Attachment 8c
Hydraulic and Bank Migration of Minor Detailed and Detailed Crossings Report

Project Note

Project: Alaska Stand Alone Pipeline/ASAP		**Project No:**	**138575**
To:	**Frank Richards**	**Deliverable No.:**	**002-14-916-008**
From:	**Mark McBroom**	**Document No.:**	**002-C-27-RTA-C-0019**
[Internal MBJ]:	**Shawn Snisarenko**	**Date Submitted:**	**10/10/2014**
Subject:	**2014 Waterways Field Program Summary: Detailed Crossings**		

Revision History

Rev	Date	Comments	Approval
A	09/23/2014	Draft Deliverable	
B	10/10/2014	Baker Revisions	

1. Trip/Fieldwork Purpose

Michael Baker, Jr., Inc. (Baker) conducted a field program in the summer of 2014 to assess selected stream crossings along the Alaska Stand Alone Pipeline (ASAP) Project right of way (ROW). The purpose of the site visits was to gather physical data and observations at pipeline stream crossing locations in support of the project Environmental Impact Statement, ROW applications, preliminary design, and Class 3 cost estimate. Prior to field deployment, selected sites were identified using several data sets including past field studies, aerial imagery, Digital Elevation Models (DEM), and spatial data sets such as Alaska Department of Fish and Game Anadromous Fish Catalog. Selected crossing sites were assigned one of three classifications: Validation, Minor, and Detailed. All of the classified sites were to be visited during the 2014 field season. The *2014 Waterways Field Study Summary,* Deliverable Number 002-14-916-009, provides a general description of all work performed during the 2014 field program. This field report presents additional information gathered at Detailed and Minor Detailed crossings as they relate to hydraulics and channel migration potential. Survbase, a land surveyor company, supported Baker in conducting detailed surveys at nine stream crossings. Air support was provided by Jayhawk Air Helicopter Company for access to three remote stream crossings. The personnel and schedule for the 2014 Detailed and Minor Detailed crossing studies are included in Table 1.

Table 1 2014 Field Assessment and Personnel Schedule

	Baker Personnel	Number of Sites	Dates in Field	Supporting Contractor
Assessment Crew	Mark McBroom Colin McKernan Guy Wade	Detailed: 8 Minor: 31	07/18-07/31/2014	Jayhawk Air
Survey Crew 1	Garrett Yager	Detailed: 7	08/08 -08/18/2014	SurvBase
Survey Crew 2	Michael Ulmgren	Detailed: 2	08/27-08/29/2014	SurvBase Phantom Charter

Initial selection of a site for further study is based on one of two factors; (1) a lack of sufficient information to develop a reasonable understanding of site conditions, or (2) possible issues of concern identified during initial stream classification and/or crossing mode determination. Minor Detailed crossings require the collection of additional data beyond Validation sites for hydraulic modeling, fish assessments, and/or design of local erosion control measures, but do not require extensive survey of channel bathymetry. Detailed studies mirror Minor studies, but require extensive bathymetric surveys for more detailed hydraulic modeling and design of large scale erosion control measures.

2. Hydraulic Assessment

Stream assessment data was collected in digital field data sheets. Geographic waypoints and digital georeferenced photographs were collected at stream crossings to support findings and document greater detail of crossing conditions. Additional fish habitat assessments performed in conjunction with

2.1 General Assessment

A general crossing assessment was performed at each crossing. This data will be used for permitting support and validation of predetermined stream classification and crossing mode determination.

Potential issues of concern, particularly scour potential and debris, were documented in this section as well as in the notes. Figure 1 shows a general stream crossing sketch and associated data capture, including additional data capture to support channel migration assessments (Section 3).

2.2 Detailed/Minor Detailed Assessment

Hydraulic modeling will ultimately be performed at all trenchless pipeline crossings, trenched crossings with excessive scour depth, and crossings requiring bank stabilization or river-training structure design. The level of required design will dictate the detail of hydraulic modeling and field assessment.

