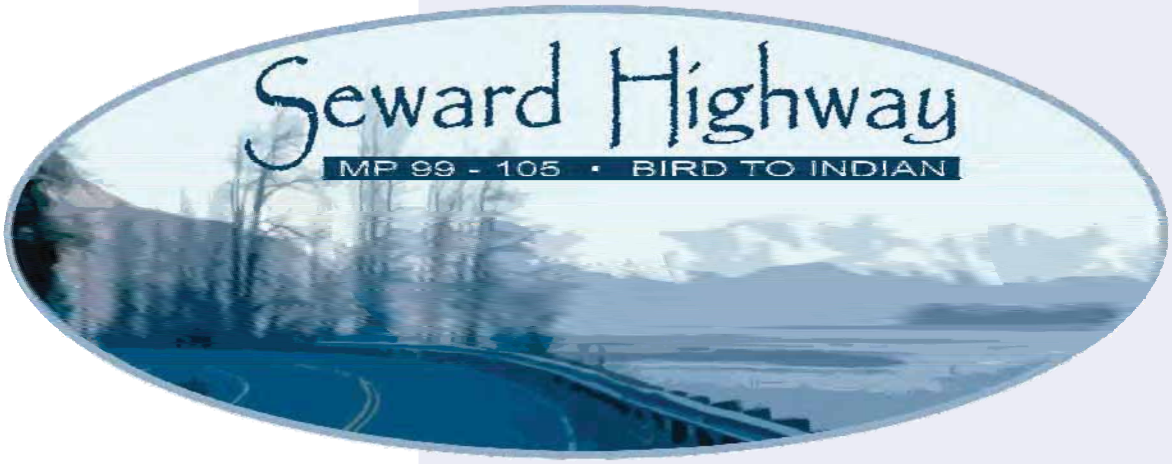

Categorical Exclusion

Seward Highway - Bird to Indian - Mileposts 99 to 105

Federal/DOT&PF Project Nos. NH-0A3-1(25)/53577

April 2011

Prepared by:
DOWL HKM

APPENDIX E

Hydrologic and Hydraulic Summary Report

Summary of Changes in Project Scope

The Seward Highway Milepost (MP) 99 to MP 105: Bird to Indian project was originally evaluated as an Environmental Assessment (EA) with 3 design alternatives: (1) No-Action Alternative; (2) resurfacing, restoration, and rehabilitation (3R) with Passing Lanes Alternative; and (3) Passing Lanes and Frontage Road Alternative. During the early planning process, rerouting the road into Turnagain Arm was discussed, but was ruled out due to cost and environmental concerns. The attached technical report may discuss multiple alternatives. However, the Categorical Exclusion (CE) document only relates to Alternative 2, 3R with Passing Lanes, which is the proposed design that is being carried forward. It is anticipated that there has been no change in the built and natural environment since the attached study was completed.

Seward Highway, Milepost 99-105 (Bird to Indian)
ADOT&PF State Project #53577
Hydrologic and Hydraulic Summary Report

Prepared for:
DOWL HKM
4041 B Street
Anchorage, AK 99503

By:

inter·fluve, inc.

1020 Wasco Street, Suite1
Hood River, OR 97031
541-386-9003
www.interfluve.com

August 21, 2007
Finalized June 16, 2010

(Intentionally Blank)

Table of Contents

Table of Tables

Table of Figures

1 Introduction

Improvements are under evaluation for the Seward Highway between Mileposts 99 and 105. This project is located approximately 20-miles from Anchorage, Alaska along the Turnagain Arm through the Chugach Mountains and includes the towns of Indian and Bird. Project location is shown in Sheet 1 (Appendix 1).

Two alternative alignments are under consideration; as of March 2007 they include: 1) improvements to the existing alignment and 2) construction of a frontage road along portions of the project to service the local communities. The improvements associated with these alternatives will affect four streams.

Highway analysis and design is being conducted by DOWL HKM. Inter-Fluve is subcontracted to DOWL HKM to conduct the hydrologic and hydraulic analysis for the stream crossings. Inter-Fluve also prepared a companion fish habitat assessment for these streams and the shoreline of Turnagain Arm along the length of the project. The companion fish habitat assessment is documented separately (Inter-Fluve, 2007).

For this alternatives level analysis, the hydrologic and hydraulic analysis and design are completed to a preliminary level. As the alternatives become more refined and detailed, additional level of detail will be applied to the Hydrology and Hydraulic Summary Report (H&H Report). This report documents preliminary level design for highway crossings of four streams. In addition, a rapid assessment was conducted of all culverts within the project corridor.

1.1 Field investigations

At the time of the August 2006 field investigations, four alignments were under consideration. In addition to improvements along the existing alignment and addition of a frontage road considered herein, alignments along the shore and through Turnagain Arm were under consideration. These latter two alignments have since been eliminated from consideration. In addition, work by DOWL HKM on the alignments since completion of the field work indicates that no changes will be made to the existing Bird Creek Bridge. Field data collection included efforts for these alignments and changes to the Bird Creek Bridge, which have subsequently been eliminated.

Field investigations of highway stream crossings were conducted during August 1-4, 2006 by Inter-Fluve's hydrologist and hydraulic engineer. Access across ARRC property to the stream and shoreline was conducted under ARRC permit #8285. Field investigation activities included:

- Rapid assessment of all culverts through the highway embankment along the project corridor.
- Visual inspection and collection of field notes and digital photos of each tributary crossing from upstream ROW to tidewater.
- Request and coordination with DOWL HKM surveyors for collection of stream profile, cross section and culvert survey data. Project aerial topographic data

prepared by Aeromap were provided by DOWL HKM. The purpose of the survey was in support of a preliminary level design of culvert replacements and therefore may require more resolution for design. As noted by DOWL HKM surveyors, the survey horizontal datum is AKDOT&PF "Anchorage Bowl 2000", US feet. The vertical Datum is 1967/68 NGS "Tentative Adjustment", US feet (DOWL HKM, November, 2006). No OHW or tidal levels were surveyed at this phase.

- Coordination with Inter-Fluve fish biologists conducting habitat assessment and data collection along streams and shoreline.
- For shoreline and Arm alignments, general observations were made of flow circulation patterns during tidal cycles along the Turnagain Arm. Visual observations were taken from shore and from an overlook perspective from Bird Ridge.

