Northern Rail Extension Project
Phase 1

Piledriver Slough 2016 Monitoring Report

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1.0 INTRODUCTION

The Alaska Railroad Corporation (ARRC) plans to construct and operate an approximately 80-mile-long extension of its existing main line from Fairbanks to Delta Junction. Phase 1 of the Northern Rail Extension (NRE) included construction of a levee along the east bank of the Tanana River that severed periodic surface water flow from the Tanana River into Piledriver Slough, which is adjacent to the Tanana River near Salcha, Alaska. Monitoring of Piledriver Slough was conducted in 2012, 2014 and 2016 as required by Special Condition No. 22 of the NRE Section 404 permit. The final monitoring will be conducted in 2020. The purpose of the monitoring is to document potential changes to Piledriver Slough as a result of construction of the levee.

This report describes conditions in 2016 at four monitoring sites that were established and sampled in accordance with an approved monitoring plan (HDR Alaska Inc., 2011) prior to levee construction. Study objectives included measurements of channel geometry, discharge, substrate, turbidity, and vegetation distribution at each monitoring site. These data will be compared to the baseline and to previous and future measurements at the end of the study period in 2020.

2.0 METHODS

2.1 Monitoring Sites

Prior to the collection of baseline field measurements, HDR Alaska Inc. (HDR), in consultation with the U.S. Army Corps of Engineers (USACE), and U.S. Fish and Wildlife Service (USFWS), conducted a one-day reconnaissance field effort and agreed upon the location of five monitoring sites along Piledriver Slough. The location of the monitoring sites is shown in Appendix A, Figure 1. Site 1 was subsequently covered during construction of the levee, and has therefore not been measured since the baseline evaluation. Subsequent to the 2012 data collection, Tanana Valley Watershed Association (TVWA) was contracted to complete the monitoring in years 4(2014), 6(2016), and 10(2020).

At each monitoring site, a single transect was established perpendicular to stream flow using steel rebar pins driven into the ground on either side of the channel. Rebar pins were left in place so the measurements can be repeated in subsequent years at the same locations. Channel geometry, stream discharge, channel substrate, and riparian vegetation have been systematically monitored in 2012, 2014, and 2016. Final monitoring will be in 2020, and a summary report will be prepared.

Field investigations were conducted according to the NRE Phase 1 Piledriver Slough Monitoring Plan, dated August 2011. A stream gage and pressure transducers were installed on April 26 and stream discharge was measured. On September 10, 2016, the stream gage was removed to prevent ice damage. Channel geometry stream discharge, channel substrate and riparian vegetation were also evaluated at the four monitoring sites on that date.

2.2 Channel Geometry

Physical characteristics of channel geometry were recorded at each monitoring site using survey equipment that included a 100-foot field measuring tape, surveyor's level, and stadia rod. The field measuring tape was strung between rebar (pins) on either side of the channel bank, which created a single and reproducible transect. The field tape was placed with zero located at the west bank pin. Measurements associated with channel geometry and water surface elevation were recorded starting at the downstream left (i.e. west) bank then progressing to the downstream right (i.e. east) bank. In addition to the transect pins, each transect also included the installation of a temporary benchmark placed off of the transect line. The temporary benchmark is used to validate the accuracy and precision of the channel geometry and water surface elevation measurements over time.

2.3 Stream Discharge Measurements

Instantaneous discharge measurements were conducted using standard U.S. Geological Survey (USGS) water measurement procedures described in Rantz and others (1982). Discharge measurements were made using a SonTek FlowTracker II acoustic velocity meter to measure stream velocity, and a top setting wading rod to measure water depth. Progressing from the left bank to the right bank, water velocity and depth were recorded across a range of distances (stationing) along each transect. Depth and velocity measurements were recorded while facing upstream with the velocity meter and wading rod held out and away from the body to avoid influencing velocity measurements. To ensure that no single measurement represented more than 5 percent of the overall stream flow and to capture changes in stream bottom shape and flow velocity, a minimum of 20 depth and velocity measurements were recorded at each transect.

2.4 Stream Gage

One stream gage was installed in Piledriver Slough at Monitoring Site 4, upstream of the intersection of Xantheus Way Bridge and Old Richardson Highway.

The stream gaging station consisted of a staff gage and two non-vented pressure transducers (model Hobo U20-001-01,Water Level, S/N 9983778, Barometric Pressure, S/N 9925074), anchored to a post driven into the stream bed.. The data loggers recorded temperature and pressure (hydraulic and barometric) data at 15-minute intervals.

The pressure transducers were suspended at specific heights on a stainless steel cable, which was affixed to a screw cap at the top of a 4 to 5-foot long PVC housing. The PVC housing was vented below and above the water line for atmospheric equalization. One data logger was suspended in the air approximately one inch from the top of the PVC housing to record barometric pressure. The second data logger was submerged and rested on a bolt in the bottom of PVC housing to record hydraulic pressure. This bolt also served as the survey reference point for the data logger elevation. The staff gage was 4 inches (in) wide by 4 feet (ft) long, and was mounted vertically on a post anchored in the stream bed.

The hydraulic and barometric pressure data will be correlated to instantaneous discharge measurements made at that location over a range of water flows. The correlation will later be used to develop a rating curve and hydrograph for the Piledriver Slough study reach.

2.5 Substrate and Water Quality

Channel substrate was characterized at each monitoring site using the Wolman pebble count method (Wolman 1954). This approach included establishing five substrate sampling transects spaced five meters apart and oriented perpendicular to flow. The substrate sample transects included the channel geometry transect described in Section 2.2, with two transects located upstream and two transects located downstream. Along each transect, a field team member recorded the substrate particle size from 20 discrete locations equally spaced across the stream. A graduated aluminum gravelometer was used to measure each substrate particle. Substrate particles were then classified by size as shown in Table 2.

Table 1. Substrate Size Classes and Codes

Substrate Type	Code	Size Class (mm)
Organic	ORG	NA
Sand/silt	SS	<2.0
Very fine gravel	VFG	2.1—3.9
Final gravel	FGR	4.0—7.9
Medium gravel	MGR	8.0—15.9
Coarse gravel	CGR	16.0—31.9
Very coarse gravel	VCG	32.0—63.9
Small cobble	SC	64.0—127.9
Large cobble	LC	128.0—255.9
Small boulder	SB	256.0—512.0
Large/medium boulder	LMB	>512.0
Bedrock	BR	NA

Water temperature, pH and turbidity were measured using a YSI Model 6920 Water Quality Meter. Measurements were taken twice at each site, and the results were averaged.

