13.22	0.10	0.04
534	9	Q100	534-box	220.00	261.00	94.98	98.75	97.26	98.94	0.001560	3.77	3.56	3.81	69.27	26.99	13.22	0.36	0.33
534	9	Q100	10Mi - Ex	220.00	261.00	94.98	102.60	97.26	102.63	0.000105	7.62	7.41	1.61	173.27	26.99	13.22	0.10	0.05

HEC-RAS River: 10-Mile Ck Reach: 534 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
534	10	Lo	534-box	10.00	290.00	95.60	96.00	96.00	96.15	0.027776	0.40	0.29	3.07	3.25	11.24	11.24	1.01	0.50
534	10	Lo	10Mi - Ex	10.00	290.00	95.60	96.08		96.17	0.013703	0.48	0.35	2.46	4.07	11.52	11.52	0.73	0.30
534	10	Lo	534-box	20.00	290.00	95.60	96.18	96.18	96.40	0.024435	0.58	0.44	3.80	5.26	11.92	11.92	1.01	0.66
534	10	Lo	10Mi - Ex	20.00	290.00	95.60	96.66		96.71	0.002119	1.06	0.88	1.76	11.48	13.69	12.88	0.33	0.11
534	10	Qfp=0.4*Q2yr	534-box	29.00	290.00	95.60	96.31	96.31	96.59	0.022481	0.71	0.55	4.23	6.86	12.46	12.40	1.00	0.76
534	10	Qfp=0.4*Q2yr	10Mi - Ex	29.00	290.00	95.60	97.13		97.17	0.001066	1.53	1.32	1.63	18.28	15.27	13.22	0.25	0.08
534	10	Lo	534-box	50.00	290.00	95.60	96.55	96.55	96.94	0.020059	0.95	0.78	5.01	10.04	13.33	12.76	1.00	0.95
534	10	Lo	10Mi - Ex	50.00	290.00	95.60	98.65		98.67	0.000199	3.05	2.84	1.17	50.00	26.99	13.22	0.12	0.03
534	10	Q2	534-box	73.00	290.00	95.60	96.89	96.78	97.28	0.013095	1.29	1.09	5.03	14.77	14.46	13.17	0.85	0.86
534	10	Q2	10Mi - Ex	73.00	290.00	95.60	101.11		101.11	0.000038	5.51	5.30	0.77	116.20	26.99	13.22	0.06	0.01
534	10	Q5	534-box	107.00	290.00	95.60	97.41		97.78	0.007529	1.81	1.60	4.92	22.71	16.70	13.22	0.69	0.73
534	10	Q5	10Mi - Ex	107.00	290.00	95.60	101.59		101.60	0.000059	5.99	5.78	1.03	129.24	26.99	13.22	0.08	0.02
534	10	Q10	534-box	130.00	290.00	95.60	97.72		98.09	0.005972	2.12	1.91	4.93	28.23	18.88	13.22	0.63	0.69
534	10	Q10	10Mi - Ex	130.00	290.00	95.60	101.83		101.84	0.000076	6.23	6.02	1.19	135.62	26.99	13.22	0.09	0.03
534	10	Q25	534-box	166.00	290.00	95.60	98.15		98.52	0.004674	2.55	2.34	5.00	37.02	22.61	13.22	0.58	0.66
534	10	Q25	10Mi - Ex	166.00	290.00	95.60	102.19		102.21	0.000100	6.59	6.38	1.43	145.40	26.99	13.22	0.10	0.04
534	10	Q50	534-box	193.00	290.00	95.60	98.43		98.80	0.004099	2.83	2.63	5.05	44.12	26.65	13.22	0.55	0.65
534	10	Q50	10Mi - Ex	193.00	290.00	95.60	102.36		102.40	0.000123	6.76	6.56	1.61	150.19	26.99	13.22	0.11	0.05
534	10	Q100	534-box	220.00	290.00	95.60	98.70		99.06	0.003601	3.10	2.89	5.05	51.27	26.99	13.22	0.52	0.63
534	10	Q100	10Mi - Ex	220.00	290.00	95.60	102.60		102.64	0.000142	7.00	6.79	1.77	156.50	26.99	13.22	0.12	0.06

Tributary 589+12 HEC-RAS

Companion 2006 Stream and Habitat Inventory (S&HI) station 612+40
Model based on ADOT&PF project datum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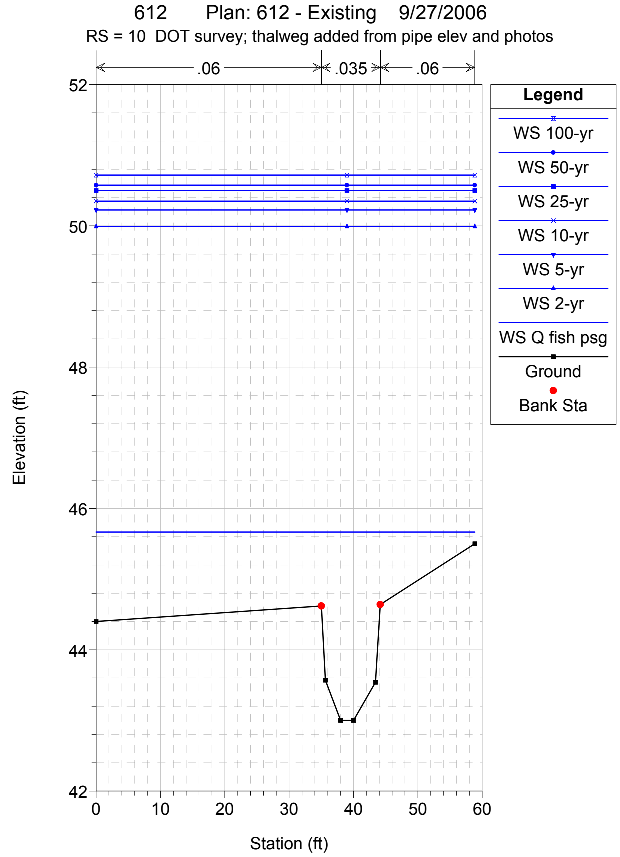
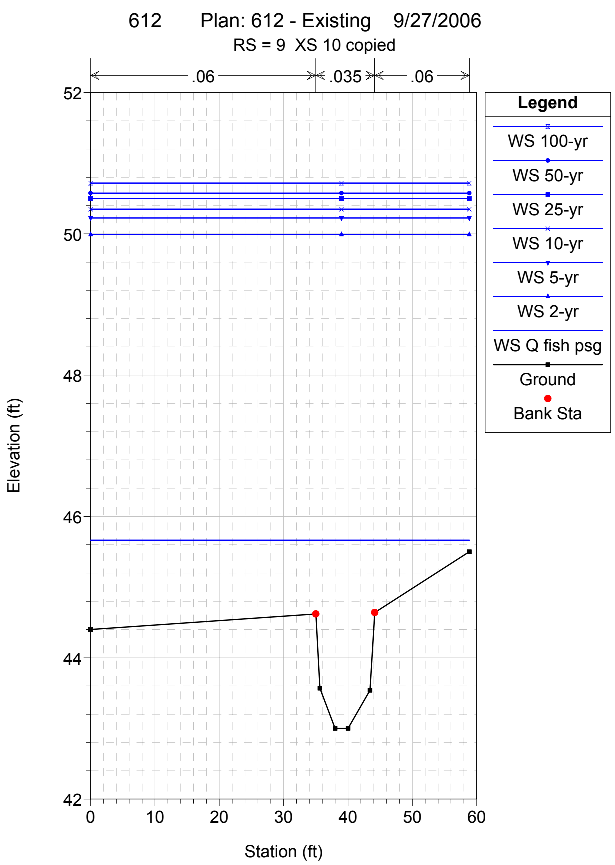
RS = 11 IFI survey - Elev approx converted to DOT
.06
.035
.06
Legend
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
WS 5-yr
WS 2-yr
WS Q fish psg
Ground
Bank Sta
Elevation (ft)
Station (ft)


612 Plan: 612 - Existing 9/27/2006
RS = 10 DOT survey; thalweg added from pipe elev and photos
.06
.035
.06
Legend
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
WS 5-yr
WS 2-yr
WS Q fish psg
Ground
Bank Sta
Elevation (ft)
Station (ft)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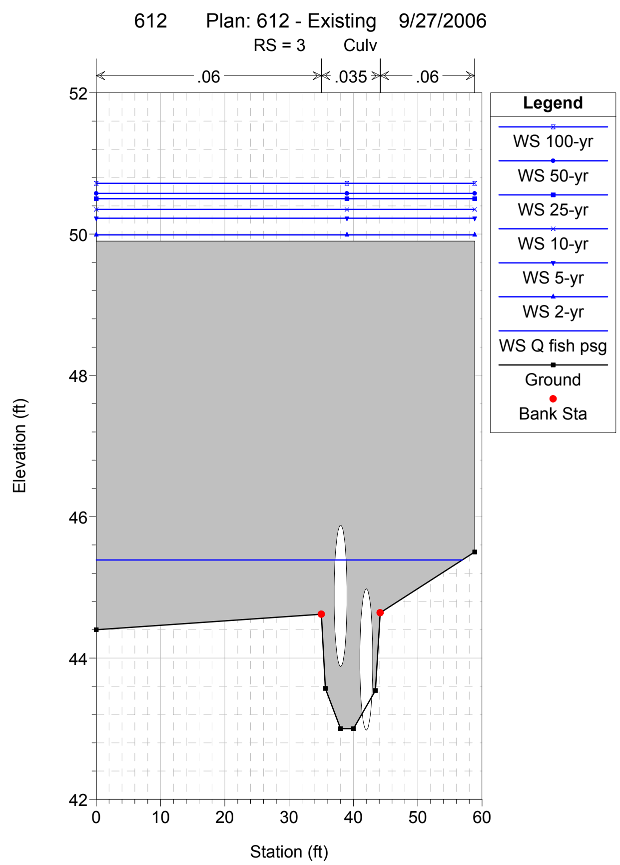
.06
.035
.06
Legend
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
WS 5-yr
WS 2-yr
WS Q fish psg
Ground
Bank Sta
Elevation (ft)
Station (ft)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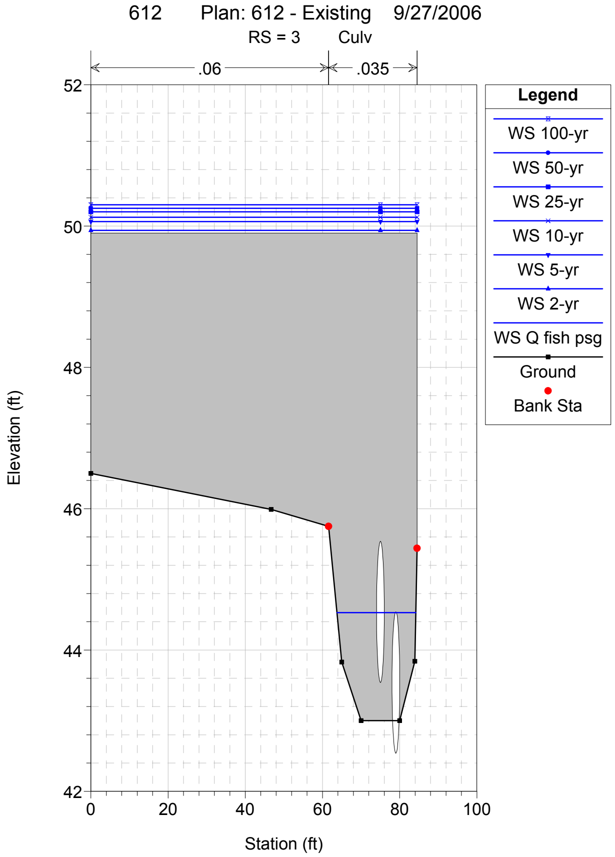
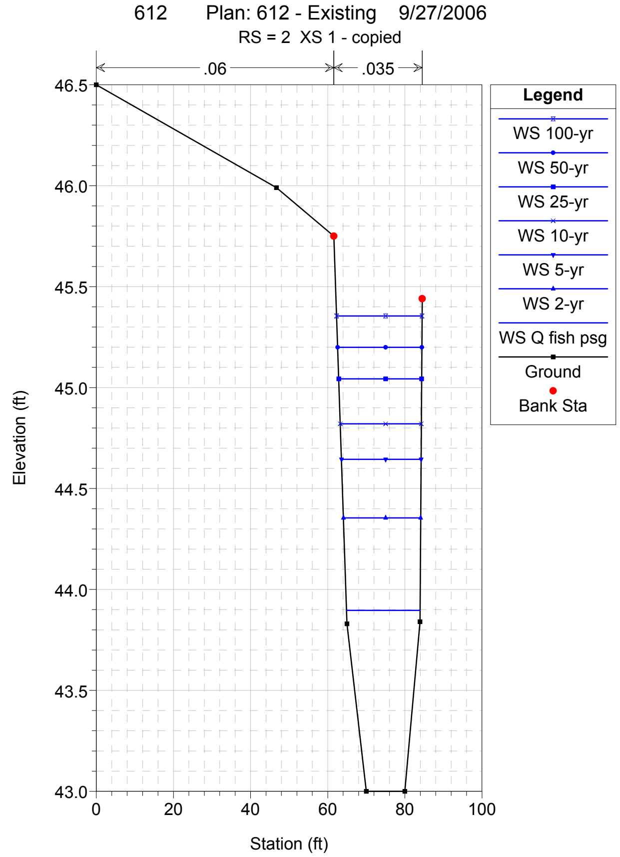
.06
.035
.06
Legend
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
WS 5-yr
WS 2-yr
WS Q fish psg
Ground
Bank Sta
Elevation (ft)
Station (ft)


612 Plan: 612 - Existing 9/27/2006
RS = 3 Culv
.06
.035
Legend
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
WS 5-yr
WS 2-yr
WS Q fish psg
Ground
Bank Sta
Elevation (ft)
Station (ft)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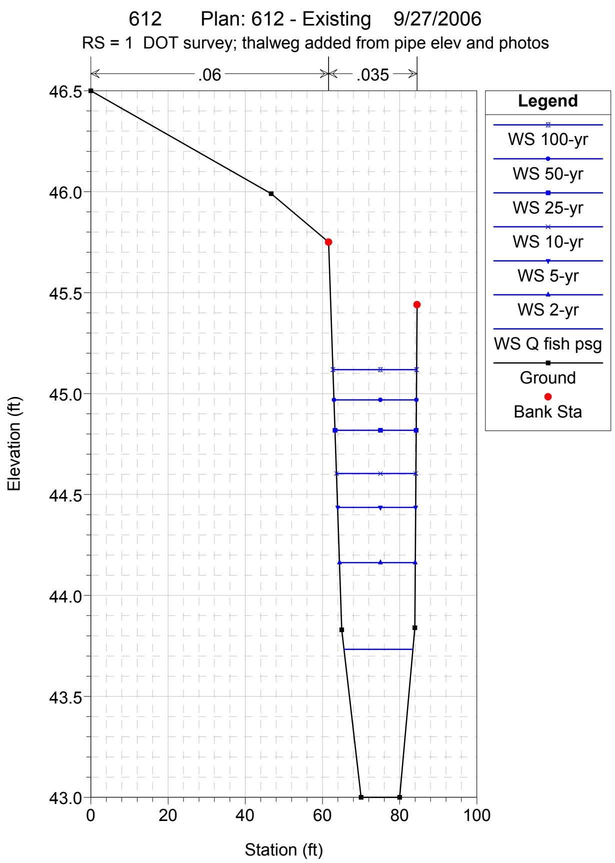
.035
Legend
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
WS 5-yr
WS 2-yr
WS Q fish psg
Ground
Bank Sta
Elevation (ft)
Station (ft)


612 Plan: 612 - Existing 9/27/2006
RS = 1 DOT survey; thalweg added from pipe elev and photos
.06
.035
Legend
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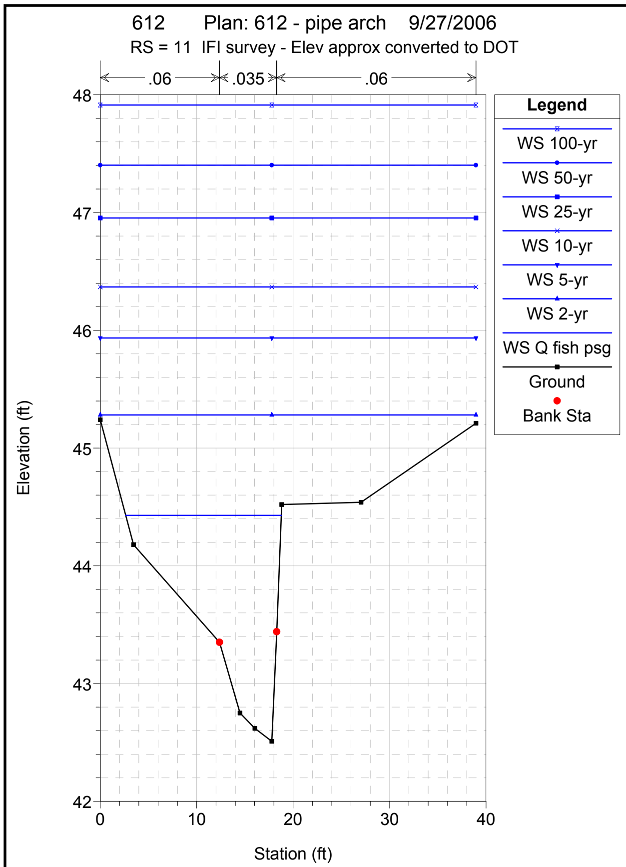
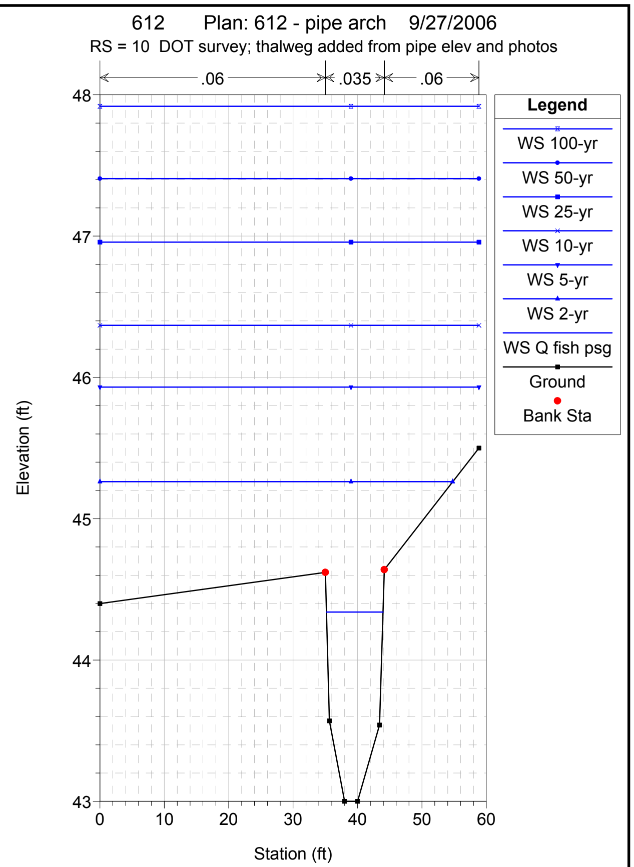
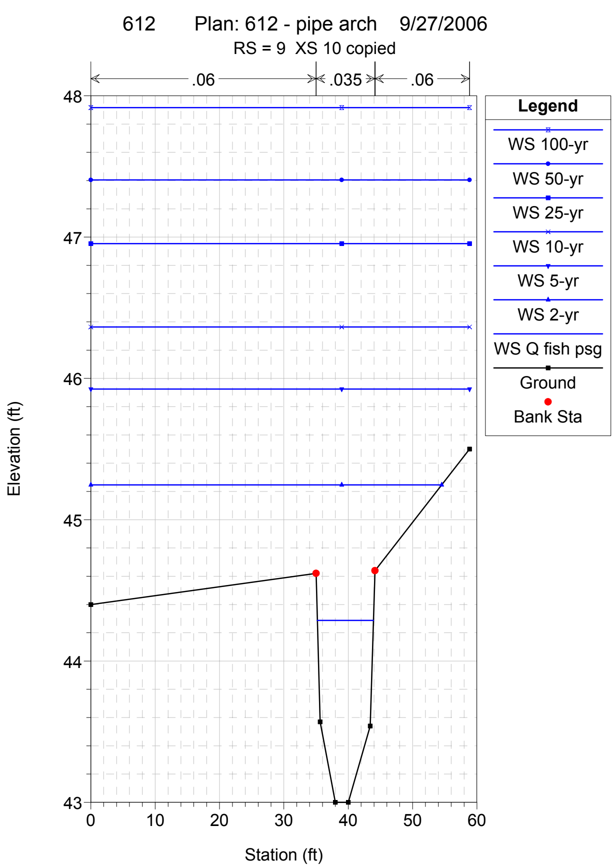
WS 50-yr
WS 25-yr
WS 10-yr
WS 5-yr
WS 2-yr
WS Q fish psg
Ground
Bank Sta
Elevation (ft)
Station (ft)


612 Plan: 612 - pipe arch 9/27/2006
RS = 11 IFI survey - Elev approx converted to DOT
.06
.035
.06
Legend
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
WS 5-yr
WS 2-yr
WS Q fish psg
Ground
Bank Sta
Elevation (ft)
Station (ft)
42
43
44
45
46
47
48
0
10
20
30
40


612 Plan: 612 - pipe arch 9/27/2006
RS = 10 DOT survey; thalweg added from pipe elev and photos
.06
.035
.06
Legend
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
WS 5-yr
WS 2-yr
WS Q fish psg
Ground
Bank Sta
Elevation (ft)
Station (ft)
43
44
45
46
47
48
0
10
20
30
40
50
60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.035
.06
Legend
WS 100-yr
WS 50-yr
WS 25-yr
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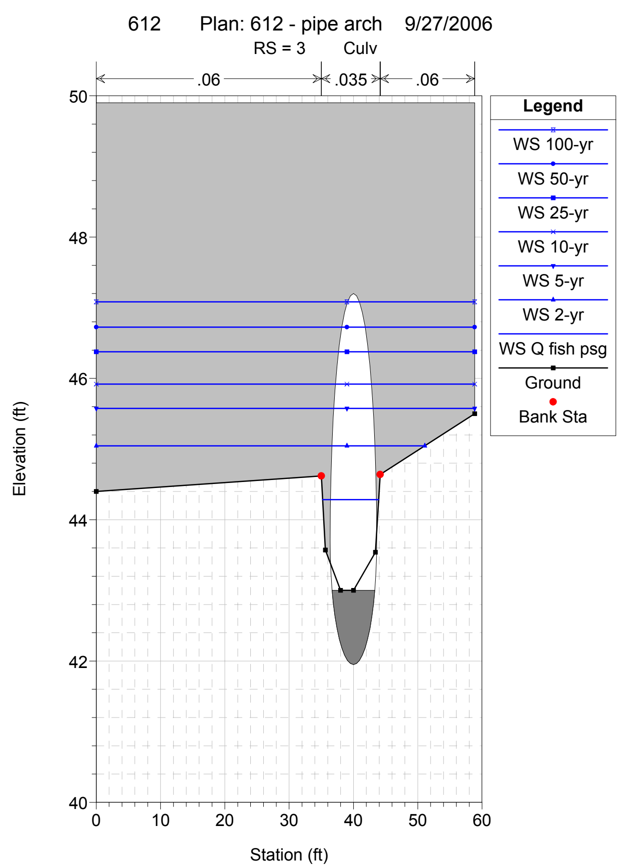
WS 5-yr
WS 2-yr
WS Q fish psg
Ground
Bank Sta
Elevation (ft)
Station (ft)
43
44
45
46
47
48
0
10
20
30
40
50
60


612 Plan: 612 - pipe arch 9/27/2006
RS = 3 Culv
.06
.035
.06
Legend
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
WS 5-yr
WS 2-yr
WS Q fish psg
Ground
Bank Sta
Elevation (ft)
Station (ft)
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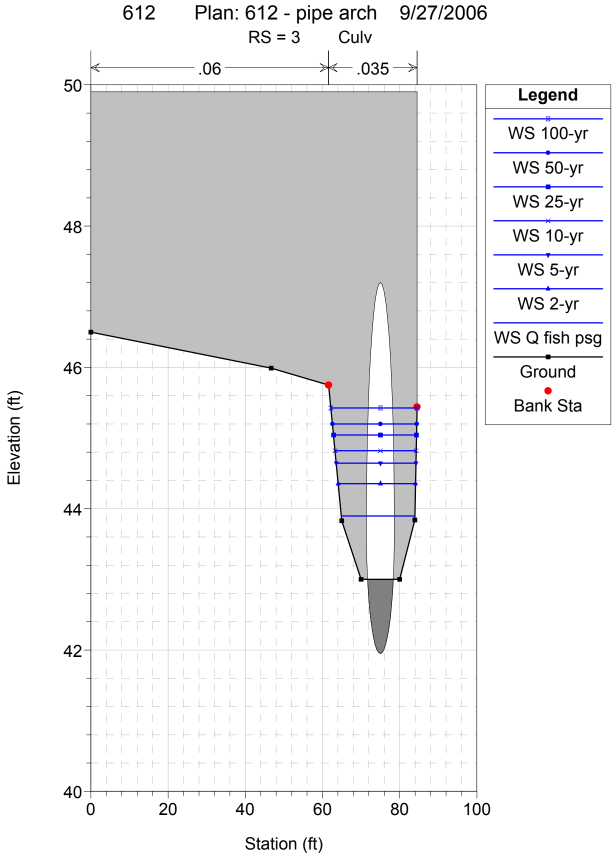
42
44
46
48
50
0
10
20
30
40
50
60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RS = 3 Culv
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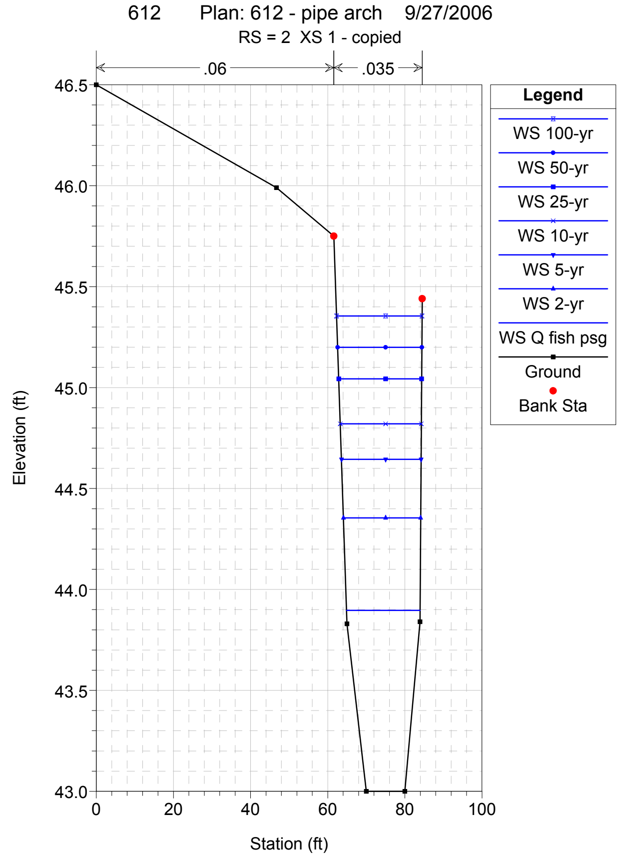
.035
Legend
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
WS 5-yr
WS 2-yr
WS Q fish psg
Ground
Bank Sta
Elevation (ft)
Station (ft)
50
48
46
44
42
40
0
20
40
60
80
100


612 Plan: 612 - pipe arch 9/27/2006
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Legend
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
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WS 2-yr
WS Q fish psg
Ground
Bank Sta
Elevation (ft)
Station (ft)
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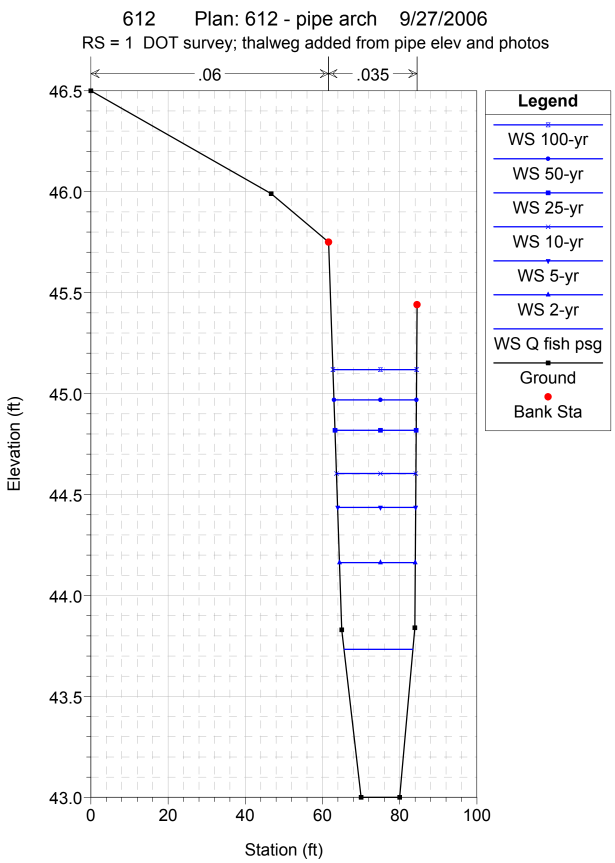
45.5
45.0
44.5
44.0
43.5
43.0
0
20
40
60
80
100


612 Plan: 612 - pipe arch 9/27/2006
RS = 1 DOT survey; thalweg added from pipe elev and photos
.06
.035
Legend
WS 100-yr
WS 50-yr
WS 25-yr
WS 10-yr
WS 5-yr
WS 2-yr
WS Q fish psg
Ground
Bank Sta
Elevation (ft)
Station (ft)
46.5
46.0
45.5
45.0
44.5
44.0
43.5
43.0
0
20
40
60
80
100

HEC-RAS River: 612 Reach: 612

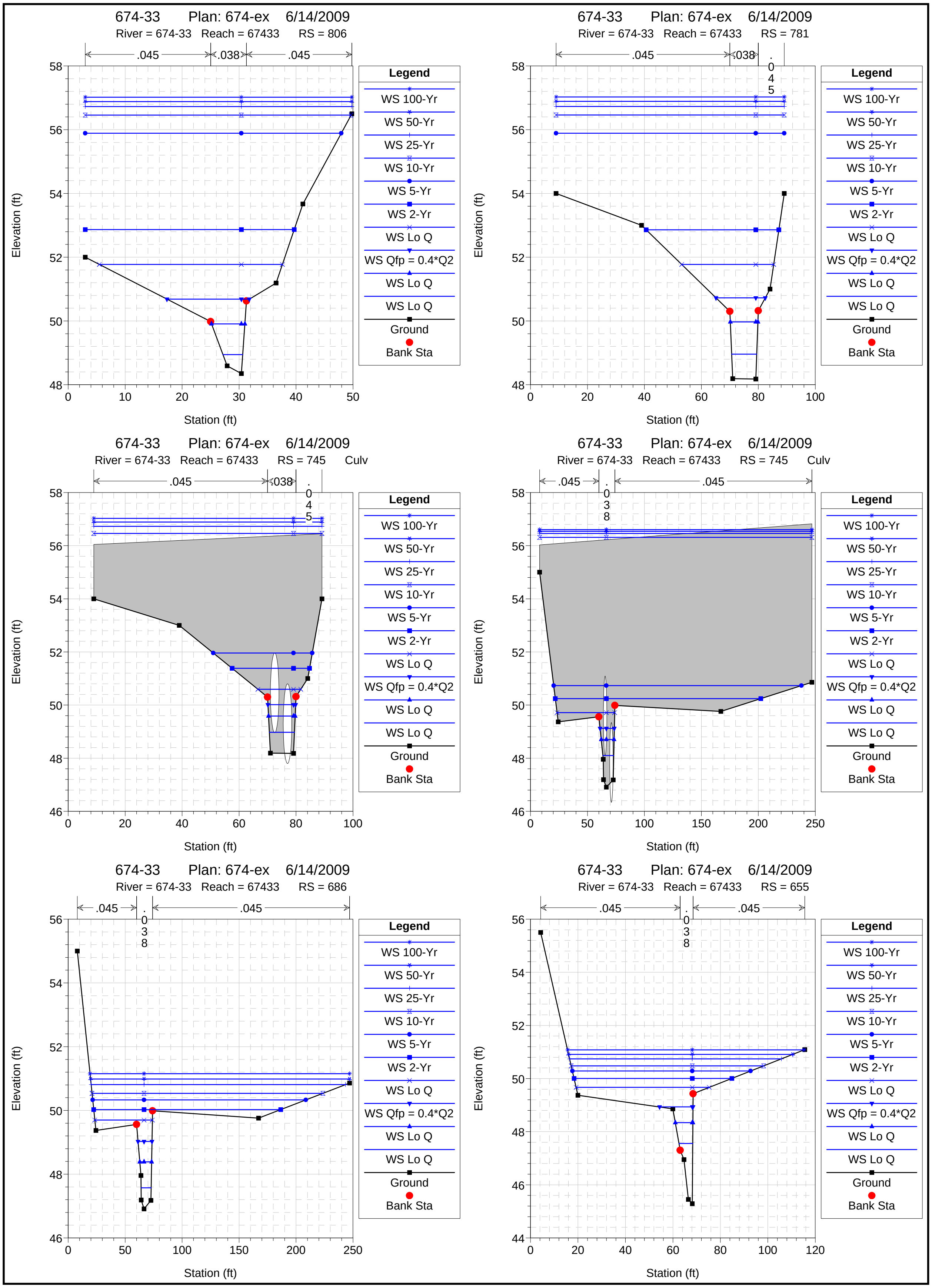
Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
612	1	Lo	612 - Parch	2.00		43.00	43.19	43.11	43.21	0.005000	0.19	0.18	0.94	2.12	12.05	12.05	0.40	0.05
612	1	Lo	612-Ex	2.00		43.00	43.19	43.11	43.21	0.005000	0.19	0.18	0.94	2.12	12.05	12.05	0.40	0.05
612	1	Lo	612 - Parch	10.00		43.00	43.49	43.30	43.53	0.005001	0.49	0.40	1.63	6.13	15.19	15.19	0.45	0.13
612	1	Lo	612-Ex	10.00		43.00	43.49	43.30	43.53	0.005001	0.49	0.40	1.63	6.13	15.19	15.19	0.45	0.13
612	1	Q fish psg	612 - Parch	21.00		43.00	43.73	43.47	43.80	0.005004	0.73	0.57	2.06	10.20	17.82	17.82	0.48	0.18
612	1	Q fish psg	612-Ex	21.00		43.00	43.73	43.47	43.80	0.005004	0.73	0.57	2.06	10.20	17.82	17.82	0.48	0.18
612	1	Lo	612 - Parch	35.00		43.00	43.95	43.64	44.05	0.005004	0.95	0.75	2.45	14.30	19.16	19.16	0.50	0.23
612	1	Lo	612-Ex	35.00		43.00	43.95	43.64	44.05	0.005004	0.95	0.75	2.45	14.30	19.16	19.16	0.50	0.23
612	1	2-yr	612 - Parch	52.00		43.00	44.16	43.81	44.29	0.005003	1.16	0.94	2.83	18.37	19.61	19.61	0.52	0.29
612	1	2-yr	612-Ex	52.00		43.00	44.16	43.81	44.29	0.005003	1.16	0.94	2.83	18.37	19.61	19.61	0.52	0.29
612	1	5-yr	612 - Parch	78.00		43.00	44.44	44.00	44.60	0.005001	1.44	1.18	3.27	23.83	20.20	20.20	0.53	0.36
612	1	5-yr	612-Ex	78.00		43.00	44.44	44.01	44.60	0.005001	1.44	1.18	3.27	23.83	20.20	20.20	0.53	0.36
612	1	10-yr	612 - Parch	96.00		43.00	44.60	44.13	44.80	0.005004	1.60	1.33	3.52	27.25	20.56	20.56	0.54	0.40
612	1	10-yr	612-Ex	96.00		43.00	44.60	44.13	44.80	0.005004	1.60	1.33	3.52	27.25	20.56	20.56	0.54	0.40
612	1	25-yr	612 - Parch	121.00		43.00	44.82	44.28	45.04	0.005000	1.82	1.51	3.82	31.70	21.02	21.02	0.55	0.45
612	1	25-yr	612-Ex	121.00		43.00	44.82	44.29	45.04	0.005000	1.82	1.51	3.82	31.70	21.02	21.02	0.55	0.45
612	1	50-yr	612 - Parch	140.00		43.00	44.97	44.39	45.22	0.005003	1.97	1.63	4.01	34.88	21.34	21.34	0.55	0.48
612	1	50-yr	612-Ex	140.00		43.00	44.97	44.39	45.22	0.005003	1.97	1.63	4.01	34.88	21.34	21.34	0.55	0.48
612	1	100-yr	612 - Parch	160.00		43.00	45.12	44.50	45.39	0.005001	2.12	1.76	4.20	38.11	21.66	21.66	0.56	0.52
612	1	100-yr	612-Ex	160.00		43.00	45.12	44.50	45.39	0.005001	2.12	1.76	4.20	38.11	21.66	21.66	0.56	0.52
612	2	Lo	612 - Parch	2.00	41.00	43.00	43.29		43.30	0.001217	0.29	0.26	0.60	3.36	13.10	13.10	0.21	0.02
612	2	Lo	612-Ex	2.00	41.00	43.00	43.29		43.30	0.001217	0.29	0.26	0.60	3.36	13.10	13.10	0.21	0.02
612	2	Lo	612 - Parch	10.00	41.00	43.00	43.63		43.65	0.001969	0.63	0.50	1.19	8.42	16.72	16.72	0.29	0.06
612	2	Lo	612-Ex	10.00	41.00	43.00	43.63		43.65	0.001974	0.63	0.50	1.19	8.42	16.72	16.72	0.30	0.06
612	2	Q fish psg	612 - Parch	21.00	41.00	43.00	43.90		43.94	0.002301	0.90	0.70	1.59	13.24	19.04	19.04	0.34	0.10
612	2	Q fish psg	612-Ex	21.00	41.00	43.00	43.90		43.94	0.002301	0.90	0.70	1.59	13.24	19.04	19.04	0.34	0.10
612	2	Lo	612 - Parch	35.00	41.00	43.00	44.13		44.19	0.002533	1.13	0.91	1.97	17.73	19.54	19.54	0.37	0.14
612	2	Lo	612-Ex	35.00	41.00	43.00	44.13		44.19	0.002532	1.13	0.91	1.97	17.74	19.54	19.54	0.37	0.14
612	2	2-yr	612 - Parch	52.00	41.00	43.00	44.35		44.44	0.002774	1.35	1.11	2.34	22.19	20.02	20.02	0.39	0.19
612	2	2-yr	612-Ex	52.00	41.00	43.00	44.35		44.44	0.002774	1.35	1.11	2.34	22.19	20.02	20.02	0.39	0.19
612	2	5-yr	612 - Parch	78.00	41.00	43.00	44.64		44.76	0.003015	1.64	1.36	2.78	28.07	20.64	20.64	0.42	0.24
612	2	5-yr	612-Ex	78.00	41.00	43.00	44.64		44.76	0.003015	1.64	1.36	2.78	28.07	20.64	20.64	0.42	0.24
612	2	10-yr	612 - Parch	96.00	41.00	43.00	44.82		44.96	0.003136	1.82	1.51	3.02	31.74	21.02	21.02	0.43	0.28
612	2	10-yr	612-Ex	96.00	41.00	43.00	44.82		44.96	0.003136	1.82	1.51	3.02	31.74	21.02	21.02	0.43	0.28
612	2	25-yr	612 - Parch	121.00	41.00	43.00	45.04		45.21	0.003264	2.04	1.70	3.32	36.48	21.50	21.50	0.45	0.33
612	2	25-yr	612-Ex	121.00	41.00	43.00	45.04		45.21	0.003263	2.04	1.70	3.32	36.48	21.50	21.50	0.45	0.33
612	2	50-yr	612 - Parch	140.00	41.00	43.00	45.20		45.39	0.003343	2.20	1.83	3.51	39.86	21.83	21.83	0.46	0.36
612	2	50-yr	612-Ex	140.00	41.00	43.00	45.20		45.39	0.003343	2.20	1.83	3.51	39.86	21.83	21.83	0.46	0.36
612	2	100-yr	612 - Parch	160.00	41.00	43.00	45.35		45.57	0.003413	2.35	1.95	3.70	43.27	22.17	22.17	0.47	0.39
612	2	100-yr	612-Ex	160.00	41.00	43.00	45.35		45.57	0.003413	2.35	1.95	3.70	43.27	22.17	22.17	0.47	0.39
612	3			Culvert														
612	9	Lo	612 - Parch	2.00	105.00	43.00	43.38	43.25	43.41	0.006033	0.38	0.25	1.31	1.52	6.00	6.00	0.46	0.09
612	9	Lo	612-Ex	2.00	105.00	43.00	43.80	43.25	43.81	0.000220	0.80	0.58	0.42	4.71	8.12	8.12	0.10	0.01
612	9	Lo	612 - Parch	10.00	105.00	43.00	43.87	43.57	43.93	0.003931	0.87	0.64	1.91	5.25	8.20	8.20	0.42	0.15
612	9	Lo	612-Ex	10.00	105.00	43.00	44.74	43.57	44.75	0.000204	1.74	1.40	0.70	20.97	45.86	9.16	0.10	0.02
612	9	Q fish psg	612 - Parch	21.00	105.00	43.00	44.29	43.81	44.38	0.003597	1.29	1.01	2.39	8.78	8.73	8.73	0.42	0.20
612	9	Q fish psg	612-Ex	21.00	105.00	43.00	45.66	43.81	45.67	0.000061	2.66	2.33	0.53	70.46	58.86	9.16	0.06	0.01
612	9	Lo	612 - Parch	35.00	105.00	43.00	44.73	44.06	44.81	0.002598	1.73	1.39	2.47	20.48	45.68	9.16	0.37	0.20
612	9	Lo	612-Ex	35.00	105.00	43.00	47.45	44.06	47.45	0.000012	4.45	4.11	0.35	175.33	58.86	9.16	0.03	0.00
612	9	2-yr	612 - Parch	52.00	105.00	43.00	45.25	44.30	45.29	0.001064	2.25	1.91	1.95	46.41	54.53	9.16	0.25	0.11
612	9	2-yr	612-Ex	52.00	105.00	43.00	49.99	44.30	49.99	0.000004	6.99	6.65	0.27	324.96	58.86	9.16	0.02	0.00
612	9	5-yr	612 - Parch	78.00	105.00	43.00	45.92	44.82	45.95	0.000493	2.92	2.59	1.63	85.80	58.86	9.16	0.18	0.07
612	9	5-yr	612-Ex	78.00	105.00	43.00	50.22	44.82	50.23	0.000008	7.22	6.89	0.39	338.89	58.86	9.16	0.03	0.00
612	9	10-yr	612 - Parch	96.00	105.00	43.00	46.36	44.92	46.38	0.000350	3.36	3.03	1.52	111.66	58.86	9.16	0.15	0.06
612	9	10-yr	612-Ex	96.00	105.00	43.00	50.35	44.92	50.35	0.000011	7.35	7.01	0.48	346.21	58.86	9.16	0.03	0.00
612	9	25-yr	612 - Parch	121.00	105.00	43.00	46.95	45.07	46.97	0.000248	3.95	3.62	1.44	146.38	58.86	9.16	0.13	0.05
612	9	25-yr	612-Ex	121.00	105.00	43.00	50.50	45.07	50.50	0.000016	7.50	7.16	0.58	355.15	58.86	9.16	0.04	0.01
612	9	50-yr	612 - Parch	140.00	105.00	43.00	47.40	45.13	47.42	0.000200	4.40	4.07	1.40	172.89	58.86	9.16	0.12	0.04
612	9	50-yr	612-Ex	140.00	105.00	43.00	50.58	45.15	50.58	0.000021	7.58	7.24	0.67	359.52	58.86	9.16	0.04	0.01
612	9	100-yr	612 - Parch	160.00	105.00	43.00	47.92	45.22	47.93	0.000160	4.92	4.58	1.36	203.03	58.86	9.16	0.11	0.04
612	9	100-yr	612-Ex	160.00	105.00	43.00	50.72	45.22	50.72	0.000026	7.72	7.38	0.75	367.95	58.86	9.16	0.05	0.01

HEC-RAS River: 612 Reach: 612 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
612	10	Lo	612 - Parch	2.00	118.00	43.00	43.45		43.46	0.003074	0.45	0.29	1.02	1.95	6.71	6.71	0.33	0.06
612	10	Lo	612-Ex	2.00	118.00	43.00	43.81		43.81	0.000217	0.81	0.58	0.42	4.73	8.12	8.12	0.10	0.01
612	10	Lo	612 - Parch	10.00	118.00	43.00	43.92		43.97	0.003057	0.92	0.69	1.76	5.69	8.27	8.27	0.37	0.12
612	10	Lo	612-Ex	10.00	118.00	43.00	44.74		44.75	0.000202	1.74	1.41	0.69	21.10	45.91	9.16	0.10	0.02
612	10	Q fish psg	612 - Parch	21.00	118.00	43.00	44.34		44.42	0.003093	1.34	1.05	2.27	9.23	8.79	8.79	0.39	0.18
612	10	Q fish psg	612-Ex	21.00	118.00	43.00	45.67		45.67	0.000061	2.67	2.33	0.53	70.50	58.86	9.16	0.06	0.01
612	10	Lo	612 - Parch	35.00	118.00	43.00	44.77		44.85	0.002210	1.77	1.44	2.33	22.51	46.44	9.16	0.34	0.17
612	10	Lo	612-Ex	35.00	118.00	43.00	47.45		47.45	0.000012	4.45	4.11	0.35	175.34	58.86	9.16	0.03	0.00
612	10	2-yr	612 - Parch	52.00	118.00	43.00	45.26		45.30	0.001020	2.26	1.92	1.92	47.24	54.79	9.16	0.24	0.11
612	10	2-yr	612-Ex	52.00	118.00	43.00	49.99		49.99	0.000004	6.99	6.65	0.27	324.96	58.86	9.16	0.02	0.00
612	10	5-yr	612 - Parch	78.00	118.00	43.00	45.93		45.95	0.000486	2.93	2.59	1.62	86.19	58.86	9.16	0.18	0.07
612	10	5-yr	612-Ex	78.00	118.00	43.00	50.22		50.23	0.000008	7.22	6.89	0.39	338.89	58.86	9.16	0.03	0.00
612	10	10-yr	612 - Parch	96.00	118.00	43.00	46.37		46.39	0.000347	3.37	3.03	1.52	111.93	58.86	9.16	0.15	0.06
612	10	10-yr	612-Ex	96.00	118.00	43.00	50.35		50.35	0.000011	7.35	7.01	0.48	346.22	58.86	9.16	0.03	0.00
612	10	25-yr	612 - Parch	121.00	118.00	43.00	46.96		46.97	0.000247	3.96	3.62	1.44	146.57	58.86	9.16	0.13	0.05
612	10	25-yr	612-Ex	121.00	118.00	43.00	50.50		50.50	0.000016	7.50	7.16	0.58	355.16	58.86	9.16	0.04	0.01
612	10	50-yr	612 - Parch	140.00	118.00	43.00	47.41		47.42	0.000200	4.41	4.07	1.40	173.04	58.86	9.16	0.12	0.04
612	10	50-yr	612-Ex	140.00	118.00	43.00	50.58		50.58	0.000021	7.58	7.24	0.67	359.53	58.86	9.16	0.04	0.01
612	10	100-yr	612 - Parch	160.00	118.00	43.00	47.92		47.93	0.000160	4.92	4.58	1.36	203.15	58.86	9.16	0.11	0.04
612	10	100-yr	612-Ex	160.00	118.00	43.00	50.72		50.72	0.000026	7.72	7.38	0.75	367.96	58.86	9.16	0.05	0.01
612	11	Lo	612 - Parch	2.00	146.00	42.51	43.48		43.48	0.000267	0.97	0.67	0.50	4.09	7.34	5.93	0.11	0.01
612	11	Lo	612-Ex	2.00	146.00	42.51	43.81		43.81	0.000065	1.30	1.01	0.32	7.14	11.06	5.93	0.06	0.00
612	11	Lo	612 - Parch	10.00	146.00	42.51	43.99		44.02	0.000874	1.48	1.19	1.31	9.31	13.07	5.93	0.21	0.06
612	11	Lo	612-Ex	10.00	146.00	42.51	44.75		44.75	0.000113	2.24	1.94	0.66	23.39	29.14	5.93	0.08	0.01
612	11	Q fish psg	612 - Parch	21.00	146.00	42.51	44.43		44.47	0.001087	1.92	1.62	1.81	15.88	16.13	5.93	0.25	0.10
612	11	Q fish psg	612-Ex	21.00	146.00	42.51	45.67		45.67	0.000072	3.16	2.86	0.68	56.85	38.96	5.93	0.07	0.01
612	11	Lo	612 - Parch	35.00	146.00	42.51	44.84		44.89	0.001122	2.33	2.03	2.13	26.09	31.03	5.93	0.26	0.13
612	11	Lo	612-Ex	35.00	146.00	42.51	47.45		47.45	0.000021	4.94	4.64	0.51	126.20	38.96	5.93	0.04	0.01
612	11	2-yr	612 - Parch	52.00	146.00	42.51	45.28		45.33	0.000937	2.77	2.48	2.22	41.86	38.96	5.93	0.25	0.13
612	11	2-yr	612-Ex	52.00	146.00	42.51	49.99		49.99	0.000008	7.48	7.18	0.42	225.24	38.96	5.93	0.03	0.00
612	11	5-yr	612 - Parch	78.00	146.00	42.51	45.93		45.98	0.000628	3.42	3.13	2.13	67.34	38.96	5.93	0.21	0.11
612	11	5-yr	612-Ex	78.00	146.00	42.51	50.22		50.23	0.000017	7.71	7.42	0.61	234.44	38.96	5.93	0.04	0.01
612	11	10-yr	612 - Parch	96.00	146.00	42.51	46.37		46.41	0.000510	3.86	3.56	2.09	84.22	38.96	5.93	0.20	0.10
612	11	10-yr	612-Ex	96.00	146.00	42.51	50.35		50.35	0.000024	7.84	7.54	0.74	239.28	38.96	5.93	0.05	0.01
612	11	25-yr	612 - Parch	121.00	146.00	42.51	46.95		46.99	0.000406	4.44	4.15	2.06	107.04	38.96	5.93	0.18	0.09
612	11	25-yr	612-Ex	121.00	146.00	42.51	50.50		50.51	0.000035	7.99	7.69	0.91	245.17	38.96	5.93	0.06	0.02
612	11	50-yr	612 - Parch	140.00	146.00	42.51	47.40		47.44	0.000349	4.89	4.60	2.05	124.50	38.96	5.93	0.17	0.09
612	11	50-yr	612-Ex	140.00	146.00	42.51	50.57		50.58	0.000045	8.06	7.77	1.04	248.04	38.96	5.93	0.07	0.02
612	11	100-yr	612 - Parch	160.00	146.00	42.51	47.91		47.94	0.000294	5.40	5.11	2.02	144.39	38.96	5.93	0.16	0.08
612	11	100-yr	612-Ex	160.00	146.00	42.51	50.72		50.73	0.000055	8.21	7.91	1.17	253.60	38.96	5.93	0.07	0.02