Detailed crossing studies were performed in part with the support of SurvBase at crossings that require enhanced hydraulic modeling including sensitive anadromous stream crossings, channels having complex hydraulics, or crossings where extensive armoring or river training structures may be deemed necessary.

Minor crossing studies were not surveyed by a professional land surveyor, but sufficient hydraulic and channel geometry data was captured to support further study for preliminary design or crossing mode determinations. Such circumstances may include uniform channels for which a simplified local erosion control measure is required and/or moderate scour potential exists.

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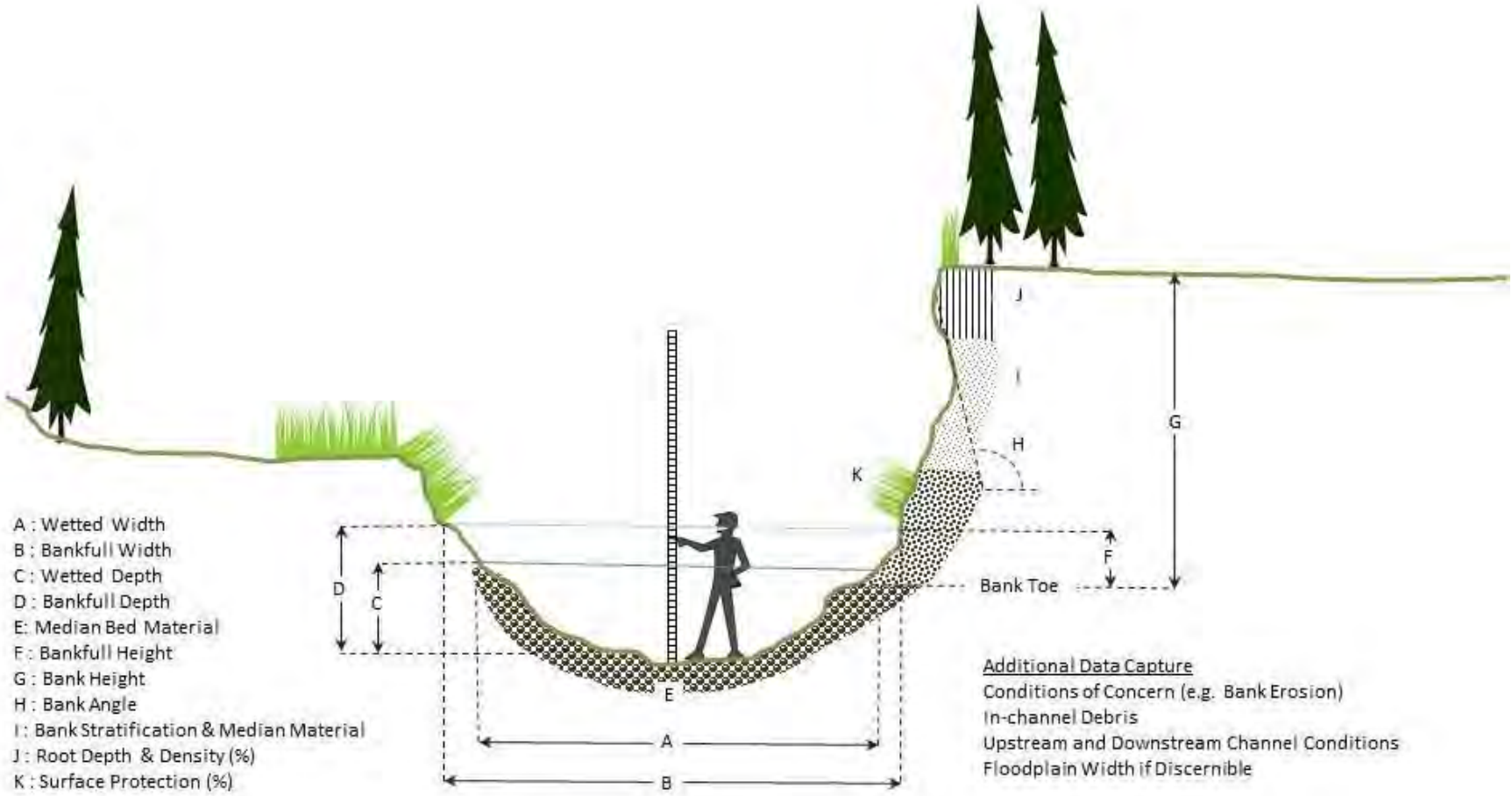