2.6 Vegetation

Baseline vegetation information was collected at each monitoring site to monitor potential changes in riparian vegetation relative to channel location over time. The riparian vegetation was classified onsite using best professional judgment to Level IV of *The Alaska Vegetation Classification* (Viereck et al., 1992).

Vegetation data collected included a series of systematic site photographs, as well as conducting a modified version of the point intercept vegetation survey method (Mueller-Dombois, 2002). Photographs were collected using a 12 megapixel digital camera. Photographs were taken looking upstream and downstream.

Vegetation transects were co-located at the channel geometry transects described in Section 2.1. At each transect, a field measuring tape was strung from the transect pin on the west bank across the channel to the transect pin on the east bank. The field tape was placed with zero located at the west bank pin. Point intercept surveys were conducted using a laser point intercept tool similar to the one manufactured by Synergy Resource Solutions, Inc., of Belgrade, Montana that was used by HDR. The device consists of a high-intensity laser pointer and a bubble level that are attached to an PVC pipe The pointer can be set to point up or down.

Using the point-intercept method, vascular plants and their distribution were recorded along each transect. The laser pointer was aimed downward to collect data on low plants (e.g., herbaceous, dwarf shrubs, low shrubs, and young saplings). Then, the mounting bracket was flipped over to project the laser upward and the transect was traversed a second time for taller plants (e.g., trees, tall shrubs, and larger saplings). Measurements were recorded at 1 ft intervals. The investigator walked along the downstream side of the measuring tape to avoid introducing errors from trampling plants or obscuring the channel by disturbing sediments. At each interval, the laser pointer was held in a vertical position by checking the level bubble, and all species of live plants that intersected the laser were recorded as a “hit” on the field form. In dense vegetation, it was common to have multiple hits representing several species at a single measurement interval. A hit was recorded when the laser contacted any live part of a plant. Laser hits to bryophytes, leaf litter, bare soil, or rock, as well as open water were also recorded. Incidental species present adjacent to the transect and near both river banks were also noted.

3.0 RESULTS

The results for each monitoring site are presented below and summarized in Tables 2, 3, 4 and 4. Table 2 lists the key physical and chemical parameters associated with the monitoring sites including latitude and longitude, a brief channel description, discharge, temperature, pH and turbidity. Table 3 lists summary information on vegetation communities (Viereck classification type) by monitoring site. Table 4 summarizes plant species commonly identified at each monitoring site. Table 5 compares frequency and cover data of riparian vegetation for 2014 and 2016 (these data for 2011 and 2012 were unavailable). Appendix B provides channel cross sections and water surface elevations associated with each monitoring site over the 4 monitoring years. Appendix C includes water stage and temperature graphs for 2016, and site photos are located in Appendix D.

Descriptive results for each monitoring site and substrate sampling results and comparisons are provided in sections 3.1 through 3.

Table 2. Physical and Chemical Parameters of Piledriver Slough Monitoring Sites (measured on September 10, 2016)

Site No.	Latitude Longitude Datum = WGS 84	Description (from 20011 Baseline Study)	pH	Temperature	Stream Discharge	Turbidity
2	N 64.56382 W 147.05695	Relatively wide and shallow single channel. West bank slightly cut as slough changed direction to the north. Multiple floodplain tiers observed on east shoreline.	7.62	7.23ºC	1.69 cfs	0
3	N 64.57742 W 147.06277	Single channel with even concave shape and no pronounced thalweg. Pronounced cut bank on west shoreline as slough changed direction to north. Single, fairly well-defined floodplain tier observed on east shoreline. Upstream gravel bars appeared to be ice-affected based on scouring lateral to thalweg.	7.545	5.81ºC	2.88 cfs	0
4	N 64.59280 W 47.07368	Single channel with relatively flat channel bed with a slight thalweg along east bank. Small and fairly well defined floodplains along both banks. Stream flow laminar throughout survey site, but became more turbulent downstream and formed a riffle.	7.80	4.01ºC	6.38 cfs	0
5	N 64.60130 W 147.09225	Single channel with moderately uneven with an indefinite thalweg near east bank. There was a well-defined floodplain along the east bank. Stream flow remained laminar throughout the surveyed area.	7.815	5.485ºC	7.91 cfs	5-10

Table 3. Vegetation Communities near Piledriver Slough Monitoring Sites

Monitoring Site	Instream Vegetation	Vegetation Along Banks	Vegetation Above Banks
2	none	West bank: IA1j - Closed White Spruce Forest East bank: IIB1b - Closed Alder Tall Shrub	West bank: IA1j - Closed White Spruce Forest East bank: IIB1b - Closed Alder Tall Shrub
3	none	IIB1d - Closed Alder Willow Tall Shrub	West bank: IA2e - Open White Spruce Forest East bank: IIB1d - Closed Alder Willow Tall Shrub
4	none	IIIA3f - Subarctic Lowland Sedge Wet Meadow	IIB1d - Closed Alder Willow Tall Shrub
5	IIID1f - Fresh Pondweed	IIIA3f - Subarctic Lowland Sedge Wet Meadow	IIB1d - Closed Alder Willow Tall Shrub

Table 4. Common Plants Observed at Piledriver Slough Monitoring Sites

Location	Plant Species		Monitoring Site Number			
	Common Name	**Scientific Name**	**2**	**3**	**4**	**5**
In Stream (aquatic plants)						
	fineleaf pondweed	*Stuckenia filiformis*	none	none	none	√
Along Banks						
Over story *(trees and tall shrubs)*	feltleaf willow	*Salix alaxensis*	√	√	√	√
	paper birch	*Betula neoalaskana*	√			
	sandbar willow	*Salix interior*			√	
	Scouler's willow	*Salix scouleriana*	√			
	Thinleaf alder	Alnus incana	√	√	√	√
	white spruce	*Picea glauca*	√			
Under story *(low/dwarf shrubs and herbaceous plants)*	beaked sedge	*Carex rostrata*				√
	bluejoint reedgrass	*Calamagrostis canadensis*	√	√		√
	Canada bunchberry	*Cornus canadensis*	√			
	field horsetail	*Equisetum arvense*	√	√	√	√
	high-bush cranberry	*Viburnum edule*	√			
	Northwest Territory sedge	*Carex utriculata*	√ (out of transect)	√ (east bank	√ (infrequent)	√
	prickly rose	*Rosa acicularis*	√	√		
	red current	*Ribes triste*	√			
	scouring rush horsetail	*Equisetum hyemale*				
	silvery sedge	*Carex canescens*				√
	tall bluebells	*Mertensia paniculata*	√			
	water sedge	*Carex aquatilis*		√ (east bank only)	√ (continuous along both banks)	√ (continuous along both banks)
Above Banks						
Over story *(trees and tall shrubs)*	balsam poplar	*Populus balsamifera*			√	√
	paper birch	*Betula neoalaskana*	√		√	
	Scouler's willow	*Salix scouleriana*				√
	Thinleaf alder	*Alnus tenufolia*	√	√	√	√
	white spruce	*Picea glauca*	√	√	√	√
Under story *(low shrubs and herbaceous plants)*	bluejoint reedgrass	*Calamagrostis canadensis*				√
	Canada bunchberry	*Cornus canadensis*		√		
	field horsetail	*Equisetum arvense*			√	√
	high-bush cranberry	*Viburnum edule*	√	√		
	mountain cranberry	*Vaccinium vitis-idaea*	√			
	prickly rose	*Rosa acicularis*	√	√		
	twinflower	*Linnaea borealis*		√		