2 Hydrology

Hydrologic analyses were performed by Inter-Fluve's hydrologist for five streams that cross the Seward Highway between Mileposts 99 and 105. The streams include Bird Creek, Indian Creek, and three smaller, unnamed streams. All five streams pass beneath the Seward Highway and the Alaska Rail Road Corporation (ARRC) railroad tracks before entering the north shore of Turnagain Arm. Bird Creek is spanned by bridges at both the highway and the railroad. Indian Creek is spanned by a bridge at the highway and three culverts at the ARRC. The remaining streams flow through culverts at both the highway and the ARRC.

Peak flow estimates for various return periods were estimated in order to analyze flood conveyance and fish passage conditions. Analyses were conducted in accordance with the Alaska Department of Transportation Highway Drainage Manual (ADOT&PF, 1995). A combination of approaches was applied, including USGS regional regression equations, the SCS Graphical Peak Discharge Method, and the Rational Method. Multiple methods were applied because the basins were not, in all cases, within the limitations of each method; and in some cases, the necessary data were not available. Using multiple approaches allowed for the comparison of multiple lines of evidence, and facilitated the selection of the most appropriate flow estimates. In consideration of the applicability and assumptions in each method, and the reasonableness of the results, the regression equations are believed to offer the most appropriate flow estimates for the basins.

The streams included in this analysis originate in the Chugach Mountains east of Anchorage, Alaska. A map of the basin locations can be found in Figure 1. The five basins vary considerably with respect to size, elevation, and hydrologic characteristics. Basin sizes range from 0.6 mi^2 to 76 mi^2. Basin elevations for the smallest basin range from sea level to 2,300 feet and for the largest basin (Bird Creek) from sea level to over 5,500 feet. Bird Creek is only 25% forested, with much of the basin lying above timberline in steep, snowmelt dominated highlands. Indian Creek has a similar elevation range and percent forest cover (28%). Runoff timing in these basins is expected to be similar to that of the adjacent Ship Creek to the north, where snowmelt results in peak flows from May through July. The smaller basins, which are lower in elevation and more densely forested (44% - 69%), are likely to exhibit a more rain-dominated runoff regime, with peak flows occurring in September and October when rainfall amounts are greatest.

Peak flow estimates for various return periods were estimated for each of the 5 basins using USGS regional regression equations (Curran et al. 2003), the SCS Graphical Peak Discharge 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.

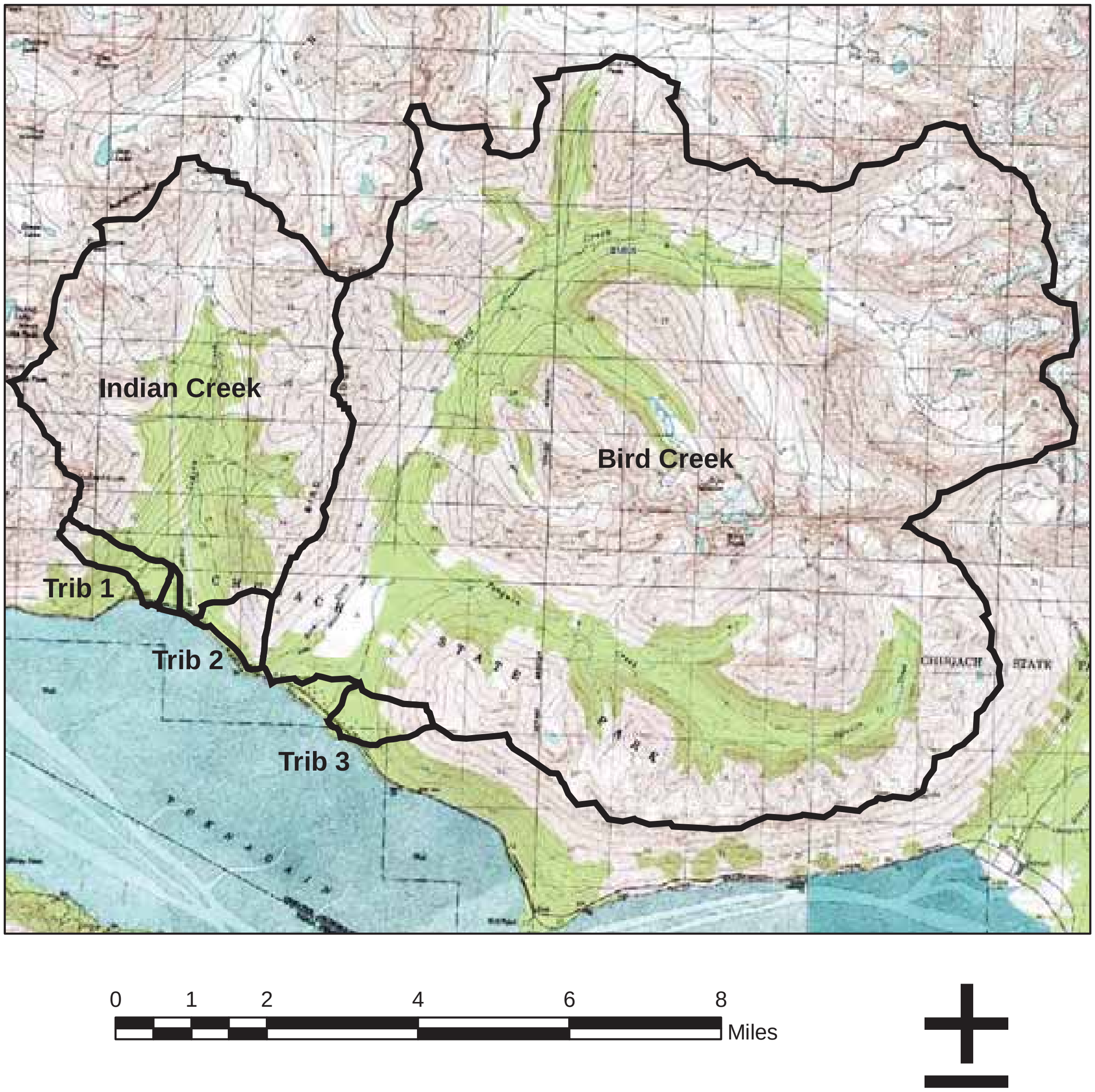

Figure 1. Locator map of major drainage basins crossing the Seward Highway between mileposts 99 and 105.