Tributary 647+20 HEC-RAS

Companion 2006 Stream and Habitat Inventory (S&HI) station 670+00
Model based on ADOT&PF project datum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Station (ft)
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WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta
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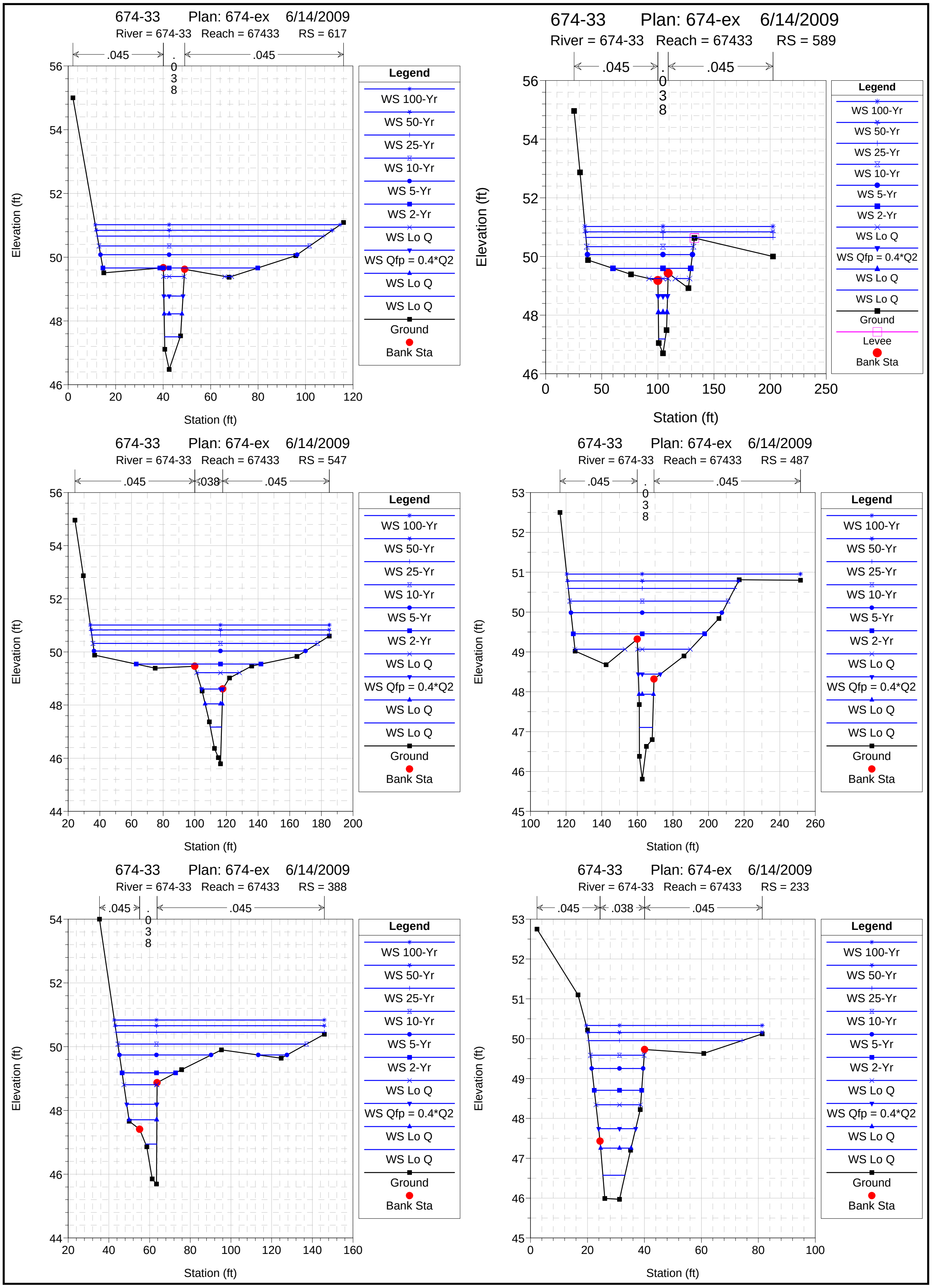
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674-33 Plan: 674-ex 6/14/2009
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.038
Legend
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WS 2-Yr
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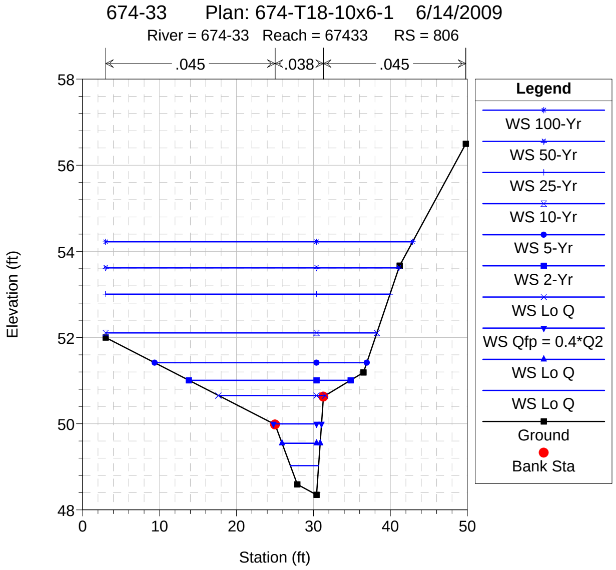
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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Station (ft)
Legend
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WS 50-Yr
WS 25-Yr
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WS 2-Yr
WS Lo Q
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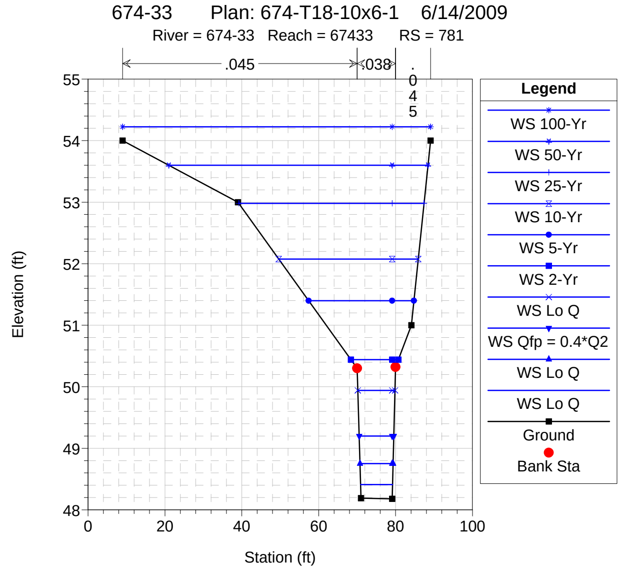
WS Lo Q
WS Lo Q
Ground
Bank Sta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Station (ft)
Legend
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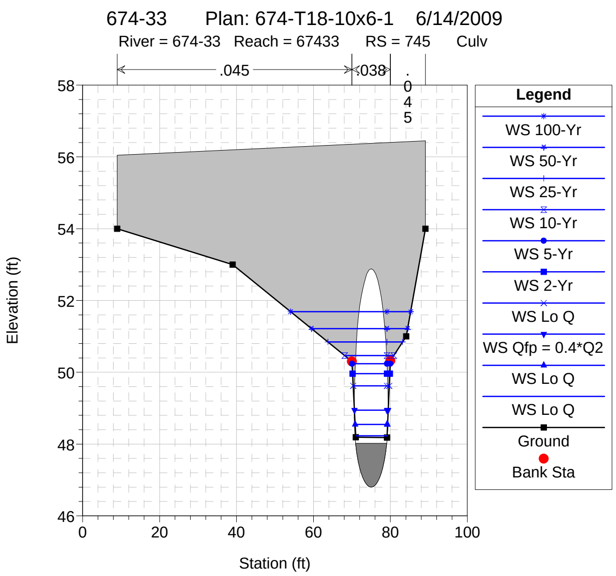
WS Lo Q
Ground
Bank Sta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.045 .038 .045
Elevation (ft)
Station (ft)
Legend
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WS 50-Yr
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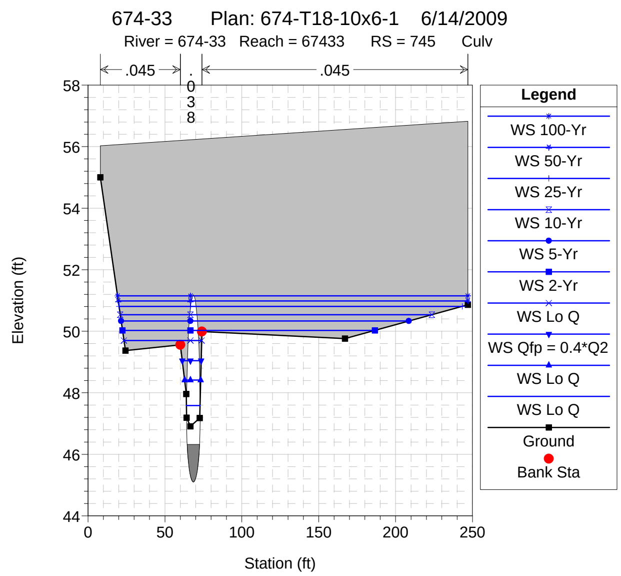
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta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.045 .038 .045
Elevation (ft)
Station (ft)
Legend
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WS 50-Yr
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WS 2-Yr
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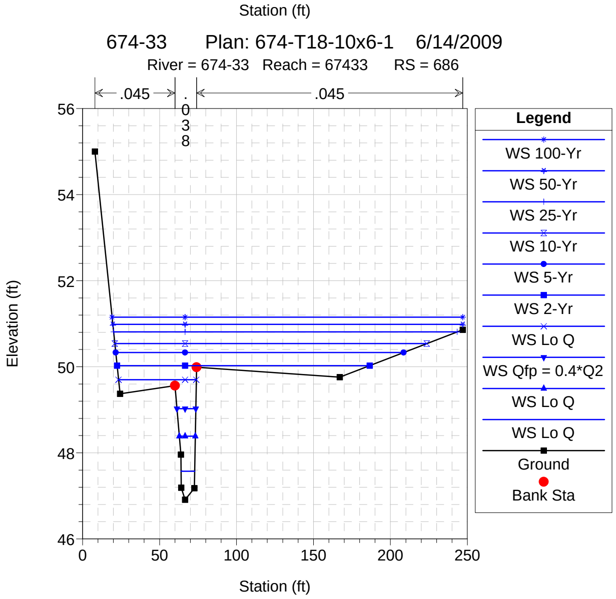
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta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Elevation (ft)
Station (ft)
Legend
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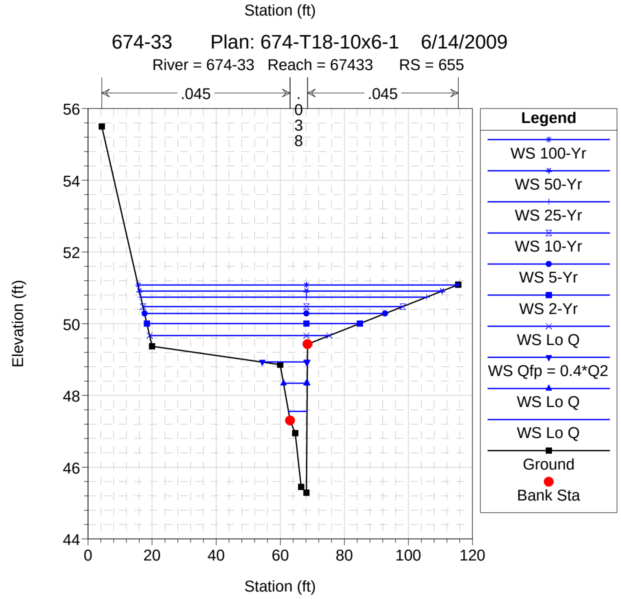
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta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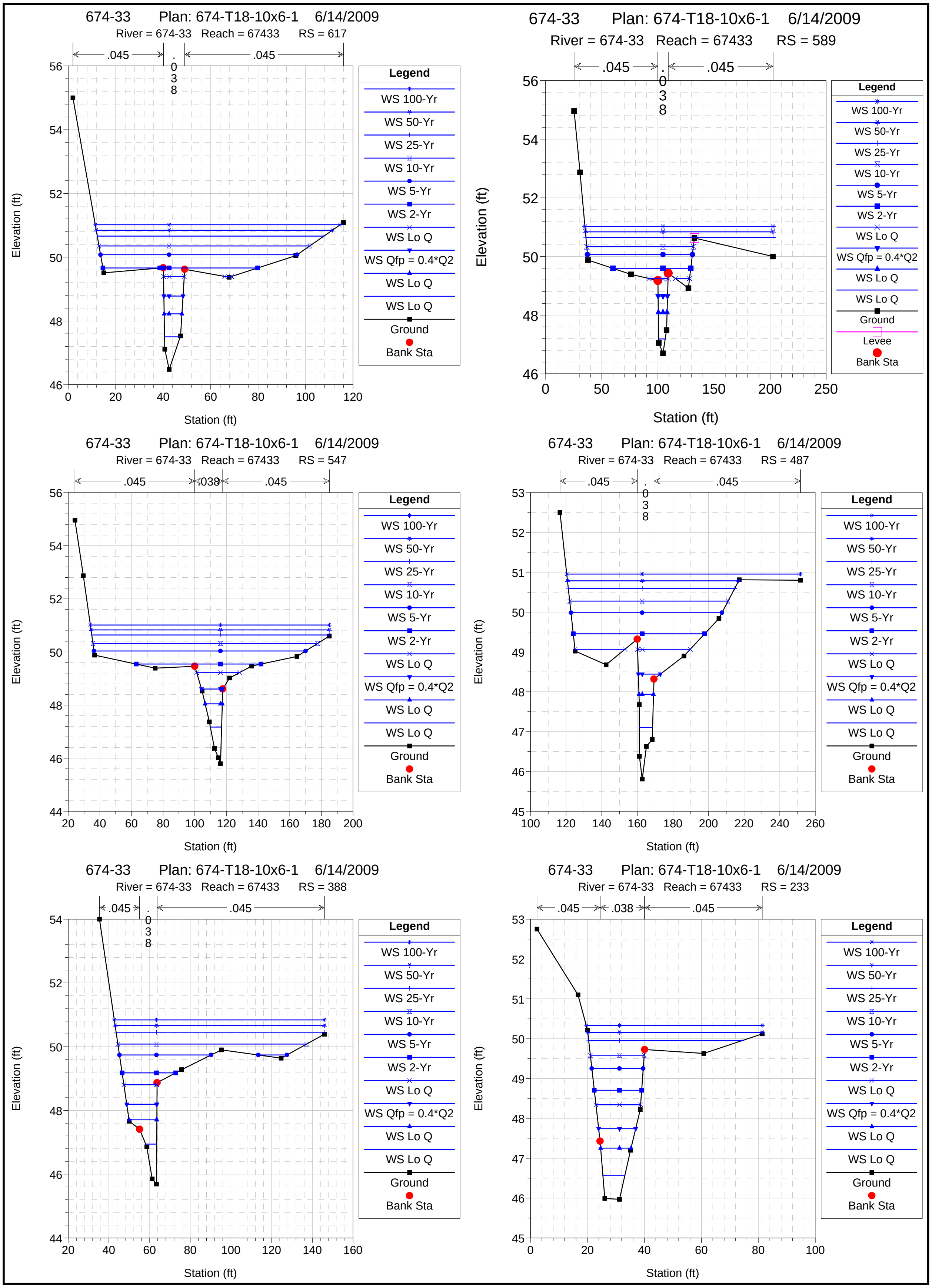
.045 .038 .045
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta


674-33 Plan: 674-T18-10x6-1 6/14/2009
River = 674-33 Reach = 67433 RS = 617
.045
.038
.045
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta
674-33 Plan: 674-T18-10x6-1 6/14/2009
River = 674-33 Reach = 67433 RS = 589
.045
.038
.045
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Levee
Bank Sta
674-33 Plan: 674-T18-10x6-1 6/14/2009
River = 674-33 Reach = 67433 RS = 547
.045
.038
.045
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta
674-33 Plan: 674-T18-10x6-1 6/14/2009
River = 674-33 Reach = 67433 RS = 487
.045
.038
.045
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta
674-33 Plan: 674-T18-10x6-1 6/14/2009
River = 674-33 Reach = 67433 RS = 388
.045
.038
.045
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta
674-33 Plan: 674-T18-10x6-1 6/14/2009
River = 674-33 Reach = 67433 RS = 233
.045
.038
.045
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta

HEC-RAS River: 674-33 Reach: 67433

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
67433	233	Lo Q	674-ex	5.00		45.97	46.57	46.27	46.60	0.003002	0.60	0.49	1.31	3.83	7.74	7.74	0.33	0.09
67433	233	Lo Q	674-T1	5.00		45.97	46.57	46.27	46.60	0.003002	0.60	0.49	1.31	3.83	7.74	7.74	0.33	0.09
67433	233	Lo Q	674-ex	20.00		45.97	47.25	46.68	47.31	0.003002	1.28	0.94	1.98	10.10	10.70	10.70	0.36	0.17
67433	233	Lo Q	674-T1	20.00		45.97	47.25	46.68	47.31	0.003002	1.28	0.94	1.98	10.10	10.70	10.70	0.36	0.17
67433	233	Qfp = 0.4*Q2	674-ex	38.00		45.97	47.74	47.00	47.83	0.003002	1.77	1.26	2.40	15.90	13.04	12.54	0.38	0.22
67433	233	Qfp = 0.4*Q2	674-T1	38.00		45.97	47.74	47.00	47.83	0.003001	1.77	1.26	2.40	15.90	13.04	12.54	0.38	0.22
67433	233	Lo Q	674-ex	70.00		45.97	48.34	47.42	48.47	0.003004	2.37	1.68	2.90	24.57	15.70	14.26	0.39	0.30
67433	233	Lo Q	674-T1	70.00		45.97	48.34	47.42	48.47	0.003004	2.37	1.68	2.90	24.57	15.70	14.26	0.39	0.30
67433	233	2-Yr	674-ex	96.00		45.97	48.71	47.69	48.87	0.003001	2.74	1.99	3.24	30.46	16.65	14.63	0.40	0.35
67433	233	2-Yr	674-T1	96.00		45.97	48.71	47.69	48.87	0.003001	2.74	1.99	3.24	30.46	16.65	14.63	0.40	0.35
67433	233	5-Yr	674-ex	142.00		45.97	49.25	48.10	49.46	0.003000	3.28	2.46	3.70	39.97	18.06	15.18	0.42	0.42
67433	233	5-Yr	674-T1	142.00		45.97	49.25	48.10	49.46	0.003000	3.28	2.46	3.70	39.97	18.06	15.18	0.42	0.42
67433	233	10-Yr	674-ex	174.00		45.97	49.59	48.33	49.82	0.003006	3.62	2.74	3.95	46.11	18.92	15.51	0.42	0.47
67433	233	10-Yr	674-T1	174.00		45.97	49.59	48.33	49.82	0.003006	3.62	2.74	3.95	46.11	18.92	15.51	0.42	0.47
67433	233	25-Yr	674-ex	220.00		45.97	49.95	48.62	50.22	0.003002	3.98	3.07	4.26	60.96	53.87	15.66	0.43	0.53
67433	233	25-Yr	674-T1	220.00		45.97	49.95	48.62	50.22	0.003002	3.98	3.07	4.26	60.96	53.87	15.66	0.43	0.53
67433	233	50-Yr	674-ex	255.00		45.97	50.16	48.82	50.43	0.003002	4.19	3.28	4.45	72.86	61.27	15.66	0.43	0.56
67433	233	50-Yr	674-T1	255.00		45.97	50.16	48.82	50.43	0.003002	4.19	3.28	4.45	72.86	61.27	15.66	0.43	0.56
67433	233	100-Yr	674-ex	291.00		45.97	50.33	49.02	50.62	0.003004	4.36	3.46	4.61	83.75	61.79	15.66	0.44	0.59
67433	233	100-Yr	674-T1	291.00		45.97	50.33	49.02	50.62	0.003004	4.36	3.46	4.61	83.75	61.79	15.66	0.44	0.59
67433	388	Lo Q	674-ex	5.00	155.00	45.69	46.95		46.97	0.001883	1.26	0.76	1.22	4.10	5.40	5.40	0.25	0.07
67433	388	Lo Q	674-T1	5.00	155.00	45.69	46.95		46.97	0.001883	1.26	0.76	1.22	4.10	5.40	5.40	0.25	0.07
67433	388	Lo Q	674-ex	20.00	155.00	45.69	47.71		47.77	0.002853	2.02	1.16	2.00	10.67	13.67	8.40	0.33	0.17
67433	388	Lo Q	674-T1	20.00	155.00	45.69	47.71		47.77	0.002851	2.02	1.16	2.00	10.67	13.67	8.40	0.33	0.17
67433	388	Qfp = 0.4*Q2	674-ex	38.00	155.00	45.69	48.19		48.28	0.002777	2.50	1.64	2.41	17.62	14.84	8.45	0.33	0.22
67433	388	Qfp = 0.4*Q2	674-T1	38.00	155.00	45.69	48.19		48.28	0.002783	2.50	1.64	2.41	17.61	14.83	8.45	0.33	0.22
67433	388	Lo Q	674-ex	70.00	155.00	45.69	48.81		48.92	0.002863	3.12	2.24	2.92	27.15	16.30	8.50	0.34	0.29
67433	388	Lo Q	674-T1	70.00	155.00	45.69	48.81		48.92	0.002865	3.12	2.24	2.92	27.15	16.30	8.50	0.34	0.29
67433	388	2-Yr	674-ex	96.00	155.00	45.69	49.18		49.32	0.002909	3.49	2.62	3.25	34.83	26.31	8.51	0.35	0.35
67433	388	2-Yr	674-T1	96.00	155.00	45.69	49.18		49.32	0.002911	3.49	2.62	3.25	34.82	26.29	8.51	0.35	0.35
67433	388	5-Yr	674-ex	142.00	155.00	45.69	49.74		49.89	0.002571	4.05	3.18	3.48	55.48	59.16	8.51	0.34	0.37
67433	388	5-Yr	674-T1	142.00	155.00	45.69	49.74		49.89	0.002571	4.05	3.18	3.48	55.46	59.13	8.51	0.34	0.37
67433	388	10-Yr	674-ex	174.00	155.00	45.69	50.08		50.20	0.002077	4.39	3.52	3.34	83.49	92.75	8.51	0.31	0.33
67433	388	10-Yr	674-T1	174.00	155.00	45.69	50.08		50.20	0.002076	4.39	3.52	3.34	83.52	92.75	8.51	0.31	0.33
67433	388	25-Yr	674-ex	220.00	155.00	45.69	50.45		50.54	0.001550	4.76	3.89	3.09	120.14	102.33	8.51	0.28	0.28
67433	388	25-Yr	674-T1	220.00	155.00	45.69	50.45		50.54	0.001549	4.76	3.89	3.09	120.18	102.33	8.51	0.28	0.27
67433	388	50-Yr	674-ex	255.00	155.00	45.69	50.66		50.74	0.001390	4.97	4.10	3.03	141.21	102.81	8.51	0.26	0.26
67433	388	50-Yr	674-T1	255.00	155.00	45.69	50.66		50.74	0.001388	4.97	4.10	3.03	141.31	102.81	8.51	0.26	0.26
67433	388	100-Yr	674-ex	291.00	155.00	45.69	50.84		50.92	0.001308	5.15	4.27	3.02	159.61	103.22	8.51	0.26	0.26
67433	388	100-Yr	674-T1	291.00	155.00	45.69	50.84		50.92	0.001307	5.15	4.28	3.02	159.66	103.22	8.51	0.26	0.25
67433	487	Lo Q	674-ex	5.00	254.00	45.81	47.11		47.12	0.001339	1.30	0.67	1.00	4.99	7.40	7.40	0.22	0.05
67433	487	Lo Q	674-T1	5.00	254.00	45.81	47.11		47.12	0.001339	1.30	0.67	1.00	4.99	7.40	7.40	0.22	0.05
67433	487	Lo Q	674-ex	20.00	254.00	45.81	47.94		47.99	0.001778	2.13	1.40	1.75	11.40	8.14	8.14	0.26	0.12
67433	487	Lo Q	674-T1	20.00	254.00	45.81	47.94		47.99	0.001777	2.13	1.40	1.75	11.40	8.14	8.14	0.26	0.12
67433	487	Qfp = 0.4*Q2	674-ex	38.00	254.00	45.81	48.45		48.54	0.002517	2.64	1.80	2.42	15.91	12.38	8.74	0.32	0.22
67433	487	Qfp = 0.4*Q2	674-T1	38.00	254.00	45.81	48.44		48.54	0.002519	2.63	1.80	2.42	15.91	12.37	8.74	0.32	0.22
67433	487	Lo Q	674-ex	70.00	254.00	45.81	49.07		49.17	0.002459	3.26	2.32	2.80	35.10	57.65	9.17	0.32	0.27
67433	487	Lo Q	674-T1	70.00	254.00	45.81	49.07		49.17	0.002460	3.26	2.32	2.81	35.09	57.64	9.17	0.32	0.27
67433	487	2-Yr	674-ex	96.00	254.00	45.81	49.45		49.52	0.001669	3.64	2.66	2.52	61.03	73.77	9.35	0.27	0.21
67433	487	2-Yr	674-T1	96.00	254.00	45.81	49.45		49.52	0.001671	3.64	2.66	2.52	61.00	73.76	9.35	0.27	0.21
67433	487	5-Yr	674-ex	142.00	254.00	45.81	49.98		50.03	0.001013	4.17	3.19	2.22	103.32	84.81	9.35	0.22	0.15
67433	487	5-Yr	674-T1	142.00	254.00	45.81	49.98		50.03	0.001013	4.17	3.19	2.22	103.31	84.80	9.35	0.22	0.15
67433	487	10-Yr	674-ex	174.00	254.00	45.81	50.28		50.32	0.000839	4.47	3.48	2.14	128.73	88.96	9.35	0.20	0.14
67433	487	10-Yr	674-T1	174.00	254.00	45.81	50.28		50.32	0.000839	4.47	3.48	2.14	128.75	88.96	9.35	0.20	0.14
67433	487	25-Yr	674-ex	220.00	254.00	45.81	50.59		50.63	0.000764	4.78	3.80	2.17	157.70	93.47	9.35	0.20	0.14
67433	487	25-Yr	674-T1	220.00	254.00	45.81	50.59		50.63	0.000764	4.78	3.80	2.16	157.73	93.47	9.35	0.20	0.14
67433	487	50-Yr	674-ex	255.00	254.00	45.81	50.78		50.82	0.000761	4.97	3.99	2.23	175.52	96.13	9.35	0.20	0.14
67433	487	50-Yr	674-T1	255.00	254.00	45.81	50.78		50.82	0.000760	4.97	3.99	2.23	175.59	96.14	9.35	0.20	0.14
67433	487	100-Yr	674-ex	291.00	254.00	45.81	50.95		51.00	0.000886	5.14	4.16	2.48	197.14	131.27	9.35	0.21	0.17
67433	487	100-Yr	674-T1	291.00	254.00	45.81	50.95		51.00	0.000886	5.14	4.16	2.48	197.19	131.27	9.35	0.21	0.17
67433	547	Lo Q	674-ex	5.00	314.00	45.79	47.17		47.18	0.000827	1.38	0.79	0.88	5.66	7.13	7.13	0.17	0.04

HEC-RAS River: 674-33 Reach: 67433 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
67433	547	Lo Q	674-T1	5.00	314.00	45.79	47.17		47.18	0.000827	1.38	0.79	0.88	5.66	7.13	7.13	0.17	0.04
67433	547	Lo Q	674-ex	20.00	314.00	45.79	48.04		48.08	0.001312	2.25	1.24	1.49	13.46	10.86	10.86	0.24	0.09
67433	547	Lo Q	674-T1	20.00	314.00	45.79	48.04		48.08	0.001312	2.25	1.24	1.49	13.46	10.86	10.86	0.24	0.09
67433	547	Qfp = 0.4*Q2	674-ex	38.00	314.00	45.79	48.60		48.66	0.001616	2.81	1.51	1.88	20.24	13.43	13.43	0.27	0.13
67433	547	Qfp = 0.4*Q2	674-T1	38.00	314.00	45.79	48.60		48.66	0.001617	2.81	1.51	1.88	20.23	13.42	13.42	0.27	0.13
67433	547	Lo Q	674-ex	70.00	314.00	45.79	49.22		49.30	0.001931	3.43	1.79	2.33	31.84	27.03	16.50	0.31	0.19
67433	547	Lo Q	674-T1	70.00	314.00	45.79	49.22		49.30	0.001931	3.43	1.79	2.33	31.83	27.02	16.49	0.31	0.19
67433	547	2-Yr	674-ex	96.00	314.00	45.79	49.54		49.64	0.002008	3.75	1.98	2.56	46.41	78.79	17.68	0.32	0.22
67433	547	2-Yr	674-T1	96.00	314.00	45.79	49.54		49.64	0.002009	3.75	1.98	2.56	46.39	78.75	17.68	0.32	0.22
67433	547	5-Yr	674-ex	142.00	314.00	45.79	50.04		50.10	0.001184	4.25	2.47	2.28	102.39	133.71	17.68	0.26	0.16
67433	547	5-Yr	674-T1	142.00	314.00	45.79	50.04		50.10	0.001184	4.25	2.47	2.28	102.38	133.71	17.68	0.26	0.16
67433	547	10-Yr	674-ex	174.00	314.00	45.79	50.32		50.36	0.000840	4.53	2.76	2.06	141.76	141.98	17.68	0.22	0.13
67433	547	10-Yr	674-T1	174.00	314.00	45.79	50.32		50.37	0.000840	4.53	2.76	2.06	141.78	141.98	17.68	0.22	0.13
67433	547	25-Yr	674-ex	220.00	314.00	45.79	50.64		50.67	0.000652	4.85	3.08	1.96	188.22	150.10	17.68	0.20	0.11
67433	547	25-Yr	674-T1	220.00	314.00	45.79	50.64		50.67	0.000651	4.85	3.08	1.95	188.26	150.10	17.68	0.20	0.11
67433	547	50-Yr	674-ex	255.00	314.00	45.79	50.83		50.86	0.000588	5.04	3.27	1.93	216.80	150.56	17.68	0.19	0.11
67433	547	50-Yr	674-T1	255.00	314.00	45.79	50.83		50.86	0.000587	5.04	3.27	1.93	216.91	150.56	17.68	0.19	0.11
67433	547	100-Yr	674-ex	291.00	314.00	45.79	51.01		51.04	0.000543	5.22	3.45	1.92	244.12	150.99	17.68	0.18	0.10
67433	547	100-Yr	674-T1	291.00	314.00	45.79	51.01		51.04	0.000542	5.22	3.45	1.92	244.17	150.99	17.68	0.18	0.10
67433	589	Lo Q	674-ex	5.00	356.00	46.70	47.19	47.19	47.33	0.032570	0.49	0.29	3.02	1.66	5.77	5.77	0.99	0.57
67433	589	Lo Q	674-T1	5.00	356.00	46.70	47.19	47.19	47.33	0.032570	0.49	0.29	3.02	1.66	5.77	5.77	0.99	0.57
67433	589	Lo Q	674-ex	20.00	356.00	46.70	48.10	47.61	48.19	0.004545	1.40	1.04	2.47	8.09	7.76	7.76	0.43	0.26
67433	589	Lo Q	674-T1	20.00	356.00	46.70	48.10	47.61	48.19	0.004544	1.40	1.04	2.47	8.09	7.76	7.76	0.43	0.26
67433	589	Qfp = 0.4*Q2	674-ex	38.00	356.00	46.70	48.65	47.95	48.79	0.004525	1.95	1.50	3.02	12.56	8.40	8.40	0.44	0.35
67433	589	Qfp = 0.4*Q2	674-T1	38.00	356.00	46.70	48.65	47.95	48.79	0.004528	1.95	1.50	3.03	12.56	8.40	8.40	0.44	0.35
67433	589	Lo Q	674-ex	70.00	356.00	46.70	49.25	48.43	49.47	0.005399	2.55	1.97	3.84	20.17	29.66	9.06	0.48	0.52
67433	589	Lo Q	674-T1	70.00	356.00	46.70	49.25	48.43	49.47	0.005400	2.55	1.97	3.84	20.16	29.64	9.06	0.48	0.52
67433	589	2-Yr	674-ex	96.00	356.00	46.70	49.59	48.75	49.78	0.004276	2.89	2.28	3.76	38.29	69.30	9.20	0.44	0.48
67433	589	2-Yr	674-T1	96.00	356.00	46.70	49.59	48.75	49.78	0.004279	2.89	2.28	3.76	38.28	69.29	9.20	0.44	0.48
67433	589	5-Yr	674-ex	142.00	356.00	46.70	50.06	49.66	50.16	0.002294	3.36	2.75	3.12	78.52	93.55	9.20	0.33	0.31
67433	589	5-Yr	674-T1	142.00	356.00	46.70	50.06	49.66	50.16	0.002295	3.36	2.75	3.12	78.51	93.55	9.20	0.33	0.31
67433	589	10-Yr	674-ex	174.00	356.00	46.70	50.34	49.79	50.41	0.001653	3.64	3.02	2.82	104.27	95.06	9.20	0.29	0.24
67433	589	10-Yr	674-T1	174.00	356.00	46.70	50.34	49.79	50.41	0.001652	3.64	3.02	2.82	104.28	95.06	9.20	0.29	0.24
67433	589	25-Yr	674-ex	220.00	356.00	46.70	50.65	49.96	50.70	0.001294	3.95	3.33	2.67	157.72	166.73	9.20	0.26	0.21
67433	589	25-Yr	674-T1	220.00	356.00	46.70	50.65	49.96	50.70	0.001293	3.95	3.33	2.67	157.76	166.73	9.20	0.26	0.21
67433	589	50-Yr	674-ex	255.00	356.00	46.70	50.84	50.04	50.89	0.001057	4.14	3.53	2.50	189.61	167.18	9.20	0.23	0.18
67433	589	50-Yr	674-T1	255.00	356.00	46.70	50.84	50.04	50.89	0.001055	4.14	3.53	2.50	189.72	167.18	9.20	0.23	0.18
67433	589	100-Yr	674-ex	291.00	356.00	46.70	51.02	50.11	51.06	0.000902	4.32	3.71	2.39	219.98	167.61	9.20	0.22	0.16
67433	589	100-Yr	674-T1	291.00	356.00	46.70	51.02	50.11	51.06	0.000902	4.32	3.71	2.39	220.04	167.61	9.20	0.22	0.16
67433	617	Lo Q	674-ex	5.00	384.00	46.48	47.50		47.53	0.002857	1.02	0.56	1.35	3.70	6.60	6.60	0.32	0.09
67433	617	Lo Q	674-T1	5.00	384.00	46.48	47.50		47.53	0.002857	1.02	0.56	1.35	3.70	6.60	6.60	0.32	0.09
67433	617	Lo Q	674-ex	20.00	384.00	46.48	48.22		48.30	0.003423	1.74	1.18	2.27	8.80	7.49	7.49	0.37	0.21
67433	617	Lo Q	674-T1	20.00	384.00	46.48	48.22		48.30	0.003423	1.74	1.18	2.27	8.80	7.49	7.49	0.37	0.21
67433	617	Qfp = 0.4*Q2	674-ex	38.00	384.00	46.48	48.78		48.91	0.003885	2.30	1.63	2.89	13.16	8.09	8.09	0.40	0.31
67433	617	Qfp = 0.4*Q2	674-T1	38.00	384.00	46.48	48.78		48.91	0.003886	2.30	1.63	2.89	13.16	8.09	8.09	0.40	0.31
67433	617	Lo Q	674-ex	70.00	384.00	46.48	49.40		49.62	0.005196	2.92	2.09	3.82	18.38	11.69	8.76	0.46	0.51
67433	617	Lo Q	674-T1	70.00	384.00	46.48	49.40		49.62	0.005196	2.92	2.09	3.82	18.37	11.69	8.76	0.46	0.51
67433	617	2-Yr	674-ex	96.00	384.00	46.48	49.66	48.78	49.95	0.006307	3.18	2.30	4.42	27.36	63.73	9.02	0.51	0.67
67433	617	2-Yr	674-T1	96.00	384.00	46.48	49.66	48.78	49.95	0.006309	3.18	2.30	4.42	27.35	63.70	9.02	0.51	0.67
67433	617	5-Yr	674-ex	142.00	384.00	46.48	50.08		50.26	0.004202	3.60	2.71	4.03	58.47	82.82	9.02	0.43	0.53
67433	617	5-Yr	674-T1	142.00	384.00	46.48	50.08		50.26	0.004204	3.60	2.71	4.03	58.46	82.82	9.02	0.43	0.53
67433	617	10-Yr	674-ex	174.00	384.00	46.48	50.35		50.48	0.002958	3.87	2.99	3.60	81.86	88.73	9.02	0.37	0.41
67433	617	10-Yr	674-T1	174.00	384.00	46.48	50.35		50.48	0.002957	3.87	2.99	3.60	81.87	88.74	9.02	0.37	0.41
67433	617	25-Yr	674-ex	220.00	384.00	46.48	50.66		50.76	0.002249	4.18	3.29	3.35	110.22	95.42	9.02	0.33	0.34
67433	617	25-Yr	674-T1	220.00	384.00	46.48	50.66		50.76	0.002248	4.18	3.29	3.35	110.25	95.42	9.02	0.33	0.34
67433	617	50-Yr	674-ex	255.00	384.00	46.48	50.84		50.93	0.002048	4.36	3.48	3.32	127.95	99.37	9.02	0.31	0.33
67433	617	50-Yr	674-T1	255.00	384.00	46.48	50.84		50.94	0.002045	4.36	3.48	3.32	128.01	99.38	9.02	0.31	0.33
67433	617	100-Yr	674-ex	291.00	384.00	46.48	51.02		51.11	0.001885	4.54	3.65	3.29	145.76	103.18	9.02	0.30	0.32
67433	617	100-Yr	674-T1	291.00	384.00	46.48	51.02		51.11	0.001884	4.54	3.65	3.29	145.80	103.19	9.02	0.30	0.32
67433	655	Lo Q	674-ex	5.00	422.00	45.29	47.56		47.56	0.000384	2.27	1.33	0.71	7.12	5.81	5.30	0.11	0.02
67433	655	Lo Q	674-T1	5.00	422.00	45.29	47.56		47.56	0.000384	2.27	1.33	0.71	7.12	5.81	5.30	0.11	0.02

HEC-RAS River: 674-33 Reach: 67433 (Continued)

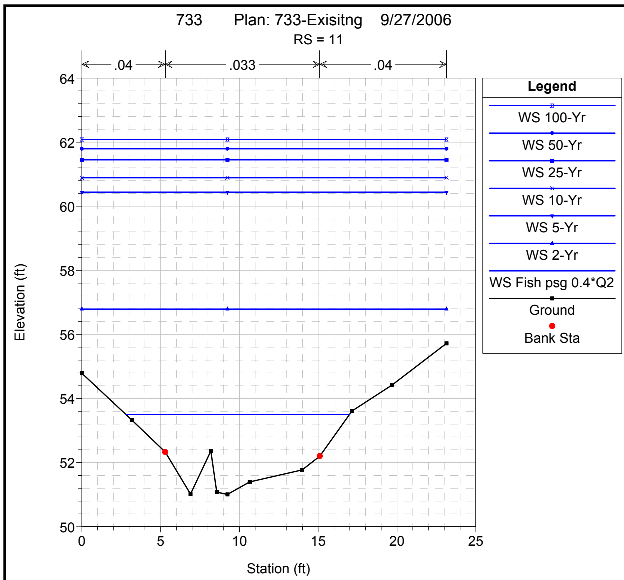
Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
67433	655	Lo Q	674-ex	20.00	422.00	45.29	48.34		48.38	0.001373	3.05	2.09	1.71	12.29	7.41	5.37	0.21	0.11
67433	655	Lo Q	674-T1	20.00	422.00	45.29	48.34		48.38	0.001373	3.05	2.09	1.71	12.29	7.41	5.37	0.21	0.11
67433	655	Qfp = 0.4*Q2	674-ex	38.00	422.00	45.29	48.93		49.02	0.002276	3.64	2.66	2.49	17.25	14.13	5.42	0.27	0.22
67433	655	Qfp = 0.4*Q2	674-T1	38.00	422.00	45.29	48.93		49.02	0.002276	3.64	2.66	2.49	17.24	14.12	5.42	0.27	0.22
67433	655	Lo Q	674-ex	70.00	422.00	45.29	49.67		49.73	0.001596	4.38	3.38	2.38	46.46	56.10	5.46	0.23	0.19
67433	655	Lo Q	674-T1	70.00	422.00	45.29	49.67		49.73	0.001596	4.38	3.38	2.38	46.45	56.09	5.46	0.23	0.19
67433	655	2-Yr	674-ex	96.00	422.00	45.29	50.01		50.05	0.001288	4.72	3.71	2.27	67.02	66.46	5.46	0.21	0.17
67433	655	2-Yr	674-T1	96.00	422.00	45.29	50.01		50.05	0.001288	4.72	3.71	2.27	67.01	66.46	5.46	0.21	0.17
67433	655	5-Yr	674-ex	142.00	422.00	45.29	50.28		50.34	0.001503	4.99	3.99	2.58	86.71	75.06	5.46	0.23	0.21
67433	655	5-Yr	674-T1	142.00	422.00	45.29	50.28		50.34	0.001503	4.99	3.99	2.58	86.71	75.06	5.46	0.23	0.21
67433	655	10-Yr	674-ex	174.00	422.00	45.29	50.48		50.54	0.001510	5.19	4.19	2.66	101.85	81.05	5.46	0.23	0.22
67433	655	10-Yr	674-T1	174.00	422.00	45.29	50.48		50.54	0.001509	5.19	4.19	2.66	101.85	81.05	5.46	0.23	0.22
67433	655	25-Yr	674-ex	220.00	422.00	45.29	50.74		50.81	0.001456	5.45	4.45	2.73	124.36	89.22	5.46	0.23	0.22
67433	655	25-Yr	674-T1	220.00	422.00	45.29	50.74		50.81	0.001455	5.45	4.45	2.73	124.38	89.23	5.46	0.23	0.22
67433	655	50-Yr	674-ex	255.00	422.00	45.29	50.91		50.98	0.001449	5.62	4.62	2.79	139.88	94.44	5.46	0.23	0.23
67433	655	50-Yr	674-T1	255.00	422.00	45.29	50.91		50.98	0.001448	5.62	4.62	2.79	139.93	94.46	5.46	0.23	0.23
67433	655	100-Yr	674-ex	291.00	422.00	45.29	51.08		51.15	0.001427	5.79	4.79	2.83	156.00	99.57	5.46	0.23	0.24
67433	655	100-Yr	674-T1	291.00	422.00	45.29	51.08		51.15	0.001426	5.79	4.79	2.83	156.03	99.58	5.46	0.23	0.24
67433	686	Lo Q	674-ex	5.00	453.00	46.91	47.57		47.59	0.002104	0.66	0.51	1.10	4.53	8.79	8.79	0.27	0.06
67433	686	Lo Q	674-T1	5.00	453.00	46.91	47.57		47.59	0.002104	0.66	0.51	1.10	4.53	8.79	8.79	0.27	0.06
67433	686	Lo Q	674-ex	20.00	453.00	46.91	48.39		48.43	0.001712	1.48	1.17	1.65	12.14	10.34	10.34	0.27	0.11
67433	686	Lo Q	674-T1	20.00	453.00	46.91	48.39		48.43	0.001712	1.48	1.17	1.65	12.14	10.34	10.34	0.27	0.11
67433	686	Qfp = 0.4*Q2	674-ex	38.00	453.00	46.91	49.03		49.09	0.001674	2.12	1.58	1.96	19.35	12.24	12.24	0.28	0.14
67433	686	Qfp = 0.4*Q2	674-T1	38.00	453.00	46.91	49.03		49.09	0.001675	2.12	1.58	1.96	19.35	12.24	12.24	0.28	0.14
67433	686	Lo Q	674-ex	70.00	453.00	46.91	49.70		49.78	0.001711	2.79	2.03	2.32	36.75	50.56	13.91	0.29	0.18
67433	686	Lo Q	674-T1	70.00	453.00	46.91	49.70		49.78	0.001711	2.79	2.03	2.32	36.74	50.56	13.91	0.29	0.18
67433	686	2-Yr	674-ex	96.00	453.00	46.91	50.03		50.09	0.001334	3.12	2.34	2.24	70.35	164.12	14.06	0.26	0.16
67433	686	2-Yr	674-T1	96.00	453.00	46.91	50.03		50.09	0.001334	3.12	2.34	2.24	70.35	164.11	14.06	0.26	0.16
67433	686	5-Yr	674-ex	142.00	453.00	46.91	50.33		50.38	0.001044	3.42	2.64	2.15	123.75	187.10	14.06	0.23	0.14
67433	686	5-Yr	674-T1	142.00	453.00	46.91	50.33		50.38	0.001044	3.42	2.64	2.15	123.75	187.09	14.06	0.23	0.14
67433	686	10-Yr	674-ex	174.00	453.00	46.91	50.54		50.57	0.000836	3.63	2.85	2.02	163.78	202.62	14.06	0.21	0.12
67433	686	10-Yr	674-T1	174.00	453.00	46.91	50.54		50.57	0.000836	3.63	2.85	2.02	163.79	202.62	14.06	0.21	0.12
67433	686	25-Yr	674-ex	220.00	453.00	46.91	50.81		50.84	0.000640	3.90	3.12	1.88	221.78	223.20	14.06	0.19	0.10
67433	686	25-Yr	674-T1	220.00	453.00	46.91	50.81		50.84	0.000640	3.90	3.12	1.88	221.81	223.21	14.06	0.19	0.10
67433	686	50-Yr	674-ex	255.00	453.00	46.91	50.98		51.01	0.000553	4.07	3.29	1.81	261.19	227.37	14.06	0.18	0.10
67433	686	50-Yr	674-T1	255.00	453.00	46.91	50.98		51.01	0.000552	4.07	3.29	1.81	261.30	227.37	14.06	0.18	0.10
67433	686	100-Yr	674-ex	291.00	453.00	46.91	51.15		51.17	0.000484	4.24	3.46	1.75	299.76	227.86	14.06	0.17	0.09
67433	686	100-Yr	674-T1	291.00	453.00	46.91	51.15		51.17	0.000483	4.24	3.46	1.75	299.82	227.86	14.06	0.17	0.09
67433	745			Culvert														
67433	781	Lo Q	674-ex	5.00	548.00	48.18	48.96	48.41	48.97	0.000653	0.78	0.74	0.76	6.55	8.79	8.79	0.16	0.03
67433	781	Lo Q	674-T1	5.00	548.00	48.18	48.41	48.41	48.52	0.036180	0.23	0.22	2.68	1.86	8.30	8.30	1.00	0.49
67433	781	Lo Q	674-ex	20.00	548.00	48.18	49.97	48.75	50.00	0.000712	1.79	1.64	1.26	15.90	9.70	9.70	0.17	0.06
67433	781	Lo Q	674-T1	20.00	548.00	48.18	48.75	48.75	49.03	0.028990	0.57	0.55	4.23	4.73	8.61	8.61	1.01	0.92
67433	781	Qfp = 0.4*Q2	674-ex	38.00	548.00	48.18	50.73	49.05	50.77	0.000749	2.55	2.34	1.60	24.93	17.34	10.00	0.18	0.09
67433	781	Qfp = 0.4*Q2	674-T1	38.00	548.00	48.18	49.20	49.05	49.50	0.015821	1.02	0.96	4.38	8.68	9.01	9.01	0.79	0.83
67433	781	Lo Q	674-ex	70.00	548.00	48.18	51.77	49.47	51.81	0.000535	3.59	3.39	1.73	51.35	32.29	10.00	0.17	0.09
67433	781	Lo Q	674-T1	70.00	548.00	48.18	49.94	49.47	50.25	0.009229	1.76	1.61	4.49	15.60	9.67	9.67	0.62	0.75
67433	781	2-Yr	674-ex	96.00	548.00	48.18	52.86	49.76	52.88	0.000254	4.68	4.47	1.44	94.26	46.59	10.00	0.12	0.06
67433	781	2-Yr	674-T1	96.00	548.00	48.18	50.44	49.76	50.78	0.007559	2.26	2.05	4.67	20.70	12.34	10.00	0.57	0.76
67433	781	5-Yr	674-ex	142.00	548.00	48.18	55.89	50.22	55.89	0.000028	7.71	7.50	0.67	316.57	80.10	10.00	0.04	0.01
67433	781	5-Yr	674-T1	142.00	548.00	48.18	51.40	50.22	51.65	0.003756	3.22	3.01	4.25	40.18	27.36	10.00	0.43	0.55
67433	781	10-Yr	674-ex	174.00	548.00	48.18	56.46	50.57	56.46	0.000028	8.28	8.07	0.70	362.26	80.10	10.00	0.04	0.01
67433	781	10-Yr	674-T1	174.00	548.00	48.18	52.08	50.57	52.25	0.002194	3.90	3.69	3.72	61.76	36.28	10.00	0.34	0.40
67433	781	25-Yr	674-ex	220.00	548.00	48.18	56.73	51.11	56.73	0.000037	8.55	8.34	0.83	383.74	80.10	10.00	0.05	0.02
67433	781	25-Yr	674-T1	220.00	548.00	48.18	52.98	51.11	53.09	0.001165	4.80	4.59	3.14	99.93	48.17	10.00	0.26	0.26
67433	781	50-Yr	674-ex	255.00	548.00	48.18	56.89	51.36	56.89	0.000045	8.71	8.50	0.93	396.45	80.10	10.00	0.06	0.02
67433	781	50-Yr	674-T1	255.00	548.00	48.18	53.60	51.36	53.69	0.000849	5.42	5.21	2.91	135.59	67.40	10.00	0.22	0.22
67433	781	100-Yr	674-ex	291.00	548.00	48.18	57.03	51.57	57.04	0.000054	8.85	8.64	1.03	407.62	80.10	10.00	0.06	0.02
67433	781	100-Yr	674-T1	291.00	548.00	48.18	54.22	51.57	54.29	0.000559	6.04	5.84	2.55	183.07	80.10	10.00	0.19	0.16
67433	806	Lo Q	674-ex	5.00	572.00	48.35	48.95	48.95	49.15	0.034232	0.60	0.40	3.59	1.39	3.48	3.48	1.00	0.75

HEC-RAS River: 674-33 Reach: 67433 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
67433	806	Lo Q	674-T1	5.00	572.00	48.35	49.03	48.95	49.16	0.019797	0.68	0.46	2.97	1.68	3.68	3.68	0.77	0.49
67433	806	Lo Q	674-ex	20.00	572.00	48.35	49.91		50.09	0.009977	1.56	1.00	3.40	5.88	5.86	5.86	0.60	0.51
67433	806	Lo Q	674-T1	20.00	572.00	48.35	49.55	49.55	49.95	0.029852	1.20	0.79	5.09	3.93	4.97	4.97	1.01	1.22
67433	806	Qfp = 0.4*Q2	674-ex	38.00	572.00	48.35	50.68		50.84	0.004912	2.33	1.69	3.27	13.38	14.47	6.30	0.44	0.40
67433	806	Qfp = 0.4*Q2	674-T1	38.00	572.00	48.35	50.00	50.00	50.54	0.028163	1.65	1.06	5.92	6.42	6.24	6.05	1.01	1.51
67433	806	Lo Q	674-ex	70.00	572.00	48.35	51.77		51.84	0.001503	3.42	2.78	2.52	39.85	32.14	6.30	0.27	0.20
67433	806	Lo Q	674-T1	70.00	572.00	48.35	50.65	50.65	51.21	0.017900	2.30	1.66	6.17	12.96	13.88	6.30	0.84	1.43
67433	806	2-Yr	674-ex	96.00	572.00	48.35	52.87		52.89	0.000448	4.52	3.87	1.72	78.50	36.68	6.30	0.15	0.08
67433	806	2-Yr	674-T1	96.00	572.00	48.35	51.01	51.01	51.55	0.014525	2.66	2.02	6.32	19.15	21.03	6.30	0.78	1.41
67433	806	5-Yr	674-ex	142.00	572.00	48.35	55.89		55.90	0.000065	7.54	6.90	0.96	200.82	44.94	6.30	0.06	0.02
67433	806	5-Yr	674-T1	142.00	572.00	48.35	51.42	51.42	51.96	0.012778	3.07	2.43	6.70	29.19	27.57	6.30	0.76	1.49
67433	806	10-Yr	674-ex	174.00	572.00	48.35	56.46		56.47	0.000069	8.11	7.47	1.04	226.91	46.67	6.30	0.07	0.02
67433	806	10-Yr	674-T1	174.00	572.00	48.35	52.11		52.36	0.004951	3.76	3.12	4.93	51.23	35.24	6.30	0.49	0.74
67433	806	25-Yr	674-ex	220.00	572.00	48.35	56.72		56.74	0.000094	8.37	7.73	1.25	239.39	46.80	6.30	0.08	0.04
67433	806	25-Yr	674-T1	220.00	572.00	48.35	53.01		53.14	0.001952	4.66	4.02	3.67	83.67	36.94	6.30	0.32	0.38
67433	806	50-Yr	674-ex	255.00	572.00	48.35	56.88		56.90	0.000116	8.53	7.89	1.40	246.75	46.80	6.30	0.09	0.04
67433	806	50-Yr	674-T1	255.00	572.00	48.35	53.62		53.72	0.001289	5.27	4.63	3.27	106.57	38.10	6.30	0.27	0.29
67433	806	100-Yr	674-ex	291.00	572.00	48.35	57.02		57.04	0.000140	8.67	8.03	1.56	253.21	46.80	6.30	0.10	0.05
67433	806	100-Yr	674-T1	291.00	572.00	48.35	54.22		54.31	0.000939	5.87	5.23	3.03	130.25	39.88	6.30	0.23	0.24

Tributary 710+75 HEC-RAS

Companion 2006 Stream and Habitat Inventory (S&HI) station 731+00
Model based on ADOT&PF project datum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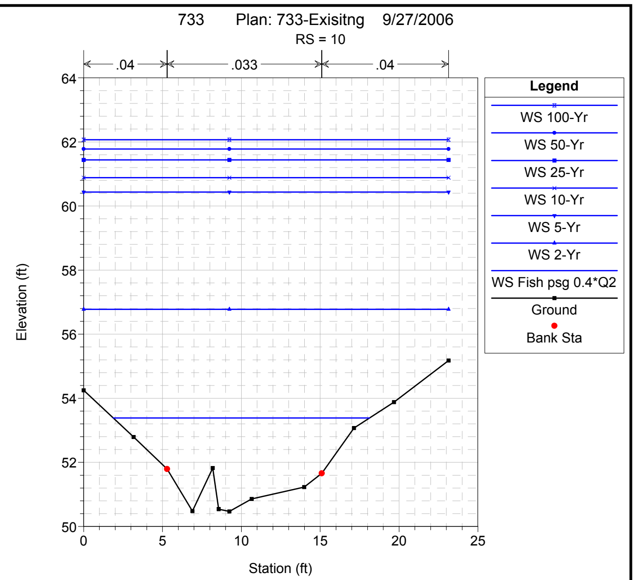
RS = 11
.04
.033
.04
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish psg 0.4*Q2
Ground
Bank Sta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.04
.033
.04
Elevation (ft)
Station (ft)
Legend
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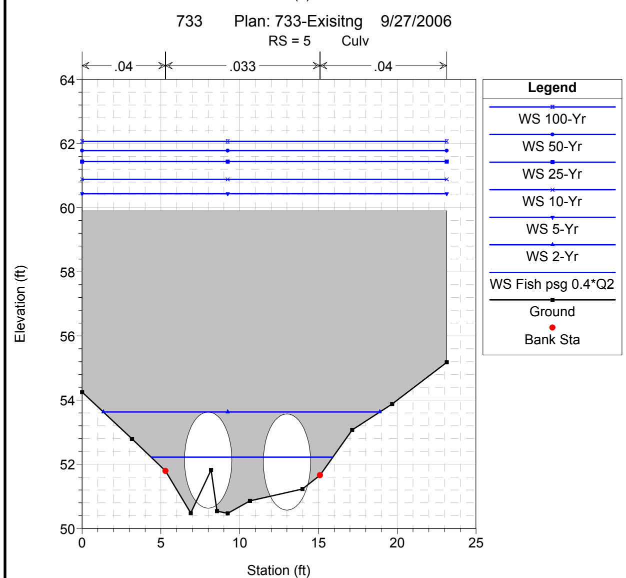
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish psg 0.4*Q2
Ground
Bank Sta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.04
.033
.04
Elevation (ft)
Station (ft)
Legend
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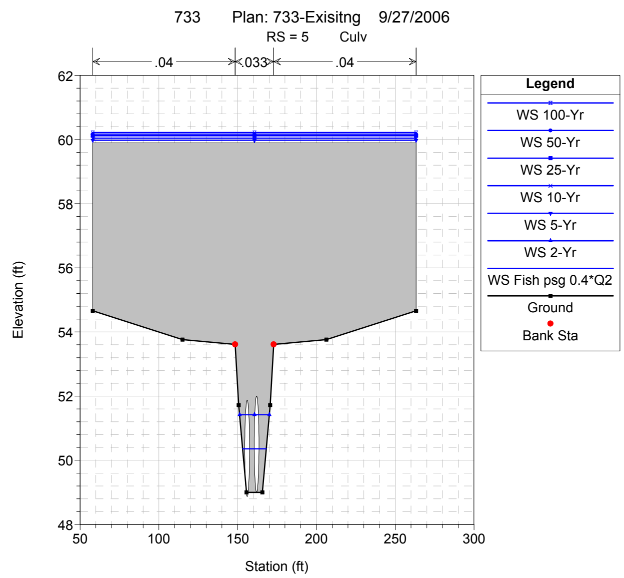
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish psg 0.4*Q2
Ground
Bank Sta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.04
.033
.04
Elevation (ft)
Station (ft)
Legend
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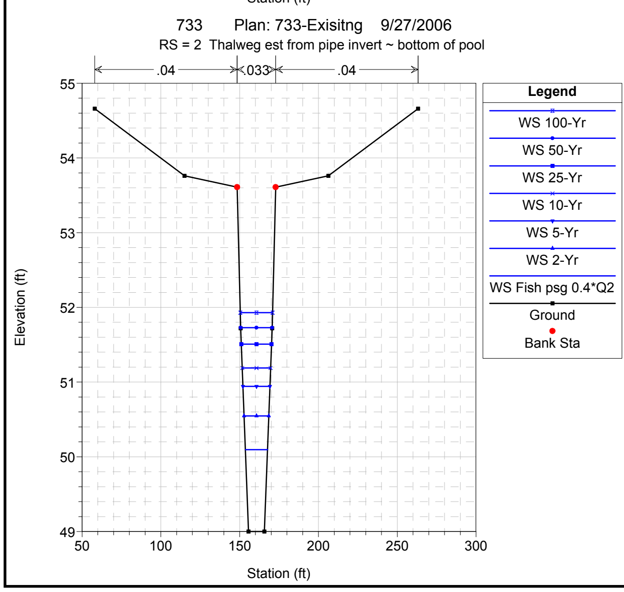
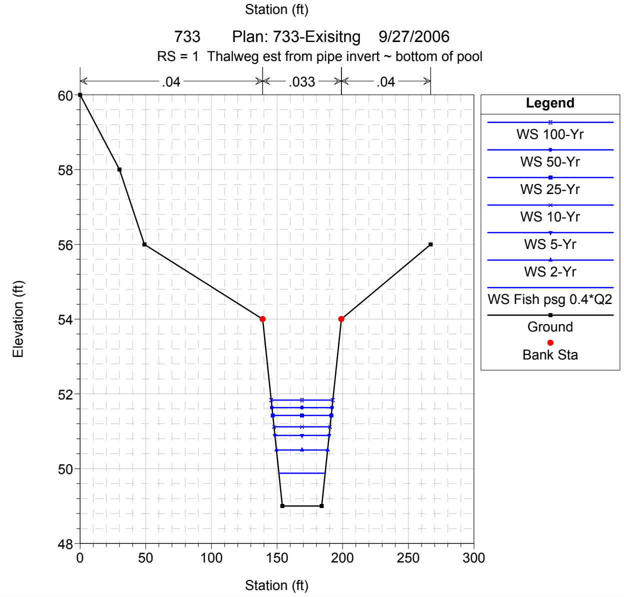
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish psg 0.4*Q2
Ground
Bank Sta