Table 5. Spatial Characteristics of Vegetation on Transects at Monitoring Sites

Attribute	Monitoring Sites							
	2 (52 ft. wide)		3 (52 ft. wide)		4 (70 ft. wide)		5 (73 ft. wide)	
	2014	2016	2014	2016	2014	2016	2014	2016
Width of open water (no aerial canopy)	28 feet	29 feet	26 feet	28 feet	26 feet	27 feet	47 feet	47 feet
Frequency of herbaceous species (#hits/total points)	0.27	0.13	0.12	0.02	0.41	0.23	0.38	0.30
Frequency of shrubs	0.14	0.06	0.10	0.02	0.16	0.10	0.12	0.03
Frequency of tall shrubs/trees	0.14	0.13	0.25	0.08	0.26	0.16	0.07	0.04

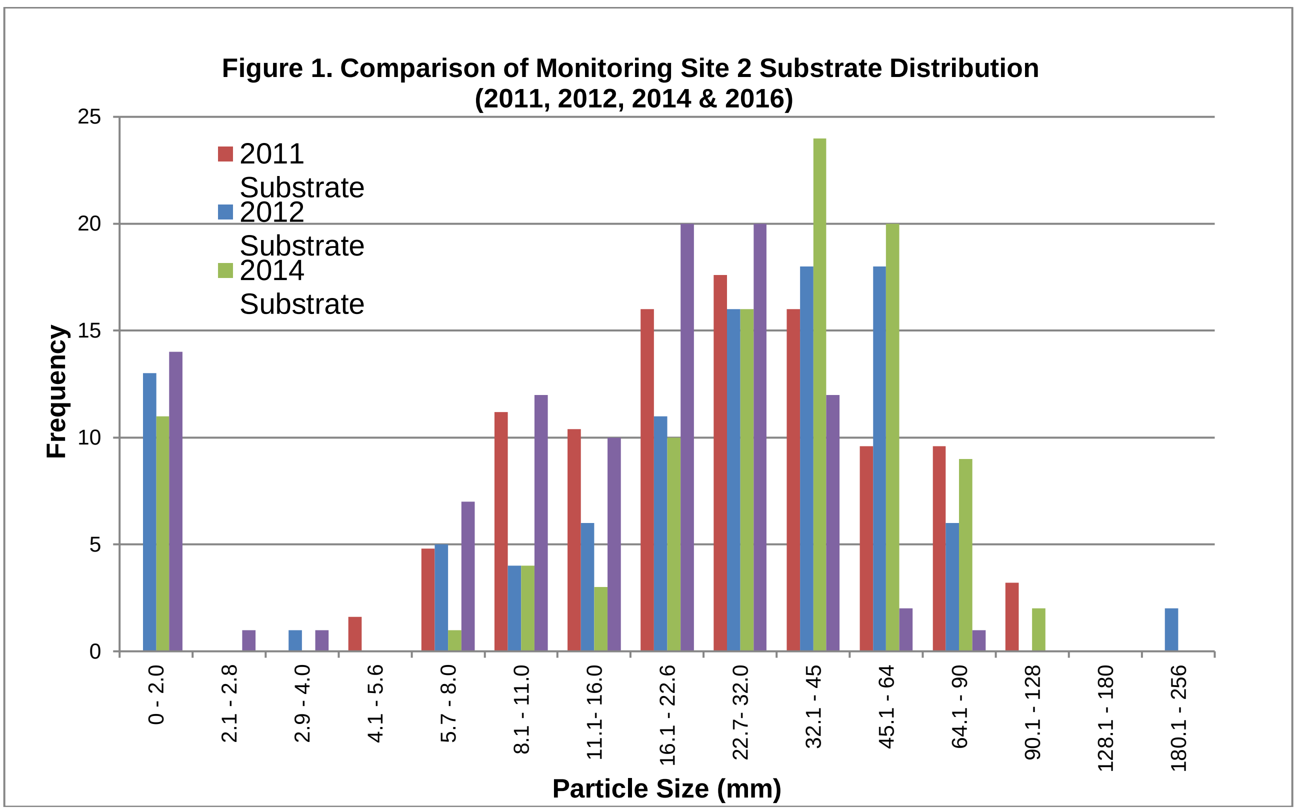
3.2 Monitoring Site 2

Monitoring Site 2 is located approximately 1 mile downstream from Monitoring Site 1, with the cross section about 230 ft upstream from the temporary construction bridge.

The stream channel at Monitoring Site 2 is wide and shallow with multiple floodplain tiers present on the east shoreline. Stream channel geometry for Monitoring Site 2 is provided in Appendix B.

Vegetation includes a closed white spruce forest (Viereck type IA1j) along the west bank and a closed alder tall shrub community along the east bank (Viereck type IIB1b). Occasional white spruce and Alaska paper birch trees were overhanging the channel upstream of transect. Thinleaf alder, Scouler's willow, and feltleaf willow overhung the east bank. A fragmented emergent fringe consisting of Northwest Territory sedge was more common along this reach than at Monitoring Site 1; however, it was not present within the survey transect and was only observed along the east bank.

Substrate size distribution for Monitoring Site 2 is shown below in Figure 1.