Note:

- Trib 1 is the unnamed tributary referred to herein as "Subdivision" Creek near MP 103.5
- Trib 2 is the unnamed tributary referred to herein as "Ball Field" Creek near MP 102.7
- Trib 3 is the unnamed tributary referred to herein as "Bear" Creek near MP 100.6

2.1 Regional Regression Analysis

The regression equations for south-central Alaska were developed from data from 71 gaging stations (Curran et al. 2003). The equations utilize drainage area, storage, and mean annual precipitation as predictor variables. The equations and accuracy information are displayed in Table 1. Basin characteristics were obtained using methods consistent with those applied by Curran et al. (2003) for model development. Drainage area for each basin was obtained through Geographic Information System (GIS) analysis using the 15-minute USGS Digital Elevation Model (DEM). Percent storage for each basin was obtained in GIS by digitizing surface water areas on USGS digitized topographic maps. Mean annual precipitation values were obtained in GIS through area-weighted averaging of values from a digitized version of the precipitation maps provided in Jones and Fahl (1994).

Table 1. USGS Regional Regression equations for estimating flood magnitude for various recurrence intervals. Equations are applicable to south-central 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*
$Q_2 = 0.2535\ A^{0.9462}\ (ST+1)^{-0.1981}\ P^{1.201}$	42	0.98
$Q_5 = 0.5171\ A^{0.9084}\ (ST+1)^{-0.2128}\ P^{1.162}$	39	2
$Q_{10} = 0.7445\ A^{0.8887}\ (ST+1)^{-0.2204}\ P^{1.147}$	38	3.5
$Q_{25} = 1.091\ A^{0.8686}\ (ST+1)^{-0.2273}\ P^{1.131}$	39	5.0
$Q_{50} = 1.395\ A^{0.8563}\ (ST+1)^{-0.2313}\ P^{1.120}$	41	5.9
$Q_{100} = 1.738\ A^{0.8457}\ (ST+1)^{-0.2347}\ P^{1.109}$	44	6.6

A=drainage area, in square miles; ST= area of lakes and ponds (storage), in percent; P=mean annual precipitation, in inches.
Applicable range of variables: A: 1.07-19,400; ST: 0-28; P: 20-158
**The number of years of systematic streamflow data that would have to be collected for a given site to estimate the streamflow statistic with accuracy equivalent to the estimate from the regression equation*

The flow estimates generated from the regression equations are presented in Table 2. This table also contains the basin-scale metrics used in the equations. Basin characteristics fall within the range of variables used to generate the equations with the exception of basin area for the three small basins. These basins, with areas between 0.6 and 0.7 square miles, are smaller than the 1.07 square mile lower limit of the basins used to develop the equations. Applying the equations to these smaller basins will likely result in greater errors in the flow predictions for these basins. It is reasonable to expect that the study basins would exhibit proportionally larger peak flows than the basins used to generate the regression equations because of quicker times of concentration (less attenuation) due to their small size.

Table 2. Flow estimates from USGS Regional Regression Equations (Curran et al. 2003).

Stream	Drainage Area (mi^2)	Mean Annual Precip (in)	Storage (%)	Flow Estimate for Indicated Return Period (ft^3/second)					
				2	5	10	25	50	100
Indian Creek	17.5	34	0.06	259	414	534	697	828	962
Bird Creek	75.6	49	0.12	1,589	2,361	2,942	3,711	4,309	4,911
Trib 1	0.62	35	0	11	21	29	40	49	60
Trib 2	0.59	35	0	11	20	27	38	48	57
Trib 3	0.66	35	0	12	22	30	42	52	63

2.2 SCS Graphical Peak Discharge Method

The SCS Method was applied to the three smallest basins as a second check because their drainage areas fall outside the range of values used to develop the regression equations. 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 discharge, which is applied to the runoff volume to determine peak flow rates (SCS 1984).

All three basins are characterized by a steep upper portion of the watershed and a relatively lower gradient lower portion. Each basin was therefore split into 2 sub-areas apiece for calculation of time of concentration and runoff Curve Number. 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 flow paths on digitized USGS 7.5 minute topographic maps (digital raster graphics). Watershed slopes were obtained from DEM analysis. The runoff Curve Number is used in the model to estimate runoff volumes. The hydrologic soil group, in combination with land cover conditions, is typically used to determine a Curve Number. For this particular area of south-central Alaska, there is no available information on hydrologic soil groups. Soil groups were therefore estimated with reference to nearby areas where soil groups were available and from professional judgment based on observations during field visits. A Type I rainfall distribution was used in the model.

For the estimate of 2-year recurrence interval flow, basin characteristics yielded values outside the range for the initial abstraction/precipitation ratio (Ia/P) used in the model. 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.

Compared to the regression estimates, SCS flows were lower for frequent flood events (2 – 10 year recurrence) and higher for large flood events (100 year recurrence) (see Table 3). There is significant uncertainty in the SCS results because of assumptions made with respect to hydrologic soil groups and because the Ia/P values are outside the limits of the model.

2.3 Rational Method

The Rational Method was applied as yet another point of comparison for flow estimates in the three small 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. Runoff coefficients of 0.16 and 0.17 were selected based on watershed slopes and hydrologic soil groups, which were estimated as described previously for the SCS Method. The Rational Method is best suited for small urban catchments and results for larger, rural basins should be viewed with caution. The ADOT Highway Drainage Manual recommends the use of the Rational Method only for catchments less than 200 acres (0.31 square miles). The three basins of interest are about twice this size. Nevertheless, the peak flow estimates are within a reasonable range of the regression estimates, with flows typically greater than regression flows for frequent floods (2 – 10 year recurrence) and less than the regression flows for infrequent floods (25 – 100 year recurrence) (see Table 3). The Rational Method flows therefore show an opposite pattern as the SCS flows, when compared to the regression estimates.