733 Plan: 733-Exisitng 9/27/2006
RS = 2 Thalweg est from pipe invert ~ bottom of pool
.04
.033
.04
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish psg 0.4*Q2
Ground
Bank Sta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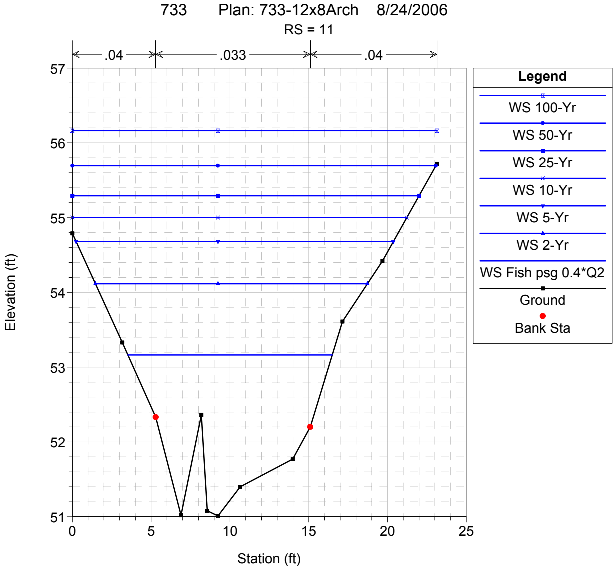
RS = 1 Thalweg est from pipe invert ~ bottom of pool
.04
.033
.04
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish psg 0.4*Q2
Ground
Bank Sta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Station (ft)
Legend
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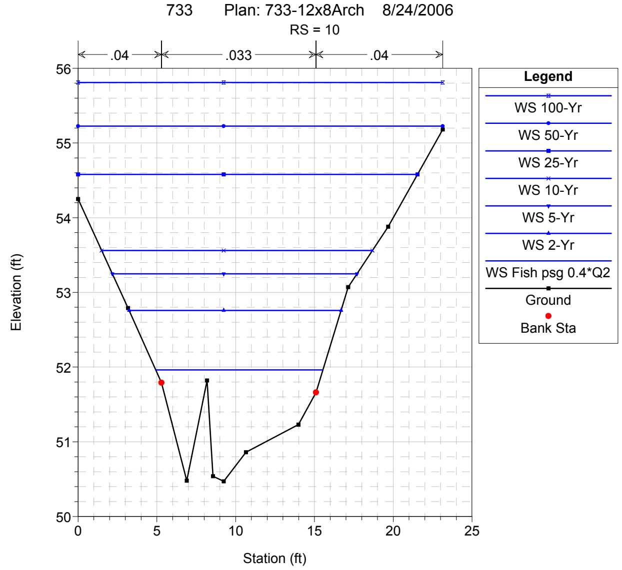
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish psg 0.4*Q2
Ground
Bank Sta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.04
.033
.04
Elevation (ft)
Station (ft)
Legend
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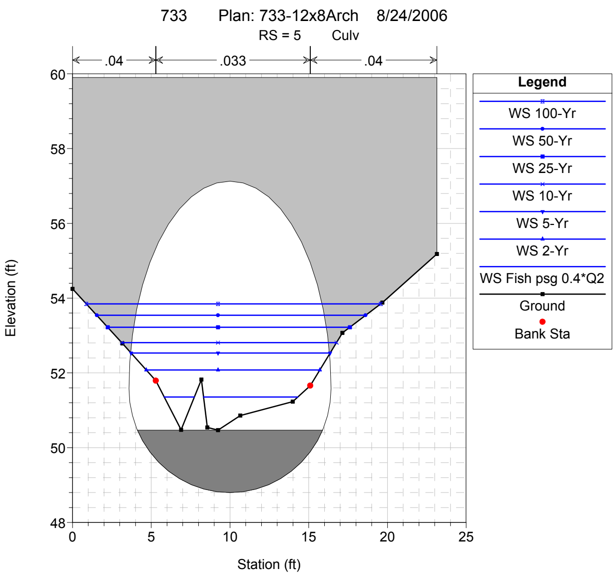
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish psg 0.4*Q2
Ground
Bank Sta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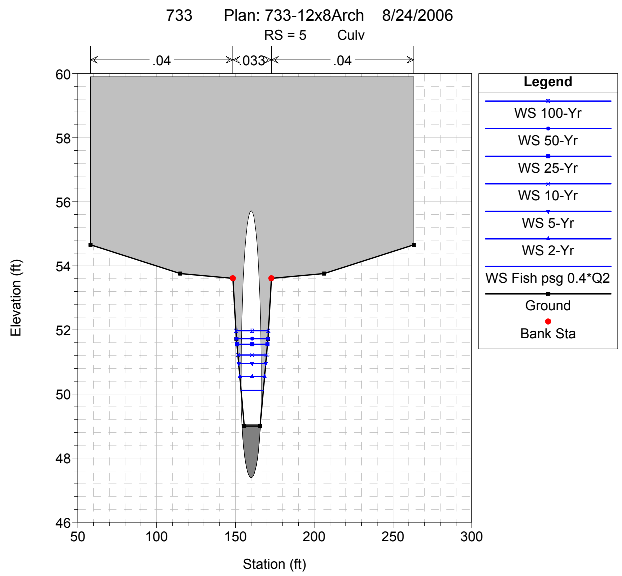
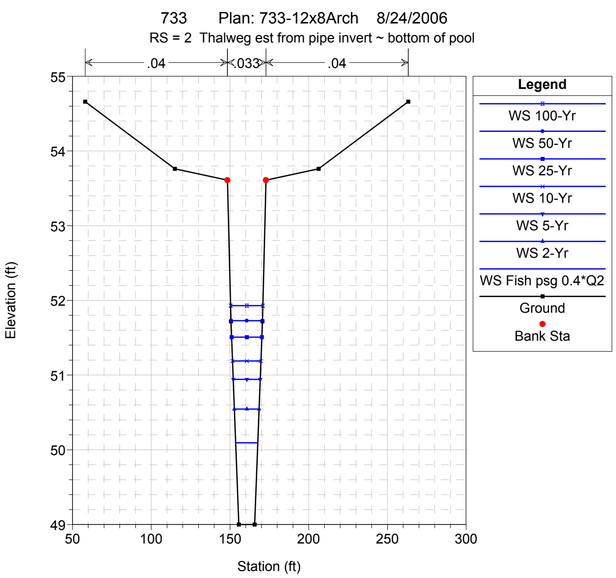
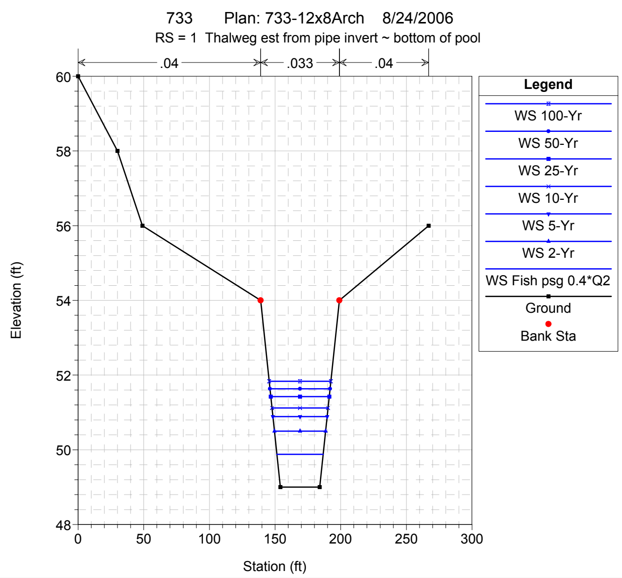
.04
.033
.04
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish psg 0.4*Q2
Ground
Bank Sta


733 Plan: 733-12x8Arch 8/24/2006
RS = 5 Culv
.04
.033
.04
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish psg 0.4*Q2
Ground
Bank Sta


733 Plan: 733-12x8Arch 8/24/2006
RS = 2 Thalweg est from pipe invert ~ bottom of pool
.04
.033
.04
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish psg 0.4*Q2
Ground
Bank Sta


733 Plan: 733-12x8Arch 8/24/2006
RS = 1 Thalweg est from pipe invert ~ bottom of pool
.04
.033
.04
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish psg 0.4*Q2
Ground
Bank Sta

HEC-RAS River: 733 Reach: 733

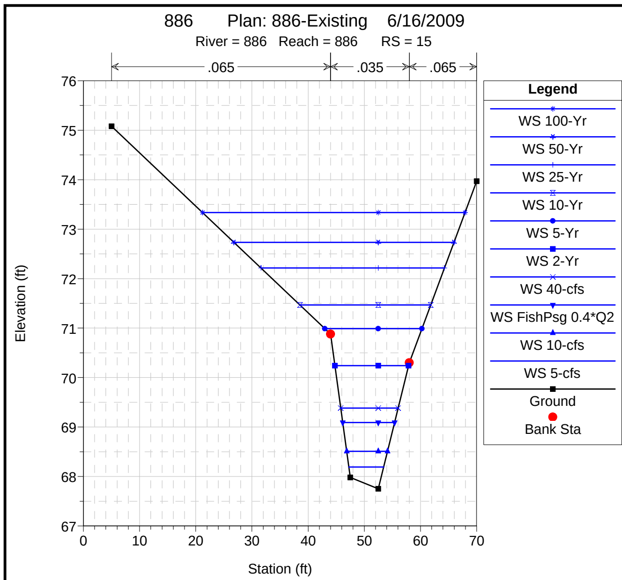
Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
733	1	5-cfs	733-Arch	5.00		49.00	49.22	49.09	49.23	0.002001	0.22	0.22	0.73	6.85	31.34	31.34	0.28	0.03
733	1	5-cfs	733-Ex	5.00		49.00	49.22	49.09	49.23	0.002001	0.22	0.22	0.73	6.85	31.34	31.34	0.28	0.03
733	1	25-cfs	733-Arch	25.00		49.00	49.58	49.28	49.61	0.002001	0.58	0.55	1.35	18.50	33.50	33.50	0.32	0.07
733	1	25-cfs	733-Ex	25.00		49.00	49.58	49.28	49.61	0.002001	0.58	0.55	1.35	18.50	33.50	33.50	0.32	0.07
733	1	Fish psg 0.4*Q2	733-Arch	50.00		49.00	49.88	49.43	49.93	0.002002	0.88	0.81	1.74	28.65	35.27	35.27	0.34	0.10
733	1	Fish psg 0.4*Q2	733-Ex	50.00		49.00	49.88	49.43	49.93	0.002002	0.88	0.81	1.74	28.65	35.27	35.27	0.34	0.10
733	1	100-cfs	733-Arch	100.00		49.00	50.32	49.68	50.40	0.002000	1.32	1.18	2.23	44.78	37.91	37.91	0.36	0.15
733	1	100-cfs	733-Ex	100.00		49.00	50.32	49.68	50.40	0.002000	1.32	1.18	2.23	44.78	37.91	37.91	0.36	0.15
733	1	2-Yr	733-Arch	125.00		49.00	50.50	49.79	50.59	0.002001	1.50	1.33	2.41	51.80	39.01	39.01	0.37	0.16
733	1	2-Yr	733-Ex	125.00		49.00	50.50	49.79	50.59	0.002001	1.50	1.33	2.41	51.80	39.01	39.01	0.37	0.16
733	1	5-Yr	733-Arch	186.00		49.00	50.89	50.02	51.01	0.002002	1.89	1.63	2.76	67.34	41.33	41.33	0.38	0.20
733	1	5-Yr	733-Ex	186.00		49.00	50.89	50.02	51.01	0.002002	1.89	1.63	2.76	67.34	41.33	41.33	0.38	0.20
733	1	10-Yr	733-Arch	228.00		49.00	51.12	50.16	51.26	0.002000	2.12	1.81	2.95	77.16	42.73	42.73	0.39	0.22
733	1	10-Yr	733-Ex	228.00		49.00	51.12	50.16	51.26	0.002000	2.12	1.81	2.95	77.16	42.73	42.73	0.39	0.22
733	1	25-Yr	733-Arch	288.00		49.00	51.42	50.35	51.58	0.002002	2.42	2.03	3.19	90.29	44.54	44.54	0.39	0.25
733	1	25-Yr	733-Ex	288.00		49.00	51.42	50.35	51.58	0.002002	2.42	2.03	3.19	90.29	44.54	44.54	0.39	0.25
733	1	50-Yr	733-Arch	334.00		49.00	51.63	50.48	51.81	0.002000	2.63	2.18	3.34	99.87	45.81	45.81	0.40	0.27
733	1	50-Yr	733-Ex	334.00		49.00	51.63	50.48	51.81	0.002000	2.63	2.18	3.34	99.87	45.81	45.81	0.40	0.27
733	1	100-Yr	733-Arch	381.00		49.00	51.84	50.62	52.02	0.002003	2.84	2.32	3.49	109.21	47.02	47.02	0.40	0.28
733	1	100-Yr	733-Ex	381.00		49.00	51.84	50.61	52.02	0.002003	2.84	2.32	3.49	109.20	47.02	47.02	0.40	0.28
733	2	5-cfs	733-Arch	5.00	95.00	49.00	49.41		49.43	0.002294	0.41	0.39	1.13	4.43	11.52	11.52	0.32	0.05
733	2	5-cfs	733-Ex	5.00	95.00	49.00	49.41		49.43	0.002294	0.41	0.39	1.13	4.43	11.52	11.52	0.32	0.05
733	2	25-cfs	733-Arch	25.00	95.00	49.00	49.82		49.93	0.005482	0.82	0.73	2.64	9.47	13.02	13.02	0.55	0.24
733	2	25-cfs	733-Ex	25.00	95.00	49.00	49.82		49.93	0.005486	0.82	0.73	2.64	9.47	13.02	13.02	0.55	0.24
733	2	Fish psg 0.4*Q2	733-Arch	50.00	95.00	49.00	50.09		50.32	0.008190	1.09	0.94	3.80	13.15	14.02	14.02	0.69	0.46
733	2	Fish psg 0.4*Q2	733-Ex	50.00	95.00	49.00	50.09		50.32	0.008187	1.09	0.94	3.80	13.15	14.02	14.02	0.69	0.46
733	2	100-cfs	733-Arch	100.00	95.00	49.00	50.43	50.33	50.91	0.012801	1.43	1.18	5.53	18.08	15.26	15.26	0.90	0.90
733	2	100-cfs	733-Ex	100.00	95.00	49.00	50.43		50.91	0.012874	1.43	1.18	5.54	18.05	15.25	15.25	0.90	0.91
733	2	2-Yr	733-Arch	125.00	95.00	49.00	50.55	50.53	51.16	0.015251	1.55	1.27	6.30	19.85	15.68	15.68	0.99	1.15
733	2	2-Yr	733-Ex	125.00	95.00	49.00	50.55	50.53	51.16	0.015166	1.55	1.27	6.29	19.89	15.69	15.69	0.98	1.14
733	2	5-Yr	733-Arch	186.00	95.00	49.00	50.94	50.94	51.72	0.014908	1.94	1.54	7.06	26.36	17.14	17.14	1.00	1.35
733	2	5-Yr	733-Ex	186.00	95.00	49.00	50.94	50.94	51.72	0.014907	1.94	1.54	7.06	26.36	17.14	17.14	1.00	1.35
733	2	10-Yr	733-Arch	228.00	95.00	49.00	51.19	51.19	52.05	0.014498	2.19	1.70	7.42	30.71	18.05	18.05	1.00	1.45
733	2	10-Yr	733-Ex	228.00	95.00	49.00	51.19	51.19	52.05	0.014499	2.19	1.70	7.42	30.71	18.05	18.05	1.00	1.45
733	2	25-Yr	733-Arch	288.00	95.00	49.00	51.51	51.51	52.47	0.014058	2.51	1.91	7.86	36.63	19.22	19.22	1.00	1.57
733	2	25-Yr	733-Ex	288.00	95.00	49.00	51.51	51.51	52.47	0.014059	2.51	1.91	7.86	36.63	19.22	19.22	1.00	1.57
733	2	50-Yr	733-Arch	334.00	95.00	49.00	51.73	51.73	52.76	0.013810	2.73	2.05	8.15	40.96	20.02	20.02	1.00	1.65
733	2	50-Yr	733-Ex	334.00	95.00	49.00	51.73	51.73	52.76	0.013809	2.73	2.05	8.15	40.96	20.02	20.02	1.00	1.65
733	2	100-Yr	733-Arch	381.00	95.00	49.00	51.93	51.93	53.04	0.013592	2.93	2.20	8.46	45.05	20.50	20.50	1.01	1.73
733	2	100-Yr	733-Ex	381.00	95.00	49.00	51.93	51.93	53.04	0.013589	2.93	2.20	8.46	45.06	20.50	20.50	1.01	1.73
733	5			Culvert														
733	10	5-cfs	733-Arch	5.00	228.00	50.47	51.08	51.08	51.23	0.029474	0.61	0.29	3.08	1.62	5.53	5.53	1.00	0.46
733	10	5-cfs	733-Ex	5.00	228.00	50.47	51.39	51.08	51.41	0.002940	0.92	0.47	1.32	3.78	8.05	8.05	0.34	0.07
733	10	25-cfs	733-Arch	25.00	228.00	50.47	51.59	51.59	51.91	0.024397	1.12	0.61	4.49	5.57	9.11	9.11	1.01	0.78
733	10	25-cfs	733-Ex	25.00	228.00	50.47	52.47	51.59	52.51	0.001198	2.00	1.43	1.74	15.02	12.41	9.81	0.26	0.09
733	10	Fish psg 0.4*Q2	733-Arch	50.00	228.00	50.47	51.96	51.96	52.43	0.021169	1.49	0.93	5.47	9.22	10.61	9.81	1.00	1.01
733	10	Fish psg 0.4*Q2	733-Ex	50.00	228.00	50.47	53.38	51.96	53.44	0.000815	2.91	2.35	1.99	28.01	16.25	9.81	0.23	0.10
733	10	100-cfs	733-Arch	100.00	228.00	50.47	52.52	52.52	53.20	0.016863	2.05	1.49	6.68	15.69	12.60	9.81	0.96	1.28
733	10	100-cfs	733-Ex	100.00	228.00	50.47	54.92	52.52	54.97	0.000460	4.45	3.89	2.09	58.42	22.44	9.81	0.19	0.09
733	10	2-Yr	733-Arch	125.00	228.00	50.47	52.76	52.76	53.51	0.015545	2.29	1.73	7.08	18.81	13.46	9.81	0.95	1.37
733	10	2-Yr	733-Ex	125.00	228.00	50.47	56.78	52.76	56.81	0.000153	6.31	5.74	1.56	101.33	23.14	9.81	0.11	0.04
733	10	5-Yr	733-Arch	186.00	228.00	50.47	53.25	53.25	54.17	0.014009	2.78	2.22	7.94	25.86	15.53	9.81	0.94	1.59
733	10	5-Yr	733-Ex	186.00	228.00	50.47	60.43	53.25	60.45	0.000058	9.96	9.40	1.34	185.98	23.14	9.81	0.08	0.03
733	10	10-Yr	733-Arch	228.00	228.00	50.47	53.56	53.56	54.55	0.012943	3.09	2.53	8.33	30.95	17.18	9.81	0.92	1.68
733	10	10-Yr	733-Ex	228.00	228.00	50.47	60.88	53.56	60.91	0.000075	10.41	9.85	1.57	196.37	23.14	9.81	0.09	0.04
733	10	25-Yr	733-Arch	288.00	228.00	50.47	54.58	53.96	55.20	0.005504	4.11	3.55	6.81	50.99	21.54	9.81	0.64	1.00
733	10	25-Yr	733-Ex	288.00	228.00	50.47	61.44	53.96	61.48	0.000099	10.97	10.40	1.87	209.19	23.14	9.81	0.10	0.05
733	10	50-Yr	733-Arch	334.00	228.00	50.47	55.23	54.24	55.74	0.003775	4.76	4.19	6.30	65.46	23.14	9.81	0.54	0.81
733	10	50-Yr	733-Ex	334.00	228.00	50.47	61.78	54.24	61.83	0.000119	11.31	10.75	2.10	217.11	23.14	9.81	0.11	0.07

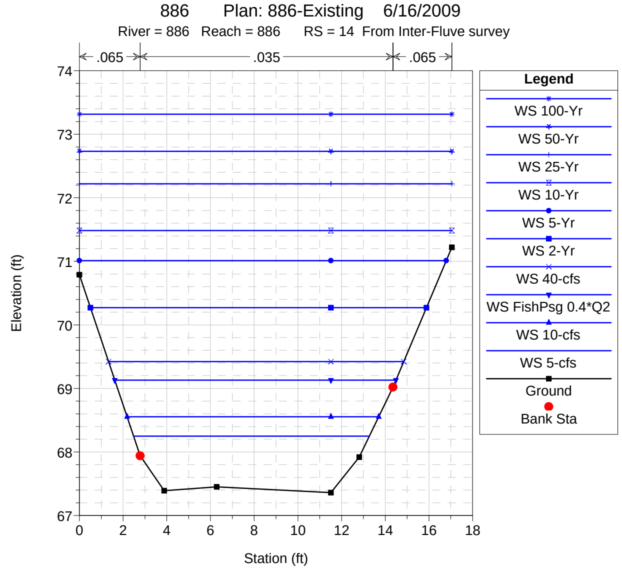
HEC-RAS River: 733 Reach: 733 (Continued)

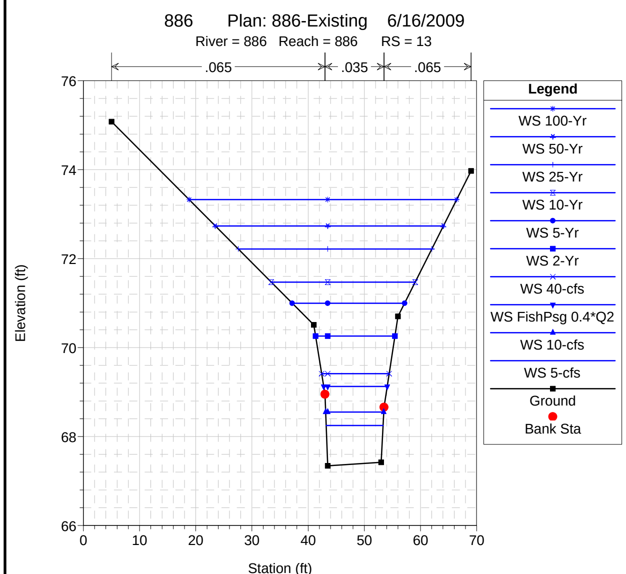
Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
733	10	100-Yr	733-Arch	381.00	228.00	50.47	55.81	54.46	56.27	0.002895	5.34	4.78	6.02	78.99	23.14	9.81	0.49	0.71
733	10	100-Yr	733-Ex	381.00	228.00	50.47	62.07	54.46	62.13	0.000143	11.60	11.03	2.33	223.73	23.14	9.81	0.12	0.08
733	11	5-cfs	733-Arch	5.00	353.00	51.01	51.95	51.62	51.98	0.002492	0.94	0.49	1.25	4.01	8.19	8.19	0.31	0.06
733	11	5-cfs	733-Ex	5.00	353.00	51.01	51.84		51.88	0.005066	0.83	0.41	1.59	3.14	7.64	7.64	0.44	0.11
733	11	25-cfs	733-Arch	25.00	353.00	51.01	52.67	52.13	52.75	0.003008	1.66	1.10	2.30	11.06	11.21	9.81	0.39	0.17
733	11	25-cfs	733-Ex	25.00	353.00	51.01	52.67		52.75	0.003043	1.66	1.09	2.31	11.02	11.20	9.81	0.39	0.17
733	11	Fish psg 0.4*Q2	733-Arch	50.00	353.00	51.01	53.16	52.50	53.31	0.003328	2.15	1.59	3.10	17.01	12.97	9.81	0.43	0.27
733	11	Fish psg 0.4*Q2	733-Ex	50.00	353.00	51.01	53.50		53.59	0.001675	2.49	1.93	2.50	21.60	14.18	9.81	0.32	0.17
733	11	100-cfs	733-Arch	100.00	353.00	51.01	53.85	53.06	54.10	0.003680	2.84	2.28	4.14	26.78	15.84	9.81	0.48	0.43
733	11	100-cfs	733-Ex	100.00	353.00	51.01	54.97		55.06	0.000787	3.96	3.40	2.50	47.84	21.15	9.81	0.24	0.14
733	11	2-Yr	733-Arch	125.00	353.00	51.01	54.11	53.30	54.41	0.003809	3.10	2.54	4.54	31.20	17.26	9.81	0.50	0.50
733	11	2-Yr	733-Ex	125.00	353.00	51.01	56.79		56.83	0.000220	5.78	5.22	1.76	89.22	23.14	9.81	0.14	0.06
733	11	5-Yr	733-Arch	186.00	353.00	51.01	54.68	53.79	55.06	0.003898	3.67	3.11	5.25	41.79	20.13	9.81	0.52	0.62
733	11	5-Yr	733-Ex	186.00	353.00	51.01	60.44		60.46	0.000071	9.43	8.87	1.42	173.63	23.14	9.81	0.08	0.03
733	11	10-Yr	733-Arch	228.00	353.00	51.01	55.00	54.10	55.43	0.003954	3.99	3.43	5.64	48.46	21.23	9.81	0.54	0.69
733	11	10-Yr	733-Ex	228.00	353.00	51.01	60.89		60.92	0.000090	9.88	9.32	1.66	184.05	23.14	9.81	0.10	0.04
733	11	25-Yr	733-Arch	288.00	353.00	51.01	55.29		55.83	0.004549	4.28	3.72	6.39	54.73	22.00	9.81	0.58	0.87
733	11	25-Yr	733-Ex	288.00	353.00	51.01	61.45		61.49	0.000118	10.44	9.87	1.97	196.93	23.14	9.81	0.11	0.06
733	11	50-Yr	733-Arch	334.00	353.00	51.01	55.70		56.23	0.004045	4.69	4.12	6.45	63.84	23.08	9.81	0.56	0.85
733	11	50-Yr	733-Ex	334.00	353.00	51.01	61.79		61.85	0.000141	10.78	10.22	2.21	204.90	23.14	9.81	0.12	0.07
733	11	100-Yr	733-Arch	381.00	353.00	51.01	56.16		56.67	0.003397	5.15	4.59	6.35	74.66	23.14	9.81	0.52	0.80
733	11	100-Yr	733-Ex	381.00	353.00	51.01	62.08		62.15	0.000168	11.07	10.51	2.45	211.58	23.14	9.81	0.13	0.09

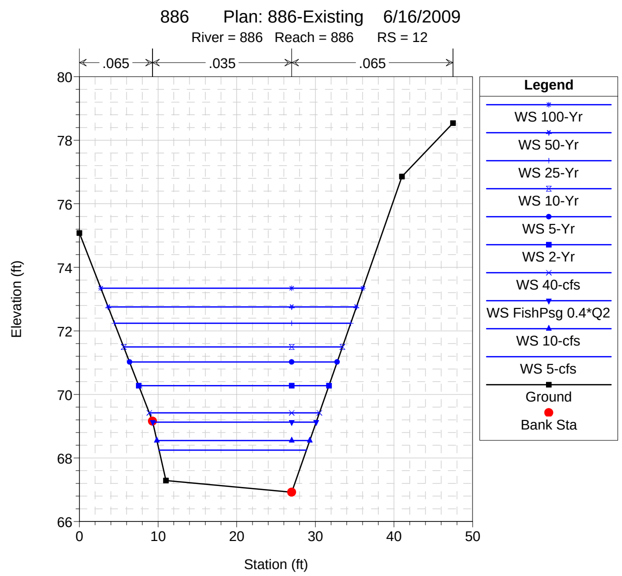
Tributary 865+88 HEC-RAS

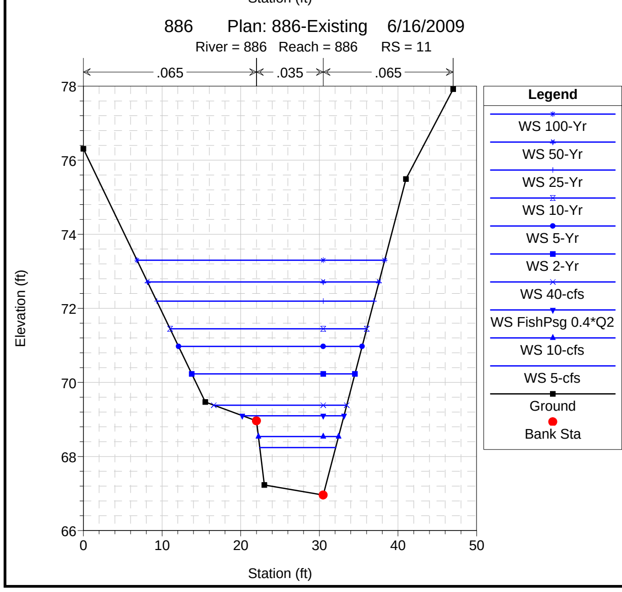
Companion 2006 Stream and Habitat Inventory (S&HI) station 886+00
Model based on ADOT&PF project datum

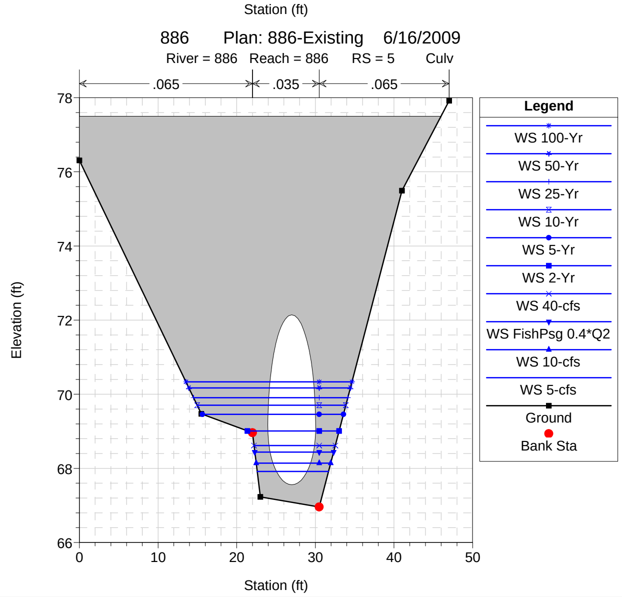

886 Plan: 886-Existing 6/16/2009
River = 886 Reach = 886 RS = 15
.065
.035
.065
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS 40-cfs
WS FishPsg 0.4*Q2
WS 10-cfs
WS 5-cfs
Ground
Bank Sta

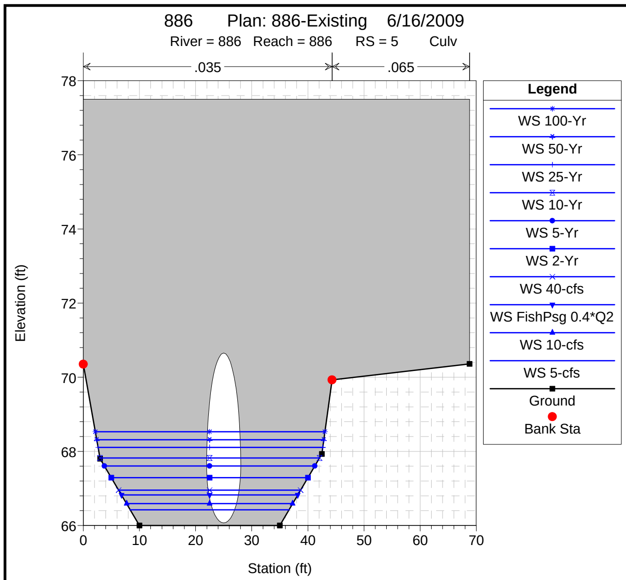

886 Plan: 886-Existing 6/16/2009
River = 886 Reach = 886 RS = 14 From Inter-Fluve survey
.065
.035
.065
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS 40-cfs
WS FishPsg 0.4*Q2
WS 10-cfs
WS 5-cfs
Ground
Bank Sta


886 Plan: 886-Existing 6/16/2009
River = 886 Reach = 886 RS = 13
.065
.035
.065
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS 40-cfs
WS FishPsg 0.4*Q2
WS 10-cfs
WS 5-cfs
Ground
Bank Sta

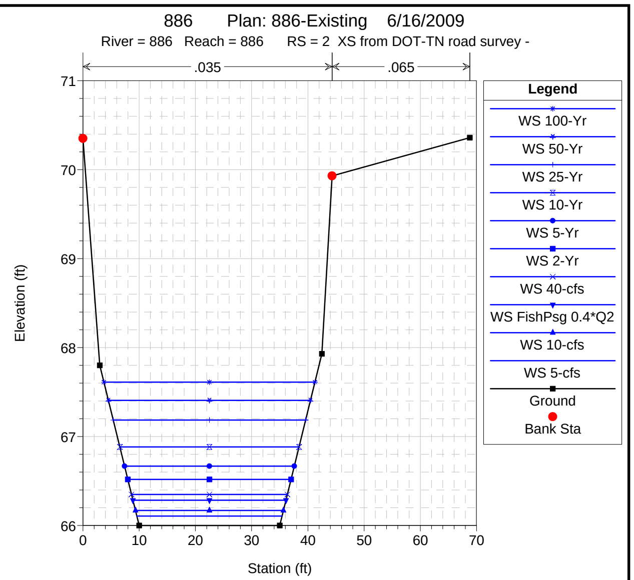

886 Plan: 886-Existing 6/16/2009
River = 886 Reach = 886 RS = 12
.065
.035
.065
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS 40-cfs
WS FishPsg 0.4*Q2
WS 10-cfs
WS 5-cfs
Ground
Bank Sta


886 Plan: 886-Existing 6/16/2009
River = 886 Reach = 886 RS = 11
.065
.035
.065
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS 40-cfs
WS FishPsg 0.4*Q2
WS 10-cfs
WS 5-cfs
Ground
Bank Sta

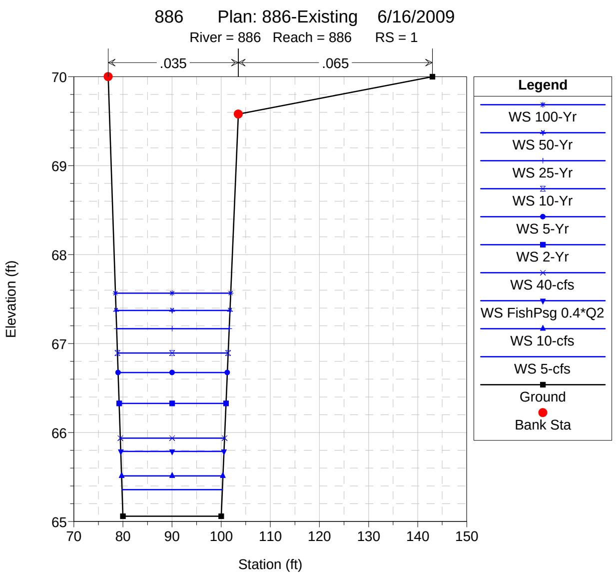

886 Plan: 886-Existing 6/16/2009
River = 886 Reach = 886 RS = 5 Culv
.065
.035
.065
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS 40-cfs
WS FishPsg 0.4*Q2
WS 10-cfs
WS 5-cfs
Ground
Bank Sta



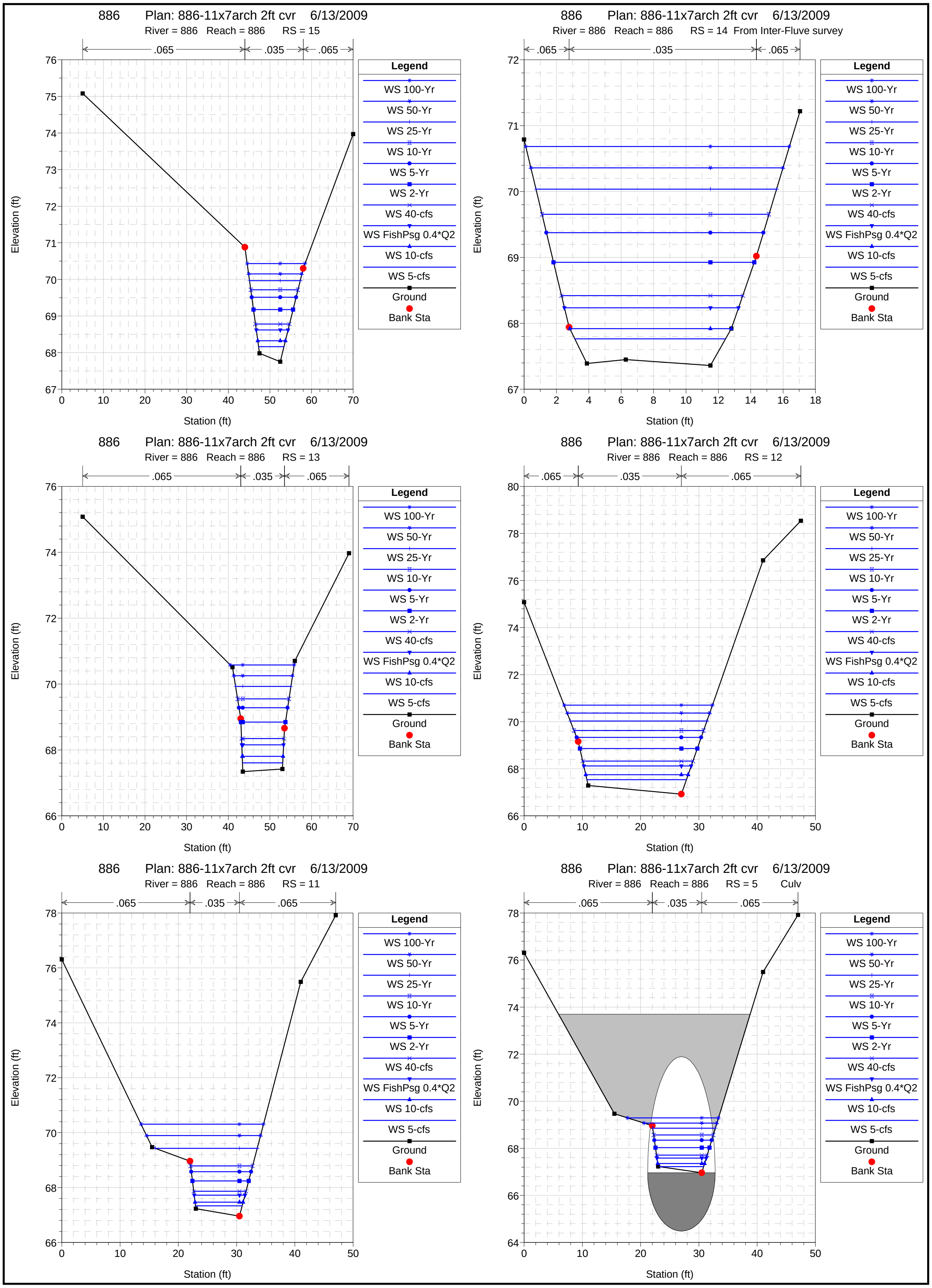
886 Plan: 886-Existing 6/16/2009
River = 886 Reach = 886 RS = 5 Culv
.035
.065
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS 40-cfs
WS FishPsg 0.4*Q2
WS 10-cfs
WS 5-cfs
Ground
Bank Sta

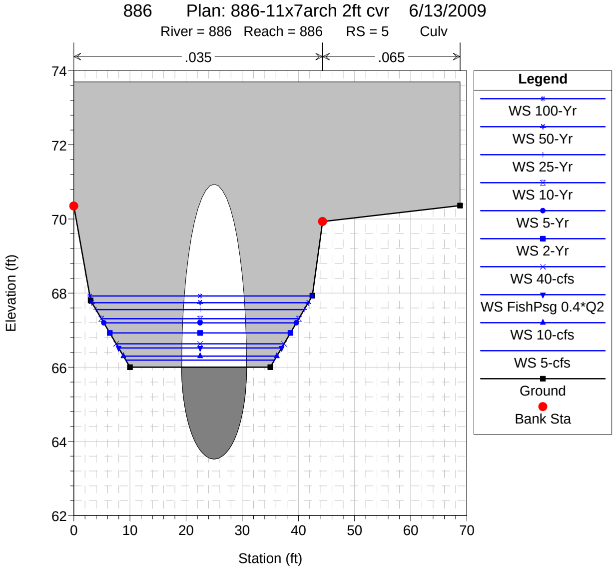


886 Plan: 886-Existing 6/16/2009
River = 886 Reach = 886 RS = 2 XS from DOT-TN road survey -
.035
.065
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS 40-cfs
WS FishPsg 0.4*Q2
WS 10-cfs
WS 5-cfs
Ground
Bank Sta

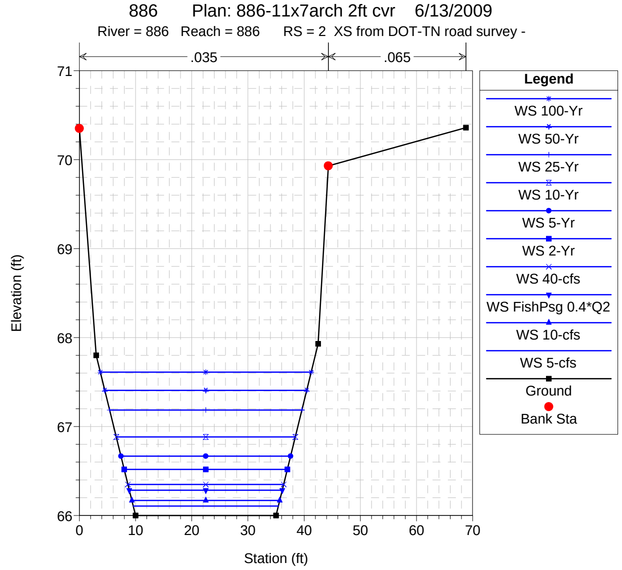


886 Plan: 886-Existing 6/16/2009
River = 886 Reach = 886 RS = 1
.035
.065
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS 40-cfs
WS FishPsg 0.4*Q2
WS 10-cfs
WS 5-cfs
Ground
Bank Sta

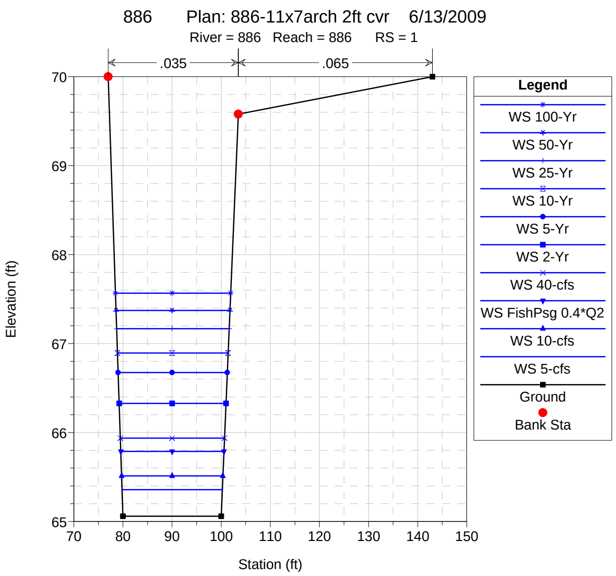

886 Plan: 886-11x7arch 2ft cvr 6/13/2009
River = 886 Reach = 886 RS = 15
886 Plan: 886-11x7arch 2ft cvr 6/13/2009
River = 886 Reach = 886 RS = 14 From Inter-Fluve survey
886 Plan: 886-11x7arch 2ft cvr 6/13/2009
River = 886 Reach = 886 RS = 13
886 Plan: 886-11x7arch 2ft cvr 6/13/2009
River = 886 Reach = 886 RS = 12
886 Plan: 886-11x7arch 2ft cvr 6/13/2009
River = 886 Reach = 886 RS = 11
886 Plan: 886-11x7arch 2ft cvr 6/13/2009
River = 886 Reach = 886 RS = 5 Culv
.065
.035
.065
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS 40-cfs
WS FishPsg 0.4*Q2
WS 10-cfs
WS 5-cfs
Ground
Bank Sta



886 Plan: 886-11x7arch 2ft cvr 6/13/2009
River = 886 Reach = 886 RS = 5 Culv
.035
.065
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS 40-cfs
WS FishPsg 0.4*Q2
WS 10-cfs
WS 5-cfs
Ground
Bank Sta



886 Plan: 886-11x7arch 2ft cvr 6/13/2009
River = 886 Reach = 886 RS = 2 XS from DOT-TN road survey -
.035
.065
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS 40-cfs
WS FishPsg 0.4*Q2
WS 10-cfs
WS 5-cfs
Ground
Bank Sta



886 Plan: 886-11x7arch 2ft cvr 6/13/2009
River = 886 Reach = 886 RS = 1
.035
.065
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS 40-cfs
WS FishPsg 0.4*Q2
WS 10-cfs
WS 5-cfs
Ground
Bank Sta

HEC-RAS River: 886 Reach: 886

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
886	1	5-cfs	886-11x7cvr	5.00		65.06	65.36	65.18	65.37	0.002001	0.30	0.29	0.83	6.01	20.41	20.41	0.27	0.04
886	1	5-cfs	886-Ex	5.00		65.06	65.36	65.18	65.37	0.002001	0.30	0.29	0.83	6.01	20.41	20.41	0.27	0.04
886	1	10-cfs	886-11x7cvr	10.00		65.06	65.51	65.26	65.53	0.002000	0.45	0.44	1.09	9.18	20.62	20.62	0.29	0.05
886	1	10-cfs	886-Ex	10.00		65.06	65.51	65.26	65.53	0.002000	0.45	0.44	1.09	9.18	20.62	20.62	0.29	0.05
886	1	FishPsg 0.4*Q2	886-11x7cvr	22.00		65.06	65.79	65.39	65.82	0.002002	0.73	0.71	1.48	14.91	21.00	21.00	0.31	0.09
886	1	FishPsg 0.4*Q2	886-Ex	22.00		65.06	65.79	65.39	65.82	0.002002	0.73	0.71	1.48	14.91	21.00	21.00	0.31	0.09
886	1	40-cfs	886-11x7cvr	30.00		65.06	65.94	65.47	65.98	0.002000	0.88	0.85	1.66	18.08	21.21	21.21	0.32	0.10
886	1	40-cfs	886-Ex	30.00		65.06	65.94	65.47	65.98	0.002000	0.88	0.85	1.66	18.08	21.21	21.21	0.32	0.10
886	1	2-Yr	886-11x7cvr	55.00		65.06	66.33	65.67	66.39	0.002001	1.27	1.22	2.08	26.45	21.75	21.75	0.33	0.14
886	1	2-Yr	886-Ex	55.00		65.06	66.33	65.67	66.39	0.002001	1.27	1.22	2.08	26.45	21.75	21.75	0.33	0.14
886	1	5-Yr	886-11x7cvr	82.00		65.06	66.68	65.86	66.76	0.002000	1.62	1.53	2.40	34.10	22.23	22.23	0.34	0.18
886	1	5-Yr	886-Ex	82.00		65.06	66.68	65.85	66.76	0.002000	1.62	1.53	2.40	34.10	22.23	22.23	0.34	0.18
886	1	10-Yr	886-11x7cvr	101.00		65.06	66.89	65.97	67.00	0.002001	1.83	1.73	2.59	38.98	22.53	22.53	0.35	0.20
886	1	10-Yr	886-Ex	101.00		65.06	66.89	65.97	67.00	0.002001	1.83	1.73	2.59	38.98	22.53	22.53	0.35	0.20
886	1	25-Yr	886-11x7cvr	127.00		65.06	67.17	66.12	67.29	0.002003	2.11	1.97	2.81	45.19	22.91	22.91	0.35	0.22
886	1	25-Yr	886-Ex	127.00		65.06	67.17	66.12	67.29	0.002003	2.11	1.97	2.81	45.19	22.91	22.91	0.35	0.22
886	1	50-Yr	886-11x7cvr	148.00		65.06	67.37	66.23	67.51	0.002000	2.31	2.15	2.96	49.95	23.20	23.20	0.36	0.24
886	1	50-Yr	886-Ex	148.00		65.06	67.37	66.23	67.51	0.002000	2.31	2.15	2.96	49.95	23.20	23.20	0.36	0.24
886	1	100-Yr	886-11x7cvr	169.00		65.06	67.57	66.34	67.72	0.002001	2.51	2.32	3.10	54.48	23.46	23.46	0.36	0.26
886	1	100-Yr	886-Ex	169.00		65.06	67.57	66.34	67.72	0.002001	2.51	2.32	3.10	54.48	23.46	23.46	0.36	0.26
886	2	5-cfs	886-11x7cvr	5.00	22.00	66.00	66.11	66.11	66.16	0.039151	0.11	0.10	1.86	2.69	25.82	25.82	1.01	0.25
886	2	5-cfs	886-Ex	5.00	22.00	66.00	66.11	66.11	66.16	0.039151	0.11	0.10	1.86	2.69	25.82	25.82	1.01	0.25
886	2	10-cfs	886-11x7cvr	10.00	22.00	66.00	66.17	66.17	66.25	0.032688	0.17	0.16	2.31	4.34	26.31	26.31	1.00	0.34
886	2	10-cfs	886-Ex	10.00	22.00	66.00	66.17	66.17	66.25	0.032688	0.17	0.16	2.31	4.34	26.31	26.31	1.00	0.34
886	2	FishPsg 0.4*Q2	886-11x7cvr	22.00	22.00	66.00	66.28	66.28	66.42	0.027783	0.28	0.27	2.97	7.41	27.21	27.21	1.00	0.47
886	2	FishPsg 0.4*Q2	886-Ex	22.00	22.00	66.00	66.28	66.28	66.42	0.027783	0.28	0.27	2.97	7.41	27.21	27.21	1.00	0.47
886	2	40-cfs	886-11x7cvr	30.00	22.00	66.00	66.35	66.35	66.51	0.025798	0.35	0.33	3.26	9.20	27.71	27.71	1.00	0.53
886	2	40-cfs	886-Ex	30.00	22.00	66.00	66.35	66.35	66.51	0.025798	0.35	0.33	3.26	9.20	27.71	27.71	1.00	0.53
886	2	2-Yr	886-11x7cvr	55.00	22.00	66.00	66.52	66.52	66.76	0.022852	0.52	0.48	3.93	13.99	29.03	29.03	1.00	0.68
886	2	2-Yr	886-Ex	55.00	22.00	66.00	66.52	66.52	66.76	0.022852	0.52	0.48	3.93	13.99	29.03	29.03	1.00	0.68
886	2	5-Yr	886-11x7cvr	82.00	22.00	66.00	66.67	66.67	66.98	0.021462	0.67	0.61	4.46	18.40	30.19	30.19	1.01	0.81
886	2	5-Yr	886-Ex	82.00	22.00	66.00	66.67	66.67	66.98	0.021462	0.67	0.61	4.46	18.40	30.19	30.19	1.01	0.81
886	2	10-Yr	886-11x7cvr	101.00	22.00	66.00	66.88		67.13	0.012450	0.88	0.79	4.02	25.11	31.87	31.87	0.80	0.61
886	2	10-Yr	886-Ex	101.00	22.00	66.00	66.88		67.13	0.012450	0.88	0.79	4.02	25.11	31.87	31.87	0.80	0.61
886	2	25-Yr	886-11x7cvr	127.00	22.00	66.00	67.19		67.39	0.007096	1.19	1.03	3.62	35.11	34.22	34.22	0.63	0.45
886	2	25-Yr	886-Ex	127.00	22.00	66.00	67.19		67.39	0.007095	1.19	1.03	3.62	35.11	34.22	34.22	0.63	0.45
886	2	50-Yr	886-11x7cvr	148.00	22.00	66.00	67.41		67.59	0.005304	1.41	1.19	3.45	42.85	35.93	35.93	0.56	0.39
886	2	50-Yr	886-Ex	148.00	22.00	66.00	67.41		67.59	0.005304	1.41	1.19	3.45	42.85	35.93	35.93	0.56	0.39
886	2	100-Yr	886-11x7cvr	169.00	22.00	66.00	67.61		67.79	0.004277	1.61	1.34	3.35	50.38	37.53	37.53	0.51	0.35
886	2	100-Yr	886-Ex	169.00	22.00	66.00	67.61		67.79	0.004277	1.61	1.34	3.35	50.38	37.53	37.53	0.51	0.35
886	5			Culvert														
886	11	5-cfs	886-11x7cvr	5.00	142.00	66.96	67.33	67.33	67.45	0.029368	0.37	0.24	2.76	1.86	8.02	7.56	1.00	0.43
886	11	5-cfs	886-Ex	5.00	142.00	66.96	68.24	67.33	68.25	0.000158	1.28	1.10	0.54	9.90	9.66	8.08	0.09	0.01
886	11	10-cfs	886-11x7cvr	10.00	142.00	66.96	67.47	67.47	67.65	0.026309	0.51	0.37	3.49	2.97	8.26	7.64	1.01	0.59
886	11	10-cfs	886-Ex	10.00	142.00	66.96	68.54	67.47	68.55	0.000293	1.58	1.37	0.85	12.84	10.20	8.26	0.13	0.02
886	11	FishPsg 0.4*Q2	886-11x7cvr	22.00	142.00	66.96	67.72	67.72	68.03	0.022368	0.76	0.61	4.48	5.15	8.73	7.79	1.01	0.83
886	11	FishPsg 0.4*Q2	886-Ex	22.00	142.00	66.96	69.10	67.72	69.13	0.000462	2.14	1.89	1.29	19.00	12.93	8.50	0.17	0.05
886	11	40-cfs	886-11x7cvr	30.00	142.00	66.96	67.87	67.87	68.24	0.021209	0.91	0.75	4.95	6.40	8.98	7.87	1.01	0.95
886	11	40-cfs	886-Ex	30.00	142.00	66.96	69.39	67.87	69.42	0.000525	2.43	2.17	1.51	23.24	16.91	8.50	0.18	0.06
886	11	2-Yr	886-11x7cvr	55.00	142.00	66.96	68.24	68.24	68.77	0.019210	1.28	1.10	5.97	9.88	9.66	8.08	1.01	1.23
886	11	2-Yr	886-Ex	55.00	142.00	66.96	70.23	68.24	70.28	0.000509	3.27	3.02	1.86	39.49	20.75	8.50	0.19	0.09
886	11	5-Yr	886-11x7cvr	82.00	142.00	66.96	68.58	68.58	69.25	0.018081	1.62	1.40	6.74	13.23	10.27	8.28	1.00	1.45
886	11	5-Yr	886-Ex	82.00	142.00	66.96	70.97	68.58	71.03	0.000481	4.01	3.76	2.09	55.80	23.34	8.50	0.19	0.10
886	11	10-Yr	886-11x7cvr	101.00	142.00	66.96	68.79	68.79	69.55	0.017541	1.83	1.59	7.17	15.45	10.65	8.40	1.00	1.58
886	11	10-Yr	886-Ex	101.00	142.00	66.96	71.45	68.79	71.51	0.000456	4.49	4.23	2.20	67.30	25.00	8.50	0.19	0.11
886	11	25-Yr	886-11x7cvr	127.00	142.00	66.96	69.43	69.05	70.00	0.008752	2.47	2.22	6.27	23.99	17.51	8.50	0.74	1.08
886	11	25-Yr	886-Ex	127.00	142.00	66.96	72.19	69.05	72.25	0.000379	5.23	4.98	2.24	86.96	27.61	8.50	0.18	0.11
886	11	50-Yr	886-11x7cvr	148.00	142.00	66.96	69.90	69.28	70.37	0.005801	2.94	2.68	5.80	32.73	19.58	8.50	0.62	0.87
886	11	50-Yr	886-Ex	148.00	142.00	66.96	72.71	69.28	72.77	0.000347	5.75	5.50	2.29	101.70	29.42	8.50	0.17	0.11
886	11	100-Yr	886-11x7cvr	169.00	142.00	66.96	70.31	69.53	70.72	0.004356	3.35	3.10	5.52	41.11	21.02	8.50	0.55	0.75
886	11	100-Yr	886-Ex	169.00	142.00	66.96	73.30	69.53	73.36	0.000301	6.34	6.09	2.28	119.69	31.49	8.50	0.16	0.10

HEC-RAS River: 886 Reach: 886 (Continued)