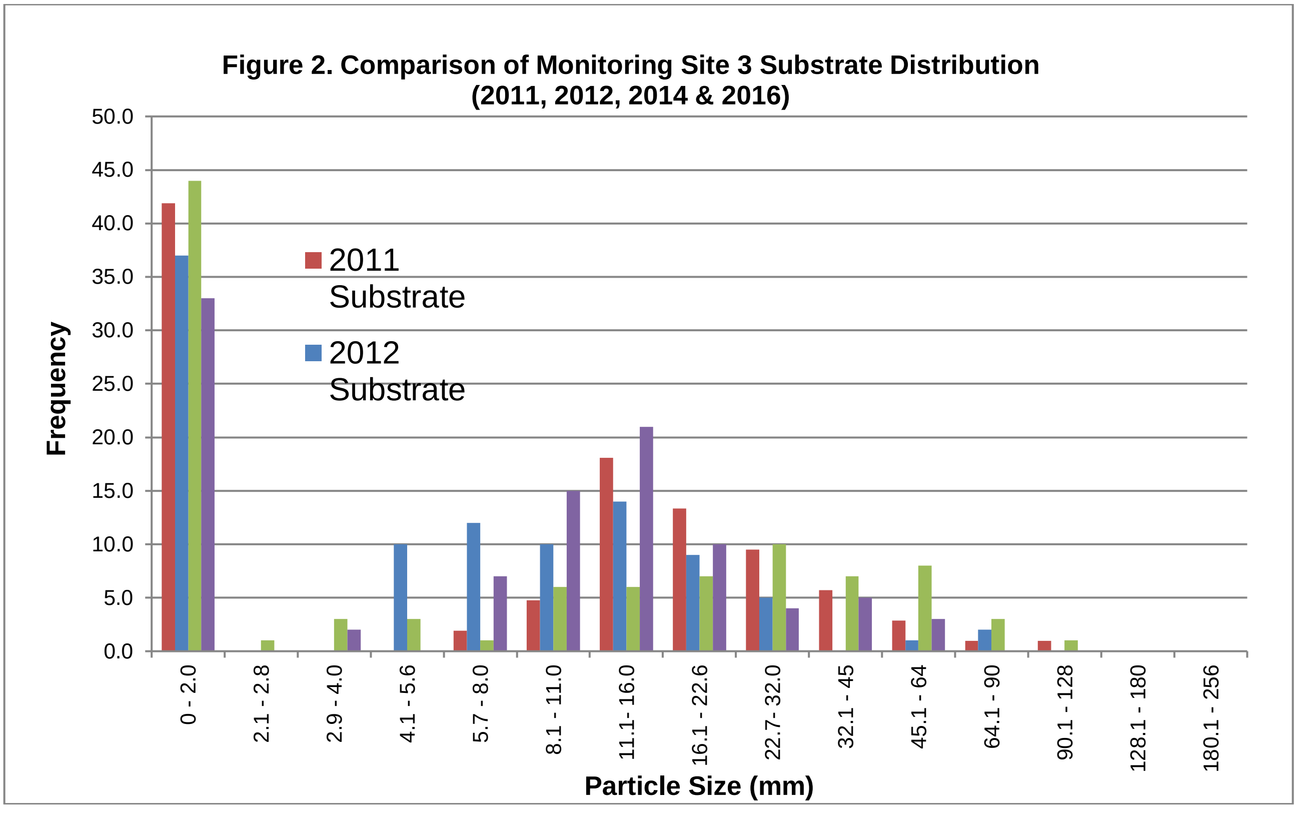
3.3 Monitoring Site 3

Monitoring Site 3 is located downstream of Sites 1 and 2. It sits on the Calicutt property upstream of a cable suspension bridge. The Old Richardson Highway is approximately 100 ft from the east bank Piledriver Slough.

The stream channel at Monitoring Site 3 consists of a single, evenly shaped concave channel and no pronounced thalweg. There is a distinct cut bank on the west stream bank as the slough changes direction to the north. A single, fairly well-defined floodplain tier exists on east shoreline. Upstream of the monitoring gravel bars appeared to be ice-affected based on scouring lateral to thalweg. Stream channel geometry for Monitoring Site 3 is provided in Appendix B.

Vegetation along both banks was dominated by a closed alder and willow tall shrub community (Viereck type IIB1d). Overhanging trees were observed along the west bank, and an alder canopy extended over the east bank. Unlike Monitoring Sites 1 and 2, this site had a significant emergent fringe community present as a continuous strip along the east bank and absent along the west bank. At the transect the fringe was approximately 5 ft wide, but within 100 ft upstream it extended up to 20 ft into the channel. The vegetation along the slough's banks was similar to Monitoring Site 1, except a lush understory was present.

Substrate size distribution for Monitoring Site 3 is shown below in Figure 2.



3.4 Monitoring Site 4

Monitoring Site 4 is located 100 ft upstream from Xantheus Way Bridge, with the Old Richardson Highway approximately 40 ft to the east.

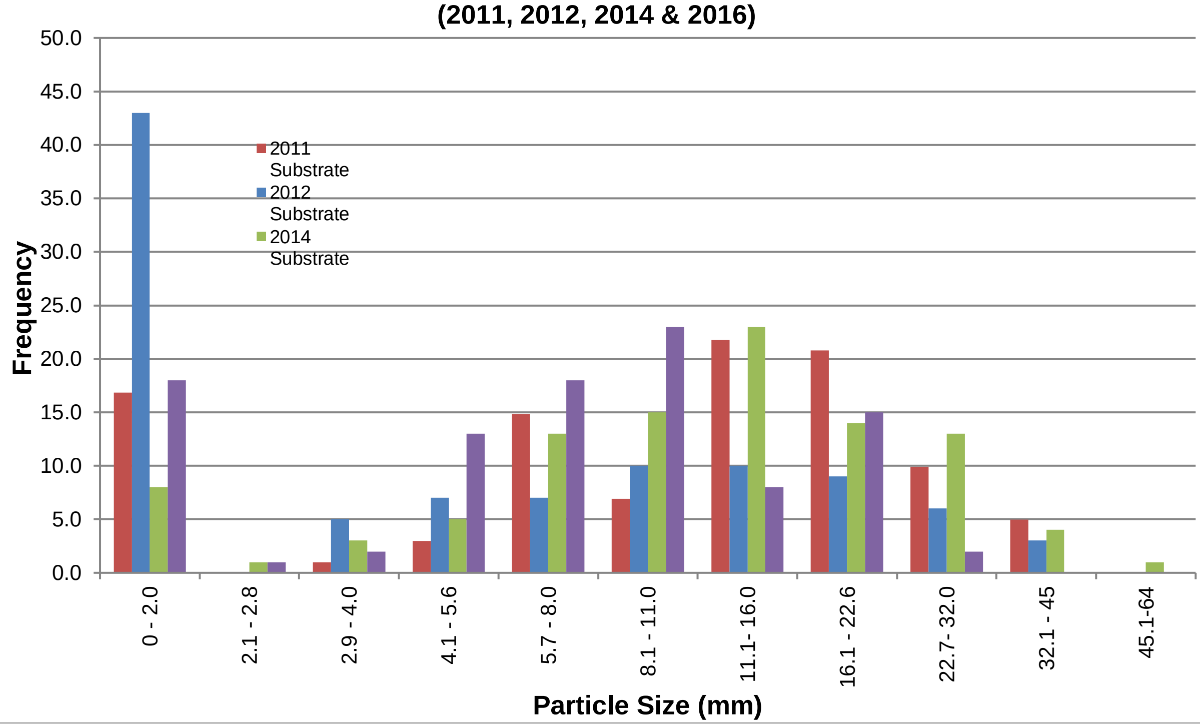
Monitoring Site 4 consists of a single, flat-bed channel and slight thalweg along the east bank. There are small and fairly well-defined floodplains along both banks. Stream flow was laminar throughout the site at the time of the survey, but became more turbulent downstream of the cross section and formed a riffle. Stream channel geometry for Monitoring Site 4 is provided in Appendix B.