2.4 Summary of flow estimates

Results of the three flow estimation methods for the small basins are displayed in Table 3. The regression estimates are fully applicable to Bird and Indian Creeks and are therefore considered the best estimates for these basins (see Table 2). With respect to the three smaller basins, neither the regression estimates, the SCS Method, or the Rational Method are fully applicable because of model limitations or lack of data. However, for a number of reasons, the regression estimates are believed to provide the best estimates. First, there are significant uncertainties with the use of the SCS and Rational Method for these rural, forested watersheds that differ substantially from those used to develop the methods. Furthermore, the lack of soils data provides a significant source of potential error, as do basin size violations for use of the Rational Method. The regression equations utilize data that is readily available; and while not developed from basins of quite this small of size, are at least represented by a number of smaller basins in the 1 to 10 square mile range (out of the 71 basins used to develop the equations, approximately 19% were from basins with areas less than 10 square miles). In addition, the regression estimates are intermediate between or more conservative (greater) than the SCS and Rational Method estimates. The regression estimates are therefore believed to provide the most reasonable approximation of stream flows to be used for hydraulic conveyance calculations and fish passage design.

Table 3. Comparison of flow estimates for smaller basins using USGS regional regressions, SCS Method, and Rational Method.

Recurrence interval (years)	Trib 1 (0.6 sq miles)			Trib 2 (0.6 sq miles)			Trib 3 (0.7 sq miles)		
	SCS Method	*USGS Regression*	*Rational Method*	*SCS Method*	*USGS Regression*	*Rational Method*	*SCS Method*	*USGS Regression*	*Rational Method*
2	2	11	20	2	11	19	1	12	20
5	8	21	27	6	20	26	5	22	27
10	22	29	30	15	27	29	11	30	30
25	43	40	34	33	38	32	27	42	34
50	60	49	40	48	48	38	41	52	41
100	92	60	42	77	57	40	69	63	43

2.5 Fish Passage Design Flows

According to the Alaska Department of Fish and Game (ADF&G) and ADOT&PF Fish Passage MOA (2001), fish passage design flow for mainland Alaska is the 2-day duration high flow for a 2-year recurrence interval (Q2 2-day, or Q_{fish}). There are no established regression equations for this flow. The MOA suggests obtaining this flow by interpolating between the Q2 from Jones and Fahl (1994) and the Q2 3-day duration flow from Ashton and Carlson (1984). This general approach was applied, with the exception that the Q2 equation from the more recent Curran et al (2003) study was utilized rather than the Q2 equation from Jones and Fahl (1994) and the Q_{fish} was conservatively estimated as the average of Q2 3-day and Q2.

Regression equations for Q2 3-day duration flows were calculated individually for the spring, summer, and fall seasons. Each of these equations was applied to the basins. The greatest seasonal flow value was used to determine Q_{fish}. Table 4 shows the Q2 3-day duration regression equations.

Table 4. Regression equations for the Q2 3-day duration flow (Ashton and Carlson 1984).

Season	**Regression Equation**	**Standard Percent Error[1]** +	–
Spring	$Q = 2.010\, A^{0.822}\, P^{0.874} (F{+}1)^{-0.393}$	24	19
Summer	$Q = 0.234\, A^{0.900}\, P^{1.273} (F{+}1)^{-0.359}$	20	17
Fall	$Q = 0.0632\, A^{0.783}\, P^{1.336}$	21	17

Q=3 day duration high flow for a 2-year recurrence interval, in cubic feet per second; A=drainage area, in square miles; P=mean annual precipitation, in inches; F = area of forest cover, in percent.

[1]The standard error represents the range around the predicted value in which approximately two-thirds of the flows at an ungaged site would be expected to fall.

The equations include the variables drainage area, mean annual precipitation, and percent forest cover. Drainage area and mean annual precipitation were determined as described previously for the Curran et al. (2003) equations. Percent forest cover was determined in GIS by delineating and quantifying the green shaded portions of the basins depicted on digital USGS topographical maps. Basin characteristics used in the equations and the equation results are presented in Table 5.

The greatest seasonal Q2-3 day flow was used with the Q2 flow to determine Q_{fish} for each study basin. The results are presented in Table 6.

Table 5. Flow estimates for the Q2 3-day duration flows.

Basin	Drainage Area (mi^2)	Mean Annual Precip (in)	Forest Cover (%)	Q2- 3 day duration Flows (cfs)		
				Spring	Summer	Fall
Indian Creek	17	34	28	123	82	66
Bird Creek	76	49	25	587	505	339
Trib 1	0.6	35	69	5.7	3.0	5.0
Trib 2	0.6	35	44	6.5	3.4	4.8
Trib 3	0.7	35	69	6.0	3.2	5.3

Table 6. Summary of Q_{fish} flows.

Station ID	Drainage Area (mi^2)	Q2 (cfs)[1]	Greatest Q2-3 day (cfs)[2]	Q2 2-day "Q_{fish}"(cfs)[3]
Indian Creek	17	259	123	191
Bird Creek	76	1,589	587	1088
Trib 1	0.6	11.5	5.7	8.6
Trib 2	0.6	11.0	6.5	8.8
Trib 3	0.7	12.3	6.0	9.1

[1]*Q2 from Curran et al (2003)*
[2]*Q2-3 day from Ashton and Carlson (1984)*
[3]*Fish passage design flow for mainland Alaska: Linear interpolation of Q2 and Q2-3 day (ADOT and ADFG 2001).*

3 MP 100.5 - “Bear” Creek

3.1 Introduction

The unnamed stream crossing Seward Highway near milepost (MP) 100.6 has been nicknamed “Bear” Creek. The improvements associated with the existing alignment alternative are assumed to have no change in foot print. The frontage road will be to the north, or hill slope side, of the existing highway and is assumed to have a road width of 30-ft. The existing highway is elevated on an embankment above the surrounding topography. At this preliminary phase, the embankment for the frontage road is assumed to be above the existing grade and will require a culvert up to 60-ft in length. Modifications to the bike trail access road on the north side of the highway are not known at this time and access function is assumed to be provided by the new frontage road.