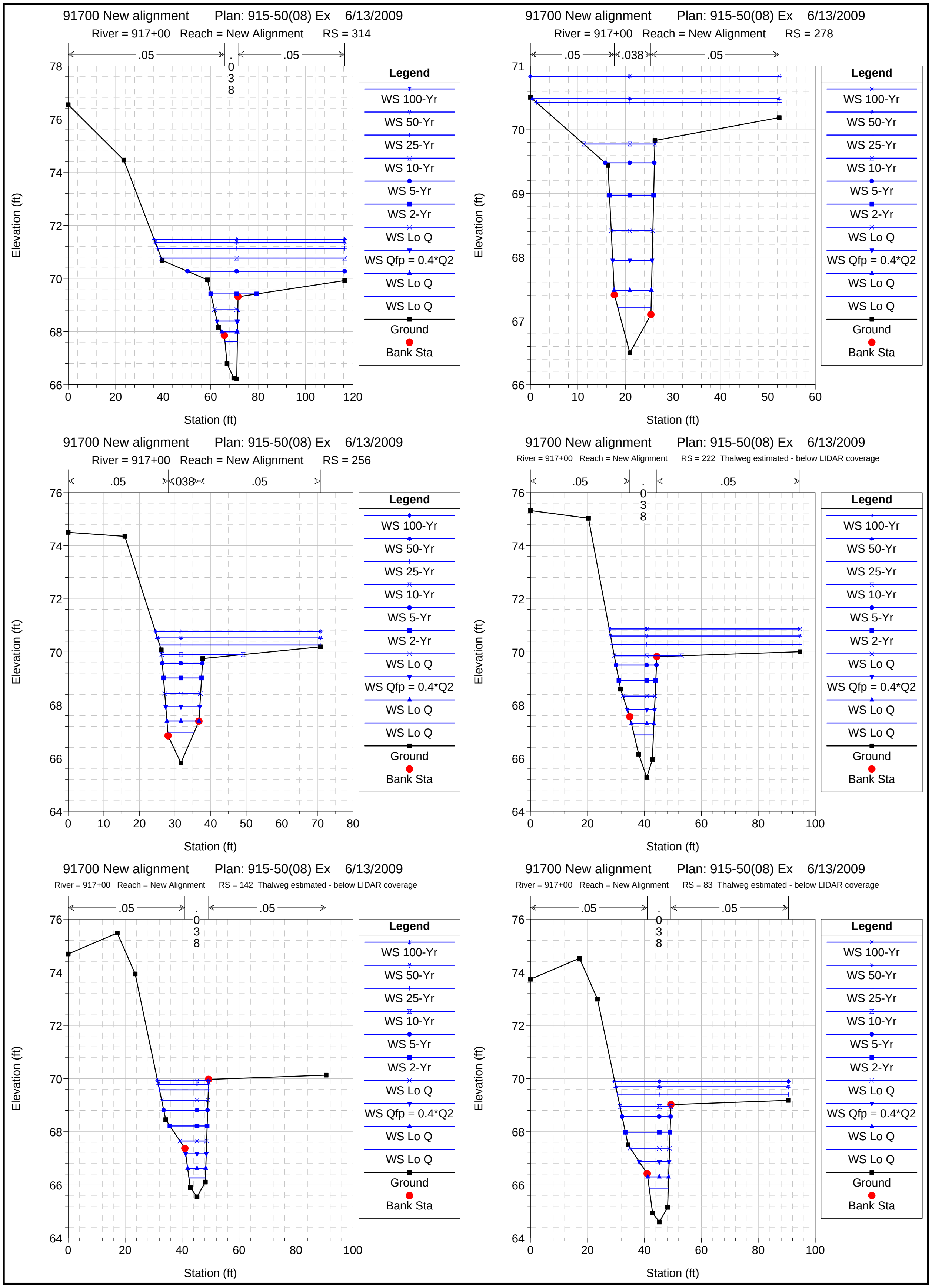
Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
886	12	5-cfs	886-11x7cvr	5.00	175.00	66.92	67.53		67.54	0.000894	0.61	0.43	0.71	7.16	17.09	16.22	0.19	0.02
886	12	5-cfs	886-Ex	5.00	175.00	66.92	68.25		68.25	0.000034	1.33	1.11	0.26	19.93	18.74	16.87	0.04	0.00
886	12	10-cfs	886-11x7cvr	10.00	175.00	66.92	67.75		67.76	0.000942	0.83	0.63	0.95	10.83	17.58	16.41	0.21	0.04
886	12	10-cfs	886-Ex	10.00	175.00	66.92	68.55		68.55	0.000062	1.63	1.39	0.41	25.72	19.44	17.15	0.06	0.01
886	12	FishPsg 0.4*Q2	886-11x7cvr	22.00	175.00	66.92	68.12		68.15	0.000984	1.20	0.99	1.30	17.56	18.44	16.75	0.23	0.06
886	12	FishPsg 0.4*Q2	886-Ex	22.00	175.00	66.92	69.13		69.13	0.000097	2.21	1.92	0.63	37.33	20.78	17.67	0.08	0.01
886	12	40-cfs	886-11x7cvr	30.00	175.00	66.92	68.33		68.36	0.000988	1.41	1.18	1.46	21.41	18.92	16.94	0.24	0.07
886	12	40-cfs	886-Ex	30.00	175.00	66.92	69.42		69.43	0.000112	2.50	2.21	0.74	43.53	21.63	17.70	0.09	0.01
886	12	2-Yr	886-11x7cvr	55.00	175.00	66.92	68.86		68.91	0.000983	1.94	1.67	1.83	31.84	20.16	17.43	0.25	0.10
886	12	2-Yr	886-Ex	55.00	175.00	66.92	70.27		70.29	0.000124	3.35	3.06	0.97	63.08	24.17	17.70	0.10	0.02
886	12	5-Yr	886-11x7cvr	82.00	175.00	66.92	69.33		69.40	0.000964	2.41	2.12	2.11	41.63	21.37	17.70	0.26	0.12
886	12	5-Yr	886-Ex	82.00	175.00	66.92	71.02		71.04	0.000130	4.10	3.81	1.14	81.91	26.39	17.70	0.10	0.03
886	12	10-Yr	886-11x7cvr	101.00	175.00	66.92	69.62		69.70	0.000944	2.70	2.41	2.27	48.01	22.24	17.70	0.26	0.14
886	12	10-Yr	886-Ex	101.00	175.00	66.92	71.50		71.52	0.000131	4.58	4.28	1.24	94.84	27.81	17.70	0.11	0.03
886	12	25-Yr	886-11x7cvr	127.00	175.00	66.92	70.03		70.12	0.000882	3.11	2.81	2.44	57.20	23.44	17.70	0.26	0.15
886	12	25-Yr	886-Ex	127.00	175.00	66.92	72.24		72.26	0.000118	5.32	5.03	1.31	116.34	30.03	17.70	0.10	0.04
886	12	50-Yr	886-11x7cvr	148.00	175.00	66.92	70.37		70.46	0.000811	3.45	3.15	2.52	65.31	24.45	17.70	0.25	0.15
886	12	50-Yr	886-Ex	148.00	175.00	66.92	72.75		72.78	0.000113	5.83	5.54	1.37	132.20	31.56	17.70	0.10	0.04
886	12	100-Yr	886-11x7cvr	169.00	175.00	66.92	70.70		70.80	0.000745	3.78	3.49	2.59	73.73	25.45	17.70	0.24	0.15
886	12	100-Yr	886-Ex	169.00	175.00	66.92	73.34		73.37	0.000103	6.42	6.13	1.40	151.24	33.31	17.70	0.10	0.04
886	13	5-cfs	886-11x7cvr	5.00	225.00	67.34	67.61		67.69	0.021920	0.27	0.23	2.28	2.19	9.66	9.66	0.85	0.30
886	13	5-cfs	886-Ex	5.00	225.00	67.34	68.25		68.25	0.000281	0.91	0.84	0.59	8.51	10.12	10.12	0.11	0.01
886	13	10-cfs	886-11x7cvr	10.00	225.00	67.34	67.81		67.90	0.011385	0.47	0.42	2.44	4.10	9.80	9.80	0.66	0.28
886	13	10-cfs	886-Ex	10.00	225.00	67.34	68.55		68.56	0.000430	1.21	1.12	0.86	11.61	10.33	10.33	0.14	0.03
886	13	FishPsg 0.4*Q2	886-11x7cvr	22.00	225.00	67.34	68.15		68.29	0.007869	0.81	0.75	2.91	7.56	10.05	10.05	0.59	0.33
886	13	FishPsg 0.4*Q2	886-Ex	22.00	225.00	67.34	69.12		69.15	0.000549	1.78	1.68	1.25	17.76	11.29	10.50	0.17	0.05
886	13	40-cfs	886-11x7cvr	30.00	225.00	67.34	68.35		68.50	0.007173	1.01	0.93	3.16	9.50	10.19	10.19	0.58	0.37
886	13	40-cfs	886-Ex	30.00	225.00	67.34	69.41		69.45	0.000597	2.07	1.97	1.45	21.13	12.02	10.50	0.18	0.06
886	13	2-Yr	886-11x7cvr	55.00	225.00	67.34	68.84		69.06	0.006245	1.50	1.40	3.75	14.69	10.69	10.47	0.56	0.46
886	13	2-Yr	886-Ex	55.00	225.00	67.34	70.26		70.31	0.000591	2.92	2.81	1.83	32.19	14.14	10.50	0.19	0.09
886	13	5-Yr	886-11x7cvr	82.00	225.00	67.34	69.28		69.56	0.005644	1.94	1.83	4.25	19.56	11.69	10.50	0.55	0.54
886	13	5-Yr	886-Ex	82.00	225.00	67.34	71.00		71.06	0.000584	3.66	3.55	2.12	44.20	20.02	10.50	0.20	0.11
886	13	10-Yr	886-11x7cvr	101.00	225.00	67.34	69.55		69.87	0.005389	2.21	2.10	4.55	22.80	12.36	10.50	0.55	0.59
886	13	10-Yr	886-Ex	101.00	225.00	67.34	71.47		71.55	0.000556	4.13	4.02	2.25	55.03	25.64	10.50	0.20	0.12
886	13	25-Yr	886-11x7cvr	127.00	225.00	67.34	69.93		70.28	0.004854	2.59	2.48	4.82	27.64	13.31	10.50	0.54	0.63
886	13	25-Yr	886-Ex	127.00	225.00	67.34	72.22		72.29	0.000446	4.88	4.77	2.26	77.44	34.48	10.50	0.18	0.11
886	13	50-Yr	886-11x7cvr	148.00	225.00	67.34	70.25		70.62	0.004315	2.91	2.80	4.93	32.09	14.12	10.50	0.52	0.63
886	13	50-Yr	886-Ex	148.00	225.00	67.34	72.73		72.80	0.000391	5.39	5.29	2.26	96.88	40.61	10.50	0.17	0.11
886	13	100-Yr	886-11x7cvr	169.00	225.00	67.34	70.58		70.96	0.003844	3.24	3.13	5.01	36.86	15.40	10.50	0.50	0.63
886	13	100-Yr	886-Ex	169.00	225.00	67.34	73.33		73.39	0.000317	5.99	5.88	2.19	122.99	47.63	10.50	0.16	0.10
886	14	5-cfs	886-11x7cvr	5.00	235.00	67.36	67.77	67.64	67.81	0.006837	0.41	0.33	1.64	3.04	9.32	9.32	0.51	0.14
886	14	5-cfs	886-Ex	5.00	235.00	67.36	68.25		68.26	0.000335	0.89	0.76	0.63	7.97	10.79	10.49	0.13	0.02
886	14	10-cfs	886-11x7cvr	10.00	235.00	67.36	67.92		67.99	0.008062	0.56	0.45	2.21	4.52	9.98	9.98	0.58	0.22
886	14	10-cfs	886-Ex	10.00	235.00	67.36	68.55		68.57	0.000451	1.19	1.02	0.89	11.37	11.52	10.92	0.16	0.03
886	14	FishPsg 0.4*Q2	886-11x7cvr	22.00	235.00	67.36	68.23		68.36	0.006916	0.87	0.74	2.83	7.81	10.76	10.47	0.58	0.31
886	14	FishPsg 0.4*Q2	886-Ex	22.00	235.00	67.36	69.13		69.15	0.000510	1.77	1.53	1.23	18.40	12.87	11.57	0.18	0.05
886	14	40-cfs	886-11x7cvr	30.00	235.00	67.36	68.42		68.57	0.006268	1.06	0.91	3.07	9.85	11.20	10.73	0.57	0.34
886	14	40-cfs	886-Ex	30.00	235.00	67.36	69.42		69.45	0.000527	2.06	1.82	1.41	22.24	13.51	11.57	0.18	0.06
886	14	2-Yr	886-11x7cvr	55.00	235.00	67.36	68.93		69.12	0.005084	1.57	1.34	3.56	15.80	12.40	11.44	0.54	0.41
886	14	2-Yr	886-Ex	55.00	235.00	67.36	70.27		70.32	0.000481	2.91	2.67	1.73	34.51	15.38	11.57	0.19	0.08
886	14	5-Yr	886-11x7cvr	82.00	235.00	67.36	69.38		69.61	0.004302	2.02	1.77	3.95	21.61	13.41	11.57	0.52	0.45
886	14	5-Yr	886-Ex	82.00	235.00	67.36	71.01		71.07	0.000459	3.65	3.41	1.99	46.47	16.79	11.57	0.19	0.09
886	14	10-Yr	886-11x7cvr	101.00	235.00	67.36	69.65		69.92	0.003982	2.29	2.05	4.18	25.43	14.02	11.57	0.51	0.49
886	14	10-Yr	886-Ex	101.00	235.00	67.36	71.48		71.55	0.000444	4.12	3.88	2.14	54.50	17.05	11.57	0.19	0.10
886	14	25-Yr	886-11x7cvr	127.00	235.00	67.36	70.04		70.33	0.003516	2.68	2.44	4.41	30.96	14.86	11.57	0.50	0.51
886	14	25-Yr	886-Ex	127.00	235.00	67.36	72.22		72.29	0.000385	4.86	4.62	2.24	67.04	17.05	11.57	0.18	0.11
886	14	50-Yr	886-11x7cvr	148.00	235.00	67.36	70.36		70.67	0.003115	3.00	2.76	4.51	35.87	15.57	11.57	0.48	0.51
886	14	50-Yr	886-Ex	148.00	235.00	67.36	72.73		72.81	0.000366	5.37	5.13	2.33	75.75	17.05	11.57	0.18	0.11
886	14	100-Yr	886-11x7cvr	169.00	235.00	67.36	70.68		71.00	0.002767	3.32	3.08	4.57	41.05	16.29	11.57	0.46	0.51
886	14	100-Yr	886-Ex	169.00	235.00	67.36	73.31		73.40	0.000331	5.95	5.71	2.39	85.70	17.05	11.57	0.18	0.11
886	15	5-cfs	886-11x7cvr	5.00	245.00	67.75	68.16	68.16	68.30	0.028205	0.41	0.28	2.97	1.68	6.11	6.11	1.00	0.47
886	15	5-cfs	886-Ex	5.00	245.00	67.75	68.19		68.30	0.020408	0.44	0.30	2.67	1.87	6.21	6.21	0.86	0.37

HEC-RAS River: 886 Reach: 886 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
886	15	10-cfs	886-11x7cvr	10.00	245.00	67.75	68.32	68.32	68.53	0.025769	0.57	0.41	3.67	2.73	6.66	6.66	1.01	0.63
886	15	10-cfs	886-Ex	10.00	245.00	67.75	68.51		68.60	0.008219	0.76	0.55	2.50	4.00	7.27	7.27	0.59	0.27
886	15	FishPsg 0.4*Q2	886-11x7cvr	22.00	245.00	67.75	68.62	68.62	68.94	0.022745	0.87	0.63	4.55	4.84	7.65	7.65	1.01	0.85
886	15	FishPsg 0.4*Q2	886-Ex	22.00	245.00	67.75	69.09		69.19	0.004044	1.34	0.96	2.49	8.82	9.24	9.24	0.45	0.22
886	15	40-cfs	886-11x7cvr	30.00	245.00	67.75	68.78	68.78	69.15	0.021587	1.03	0.75	4.92	6.10	8.18	8.18	1.00	0.94
886	15	40-cfs	886-Ex	30.00	245.00	67.75	69.38		69.49	0.003442	1.63	1.14	2.57	11.65	10.21	10.21	0.42	0.23
886	15	2-Yr	886-11x7cvr	55.00	245.00	67.75	69.17	69.17	69.68	0.019914	1.42	1.01	5.73	9.60	9.52	9.52	1.01	1.16
886	15	2-Yr	886-Ex	55.00	245.00	67.75	70.24		70.34	0.002087	2.49	1.65	2.54	21.67	13.10	13.10	0.35	0.20
886	15	5-Yr	886-11x7cvr	82.00	245.00	67.75	69.51	69.51	70.13	0.018987	1.76	1.22	6.31	12.99	10.65	10.65	1.01	1.33
886	15	5-Yr	886-Ex	82.00	245.00	67.75	70.99		71.09	0.001405	3.24	2.28	2.56	32.72	17.27	14.00	0.30	0.18
886	15	10-Yr	886-11x7cvr	101.00	245.00	67.75	69.72	69.72	70.40	0.018535	1.97	1.34	6.63	15.23	11.33	11.33	1.01	1.42
886	15	10-Yr	886-Ex	101.00	245.00	67.75	71.47		71.57	0.001102	3.72	2.75	2.58	42.39	23.26	14.00	0.27	0.17
886	15	25-Yr	886-11x7cvr	127.00	245.00	67.75	69.96	69.96	70.72	0.018044	2.21	1.49	6.99	18.16	12.17	12.17	1.01	1.53
886	15	25-Yr	886-Ex	127.00	245.00	67.75	72.21		72.30	0.000719	4.46	3.50	2.44	63.30	32.65	14.00	0.23	0.14
886	15	50-Yr	886-11x7cvr	148.00	245.00	67.75	70.15	70.15	70.96	0.017652	2.40	1.60	7.23	20.47	12.79	12.79	1.01	1.60
886	15	50-Yr	886-Ex	148.00	245.00	67.75	72.73		72.81	0.000567	4.98	4.02	2.38	81.98	39.18	14.00	0.21	0.13
886	15	100-Yr	886-11x7cvr	169.00	245.00	67.75	70.43	70.32	71.19	0.014188	2.68	1.80	6.98	24.23	13.89	13.46	0.92	1.44
886	15	100-Yr	886-Ex	169.00	245.00	67.75	73.33		73.40	0.000419	5.58	4.62	2.24	107.74	46.71	14.00	0.18	0.11

Tributary 887+60 HEC-RAS

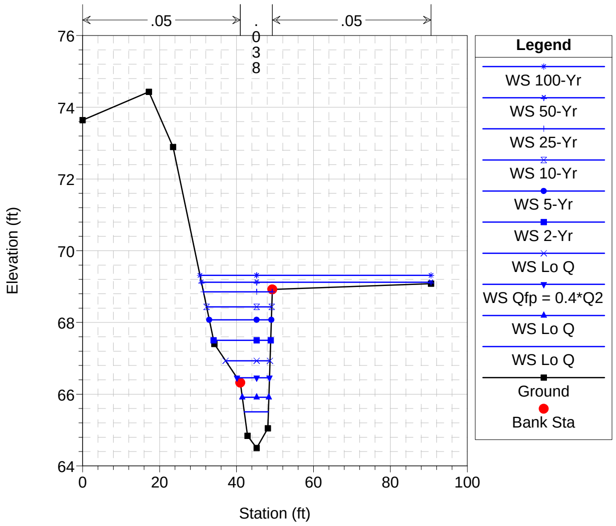
Companion 2006 Stream and Habitat Inventory (S&HI) station 917+00
Model based on ADOT&PF project datum

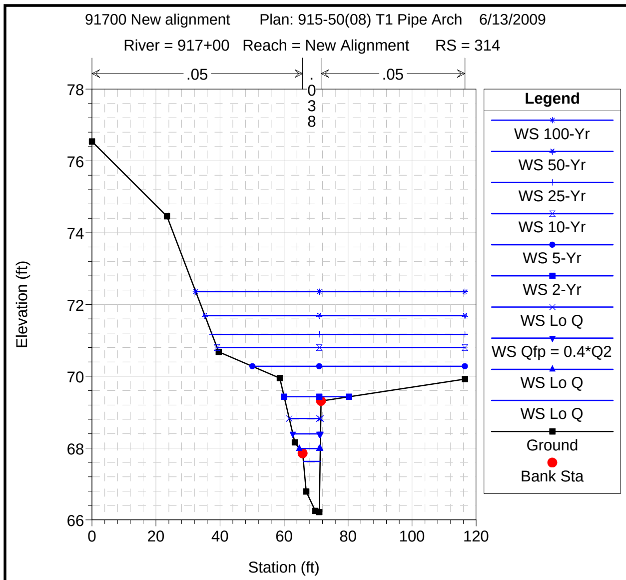


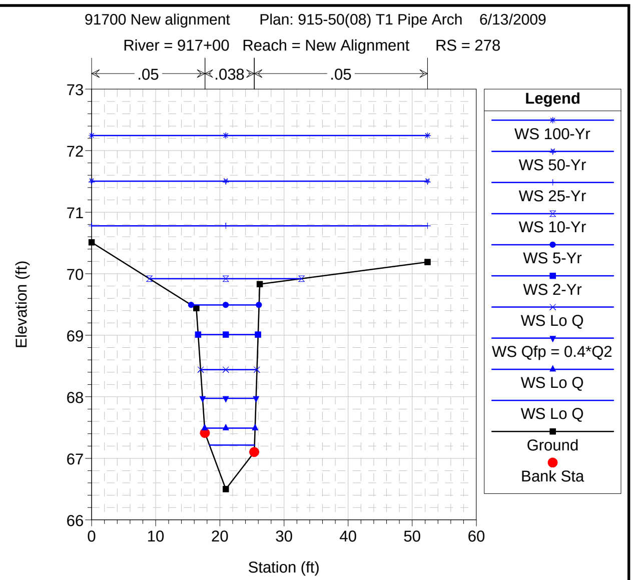
91700 New alignment Plan: 915-50(08) Ex 6/13/2009
River = 917+00 Reach = New Alignment RS = 314
91700 New alignment Plan: 915-50(08) Ex 6/13/2009
River = 917+00 Reach = New Alignment RS = 278
91700 New alignment Plan: 915-50(08) Ex 6/13/2009
River = 917+00 Reach = New Alignment RS = 256
91700 New alignment Plan: 915-50(08) Ex 6/13/2009
River = 917+00 Reach = New Alignment RS = 222 Thalweg estimated - below LIDAR coverage
91700 New alignment Plan: 915-50(08) Ex 6/13/2009
River = 917+00 Reach = New Alignment RS = 142 Thalweg estimated - below LIDAR coverage
91700 New alignment Plan: 915-50(08) Ex 6/13/2009
River = 917+00 Reach = New Alignment RS = 83 Thalweg estimated - below LIDAR coverage
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta
Elevation (ft)
Station (ft)

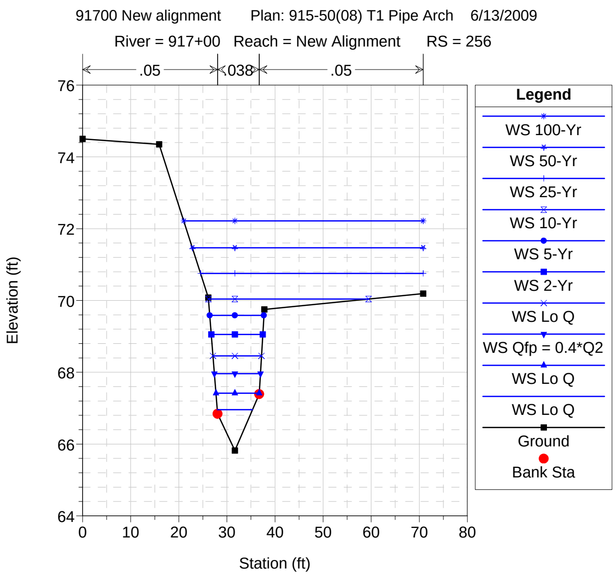
91700 New alignment Plan: 915-50(08) Ex 6/13/2009

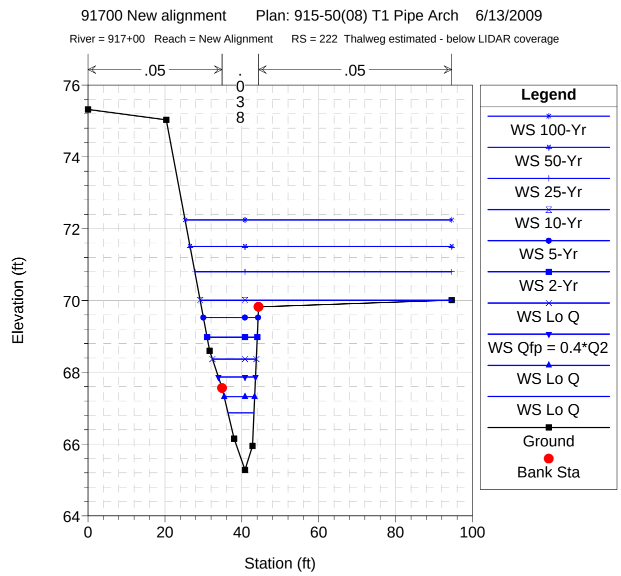
River = 917+00 Reach = New Alignment RS = 1 Thalweg estimated - below LIDAR coverage

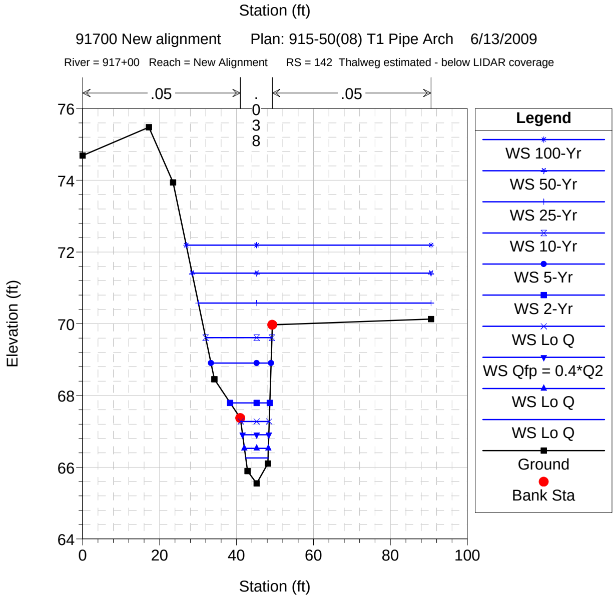


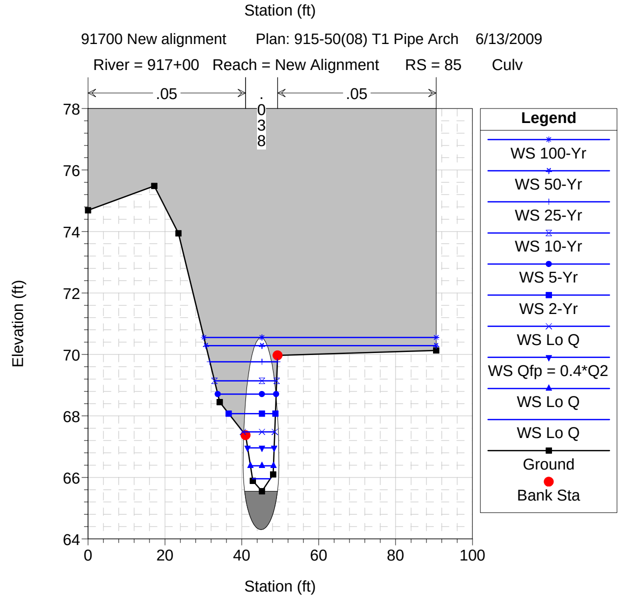

91700 New alignment Plan: 915-50(08) T1 Pipe Arch 6/13/2009
River = 917+00 Reach = New Alignment RS = 314
.05
.038
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta

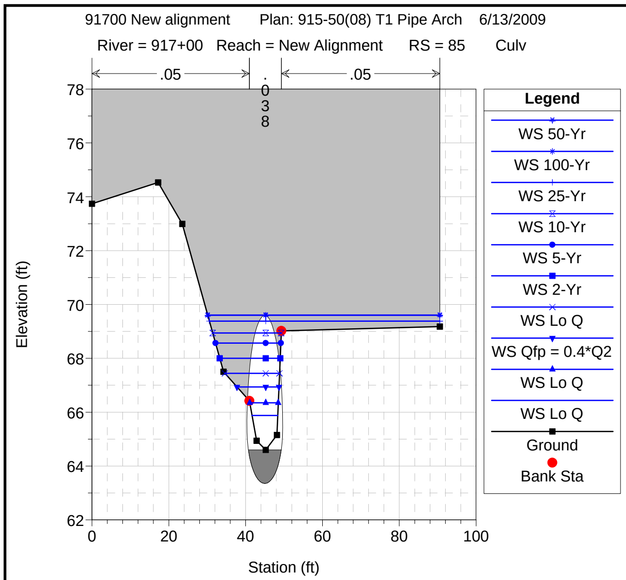

91700 New alignment Plan: 915-50(08) T1 Pipe Arch 6/13/2009
River = 917+00 Reach = New Alignment RS = 278
.05
.038
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta

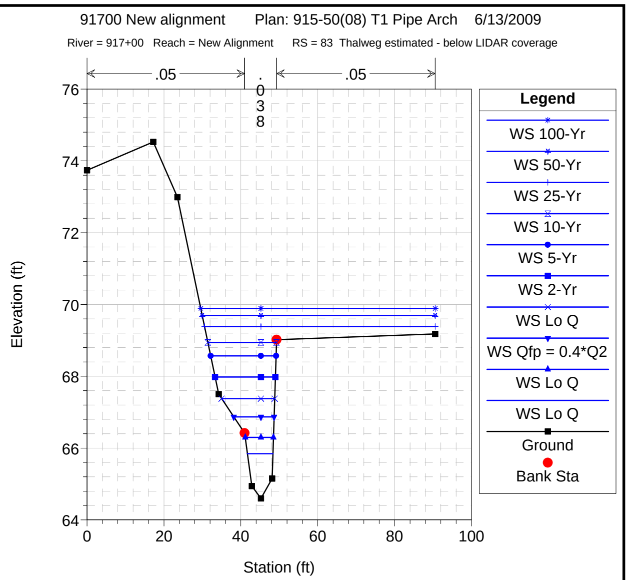

91700 New alignment Plan: 915-50(08) T1 Pipe Arch 6/13/2009
River = 917+00 Reach = New Alignment RS = 256
.05
.038
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta

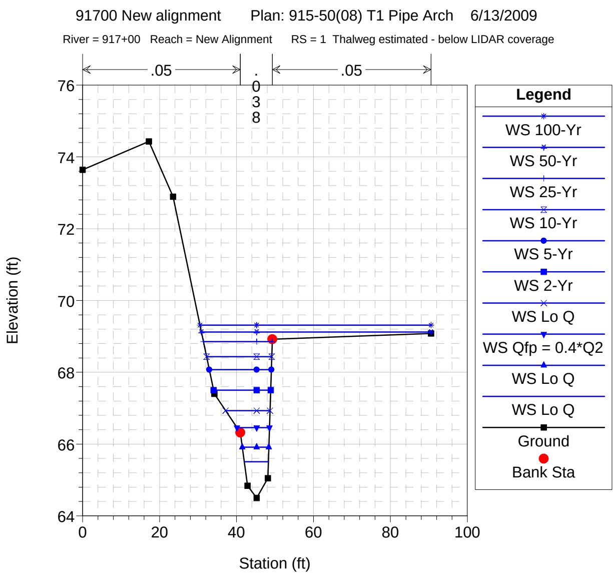

91700 New alignment Plan: 915-50(08) T1 Pipe Arch 6/13/2009
River = 917+00 Reach = New Alignment RS = 222 Thalweg estimated - below LIDAR coverage
.05
.038
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta


91700 New alignment Plan: 915-50(08) T1 Pipe Arch 6/13/2009
River = 917+00 Reach = New Alignment RS = 142 Thalweg estimated - below LIDAR coverage
.05
.038
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta


91700 New alignment Plan: 915-50(08) T1 Pipe Arch 6/13/2009
River = 917+00 Reach = New Alignment RS = 85 Culv
.05
.038
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta


91700 New alignment Plan: 915-50(08) T1 Pipe Arch 6/13/2009
River = 917+00 Reach = New Alignment RS = 85 Culv
.05
.038
.05
Elevation (ft)
Station (ft)
Legend
WS 50-Yr
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta


91700 New alignment Plan: 915-50(08) T1 Pipe Arch 6/13/2009
River = 917+00 Reach = New Alignment RS = 83 Thalweg estimated - below LIDAR coverage
.05
.038
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta


91700 New alignment Plan: 915-50(08) T1 Pipe Arch 6/13/2009
River = 917+00 Reach = New Alignment RS = 1 Thalweg estimated - below LIDAR coverage
.05
.038
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Lo Q
WS Qfp = 0.4*Q2
WS Lo Q
WS Lo Q
Ground
Bank Sta

HEC-RAS River: 917+00 Reach: New Alignment

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
New Alignment	1	Lo Q	915(08)-Ex	10.00		64.50	65.51	65.21	65.59	0.006004	1.01	0.71	2.25	4.44	6.27	6.27	0.47	0.24
New Alignment	1	Lo Q	915(08)-T1PA	10.00		64.50	65.51	65.21	65.59	0.006004	1.01	0.71	2.25	4.44	6.27	6.27	0.47	0.24
New Alignment	1	Lo Q	915(08)-Ex	20.00		64.50	65.92	65.47	66.04	0.006010	1.42	1.03	2.81	7.13	6.91	6.91	0.49	0.33
New Alignment	1	Lo Q	915(08)-T1PA	20.00		64.50	65.92	65.47	66.04	0.006010	1.42	1.03	2.81	7.13	6.91	6.91	0.49	0.33
New Alignment	1	Qfp = 0.4*Q2	915(08)-Ex	38.00		64.50	66.46	65.85	66.64	0.006001	1.96	1.46	3.43	11.15	8.44	7.59	0.50	0.45
New Alignment	1	Qfp = 0.4*Q2	915(08)-T1PA	38.00		64.50	66.46	65.85	66.64	0.006001	1.96	1.46	3.43	11.15	8.44	7.59	0.50	0.45
New Alignment	1	Lo Q	915(08)-Ex	60.00		64.50	66.93	66.23	67.17	0.006004	2.43	1.90	4.00	15.88	11.54	7.73	0.51	0.57
New Alignment	1	Lo Q	915(08)-T1PA	60.00		64.50	66.93	66.23	67.17	0.006004	2.43	1.90	4.00	15.88	11.54	7.73	0.51	0.57
New Alignment	1	2-Yr	915(08)-Ex	95.00		64.50	67.50	66.74	67.81	0.006001	3.00	2.43	4.58	23.50	14.84	7.90	0.52	0.70
New Alignment	1	2-Yr	915(08)-T1PA	95.00		64.50	67.50	66.74	67.81	0.006001	3.00	2.43	4.58	23.50	14.84	7.90	0.52	0.70
New Alignment	1	5-Yr	915(08)-Ex	141.00		64.50	68.07	67.32	68.43	0.006003	3.57	2.94	5.09	32.33	16.13	8.07	0.52	0.82
New Alignment	1	5-Yr	915(08)-T1PA	141.00		64.50	68.07	67.32	68.43	0.006003	3.57	2.94	5.09	32.33	16.13	8.07	0.52	0.82
New Alignment	1	10-Yr	915(08)-Ex	175.00		64.50	68.43	67.65	68.82	0.006001	3.93	3.26	5.37	38.33	16.94	8.18	0.52	0.89
New Alignment	1	10-Yr	915(08)-T1PA	175.00		64.50	68.43	67.65	68.82	0.006001	3.93	3.26	5.37	38.33	16.94	8.18	0.52	0.89
New Alignment	1	25-Yr	915(08)-Ex	219.00		64.50	68.85	67.96	69.28	0.006012	4.35	3.62	5.69	45.60	17.88	8.31	0.53	0.96
New Alignment	1	25-Yr	915(08)-T1PA	219.00		64.50	68.85	67.96	69.28	0.006012	4.35	3.62	5.69	45.60	17.88	8.31	0.53	0.96
New Alignment	1	50-Yr	915(08)-Ex	255.00		64.50	69.12	68.19	69.58	0.006007	4.62	3.89	5.94	55.57	59.67	8.33	0.53	1.03
New Alignment	1	50-Yr	915(08)-T1PA	255.00		64.50	69.12	68.19	69.58	0.006007	4.62	3.89	5.94	55.57	59.67	8.33	0.53	1.03
New Alignment	1	100-Yr	915(08)-Ex	291.00		64.50	69.31	68.40	69.77	0.006010	4.81	4.08	6.13	66.92	60.04	8.33	0.54	1.08
New Alignment	1	100-Yr	915(08)-T1PA	291.00		64.50	69.31	68.40	69.77	0.006010	4.81	4.08	6.13	66.92	60.04	8.33	0.54	1.08
New Alignment	83	Lo Q	915(08)-Ex	10.00	80.00	64.60	65.84		65.89	0.002521	1.24	0.90	1.68	5.96	6.64	6.64	0.31	0.12
New Alignment	83	Lo Q	915(08)-T1PA	10.00	80.00	64.60	65.84		65.89	0.002521	1.24	0.90	1.68	5.96	6.64	6.64	0.31	0.12
New Alignment	83	Lo Q	915(08)-Ex	20.00	80.00	64.60	66.30		66.37	0.002969	1.70	1.24	2.19	9.13	7.35	7.35	0.35	0.19
New Alignment	83	Lo Q	915(08)-T1PA	20.00	80.00	64.60	66.30		66.37	0.002969	1.70	1.24	2.19	9.13	7.35	7.35	0.35	0.19
New Alignment	83	Qfp = 0.4*Q2	915(08)-Ex	38.00	80.00	64.60	66.87		66.99	0.003222	2.27	1.75	2.79	14.10	10.48	7.68	0.37	0.28
New Alignment	83	Qfp = 0.4*Q2	915(08)-T1PA	38.00	80.00	64.60	66.87		66.99	0.003222	2.27	1.75	2.79	14.10	10.48	7.68	0.37	0.28
New Alignment	83	Lo Q	915(08)-Ex	60.00	80.00	64.60	67.38		67.54	0.003385	2.78	2.22	3.28	20.26	13.80	7.83	0.39	0.37
New Alignment	83	Lo Q	915(08)-T1PA	60.00	80.00	64.60	67.38		67.54	0.003385	2.78	2.22	3.28	20.26	13.80	7.83	0.39	0.37
New Alignment	83	2-Yr	915(08)-Ex	95.00	80.00	64.60	67.98		68.18	0.003503	3.38	2.77	3.76	29.26	15.69	8.02	0.40	0.45
New Alignment	83	2-Yr	915(08)-T1PA	95.00	80.00	64.60	67.98		68.18	0.003503	3.38	2.77	3.76	29.26	15.69	8.02	0.40	0.45
New Alignment	83	5-Yr	915(08)-Ex	141.00	80.00	64.60	68.57		68.81	0.003744	3.97	3.29	4.27	38.92	17.02	8.19	0.41	0.56
New Alignment	83	5-Yr	915(08)-T1PA	141.00	80.00	64.60	68.57		68.81	0.003744	3.97	3.29	4.27	38.92	17.02	8.19	0.41	0.56
New Alignment	83	10-Yr	915(08)-Ex	175.00	80.00	64.60	68.94		69.22	0.003879	4.34	3.62	4.56	45.41	17.86	8.31	0.42	0.62
New Alignment	83	10-Yr	915(08)-T1PA	175.00	80.00	64.60	68.94		69.22	0.003879	4.34	3.62	4.56	45.41	17.86	8.31	0.42	0.62
New Alignment	83	25-Yr	915(08)-Ex	219.00	80.00	64.60	69.38		69.66	0.003551	4.78	4.05	4.69	65.15	59.99	8.33	0.41	0.63
New Alignment	83	25-Yr	915(08)-T1PA	219.00	80.00	64.60	69.38		69.66	0.003551	4.78	4.05	4.69	65.14	59.99	8.33	0.41	0.63
New Alignment	83	50-Yr	915(08)-Ex	255.00	80.00	64.60	69.69		69.93	0.003090	5.09	4.35	4.60	83.69	60.59	8.33	0.39	0.59
New Alignment	83	50-Yr	915(08)-T1PA	255.00	80.00	64.60	69.69		69.93	0.003090	5.09	4.35	4.60	83.69	60.59	8.33	0.39	0.59
New Alignment	83	100-Yr	915(08)-Ex	291.00	80.00	64.60	69.89		70.13	0.003038	5.29	4.55	4.70	95.77	60.97	8.33	0.39	0.61
New Alignment	83	100-Yr	915(08)-T1PA	291.00	80.00	64.60	69.89		70.13	0.003038	5.29	4.55	4.70	95.77	60.97	8.33	0.39	0.61
New Alignment	142	Lo Q	915(08)-Ex	10.00	155.00	65.55	66.26	66.26	66.48	0.029765	0.71	0.45	3.83	2.61	5.80	5.80	1.00	0.79
New Alignment	142	Lo Q	915(08)-T1PA	10.00	155.00	65.55	66.26	66.26	66.48	0.029765	0.71	0.45	3.83	2.61	5.80	5.80	1.00	0.79
New Alignment	142	Lo Q	915(08)-Ex	20.00	155.00	65.55	66.62		66.89	0.018874	1.07	0.76	4.15	4.81	6.37	6.37	0.84	0.80
New Alignment	142	Lo Q	915(08)-T1PA	20.00	155.00	65.55	66.52	66.52	66.87	0.027676	0.97	0.68	4.73	4.23	6.22	6.22	1.01	1.07
New Alignment	142	Qfp = 0.4*Q2	915(08)-Ex	38.00	155.00	65.55	67.17		67.47	0.012854	1.62	1.18	4.44	8.56	7.23	7.23	0.72	0.80
New Alignment	142	Qfp = 0.4*Q2	915(08)-T1PA	38.00	155.00	65.55	66.90	66.90	67.40	0.026031	1.35	0.98	5.68	6.69	6.81	6.81	1.01	1.39
New Alignment	142	Lo Q	915(08)-Ex	60.00	155.00	65.55	67.65		68.02	0.011162	2.10	1.59	4.92	12.40	9.37	7.63	0.69	0.90
New Alignment	142	Lo Q	915(08)-T1PA	60.00	155.00	65.55	67.27	67.27	67.92	0.025040	1.72	1.26	6.43	9.34	7.39	7.39	1.01	1.65
New Alignment	142	2-Yr	915(08)-Ex	95.00	155.00	65.55	68.21		68.67	0.010158	2.66	2.12	5.52	18.75	13.07	7.80	0.67	1.05
New Alignment	142	2-Yr	915(08)-T1PA	95.00	155.00	65.55	67.79	67.79	68.57	0.021166	2.24	1.73	7.10	13.82	10.31	7.67	0.95	1.84
New Alignment	142	5-Yr	915(08)-Ex	141.00	155.00	65.55	68.81		69.31	0.009080	3.26	2.66	5.93	27.41	15.42	7.98	0.64	1.14
New Alignment	142	5-Yr	915(08)-T1PA	141.00	155.00	65.55	68.90	68.37	69.35	0.008012	3.35	2.74	5.66	28.82	15.63	8.01	0.60	1.03
New Alignment	142	10-Yr	915(08)-Ex	175.00	155.00	65.55	69.19		69.70	0.008511	3.64	3.00	6.12	33.41	16.28	8.09	0.62	1.17
New Alignment	142	10-Yr	915(08)-T1PA	175.00	155.00	65.55	69.61	68.70	69.96	0.005209	4.06	3.37	5.10	40.50	17.23	8.22	0.49	0.79
New Alignment	142	25-Yr	915(08)-Ex	219.00	155.00	65.55	69.57		70.13	0.008498	4.02	3.34	6.48	39.86	17.15	8.21	0.62	1.28
New Alignment	142	25-Yr	915(08)-T1PA	219.00	155.00	65.55	70.58	69.01	70.77	0.002501	5.03	4.29	4.09	79.78	60.46	8.33	0.35	0.47
New Alignment	142	50-Yr	915(08)-Ex	255.00	155.00	65.55	69.79	69.24	70.42	0.009165	4.24	3.53	6.92	43.57	17.63	8.27	0.65	1.44
New Alignment	142	50-Yr	915(08)-T1PA	255.00	155.00	65.55	71.41	69.24	71.50	0.001111	5.86	5.12	3.07	130.84	62.09	8.33	0.24	0.25
New Alignment	142	100-Yr	915(08)-Ex	291.00	155.00	65.55	69.93		70.66	0.010367	4.38	3.64	7.49	46.02	17.94	8.32	0.69	1.67
New Alignment	142	100-Yr	915(08)-T1PA	291.00	155.00	65.55	72.19	69.45	72.25	0.000615	6.64	5.91	2.51	180.05	63.62	8.33	0.18	0.16
New Alignment	222	Lo Q	915(08)-Ex	10.00	235.00	65.28	66.87		66.91	0.001997	1.59	0.96	1.55	6.47	6.75	6.75	0.28	0.10

HEC-RAS River: 917+00 Reach: New Alignment (Continued)

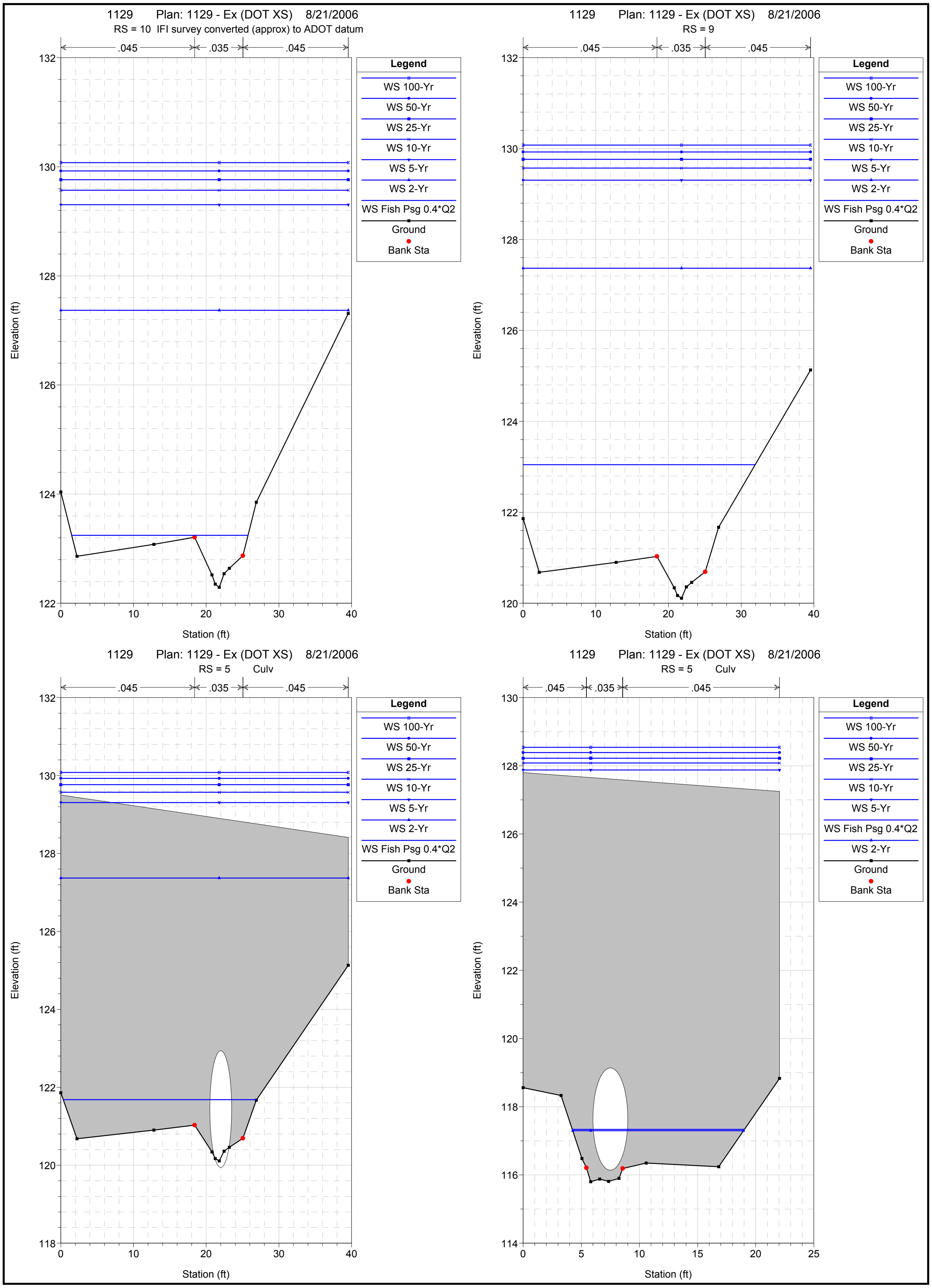
Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
New Alignment	222	Lo Q	915(08)-T1PA	10.00	235.00	65.28	66.87		66.91	0.002009	1.59	0.96	1.55	6.45	6.75	6.75	0.28	0.10
New Alignment	222	Lo Q	915(08)-Ex	20.00	235.00	65.28	67.30		67.37	0.002723	2.02	1.22	2.09	9.59	7.88	7.88	0.33	0.18
New Alignment	222	Lo Q	915(08)-T1PA	20.00	235.00	65.28	67.32		67.39	0.002590	2.04	1.23	2.05	9.77	7.94	7.94	0.33	0.17
New Alignment	222	Qfp = 0.4*Q2	915(08)-Ex	38.00	235.00	65.28	67.84		67.95	0.003184	2.56	1.63	2.69	14.23	9.54	8.68	0.37	0.27
New Alignment	222	Qfp = 0.4*Q2	915(08)-T1PA	38.00	235.00	65.28	67.87		67.98	0.002989	2.59	1.66	2.63	14.55	9.65	8.69	0.36	0.26
New Alignment	222	Lo Q	915(08)-Ex	60.00	235.00	65.28	68.34		68.49	0.003354	3.06	2.08	3.20	19.44	11.30	8.88	0.39	0.35
New Alignment	222	Lo Q	915(08)-T1PA	60.00	235.00	65.28	68.37		68.52	0.003191	3.09	2.11	3.14	19.81	11.41	8.90	0.38	0.34
New Alignment	222	2-Yr	915(08)-Ex	95.00	235.00	65.28	68.93		69.15	0.003643	3.65	2.62	3.80	26.77	12.95	9.13	0.41	0.47
New Alignment	222	2-Yr	915(08)-T1PA	95.00	235.00	65.28	68.98		69.19	0.003449	3.70	2.66	3.73	27.34	13.05	9.15	0.40	0.45
New Alignment	222	5-Yr	915(08)-Ex	141.00	235.00	65.28	69.51		69.80	0.004142	4.23	3.12	4.48	34.52	14.19	9.36	0.45	0.61
New Alignment	222	5-Yr	915(08)-T1PA	141.00	235.00	65.28	69.52		69.81	0.004076	4.24	3.13	4.45	34.73	14.22	9.37	0.44	0.61
New Alignment	222	10-Yr	915(08)-Ex	175.00	235.00	65.28	69.85		70.20	0.004462	4.57	3.42	4.90	39.72	23.68	9.49	0.47	0.72
New Alignment	222	10-Yr	915(08)-T1PA	175.00	235.00	65.28	70.01		70.31	0.003702	4.73	3.58	4.60	46.75	65.43	9.49	0.43	0.62
New Alignment	222	25-Yr	915(08)-Ex	219.00	235.00	65.28	70.28	68.97	70.60	0.003828	5.00	3.85	4.91	64.60	65.91	9.49	0.44	0.69
New Alignment	222	25-Yr	915(08)-T1PA	219.00	235.00	65.28	70.80		70.94	0.001694	5.52	4.37	3.55	98.85	66.81	9.49	0.30	0.35
New Alignment	222	50-Yr	915(08)-Ex	255.00	235.00	65.28	70.60		70.86	0.003131	5.32	4.16	4.68	85.47	66.46	9.49	0.40	0.61
New Alignment	222	50-Yr	915(08)-T1PA	255.00	235.00	65.28	71.50		71.58	0.000873	6.22	5.07	2.82	146.45	68.05	9.49	0.22	0.21
New Alignment	222	100-Yr	915(08)-Ex	291.00	235.00	65.28	70.87		71.09	0.002701	5.59	4.43	4.53	103.40	66.93	9.49	0.38	0.56
New Alignment	222	100-Yr	915(08)-T1PA	291.00	235.00	65.28	72.24		72.29	0.000500	6.96	5.81	2.34	197.31	69.34	9.49	0.17	0.14
New Alignment	256	Lo Q	915(08)-Ex	10.00	269.00	65.82	66.96		67.04	0.007293	1.14	0.60	2.30	4.34	7.33	7.26	0.53	0.26
New Alignment	256	Lo Q	915(08)-T1PA	10.00	269.00	65.82	66.96		67.04	0.007348	1.14	0.60	2.31	4.33	7.33	7.26	0.53	0.26
New Alignment	256	Lo Q	915(08)-Ex	20.00	269.00	65.82	67.40		67.50	0.005063	1.58	0.91	2.54	7.96	8.99	8.66	0.47	0.28
New Alignment	256	Lo Q	915(08)-T1PA	20.00	269.00	65.82	67.42		67.51	0.004762	1.60	0.93	2.49	8.11	9.01	8.66	0.46	0.26
New Alignment	256	Qfp = 0.4*Q2	915(08)-Ex	38.00	269.00	65.82	67.93		68.07	0.003858	2.11	1.44	3.01	12.92	9.55	8.66	0.44	0.33
New Alignment	256	Qfp = 0.4*Q2	915(08)-T1PA	38.00	269.00	65.82	67.96		68.10	0.003631	2.14	1.47	2.96	13.17	9.57	8.66	0.43	0.32
New Alignment	256	Lo Q	915(08)-Ex	60.00	269.00	65.82	68.43		68.62	0.003554	2.61	1.94	3.52	17.77	10.06	8.66	0.45	0.41
New Alignment	256	Lo Q	915(08)-T1PA	60.00	269.00	65.82	68.46		68.64	0.003392	2.64	1.97	3.47	18.04	10.09	8.66	0.44	0.40
New Alignment	256	2-Yr	915(08)-Ex	95.00	269.00	65.82	69.02		69.29	0.003618	3.20	2.53	4.24	23.87	10.67	8.66	0.47	0.55
New Alignment	256	2-Yr	915(08)-T1PA	95.00	269.00	65.82	69.06		69.32	0.003442	3.24	2.56	4.18	24.27	10.71	8.66	0.46	0.53
New Alignment	256	5-Yr	915(08)-Ex	141.00	269.00	65.82	69.57		69.97	0.004041	3.75	3.08	5.12	29.96	11.24	8.66	0.51	0.74
New Alignment	256	5-Yr	915(08)-T1PA	141.00	269.00	65.82	69.59		69.98	0.003984	3.77	3.10	5.09	30.10	11.26	8.66	0.51	0.74
New Alignment	256	10-Yr	915(08)-Ex	175.00	269.00	65.82	69.90		70.39	0.004421	4.08	3.41	5.72	34.55	22.88	8.66	0.55	0.90
New Alignment	256	10-Yr	915(08)-T1PA	175.00	269.00	65.82	70.04		70.48	0.003796	4.22	3.55	5.45	38.42	33.29	8.66	0.51	0.81
New Alignment	256	25-Yr	915(08)-Ex	219.00	269.00	65.82	70.26		70.81	0.004550	4.44	3.77	6.21	47.36	45.09	8.66	0.56	1.03
New Alignment	256	25-Yr	915(08)-T1PA	219.00	269.00	65.82	70.76		71.05	0.002329	4.94	4.26	4.82	70.11	46.28	8.66	0.41	0.59
New Alignment	256	50-Yr	915(08)-Ex	255.00	269.00	65.82	70.53		71.07	0.004278	4.71	4.04	6.30	59.65	45.73	8.66	0.55	1.03
New Alignment	256	50-Yr	915(08)-T1PA	255.00	269.00	65.82	71.47		71.65	0.001325	5.65	4.98	4.03	103.70	47.99	8.66	0.32	0.39
New Alignment	256	100-Yr	915(08)-Ex	291.00	269.00	65.82	70.78		71.29	0.003999	4.96	4.29	6.34	71.09	46.33	8.66	0.54	1.02
New Alignment	256	100-Yr	915(08)-T1PA	291.00	269.00	65.82	72.22		72.34	0.000804	6.40	5.73	3.45	140.27	49.78	8.66	0.25	0.28
New Alignment	278	Lo Q	915(08)-Ex	10.00	291.00	66.50	67.22	67.22	67.42	0.030409	0.72	0.39	3.62	2.76	7.03	6.99	1.02	0.74
New Alignment	278	Lo Q	915(08)-T1PA	10.00	291.00	66.50	67.22	67.22	67.42	0.030409	0.72	0.39	3.62	2.76	7.03	6.99	1.02	0.74
New Alignment	278	Lo Q	915(08)-Ex	20.00	291.00	66.50	67.48	67.45	67.76	0.022808	0.98	0.62	4.22	4.76	7.85	7.68	0.95	0.86
New Alignment	278	Lo Q	915(08)-T1PA	20.00	291.00	66.50	67.49	67.45	67.76	0.021823	0.99	0.63	4.16	4.83	7.86	7.68	0.93	0.83
New Alignment	278	Qfp = 0.4*Q2	915(08)-Ex	38.00	291.00	66.50	67.95		68.27	0.012413	1.45	1.09	4.54	8.55	8.30	7.68	0.77	0.82
New Alignment	278	Qfp = 0.4*Q2	915(08)-T1PA	38.00	291.00	66.50	67.97		68.28	0.011562	1.47	1.11	4.44	8.74	8.33	7.68	0.74	0.78
New Alignment	278	Lo Q	915(08)-Ex	60.00	291.00	66.50	68.42		68.80	0.009317	1.92	1.55	4.98	12.51	8.76	7.68	0.71	0.88
New Alignment	278	Lo Q	915(08)-T1PA	60.00	291.00	66.50	68.44		68.81	0.008801	1.94	1.58	4.90	12.74	8.78	7.68	0.69	0.85
New Alignment	278	2-Yr	915(08)-Ex	95.00	291.00	66.50	68.97		69.48	0.008257	2.47	2.11	5.76	17.53	9.30	7.68	0.70	1.06
New Alignment	278	2-Yr	915(08)-T1PA	95.00	291.00	66.50	69.01		69.50	0.007766	2.51	2.14	5.65	17.89	9.34	7.68	0.68	1.02
New Alignment	278	5-Yr	915(08)-Ex	141.00	291.00	66.50	69.48		70.19	0.008750	2.98	2.61	6.84	22.39	10.37	7.68	0.75	1.40
New Alignment	278	5-Yr	915(08)-T1PA	141.00	291.00	66.50	69.49		70.19	0.008612	2.99	2.63	6.81	22.53	10.57	7.68	0.74	1.38
New Alignment	278	10-Yr	915(08)-Ex	175.00	291.00	66.50	69.78	69.35	70.64	0.009309	3.28	2.91	7.58	26.14	14.98	7.68	0.78	1.66
New Alignment	278	10-Yr	915(08)-T1PA	175.00	291.00	66.50	69.92	69.35	70.69	0.007839	3.42	3.05	7.18	28.76	23.72	7.68	0.72	1.46
New Alignment	278	25-Yr	915(08)-Ex	219.00	291.00	66.50	70.43	70.43	71.05	0.005779	3.93	3.56	6.83	50.06	51.12	7.68	0.64	1.26
New Alignment	278	25-Yr	915(08)-T1PA	219.00	291.00	66.50	70.78		71.13	0.003239	4.28	3.91	5.45	68.36	52.39	7.68	0.49	0.77
New Alignment	278	50-Yr	915(08)-Ex	255.00	291.00	66.50	70.49		71.26	0.007098	3.99	3.62	7.66	53.19	52.04	7.68	0.71	1.57
New Alignment	278	50-Yr	915(08)-T1PA	255.00	291.00	66.50	71.50		71.68	0.001554	5.00	4.64	4.23	106.42	52.39	7.68	0.35	0.44
New Alignment	278	100-Yr	915(08)-Ex	291.00	291.00	66.50	70.84		71.40	0.005205	4.34	3.97	6.97	71.46	52.39	7.68	0.62	1.26
New Alignment	278	100-Yr	915(08)-T1PA	291.00	291.00	66.50	72.25		72.36	0.000878	5.75	5.38	3.51	145.31	52.39	7.68	0.27	0.29
New Alignment	314	Lo Q	915(08)-Ex	10.00	327.00	66.22	67.63		67.68	0.002958	1.41	1.05	1.84	5.45	5.21	5.21	0.32	0.15
New Alignment	314	Lo Q	915(08)-T1PA	10.00	327.00	66.22	67.63		67.68	0.002958	1.41	1.05	1.84	5.45	5.21	5.21	0.32	0.15

HEC-RAS   River: 917+00   Reach: New Alignment (Continued)

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
New Alignment	314	Lo Q	915(08)-Ex	20.00	327.00	66.22	67.99		68.10	0.004850	1.77	1.35	2.70	7.47	6.60	5.49	0.41	0.30
New Alignment	314	Lo Q	915(08)-T1PA	20.00	327.00	66.22	67.99		68.10	0.004887	1.77	1.34	2.71	7.44	6.58	5.49	0.41	0.30
New Alignment	314	Qfp = 0.4*Q2	915(08)-Ex	38.00	327.00	66.22	68.40		68.61	0.007269	2.18	1.73	3.81	10.68	8.66	5.56	0.51	0.55
New Alignment	314	Qfp = 0.4*Q2	915(08)-T1PA	38.00	327.00	66.22	68.39		68.61	0.007296	2.17	1.73	3.82	10.66	8.66	5.56	0.51	0.56
New Alignment	314	Lo Q	915(08)-Ex	60.00	327.00	66.22	68.82		69.12	0.008396	2.60	2.13	4.58	14.60	9.84	5.64	0.55	0.76
New Alignment	314	Lo Q	915(08)-T1PA	60.00	327.00	66.22	68.82		69.13	0.008347	2.60	2.13	4.57	14.64	9.85	5.64	0.55	0.75
New Alignment	314	2-Yr	915(08)-Ex	95.00	327.00	66.22	69.42		69.79	0.008450	3.20	2.69	5.22	21.40	19.38	5.72	0.56	0.92
New Alignment	314	2-Yr	915(08)-T1PA	95.00	327.00	66.22	69.43		69.80	0.008298	3.21	2.71	5.18	21.63	20.26	5.72	0.56	0.91
New Alignment	314	5-Yr	915(08)-Ex	141.00	327.00	66.22	70.27	69.32	70.43	0.003558	4.05	3.55	4.07	62.41	66.22	5.72	0.38	0.51
New Alignment	314	5-Yr	915(08)-T1PA	141.00	327.00	66.22	70.28	69.32	70.44	0.003514	4.06	3.55	4.05	62.79	66.36	5.72	0.38	0.51
New Alignment	314	10-Yr	915(08)-Ex	175.00	327.00	66.22	70.76		70.85	0.001906	4.54	4.04	3.25	98.06	77.27	5.72	0.28	0.31
New Alignment	314	10-Yr	915(08)-T1PA	175.00	327.00	66.22	70.80		70.88	0.001766	4.58	4.08	3.14	100.89	77.43	5.72	0.27	0.29
New Alignment	314	25-Yr	915(08)-Ex	219.00	327.00	66.22	71.13		71.20	0.001470	4.91	4.41	3.02	126.76	78.85	5.72	0.25	0.26
New Alignment	314	25-Yr	915(08)-T1PA	219.00	327.00	66.22	71.17		71.23	0.001382	4.95	4.44	2.94	129.55	79.00	5.72	0.25	0.25
New Alignment	314	50-Yr	915(08)-Ex	255.00	327.00	66.22	71.35		71.42	0.001370	5.13	4.63	3.01	144.46	79.80	5.72	0.25	0.26
New Alignment	314	50-Yr	915(08)-T1PA	255.00	327.00	66.22	71.69		71.73	0.000830	5.47	4.97	2.46	171.56	81.24	5.72	0.19	0.17
New Alignment	314	100-Yr	915(08)-Ex	291.00	327.00	66.22	71.47		71.54	0.001492	5.25	4.74	3.20	153.66	80.29	5.72	0.26	0.29
New Alignment	314	100-Yr	915(08)-T1PA	291.00	327.00	66.22	72.36		72.39	0.000473	6.14	5.63	2.02	226.68	84.10	5.72	0.15	0.11