The vegetation on the banks consisted of a closed alder and willow tall shrub community (Viereck type IIB1d) similar to Monitoring Site 3, except that emergent sedges were even more prominent and occurred as continuous strips along both banks and overhanging trees and shrubs were common throughout this area. The fringe continued to be dominated by water sedge.

The Piledriver Slough stream gage station was located on the east bank of the slough, 10 ft upstream of the cross section. Section 3.6 provides a description of the gage station results.

Substrate size distribution for Monitoring Site 4 is shown below in Figure 3.

Figure 3. Comparison of Monitoring Site 4 Substrate Distribution (2011, 2012, 2014 & 2016)



3.5 Monitoring Site 5

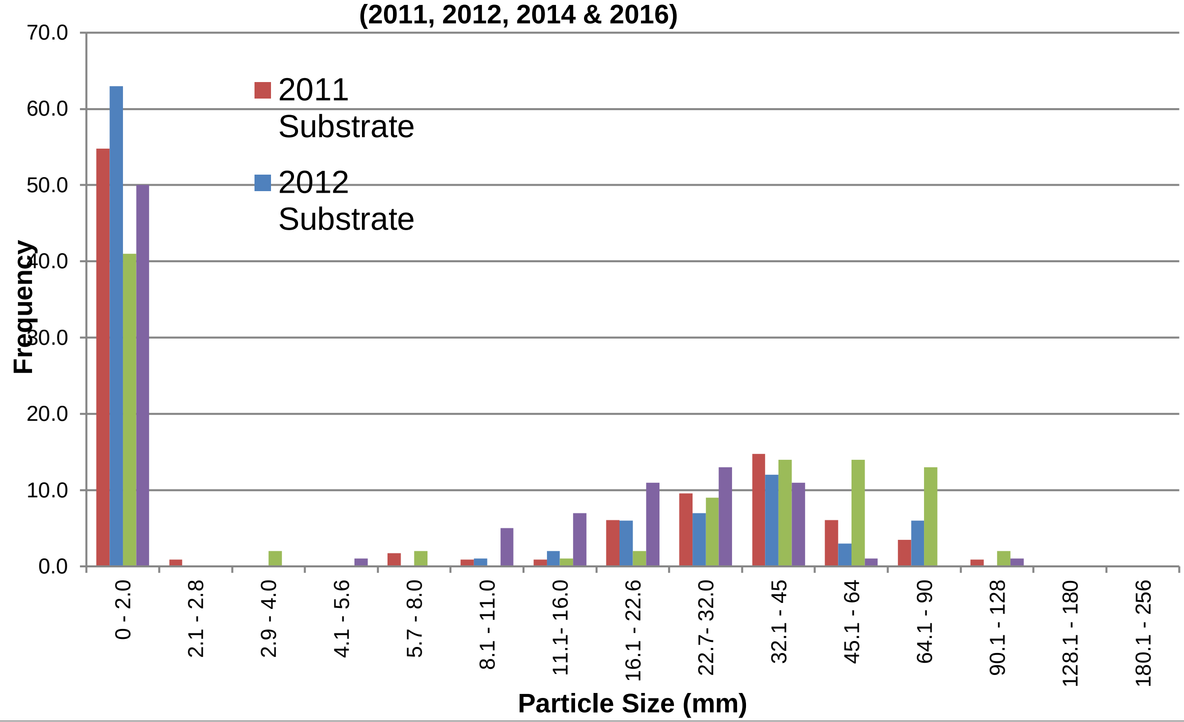
Monitoring Site 5 is located 200 ft upstream from two large culverts that pass under the Old Richardson Highway.

Monitoring Site 5 consists of a single channel, prominent thalweg near the east bank and a well-defined floodplain along the downstream west bank. Stream flow at the time of the survey was laminar in nature. Stream channel geometry for Monitoring Site 5 is provided in Appendix B.

This site had the most extensive riparian vegetation of all the monitoring sites. Aquatic plants were growing in a thick, submerged mat along the west side of the channel. Emergent sedges were found along both sides of the channel. This fringe was 2 ft wide along the west bank 23 ft wide along the east bank. A thin, two foot wide sedge fringe was present on the west bank, and was extensive on the east bank.

Substrate size distribution for Monitoring Site 5 is shown below in Figure 4.

Figure 4. Substrate Distribution at Monitoring Site 5 (2011, 2012, 2014 & 2016)



3.6 Gage Stations

3.6.1 Piledriver Slough Gage Station

The Piledriver Slough gage station was located at Monitoring Site #4 (Appendix A). This station included a staff gage, as well as a hydraulic pressure transducer and water temperature sensor, and an ambient barometric air pressure and temperature sensor. A photograph of the Piledriver Slough gage is located in Appendix D.

Stream gage equipment was deployed on April 26, 2016. Water depth on the staff gage was 0.85 feet and discharge measured 2.03 cubic feet per second (cfs). On September 10, 2016 equipment was removed to avoid ice damage. Measured discharge was 6.38 cfs, corresponding water depth on the staff gage was 1.07 feet.

Charts showing daily average water stage and water temperature data for May 1 through September 10, 2016 for the Piledriver Slough gage station are included Appendix C. For comparison, daily average stage data (May 1 – September 30, 2016) for the USGS Tanana River at Fairbanks Gage Station #15485500 and the USGS Chena River below Moose Creek Dam gage station #15493700 are also included in Appendix C.

4.1 DISCUSSION

The NRE Phase 1 Section 404 permit (Special Condition No. 22) required the ARRC to develop and implement a 10-year monitoring program to evaluate secondary impacts that may result from building a levee adjacent to the Tanana River. The objective of the monitoring program is to evaluate potential secondary impacts to Piledriver Slough by characterizing abiotic and biotic changes that may occur as a result of a reduction in surface water flow within the upper reaches of Piledriver Slough. The 2011 and future baseline data efforts focus on examining physical changes to channel geometry, substrate composition, vegetation, and stream flow that may occur as a result of the NRE Phase 1 project.