The existing stream alignment flows through 48-inch diameter CMP culverts at the bike path access road (upstream of the highway) and at the highway crossing. Between these culverts, the stream flows for about 35-ft through a 4-ft wide by 1- to 1.5-ft deep straightened channel. Based on project survey data collected by DOWL HKM surveyors, the Seward Highway crossing culvert is 133-ft long. The invert elevations at the inlet and outlet are 52.25-ft and 45.9-ft, respectively, for a slope equal to 4.8-percent. Two surveyed shots along the uphill edge of highway bracketing the inlet of the pipe are 72.75- and 72.24-ft elevation. The culvert outlet is perched approximately 1.5-ft above the downstream channel. Below the culvert, the stream averages 6-ft in width at an approximate slope of 6-percent for 175-ft before passing beneath the bike trail bridge downstream of the highway. The channel flows for a total distance of 560-ft from the highway culvert outlet to the ARRC embankment. The stream crosses the ARRC embankment through a 70-ft long culvert, which discharges to the tidal zone of Turnagain Arm.

This stream is not currently listed in the ADF&G Anadromous Waters Catalog although Dolly Varden char (*Salvelinus malma*), have been trapped near the bike path crossing (Ed Weiss, DNR, agency meeting of August 1, 2006 and June 28, 2006 email to K. Hansen, DOWL HKM). DNR has requested that fish passage be provided by new culverts. It is not known if the railroad culvert allows for fish passage.

At this preliminary alternatives analysis stage, new culverts were designed to pass the design flood according to HDM criteria (HW/D < 1.5). Further, fish passage was designed to a preliminary level using the August 2001 *Memorandum of Agreement between Alaska Department of Fish and Game (ADF&G) and Alaska Department of Transportation and Public Facilities (ADOT&PF) for the Design, Permitting and Construction of Culverts for Fish Passage*; referred to herein as the MOA. The MOA details use of FHWA’s FISHPASS for Tier 2 culvert design. Further information provided by ADOT&PF indicates that FishXing is now accepted by ADFG and ADOT&PF for analysis and design of Tier 2 culverts (P. Janke, June 2007. Memorandum of comments on Draft H&H Report). Through interim design steps, the Tier 2 method did not satisfy fish passage criteria in FishXing and would meet FISHPASS only if baffles are included in the culvert bottom. Therefore, the culvert was designed to.provide fish passage based on Tier 1 methods. The frontage road and highway crossing pipes should be 6'1"x4'7" pipe arch to meet Tier 1 and HW/D < 1.5 criteria.

3.2 Hydraulic History

During the site visit in August 2006, a rapid assessment was conducted by visual inspection and simple measurements were completed. A follow up survey of culvert inlet/outlet and stream profile and cross section were completed at a later date by DOWL HKM surveyors. 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 with a stain line at 2.6-ft and 2.3-ft depth at the inlet and outlet, respectively. Average channel widths upstream and downstream of the culvert are 4.5-ft and 5.5-ft, respectively. The existing pipe is approximately 133-ft long with an approximate slope of 0.048-ft/ft. Flow was observed at depths of 0.3-ft to 0.25-ft at the inlet and outlet, respectively.

Tidal

No tidal influence extends to this elevation or location of stream. From the outlet of the Seward Highway culvert, the stream flows for about 430-ft, dropping approximately 30-ft in elevation before entering a potentially tidally influenced grassy meadow on the upstream side of the ARRC embankment. The stream then flows for about 130-ft across this low gradient meadow to the ARRC culvert and ultimately discharges into the tidal zone of Turnagain Arm.

Non-tidal

This stream is moderately small. It flows along a low gradient reach before passing through 48-inch diameter CMP culverts through the bike trial access road and highway embankment. The stream has an active channel about 4-ft wide by 1- to 1.5-ft deep. No historical flood data were identified 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 Study boundaries are mapped for this tributary (FEMA FIRM, 1987).

Navigation

The creek is too small and steep for navigation. There is no navigation currently or possible in the future.

Confluences

The stream flows for 560-ft before passing through the ARRC embankment and discharging into the tidal areas of Turnagain Arm. No upstream confluences were observed in the vicinity. Therefore, no impacts to confluences are expected.

Mining

The investigators found no evidence of past or present mining activity on this stream.

Debris and icing Problems

No debris beyond small gravel, grasses and small sticks were observed in the channel or culverts. Thaw pipes were noted on a number of culverts throughout the project corridor. The proposed pipe will have a larger open conveyance area than the existing 48-inch CMP and exceeds the 36-inch diameter minimum for icing conditions.

Bed Load

Bed load is limited to small gravel or smaller substrate. Volume of bed load is small. Areas of deposition were limited in area and volume. The stream and culvert system appears to be able to pass the bed load with no evidence of excessive deposition or erosion.

Geomorphic Conditions

Geomorphic conditions are summarized in the Fish Habitat Inventory prepared by Inter-Fluve (Inter-Fluve, 2007) and recounted in the remainder of this section. From observations and simple hand tape measurements, this stream survey was conducted between tidewater and a point 120-ft upstream of the culvert crossing the access road immediately to the north of the highway. At the upstream end of the surveyed section, the stream flows through a birch and alder forest and the stream banks are well vegetated with grasses. This part of the stream is composed of a 5-ft wide glide reach with a length of 90-ft, leading into a backwater pool upstream of the culvert inlet. There is a substantial quantity of organic debris within the stream, the substrate is gravel, and the habitat appears well suited for rearing Coho and Dolly Varden.

Between the access road culvert and the highway culvert is a 4-ft wide riffle and glide section with a length of 35-ft. The highway culvert itself is 132-ft in length and, according to data from Alaska Department of Fish and Game (ADF&G) surveys, this culvert does not provide fish passage (Ed Weiss, Alaska Department of Natural Resource (DNR) 4/18/06 scoping comments). At the outlet of the highway culvert the stream drops 1.5-ft into a 6-ft wide plunge pool in a rocky substrate. The stream then flows through a short 30-ft riffle section and into an extended reach of step pool habitat. The step pool reach is 252-ft in length and averages 6-ft in width. In this reach, the step pools are formed by periodic debris dams, the stream substrate is primarily gravel and rock, the riparian area is thickly vegetated, and there is a mature forested canopy of cottonwood, birch and spruce over much of the stream. The stream then flows into a 5-ft wide riffle section, first through 65-ft of continued forest conditions, and then for another 160-ft through a grassy meadow. Within the forest, the stream substrate is gravel and rock, and the stream bed is stable, with 2-ft well vegetated banks. In contrast, the stream in the meadow section is incised to a depth of up to 6-ft, and although there is a thick vegetative mat of grasses covering the meadow, the silty soil in this area is easily eroded and the stream banks are unstable. The stream flow is adequate to transport much of the finer material, so the stream substrate remains primarily gravel. Just upstream of the railroad crossing culvert there is a 1.5-ft deep pool and then an 8-ft long riffle section. The railroad culvert is perched about 3-ft and discharges onto riprap. Below a short riprap zone, the stream flows through a well defined channel through the mud of the intertidal zone.