Tributary 1102+19 HEC-RAS

Companion 2006 Stream and Habitat Inventory (S&HI) station 1123+25
Model based on ADOT&PF project datum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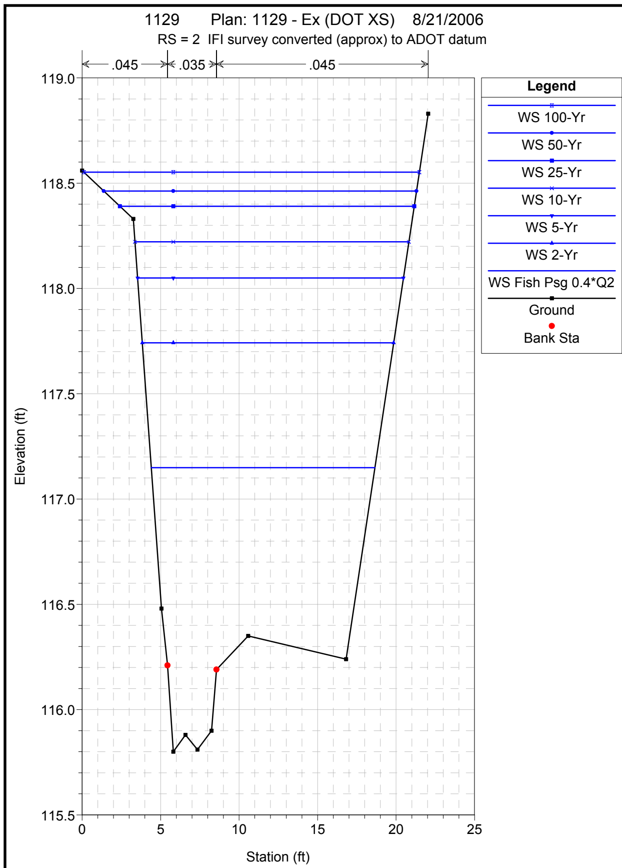
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish Psg 0.4*Q2
Ground
Bank Sta
Elevation (ft)
Station (ft)
1129 Plan: 1129 - Ex (DOT XS) 8/21/2006
RS = 9
Elevation (ft)
Station (ft)
1129 Plan: 1129 - Ex (DOT XS) 8/21/2006
RS = 5 Culv
Elevation (ft)
Station (ft)
1129 Plan: 1129 - Ex (DOT XS) 8/21/2006
RS = 5 Culv
Elevation (ft)
Station (ft)



1129 Plan: 1129 - Ex (DOT XS) 8/21/2006
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.045
Legend
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WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish Psg 0.4*Q2
Ground
Bank Sta
Elevation (ft)
Station (ft)
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15
20
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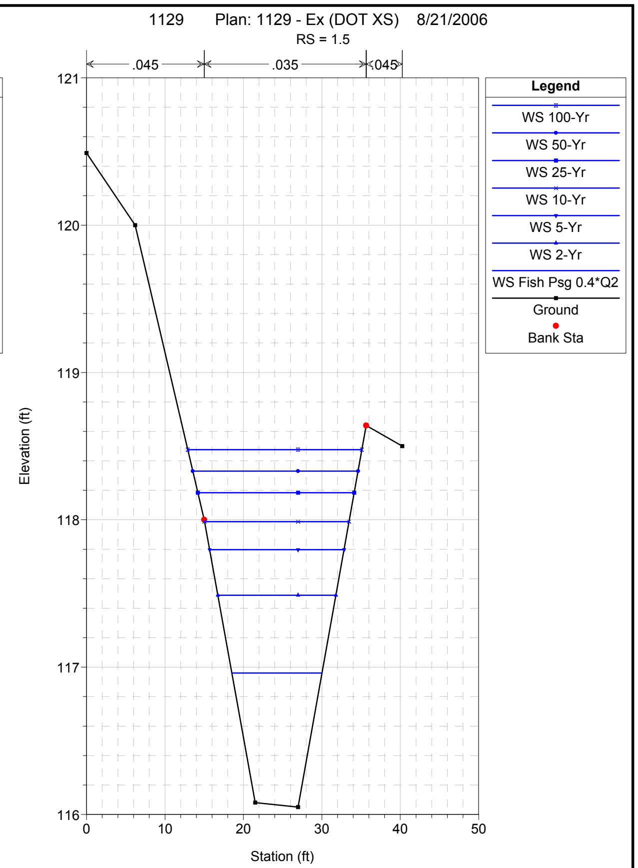

1129 Plan: 1129 - Ex (DOT XS) 8/21/2006
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.035
.045
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish Psg 0.4*Q2
Ground
Bank Sta
Elevation (ft)
Station (ft)
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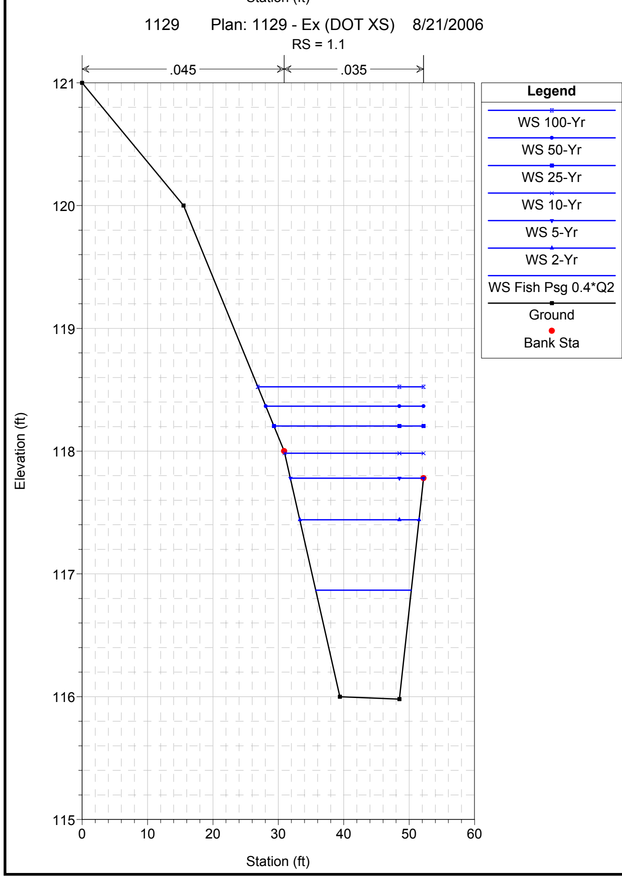
120
119
118
117
116
0
10
20
30
40
50



1129 Plan: 1129 - Ex (DOT XS) 8/21/2006
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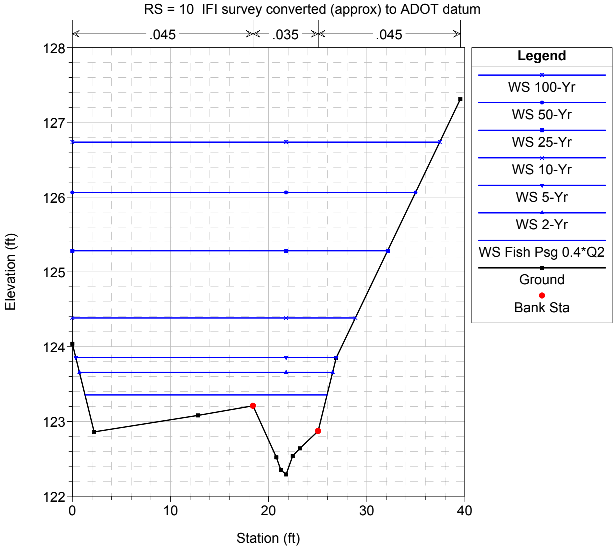
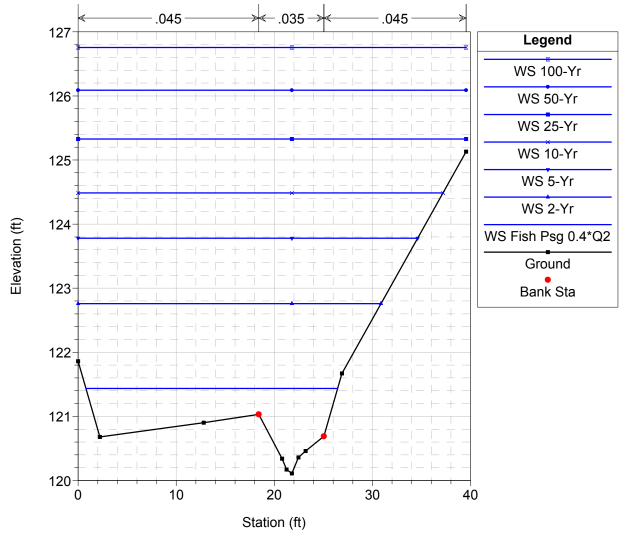
.035
Legend
WS 100-Yr
WS 50-Yr
WS 25-Yr
WS 10-Yr
WS 5-Yr
WS 2-Yr
WS Fish Psg 0.4*Q2
Ground
Bank Sta
Elevation (ft)
Station (ft)
121
120
119
118
117
116
115
0
10
20
30
40
50
60

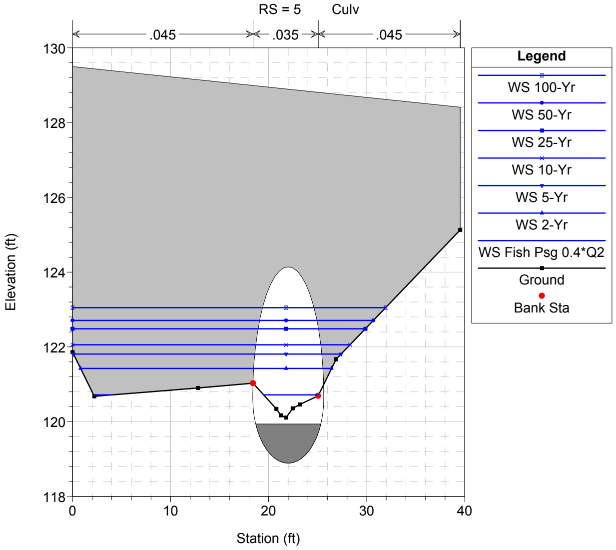
1129 Plan: 1129-PA7.25x5.25(DOT xs) 9/27/2006
RS = 10 IFI survey converted (approx) to ADOT datum



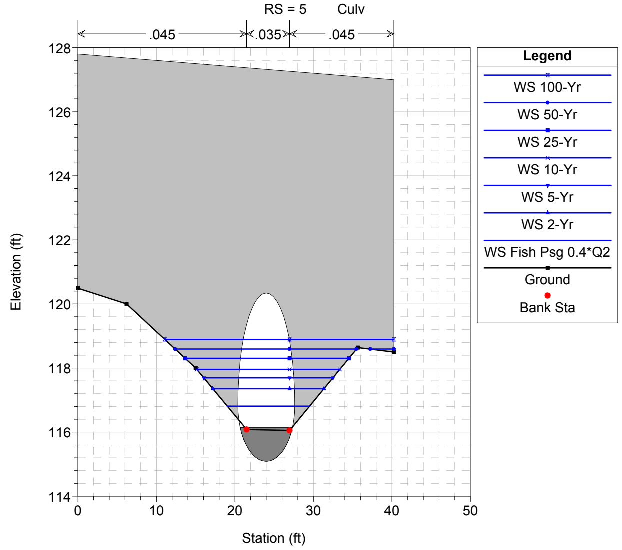
1129 Plan: 1129-PA7.25x5.25(DOT xs) 9/27/2006
RS = 9



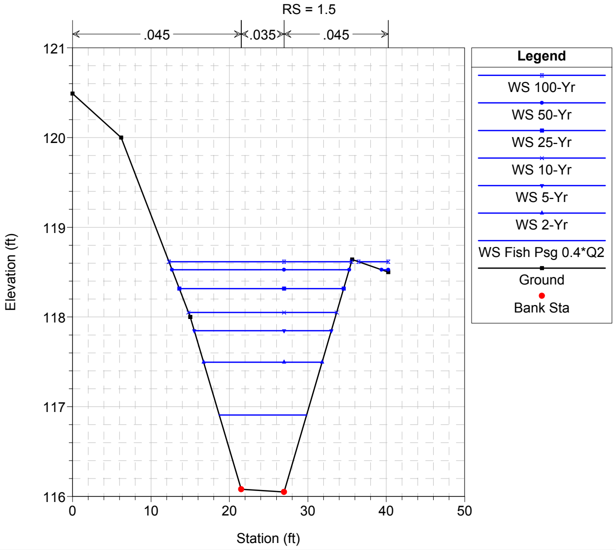
1129 Plan: 1129-PA7.25x5.25(DOT xs) 9/27/2006
RS = 5 Culv



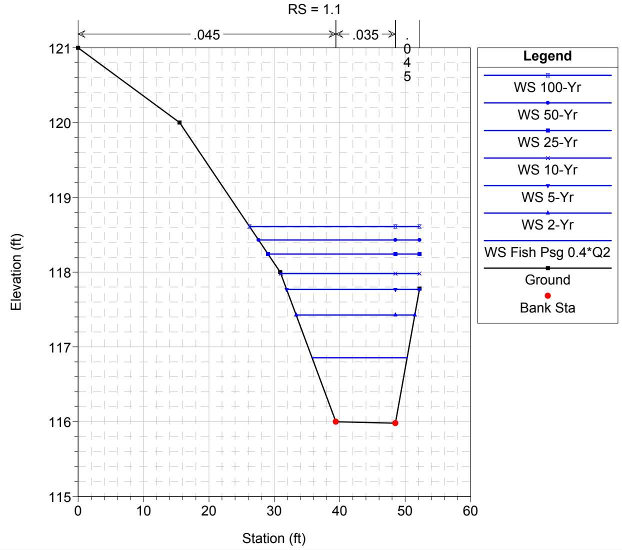
1129 Plan: 1129-PA7.25x5.25(DOT xs) 9/27/2006
RS = 5 Culv



1129 Plan: 1129-PA7.25x5.25(DOT xs) 9/27/2006
RS = 1.5



1129 Plan: 1129-PA7.25x5.25(DOT xs) 9/27/2006
RS = 1.1



HEC-RAS River: 1129 Reach: 1129

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
1129	1.1	5-cfs	1129pa7dot	5.00		115.98	116.31	116.20	116.35	0.007001	0.33	0.32	1.65	3.19	11.08	9.10	0.52	0.14
1129	1.1	5-cfs	1129Ex(dot)	5.00		115.98	116.31	116.20	116.35	0.007001	0.33	0.29	1.55	3.23	11.10	11.10	0.51	0.13
1129	1.1	10-cfs	1129pa7dot	10.00		115.98	116.46	116.32	116.53	0.006992	0.48	0.47	2.16	5.01	12.06	9.10	0.55	0.21
1129	1.1	10-cfs	1129Ex(dot)	10.00		115.98	116.47	116.31	116.53	0.007005	0.49	0.42	1.97	5.07	12.10	12.10	0.54	0.18
1129	1.1	Fish Psg 0.4*Q2	1129pa7dot	29.00		115.98	116.86	116.63	117.00	0.007004	0.88	0.87	3.23	10.22	14.54	9.10	0.61	0.38
1129	1.1	Fish Psg 0.4*Q2	1129Ex(dot)	29.00		115.98	116.87	116.62	116.99	0.007001	0.89	0.71	2.79	10.39	14.61	14.61	0.58	0.30
1129	1.1	50-cfs	1129pa7dot	50.00		115.98	117.16	116.90	117.37	0.007004	1.18	1.17	3.95	14.94	16.46	9.10	0.64	0.51
1129	1.1	50-cfs	1129Ex(dot)	50.00		115.98	117.17	116.87	117.34	0.007004	1.19	0.92	3.30	15.16	16.54	16.54	0.61	0.39
1129	1.1	2-Yr	1129pa7dot	73.00		115.98	117.43	117.13	117.70	0.007001	1.45	1.44	4.52	19.56	18.14	9.10	0.67	0.63
1129	1.1	2-Yr	1129Ex(dot)	73.00		115.98	117.44	117.09	117.65	0.007001	1.46	1.09	3.69	19.80	18.22	18.22	0.62	0.46
1129	1.1	5-Yr	1129pa7dot	109.00		115.98	117.77	117.45	118.12	0.007008	1.79	1.78	5.22	26.13	20.30	9.10	0.69	0.78
1129	1.1	5-Yr	1129Ex(dot)	109.00		115.98	117.78	117.38	118.05	0.007005	1.80	1.29	4.14	26.35	20.37	20.37	0.64	0.55
1129	1.1	10-Yr	1129pa7dot	135.00		115.98	117.98	117.64	118.38	0.006999	2.00	1.99	5.62	30.51	21.21	9.10	0.70	0.87
1129	1.1	10-Yr	1129Ex(dot)	135.00		115.98	117.98	117.56	118.29	0.007009	2.00	1.44	4.42	30.57	21.23	21.23	0.65	0.61
1129	1.1	25-Yr	1129pa7dot	170.00		115.98	118.24	117.89	118.70	0.007004	2.26	2.25	6.10	36.31	23.16	9.10	0.72	0.98
1129	1.1	25-Yr	1129Ex(dot)	170.00		115.98	118.20	117.77	118.56	0.007004	2.22	1.66	4.81	35.45	22.87	21.30	0.66	0.69
1129	1.1	50-Yr	1129pa7dot	198.00		115.98	118.43	118.01	118.93	0.007002	2.45	2.44	6.44	40.81	24.61	9.10	0.73	1.07
1129	1.1	50-Yr	1129Ex(dot)	198.00		115.98	118.37	117.92	118.77	0.007002	2.39	1.82	5.10	39.26	24.12	21.30	0.67	0.75
1129	1.1	100-Yr	1129pa7dot	227.00		115.98	118.61	118.20	119.15	0.007001	2.63	2.62	6.75	45.35	25.99	9.10	0.73	1.14
1129	1.1	100-Yr	1129Ex(dot)	227.00		115.98	118.52	118.06	118.97	0.007001	2.54	1.98	5.36	43.16	25.34	21.30	0.67	0.81
1129	1.5	5-cfs	1129pa7dot	5.00	17.00	116.05	116.43		116.50	0.010703	0.38	0.37	2.25	2.46	7.93	5.46	0.65	0.25
1129	1.5	5-cfs	1129Ex(dot)	5.00	17.00	116.05	116.44		116.50	0.010445	0.39	0.31	1.99	2.51	7.98	7.98	0.63	0.20
1129	1.5	10-cfs	1129pa7dot	10.00	17.00	116.05	116.58		116.71	0.013208	0.53	0.51	3.12	3.67	8.90	5.46	0.77	0.42
1129	1.5	10-cfs	1129Ex(dot)	10.00	17.00	116.05	116.59		116.70	0.012378	0.54	0.42	2.63	3.80	9.01	9.01	0.71	0.32
1129	1.5	Fish Psg 0.4*Q2	1129pa7dot	29.00	17.00	116.05	116.91	116.91	117.24	0.017815	0.86	0.84	5.05	6.99	11.14	5.46	0.97	0.94
1129	1.5	Fish Psg 0.4*Q2	1129Ex(dot)	29.00	17.00	116.05	116.96		117.19	0.014518	0.91	0.66	3.82	7.59	11.50	11.50	0.83	0.59
1129	1.5	50-cfs	1129pa7dot	50.00	17.00	116.05	117.22	117.22	117.66	0.015979	1.17	1.16	5.91	10.82	13.26	5.46	0.97	1.15
1129	1.5	50-cfs	1129Ex(dot)	50.00	17.00	116.05	117.24	117.15	117.56	0.015144	1.19	0.83	4.52	11.05	13.37	13.37	0.88	0.76
1129	1.5	2-Yr	1129pa7dot	73.00	17.00	116.05	117.50	117.50	118.01	0.014891	1.45	1.43	6.58	14.71	15.11	5.46	0.97	1.33
1129	1.5	2-Yr	1129Ex(dot)	73.00	17.00	116.05	117.49	117.40	117.88	0.014992	1.44	0.97	5.00	14.60	15.06	15.06	0.90	0.88
1129	1.5	5-Yr	1129pa7dot	109.00	17.00	116.05	117.85	117.85	118.46	0.013863	1.80	1.78	7.35	20.44	17.48	5.46	0.97	1.54
1129	1.5	5-Yr	1129Ex(dot)	109.00	17.00	116.05	117.80	117.72	118.28	0.014962	1.75	1.14	5.57	19.58	17.15	17.15	0.92	1.04
1129	1.5	10-Yr	1129pa7dot	135.00	17.00	116.05	118.05	118.05	118.74	0.013736	2.00	1.99	7.86	24.15	18.91	5.46	0.98	1.70
1129	1.5	10-Yr	1129Ex(dot)	135.00	17.00	116.05	117.99	117.91	118.52	0.014893	1.94	1.25	5.88	22.96	18.42	18.42	0.93	1.12
1129	1.5	25-Yr	1129pa7dot	170.00	17.00	116.05	118.32	118.32	119.06	0.013114	2.27	2.25	8.35	29.42	20.96	5.46	0.98	1.84
1129	1.5	25-Yr	1129Ex(dot)	170.00	17.00	116.05	118.18	118.13	118.82	0.015079	2.13	1.39	6.37	26.73	19.94	19.13	0.95	1.27
1129	1.5	50-Yr	1129pa7dot	198.00	17.00	116.05	118.53	118.53	119.30	0.012268	2.48	2.46	8.57	34.02	23.46	5.46	0.96	1.89
1129	1.5	50-Yr	1129Ex(dot)	198.00	17.00	116.05	118.33	118.29	119.03	0.015067	2.28	1.50	6.70	29.74	21.08	19.62	0.96	1.37
1129	1.5	100-Yr	1129pa7dot	227.00	17.00	116.05	118.62	118.62	119.52	0.013876	2.57	2.55	9.34	36.27	27.08	5.46	1.03	2.21
1129	1.5	100-Yr	1129Ex(dot)	227.00	17.00	116.05	118.48	118.45	119.23	0.014943	2.43	1.61	6.99	32.89	22.21	20.11	0.97	1.46
1129	2	5-cfs	1129Ex(dot)	5.00	24.00	115.80	116.50		116.55	0.004119	0.70	0.62	1.86	3.84	12.33	3.12	0.42	0.14
1129	2	10-cfs	1129Ex(dot)	10.00	24.00	115.80	116.70		116.75	0.004336	0.90	0.81	2.28	6.26	12.90	3.12	0.45	0.20
1129	2	Fish Psg 0.4*Q2	1129Ex(dot)	29.00	24.00	115.80	117.15		117.25	0.004938	1.35	1.26	3.27	12.40	14.25	3.12	0.51	0.35
1129	2	50-cfs	1129Ex(dot)	50.00	24.00	115.80	117.47		117.63	0.005594	1.67	1.59	4.06	17.20	15.22	3.12	0.57	0.50
1129	2	2-Yr	1129Ex(dot)	73.00	24.00	115.80	117.74		117.96	0.006305	1.94	1.86	4.78	21.39	16.02	3.12	0.62	0.66
1129	2	5-Yr	1129Ex(dot)	109.00	24.00	115.80	118.05		118.37	0.007581	2.25	2.16	5.81	26.45	16.94	3.12	0.70	0.93
1129	2	10-Yr	1129Ex(dot)	135.00	24.00	115.80	118.22		118.62	0.008562	2.42	2.34	6.50	29.41	17.45	3.12	0.75	1.14
1129	2	25-Yr	1129Ex(dot)	170.00	24.00	115.80	118.39		118.91	0.010396	2.59	2.51	7.50	32.42	18.75	3.12	0.83	1.48
1129	2	50-Yr	1129Ex(dot)	198.00	24.00	115.80	118.46		119.12	0.012679	2.66	2.58	8.44	33.82	19.92	3.12	0.93	1.86
1129	2	100-Yr	1129Ex(dot)	227.00	24.00	115.80	118.55	118.29	119.34	0.014591	2.75	2.67	9.26	35.66	21.37	3.12	1.00	2.21
1129	5			Culvert														
1129	9	5-cfs	1129pa7dot	5.00	112.00	120.11	120.74	120.74	120.87	0.025093	0.63	0.30	2.95	1.76	8.48	5.61	0.95	0.46
1129	9	5-cfs	1129Ex(dot)	5.00	112.00	120.11	121.10	120.74	121.11	0.000834	0.99	0.60	0.85	8.33	24.39	6.63	0.19	0.03
1129	9	10-cfs	1129pa7dot	10.00	112.00	120.11	120.91	120.91	121.05	0.016991	0.80	0.44	3.13	4.14	18.24	6.23	0.83	0.45
1129	9	10-cfs	1129Ex(dot)	10.00	112.00	120.11	121.63	120.91	121.63	0.000196	1.52	1.12	0.63	21.74	26.38	6.63	0.10	0.01
1129	9	Fish Psg 0.4*Q2	1129pa7dot	29.00	112.00	120.11	121.44	121.18	121.50	0.003673	1.33	0.93	2.41	16.71	25.65	6.63	0.44	0.21
1129	9	Fish Psg 0.4*Q2	1129Ex(dot)	29.00	112.00	120.11	123.05	121.18	123.05	0.000065	2.94	2.54	0.63	63.26	31.93	6.63	0.07	0.01
1129	9	50-cfs	1129pa7dot	50.00	112.00	120.11	122.13	121.34	122.16	0.001104	2.02	1.62	1.91	35.49	28.57	6.63	0.26	0.11
1129	9	50-cfs	1129Ex(dot)	50.00	112.00	120.11	124.42	121.34	124.42	0.000039	4.31	3.91	0.64	110.44	36.94	6.63	0.06	0.01
1129	9	2-Yr	1129pa7dot	73.00	112.00	120.11	122.76	121.48	122.79	0.000655	2.65	2.25	1.83	54.24	30.87	6.63	0.21	0.09
1129	9	2-Yr	1129Ex(dot)	73.00	112.00	120.11	127.37	121.48	127.37	0.000010	7.26	6.86	0.48	226.31	39.55	6.63	0.03	0.00

HEC-RAS River: 1129 Reach: 1129 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Cum Ch Len	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Vel Chnl	Flow Area	Top Width	Top W Chnl	Froude # Chl	Shear Chan
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)	(ft)		(lb/sq ft)
1129	9	5-Yr	1129pa7dot	109.00	112.00	120.11	123.78	121.67	123.81	0.000356	3.67	3.27	1.73	87.63	34.61	6.63	0.17	0.07
1129	9	5-Yr	1129Ex(dot)	109.00	112.00	120.11	129.31	121.67	129.31	0.000010	9.20	8.80	0.55	302.86	39.55	6.63	0.03	0.01
1129	9	10-Yr	1129pa7dot	135.00	112.00	120.11	124.49	121.81	124.51	0.000263	4.38	3.98	1.70	113.06	37.20	6.63	0.15	0.06
1129	9	10-Yr	1129Ex(dot)	135.00	112.00	120.11	129.57	121.81	129.57	0.000013	9.46	9.07	0.66	313.33	39.55	6.63	0.04	0.01
1129	9	25-Yr	1129pa7dot	170.00	112.00	120.11	125.33	121.97	125.35	0.000203	5.22	4.82	1.69	145.50	39.55	6.63	0.14	0.06
1129	9	25-Yr	1129Ex(dot)	170.00	112.00	120.11	129.76	121.97	129.77	0.000020	9.65	9.26	0.81	320.99	39.55	6.63	0.05	0.01
1129	9	50-Yr	1129pa7dot	198.00	112.00	120.11	126.09	122.09	126.11	0.000158	5.98	5.58	1.65	175.62	39.55	6.63	0.12	0.05
1129	9	50-Yr	1129Ex(dot)	198.00	112.00	120.11	129.93	122.09	129.93	0.000025	9.82	9.42	0.93	327.38	39.55	6.63	0.05	0.01
1129	9	100-Yr	1129pa7dot	227.00	112.00	120.11	126.76	122.21	126.78	0.000137	6.64	6.25	1.65	202.00	39.55	6.63	0.12	0.05
1129	9	100-Yr	1129Ex(dot)	227.00	112.00	120.11	130.08	122.21	130.09	0.000031	9.97	9.57	1.05	333.41	39.55	6.63	0.06	0.02
1129	10	5-cfs	1129pa7dot	5.00	168.00	122.29	122.92	122.92	123.05	0.025081	0.63	0.30	2.95	1.76	8.48	5.61	0.95	0.46
1129	10	5-cfs	1129Ex(dot)	5.00	168.00	122.29	122.88	122.92	123.06	0.038451	0.59	0.27	3.40	1.48	6.39	5.48	1.16	0.63
1129	10	10-cfs	1129pa7dot	10.00	168.00	122.29	123.09	123.09	123.23	0.016991	0.80	0.44	3.13	4.14	18.24	6.23	0.83	0.45
1129	10	10-cfs	1129Ex(dot)	10.00	168.00	122.29	123.01	123.09	123.27	0.038429	0.72	0.37	4.23	2.78	13.58	5.93	1.22	0.87
1129	10	Fish Psg 0.4*Q2	1129pa7dot	29.00	168.00	122.29	123.36	123.36	123.53	0.016063	1.07	0.67	4.04	10.15	24.67	6.63	0.87	0.65
1129	10	Fish Psg 0.4*Q2	1129Ex(dot)	29.00	168.00	122.29	123.24	123.36	123.60	0.038412	0.95	0.56	5.54	7.43	24.25	6.63	1.31	1.30
1129	10	50-cfs	1129pa7dot	50.00	168.00	122.29	123.52	123.52	123.77	0.017505	1.23	0.84	4.89	14.28	25.29	6.63	0.94	0.89
1129	10	50-cfs	1129Ex(dot)	50.00	168.00	122.29	124.40	123.52	124.43	0.000882	2.11	1.72	1.77	38.22	28.91	6.63	0.24	0.09
1129	10	2-Yr	1129pa7dot	73.00	168.00	122.29	123.66	123.66	123.99	0.019299	1.37	0.97	5.68	17.78	25.81	6.63	1.01	1.14
1129	10	2-Yr	1129Ex(dot)	73.00	168.00	122.29	127.37	123.66	127.37	0.000042	5.08	4.68	0.75	140.04	39.55	6.63	0.06	0.01
1129	10	5-Yr	1129pa7dot	109.00	168.00	122.29	123.85	123.85	124.28	0.019781	1.56	1.17	6.50	22.95	26.56	6.63	1.06	1.40
1129	10	5-Yr	1129Ex(dot)	109.00	168.00	122.29	129.30	123.86	129.31	0.000026	7.01	6.62	0.74	216.61	39.55	6.63	0.05	0.01
1129	10	10-Yr	1129pa7dot	135.00	168.00	122.29	124.38		124.62	0.006729	2.09	1.70	4.86	37.65	28.84	6.63	0.66	0.69
1129	10	10-Yr	1129Ex(dot)	135.00	168.00	122.29	129.57	123.99	129.58	0.000034	7.28	6.88	0.88	227.07	39.55	6.63	0.06	0.01
1129	10	25-Yr	1129pa7dot	170.00	168.00	122.29	125.28		125.41	0.002067	2.99	2.60	3.58	65.08	32.13	6.63	0.39	0.33
1129	10	25-Yr	1129Ex(dot)	170.00	168.00	122.29	129.76	124.15	129.77	0.000049	7.47	7.08	1.08	234.72	39.55	6.63	0.07	0.02
1129	10	50-Yr	1129pa7dot	198.00	168.00	122.29	126.06		126.15	0.001046	3.77	3.38	3.03	91.21	34.98	6.63	0.29	0.21
1129	10	50-Yr	1129Ex(dot)	198.00	168.00	122.29	129.92	124.27	129.94	0.000062	7.63	7.24	1.22	241.08	39.55	6.63	0.08	0.03
1129	10	100-Yr	1129pa7dot	227.00	168.00	122.29	126.74		126.81	0.000697	4.45	4.05	2.79	115.62	37.45	6.63	0.24	0.17
1129	10	100-Yr	1129Ex(dot)	227.00	168.00	122.29	130.08	124.39	130.09	0.000075	7.79	7.39	1.37	247.10	39.55	6.63	0.09	0.03

23.5.3 Hydraulic Output – Small Fish Pipes

2009 Alignment Station: 228+95

1 2006 S&HI Station 252+00 Existing conditions

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 11:28:57 FILE NAME: 252-EX

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	22.29	21.43	70.01	1 CSP	2.00	2.00	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 252-EX DATE: 08-17-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
22.29	0	0	0	0	0	0	0	0	1
23.31	3	3	0	0	0	0	0	0	1
23.6	5	5	0	0	0	0	0	0	1
24.12	9	9	0	0	0	0	0	0	1
24.45	12	12	0	0	0	0	0	0	1
24.81	15	15	0	0	0	0	0	0	1
25.44	18	18	0	0	0	0	0	0	1
26.56	21	21	0	0	0	0	0	0	1
26.81	24	21.6	0	0	0	0	0	2.22	9
26.89	27	21.9	0	0	0	0	0	4.96	5
26.96	30	22.1	0	0	0	0	0	7.71	4
26.7	21.4	21.4	0	0	0	0	0	OVERTOPP ING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 252-EX DATE: 08-17-2006

HEAD ELEV (ft)	HEAD ERROR (ft	TOTAL FLOW (cfs	FLOW ERROR (c	% FLOW ERROR
22.29	0	0	0	0
23.31	0	3	0	0
23.6	0	5	0	0
24.12	0	9	0	0
24.45	0	12	0	0
24.81	0	15	0	0

25.44	0	18	0	0
26.56	0	21	0	0
26.81	-0.004	24	0.13	0.54
26.89	-0.004	27	0.15	0.56
26.96	-0.007	30	0.21	0.7

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

2

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 11:28:57 FILE NAME: 252-EX

PERFORMANCE CURVE FOR CULVERT 1 - 1(2.00 (ft) BY 2.00 (ft)) CSP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)
0	22.29	0	0	0-NF	0	0	0	-0.8	0
3	23.31	0.89	1.02	2-M2c	0.63	0.6	0.6	0.32	3.75
5	23.6	1.18	1.31	2-M2c	0.84	0.79	0.79	0.44	4.36
9	24.12	1.69	1.83	2-M2c	1.19	1.07	1.07	0.57	5.28
12	24.45	2.08	2.16	2-M2c	1.46	1.24	1.24	0.64	5.85
15	24.81	2.52	2.52	2-M2c	2	1.4	1.4	0.69	6.41
18	25.44	3.04	3.15	2-M2c	2	1.52	1.52	0.74	7.03
21	26.56	3.66	4.27	2-M2c	2	1.63	1.63	0.78	7.63
21.65	26.8	3.81	4.51	2-M2c	2	1.65	1.65	0.82	7.82
21.89	26.89	3.86	4.6	2-M2c	2	1.66	1.66	0.86	7.88
22.08	26.95	3.91	4.66	2-M2c	2	1.67	1.67	0.89	7.92

El. inlet face invert 22.29 ft El. outlet invert 21.43 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION 0.00 ft
INLET ELEVATION 22.29 ft
OUTLET STATION 70.00 ft
OUTLET ELEVATION 21.43 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0123
CULVERT LENGTH ALONG SLOPE 70.01 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE CIRCULAR
BARREL DIAMETER 2.00 ft
BARREL MATERIAL CORRUGATED STEEL
BARREL MANNING'S n 0.024
INLET TYPE CONVENTIONAL

INLET EDGE AND WALL THIN EDGE PROJECTING
INLET DEPRESSION NONE

3

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 11:28:57 FILE NAME: 252-EX

TAILWATER

***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 252-TW
MAIN CHANNEL AND LT & RT OVER BANKS FILE DATE: 08-16-2006
LEFT CHANNEL BOUNDARY 2
RIGHT CHANNEL BOUNDARY 5
MANNING n LEFT OVER BANK 0.050
MANNING n MAIN CHANNEL 0.038
MANNING n RIGHT OVER BANK 0.050
SLOPE OF CHANNEL 0.0020 ft/ft

CROSS-SECTION COORD. NO.	X (ft)	Y (ft)
1	0.00	23.00
2	100.00	21.63
3	100.50	20.63
4	102.50	20.63
5	103.00	21.63
6	203.00	23.00

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	20.63	0.000	-0.80	0.00	0.00
3.00	21.75	0.243	0.32	1.34	0.08
5.00	21.87	0.248	0.44	1.45	0.09
9.00	22.00	0.253	0.57	1.57	0.11
12.00	22.07	0.255	0.64	1.63	0.11
15.00	22.12	0.257	0.69	1.68	0.12
18.00	22.17	0.258	0.74	1.72	0.12
21.00	22.21	0.260	0.78	1.75	0.13
24.00	22.25	0.261	0.82	1.78	0.13
27.00	22.29	0.262	0.86	1.81	0.13
30.00	22.32	0.263	0.89	1.84	0.14

Note: Shear stress was calculated using R.

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE PAVED
EMBANKMENT TOP WIDTH 22.00 ft
CREST LENGTH 20.00 ft
OVERTOPPING CREST ELEVATION 26.70 ft

2009 Alignment Station: 228+95

2006 S&HI Station 252+00 Tier 2 FISH PASS design

Analysis of **Existing conditions**

no baffles

Juvenile Coho

```
C:\Client\ALASKA~1\ADFGFI~1\fishpass.exe
Help  Print  Status  Backwater  Inlet  CalcMode  cOrrugations
                    Weak Swimming Fish Passage
      Length                                        Culvert   — Depth —
Fish   Culvert   Slope     Manning n         Q       Diam.    Bed   Outlet
(mm)    (ft)      (%)     Wall     Bed     (cfs)     (ft)     (ft)   (ft)
96      70        1.2     .024     0        3        2        0      .7

                      Calculated Fish Parameters
      --- Fish Passage ---                        Possible Energy (joules)
Allowable Vel. Min. Flow Depth  Possible Power   Outlet     Inlet
   4.4 ft/sec       0.54 ft       0.42 watts      0.77       0.77

                      Calculated Flow Parameters
                                             Normal Flow  Critical Flow
                                Depth (ft)      0.64          0.60
Avg., cross-section, water velocity (ft/sec)    3.44          3.75

  Fish power required in outlet zone (watts)
Fish energy required in outlet zone (joules)
      Fish power required at inlet (watts)      0.21
    Fish energy required at inlet (joules)      0.43
Acceptable Design
Alt = Menu <F1 = Current Field Help>                 <Esc = Exit>
```

Adult Coho 600-mm

```
C:\Client\ALASKA~1\ADFGFI~1\fishpass.exe
Help  Print  Status  Backwater  Inlet  CalcMode  cOrrugations
                    Weak Swimming Fish Passage
      Length                                        Culvert   — Depth —
Fish   Culvert   Slope     Manning n         Q       Diam.    Bed   Outlet
(mm)    (ft)      (%)     Wall     Bed     (cfs)     (ft)     (ft)   (ft)
600     70        1.2     .024     0        3        2        0      .7

                      Calculated Fish Parameters
      --- Fish Passage ---                        Possible Energy (joules)
Allowable Vel. Min. Flow Depth  Possible Power   Outlet     Inlet
   6.0 ft/sec       0.43 ft      38.11 watts     187.50     187.50

                      Calculated Flow Parameters
                                             Normal Flow  Critical Flow
                                Depth (ft)      0.64          0.60
Avg., cross-section, water velocity (ft/sec)    3.44          3.75

  Fish power required in outlet zone (watts)
Fish energy required in outlet zone (joules)
      Fish power required at inlet (watts)      9.84
    Fish energy required at inlet (joules)     19.68
Acceptable Design
Alt = Menu <F1 = Current Field Help>                 <Esc = Exit>
```

Adult Coho 600 1.57 942

Note: L * 1.57 converts swimming ability to 'equivalent' grayling

Assume depth based on actual body size of 600-mm fish above

```
C:\Client\ALASKA~1\ADFGFI~1\fishpass.exe
Help  Print  Status  Backwater  Inlet  CalcMode  cOrrugations
                    Weak Swimming Fish Passage
      Length                                        Culvert   — Depth —
Fish   Culvert   Slope     Manning n         Q       Diam.    Bed   Outlet
(mm)    (ft)      (%)     Wall     Bed     (cfs)     (ft)     (ft)   (ft)
942     70        1.2     .024     0        3        2        0      .7

                      Calculated Fish Parameters
      --- Fish Passage ---                        Possible Energy (joules)
Allowable Vel. Min. Flow Depth  Possible Power   Outlet     Inlet
   6.4 ft/sec       0.41 ft     115.59 watts     725.60

                      Calculated Flow Parameters
                                             Normal Flow  Critical Flow
                                Depth (ft)      0.64          0.60
Avg., cross-section, water velocity (ft/sec)    3.44          3.75

  Fish power required in outlet zone (watts)
Fish energy required in outlet zone (joules)
      Fish power required at inlet (watts)
    Fish energy required at inlet (joules)
Normal Depth too shallow
Alt = Menu <F1 = Current Field Help>                 <Esc = Exit>
```

2009 Alignment Station: 240+38

1 2006 S&HI Station 263+50 Existing conditions

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 12:26:58 FILE NAME: 26350

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	22.66	21.49	59.01	1 CSP	2.00	2.00	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 26350 DATE: 08-17-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
22.66	0	0	0	0	0	0	0	0	1
23.83	5	5	0	0	0	0	0	0	1
24.74	12	12	0	0	0	0	0	0	1
25.69	18	18	0	0	0	0	0	0	1
27.32	24	24	0	0	0	0	0	0	1
28.95	30	28.3	0	0	0	0	0	1.54	8
29.19	36	28.9	0	0	0	0	0	6.96	4
29.36	42	29.3	0	0	0	0	0	12.34	3
29.52	48	29.7	0	0	0	0	0	18.02	3
29.66	54	30	0	0	0	0	0	23.83	3
29.79	60	30.2	0	0	0	0	0	29.57	3
28.81	28	28	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 26350 DATE: 08-17-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
22.66	0.000	0.00	0.00	0.00
23.83	0.000	5.00	0.00	0.00
24.74	0.000	12.00	0.00	0.00
25.69	0.000	18.00	0.00	0.00
27.32	0.000	24.00	0.00	0.00
28.95	-0.005	30.00	0.14	0.47

29.19	-0.005	36.00	0.19	0.53
29.36	-0.008	42.00	0.39	0.93
29.52	-0.006	48.00	0.32	0.67
29.66	-0.003	54.00	0.17	0.31
29.79	-0.004	60.00	0.20	0.33

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

2

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 12:26:58 FILE NAME: 26350

PERFORMANCE CURVE FOR CULVERT 1 - 1(2.00 (ft) BY 2.00 (ft)) CSP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)
0	22.66	0	0	0-NF	0	0	0	0.16	0
5	23.83	1.17	1.17	1-S2n	0.73	0.79	0.73	1.31	4.84
12	24.74	2.08	2.08	5-S2n	1.23	1.24	1.14	1.52	6.48
18	25.69	3.03	2.89	3-M2t	1.75	1.52	1.62	1.62	6.6
24	27.32	4.38	4.66	2-M2c	2	1.72	1.72	1.69	8.37
28.32	28.97	5.66	6.31	2-M2c	2	1.85	1.85	1.76	9.38
28.85	29.19	5.83	6.53	2-M2c	2	1.87	1.87	1.81	9.52
29.28	29.36	5.98	6.7	2-M2c	2	1.88	1.88	1.86	9.62
29.66	29.52	6.11	6.86	3-M2t	2	1.89	1.9	1.9	9.7
30	29.7	6.22	7.04	3-M2t	2	1.9	1.94	1.94	9.71
30.24	29.8	6.31	7.14	3-M2t	2	1.91	1.98	1.98	9.69

El. inlet face invert 22.66 ft El. outlet invert 21.49 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION 0.00 ft
INLET ELEVATION 22.66 ft
OUTLET STATION 59.00 ft
OUTLET ELEVATION 21.49 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0198
CULVERT LENGTH ALONG SLOPE 59.01 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE CIRCULAR
BARREL DIAMETER 2.00 ft
BARREL MATERIAL CORRUGATED STEEL
BARREL MANNING'S n 0.024
INLET TYPE CONVENTIONAL

INLET EDGE AND WALL THIN EDGE PROJECTING
INLET DEPRESSION NONE

3

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 12:26:58 FILE NAME: 26350

TAILWATER

***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 263-TW
MAIN CHANNEL AND LT & RT OVER BANKS FILE DATE: 08-17-2006
LEFT CHANNEL BOUNDARY 2
RIGHT CHANNEL BOUNDARY 5
MANNING n LEFT OVER BANK 0.050
MANNING n MAIN CHANNEL 0.038
MANNING n RIGHT OVER BANK 0.050
SLOPE OF CHANNEL 0.0036 ft/ft

CROSS-SECTION COORD. NO.	X (ft)	Y (ft)
1	0.00	24.00
2	100.00	22.65
3	100.50	21.65
4	102.50	21.65
5	103.00	22.65
6	203.00	24.00

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	21.65	0.000	0.16	0.00	0.00
5.00	22.80	0.328	1.31	1.85	0.16
12.00	23.01	0.338	1.52	2.10	0.19
18.00	23.11	0.343	1.62	2.21	0.21
24.00	23.18	0.346	1.69	2.30	0.22
30.00	23.25	0.349	1.76	2.37	0.23
36.00	23.30	0.351	1.81	2.42	0.24
42.00	23.35	0.353	1.86	2.47	0.24
48.00	23.39	0.354	1.90	2.52	0.25
54.00	23.43	0.356	1.94	2.56	0.26
60.00	23.47	0.357	1.98	2.60	0.26

Note: Shear stress was calculated using R.

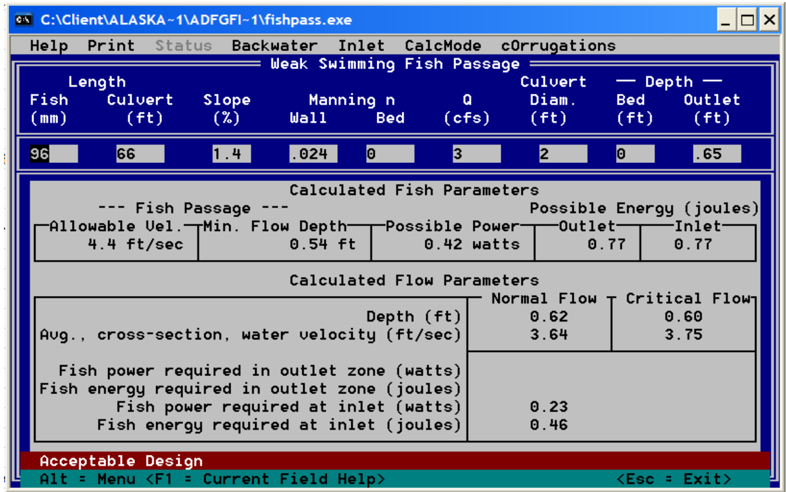
ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	22.00 ft
CREST LENGTH	10.00 ft
OVERTOPPING CREST ELEVATION	28.81 ft

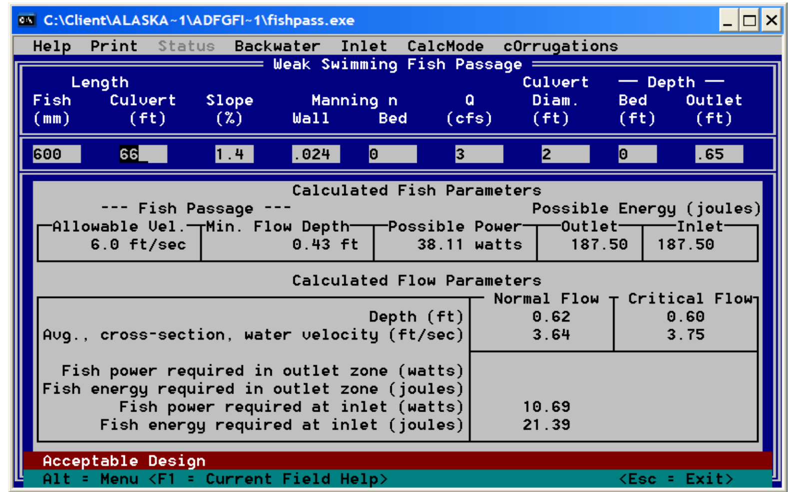
<u>2009 Alignment Station: 240+38</u>
<u>2006 S&HI Station 263+50 Tier 2 FISH PASS design</u>
Analysis of **<u>Existing conditions</u>**

<u>no baffles</u>

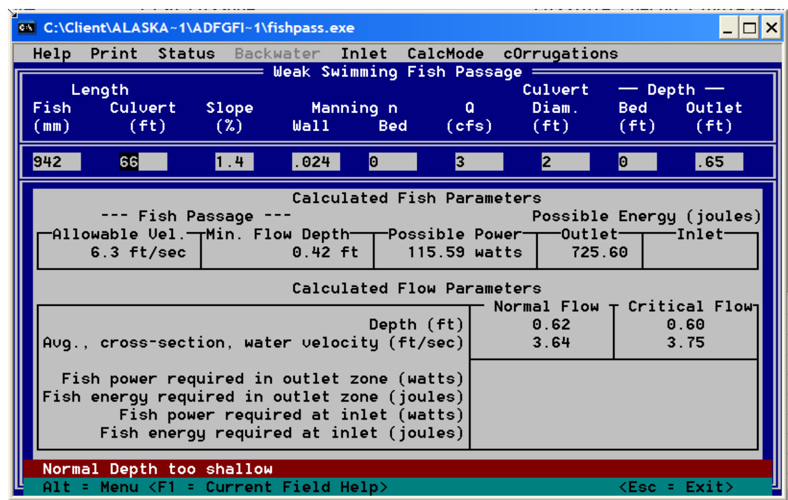
Juvenile Coho

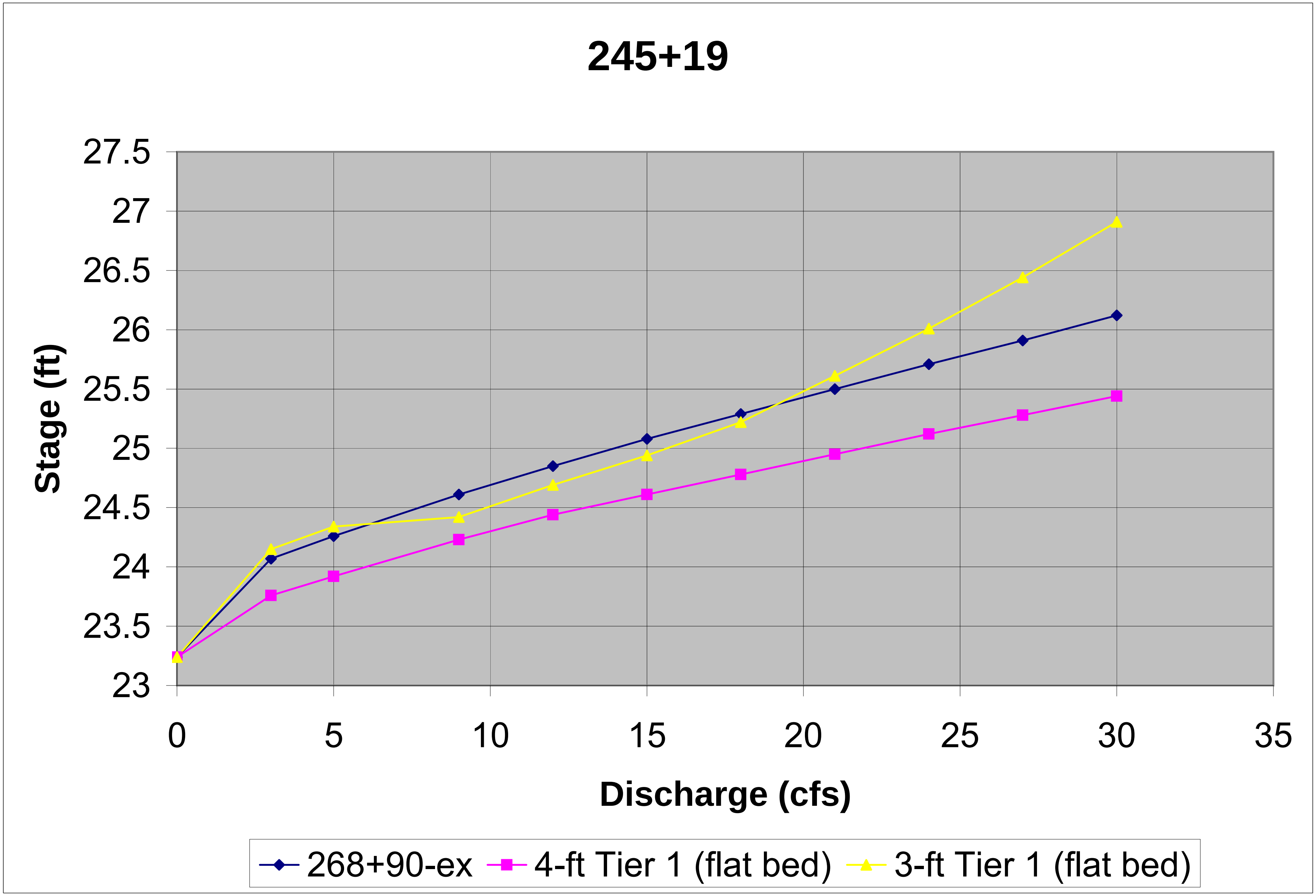


Adult Coho 600-mm Adult Coho



Adult Coho 600 1.57 942
Note: L * 1.57 converts swimming ability to 'equivalent' grayling
Assume depth based on actual body size of <u>600-mm</u> fish above





245+19
Stage (ft)
27.5
27
26.5
26
25.5
25
24.5
24
23.5
23
0
5
10
15
20
25
30
35
Discharge (cfs)
268+90-ex
4-ft Tier 1 (flat bed)
3-ft Tier 1 (flat bed)

2009 Alignment Station: 245+19

1 2006 S&HI Station 268+90 Existing conditions

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 11:17:47 FILE NAME: 26890EX

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	23.24	21.71	58.02	1 CSP	3.00	3.00	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 26890EX DATE: 08-25-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
23.24	0	0	0	0	0	0	0	0	1
24.07	3	3	0	0	0	0	0	0	1
24.26	5	5	0	0	0	0	0	0	1
24.61	9	9	0	0	0	0	0	0	1
24.85	12	12	0	0	0	0	0	0	1
25.08	15	15	0	0	0	0	0	0	1
25.29	18	18	0	0	0	0	0	0	1
25.5	21	21	0	0	0	0	0	0	1
25.71	24	24	0	0	0	0	0	0	1
25.91	27	27	0	0	0	0	0	0	1
26.12	30	30	0	0	0	0	0	0	1
27.64	48.2	48.2	0	0	0	0	0	OVERTOPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 26890EX DATE: 08-25-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
23.24	0.000	0.00	0.00	0.00
24.07	0.000	3.00	0.00	0.00
24.26	0.000	5.00	0.00	0.00
24.61	0.000	9.00	0.00	0.00
24.85	0.000	12.00	0.00	0.00
25.08	0.000	15.00	0.00	0.00
25.29	0.000	18.00	0.00	0.00
25.50	0.000	21.00	0.00	0.00
25.71	0.000	24.00	0.00	0.00
25.91	0.000	27.00	0.00	0.00

26.12 0.000 30.00 0.00 0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

2

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 11:17:47 FILE NAME: 26890EX

PERFORMANCE CURVE FOR CULVERT 1 - 1(3.00 (ft) BY 3.00 (ft)) CSP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	23.24	0.00	0.00	0-NF	0.00	0.00	0.00	-0.56	0.00	0.00
3.00	24.07	0.83	0.83	1-S2n	0.44	0.52	0.32	0.33	8.21	1.85
5.00	24.26	1.02	1.02	1-S2n	0.59	0.69	0.49	0.39	6.52	1.96
9.00	24.61	1.37	1.37	1-S2n	0.78	0.94	0.78	0.47	6.09	2.10
12.00	24.85	1.61	1.61	1-S2n	0.92	1.09	0.79	0.52	8.00	2.17
15.00	25.08	1.84	1.84	1-S2n	1.03	1.23	0.93	0.56	8.04	2.23
18.00	25.29	2.05	2.05	1-S2n	1.13	1.35	1.05	0.60	8.13	2.29
21.00	25.50	2.26	2.26	1-S2n	1.24	1.47	1.17	0.63	8.22	2.34
24.00	25.71	2.47	2.47	1-S2n	1.33	1.57	1.27	0.65	8.39	2.38
27.00	25.91	2.67	2.67	1-S2n	1.42	1.67	1.37	0.68	8.56	2.42
30.00	26.12	2.88	2.88	1-S2n	1.52	1.77	1.51	0.70	8.40	2.45

El. inlet face invert 23.24 ft El. outlet invert 21.71 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************
INLET STATION 0.00 ft
INLET ELEVATION 23.24 ft
OUTLET STATION 58.00 ft
OUTLET ELEVATION 21.71 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0264
CULVERT LENGTH ALONG SLOPE 58.02 ft

***** CULVERT DATA SUMMARY ************************
BARREL SHAPE CIRCULAR
BARREL DIAMETER 3.00 ft
BARREL MATERIAL CORRUGATED STEEL
BARREL MANNING'S n 0.024
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL THIN EDGE PROJECTING
INLET DEPRESSION NONE

3

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006

CURRENT TIME: 11:17:47 FILE NAME: 26890EX

TAILWATER

***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 26890TW
MAIN CHANNEL AND LT & RT OVER BANKS FILE DATE: 08-25-2006
LEFT CHANNEL BOUNDARY 2
RIGHT CHANNEL BOUNDARY 5
MANNING n LEFT OVER BANK 0.050
MANNING n MAIN CHANNEL 0.038
MANNING n RIGHT OVER BANK 0.050
SLOPE OF CHANNEL 0.0053 ft/ft

CROSS-SECTION COORD. NO.	X (ft)	Y (ft)
1	0.00	23.00
2	100.00	21.85
3	100.50	21.15
4	101.50	21.15
5	102.00	21.85
6	202.00	23.00

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	21.15	0.000	-0.56	0.00	0.00
3.00	22.04	0.386	0.33	1.85	0.17
5.00	22.10	0.392	0.39	1.96	0.19
9.00	22.18	0.398	0.47	2.10	0.21
12.00	22.23	0.402	0.52	2.17	0.22
15.00	22.27	0.405	0.56	2.23	0.23
18.00	22.31	0.407	0.60	2.29	0.24
21.00	22.34	0.409	0.63	2.34	0.25
24.00	22.36	0.411	0.65	2.38	0.25
27.00	22.39	0.413	0.68	2.42	0.26
30.00	22.41	0.414	0.70	2.45	0.26

Note: Shear stress was calculated using R.