Water stage data recorded at the Piledriver Slough gage over the course of the 2016 field season correlates well with the Tanana River gage at Fairbanks for the same period of record (Figure XX, Appendix C). At both gage stations flows largely increased from about May 12 through late July. Peak flows occurred July 21-22 and generally declined from late July through September. Although stage data for the USGS Chena River below Moose Creek Dam gage shows peak flows also occurring in late July there is not a strong correlation between the 2016 Chena River gage record and 2016 gage records for Piledriver Sough or Tanana River.

Comparisons of channel geometry, substrate distribution and vegetation frequency and cover between years indicate any changes have been minor thus far. Turbidity decreased from 5-10 NTUs to undetectable levels between 2011 and 2012, when the levee was completed. Other physical and chemical differences are not yet apparent.

The final monitoring event will be in 2020, when a final analysis will be conducted, and recommendations for future monitoring, if any, will be made.

REFERENCES

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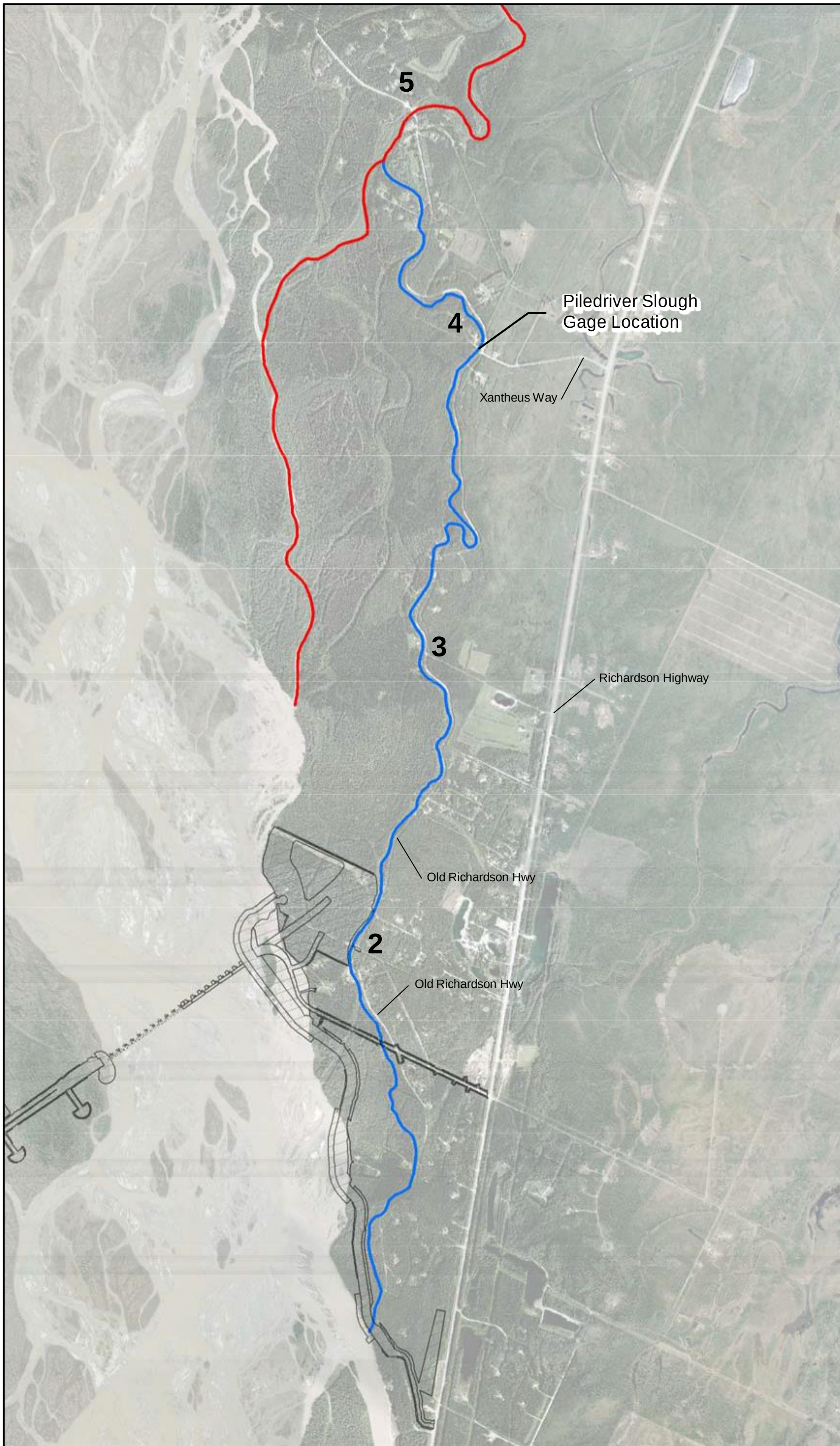
APPENDIX A

Map of Monitoring Site Locations



Alaska Railroad Northern Rail Extension Project
ARRC & HDR

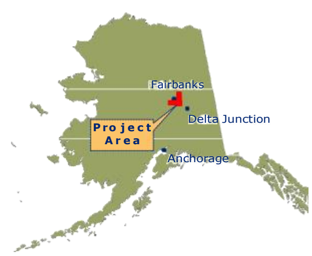
Figure 1

Piledriver Slough Monitoring Sites

Legend

IDENT

- Monitoring Site
- NRE Project Footprint
- Piledriver Slough Anadromous
- Piledriver Slough Nonanadromous