Figure 1 Stream Crossing Data Capture

2.3 Field Notes

Field notes, supplemental to defined assessment data, were captured digitally in the field data sheet and/or in field notebooks. Field books were scanned and relevant information transcribed to the digital field data sheet. Survey of water surface elevations (WSE) and a standard method direct discharge measurement of the Dietrich River at ST_180.4 were also recorded in field books. Additional notes were captured during the detailed survey.

Survey of WSEs at Detailed crossings were tied to temporary bench marks (TBM), either existing or established by the assessment crew. This would allow for tie-in of the WSE to the project datum and ground topography, providing supplemental data for hydraulic model calibration and validation. WSEs were surveyed at a selection of Minor Detailed crossings dependent on whether or not the assessment crew determined it was of sufficient need for subsequent analysis. At some sites, WSEs were tied to an existing TBM, a TBM established by the assessment crew, and/or topographic features that would provide coarse correlation with the existing LiDAR-based digital elevation model (DEM).

2.4 Georeferenced and Scaled Site Photographs

GPS-linked cameras were used to document site conditions during all field studies. When relevant a scaled object (i.e. survey rod, pocket rod) was included in the image to provide a scale of observable features in the photograph. Items of unique interest included channel bed material, bank material, bank erosion, upstream and downstream conditions, as well as debris or other hydraulic features of interest. An example photograph of scaled bed material is presented in Photo 1.

Photo 1 Bed Material Deposited on Bar of Main Channel of South Fork Koyukuk River (ST_261.9)

2.5 Direct Discharge Measurement

Direct discharge measurements were collected in one of two ways; standard methods using a Marsh-McBirney FLO-MATE and wading rod, or Teledyne RiverRay Acoustic Doppler Current Profiler (ADCP). The FLO-MATE was only implemented once on the Dietrich River at ST_180.4 (Photo 2).

Photo 2 Standard Methods Discharge Measurements using Marsh-McBirney FLO-MATE and Wading Rod on Dietric River (ST_180.4)

The Teledyne RiverRay ADCP unit was deployed in one of three ways; attached to a manned Achilles inflatable boat with 20 horsepower Yamaha outboard motor (Photo 3), one man tether from bridge (Photo 4), or two man tether from left and right banks (Photo 5). All diagnostic tests, calibrations, and measurements were performed using WinRiver II (version 2.13) software running on a Panasonic Toughbook via bluetooth connection to the RiverRay unit. Several challenges arose with this particular setup. The Parani-UD100 external Bluetooth adapter and antenna was not field-robust and of poor reliability. Compass calibration was also inconsistent and challenging to achieve within the recommended limits of error. The leased RiverRay unit was in poor operating condition and required field modifications throughout the field program. The last measurement to be performed, on the Chatanika River, was unsuccessful because of failure of one of the boat pontoon frame arms.

Bottom tracking was used to establish spatial orientation of the measured channel profile in lieu of DGPS or RTK methods. When using bottom tracking, measurements are subject to minor errors in computed discharge as a result of active bed transport. To account for this error a loop test is performed to quantify an average velocity correction that is then applied to each discharge measurement, the average of which being the reported discharge.