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE PAVED
EMBANKMENT TOP WIDTH 24.00 ft
CREST LENGTH 10.00 ft
OVERTOPPING CREST ELEVATION 27.64 ft

2009 Alignment Station: 272+40

1 2006 S&HI Station 268+90 Tier 1 fish passage - 4-ft CMP

CURRENT DATE: 08-29-2006 FILE DATE: 08-29-2006
CURRENT TIME: 19:31:05 FILE NAME: 268-TW

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA: INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	23.24	21.71	58.02	1 ICMP	4.00	2.40	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 268-TW DATE: 08-29-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
23.24	0	0	0	0	0	0	0	0	1
23.76	3	3	0	0	0	0	0	0	1
23.92	5	5	0	0	0	0	0	0	1
24.23	9	9	0	0	0	0	0	0	1
24.44	12	12	0	0	0	0	0	0	1
24.61	15	15	0	0	0	0	0	0	1
24.78	18	18	0	0	0	0	0	0	1
24.95	21	21	0	0	0	0	0	0	1
25.12	24	24	0	0	0	0	0	0	1
25.28	27	27	0	0	0	0	0	0	1
25.44	30	30	0	0	0	0	0	0	1
27.64	57.4	57.4	0	0	0	0	0	OVERTOPP ING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 268-TW DATE: 08-29-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
23.24	0.000	0.00	0.00	0.00
23.76	0.000	3.00	0.00	0.00
23.92	0.000	5.00	0.00	0.00
24.23	0.000	9.00	0.00	0.00
24.44	0.000	12.00	0.00	0.00
24.61	0.000	15.00	0.00	0.00
24.78	0.000	18.00	0.00	0.00
24.95	0.000	21.00	0.00	0.00
25.12	0.000	24.00	0.00	0.00
25.28	0.000	27.00	0.00	0.00
25.44	0.000	30.00	0.00	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

2

CURRENT DATE: 08-29-2006 FILE DATE: 08-29-2006

CURRENT TIME: 19:31:05 FILE NAME: 268-TW

□□

PERFORMANCE CURVE FOR CULVERT 1 - 1(4.00 (ft) BY 2.40 (ft)) ICMP

□□

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	23.24	0.00	0.00	0-NF	0.00	0.00	0.00	-0.56	0.00	0.00
3.00	23.76	0.52	0.52	1-S2n	0.21	0.26	0.16	0.33	3.59	1.85
5.00	23.92	0.68	0.68	1-S2n	0.30	0.36	0.30	0.39	4.25	1.96
9.00	24.23	0.99	0.99	1-S2n	0.44	0.54	0.34	0.47	6.73	2.10
12.00	24.44	1.20	1.20	1-S2n	0.53	0.65	0.45	0.52	6.70	2.17
15.00	24.61	1.37	1.37	1-S2n	0.61	0.76	0.56	0.56	6.79	2.23
18.00	24.78	1.54	1.54	1-S2n	0.70	0.85	0.69	0.60	6.58	2.29
21.00	24.95	1.71	1.71	1-S2n	0.78	0.95	0.65	0.63	8.23	2.34
24.00	25.12	1.88	1.88	1-S2n	0.85	1.03	0.73	0.65	8.33	2.38
27.00	25.28	2.04	2.04	1-S2n	0.93	1.11	0.81	0.68	8.45	2.42
30.00	25.44	2.20	2.20	1-S2n	1.00	1.19	0.89	0.70	8.54	2.45

□□

El. inlet face invert 23.24 ft El. outlet invert 21.71 ft

El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

□□

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION 0.00 ft
INLET ELEVATION 23.24 ft
OUTLET STATION 58.00 ft
OUTLET ELEVATION 21.71 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0264
CULVERT LENGTH ALONG SLOPE 58.02 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE USER DEFINED
BARREL SPAN 4.00 ft
BARREL RISE 2.40 ft
BARREL MATERIAL STEEL OR ALUMINUM
BARREL MANNING'S n 0.024 FOR SIDES AND TOP
0.038 FOR BOTTOM
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL MITERED
INLET DEPRESSION NONE

□□
□

CURRENT DATE: 08-29-2006 FILE DATE: 08-29-2006
CURRENT TIME: 19:31:05 FILE NAME: 268-TW

□□

***** USER DEFINED CULVERT CROSS-SECTION - CULVERT # 1

COORDINATE NUMBER	X (ft)	Y-TOP (ft)	Y-BOTTOM (ft)
1	73.20	23.64	23.64
2	73.21	24.04	23.24
3	73.60	24.88	23.24
4	74.00	25.26	23.24
5	74.40	25.48	23.24
6	74.80	25.60	23.24

7	75.20	25.64	23.24
8	75.60	25.60	23.24
9	76.00	25.48	23.24
10	76.30	25.26	23.24
11	76.70	24.88	23.24
12	77.10	24.04	23.24
13	77.20	23.64	23.64

4

CURRENT DATE: 08-29-2006 FILE DATE: 08-29-2006
CURRENT TIME: 19:31:05 FILE NAME: 268-TW

TAILWATER

***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 268TW4
MAIN CHANNEL AND LT & RT OVER BANKS FILE DATE: 08-29-2006
LEFT CHANNEL BOUNDARY 2
RIGHT CHANNEL BOUNDARY 5
MANNING n LEFT OVER BANK 0.050
MANNING n MAIN CHANNEL 0.038
MANNING n RIGHT OVER BANK 0.050
SLOPE OF CHANNEL 0.0053 ft/ft

CROSS-SECTION COORD. NO.	X (ft)	Y (ft)
1	0.00	23.00
2	100.00	21.85
3	100.50	21.15
4	101.50	21.15
5	102.00	21.85
6	202.00	23.00

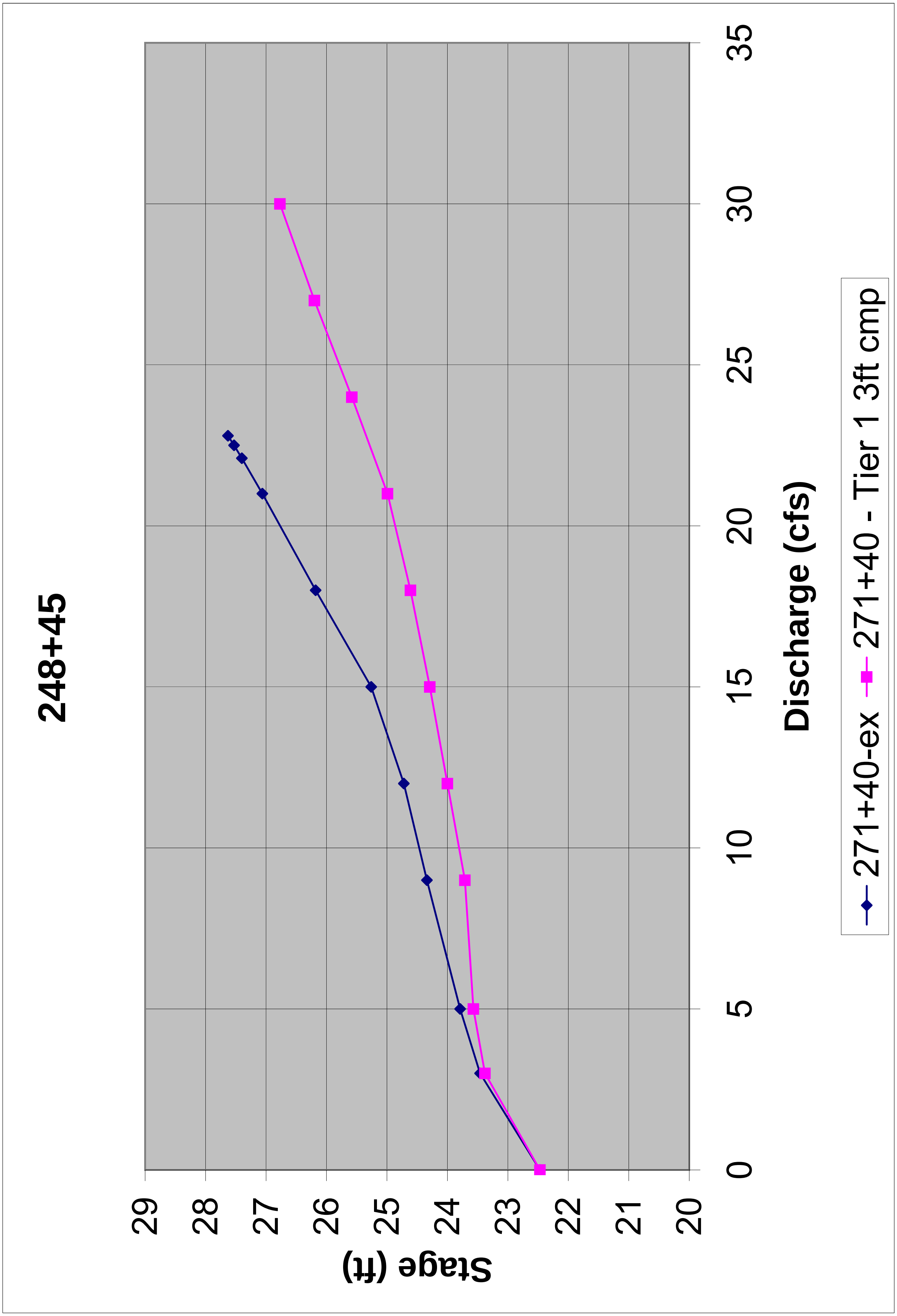
******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	21.15	0.000	-0.56	0.00	0.00
3.00	22.04	0.386	0.33	1.85	0.17
5.00	22.10	0.392	0.39	1.96	0.19
9.00	22.18	0.398	0.47	2.10	0.21
12.00	22.23	0.402	0.52	2.17	0.22
15.00	22.27	0.405	0.56	2.23	0.23
18.00	22.31	0.407	0.60	2.29	0.24
21.00	22.34	0.409	0.63	2.34	0.25
24.00	22.36	0.411	0.65	2.38	0.25
27.00	22.39	0.413	0.68	2.42	0.26
30.00	22.41	0.414	0.70	2.45	0.26

Note: Shear stress was calculated using R.

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE PAVED
EMBANKMENT TOP WIDTH 24.00 ft
CREST LENGTH 10.00 ft
OVERTOPPING CREST ELEVATION 27.64 ft



248+45
Stage (ft)
Discharge (cfs)
29
28
27
26
25
24
23
22
21
20
0
5
10
15
20
25
30
35
271+40-ex
271+40 - Tier 1 3ft cmp

2009 Alignment Station: 248+45

1 2006 S&HI Station 271+40 Existing conditions

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 11:21:00 FILE NAME: 27140EX

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	22.47	22.20	58.00	1 CSP	2.00	2.00	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 27140EX DATE: 08-25-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
22.47	0	0	0	0	0	0	0	0	1
23.46	3	3	0	0	0	0	0	0	1
23.79	5	5	0	0	0	0	0	0	1
24.34	9	9	0	0	0	0	0	0	1
24.72	12	12	0	0	0	0	0	0	1
25.26	15	15	0	0	0	0	0	0	1
26.18	18	18	0	0	0	0	0	0	1
27.06	21	21	0	0	0	0	0	0	1
27.4	24	22.1	0	0	0	0	0	1.7	6
27.53	27	22.5	0	0	0	0	0	4.33	4
27.63	30	22.8	0	0	0	0	0	7.08	4
27.25	21.6	21.6	0	0	0	0	0	OVERTOPP ING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 27140EX DATE: 08-25-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
22.47	0.000	0.00	0.00	0.00
23.46	0.000	3.00	0.00	0.00
23.79	0.000	5.00	0.00	0.00
24.34	0.000	9.00	0.00	0.00
24.72	0.000	12.00	0.00	0.00
25.26	0.000	15.00	0.00	0.00
26.18	0.000	18.00	0.00	0.00
27.06	0.000	21.00	0.00	0.00

27.40	-0.007	24.00	0.22	0.92
27.53	-0.004	27.00	0.18	0.67
27.63	-0.008	30.00	0.09	0.30

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

2

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 11:21:00 FILE NAME: 27140EX

PERFORMANCE CURVE FOR CULVERT 1 - 1(2.00 (ft) BY 2.00 (ft)) CSP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	22.47	0.00	0.00	0-NF	0.00	0.00	0.00	-0.54	0.00	0.00
3.00	23.46	0.90	0.99	2-M2c	0.82	0.60	0.60	0.22	3.75	2.00
5.00	23.79	1.19	1.32	2-M2c	1.11	0.79	0.79	0.31	4.36	2.17
9.00	24.34	1.70	1.87	2-M2c	2.00	1.07	1.07	0.39	5.28	2.34
12.00	24.72	2.09	2.25	2-M2c	2.00	1.24	1.24	0.43	5.85	2.42
15.00	25.26	2.53	2.79	2-M2c	2.00	1.40	1.40	0.47	6.41	2.48
18.00	26.18	3.05	3.71	2-M2c	2.00	1.52	1.52	0.50	7.03	2.54
21.00	27.06	3.67	4.59	2-M2c	2.00	1.63	1.63	0.53	7.63	2.59
22.09	27.40	3.92	4.93	2-M2c	2.00	1.67	1.67	0.55	7.92	2.63
22.49	27.52	4.02	5.05	2-M2c	2.00	1.68	1.68	0.57	8.02	2.67
22.83	27.63	4.10	5.16	2-M2c	2.00	1.69	1.69	0.59	8.10	2.71

El. inlet face invert 22.47 ft El. outlet invert 22.20 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION 0.00 ft
INLET ELEVATION 22.47 ft
OUTLET STATION 58.00 ft
OUTLET ELEVATION 22.20 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0047
CULVERT LENGTH ALONG SLOPE 58.00 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE CIRCULAR
BARREL DIAMETER 2.00 ft
BARREL MATERIAL CORRUGATED STEEL
BARREL MANNING'S n 0.024
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL THIN EDGE PROJECTING
INLET DEPRESSION NONE

3

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 11:21:00 FILE NAME: 27140EX

TAILWATER

***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 27140TW
MAIN CHANNEL AND LT & RT OVER BANKS FILE DATE: 08-25-2006

LEFT CHANNEL BOUNDARY	2
RIGHT CHANNEL BOUNDARY	5
MANNING n LEFT OVER BANK	0.050
MANNING n MAIN CHANNEL	0.035
MANNING n RIGHT OVER BANK	0.050
SLOPE OF CHANNEL	0.0053 ft/ft

CROSS-SECTION COORD. NO.	X (ft)	Y (ft)
1	0.00	23.00
2	100.00	22.36
3	100.50	21.66
4	102.50	21.66
5	103.00	22.36
6	203.00	23.00

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	21.66	0.000	-0.54	0.00	0.00
3.00	22.42	0.439	0.22	2.00	0.17
5.00	22.51	0.448	0.31	2.17	0.19
9.00	22.59	0.456	0.39	2.34	0.22
12.00	22.64	0.460	0.43	2.42	0.23
15.00	22.67	0.463	0.47	2.48	0.24
18.00	22.70	0.466	0.50	2.54	0.25
21.00	22.73	0.468	0.53	2.59	0.25
24.00	22.75	0.470	0.55	2.63	0.26
27.00	22.77	0.472	0.57	2.67	0.27
30.00	22.79	0.473	0.59	2.71	0.27

Note: Shear stress was calculated using R.

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	24.00 ft
CREST LENGTH	10.00 ft
OVERTOPPING CREST ELEVATION	27.25 ft

2009 Alignment Station: 248+45

1 2006 S&HI Station 271+40 Tier 1 fish passage - 3-ft CMP

CURRENT DATE: 08-29-2006 FILE DATE: 08-29-2006
CURRENT TIME: 20:14:01 FILE NAME: 271-T3

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	22.47	22.20	58.00	1 ICMP	3.10	1.80	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 271-T3 DATE: 08-29-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
22.47	0	0	0	0	0	0	0	0	1
23.38	3	3	0	0	0	0	0	0	1
23.57	5	5	0	0	0	0	0	0	1
23.71	9	9	0	0	0	0	0	0	1
24	12	12	0	0	0	0	0	0	1
24.29	15	15	0	0	0	0	0	0	1
24.61	18	18	0	0	0	0	0	0	1
24.99	21	21	0	0	0	0	0	0	1
25.58	24	24	0	0	0	0	0	0	1
26.2	27	27	0	0	0	0	0	0	1
26.77	30	30	0	0	0	0	0	0	1
27.25	32	32	0	0	0	0	0	OVERTOPP ING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 271-T3 DATE: 08-29-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
22.47	0.000	0.00	0.00	0.00
23.38	0.000	3.00	0.00	0.00
23.57	0.000	5.00	0.00	0.00
23.71	0.000	9.00	0.00	0.00
24.00	0.000	12.00	0.00	0.00
24.29	0.000	15.00	0.00	0.00

24.61	0.000	18.00	0.00	0.00
24.99	0.000	21.00	0.00	0.00
25.58	0.000	24.00	0.00	0.00
26.20	0.000	27.00	0.00	0.00
26.77	0.000	30.00	0.00	0.00

□□□

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

□□□
□

2

CURRENT DATE: 08-29-2006 FILE DATE: 08-29-2006
CURRENT TIME: 20:14:01 FILE NAME: 271-T3

□□□

PERFORMANCE CURVE FOR CULVERT 1 - 1(3.10 (ft) BY 1.80 (ft)) ICMP

□□□

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	22.47	0.00	0.00	0-NF	0.00	0.00	0.00	-0.54	0.00	0.00
3.00	23.38	0.91	0.57	2-M2c	0.46	0.31	0.31	0.24	3.22	1.88
5.00	23.57	1.10	0.82	2-M2c	0.66	0.44	0.44	0.32	3.81	2.02
9.00	23.71	1.18	1.24	2-M2c	1.06	0.64	0.64	0.40	4.70	2.16
12.00	24.00	1.44	1.53	2-M2c	1.43	0.78	0.78	0.44	5.23	2.24
15.00	24.29	1.69	1.82	2-M2c	1.80	0.90	0.90	0.47	5.70	2.30
18.00	24.61	1.97	2.14	2-M2c	1.80	1.02	1.02	0.50	6.16	2.35
21.00	24.99	2.35	2.52	2-M2c	1.80	1.13	1.13	0.53	6.56	2.39
24.00	25.58	2.75	3.11	2-M2c	1.80	1.23	1.23	0.55	6.99	2.43
27.00	26.20	3.18	3.73	2-M2c	1.80	1.31	1.31	0.58	7.46	2.47
30.00	26.77	3.64	4.30	2-M2c	1.80	1.39	1.39	0.60	7.94	2.50

□□□

El. inlet face invert 22.47 ft El. outlet invert 22.20 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

□□□

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION 0.00 ft
INLET ELEVATION 22.47 ft
OUTLET STATION 58.00 ft
OUTLET ELEVATION 22.20 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0047
CULVERT LENGTH ALONG SLOPE 58.00 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE USER DEFINED
BARREL SPAN 3.10 ft
BARREL RISE 1.80 ft
BARREL MATERIAL STEEL OR ALUMINUM
BARREL MANNING'S n 0.024 FOR SIDES AND TOP

0.038 FOR BOTTOM
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL MITERED
INLET DEPRESSION NONE

□□□
□
3

CURRENT DATE: 08-29-2006 FILE DATE: 08-29-2006
CURRENT TIME: 20:14:01 FILE NAME: 271-T3

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***** USER DEFINED CULVERT CROSS-SECTION - CULVERT # 1

COORDINATE NUMBER	X (ft)	Y-TOP (ft)	Y-BOTTOM (ft)
1	73.30	22.77	22.77
2	73.40	23.07	22.47
3	73.70	23.70	22.47
4	74.00	23.98	22.47
5	74.30	24.15	22.47
6	74.60	24.24	22.47
7	74.80	24.27	22.47
8	75.10	24.24	22.47
9	75.40	24.15	22.47
10	75.70	23.98	22.47
11	76.00	23.70	22.47
12	76.30	23.07	22.47
13	76.40	22.77	22.77

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4

CURRENT DATE: 08-29-2006 FILE DATE: 08-29-2006
CURRENT TIME: 20:14:01 FILE NAME: 271-T3

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***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 271-T3
MAIN CHANNEL AND LT & RT OVER BANKS FILE DATE: 08-29-2006
LEFT CHANNEL BOUNDARY 2
RIGHT CHANNEL BOUNDARY 5
MANNING n LEFT OVER BANK 0.050
MANNING n MAIN CHANNEL 0.038
MANNING n RIGHT OVER BANK 0.050
SLOPE OF CHANNEL 0.0053 ft/ft

CROSS-SECTION X Y

COORD. NO.	(ft)	(ft)
1	0.00	23.00
2	100.00	22.36
3	100.50	21.66
4	102.50	21.66
5	103.00	22.36
6	203.00	23.00

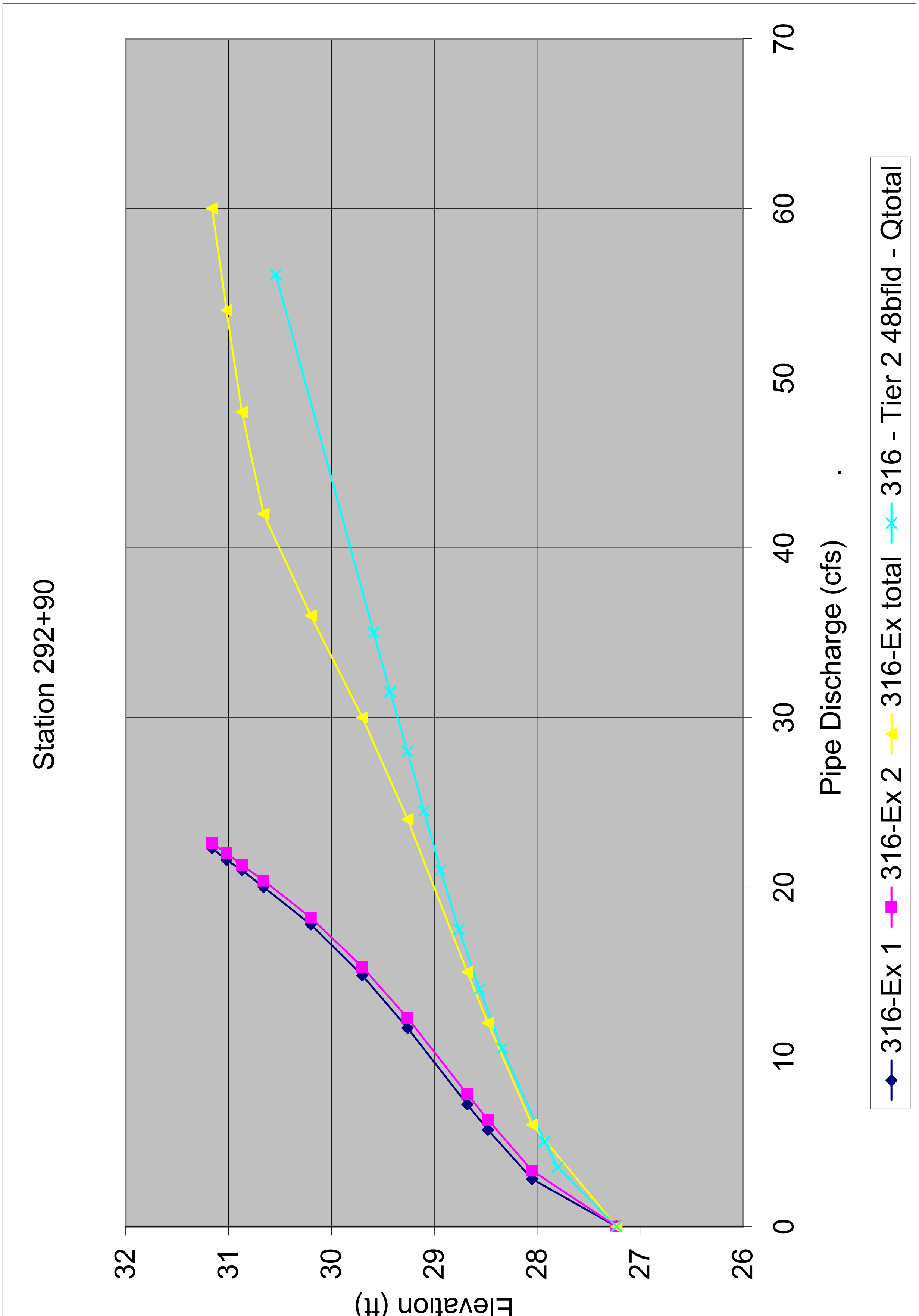
******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	21.66	0.000	-0.54	0.00	0.00
3.00	22.44	0.406	0.24	1.88	0.18
5.00	22.52	0.413	0.32	2.02	0.20
9.00	22.60	0.421	0.40	2.16	0.22
12.00	22.64	0.424	0.44	2.24	0.23
15.00	22.67	0.427	0.47	2.30	0.24
18.00	22.70	0.429	0.50	2.35	0.25
21.00	22.73	0.431	0.53	2.39	0.25
24.00	22.75	0.433	0.55	2.43	0.26
27.00	22.78	0.435	0.58	2.47	0.27
30.00	22.80	0.436	0.60	2.50	0.27

Note: Shear stress was calculated using R.

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	24.00 ft
CREST LENGTH	10.00 ft
OVERTOPPING CREST ELEVATION	27.25 ft



Station 292+90
Elevation (ft)
32
31
30
29
28
27
26
0
10
20
30
40
50
60
70
Pipe Discharge (cfs)
316-Ex 1
316-Ex 2
316-Ex total
316 - Tier 2 48bfld - Qtotal

2009 Alignment Station: 292+90

1 2006 S&HI Station 316+00 Existing conditions

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 13:41:30 FILE NAME: 316-EX

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA: INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	27.23	25.55	49.03	1 CSP	2.00	2.00	.024	CONVENTIONAL
2	27.15	25.52	50.03	1 CSP	2.00	2.00	.024	CONVENTIONAL
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 316-EX DATE: 08-17-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWA`	ITR
27.23	0	0	0	0	0	0	0	0	0
28.05	6	2.8	3.3	0	0	0	0	0	4
28.48	12	5.7	6.3	0	0	0	0	0	3
28.68	15	7.2	7.8	0	0	0	0	0	2
29.26	24	11.7	12.3	0	0	0	0	0	3
29.7	30	14.8	15.3	0	0	0	0	0	3
30.2	36	17.8	18.2	0	0	0	0	0	3
30.66	42	20	20.4	0	0	0	0	1.2	5
30.87	48	21	21.3	0	0	0	0	5.55	4
31.02	54	21.6	22	0	0	0	0	10.05	3
31.16	60	22.3	22.6	0	0	0	0	14.9	3
30.54	39.3	19.5	19.9	0	0	0	0	OVERTOF	ING

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 316-EX DATE: 08-17-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
27.23	0.000	0.00	0.00	0.00
28.05	-0.005	6.00	0.00	0.00
28.48	0.001	12.00	-0.01	-0.08
28.68	0.003	15.00	-0.05	-0.33
29.26	0.002	24.00	-0.03	-0.13
29.70	0.004	30.00	-0.05	-0.17
30.20	-0.006	36.00	0.09	0.25
30.66	-0.010	42.00	0.35	0.83
30.87	-0.004	48.00	0.19	0.40
31.02	-0.006	54.00	0.33	0.61
31.16	-0.005	60.00	0.26	0.43

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

2

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 13:41:30 FILE NAME: 316-EX

PERFORMANCE CURVE FOR CULVERT 1 - 1(2.00 (ft) BY 2.00 (ft)) CSP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	27.23	0	0	0-NF	0	0	0	0.02	0	0
2.75	28.06	0.83	0.83	1-S2n	0.46	0.57	0.37	0.34	6.69	1.75
5.73	28.49	1.26	1.26	1-S2n	0.68	0.84	0.67	0.48	6.16	2.19
7.22	28.68	1.45	1.45	1-S2n	0.77	0.95	0.65	0.54	8.12	2.37
11.73	29.26	2.03	2.03	5-S2n	1.02	1.23	0.93	0.69	8.22	2.78
14.78	29.7	2.47	2.47	5-S2n	1.17	1.38	1.08	0.78	8.5	3
17.75	30.2	2.97	2.97	5-S2n	1.33	1.51	1.21	0.87	8.91	3.19
20.04	30.66	3.43	3.43	5-S2n	1.46	1.61	1.41	0.95	8.49	3.36
20.95	30.86	3.63	3.63	5-S2n	1.52	1.63	1.43	1.02	8.69	3.51
21.64	31.01	3.78	3.78	5-S2n	1.56	1.65	1.45	1.09	8.87	3.65
22.26	31.16	3.93	3.93	5-S2n	1.6	1.67	1.59	1.15	8.31	3.77

El. inlet face invert 27.23 ft El. outlet invert 25.55 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************
INLET STATION 1.00 ft
INLET ELEVATION 27.23 ft
OUTLET STATION 50.00 ft
OUTLET ELEVATION 25.55 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0343
CULVERT LENGTH ALONG SLOPE 49.03 ft

***** CULVERT DATA SUMMARY ************************
BARREL SHAPE CIRCULAR
BARREL DIAMETER 2.00 ft
BARREL MATERIAL CORRUGATED STEEL
BARREL MANNING'S n 0.024
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL THIN EDGE PROJECTING
INLET DEPRESSION NONE

3

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 13:41:30 FILE NAME: 316-EX

PERFORMANCE CURVE FOR CULVERT 2 - 1(2.00 (ft) BY 2.00 (ft)) CSP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	27.15	0.00	0.00	0-NF	0.00	0.00	0.00	0.05	0.00	0.00
3.25	28.06	0.91	0.91	1-S2n	0.51	0.63	0.43	0.37	6.70	1.75
6.28	28.48	1.33	1.33	1-S2n	0.72	0.88	0.72	0.51	6.13	2.19
7.83	28.68	1.53	1.53	1-S2n	0.82	0.99	0.69	0.57	8.04	2.37
12.30	29.25	2.10	2.10	5-S2n	1.06	1.26	0.96	0.72	8.28	2.78
15.27	29.70	2.55	2.55	5-S2n	1.22	1.41	1.11	0.81	8.56	3.00
18.16	30.20	3.05	3.05	5-S2n	1.38	1.53	1.37	0.90	7.93	3.19
20.41	30.66	3.51	3.51	5-S2n	1.52	1.62	1.42	0.98	8.57	3.36
21.30	30.86	3.71	3.71	5-S2n	1.58	1.64	1.44	1.05	8.76	3.51
21.98	31.01	3.86	3.86	5-S2n	1.63	1.66	1.56	1.12	8.36	3.65
22.58	31.16	4.01	3.59	2-M2c	1.69	1.68	1.68	1.18	8.04	3.77

El. inlet face invert 27.15 ft El. outlet invert 25.52 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************
INLET STATION 0.00 ft
INLET ELEVATION 27.15 ft
OUTLET STATION 50.00 ft
OUTLET ELEVATION 25.52 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0326
CULVERT LENGTH ALONG SLOPE 50.03 ft

***** CULVERT DATA SUMMARY ************************
BARREL SHAPE CIRCULAR
BARREL DIAMETER 2.00 ft
BARREL MATERIAL CORRUGATED STEEL
BARREL MANNING'S n 0.024
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL THIN EDGE PROJECTING
INLET DEPRESSION NONE

4

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 13:41:30 FILE NAME: 316-EX

TAILWATER

***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 316-TW
MAIN CHANNEL AND LT & RT OVER BANKS FILE DATE: 08-17-2006
LEFT CHANNEL BOUNDARY 2
RIGHT CHANNEL BOUNDARY 5
MANNING n LEFT OVER BANK 0.050

MANNING n MAIN CHANNEL 0.038
MANNING n RIGHT OVER BANK 0.050
SLOPE OF CHANNEL 0.0100 ft/ft

CROSS-SECTION COORD. NO.	X (ft)	Y (ft)
1	0.00	29.32
2	17.50	28.65
3	23.50	25.57
4	35.50	25.57
5	40.50	28.02
6	58.50	29.30

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	25.57	0.000	0.02	0.00	0.00
6.00	25.89	0.560	0.34	1.75	0.19
12.00	26.03	0.592	0.48	2.19	0.26
15.00	26.09	0.603	0.54	2.37	0.29
24.00	26.24	0.626	0.69	2.78	0.37
30.00	26.33	0.637	0.78	3.00	0.42
36.00	26.42	0.646	0.87	3.19	0.46
42.00	26.50	0.654	0.95	3.36	0.50
48.00	26.57	0.661	1.02	3.51	0.53
54.00	26.64	0.667	1.09	3.65	0.56
60.00	26.70	0.672	1.15	3.77	0.59

Note: Shear stress was calculated using R.

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□□

ROADWAY SURFACE PAVED
EMBANKMENT TOP WIDTH 24.00 ft
CREST LENGTH 10.00 ft
OVERTOPPING CREST ELEVATION 30.54 ft

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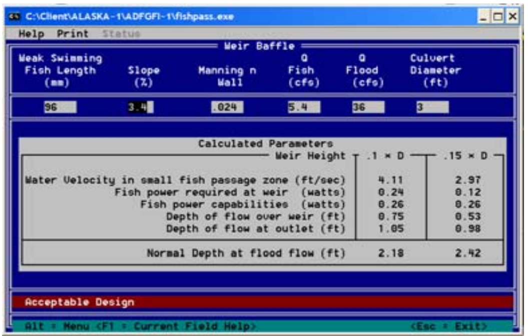
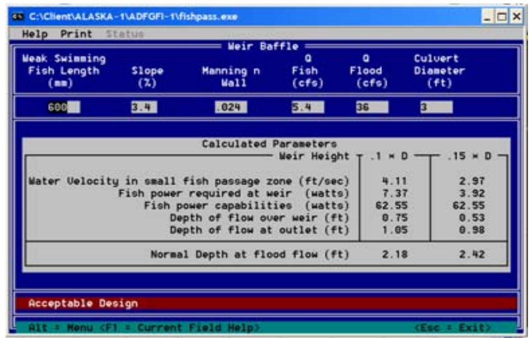
2009 Alignment Station: 292+90
2006 S&HI Station 316+00 Tier 2 FISH PASS design

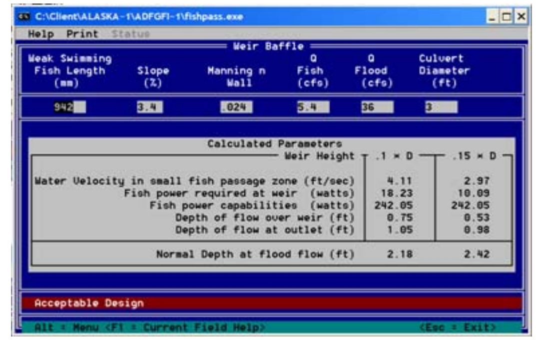
Baffle design: Juvenile Fish



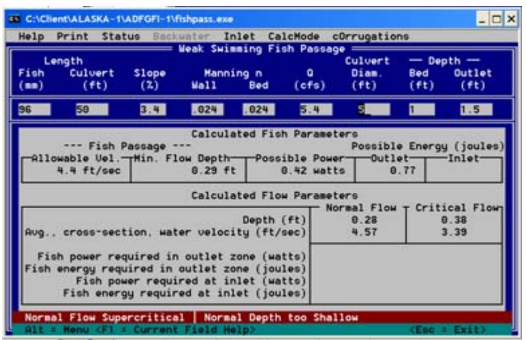
Adult fish - 600-mm

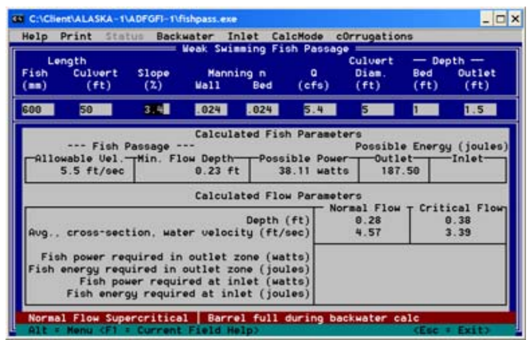


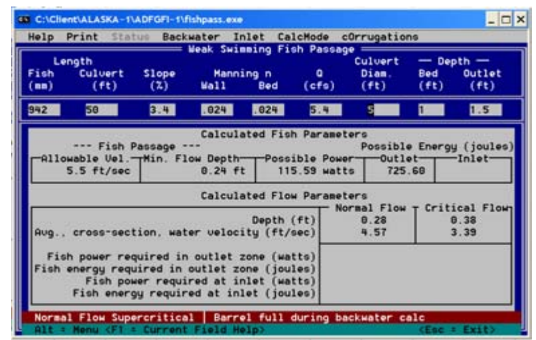
Adult fish - adjusted to 'equivalent' grayling



non-baffle design big pipe:







2009 Alignment Station: 292+90

1 2006 S&HI Station 316+00 Tier 2 fish passage - 4-ft baffled CMP

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006
CURRENT TIME: 16:17:10 FILE NAME: 316T2-4B

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	27.23	25.55	50.03	1 ICMP	4.00	3.40	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 316T2-4B DATE: 09-07-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWA`	ITR
27.23	0	0	0	0	0	0	0	0	1
27.8	3.5	3.5	0	0	0	0	0	0	1
27.93	5	5	0	0	0	0	0	0	1
28.34	10.5	10.5	0	0	0	0	0	0	1
28.56	14	14	0	0	0	0	0	0	1
28.76	17.5	17.5	0	0	0	0	0	0	1
28.94	21	21	0	0	0	0	0	0	1
29.1	24.5	24.5	0	0	0	0	0	0	1
29.26	28	28	0	0	0	0	0	0	1
29.43	31.5	31.5	0	0	0	0	0	0	1
29.59	35	35	0	0	0	0	0	0	1
30.54	56.1	56.1	0	0	0	0	0	OVERTOF	ING

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 316T2-4B DATE: 09-07-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
27.23	0.000	0.00	0.00	0.00
27.80	0.000	3.50	0.00	0.00
27.93	0.000	5.00	0.00	0.00
28.34	0.000	10.50	0.00	0.00
28.56	0.000	14.00	0.00	0.00
28.76	0.000	17.50	0.00	0.00
28.94	0.000	21.00	0.00	0.00
29.10	0.000	24.50	0.00	0.00
29.26	0.000	28.00	0.00	0.00
29.43	0.000	31.50	0.00	0.00
29.59	0.000	35.00	0.00	0.00

□□

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

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□

2

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006
CURRENT TIME: 16:17:10 FILE NAME: 316T2-4B

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PERFORMANCE CURVE FOR CULVERT 1 - 1(4.00 (ft) BY 3.40 (ft)) ICMP

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DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	27.23	0.00	0.00	0-NF	0.00	0.00	0.00	0.02	0.00	0.00
3.50	27.80	0.57	0.57	1-S2n	0.23	0.35	0.15	0.26	4.89	1.50
5.00	27.93	0.70	0.70	1-S2n	0.32	0.42	0.22	0.31	5.35	1.67
10.50	28.34	1.11	1.11	1-S2n	0.50	0.69	0.39	0.44	8.37	2.13
14.00	28.56	1.33	1.33	1-S2n	0.60	0.82	0.52	0.51	8.18	2.35
17.50	28.76	1.53	1.53	1-S2n	0.70	0.95	0.65	0.58	8.07	2.53
21.00	28.94	1.71	1.71	1-S2n	0.78	1.07	0.67	0.64	9.40	2.69
24.50	29.10	1.87	1.87	1-S2n	0.86	1.17	0.77	0.69	9.32	2.84
28.00	29.26	2.03	2.03	1-S2n	0.94	1.28	0.88	0.75	9.25	2.97
31.50	29.43	2.20	2.20	1-S2n	1.02	1.38	1.03	0.80	8.81	3.09
35.00	29.59	2.36	2.36	1-S2n	1.09	1.47	1.10	0.85	9.05	3.20

□□

El. inlet face invert 27.23 ft El. outlet invert 25.55 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

□□

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION 0.00 ft
INLET ELEVATION 27.23 ft
OUTLET STATION 50.00 ft
OUTLET ELEVATION 25.55 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0336
CULVERT LENGTH ALONG SLOPE 50.03 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE USER DEFINED
BARREL SPAN 4.00 ft
BARREL RISE 3.40 ft
BARREL MATERIAL STEEL OR ALUMINUM
BARREL MANNING'S n 0.024 FOR SIDES AND TOP
0.038 FOR BOTTOM
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL MITERED
INLET DEPRESSION NONE

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3

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006

CURRENT TIME: 16:17:10 FILE NAME: 316T2-4B

□□

***** USER DEFINED CULVERT CROSS-SECTION - CULVERT # 1

COORDIN NUMBER	X (ft)	Y-TOP (ft)	Y-BOTTOM (ft)
1	0	28.63	28.63
2	0.19	29.48	27.78
3	0.38	29.8	27.46
4	0.57	30.03	27.23
5	0.93	30.32	27.23
6	1.29	30.5	27.23
7	1.64	30.6	27.23
8	2	30.63	27.23
9	2.36	30.6	27.23
10	2.71	30.5	27.23
11	3.07	30.32	27.23
12	3.43	30.03	27.23
13	3.62	29.8	27.46
14	3.81	29.48	27.78
15	4	28.63	28.63

□□
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4

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006
CURRENT TIME: 16:17:10 FILE NAME: 316T2-4B

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***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 316T2-4
MAIN CHANNEL AND LT & RT OVER BANKS FILE DATE: 09-07-2006
LEFT CHANNEL BOUNDARY 2
RIGHT CHANNEL BOUNDARY 5
MANNING n LEFT OVER BANK 0.050
MANNING n MAIN CHANNEL 0.038
MANNING n RIGHT OVER BANK 0.050
SLOPE OF CHANNEL 0.0104 ft/ft

CROSS-SECTION COORD. NO.	X (ft)	Y (ft)
1	0.00	29.32
2	17.50	28.65
3	23.50	25.57
4	35.50	25.57
5	40.50	28.02
6	58.50	29.30

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

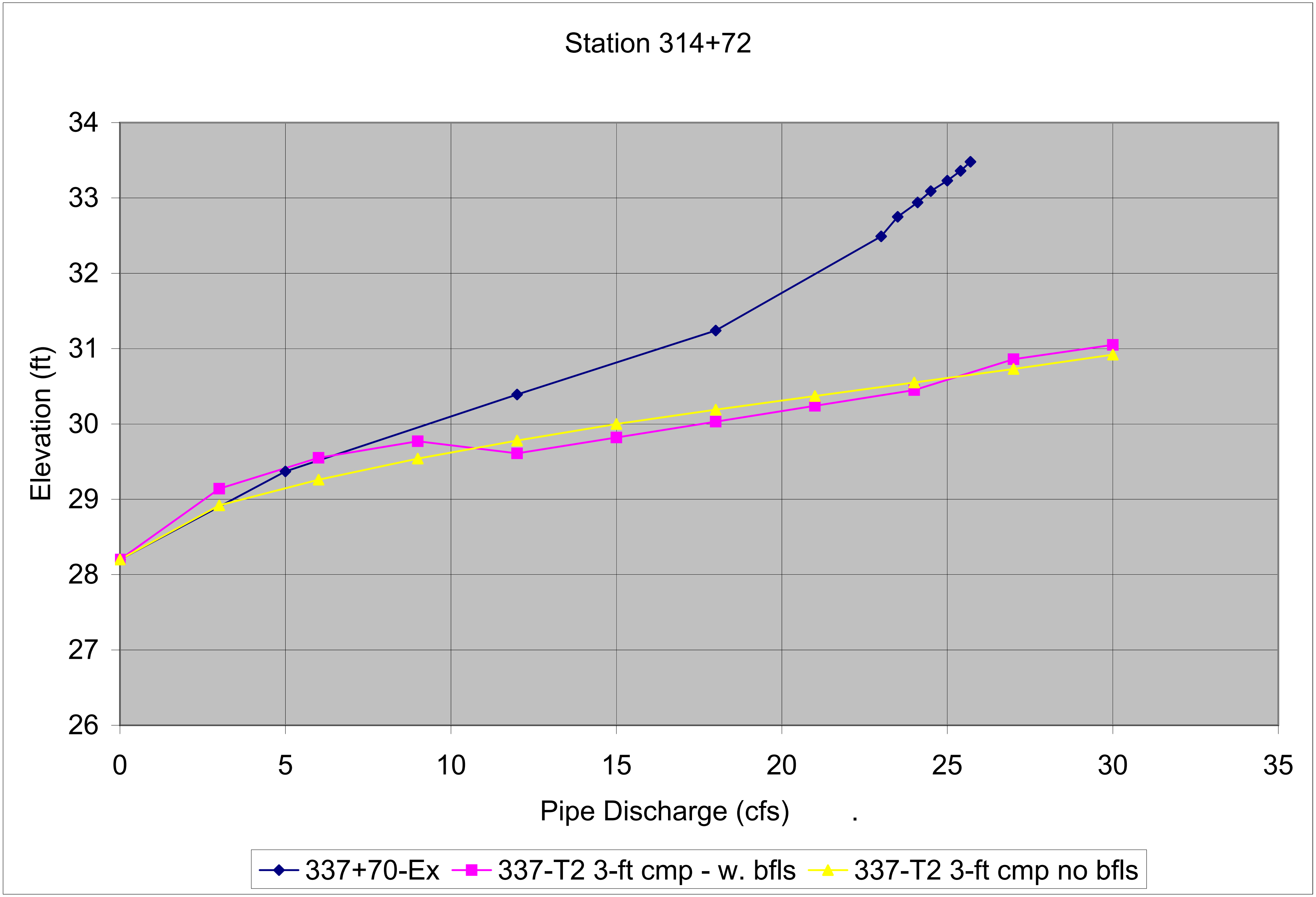
FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	25.57	0.000	0.02	0.00	0.00

3.50	25.81	0.548	0.26	1.50	0.15
5.00	25.86	0.562	0.31	1.67	0.18
10.50	25.99	0.596	0.44	2.13	0.25
14.00	26.06	0.610	0.51	2.35	0.29
17.50	26.13	0.622	0.58	2.53	0.33
21.00	26.19	0.631	0.64	2.69	0.36
24.50	26.24	0.638	0.69	2.84	0.39
28.00	26.30	0.645	0.75	2.97	0.42
31.50	26.35	0.651	0.80	3.09	0.44
35.00	26.40	0.657	0.85	3.20	0.47

Note: Shear stress was calculated using R.

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE PAVED
EMBANKMENT TOP WIDTH 24.00 ft
CREST LENGTH 10.00 ft
OVERTOPPING CREST ELEVATION 30.54 ft



Station 314+72
34
33
32
31
30
29
28
27
26
Elevation (ft)
0
5
10
15
20
25
30
35
Pipe Discharge (cfs)
337+70-Ex
337-T2 3-ft cmp - w. bfls
337-T2 3-ft cmp no bfls

2009 Alignment Station: 314+72

1 2006 S&HI Station 337+70 Existing conditions

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 13:50:32 FILE NAME: 33770

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	28.20	27.33	52.01	1 CSP	2.00	2.00	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 33770 DATE: 08-17-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
28.2	0	0	0	0	0	0	0	0	1
29.37	5	5	0	0	0	0	0	0	1
30.39	12	12	0	0	0	0	0	0	1
31.24	18	18	0	0	0	0	0	0	1
32.49	24	23	0	0	0	0	0	0.82	8
32.75	30	23.5	0	0	0	0	0	6.28	4
32.94	36	24.1	0	0	0	0	0	11.85	4
33.09	42	24.5	0	0	0	0	0	17.2	3
33.23	48	25	0	0	0	0	0	22.79	3
33.36	54	25.4	0	0	0	0	0	28.44	3
33.48	60	25.7	0	0	0	0	0	34.1	3
32.4	22.7	22.7	0	0	0	0	0	OVERTOPP	ING

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 33770 DATE: 08-17-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
28.20	0.000	0.00	0.00	0.00
29.37	0.000	5.00	0.00	0.00
30.39	0.000	12.00	0.00	0.00
31.24	0.000	18.00	0.00	0.00
32.49	-0.007	24.00	0.22	0.92
32.75	-0.006	30.00	0.25	0.83

32.94	-0.009	36.00	0.09	0.25
33.09	-0.005	42.00	0.26	0.62
33.23	-0.004	48.00	0.23	0.48
33.36	-0.003	54.00	0.19	0.35
33.48	-0.003	60.00	0.16	0.27

□□

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

□□
□

2

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 13:50:32 FILE NAME: 33770

□□

PERFORMANCE CURVE FOR CULVERT 1 - 1(2.00 (ft) BY 2.00 (ft)) CSP

□□

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)
0	28.2	0	0	0-NF	0	0	0	-0.05	0
5	29.37	1.17	1.17	1-S2n	0.77	0.79	0.69	0.23	5.23
12	30.39	2.08	2.19	2-M2c	1.3	1.24	1.24	0.36	5.85
18	31.24	3.04	2.88	2-M2c	2	1.52	1.52	0.46	7.03
22.96	32.49	4.12	4.29	2-M2c	2	1.69	1.69	0.54	8.13
23.47	32.75	4.25	4.55	2-M2c	2	1.71	1.71	0.61	8.25
24.06	32.93	4.4	4.73	2-M2c	2	1.72	1.72	0.68	8.38
24.54	33.08	4.53	4.88	2-M2c	2	1.74	1.74	0.74	8.49
24.98	33.23	4.65	5.03	2-M2c	2	1.75	1.75	0.8	8.59
25.37	33.35	4.76	5.15	2-M2c	2	1.76	1.76	0.85	8.67
25.74	33.47	4.87	5.27	2-M2c	2	1.77	1.77	0.91	8.75

□□

El. inlet face invert 28.20 ft El. outlet invert 27.33 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

□□

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION 0.00 ft
INLET ELEVATION 28.20 ft
OUTLET STATION 52.00 ft
OUTLET ELEVATION 27.33 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0167
CULVERT LENGTH ALONG SLOPE 52.01 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE CIRCULAR
BARREL DIAMETER 2.00 ft
BARREL MATERIAL CORRUGATED STEEL
BARREL MANNING'S n 0.024
INLET TYPE CONVENTIONAL

INLET EDGE AND WALL THIN EDGE PROJECTING
INLET DEPRESSION NONE

3

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 13:50:32 FILE NAME: 33770

TAILWATER

***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 33770-TW
MAIN CHANNEL ONLY FILE DATE: 08-17-2006
LEFT CHANNEL BOUNDARY 0
RIGHT CHANNEL BOUNDARY 0
MANNING n LEFT OVER BANK 0.000
MANNING n MAIN CHANNEL 0.040
MANNING n RIGHT OVER BANK 0.000
SLOPE OF CHANNEL 0.0290 ft/ft

CROSS-SECTION COORD. NO.	X (ft)	Y (ft)
1	0.00	31.19
2	7.00	27.36
3	17.20	27.28
4	30.20	31.04

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	27.28	0.000	-0.05	0.00	0.00
5.00	27.56	0.865	0.23	2.32	0.40
12.00	27.69	0.926	0.36	3.08	0.62
18.00	27.79	0.957	0.46	3.54	0.76
24.00	27.87	0.979	0.54	3.88	0.87
30.00	27.94	0.996	0.61	4.18	0.97
36.00	28.01	1.011	0.68	4.44	1.07
42.00	28.07	1.023	0.74	4.67	1.15
48.00	28.13	1.033	0.80	4.88	1.22
54.00	28.18	1.043	0.85	5.06	1.29
60.00	28.24	1.051	0.91	5.24	1.36

Note: Shear stress was calculated using R.