Fish Utilization

This stream is not currently listed in the ADF&G Anadromous Waters Catalog although Dolly Varden char (*Salvelinus malma*) have recently been trapped just below the bike path crossing (Ed Weiss, DNR, 6/28/2006 email to K. Hansen, DOWL HKM; and, agency meeting of 8/1/06). It is unknown if the railroad culvert allows for fish passage.

3.3 Hydrology

As noted in the Hydrology section, this stream (Trib 3), has a contributing basin drainage area of approximately 0.66 square miles and is relatively low in elevation and densely forested (69%). Some residential development is located in the lower elevations. This watershed is expected to exhibit a rain-dominated runoff regime, with peak flows occurring in September and October when rainfall amounts are greatest.

There is no known gage information for this stream. As shown in Table 2, peak flow estimates using regional regression equations ranged from 12-cfs for the 2-year event to 63-cfs for the 100-year flood. As shown in Table 6 for trib 3, the fish passage design flow, Q_{fish} is estimated to be 9.1-cfs. There is no local input to report for this basin.

Backwater analysis has been completed and is reported in the Hydraulic Design Section and appendix.

Scour was observed at the outlet of the existing culverts. The proposed culverts are larger in size resulting in lower energy and scour potential. In addition, the pipe was designed using Tier 1 methods to provide continuity of stream process and fish passage. Tier 1 methods include design of substrate to be placed in the bottom of the culvert to remain stable up to the design flow. At this preliminary stage no detailed scour analysis or protection design has been conducted. The need for scour protection will be revisited during the design phase.

3.4 Hydraulic Design

At this phase, preliminary design was completed in support of the Preliminary Engineering Report. More detailed designs will be prepared and documented during subsequent phases.

A 6’-1” by 4’-7” pipe arch is recommended as the replacement at the frontage road and highway crossings. As described above the pipes did not satisfy Tier 2 FishXing analysis and would require baffles to satisfy the FISHPASS method. Therefore these pipes were designed 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 average of channel widths surveyed upstream and downstream of the culvert of about 4-ft and 6-ft, respectively. The existing culvert is at about 0.048-ft/ft slope. The outlet is perched above the downstream channel about 1.5-ft. The stream below the culvert is at an average slope of 0.06-ft/ft. Matching the new culvert inverts to the existing stream profile would provide a slope of 0.0597-ft/ft. This remains within the criteria for adjacent stream slope and maximum slope. Given that the slope is nearly 6-percent, sediment retention baffles should be considered during design to aid in stability of the substrate placed in the bottom of the culvert. At this preliminary level, headwalls were not designed but should be considered during the design phase. Concepts are shown in Sheet 2 (Appendix 1).

Stream substrate will be placed in the bottom of the pipe to fill a minimum of 20-percent of the rise. Through engineering methods, the size of stream substrate will be designed during a later design phase to be dynamically stable for flows up to a 50-year flood. The gradation of the stream substrate will be designed using methods first published as guidelines by Washington Department of Fish and Wildlife (WDFW) to replicate gradations of naturally occurring substrates.

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 0.61 and 0.59 at the highway and frontage road, respectively. The size of the culvert is governed by Tier 1 fish passage criteria.

Table 7. "Bear" Creek crossing Seward Highway – H&H Summary

Drainage Area = 0.66-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs)	30	52	63
Flow depth at inlet (ft)	1.76	2.18	2.36
Hw/D	0.49	0.61	0.66

Table 8. "Bear" Creek crossing Frontage Road – H&H Summary

Drainage Area = 0.66-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs)	30	52	63
Flow depth at inlet (ft)	1.58	2.11	2.35
Hw/D	0.44	0.59	0.66

3.5 23 CFR

No Flood Insurance Studies boundaries are mapped for this tributary (FEMA FIRM, 1987). 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 affects and greater conveyance area for flows and debris through the pipe. Floodplain values are not expected to be impacted.

3.6 Conclusion

The hydraulic features of the proposed action are developed to a preliminary level at this phase in support of the Preliminary Engineering Report. The proposed culvert is not expected to adversely impact the floodplain or environment. The proposed culvert meets ADOT&PF's requirements for flood 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 through the Seward Highway embankment is presented in Table 7. The hydrologic and hydraulic summary for the proposed culvert through the Frontage Road embankment is presented in Table 8.

3.7 Riprap

The proposed culvert is designed to provide fish passage using Tier 1 stream simulation to maintain continuity of flow of water and sediment. No scour is noted for existing conditions; proposed conditions will have a larger culvert. No riprap is proposed at this preliminary phase but will be considered during the design phase.

3.8 Existing conditions photos

Photos of existing conditions follow on the next two pages.

3.8—Existing conditions photos

"Bear" Creek stream above highway culvert

"Bear" Creek highway culvert inlet

"Bear" Creek highway culvert outlet

"Bear" Creek stream below highway

4 MP 102.9 - “Ball Field” Creek

4.1 Introduction

The unnamed stream crossing Seward Highway near milepost (MP) 102.7 flows past the east side of the ball field at the Indian Creek roadside parking lot and has been nicknamed “Ball Field” Creek. The improvements associated with the existing alignment alternative are assumed to have no change in foot print. The frontage road will be to the north, or hill slope side, of the existing highway and is assumed to have a road width of 30-ft. The existing highway is about equal in elevation to the surrounding topography on the uphill side. Therefore, at this preliminary phase, the embankment for the frontage road is assumed to be at or near existing grade and will require a culvert up to 45-ft in length.