Photo 3 Motorized Boat Deployment of RiverRay ADCP on Tanana River (ST_469.5)

Photo 4 Tethered Deployment of RiverRay ADCP from Bridge on Dietrich River (ST_210.3)

Photo 5 Two Man Tethered Deployment of RiverRAy on Kanuti River (ST_307.9)

Direct discharge could not be collected at the Chulitna River crossing (ST_635.4) due to unapproved site access. The nearest public access point to launch a watercraft is in Talkeetna, nearly 30 miles downstream of the crossing. Survey Crew 2 was able to access the site for detailed survey and site assessments by way of Phantom Charters which has commercial access approval from a private landowner at the Parks Highway Bridge crossing. Digital files for measurements collected at the Dietrich River (ST_210.3) were inexplicably lost, however the average discharge measurement was recorded in the field data sheet immediately after measurements were collected. Because the data could not be corrected using the loop test results, the discharge is given a poor rating. Flow was confined to one channel at all but one crossing; ST_212.6 (Middle Fork Koyukuk (3)). A small volume of split flow was diverted from the main channel just upstream of the direct discharge measurement on the Middle Fork Koyukuk. Cross section geometry and approximate flow velocities were used to estimate the split flow volume not captured in the direct measurement. The lateral flow proved to be a small percentage (less than 3%) of the total measured direct discharge. At some of the Minor Detailed crossings, flow conditions were not conducive to direct discharge measurements. Turbulent flow conditions, active bedform change, shallow depths, and near quiescent flow conditions contributed on some level to poor discharge ratings. Table 2 presents the average discharge at measured crossings.

Table 2 Direct Discharge Measurement Results

	Name	Date	Average Discharge (cfs)	Rating
ST_3.1	Putuligayuk River	07/15/2014	30	Poor
ST_147.1	Atigun River	07/16/2014	1,790	Good
ST_164.5	Atigun River	07/17/2014	160	Poor
ST_180.3	Dietrich River	07/18/2014	200	Good
ST_210.3	Dietrich River	07/19/2014	2,500	Poor
ST_212.6	Middle Fork Koyukuk (3)	07/19/2014	4,340	Good
ST_226.8	Middle Fork Koyukuk (2)	07/20/2014	4,250	Excellent
ST_229.3	Middle Fork Koyukuk (1)	07/20/2014	4,550	Poor
ST_261.9	South Fork Koyukuk	07/21/2014	1,950	Good
ST_307.9	Kanuti River	07/21/2014	785	Excellent
ST_428.5	Tatalina River	07/31/2014	400	Poor
ST_469.5	Tanana River	07/24/2014	73,800	Excellent
ST_473.3	Nenana River	07/24/2014	2,390	Good
ST_555.6	Nenana River	07/25/2014	3,570	Good
ST_688.2	Kashwitna River	07/28/2014	1,590	Excellent

2.6 Detailed Survey

SurvBase collected bathymetric data as part of the Detailed studies. A Baker engineer worked closely with surveyors in the field to identify key features for survey. Points of interest included top of bank, toe of bank, thalweg, edge of water, high water marks, debris and ice marks, hydraulic structure geometries if present and necessary, and any other unique or distinguishing features in the channel or floodplain.

3. Channel Migration Assessment

As part of the general assessment, concerns regarding bank erosion and channel migration were identified. If channel migration concerns were evident at the time of the site visit, a Channel Migration Assessment was performed. The Channel Migration Assessment consists of two sub-assessments, Bank Stability Assessment and Avulsion Assessment, either of which could help qualify if not quantify channel migration potential.

Data of interest captured under the Bank Stability Assessment included bank hazard index parameters (bankfull height, surface protection, root depth, & root density), a scaled photo, general description of bank material and possible stratification, and erosion indicators (active erosion, mass wasting, seepage, etc.). Under the Avulsion Assessment, data of interest could include the presence of relic channels, meander bend cutoffs, main channel aggradation, in-channel debris, and secondary channels.

If erosion control design was deemed necessary the general extent of control measures was identified. Digital photos were captured to support and supplement Channel Migration Assessment data. Photo 6 shows the eroding right bank of the Putuligayuk River (ST_3.1).

Photo 6 Eroding Right Bank of the Putuligayuk River (ST_3.1) Looking Upstream

4. Summary of Site Specific Concerns

Predominant site specific concerns identified during the 2014 Detailed and Minor Detailed field studies as they relate to scour potential, channel migration, and fish habitat are presented below in Table 3, Table 4, and Table 5, respectively.