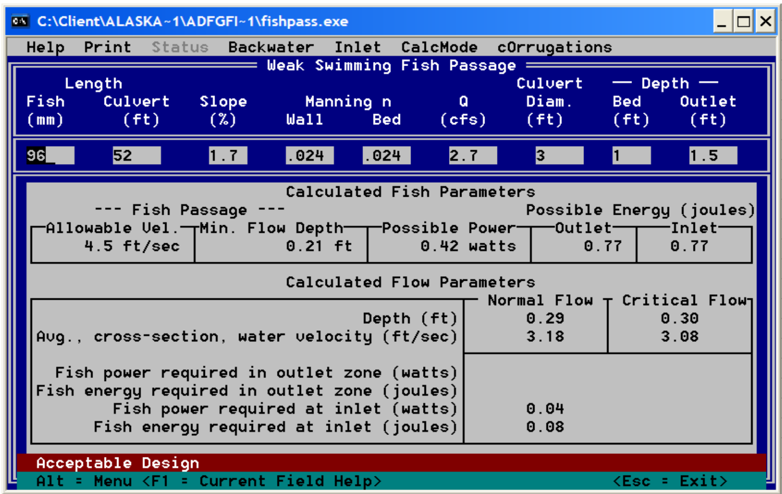
ROADWAY OVERTOPPING DATA

ROADWAY SURFACE PAVED

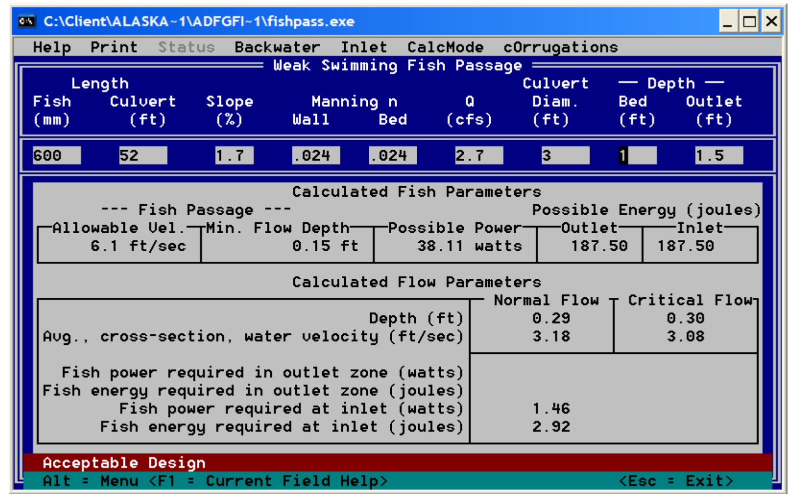
EMBANKMENT TOP WIDTH	24.00 ft
CREST LENGTH	10.00 ft
OVERTOPPING CREST ELEVATION	32.40 ft

2009 Alignment Station: 314+72
2006 S&HI Station 337+70 Tier 2 FISH PASS design

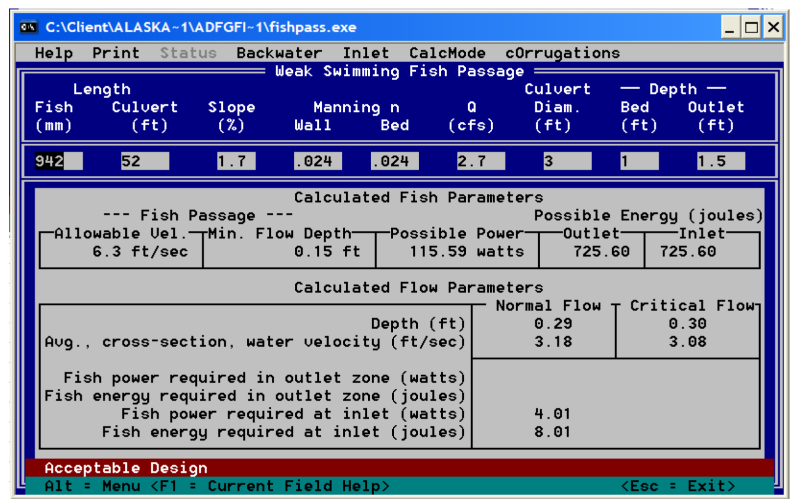
non-baffle design: Juvenile Coho



adult coho - 600mm



Adult coho - adjusted to 'equivalent' grayling



1 2006 S&HI Station 337+70 Tier 2 fish passage - 3-ft CMP

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006
CURRENT TIME: 16:53:01 FILE NAME: 337T2-3

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	28.20	27.33	52.01	1 CSP	3.00	3.00	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 337T2-3 DATE: 09-07-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWA`	ITR
28.2	0	0	0	0	0	0	0	0	1
28.92	3	3	0	0	0	0	0	0	1
29.26	6	6	0	0	0	0	0	0	1
29.54	9	9	0	0	0	0	0	0	1
29.78	12	12	0	0	0	0	0	0	1
30	15	15	0	0	0	0	0	0	1
30.19	18	18	0	0	0	0	0	0	1
30.37	21	21	0	0	0	0	0	0	1
30.55	24	24	0	0	0	0	0	0	1
30.73	27	27	0	0	0	0	0	0	1
30.92	30	30	0	0	0	0	0	0	1
32.4	48.5	48.5	0	0	0	0	0	OVERTOF	ING

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 337T2-3 DATE: 09-07-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
28.20	0.000	0.00	0.00	0.00
28.92	0.000	3.00	0.00	0.00
29.26	0.000	6.00	0.00	0.00
29.54	0.000	9.00	0.00	0.00
29.78	0.000	12.00	0.00	0.00
30.00	0.000	15.00	0.00	0.00

30.19	0.000	18.00	0.00	0.00
30.37	0.000	21.00	0.00	0.00
30.55	0.000	24.00	0.00	0.00
30.73	0.000	27.00	0.00	0.00
30.92	0.000	30.00	0.00	0.00

□□

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

□□
□

2

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006
CURRENT TIME: 16:53:01 FILE NAME: 337T2-3

□□

PERFORMANCE CURVE FOR CULVERT 1 - 1(3.00 (ft) BY 3.00 (ft)) CSP

□□

DIS- CHARGE FLOW (cfs)	HEAD- WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	28.20	0.00	0.00	0-NF	0.00	0.00	0.00	-0.05	0.00	0.00
3.00	28.92	0.72	0.72	1-S2n	0.49	0.52	0.42	0.17	4.75	2.07
6.00	29.26	1.06	1.06	1-S2n	0.71	0.76	0.66	0.24	5.22	2.55
9.00	29.54	1.34	1.34	1-S2n	0.89	0.94	0.88	0.30	5.18	2.91
12.00	29.78	1.58	1.58	1-S2n	1.03	1.09	1.03	0.35	5.56	3.20
15.00	30.00	1.80	1.80	1-S2n	1.17	1.23	1.03	0.40	6.95	3.45
18.00	30.19	1.99	1.99	1-S2n	1.29	1.35	1.15	0.44	7.20	3.66
21.00	30.37	2.17	2.17	1-S2n	1.41	1.47	1.27	0.48	7.37	3.86
24.00	30.55	2.35	2.35	1-S2n	1.52	1.57	1.47	0.52	6.94	4.04
27.00	30.73	2.53	2.53	1-S2n	1.63	1.67	1.57	0.56	7.20	4.20
30.00	30.92	2.72	2.72	1-S2n	1.75	1.77	1.67	0.59	7.41	4.35

□□

El. inlet face invert 28.20 ft El. outlet invert 27.33 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

□□

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION 0.00 ft
INLET ELEVATION 28.20 ft
OUTLET STATION 52.00 ft
OUTLET ELEVATION 27.33 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0167
CULVERT LENGTH ALONG SLOPE 52.01 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE CIRCULAR
BARREL DIAMETER 3.00 ft
BARREL MATERIAL CORRUGATED STEEL
BARREL MANNING'S n 0.024
INLET TYPE CONVENTIONAL

INLET EDGE AND WALL MITERED TO CONFORM TO SLOPE
INLET DEPRESSION   NONE

3

CURRENT DATE: 09-07-2006   FILE DATE: 09-07-2006
CURRENT TIME: 16:53:01   FILE NAME: 337T2-3

TAILWATER

***** USER DEFINED CHANNEL CROSS-SECTION   FILE NAME: 337T2-3
MAIN CHANNEL ONLY   FILE DATE: 09-07-2006
LEFT CHANNEL BOUNDARY   0
RIGHT CHANNEL BOUNDARY   0
MANNING n LEFT OVER BANK   0.000
MANNING n MAIN CHANNEL   0.038
MANNING n RIGHT OVER BANK   0.000
SLOPE OF CHANNEL   0.0294 ft/ft

CROSS-SECTION COORD. NO.	X (ft)	Y (ft)
1	0.00	31.19
2	7.00	27.36
3	17.20	27.28
4	30.20	31.04

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

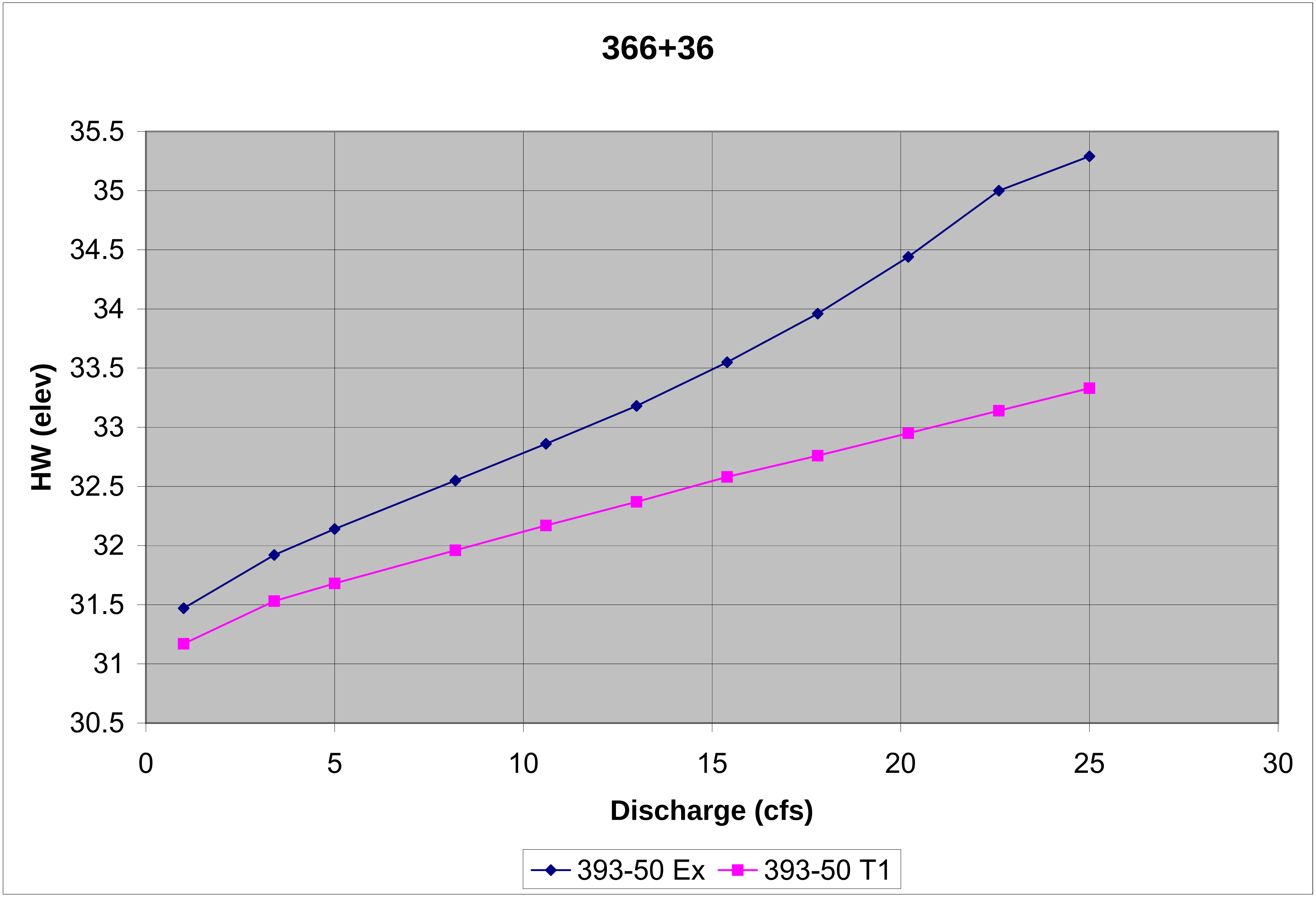
FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	27.28	0.000	-0.05	0.00	0.00
3.00	27.50	0.878	0.17	2.07	0.31
6.00	27.57	0.924	0.24	2.55	0.43
9.00	27.63	0.954	0.30	2.91	0.52
12.00	27.68	0.977	0.35	3.20	0.61
15.00	27.73	0.994	0.40	3.45	0.68
18.00	27.77	1.009	0.44	3.66	0.74
21.00	27.81	1.022	0.48	3.86	0.80
24.00	27.85	1.033	0.52	4.04	0.86
27.00	27.89	1.043	0.56	4.20	0.91
30.00	27.92	1.051	0.59	4.35	0.96

Note: Shear stress was calculated using R.

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE   PAVED

EMBANKMENT TOP WIDTH 24.00 ft
CREST LENGTH 10.00 ft
OVERTOPPING CREST ELEVATION 32.40 ft



366+36
35.5
35
34.5
34
33.5
33
32.5
32
31.5
31
30.5
HW (elev)
0
5
10
15
20
25
30
Discharge (cfs)
393-50 Ex
393-50 T1

HY-8 Culvert Analysis Report

2009 Alignment Station 366+36
Existing conditions

Table 1 - Summary of Culvert Flows at Crossing: 39350-ex

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
31.47	1.00	1.00	0.00	1
31.92	3.40	3.40	0.00	1
32.14	5.00	5.00	0.00	1
32.55	8.20	8.20	0.00	1
32.86	10.60	10.60	0.00	1
33.18	13.00	13.00	0.00	1
33.55	15.40	15.40	0.00	1
33.96	17.80	17.80	0.00	1
34.44	20.20	20.20	0.00	1
35.00	22.60	22.60	0.00	1
35.29	25.00	23.78	1.09	18

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.00	1.00	31.47	0.488	0.000	1-S2n	0.276	0.332	0.282	0.128	3.581	1.886
3.40	3.40	31.92	0.938	0.000	1-S2n	0.528	0.640	0.530	0.269	5.057	2.956
5.00	5.00	32.14	1.160	0.000	1-S2n	0.649	0.786	0.655	0.340	5.571	3.385
8.20	8.20	32.55	1.575	0.000	1-S2n	0.850	1.018	0.852	0.456	6.420	4.038
10.60	10.60	32.86	1.879	0.000	1-S2n	0.986	1.164	0.987	0.532	6.857	4.396
13.00	13.00	33.18	2.204	0.000	5-S2n	1.115	1.293	1.122	0.600	7.171	4.707
15.40	15.40	33.55	2.567	0.000	5-S2n	1.246	1.413	1.246	0.664	7.481	4.975
17.80	17.80	33.96	2.983	0.000	5-S2n	1.379	1.514	1.383	0.724	7.683	5.208
20.20	20.20	34.44	3.463	0.000	5-S2n	1.533	1.611	1.535	0.779	7.825	5.422
22.60	22.60	35.00	4.016	3.511	2-M2c	1.744	1.681	1.681	0.832	8.043	5.623
25.00	23.78	35.29	4.314	3.860	7-M2c	2.000	1.716	1.716	0.882	8.316	5.802

****

Inlet Elevation (invert): 30.98 ft, Outlet Elevation (invert): 29.23 ft

Culvert Length: 56.03 ft, Culvert Slope: 0.0313

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 30.98 ft

Outlet Station: 56.00 ft

Outlet Elevation: 29.23 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel

Barrel Manning's n: 0.0240

Inlet Type: Conventional

Inlet Edge Condition: Thin Edge Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 39350-ex)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.00	29.36	0.13	1.89	0.30	0.94
3.40	29.50	0.27	2.96	0.64	1.03
5.00	29.57	0.34	3.39	0.81	1.06
8.20	29.69	0.46	4.04	1.08	1.11
10.60	29.76	0.53	4.40	1.26	1.12
13.00	29.83	0.60	4.71	1.42	1.14
15.40	29.89	0.66	4.97	1.57	1.15
17.80	29.95	0.72	5.21	1.72	1.16
20.20	30.01	0.78	5.42	1.85	1.17
22.60	30.06	0.83	5.62	1.97	1.18
25.00	30.11	0.88	5.80	2.09	1.18

Tailwater Channel Data - 39350-ex

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 1.00 (_:1)

Channel Slope: 0.0380

Channel Manning's n: 0.0380

Channel Invert Elevation: 29.23 ft

Roadway Data for Crossing: 39350-ex

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 35.27 ft

Roadway Surface: Paved

Roadway Top Width: 28.00 ft

HY-8 Culvert Analysis Report

2009 Alignment Station 366+36
Tier 1 Fish Passage

42”x29” pipe arch
20-percent fill with substrate modeled with user defined coordinates

Table 1 - Summary of Culvert Flows at Crossing: 39350-T1user

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
31.17	1.00	1.00	0.00	1
31.53	3.40	3.40	0.00	1
31.68	5.00	5.00	0.00	1
31.96	8.20	8.20	0.00	1
32.17	10.60	10.60	0.00	1
32.37	13.00	13.00	0.00	1
32.58	15.40	15.40	0.00	1
32.76	17.80	17.80	0.00	1
32.95	20.20	20.20	0.00	1
33.14	22.60	22.60	0.00	1
33.33	25.00	25.00	0.00	1

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.00	1.00	31.17	0.190	0.190	1-S2n	0.087	0.121	0.090	0.128	2.178	1.886
3.40	3.40	31.53	0.549	0.549	1-S2n	0.246	0.311	0.250	0.269	4.079	2.956
5.00	5.00	31.68	0.704	0.704	1-S2n	0.315	0.410	0.324	0.340	4.618	3.385
8.20	8.20	31.96	0.980	0.980	1-S2n	0.440	0.567	0.446	0.456	5.483	4.038
10.60	10.60	32.17	1.186	1.186	1-S2n	0.522	0.670	0.529	0.532	5.973	4.396
13.00	13.00	32.37	1.392	0.000	1-S2n	0.602	0.769	0.602	0.600	6.433	4.707
15.40	15.40	32.58	1.596	0.000	1-S2n	0.675	0.856	0.675	0.664	6.816	4.975
17.80	17.80	32.76	1.783	0.000	1-S2n	0.748	0.940	0.749	0.724	7.114	5.208
20.20	20.20	32.95	1.970	0.000	5-S2n	0.821	1.020	0.821	0.779	7.378	5.422
22.60	22.60	33.14	2.158	0.000	5-S2n	0.893	1.097	0.896	0.832	7.616	5.623
25.00	25.00	33.33	2.351	0.000	5-S2n	0.966	1.173	0.967	0.882	7.835	5.802

****

Inlet Elevation (invert): 30.98 ft, Outlet Elevation (invert): 29.23 ft

Culvert Length: 56.03 ft, Culvert Slope: 0.0313

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 30.98 ft

Outlet Station: 56.00 ft

Outlet Elevation: 29.23 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: User Defined

Barrel Span: 3.42 ft

Barrel Rise: 1.97 ft

Barrel Material: Corrugated Metal Riveted or Welded

Barrel Manning's n: 0.0240 (top and sides)

Manning's n: 1.4lf (bottom)

Inlet Type: Conventional

Inlet Edge Condition: Thin Edge Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 39350-T1user)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.00	29.36	0.13	1.89	0.30	0.94
3.40	29.50	0.27	2.96	0.64	1.03
5.00	29.57	0.34	3.39	0.81	1.06
8.20	29.69	0.46	4.04	1.08	1.11
10.60	29.76	0.53	4.40	1.26	1.12
13.00	29.83	0.60	4.71	1.42	1.14
15.40	29.89	0.66	4.97	1.57	1.15
17.80	29.95	0.72	5.21	1.72	1.16
20.20	30.01	0.78	5.42	1.85	1.17
22.60	30.06	0.83	5.62	1.97	1.18
25.00	30.11	0.88	5.80	2.09	1.18

Tailwater Channel Data - 39350-T1user

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 1.00 (_:1)

Channel Slope: 0.0380

Channel Manning's n: 0.0380

Channel Invert Elevation: 29.23 ft

Roadway Data for Crossing: 39350-T1user

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 35.27 ft

Roadway Surface: Paved

Roadway Top Width: 28.00 ft

HY-8 Culvert Analysis Report

2009 Alignment Station 382+07
Existing conditions

Table 1 - Summary of Culvert Flows at Crossing: 409-25ex

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
31.12	1.00	1.00	0.00	1
31.94	6.90	6.90	0.00	1
32.47	12.80	12.80	0.00	1
32.94	18.70	18.70	0.00	1
33.03	20.00	20.00	0.00	1
33.80	30.50	30.50	0.00	1
34.29	36.40	36.40	0.00	1
34.89	42.30	42.30	0.00	1
35.57	48.20	48.20	0.00	1
36.29	54.10	54.10	0.00	1
36.67	60.00	57.08	2.77	16

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.00	1.00	31.12	0.461	0.616	3-M2t	0.705	0.306	0.530	3.000	1.166	0.000
6.90	6.90	31.94	1.224	1.437	2-M2c	2.163	0.816	0.816	3.000	4.408	0.000
12.80	12.80	32.47	1.713	1.972	2-M2c	3.000	1.131	1.131	3.000	5.242	0.000
18.70	18.70	32.94	2.139	2.437	2-M2c	3.000	1.378	1.378	3.000	5.896	0.000
20.00	20.00	33.03	2.230	2.528	2-M2c	3.000	1.430	1.430	3.000	6.014	0.000
30.50	30.50	33.80	2.957	3.295	2-M2c	3.000	1.789	1.789	3.000	6.940	0.000
36.40	36.40	34.29	3.397	3.791	7-M2c	3.000	1.955	1.955	3.000	7.472	0.000
42.30	42.30	34.89	3.885	4.395	7-M2c	3.000	2.117	2.117	3.000	7.933	0.000
48.20	48.20	35.57	4.436	5.070	7-M2c	3.000	2.252	2.252	3.000	8.489	0.000
54.10	54.10	36.29	5.062	5.792	7-M2c	3.000	2.387	2.387	3.000	8.974	0.000
60.00	57.08	36.67	5.410	6.175	7-M2c	3.000	2.439	2.439	3.000	9.263	0.000

****

Inlet Elevation (invert): 30.50 ft, Outlet Elevation (invert): 30.47 ft

Culvert Length: 62.00 ft, Culvert Slope: 0.0005

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 30.50 ft

Outlet Station: 62.00 ft

Outlet Elevation: 30.47 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Corrugated Steel

Barrel Manning's n: 0.0240

Inlet Type: Conventional

Inlet Edge Condition: Thin Edge Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 409-25ex)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
1.00	31.00	3.00
6.90	31.00	3.00
12.80	31.00	3.00
18.70	31.00	3.00
20.00	31.00	3.00
30.50	31.00	3.00
36.40	31.00	3.00
42.30	31.00	3.00
48.20	31.00	3.00
54.10	31.00	3.00
60.00	31.00	3.00

Tailwater Channel Data - 409-25ex

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 31.00 ft

Roadway Data for Crossing: 409-25ex

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 36.63 ft

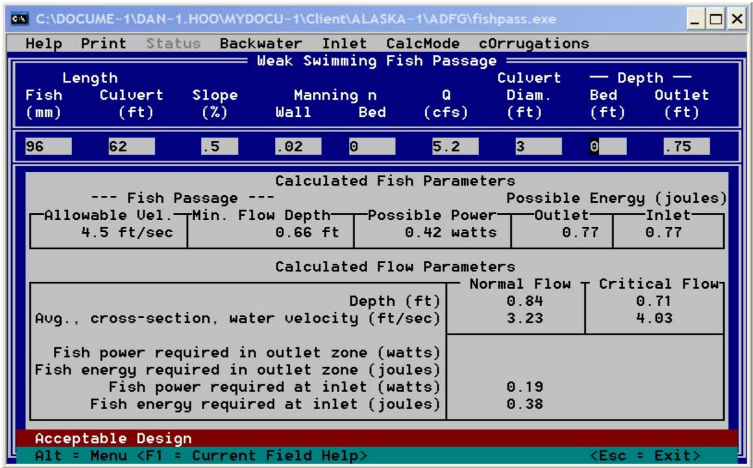
Roadway Surface: Paved

Roadway Top Width: 25.00 ft

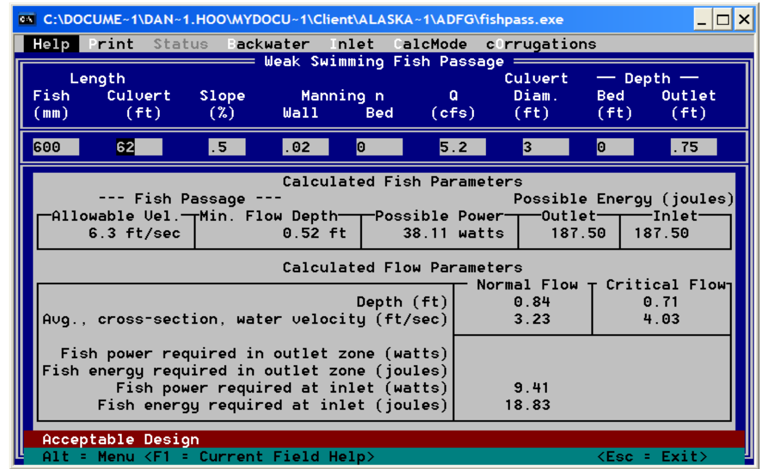
2009 Alignment Station: 382+07

2006 S&HI Station 405+00 Tier 2 FISH PASS design

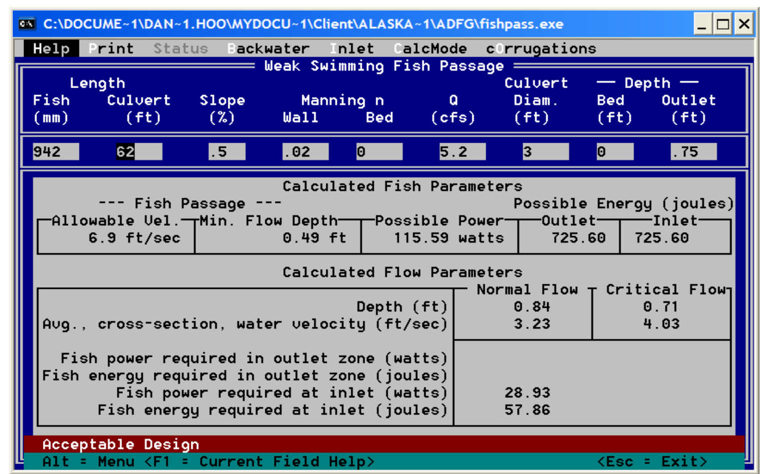
non-baffle design: Juvenile Coho

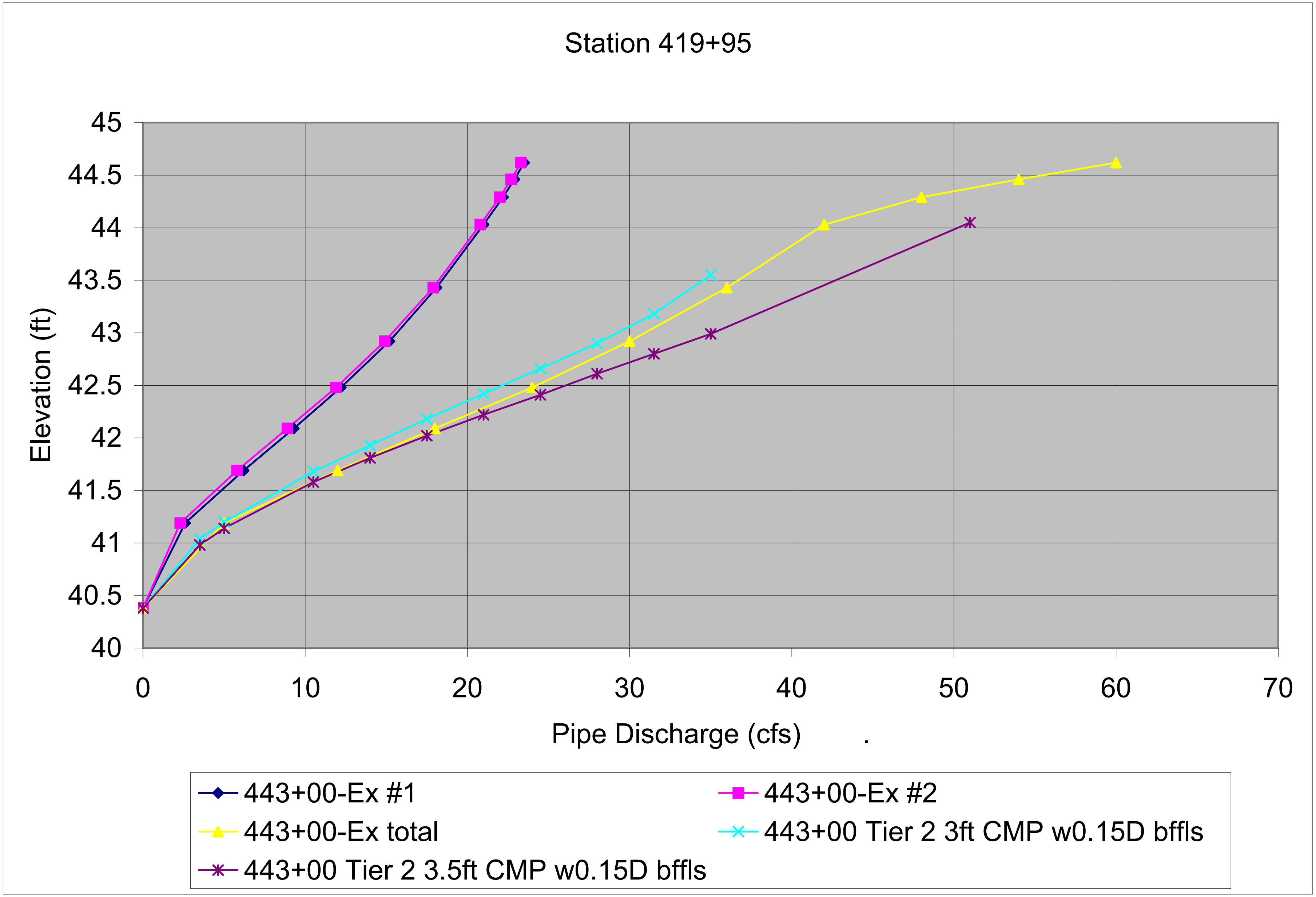


adult coho - 600mm



Adult coho - adjusted to 'equivalent' grayling




Station 419+95
Elevation (ft)
45
44.5
44
43.5
43
42.5
42
41.5
41
40.5
40
0
10
20
30
40
50
60
70
Pipe Discharge (cfs)
443+00-Ex #1
443+00-Ex #2
443+00-Ex total
443+00 Tier 2 3ft CMP w0.15D bffls
443+00 Tier 2 3.5ft CMP w0.15D bffls

2009 Alignment Station: 419+95

1 2006 S&HI Station 443+00 Existing conditions

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 14:33:05 FILE NAME: 44300-EX

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	40.38	38.75	55.17	1 CSP	2.00	2.00	.024	CONVENTIONAL
2	40.43	38.67	55.03	1 CSP	2.00	2.00	.024	CONVENTIONAL
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 44300-EX DATE: 08-17-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
40.38	0	0	0	0	0	0	0	0	0
41.19	5	2.6	2.3	0	0	0	0	0	4
41.69	12	6.2	5.8	0	0	0	0	0	3
42.09	18	9.3	8.9	0	0	0	0	0	2
42.48	24	12.2	11.9	0	0	0	0	0	3
42.92	30	15.2	14.9	0	0	0	0	0	3
43.43	36	18.1	17.9	0	0	0	0	0	3
44.03	42	21	20.8	0	0	0	0	0	7
44.29	48	22.2	22	0	0	0	0	3.57	4
44.46	54	22.9	22.7	0	0	0	0	8.03	3
44.62	60	23.5	23.3	0	0	0	0	12.92	3
44.05	42	21.1	20.9	0	0	0	0	OVERTOPP ING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 44300-EX DATE: 08-17-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
40.38	0.000	0.00	0.00	0.00
41.19	-0.006	5.00	0.01	0.20
41.69	0.000	12.00	0.00	0.00
42.09	0.008	18.00	-0.13	-0.72
42.48	0.005	24.00	-0.08	-0.33
42.92	0.003	30.00	-0.05	-0.17
43.43	0.002	36.00	-0.03	-0.08
44.03	-0.007	42.00	0.19	0.45
44.29	-0.007	48.00	0.30	0.63
44.46	-0.009	54.00	0.43	0.80
44.62	-0.006	60.00	0.32	0.53

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

2

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 14:33:05 FILE NAME: 44300-EX

PERFORMANCE CURVE FOR CULVERT 1 - 1(2.00 (ft) BY 2.00 (ft)) CSP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0	40.38	0	0	0-NF	0	0	0	-0.6	0	0
2.64	41.2	0.82	0.82	1-S2n	0.47	0.56	0.36	-0.28	6.74	2.24
6.18	41.7	1.32	1.32	1-S2n	0.74	0.88	0.68	-0.14	6.61	2.95
9.25	42.09	1.71	1.71	1-S2n	0.92	1.08	0.92	-0.04	6.53	3.37
12.2	42.47	2.09	2.09	5-S2n	1.09	1.25	1.08	0.04	7.04	3.7
15.17	42.91	2.53	2.53	5-S2n	1.26	1.4	1.2	0.12	7.68	3.97
18.14	43.43	3.05	3.05	5-S2n	1.43	1.53	1.33	0.19	8.2	4.21
21.01	44.02	3.64	3.35	2-M2c	1.64	1.63	1.63	0.25	7.63	4.42
22.16	44.29	3.91	3.45	2-M2c	1.76	1.67	1.67	0.31	7.94	4.61
22.87	44.46	4.08	2.43	2-M2c	2	1.69	1.69	0.36	8.11	4.78
23.47	44.62	4.24	3.48	2-M2c	2	1.71	1.71	0.42	8.25	4.94

El. inlet face invert 40.38 ft El. outlet invert 38.75 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************
INLET STATION 0.00 ft
INLET ELEVATION 40.38 ft
OUTLET STATION 55.15 ft
OUTLET ELEVATION 38.75 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0296
CULVERT LENGTH ALONG SLOPE 55.17 ft

***** CULVERT DATA SUMMARY ************************
BARREL SHAPE CIRCULAR
BARREL DIAMETER 2.00 ft
BARREL MATERIAL CORRUGATED STEEL
BARREL MANNING'S n 0.024
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL THIN EDGE PROJECTING
INLET DEPRESSION NONE

3

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 14:33:05 FILE NAME: 44300-EX

PERFORMANCE CURVE FOR CULVERT 2 - 1(2.00 (ft) BY 2.00 (ft)) CSP

DIS- HEAD- INLET OUTLET
CHARGE WATER CONTROL CONTROL FLOW NORMAL CRIT. OUTLET TW OUTLET TW

FLOW (cfs)	ELEV. (ft)	DEPTH (ft)	DEPTH (ft)	TYPE <F4>	DEPTH (ft)	DEPTH (ft)	DEPTH (ft)	DEPTH (ft)	VEL. (fps)	VEL. (fps)
0.00	40.43	0.00	0.00	0-NF	0.00	0.00	0.00	-0.52	0.00	0.00
2.35	41.20	0.77	0.77	1-S2n	0.44	0.53	0.33	-0.20	6.90	2.24
5.82	41.70	1.27	1.27	1-S2n	0.70	0.85	0.65	-0.06	6.64	2.95
8.88	42.09	1.66	1.66	1-S2n	0.88	1.06	0.76	0.04	8.10	3.37
11.88	42.48	2.05	2.05	5-S2n	1.05	1.24	0.94	0.12	8.24	3.70
14.87	42.91	2.48	2.48	5-S2n	1.21	1.39	1.09	0.20	8.51	3.97
17.89	43.43	3.00	3.00	5-S2n	1.37	1.52	1.32	0.27	8.16	4.21
20.80	44.02	3.59	3.59	5-S2n	1.56	1.63	1.43	0.33	8.66	4.42
21.96	44.29	3.86	3.86	5-S2n	1.65	1.66	1.56	0.39	8.35	4.61
22.67	44.46	4.03	3.60	2-M2c	1.72	1.68	1.68	0.44	8.06	4.78
23.29	44.62	4.19	3.60	2-M2c	1.79	1.70	1.70	0.50	8.20	4.94

El. inlet face invert 40.43 ft El. outlet invert 38.67 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

□□

***** SITE DATA ***** CULVERT INVERT **************
INLET STATION 0.00 ft
INLET ELEVATION 40.43 ft
OUTLET STATION 55.00 ft
OUTLET ELEVATION 38.67 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0320
CULVERT LENGTH ALONG SLOPE 55.03 ft

***** CULVERT DATA SUMMARY ************************
BARREL SHAPE CIRCULAR
BARREL DIAMETER 2.00 ft
BARREL MATERIAL CORRUGATED STEEL
BARREL MANNING'S n 0.024
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL THIN EDGE PROJECTING
INLET DEPRESSION NONE

□□
□
4

CURRENT DATE: 08-17-2006 FILE DATE: 08-17-2006
CURRENT TIME: 14:33:05 FILE NAME: 44300-EX

□□
□□□□□□□□□□□□□□□□ TAILWATER □□□□□□□□□□□□□□□□
□□

***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 44300-TW
MAIN CHANNEL ONLY FILE DATE: 08-17-2006
LEFT CHANNEL BOUNDARY 0
RIGHT CHANNEL BOUNDARY 0
MANNING n LEFT OVER BANK 0.000
MANNING n MAIN CHANNEL 0.040
MANNING n RIGHT OVER BANK 0.000
SLOPE OF CHANNEL 0.0260 ft/ft

CROSS-SECTION X Y
COORD. NO. (ft) (ft)

1	0.00	41.52
2	7.00	38.15
3	17.20	38.30
4	30.20	41.20

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	38.15	0.000	-0.60	0.00	0.00
5.00	38.47	0.822	-0.28	2.24	0.37
12.00	38.61	0.880	-0.14	2.95	0.56
18.00	38.71	0.909	-0.04	3.37	0.69
24.00	38.79	0.929	0.04	3.70	0.79
30.00	38.87	0.945	0.12	3.97	0.88
36.00	38.94	0.959	0.19	4.21	0.96
42.00	39.00	0.970	0.25	4.42	1.03
48.00	39.06	0.979	0.31	4.61	1.09
54.00	39.11	0.988	0.36	4.78	1.16
60.00	39.17	0.996	0.42	4.94	1.21

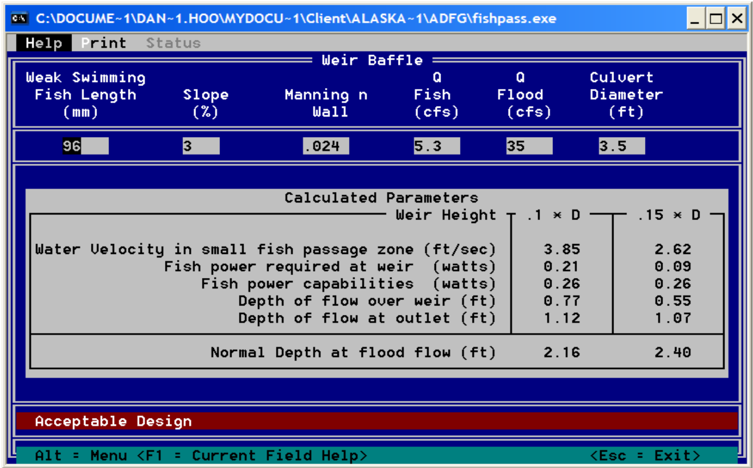
Note: Shear stress was calculated using R.

ROADWAY OVERTOPPING DATA

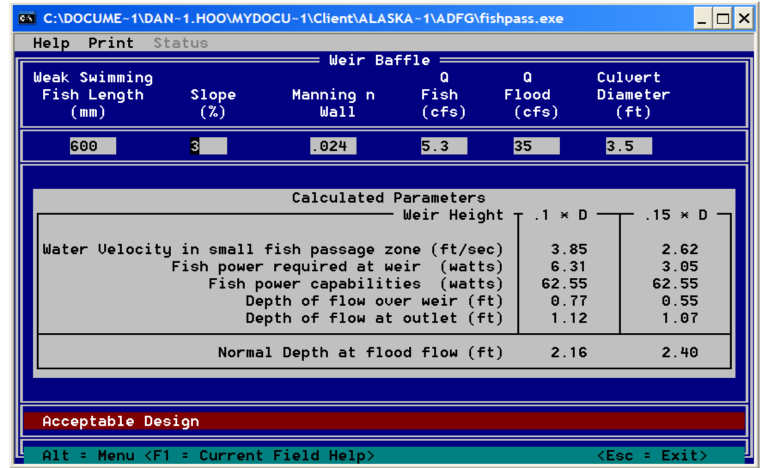
ROADWAY SURFACE PAVED
EMBANKMENT TOP WIDTH 24.00 ft
CREST LENGTH 10.00 ft
OVERTOPPING CREST ELEVATION 44.05 ft

2009 Alignment Station: 419+95
2006 S&HI Station 443+00 Tier 2 FISH PASS design

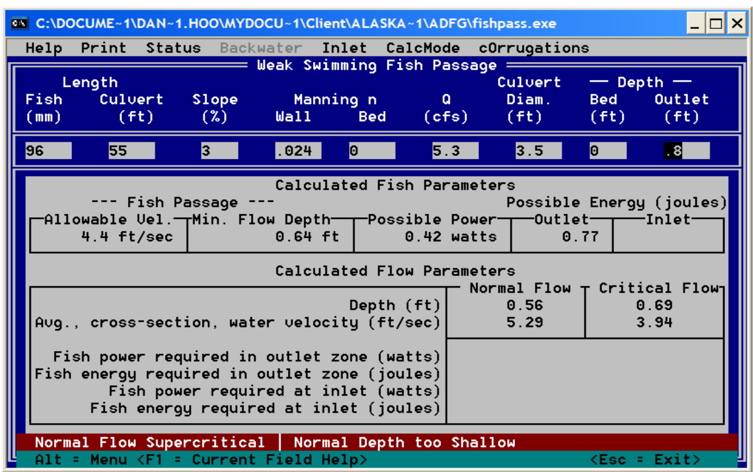
baffle design: 3.5-ft pipe / Juvenile Coho



3.5-ft pipe / Adult Coho



non-baffle design:



2009 Alignment Station: 419+95

1 2006 S&HI Station 443+00 Tier 2 fish passage - 3.5-ft baffled CMP

CURRENT DATE: 09-05-2006 FILE DATE: 09-05-2006
CURRENT TIME: 17:16:59 FILE NAME: 443T42

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

CULV NO.	SITE DATA: INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	40.38	38.75	55.02	1 ICMP	3.50	2.98	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 443T42 DATE: 09-05-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
40.38	0	0	0	0	0	0	0	0	1
40.98	3.5	3.5	0	0	0	0	0	0	1
41.14	5	5	0	0	0	0	0	0	1
41.58	10.5	10.5	0	0	0	0	0	0	1
41.81	14	14	0	0	0	0	0	0	1
42.02	17.5	17.5	0	0	0	0	0	0	1
42.22	21	21	0	0	0	0	0	0	1
42.41	24.5	24.5	0	0	0	0	0	0	1
42.61	28	28	0	0	0	0	0	0	1
42.8	31.5	31.5	0	0	0	0	0	0	1
42.99	35	35	0	0	0	0	0	0	1
44.05	51	51	0	0	0	0	0	OVERTOPP ING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 443T42 DATE: 09-05-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
40.38	0.000	0.00	0.00	0.00
40.98	0.000	3.50	0.00	0.00
41.14	0.000	5.00	0.00	0.00
41.58	0.000	10.50	0.00	0.00
41.81	0.000	14.00	0.00	0.00
42.02	0.000	17.50	0.00	0.00
42.22	0.000	21.00	0.00	0.00
42.41	0.000	24.50	0.00	0.00
42.61	0.000	28.00	0.00	0.00
42.80	0.000	31.50	0.00	0.00
42.99	0.000	35.00	0.00	0.00

□□
<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000
□□
□

2

CURRENT DATE: 09-05-2006 FILE DATE: 09-05-2006
CURRENT TIME: 17:16:59 FILE NAME: 443T42

□□

PERFORMANCE CURVE FOR CULVERT 1 - 1(3.50 (ft) BY 2.98 (ft)) ICMP

□□

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	40.38	0.00	0.00	0-NF	0.00	0.00	0.00	-0.60	0.00	0.00
3.50	40.98	0.60	0.60	1-S2n	0.30	0.36	0.16	-0.32	5.38	2.08
5.00	41.14	0.76	0.76	1-S2n	0.36	0.46	0.26	-0.29	6.24	2.31
10.50	41.58	1.20	1.20	1-S2n	0.58	0.74	0.58	-0.17	6.16	2.92
14.00	41.81	1.43	1.43	1-S2n	0.69	0.90	0.60	-0.12	8.02	3.21
17.50	42.02	1.64	1.64	1-S2n	0.80	1.03	0.73	-0.06	8.06	3.45
21.00	42.22	1.84	1.84	1-S2n	0.90	1.16	0.90	-0.01	7.70	3.66
24.50	42.41	2.03	2.03	1-S2n	0.99	1.27	1.00	0.03	7.95	3.85
28.00	42.61	2.23	2.23	1-S2n	1.08	1.37	0.97	0.08	9.40	4.03
31.50	42.80	2.42	2.42	1-S2n	1.17	1.47	1.07	0.12	9.46	4.18
35.00	42.99	2.61	2.61	1-S2n	1.26	1.57	1.17	0.15	9.59	4.32

□□

El. inlet face invert 40.38 ft El. outlet invert 38.75 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

□□

***** SITE DATA ***** CULVERT INVERT **************
INLET STATION 0.00 ft
INLET ELEVATION 40.38 ft
OUTLET STATION 55.00 ft
OUTLET ELEVATION 38.75 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0296
CULVERT LENGTH ALONG SLOPE 55.02 ft

***** CULVERT DATA SUMMARY ************************
BARREL SHAPE USER DEFINED
BARREL SPAN 3.50 ft
BARREL RISE 2.98 ft
BARREL MATERIAL STEEL OR ALUMINUM
BARREL MANNING'S n 0.024 FOR SIDES AND TOP
0.038 FOR BOTTOM
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL MITERED
INLET DEPRESSION NONE

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□

3

CURRENT DATE: 09-05-2006 FILE DATE: 09-05-2006

CURRENT TIME: 17:16:59 FILE NAME: 443T42

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***** USER DEFINED CULVERT CROSS-SECTION - CULVERT # 1

COORDIN NUMBER	X (ft)	Y-TOP (ft)	Y-BOTTOM (ft)
1	0	41.61	41.61
2	0.17	42.35	40.86
3	0.33	42.63	40.58
4	0.5	42.83	40.38
5	0.81	43.08	40.38
6	1.13	43.24	40.38
7	1.44	43.33	40.38
8	1.75	43.36	40.38
9	2.06	43.33	40.38
10	2.37	43.24	40.38
11	2.69	43.08	40.38
12	3	42.83	40.38
13	3.17	42.63	40.58
14	3.33	42.35	40.86
15	3.5	41.61	41.61

□□
□

4

CURRENT DATE: 09-05-2006 FILE DATE: 09-05-2006
CURRENT TIME: 17:16:59 FILE NAME: 443T42

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□□

***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 443T42BF

MAIN CHANNEL ONLY FILE DATE: 09-05-2006
LEFT CHANNEL BOUNDARY 0
RIGHT CHANNEL BOUNDARY 0
MANNING n LEFT OVER BANK 0.000
MANNING n MAIN CHANNEL 0.038
MANNING n RIGHT OVER BANK 0.000
SLOPE OF CHANNEL 0.0260 ft/ft

CROSS-SECTION COORD. NO.	X (ft)	Y (ft)
1	0.00	41.52
2	7.00	38.15
3	17.20	38.30
4	30.20	41.20

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

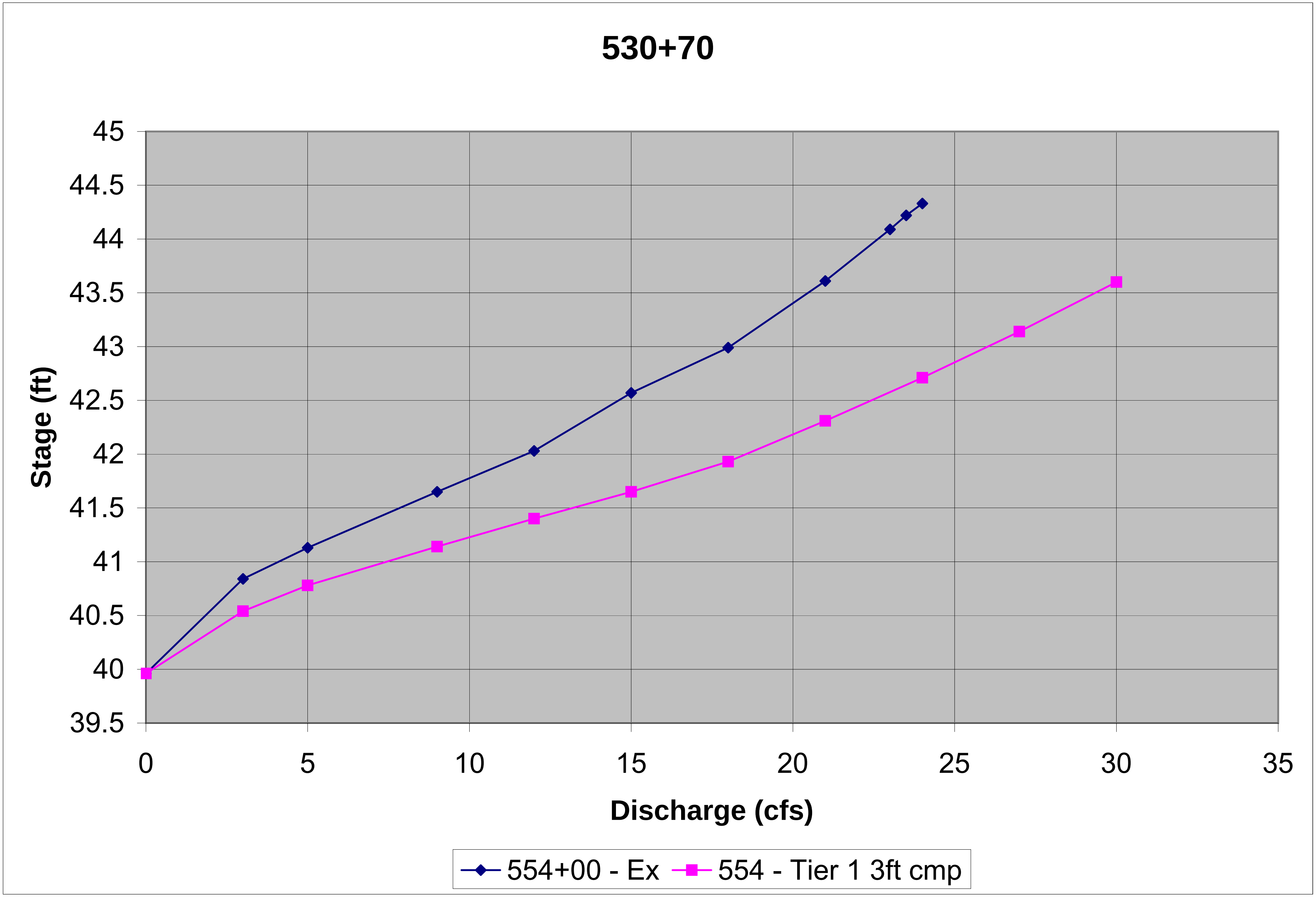
FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	38.15	0.000	-0.60	0.00	0.00
3.50	38.43	0.839	-0.32	2.08	0.31
5.00	38.46	0.862	-0.29	2.31	0.36

10.50	38.58	0.912	-0.17	2.92	0.51
14.00	38.63	0.933	-0.12	3.21	0.59
17.50	38.69	0.950	-0.06	3.45	0.66
21.00	38.74	0.964	-0.01	3.66	0.72
24.50	38.78	0.975	0.03	3.85	0.77
28.00	38.83	0.986	0.08	4.03	0.83
31.50	38.87	0.995	0.12	4.18	0.87
35.00	38.90	1.003	0.15	4.32	0.92

Note: Shear stress was calculated using R.

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE PAVED
EMBANKMENT TOP WIDTH 24.00 ft
CREST LENGTH 10.00 ft
OVERTOPPING CREST ELEVATION 44.05 ft


530+70
Stage (ft)
45
44.5
44
43.5
43
42.5
42
41.5
41
40.5
40
39.5
0
5
10
15
20
25
30
35
Discharge (cfs)
554+00 - Ex
554 - Tier 1 3ft cmp

2009 Alignment Station: 530+70

1 2006 S&HI Station 554+00 Existing conditions

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 16:36:43 FILE NAME: 55400EX

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	39.96	38.91	49.01	1 CSP	2.00	2.00	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 55400EX DATE: 08-25-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWA`	ITR
39.96	0	0	0	0	0	0	0	0	1
40.84	3	3	0	0	0	0	0	0	1
41.13	5	5	0	0	0	0	0	0	1
41.65	9	9	0	0	0	0	0	0	1
42.03	12	12	0	0	0	0	0	0	1
42.57	15	15	0	0	0	0	0	0	1
42.99	18	18	0	0	0	0	0	0	1
43.61	21	21	0	0	0	0	0	0	1
44.09	24	23	0	0	0	0	0	0.88	8
44.22	27	23.5	0	0	0	0	0	3.29	4
44.33	30	24	0	0	0	0	0	5.95	4
43.99	22.6	22.6	0	0	0	0	0	OVERTOF	ING

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 55400EX DATE: 08-25-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
39.96	0.000	0.00	0.00	0.00
40.84	0.000	3.00	0.00	0.00
41.13	0.000	5.00	0.00	0.00
41.65	0.000	9.00	0.00	0.00
42.03	0.000	12.00	0.00	0.00
42.57	0.000	15.00	0.00	0.00
42.99	0.000	18.00	0.00	0.00
43.61	0.000	21.00	0.00	0.00
44.09	-0.010	24.00	0.12	0.50
44.22	-0.005	27.00	0.21	0.78
44.33	-0.008	30.00	0.10	0.33

□□□
<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000
□□□
□

2

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 16:36:43 FILE NAME: 55400EX

□□□
PERFORMANCE CURVE FOR CULVERT 1 - 1(2.00 (ft) BY 2.00 (ft)) CSP
□□□

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	39.96	0.00	0.00	0-NF	0.00	0.00	0.00	0.59	0.00	0.00
3.00	40.84	0.88	0.88	1-S2n	0.55	0.60	0.40	1.04	6.63	1.63
5.00	41.13	1.17	1.17	1-S2n	0.72	0.79	0.59	1.10	6.51	1.76
9.00	41.65	1.69	1.69	1-S2n	1.00	1.07	0.87	1.17	6.89	1.94
12.00	42.03	2.07	2.07	5-S2n	1.20	1.24	1.14	1.22	6.48	2.04
15.00	42.57	2.51	2.61	2-M2c	1.40	1.40	1.40	1.26	6.41	2.13
18.00	42.99	3.03	2.90	2-M2c	1.66	1.52	1.52	1.29	7.03	2.21
21.00	43.61	3.65	3.06	2-M2c	2.00	1.63	1.63	1.32	7.63	2.27
23.01	44.09	4.13	3.92	2-M2c	2.00	1.69	1.69	1.35	8.14	2.33
23.50	44.21	4.25	4.23	2-M2c	2.00	1.71	1.71	1.37	8.25	2.39
23.95	44.33	4.37	4.36	2-M2c	2.00	1.72	1.72	1.40	8.36	2.44

□□□
El. inlet face invert 39.96 ft El. outlet invert 38.91 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft
□□□

***** SITE DATA ***** CULVERT INVERT **************
INLET STATION 0.00 ft
INLET ELEVATION 39.96 ft
OUTLET STATION 49.00 ft
OUTLET ELEVATION 38.91 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0214
CULVERT LENGTH ALONG SLOPE 49.01 ft

***** CULVERT DATA SUMMARY ************************
BARREL SHAPE CIRCULAR
BARREL DIAMETER 2.00 ft
BARREL MATERIAL CORRUGATED STEEL
BARREL MANNING'S n 0.024
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL THIN EDGE PROJECTING
INLET DEPRESSION NONE

□□□
□

3

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 16:36:43 FILE NAME: 55400EX

TAILWATER

***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 55400-TW
MAIN CHANNEL AND LT & RT OVER BANKS FILE DATE: 08-25-2006
LEFT CHANNEL BOUNDARY 2
RIGHT CHANNEL BOUNDARY 5
MANNING n LEFT OVER BANK 0.050
MANNING n MAIN CHANNEL 0.035
MANNING n RIGHT OVER BANK 0.050
SLOPE OF CHANNEL 0.0050 ft/ft

CROSS-SECTION COORD. NO.	X (ft)	Y (ft)
1	0.00	41.00
2	100.00	39.70
3	100.25	39.50
4	101.75	39.50
5	102.00	39.70
6	203.00	41.00

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	39.50	0.000	0.59	0.00	0.00
3.00	39.95	0.439	1.04	1.63	0.13
5.00	40.01	0.447	1.10	1.76	0.14
9.00	40.08	0.459	1.17	1.94	0.16
12.00	40.13	0.465	1.22	2.04	0.17
15.00	40.17	0.469	1.26	2.13	0.19
18.00	40.20	0.474	1.29	2.21	0.20
21.00	40.23	0.477	1.32	2.27	0.20
24.00	40.26	0.480	1.35	2.33	0.21
27.00	40.28	0.483	1.37	2.39	0.22
30.00	40.31	0.486	1.40	2.44	0.23

Note: Shear stress was calculated using R.

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE PAVED
EMBANKMENT TOP WIDTH 24.00 ft
CREST LENGTH 10.00 ft
OVERTOPPING CREST ELEVATION 43.99 ft

2009 Alignment Station: 530+70

1 2006 S&HI Station 554+00 Tier 1 fish passage - 3-ft CMP

CURRENT DATE: 08-29-2006 FILE DATE: 08-29-2006
CURRENT TIME: 20:53:14 FILE NAME: 554-T3

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	39.96	38.91	49.01	1 ICMP	3.10	1.80	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 554-T3 DATE: 08-29-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWA`	ITR
39.96	0	0	0	0	0	0	0	0	1
40.54	3	3	0	0	0	0	0	0	1
40.78	5	5	0	0	0	0	0	0	1
41.14	9	9	0	0	0	0	0	0	1
41.4	12	12	0	0	0	0	0	0	1
41.65	15	15	0	0	0	0	0	0	1
41.93	18	18	0	0	0	0	0	0	1
42.31	21	21	0	0	0	0	0	0	1
42.71	24	24	0	0	0	0	0	0	1
43.14	27	27	0	0	0	0	0	0	1
43.6	30	30	0	0	0	0	0	0	1
43.99	32.3	32.3	0	0	0	0	0	OVERTOF	ING

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 554-T3 DATE: 08-29-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
39.96	0.000	0.00	0.00	0.00
40.54	0.000	3.00	0.00	0.00
40.78	0.000	5.00	0.00	0.00
41.14	0.000	9.00	0.00	0.00
41.40	0.000	12.00	0.00	0.00
41.65	0.000	15.00	0.00	0.00
41.93	0.000	18.00	0.00	0.00
42.31	0.000	21.00	0.00	0.00
42.71	0.000	24.00	0.00	0.00
43.14	0.000	27.00	0.00	0.00
43.60	0.000	30.00	0.00	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

2

CURRENT DATE: 08-29-2006 FILE DATE: 08-29-2006
CURRENT TIME: 20:53:14 FILE NAME: 554-T3

PERFORMANCE CURVE FOR CULVERT 1 - 1(3.10 (ft) BY 1.80 (ft)) ICMP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	39.96	0.00	0.00	0-NF	0.00	0.00	0.00	0.59	0.00	0.00
3.00	40.54	0.58	0.58	1-S2n	0.28	0.31	0.21	1.05	5.79	1.51
5.00	40.78	0.82	0.82	1-S2n	0.39	0.44	0.34	1.10	4.95	1.63
9.00	41.14	1.18	1.18	1-S2n	0.58	0.64	0.44	1.17	6.77	1.79
12.00	41.40	1.44	1.44	1-S2n	0.72	0.78	0.72	1.22	5.63	1.89
15.00	41.65	1.69	1.69	1-S2n	0.86	0.90	0.80	1.26	6.35	1.97
18.00	41.93	1.97	1.97	5-S2n	1.00	1.02	0.92	1.29	6.73	2.04
21.00	42.31	2.35	2.27	3-M1t	1.15	1.13	1.32	1.32	5.78	2.10
24.00	42.71	2.75	2.47	3-M1t	1.32	1.23	1.35	1.35	6.50	2.15
27.00	43.14	3.18	2.72	3-M2t	1.60	1.31	1.38	1.38	7.21	2.20
30.00	43.60	3.64	2.92	3-M2t	1.80	1.39	1.40	1.40	7.91	2.25

El. inlet face invert 39.96 ft El. outlet invert 38.91 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** CULVERT INVERT **************
INLET STATION 0.00 ft
INLET ELEVATION 39.96 ft
OUTLET STATION 49.00 ft
OUTLET ELEVATION 38.91 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0214
CULVERT LENGTH ALONG SLOPE 49.01 ft

***** CULVERT DATA SUMMARY ************************
BARREL SHAPE USER DEFINED
BARREL SPAN 3.10 ft
BARREL RISE 1.80 ft
BARREL MATERIAL STEEL OR ALUMINUM
BARREL MANNING'S n 0.024 FOR SIDES AND TOP
0.038 FOR BOTTOM
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL MITERED
INLET DEPRESSION NONE

3

CURRENT DATE: 08-29-2006 FILE DATE: 08-29-2006

CURRENT TIME: 20:53:14 FILE NAME: 554-T3

***** USER DEFINED CULVERT CROSS-SECTION - CULVERT # 1

COORDIN NUMBER	X (ft)	Y-TOP (ft)	Y-BOTTOM (ft)
1	73.3	40.26	40.26
2	73.4	40.56	39.96
3	73.7	41.19	39.96
4	74	41.47	39.96
5	74.3	41.64	39.96
6	74.6	41.73	39.96
7	74.8	41.76	39.96
8	75.1	41.73	39.96
9	75.4	41.64	39.96
10	75.7	41.47	39.96
11	76	41.19	39.96
12	76.3	40.56	39.96
13	76.4	40.26	40.26

4

CURRENT DATE: 08-29-2006 FILE DATE: 08-29-2006
CURRENT TIME: 20:53:14 FILE NAME: 554-T3

TAILWATER

***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 554-T3
MAIN CHANNEL AND LT & RT OVER BANKS FILE DATE: 08-29-2006
LEFT CHANNEL BOUNDARY 2
RIGHT CHANNEL BOUNDARY 5
MANNING n LEFT OVER BANK 0.050
MANNING n MAIN CHANNEL 0.038
MANNING n RIGHT OVER BANK 0.050
SLOPE OF CHANNEL 0.0050 ft/ft

CROSS-SECTION COORD. NO.	X (ft)	Y (ft)
1	0.00	41.00
2	100.00	39.70
3	100.25	39.50
4	101.75	39.50
5	102.00	39.70
6	203.00	41.00

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	39.50	0.000	0.59	0.00	0.00
3.00	39.96	0.405	1.05	1.51	0.13
5.00	40.01	0.413	1.10	1.63	0.14

9.00	40.08	0.423	1.17	1.79	0.16
12.00	40.13	0.428	1.22	1.89	0.18
15.00	40.17	0.433	1.26	1.97	0.19
18.00	40.20	0.436	1.29	2.04	0.20
21.00	40.23	0.440	1.32	2.10	0.21
24.00	40.26	0.443	1.35	2.15	0.21
27.00	40.29	0.445	1.38	2.20	0.22
30.00	40.31	0.447	1.40	2.25	0.23

Note: Shear stress was calculated using R.