The existing stream alignment flows through an existing 24-inch diameter CMP culvert at the highway embankment. Based on project survey data collected by DOWL HKM surveyors, the Seward Highway crossing culvert is 101.5-ft long. The invert elevations at the inlet and outlet are 54.3-ft and 53.53-ft, respectively, for a slope equal to 0.76-percent. Two surveyed elevations along the uphill edge of highway bracketing the inlet are 64.22- to 64.47-ft. Upon exiting the culvert, the stream flows for 250-ft along a channel averaging 3-ft in width at approximately 0.006-ft/ft slope before passing through a 24-inch diameter CMP culvert through the bike trail embankment. The stream then continues for approximately 670-ft through the forest before discharging at elevation 25.98-ft to the top of a 70-ft long steep, straightened reach parallel to the ARRC tracks before passing through a culvert through the ARRC embankment and discharging onto the riprap lined bank at the edge of the Turnagain Arm tidal area.

Salmonids are not able to access this stream. No information was found indicating if ADF&G or DNR have investigated fish presence in this stream. No fish were noted by Inter-Fluve fish biologist during the field habitat inventory effort (Inter-Fluve, 2007). However, the stream has the potential to provide high quality spawning and rearing habitat. Given that fish have been trapped along “Subdivision” Creek (as described in Section 6.1), which has similar passage barrier conditions, it was assumed that fish might be present and that fish passage should be provided through new culverts. ADF&G will be consulted during the design phase of the project to determine whether the crossing at Ball Field Creek will need to comply with fish passage criteria.

At this preliminary, alternatives analysis stage, new culverts were designed to pass the estimated design flood within HDM criteria (HW/D < 1.5). Fish passage was designed to satisfy the MOA. Preliminary design calculations indicate that pipes which satisfy flood conveyance criteria fail FishXing Tier 2 criteria when the bed is bare. Baffles are required to meet FISHPASS Tier 2 criteria. Therefore, fish passage was designed at this preliminary level based on Tier 1 methods. The highway crossing would be a 5’6”x4’3” pipe arch based on Tier 1 and HW/D < 1.5 considerations. Note that the stream immediately above the highway is locally wider than average stream conditions – Tier 1 considerations for the pipe are based on upstream average stream width and a slope of 0.011-ft/ft.

4.2 Hydraulic History

During the site visit in August 2006, a rapid assessment was conducted by visual inspection and simple measurements were completed.. A follow up survey of culvert inlet/outlet and stream profile and cross section were completed at a later date by DOWL HKM surveyors. The existing culvert is a 24-inch CMP with 0.1-ft and 0.4-ft of stream substrate material in the bottom of the pipe at the inlet and outlet, respectively. The bottom of the pipe is rusted with a stain line to 1.8-ft depth at the outlet. The rapid assessment noted average channel width upstream and downstream of the culvert to be 4-ft and 5-ft, respectively. From the site survey, the existing pipe is approximately 101.5-ft long. The invert elevations at the inlet and outlet are 54.3-ft and 53.53-ft, respectively, for a slope equal to 0.76-percent. Flow was observed to a depth 0.5-ft to 0.7-ft at the inlet and outlet, respectively.

Tidal

No tidal influence extends to this elevation or location of stream. The stream crosses the Seward Highway through a 24-inch diameter CMP culvert with an outlet invert elevation equal to 53.53-ft. The stream then drops to an elevation of 25.98-ft at the top of a steep 70-ft long channelized reach before passing through the ARRC culvert and discharging onto the riprap lined bank along the Turnagain Arm shoreline. The culvert and stream at the highway is above tidal influence from Turnagain Arm.

Non-tidal

This stream is relatively small – it passes through 24-inch diameter CMP culverts through the highway and downstream bike path. The active channel is 4- to 5-ft wide near the highway culvert and is approximately1-ft deep. No historical flood data were identified 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 boundaries are mapped for this tributary (FEMA FIRM, 1987).

Navigation

The creek is too small and obstructed by vegetation for navigation or recreational boating. There is no navigation currently or possible in the future.

Confluences

From the highway, the stream flows for about 670-ft before passing through the ARRC embankment then discharging onto the riprap lined bank then entering the Turnagain Arm. No upstream confluences were observed in the vicinity. Therefore, no impacts to confluences are expected.

Mining

There is no evidence that mining occurs on this stream.

Debris and icing Problems

No debris beyond organic matter and minimal sand to small gravel, grasses and small sticks were observed in the channel or culverts. Thaw pipes were noted on a number of culverts through the project corridor. The proposed pipe will have a larger open conveyance area and exceeds the 36-inch diameter minimum for icing conditions.

Geomorphic Conditions

Geomorphic conditions are summarized in the Fish Habitat Inventory prepared by Inter-Fluve (Inter-Fluve, 2007) and recounted in the remainder of this section. From observations and simple hand tape measurements, this stream is fed by a large wetland complex that lies along the north side of the highway between MP 102.2 and MP 102.7. The wetlands are composed of pools and low gradient streams heavily vegetated with sedges and grasses. The stream substrate through this area is primarily organic matter over a variety of sediment sizes, with the typical channel approximately three feet wide and 8- to 12-inches deep. Between the highway crossing culvert and the wetlands, the stream flows through a series of glides and riffles for about 140-ft. Most of this reach is forested, primarily with alder, and the substrate is rocky. Immediately upstream of the culvert is a shallow, short glide that locally widens to 10-ft. Between the highway culvert and the bike path culvert the stream is composed of a very uniform 3-ft wide glide reach with high banks vegetated with cottonwood and alder. There is some organic debris in the streambed of this 250-ft reach.