Table 3 Notable Scour Concerns

	Name	Flied Class	Comments
ST_3.1	Putuligayuk River	Minor Detailed	Crossing located at broad bend with steep cutbank D/S of wide riffle. Ice jamming impacts could increase scour potential.
ST_147.1	Atigun River	Minor Detailed	Finer bed material, though measured depth does not suggest excessive scour.
ST_189.1	Nutirwik Creek	Minor Detailed	Wide braided channel confined to narrow width by bridge guidebanks.
ST_210.3	Dietrich River	Detailed	Confined flow path, bound by infrastructure (bridges and armored banks).
ST_226.8	Middle Fork Koyukuk (2)	Detailed	Crossing located D/S of bridge subject to debris loading and near bend PI.
ST_261.9	South Fork Koyukuk	Minor Detailed	Crossing located near PI of broad bend with steep cutbank.
ST_469.5	Tanana River	Detailed	Dynamic channel bed with evidence of excessive scour, debris, and aggradation within study reach.
ST_473.3	Nenana River	Detailed	Crossing at bend apex with steep cutbank with fine bed material evident.
ST_555.6	Nenana River	Detailed	Crossing located D/S of bend with potential toe scour along LB revetment.
ST_561.9	Jack River	Minor Detailed	Perched main channel with numerous scouring/aggrading channels in LOB.

Table 4 Notable Bank Migration Concerns

	Name	Field Class	Comments
ST_3.1	Putuligayuk River	Minor Detailed	Steep right bank actively eroding.
ST_164.5	Atigun River	Minor Detailed	Left bank eroding at confluence of tributary and undercutting downstream.
ST_167.9	Spike Camp Creek	Minor Detailed	Guidebanks look to be eroding and show some signs of possible failure.
ST_212.6	Middle Fork Koyukuk (3)	Detailed	Active bank migration at limits of channel and of established islands within channel.
ST_229.3	Middle Fork Koyukuk (1)	Detailed	Bedform downstream of bridge directing flow toward left cut bank.
ST_261.9	South Fork Koyukuk	Minor Detailed	Left cutbank actively eroding into wooded overbank.
ST_469.5	Tanana River	Detailed	Left cutbank actively eroding into wooded overbank.
ST_473.3	Nenana River	Detailed	Steep Left cutbank actively eroding.
ST_561.9	Jack River	Minor Detailed	Perched main channel with numerous scouring/aggrading channels in LOB.

Table 5 Notable Fish Habitat Concerns

	Name	Field Class	Anadromous	Spawning	Rearing	Over-wintering
ST_634.4	Troublesome Creek	Detailed	Yes	Medium	Medium	Medium
ST_634.4	Troublesome Creek - Downstream	Detailed	Yes	High	High	High
ST_164.5	Atigun River	Minor Detailed	No	Medium	Medium	Medium
ST_180.8a	Dietrich River	Minor Detailed	No	Medium	Medium	Medium
ST_180.8b	Dietrich River	Minor Detailed	No	Medium	Medium	Medium
ST_180.8c	Dietrich River	Minor Detailed	No	Medium	Medium	Medium
ST_261.9	South Fork Koyukuk	Minor Detailed	Yes	Medium	Medium	Medium
ST_334.8	No Name Creek	Minor Detailed	No	Medium	Medium	Medium
ST_561.9	Jack River	Minor Detailed	No	High	High	High
ST_592.4	Honolulu Creek	Minor Detailed	Yes	Low	Low	Low
ST_674.8	Montana Creek	Minor Detailed	Yes	Medium	Medium	Medium
ST_684.2	Sheep Creek Slough	Minor Detailed	Yes	Low	Low	Low
ST_686.2	Caswell Creek	Minor Detailed	Yes	Medium	Medium	Medium
ST_688.2	Kashwitna River	Minor Detailed	Yes	Medium	Medium	Medium
ST_689.8	197 1/2 Mile Creek	Minor Detailed	Yes	Medium	Medium	Medium
ST_696.1	Little Willow Creek	Minor Detailed	Yes	Medium	Medium	Medium
ST_698.8	Willow Creek	Minor Detailed	Yes	High	High	High