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	24.00 ft
CREST LENGTH	10.00 ft
OVERTOPPING CREST ELEVATION	43.99 ft

2009 Alignment Station: 606+68

1 2006 S&HI Station 630+00 Existing conditions

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 16:39:00 FILE NAME: 63000

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA: INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	45.81	45.36	59.00	1 CSP	2.00	2.00	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 63000 DATE: 08-25-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
45.81	0	0	0	0	0	0	0	0	1
46.78	3	3	0	0	0	0	0	0	1
47.1	5	5	0	0	0	0	0	0	1
47.63	9	9	0	0	0	0	0	0	1
48.03	12	12	0	0	0	0	0	0	1
48.34	15	15	0	0	0	0	0	0	1
49.31	18	18	0	0	0	0	0	0	1
50.23	21	21	0	0	0	0	0	0	1
51.11	24	23.6	0	0	0	0	0	0.33	6
51.27	27	24	0	0	0	0	0	2.84	5
51.38	30	24.4	0	0	0	0	0	5.49	4
51.06	23.4	23.4	0	0	0	0	0	OVERTOPP	ING

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 63000 DATE: 08-25-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
45.81	0.000	0.00	0.00	0.00
46.78	0.000	3.00	0.00	0.00
47.10	0.000	5.00	0.00	0.00
47.63	0.000	9.00	0.00	0.00
48.03	0.000	12.00	0.00	0.00
48.34	0.000	15.00	0.00	0.00
49.31	0.000	18.00	0.00	0.00
50.23	0.000	21.00	0.00	0.00
51.11	-0.005	24.00	0.08	0.33
51.27	-0.008	27.00	0.12	0.44
51.38	-0.009	30.00	0.12	0.40

□□

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

□□
□

2

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 16:39:00 FILE NAME: 63000

□□

PERFORMANCE CURVE FOR CULVERT 1 - 1(2.00 (ft) BY 2.00 (ft)) CSP

□□

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	45.81	0.00	0.00	0-NF	0.00	0.00	0.00	0.14	0.00	0.00
3.00	46.78	0.89	0.97	2-M2c	0.72	0.60	0.60	0.14	3.75	0.00
5.00	47.10	1.18	1.29	2-M2c	0.96	0.79	0.79	0.14	4.36	0.00
9.00	47.63	1.70	1.82	2-M2c	1.41	1.07	1.07	0.14	5.28	0.00
12.00	48.03	2.09	2.22	2-M2c	2.00	1.24	1.24	0.14	5.85	0.00
15.00	48.34	2.53	2.41	2-M2c	2.00	1.40	1.40	0.14	6.41	0.00
18.00	49.31	3.04	3.50	2-M2c	2.00	1.52	1.52	0.14	7.03	0.00
21.00	50.23	3.66	4.42	2-M2c	2.00	1.63	1.63	0.14	7.63	0.00
23.59	51.12	4.29	5.31	2-M2c	2.00	1.71	1.71	0.14	8.27	0.00
24.05	51.27	4.41	5.46	2-M2c	2.00	1.72	1.72	0.14	8.38	0.00
24.39	51.38	4.50	5.57	2-M2c	2.00	1.73	1.73	0.14	8.46	0.00

□□

El. inlet face invert 45.81 ft El. outlet invert 45.36 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

□□

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION 0.00 ft
INLET ELEVATION 45.81 ft
OUTLET STATION 59.00 ft
OUTLET ELEVATION 45.36 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0076
CULVERT LENGTH ALONG SLOPE 59.00 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE CIRCULAR
BARREL DIAMETER 2.00 ft
BARREL MATERIAL CORRUGATED STEEL
BARREL MANNING'S n 0.024
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL THIN EDGE PROJECTING
INLET DEPRESSION NONE

□□
□

3

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 16:39:00 FILE NAME: 63000

TAILWATER

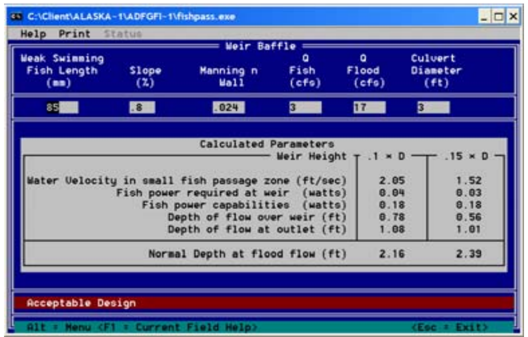
CONSTANT WATER SURFACE ELEVATION
45.5

ROADWAY OVERTOPPING DATA

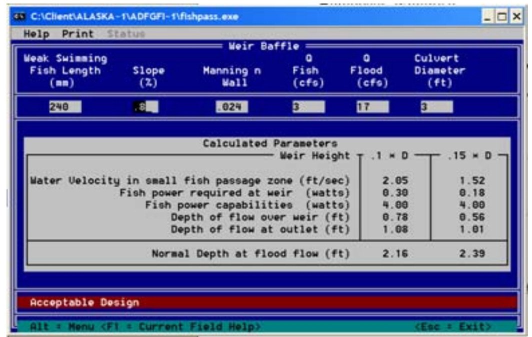
ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	24.00 ft
CREST LENGTH	10.00 ft
OVERTOPPING CREST ELEVATION	51.06 ft

2009 Alignment Station: 606+68
2006 S&HI Station 630+00 Tier 2 FISH PASS design

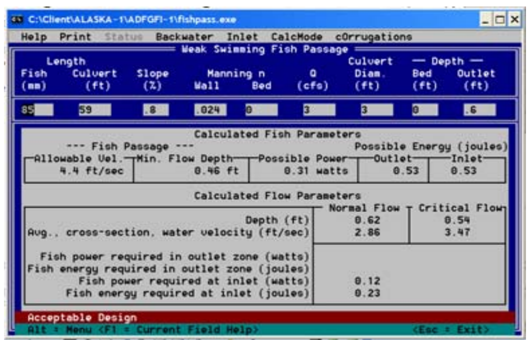
baffle design: 3-ft pipe / Juvenile Cutthroat
Juvenile Cutthroat trout assumed equal to Dolly Varden - equivalent length to input to Fish Pass is 85mm



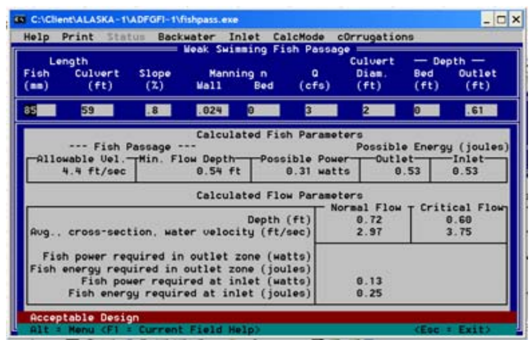
3-ft pipe / Adult Cutthroat
Adult Cutthroat trout assumed equal to Arctic Grayling - equivalent length to input to Fish Pass is 240 mm



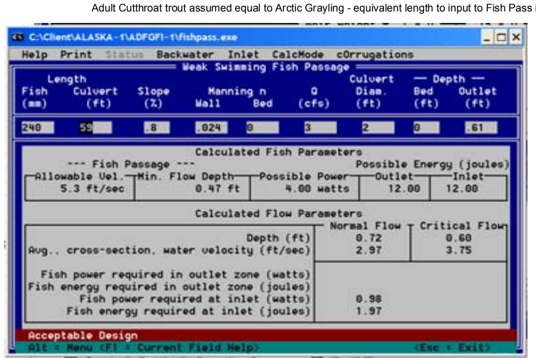
non-baffle design: 3-ft pipe / Juvenile Coho
Need to maintain 0.6-ft of TW



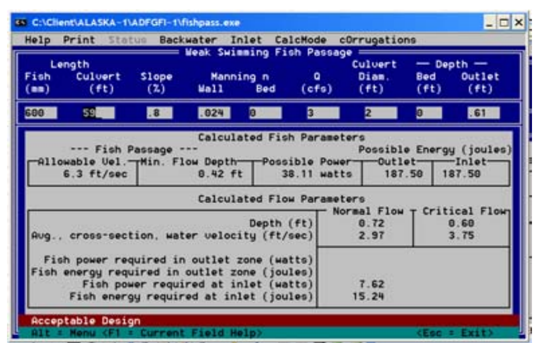
2-ft pipe / Juvenile Coho



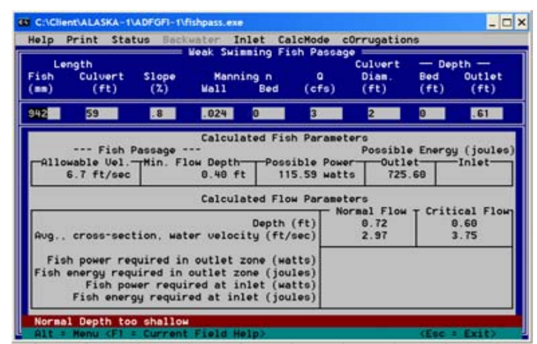
2-ft pipe / Adult Cutthroat
Adult Cutthroat trout assumed equal to Arctic Grayling - equivalent length to input to Fish Pass is 240 mm

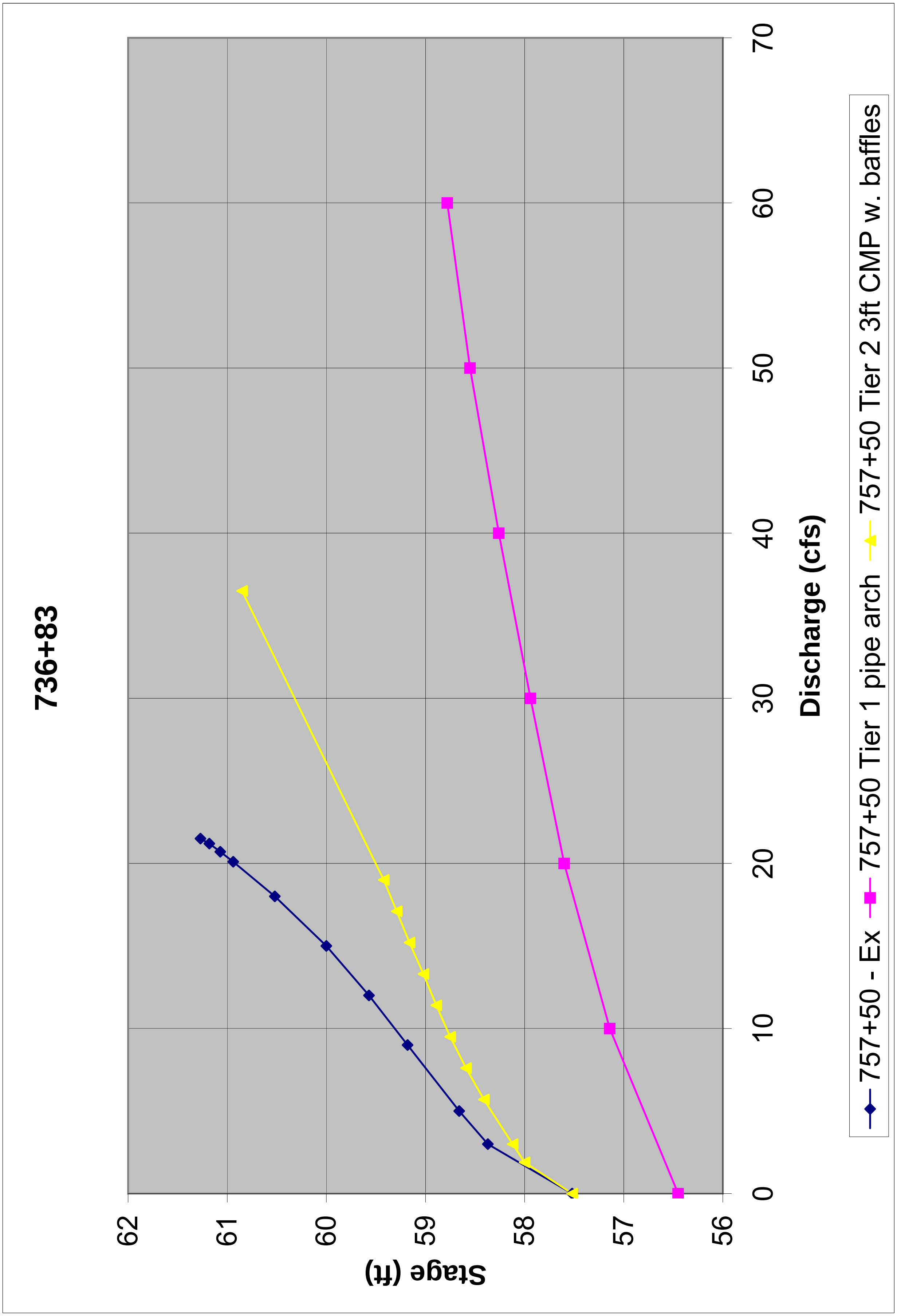


2-ft pipe / Adult Coho



Adult Coho
Note: L * 1.57 converts swimming ability to 'equivalent' grayling
Assume depth based on actual body size o600-mm fish shown to adjacen




736+83
Stage (ft)
Discharge (cfs)
62
61
60
59
58
57
56
0
10
20
30
40
50
60
70
757+50 - Ex
757+50 Tier 1 pipe arch
757+50 Tier 2 3ft CMP w. baffles

2009 Alignment Station: 736+83

1 2006 S&HI Station 757+50 Existing conditions

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 16:42:47 FILE NAME: 75750EX

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	57.52	54.50	60.48	1 CSP	2.00	2.00	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 75750EX DATE: 08-25-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
57.52	0	0	0	0	0	0	0	0	1
58.37	3	3	0	0	0	0	0	0	1
58.66	5	5	0	0	0	0	0	0	1
59.18	9	9	0	0	0	0	0	0	1
59.57	12	12	0	0	0	0	0	0	1
60	15	15	0	0	0	0	0	0	1
60.52	18	18	0	0	0	0	0	0	1
60.94	21	20.1	0	0	0	0	0	0.8	8
61.07	24	20.7	0	0	0	0	0	3.12	4
61.18	27	21.2	0	0	0	0	0	5.72	4
61.27	30	21.5	0	0	0	0	0	8.21	3
60.85	19.6	19.6	0	0	0	0	0	OVERTOPP ING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 75750EX DATE: 08-25-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
57.52	0.000	0.00	0.00	0.00
58.37	0.000	3.00	0.00	0.00
58.66	0.000	5.00	0.00	0.00
59.18	0.000	9.00	0.00	0.00
59.57	0.000	12.00	0.00	0.00
60.00	0.000	15.00	0.00	0.00
60.52	0.000	18.00	0.00	0.00
60.94	-0.008	21.00	0.12	0.57
61.07	-0.005	24.00	0.21	0.88
61.18	-0.009	27.00	0.12	0.44
61.27	-0.006	30.00	0.26	0.87

□□

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

□□
□

2

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 16:42:47 FILE NAME: 75750EX

□□

PERFORMANCE CURVE FOR CULVERT 1 - 1(2.00 (ft) BY 2.00 (ft)) CSP

□□

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	57.52	0.00	0.00	0-NF	0.00	0.00	0.00	-0.74	0.00	0.00
3.00	58.37	0.85	0.85	1-S2n	0.44	0.60	0.30	-0.41	9.65	2.21
5.00	58.66	1.14	1.14	1-S2n	0.57	0.79	0.49	-0.34	8.39	2.58
9.00	59.18	1.66	1.66	1-S2n	0.79	1.07	0.67	-0.22	9.78	3.11
12.00	59.57	2.05	2.05	5-S2n	0.92	1.24	0.84	-0.15	9.58	3.42
15.00	60.00	2.48	2.48	5-S2n	1.05	1.40	1.00	-0.08	9.60	3.68
18.00	60.52	3.00	3.00	5-S2n	1.18	1.52	1.12	-0.01	9.92	3.92
20.09	60.94	3.42	3.42	5-S2n	1.27	1.61	1.21	0.05	10.13	4.12
20.67	61.07	3.55	3.55	5-S2n	1.30	1.62	1.22	0.11	10.25	4.30
21.17	61.18	3.66	3.66	5-S2n	1.32	1.64	1.24	0.16	10.35	4.48
21.53	61.26	3.74	3.74	5-S2n	1.34	1.65	1.25	0.22	10.42	4.63

□□

El. inlet face invert 57.52 ft El. outlet invert 54.50 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

□□

***** SITE DATA ***** CULVERT INVERT **************
INLET STATION 0.00 ft
INLET ELEVATION 57.52 ft
OUTLET STATION 60.40 ft
OUTLET ELEVATION 54.50 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0500
CULVERT LENGTH ALONG SLOPE 60.48 ft

***** CULVERT DATA SUMMARY ************************
BARREL SHAPE CIRCULAR
BARREL DIAMETER 2.00 ft
BARREL MATERIAL CORRUGATED STEEL
BARREL MANNING'S n 0.024
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL THIN EDGE PROJECTING
INLET DEPRESSION NONE

□□
□

3

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 16:42:47 FILE NAME: 75750EX

TAILWATER

***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 75750TW

MAIN CHANNEL ONLY FILE DATE: 08-25-2006

LEFT CHANNEL BOUNDARY 0

RIGHT CHANNEL BOUNDARY 0

MANNING n LEFT OVER BANK 0.000

MANNING n MAIN CHANNEL 0.035

MANNING n RIGHT OVER BANK 0.000

SLOPE OF CHANNEL 0.0180 ft/ft

CROSS-SECTION COORD. NO.	X (ft)	Y (ft)
1	0.00	57.61
2	3.40	53.76
3	6.50	53.82
4	10.20	53.91
5	12.80	57.07

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	53.76	0.000	-0.74	0.00	0.00
3.00	54.09	0.780	-0.41	2.21	0.27
5.00	54.16	0.807	-0.34	2.58	0.34
9.00	54.28	0.840	-0.22	3.11	0.45
12.00	54.35	0.857	-0.15	3.42	0.52
15.00	54.42	0.870	-0.08	3.68	0.58
18.00	54.49	0.881	-0.01	3.92	0.64
21.00	54.55	0.890	0.05	4.12	0.69
24.00	54.61	0.897	0.11	4.30	0.74
27.00	54.66	0.904	0.16	4.48	0.78
30.00	54.72	0.910	0.22	4.63	0.82

Note: Shear stress was calculated using R.

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE PAVED

EMBANKMENT TOP WIDTH 24.00 ft

CREST LENGTH 10.00 ft

OVERTOPPING CREST ELEVATION 60.85 ft

2009 Alignment Station: 736+83

1 2006 S&HI Station 757+50 Tier 1 fish passage - Pipe arch

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006
CURRENT TIME: 18:39:05 FILE NAME: 757T1AR

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	56.45	53.43	60.48	1 ICMP	7.26	4.18	.028	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 757T1AR DATE: 09-07-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
56.45	0	0	0	0	0	0	0	0	1
57.14	10	10	0	0	0	0	0	0	1
57.6	20	20	0	0	0	0	0	0	1
57.94	30	30	0	0	0	0	0	0	1
58.26	40	40	0	0	0	0	0	0	1
58.55	50	50	0	0	0	0	0	0	1
58.78	60	60	0	0	0	0	0	0	1
59.02	70	70	0	0	0	0	0	0	1
59.25	80	80	0	0	0	0	0	0	1
59.49	90	90	0	0	0	0	0	0	1
59.72	100	100	0	0	0	0	0	0	1
60.85	149.4	149.4	0	0	0	0	0	OVERTOPP ING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 757T1AR DATE: 09-07-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
56.45	0.000	0.00	0.00	0.00
57.14	0.000	10.00	0.00	0.00
57.60	0.000	20.00	0.00	0.00
57.94	0.000	30.00	0.00	0.00
58.26	0.000	40.00	0.00	0.00
58.55	0.000	50.00	0.00	0.00

58.78	0.000	60.00	0.00	0.00
59.02	0.000	70.00	0.00	0.00
59.25	0.000	80.00	0.00	0.00
59.49	0.000	90.00	0.00	0.00
59.72	0.000	100.00	0.00	0.00

□□

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

□□□

2

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006
CURRENT TIME: 18:39:05 FILE NAME: 757T1AR

□□

PERFORMANCE CURVE FOR CULVERT 1 - 1(7.26 (ft) BY 4.18 (ft)) ICMP

□□

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	56.45	0.00	0.00	0-NF	0.00	0.00	0.00	0.33	0.00	0.00
10.00	57.14	0.69	0.69	1-S2n	0.23	0.39	0.09	0.88	8.78	3.22
20.00	57.60	1.15	1.15	1-S2n	0.44	0.61	0.31	1.10	7.27	4.05
30.00	57.94	1.49	1.49	1-S2n	0.55	0.82	0.56	1.29	7.54	4.63
40.00	58.26	1.81	1.81	1-S2n	0.66	0.98	0.58	1.45	9.67	5.09
50.00	58.55	2.10	2.10	1-S2n	0.78	1.14	0.79	1.59	8.93	5.47
60.00	58.78	2.33	2.33	1-S2n	0.88	1.29	0.79	1.73	10.63	5.79
70.00	59.02	2.57	2.57	1-S2n	0.97	1.43	0.93	1.85	10.60	6.07
80.00	59.25	2.80	2.80	1-S2n	1.06	1.56	0.96	1.97	11.68	6.33
90.00	59.49	3.04	3.04	1-S2n	1.15	1.69	1.09	2.09	11.57	6.56
100.00	59.72	3.27	3.27	1-S2n	1.24	1.81	1.25	2.19	11.28	6.78

□□

El. inlet face invert 56.45 ft El. outlet invert 53.43 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

□□

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION 0.00 ft
INLET ELEVATION 56.45 ft
OUTLET STATION 60.40 ft
OUTLET ELEVATION 53.43 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0500
CULVERT LENGTH ALONG SLOPE 60.48 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE USER DEFINED
BARREL SPAN 7.26 ft
BARREL RISE 4.18 ft
BARREL MATERIAL STEEL OR ALUMINUM
BARREL MANNING'S n 0.028 FOR SIDES AND TOP

0.038 FOR BOTTOM
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL MITERED
INLET DEPRESSION NONE

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3

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006
CURRENT TIME: 18:39:05 FILE NAME: 757T1AR

□□

***** USER DEFINED CULVERT CROSS-SECTION - CULVERT # 1

COORDINATE NUMBER	X (ft)	Y-TOP (ft)	Y-BOTTOM (ft)
1	0.00	58.26	58.26
2	0.17	59.16	57.52
3	0.86	60.42	57.52
4	1.55	61.05	57.52
5	2.24	61.43	57.52
6	2.94	61.63	57.52
7	3.63	61.70	57.52
8	4.32	61.63	57.52
9	5.01	61.43	57.52
10	5.71	61.05	57.52
11	6.40	60.42	57.52
12	7.09	59.16	57.52
13	7.26	58.18	58.18

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4

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006
CURRENT TIME: 18:39:05 FILE NAME: 757T1AR

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□□

***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 75750TW
MAIN CHANNEL ONLY FILE DATE: 08-25-2006
LEFT CHANNEL BOUNDARY 0
RIGHT CHANNEL BOUNDARY 0
MANNING n LEFT OVER BANK 0.000
MANNING n MAIN CHANNEL 0.035
MANNING n RIGHT OVER BANK 0.000
SLOPE OF CHANNEL 0.0180 ft/ft

CROSS-SECTION X Y

COORD. NO.	(ft)	(ft)
1	0.00	57.61
2	3.40	53.76
3	6.50	53.82
4	10.20	53.91
5	12.80	57.07

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	53.76	0.000	0.33	0.00	0.00
10.00	54.31	0.847	0.88	3.22	0.48
20.00	54.53	0.887	1.10	4.05	0.67
30.00	54.72	0.910	1.29	4.63	0.82
40.00	54.88	0.925	1.45	5.09	0.95
50.00	55.02	0.937	1.59	5.47	1.06
60.00	55.16	0.946	1.73	5.79	1.15
70.00	55.28	0.954	1.85	6.07	1.24
80.00	55.40	0.960	1.97	6.33	1.32
90.00	55.52	0.965	2.09	6.56	1.39
100.00	55.62	0.970	2.19	6.78	1.46

Note: Shear stress was calculated using R.

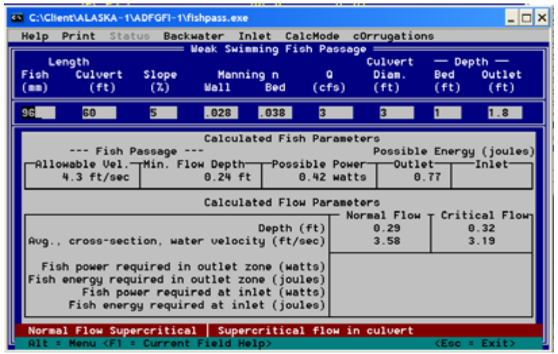
ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	24.00 ft
CREST LENGTH	10.00 ft
OVERTOPPING CREST ELEVATION	60.85 ft

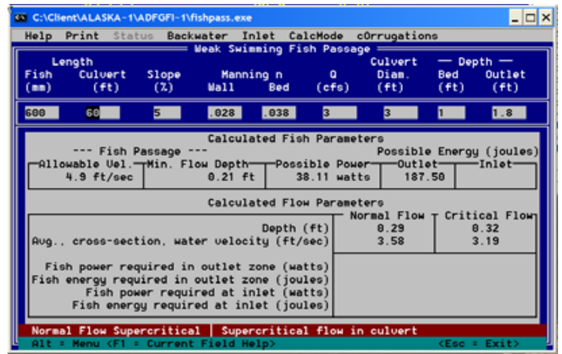
2009 Alignment Station: 736+83
2006 S&HI Station 757+50 Tier 2 FISH PASS design

non baffled design: 3-ft pipe at slope of existing pipe

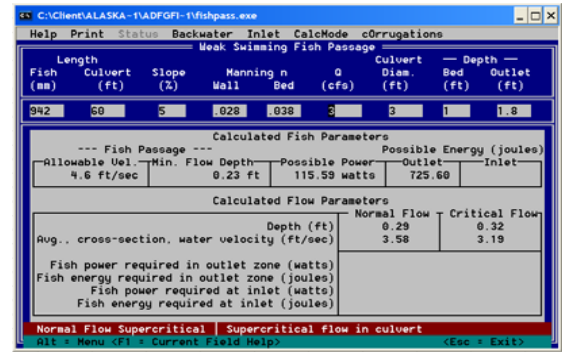
Juvenile Coho



Adult Coho

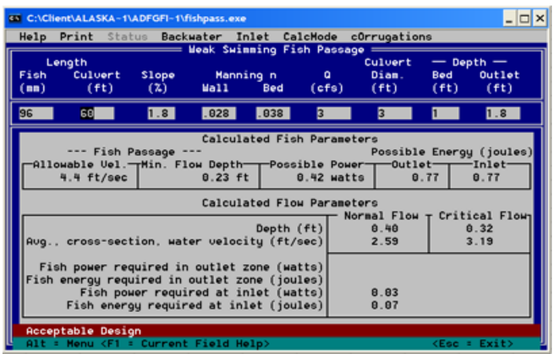


Adult coho - adjusted to 'equivalent' grayling

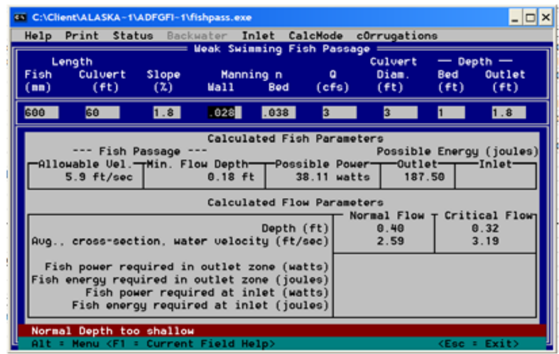


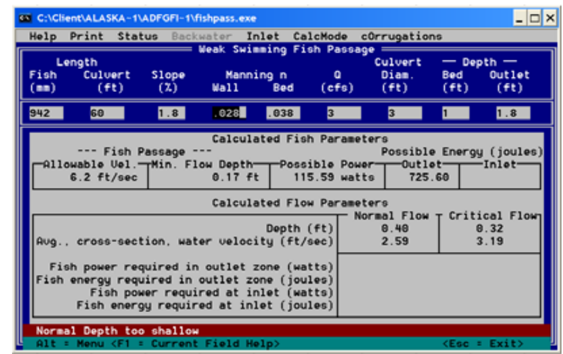
3-ft pipe at slope of existing d/s channel

Juvenile Coho



Adult Coho

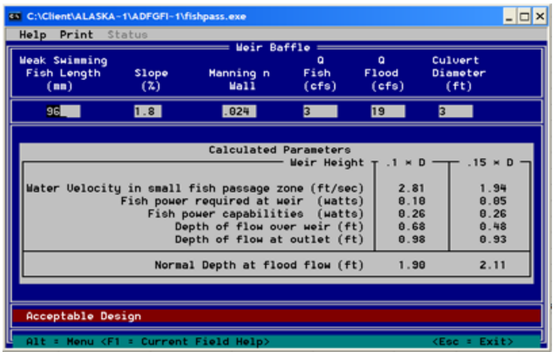




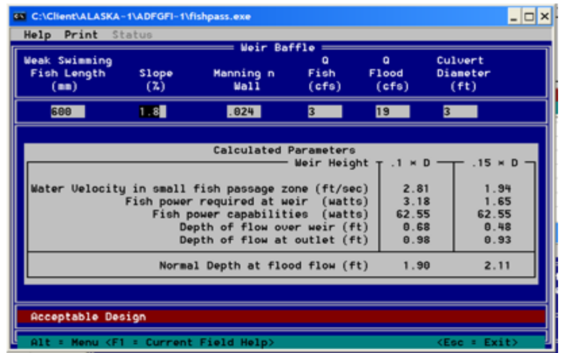
baffle design:

3-ft pipe at slope of existing d/s channel

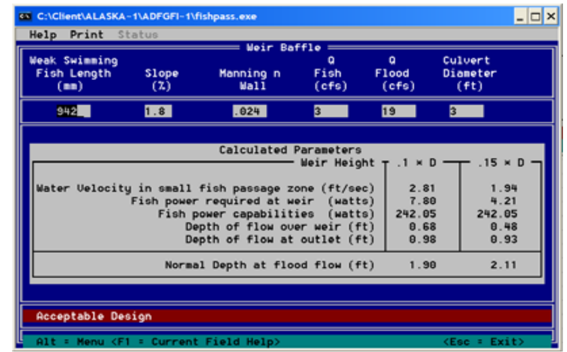
Juvenile Coho



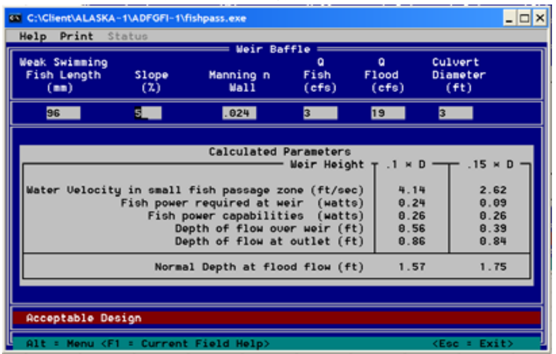
Adult Coho

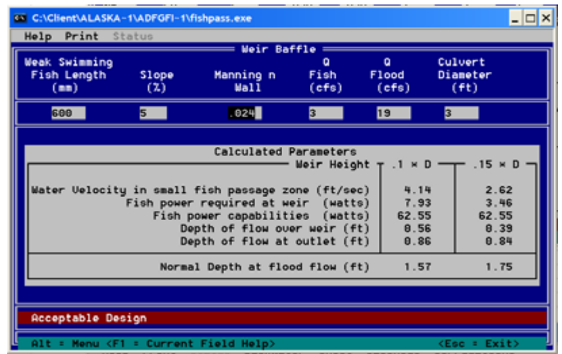


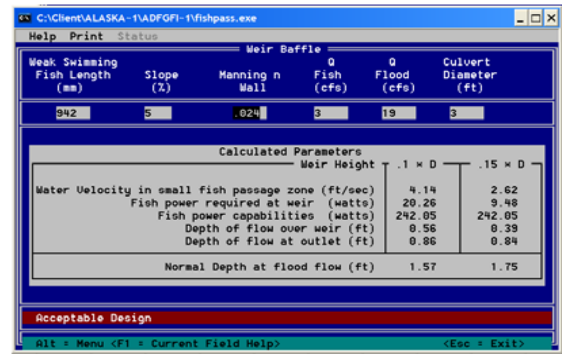
Adult coho - adjusted to 'equivalent' grayling



3-ft pipe at slope of existing pipe







2009 Alignment Station: 736+83

1 2006 S&HI Station 757+50 Tier 2 fish passage - 3-ft baffled CMP

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006
CURRENT TIME: 19:05:25 FILE NAME: 757T2-3B

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	57.52	54.50	60.08	1 ICMP	3.00	2.55	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 757T2-3B DATE: 09-07-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWA`	ITR
57.52	0	0	0	0	0	0	0	0	1
58	1.9	1.9	0	0	0	0	0	0	1
58.12	3	3	0	0	0	0	0	0	1
58.41	5.7	5.7	0	0	0	0	0	0	1
58.59	7.6	7.6	0	0	0	0	0	0	1
58.75	9.5	9.5	0	0	0	0	0	0	1
58.89	11.4	11.4	0	0	0	0	0	0	1
59.02	13.3	13.3	0	0	0	0	0	0	1
59.16	15.2	15.2	0	0	0	0	0	0	1
59.29	17.1	17.1	0	0	0	0	0	0	1
59.42	19	19	0	0	0	0	0	0	1
60.85	36.5	36.5	0	0	0	0	0	OVERTOF ING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 757T2-3B DATE: 09-07-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
57.52	0.000	0.00	0.00	0.00
58.00	0.000	1.90	0.00	0.00
58.12	0.000	3.00	0.00	0.00
58.41	0.000	5.70	0.00	0.00
58.59	0.000	7.60	0.00	0.00
58.75	0.000	9.50	0.00	0.00
58.89	0.000	11.40	0.00	0.00
59.02	0.000	13.30	0.00	0.00
59.16	0.000	15.20	0.00	0.00
59.29	0.000	17.10	0.00	0.00
59.42	0.000	19.00	0.00	0.00

□□□
<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000
□□□
□
2

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006
CURRENT TIME: 19:05:25 FILE NAME: 757T2-3B
□□□
PERFORMANCE CURVE FOR CULVERT 1 - 1(3.00 (ft) BY 2.55 (ft)) ICMP
□□□

DIS- CHARGE FLOW (cfs)	HEAD- WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	57.52	0.00	0.00	0-NF	0.00	0.00	0.00	-0.74	0.00	0.00
1.90	58.00	0.48	0.48	1-S2n	0.16	0.27	0.07	-0.45	6.38	1.86
3.00	58.12	0.60	0.60	1-S2n	0.26	0.36	0.16	-0.40	5.83	2.10
5.70	58.41	0.89	0.89	1-S2n	0.36	0.55	0.25	-0.30	9.54	2.55
7.60	58.59	1.07	1.07	1-S2n	0.44	0.66	0.36	-0.24	8.64	2.79
9.50	58.75	1.23	1.23	1-S2n	0.51	0.77	0.51	-0.19	7.47	3.01
11.40	58.89	1.37	1.37	1-S2n	0.57	0.86	0.46	-0.13	10.05	3.19
13.30	59.02	1.50	1.50	1-S2n	0.63	0.94	0.54	-0.08	9.71	3.36
15.20	59.16	1.64	1.64	1-S2n	0.68	1.03	0.63	-0.04	9.40	3.51
17.10	59.29	1.77	1.77	1-S2n	0.74	1.10	0.75	0.00	8.80	3.65
19.00	59.42	1.90	1.90	1-S2n	0.79	1.17	0.67	0.04	10.97	3.78

□□□
El. inlet face invert 57.52 ft El. outlet invert 54.50 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft
□□□

***** SITE DATA ***** CULVERT INVERT **************
INLET STATION 0.00 ft
INLET ELEVATION 57.52 ft
OUTLET STATION 60.00 ft
OUTLET ELEVATION 54.50 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0503
CULVERT LENGTH ALONG SLOPE 60.08 ft

***** CULVERT DATA SUMMARY ************************
BARREL SHAPE USER DEFINED
BARREL SPAN 3.00 ft
BARREL RISE 2.55 ft
BARREL MATERIAL STEEL OR ALUMINUM
BARREL MANNING'S n 0.024 FOR SIDES AND TOP
0.038 FOR BOTTOM
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL MITERED
INLET DEPRESSION NONE

□□□
□
3

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006

CURRENT TIME: 19:05:25 FILE NAME: 757T2-3B

***** USER DEFINED CULVERT CROSS-SECTION - CULVERT # 1

COORDINATE NUMBER	X (ft)	Y-TOP (ft)	Y-BOTTOM (ft)
1	0.00	58.57	58.57
2	0.14	59.21	57.93
3	0.29	59.45	57.69
4	0.43	59.62	57.52
5	0.70	59.84	57.52
6	0.96	59.97	57.52
7	1.23	60.05	57.52
8	1.50	60.07	57.52
9	1.77	60.05	57.52
10	2.04	59.97	57.52
11	2.30	59.84	57.52
12	2.57	59.62	57.52
13	2.71	59.45	57.69
14	2.86	59.21	57.93
15	3.00	58.57	58.57

4

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006
CURRENT TIME: 19:05:25 FILE NAME: 757T2-3B

TAILWATER

***** USER DEFINED CHANNEL CROSS-SECTION FILE NAME: 757T2-3B
MAIN CHANNEL ONLY FILE DATE: 09-07-2006
LEFT CHANNEL BOUNDARY 0
RIGHT CHANNEL BOUNDARY 0
MANNING n LEFT OVER BANK 0.000
MANNING n MAIN CHANNEL 0.038
MANNING n RIGHT OVER BANK 0.000
SLOPE OF CHANNEL 0.0180 ft/ft

CROSS-SECTION COORD. NO.	X (ft)	Y (ft)
1	0.00	57.61
2	3.40	53.76
3	6.50	53.82
4	10.20	53.91
5	12.80	57.07

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

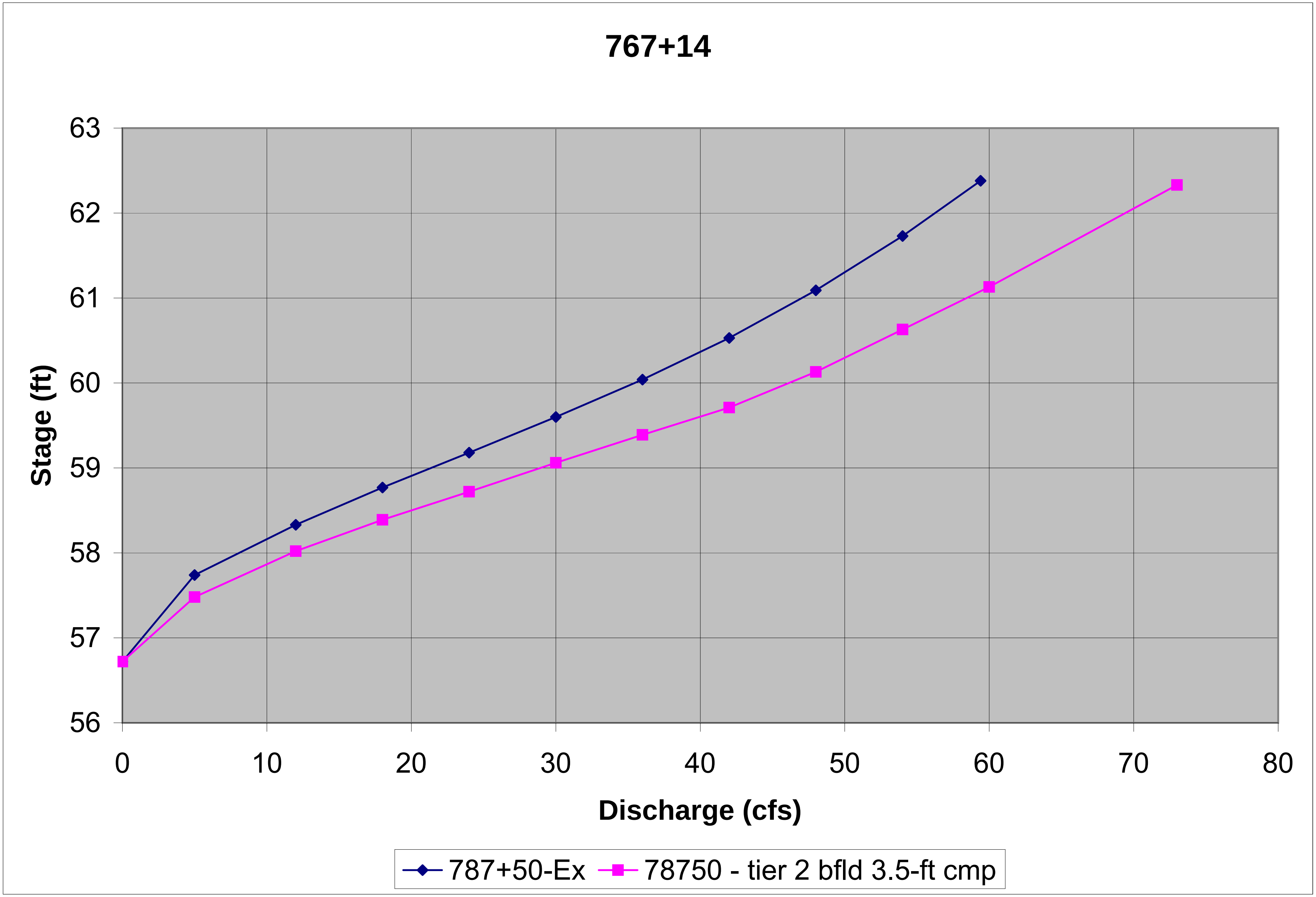
FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	53.76	0.000	-0.74	0.00	0.00
1.90	54.05	0.704	-0.45	1.86	0.24

3.00	54.10	0.724	-0.40	2.10	0.28
5.70	54.20	0.755	-0.30	2.55	0.38
7.60	54.26	0.770	-0.24	2.79	0.44
9.50	54.31	0.782	-0.19	3.01	0.49
11.40	54.37	0.792	-0.13	3.19	0.53
13.30	54.42	0.800	-0.08	3.36	0.58
15.20	54.46	0.807	-0.04	3.51	0.61
17.10	54.50	0.813	0.00	3.65	0.65
19.00	54.54	0.819	0.04	3.78	0.69

Note: Shear stress was calculated using R.

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	24.00 ft
CREST LENGTH	10.00 ft
OVERTOPPING CREST ELEVATION	60.85 ft


767+14
Stage (ft)
63
62
61
60
59
58
57
56
0
10
20
30
40
50
60
70
80
Discharge (cfs)
787+50-Ex
78750 - tier 2 bfld 3.5-ft cmp

2009 Alignment Station: 767+14

1 2006 S&HI Station 787+50 Existing conditions

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 16:45:22 FILE NAME: 78750EX

FHWA CULVERT ANALYSIS

HY-8, VERSION 6.1

C U L V NO.	SITE DATA: INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	56.72	55.16	52.02	1 CSP	3.00	3.00	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 78750EX DATE: 08-25-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
56.72	0	0	0	0	0	0	0	0	1
57.74	5	5	0	0	0	0	0	0	1
58.33	12	12	0	0	0	0	0	0	1
58.77	18	18	0	0	0	0	0	0	1
59.18	24	24	0	0	0	0	0	0	1
59.6	30	30	0	0	0	0	0	0	1
60.04	36	36	0	0	0	0	0	0	1
60.53	42	42	0	0	0	0	0	0	1
61.09	48	48	0	0	0	0	0	0	1
61.73	54	54	0	0	0	0	0	0	1
62.38	60	59.4	0	0	0	0	0	0.32	6
62.33	59	59	0	0	0	0	0	OVERTOPP	ING

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 78750EX DATE: 08-25-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
56.72	0.000	0.00	0.00	0.00
57.74	0.000	5.00	0.00	0.00
58.33	0.000	12.00	0.00	0.00
58.77	0.000	18.00	0.00	0.00
59.18	0.000	24.00	0.00	0.00
59.60	0.000	30.00	0.00	0.00
60.04	0.000	36.00	0.00	0.00
60.53	0.000	42.00	0.00	0.00
61.09	0.000	48.00	0.00	0.00
61.73	0.000	54.00	0.00	0.00
62.38	-0.008	60.00	0.23	0.38

□□
<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000
□□
□

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 16:45:22 FILE NAME: 78750EX

□□

PERFORMANCE CURVE FOR CULVERT 1 - 1(3.00 (ft) BY 3.00 (ft)) CSP

□□

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	56.72	0.00	0.00	0-NF	0.00	0.00	0.00	0.34	0.00	0.00
5.00	57.74	1.02	1.02	1-S2n	0.56	0.69	0.49	0.34	6.52	0.00
12.00	58.33	1.61	1.61	1-S2n	0.89	1.09	0.79	0.34	8.00	0.00
18.00	58.77	2.05	2.05	1-S2n	1.09	1.35	1.10	0.34	7.64	0.00
24.00	59.18	2.46	2.46	1-S2n	1.28	1.57	1.17	0.34	9.36	0.00
30.00	59.60	2.88	2.88	1-S2n	1.46	1.77	1.37	0.34	9.51	0.00
36.00	60.04	3.32	3.32	5-S2n	1.63	1.94	1.54	0.34	9.82	0.00
42.00	60.53	3.81	3.81	5-S2n	1.80	2.11	1.71	0.34	10.10	0.00
48.00	61.09	4.37	4.37	5-S2n	1.97	2.25	1.98	0.34	9.72	0.00
54.00	61.73	5.01	5.01	5-S2n	2.15	2.38	2.08	0.34	10.30	0.00
59.44	62.38	5.66	5.66	5-S2n	2.34	2.48	2.28	0.34	10.35	0.00

□□

El. inlet face invert 56.72 ft El. outlet invert 55.16 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

□□

***** SITE DATA ***** CULVERT INVERT **************

INLET STATION 0.00 ft
INLET ELEVATION 56.72 ft
OUTLET STATION 52.00 ft
OUTLET ELEVATION 55.16 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0300
CULVERT LENGTH ALONG SLOPE 52.02 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE CIRCULAR
BARREL DIAMETER 3.00 ft
BARREL MATERIAL CORRUGATED STEEL
BARREL MANNING'S n 0.024
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL THIN EDGE PROJECTING
INLET DEPRESSION NONE

□□
□

CURRENT DATE: 08-25-2006 FILE DATE: 08-25-2006
CURRENT TIME: 16:45:22 FILE NAME: 78750EX

TAILWATER

CONSTANT WATER SURFACE ELEVATION
55.5

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	24.00 ft
CREST LENGTH	10.00 ft
OVERTOPPING CREST ELEVATION	62.33 ft

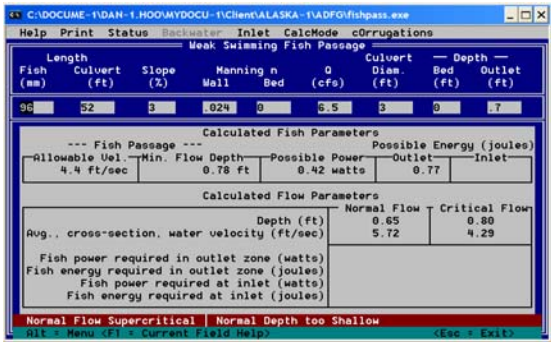
767+14 Tier 2 FISH PASS design

2006 S&HI XS 787+50 Tier 2 FISH PASS design

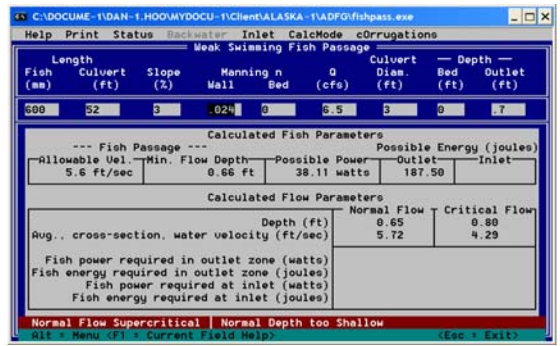
June 16, 2009

Non baffle design

Juvenile coho in 3-ft CMP

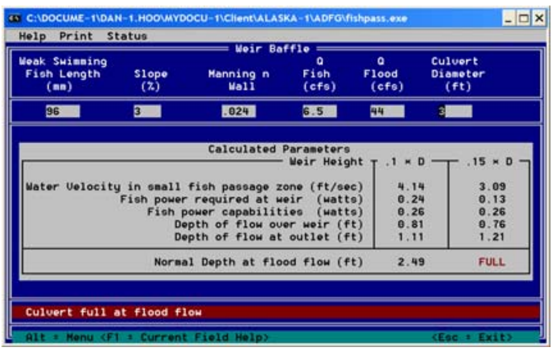


adult coho

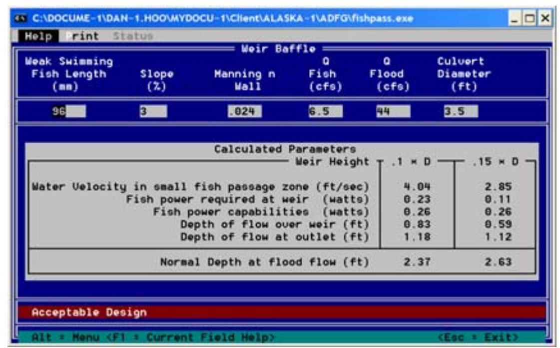


Baffle design

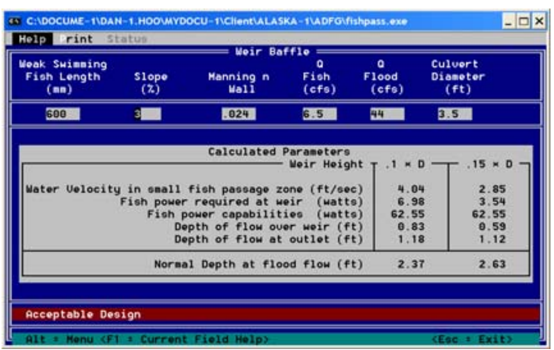
Juvenile coho in 3-ft CMP



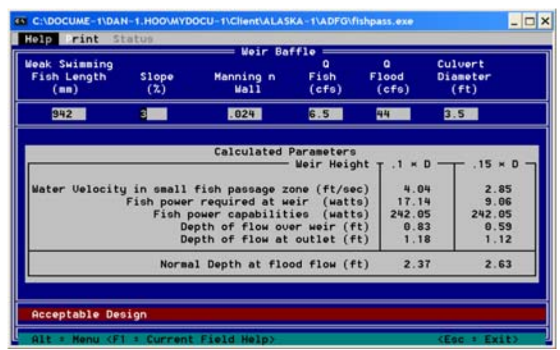
Juvenile coho in 3.5-ft CMP



Adult coho in 3.5-ft CMP



Adult coho adjusted to 'equivalent' grayling



2009 Alignment Station: 767+14

1 2006 S&HI Station 787+50 Tier 2 fish passage - 3.5-ft baffled CMP

CURRENT DATE: 09-07-2006 FILE DATE: 09-07-2006
CURRENT TIME: 19:53:59 FILE NAME: 787T2-42

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	56.72	55.16	52.02	1 ICMP	3.50	2.98	.024	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 787T2-42 DATE: 09-07-2006

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
56.72	0	0	0	0	0	0	0	0	1
57.48	5	5	0	0	0	0	0	0	1
58.02	12	12	0	0	0	0	0	0	1
58.39	18	18	0	0	0	0	0	0	1
58.72	24	24	0	0	0	0	0	0	1
59.06	30	30	0	0	0	0	0	0	1
59.39	36	36	0	0	0	0	0	0	1
59.71	42	42	0	0	0	0	0	0	1
60.13	48	48	0	0	0	0	0	0	1
60.63	54	54	0	0	0	0	0	0	1
61.13	60	60	0	0	0	0	0	0	1
62.33	73	73	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 787T2-42 DATE: 09-07-2006

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
56.72	0.000	0.00	0.00	0.00
57.48	0.000	5.00	0.00	0.00
58.02	0.000	12.00	0.00	0.00
58.39	0.000	18.00	0.00	0.00
58.72	0.000	24.00	0.00	0.00
59.06	0.000	30.00	0.00	0.00
59.39	0.000	36.00	0.00	0.00
59.71	0.000	42.00	0.00	0.00
60.13	0.000	48.00	0.00	0.00
60.63	0.000	54.00	0.00	0.00
61.13	0.000	60.00	0.00	0.00

□□□

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

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PERFORMANCE CURVE FOR CULVERT 1 - 1(3.50 (ft) BY 2.98 (ft)) ICMP

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DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	56.72	0.00	0.00	0-NF	0.00	0.00	0.00	0.34	0.00	0.00
5.00	57.48	0.76	0.76	1-S2n	0.36	0.46	0.26	0.34	6.24	0.00
12.00	58.02	1.30	1.30	1-S2n	0.63	0.81	0.51	0.34	8.17	0.00
18.00	58.39	1.67	1.67	1-S2n	0.81	1.04	0.74	0.34	8.07	0.00
24.00	58.72	2.00	2.00	1-S2n	0.97	1.25	0.97	0.34	8.04	0.00
30.00	59.06	2.34	2.34	1-S2n	1.13	1.43	1.03	0.34	9.44	0.00
36.00	59.39	2.67	2.67	1-S2n	1.27	1.59	1.19	0.34	9.63	0.00
42.00	59.71	2.99	2.99	5-S2n	1.41	1.75	1.35	0.34	9.81	0.00
48.00	60.13	3.41	3.41	5-S2n	1.56	1.89	1.49	0.34	10.06	0.00
54.00	60.63	3.91	3.91	5-S2n	1.70	2.03	1.63	0.34	10.33	0.00
60.00	61.13	4.41	4.41	5-S2n	1.84	2.15	1.75	0.34	10.66	0.00

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El. inlet face invert 56.72 ft El. outlet invert 55.16 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

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***** SITE DATA ***** CULVERT INVERT **************

INLET STATION 0.00 ft
INLET ELEVATION 56.72 ft
OUTLET STATION 52.00 ft
OUTLET ELEVATION 55.16 ft
NUMBER OF BARRELS 1
SLOPE (V/H) 0.0300
CULVERT LENGTH ALONG SLOPE 52.02 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE USER DEFINED
BARREL SPAN 3.50 ft
BARREL RISE 2.98 ft
BARREL MATERIAL STEEL OR ALUMINUM
BARREL MANNING'S n 0.024 FOR SIDES AND TOP
0.038 FOR BOTTOM
INLET TYPE CONVENTIONAL
INLET EDGE AND WALL MITERED
INLET DEPRESSION NONE

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***** USER DEFINED CULVERT CROSS-SECTION - CULVERT # 1

COORDINATE NUMBER	X (ft)	Y-TOP (ft)	Y-BOTTOM (ft)
1	0.00	57.95	57.95
2	0.17	58.69	57.20
3	0.33	58.97	56.92
4	0.50	59.17	56.72
5	0.81	59.42	56.72
6	1.13	59.58	56.72
7	1.44	59.67	56.72
8	1.75	59.70	56.72
9	2.06	59.67	56.72
10	2.37	59.58	56.72
11	2.69	59.42	56.72
12	3.00	59.17	56.72
13	3.17	58.97	56.92
14	3.33	58.69	57.20
15	3.50	57.95	57.95

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TAILWATER

CONSTANT WATER SURFACE ELEVATION
55.5

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE PAVED
EMBANKMENT TOP WIDTH 24.00 ft
CREST LENGTH 10.00 ft
OVERTOPPING CREST ELEVATION 62.33 ft