Downstream of the bike path culvert the stream grade steepens and falls through a series of 5-ft wide rocky step pools for about 90-ft. It then broadens into an 8-ft wide glide for another 90-ft. The riparian vegetation over this area is dense, and composed of overhanging alder and mature cottonwood. There is a large amount of woody debris in the stream and the habitat appears ideal for rearing Coho or Dolly Varden. The stream then narrows to a steeper step pool section, with the pools formed by dams of organic debris, and then broadens once more into a 185-ft backwater pool with a width that varies from 5-ft to 20-ft. The substrate in this area appears to be primarily organic matter over top of fine sediments. Downstream of the backwater pool is a 5-ft wide step pool section similarly formed by periodic, small organic debris dams. The stream then runs through a series of narrow riffle sections for about 140-ft before it enters the railroad crossing culvert. The outlet of this culvert spills the stream onto a rocky riprap section of the upper intertidal zone, and the stream then spreads broadly over the gravel area of the beach, once more becoming a more defined channel in the muddy substrate of the lower intertidal zone.

Fish Utilization

This stream is not listed in the ADF&G Anadromous Waters Catalog. The lack of a defined channel through the upper intertidal zone, combined with a perched pipe and flow spilling onto a riprap lined bank at the railroad crossing may prevent fish from accessing the stream at all, although this may not be the case during certain high tide events. This stream appears to have the potential to be a highly productive system for rearing fish, and has sufficient flow and gradient in some reaches to serve as spawning habitat. The culverts under the bike path and highway may provide adequate fish passage in their current condition, but could be improved. The extensive wetland habitat upstream of the highway crossing is ideal juvenile Coho and Dolly Varden rearing habitat. Though fish have not been documented, this stream has similarities to "Subdivision" Creek which has been documented to hold Dolly Varden. Therefore, it was assumed that fish might be present and fish passage should be provided at new culverts.

Bed Load

Bed load is limited to small gravel or smaller substrate. Volume of bed load is small. Areas of deposition are very limited in area and volume. The stream and culvert system appears to be able to pass what minimal bed load there may be with no evidence of excessive deposition or erosion.

4.3 Hydrology

As noted in the Hydrology section, this stream (Trib 2), has a contributing basin drainage area of approximately 0.6 square miles, is relatively low in elevation, is moderately forested (44%), and includes a large wetland area. Little development is located in the lower elevations. This watershed is expected to exhibit a rain-dominated runoff regime, with peak flows occurring in September and October when rainfall amounts are greatest.

There is no known gage information for this stream. As shown in Table 2, peak flow estimates using regional regression equations range from 11-cfs for the 2-year event to 57-cfs for the 100-year flood. As shown in Table 6, the fish passage design flow, Q_{fish} is estimated to be 8.8-cfs. There is no local input to report for this basin.

Backwater analysis has been completed and is reported in the Hydraulic Design Section and appendix.

Minor perching and slight scouring at the outlet of the highway culvert was noted. The proposed culvert is larger in size and would have lower energy and scour potential. Tier 1 methods include design of substrate to be placed in the bottom of the culvert to remain stable up to the design flow. At this preliminary stage no detailed scour analysis or protection design has been conducted.

4.4 Hydraulic Design

At this phase, preliminary design was completed in support of the Preliminary Engineering Report. More detailed designs will be prepared and documented during subsequent phases.

A 5'-6" by 4'-3" pipe arch is recommended as the replacement at this crossing. As described above, a Tier 1 (stream simulation) fish passage design is recommended. This size pipe will satisfy requirements of the Tier 1 design method for fish passage as stated in the MOA. This size culvert will provide sufficient span at the highway and frontage road to accommodate the average of channel widths noted in the rapid assessment upstream and downstream of the culvert of about 4-ft and 5-ft, respectively. The existing highway culvert is at about 0.008-ft/ft slope. The stream above and below the culvert is at an average slope of 0.01-ft/ft and 0.006-ft/ft, respectively. Matching the new culvert inverts to the existing stream profile would provide a slope of 0.01-ft/ft. This meets Tier 1 criteria for adjacent stream slope and maximum slope. At this preliminary level, headwalls were not designed but should be considered during the design phase. Concepts are shown in Sheet 3 (Appendix 1).

Stream substrate will be placed in the bottom of the pipe to fill a minimum of 20-percent of the rise. Through engineering methods, the size of stream substrate will be designed to be dynamically stable for flows up to a 50-year flood. The gradation of the stream substrate will be designed using methods first published as guidelines by Washington Department of Fish and Wildlife (WDFW) to replicate gradations of naturally occurring substrates.

Existing and proposed conditions were modeled with HEC-RAS. For this size culvert, HEC-RAS defaults to a slightly different dimensioned 5'-5" by 4'-1" pipe arch. Results of modeling indicate that the proposed culvert will pass the 50-year flood with headwater elevation to culvert rise equal to 0.78 and 0.65 at the highway and frontage road, respectively. The size of the culvert is governed by Tier 1 fish passage criteria.

Table 9. "Ball Field" Creek crossing Seward Highway – H&H Summary

Drainage Area = 0.6-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs)	27	48	57
Flow depth at inlet (ft)	1.58	2.37	2.7
Hw/D	0.52	0.78	0.89

Table 10. "Ball Field" Creek crossing Frontage Road – H&H Summary

Drainage Area = 0.6-square miles

Exceedance probability	10%	2%	1%
Return period	10-year (Q10)	50-year (Q50)	100-year (Q100)
Design discharge (cfs)	27	48	57
Flow depth at inlet (ft)	1.56	1.97	2.12
Hw/D	0.51	0.65	0.70

4.5 23 CFR

No Flood Insurance Studies boundaries are mapped for this tributary (FEMA FIRM, 1987). 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 affects and greater conveyance area for flows and debris through the pipe. Floodplain values are not expected to be impacted.

4.6 Conclusion

The hydraulic features of the proposed action are developed to a preliminary level at this phase in support of the Preliminary Engineering Report. The proposed culvert is not expected to adversely impact the flood plain or environment. The proposed culvert meets ADOT&PF's requirements for flood 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 crossing the Seward Highway are presented Table 9. The hydrologic and hydraulic summary for the proposed culvert crossing the Frontage Road are presented Table 10.

4.7 Riprap

The culvert was designed to provide fish passage using Tier 1 stream simulation to maintain continuity of flow of water and sediment. Minor scour is noted for existing conditions; proposed conditions will have a larger culvert with less energy for scour. Substrate will be placed in the bottom of the culvert and sized to stability criteria. Therefore, no riprap is proposed at this preliminary phase.

4.8 Existing conditions photos

Photos of existing conditions follow on the next three pages.