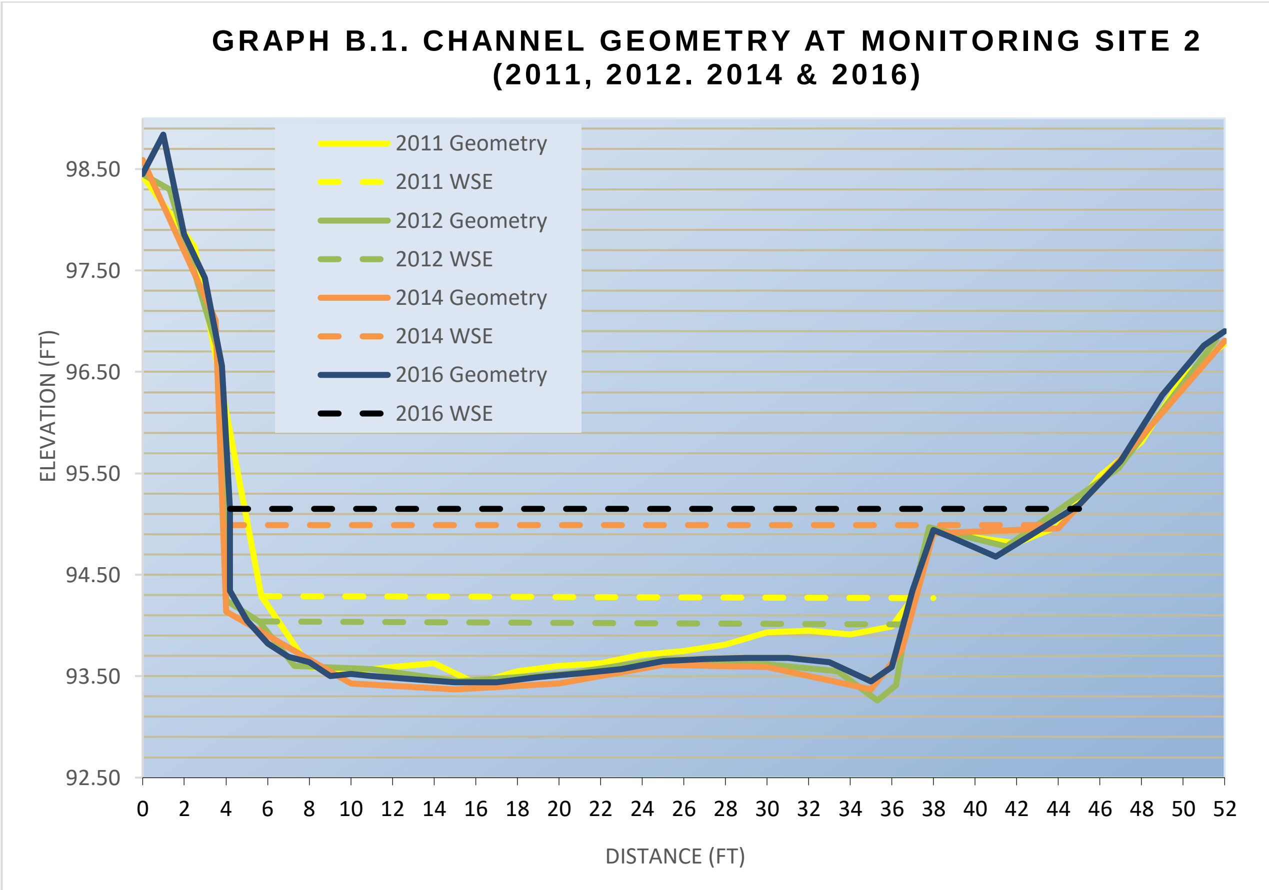


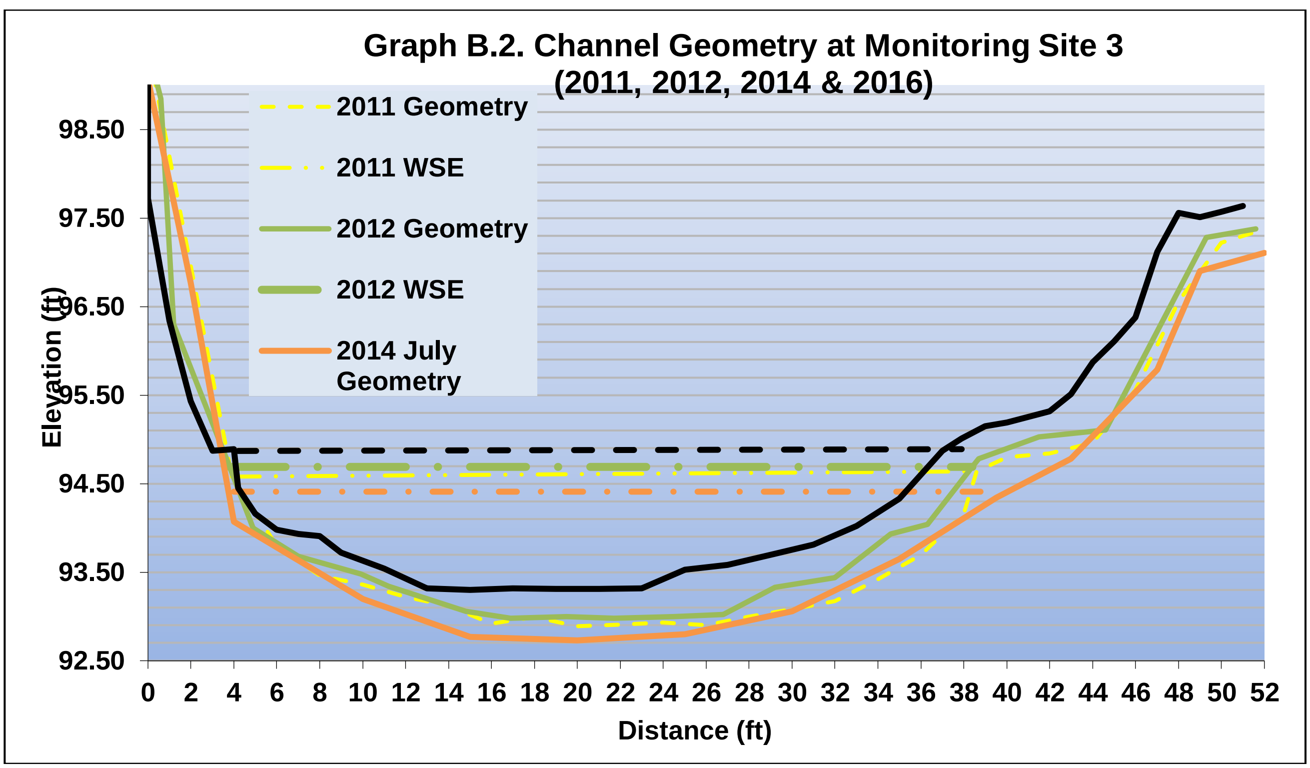
Miles

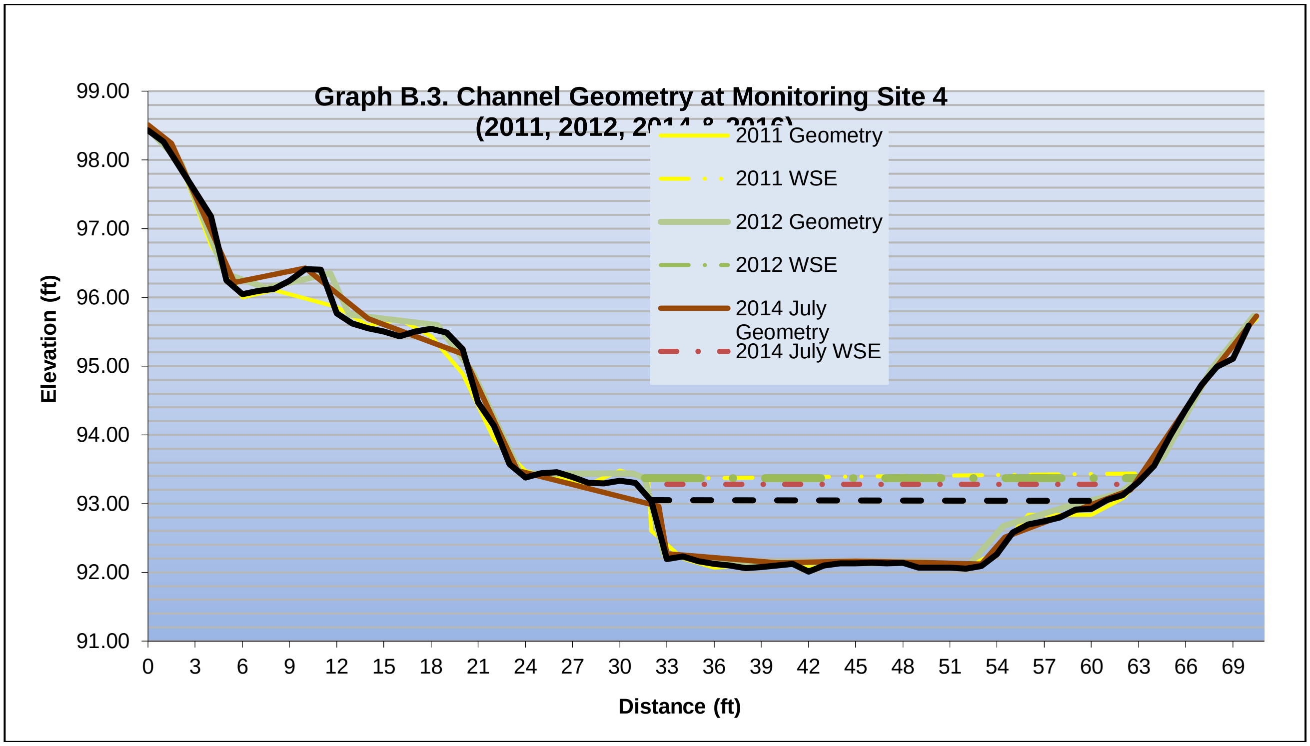
Map Projection: NAD 83 ASP 3 Feet
Data Sources: HDR, Hanson, CES/CERR
Author: HDR Alaska, Inc.
Date: 6/6/2012

APPENDIX B

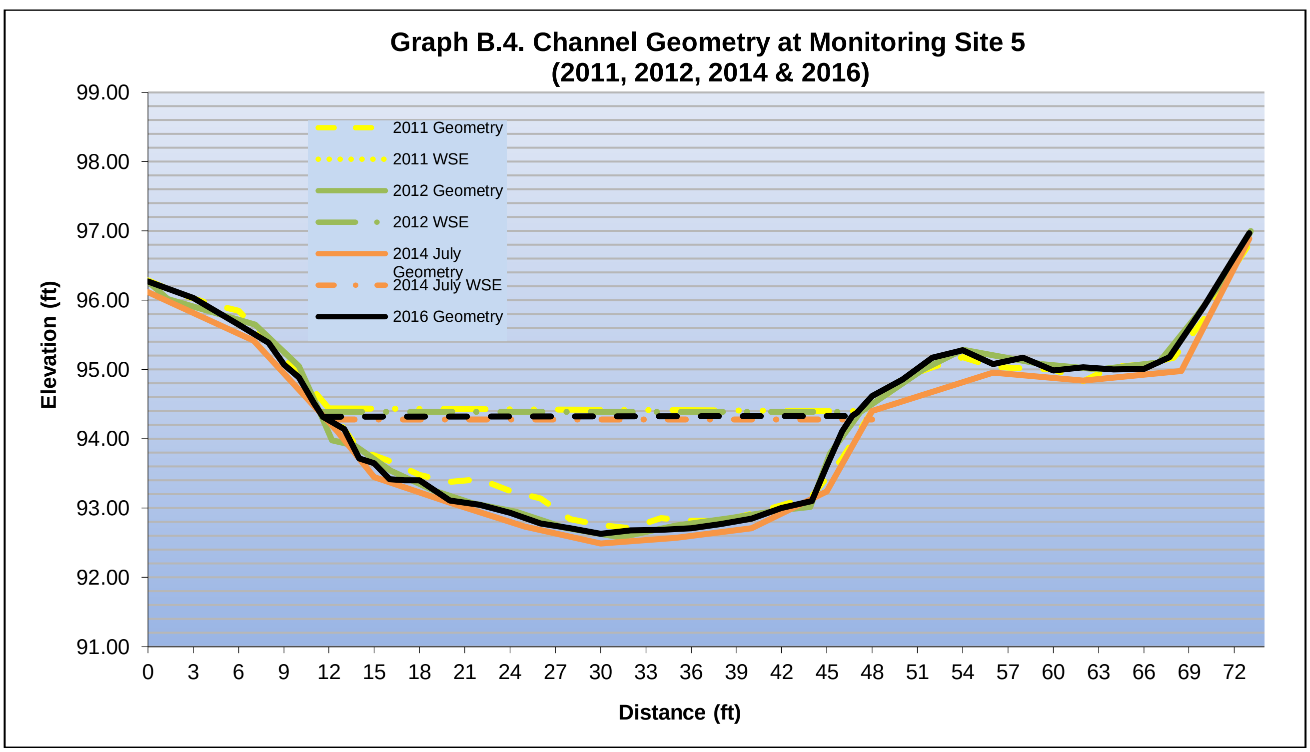
Monitoring Site Cross Sections


GRAPH B.1. CHANNEL GEOMETRY AT MONITORING SITE 2 (2011, 2012. 2014 & 2016)
2011 Geometry
2011 WSE
2012 Geometry
2012 WSE
2014 Geometry
2014 WSE
2016 Geometry
2016 WSE
ELEVATION (FT)
98.50
97.50
96.50
95.50
94.50
93.50
92.50
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52
DISTANCE (FT)


Graph B.2. Channel Geometry at Monitoring Site 3 (2011, 2012, 2014 & 2016)
2011 Geometry
2011 WSE
2012 Geometry
2012 WSE
2014 July Geometry
Elevation (ft)
98.50
97.50
96.50
95.50
94.50
93.50
92.50
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52
Distance (ft)



Graph B.3. Channel Geometry at Monitoring Site 4 (2011, 2012, 2014 & 2016)



Graph B.4. Channel Geometry at Monitoring Site 5 (2011, 2012, 2014 & 2016)

APPENDIX C

Stage and Temperature Information

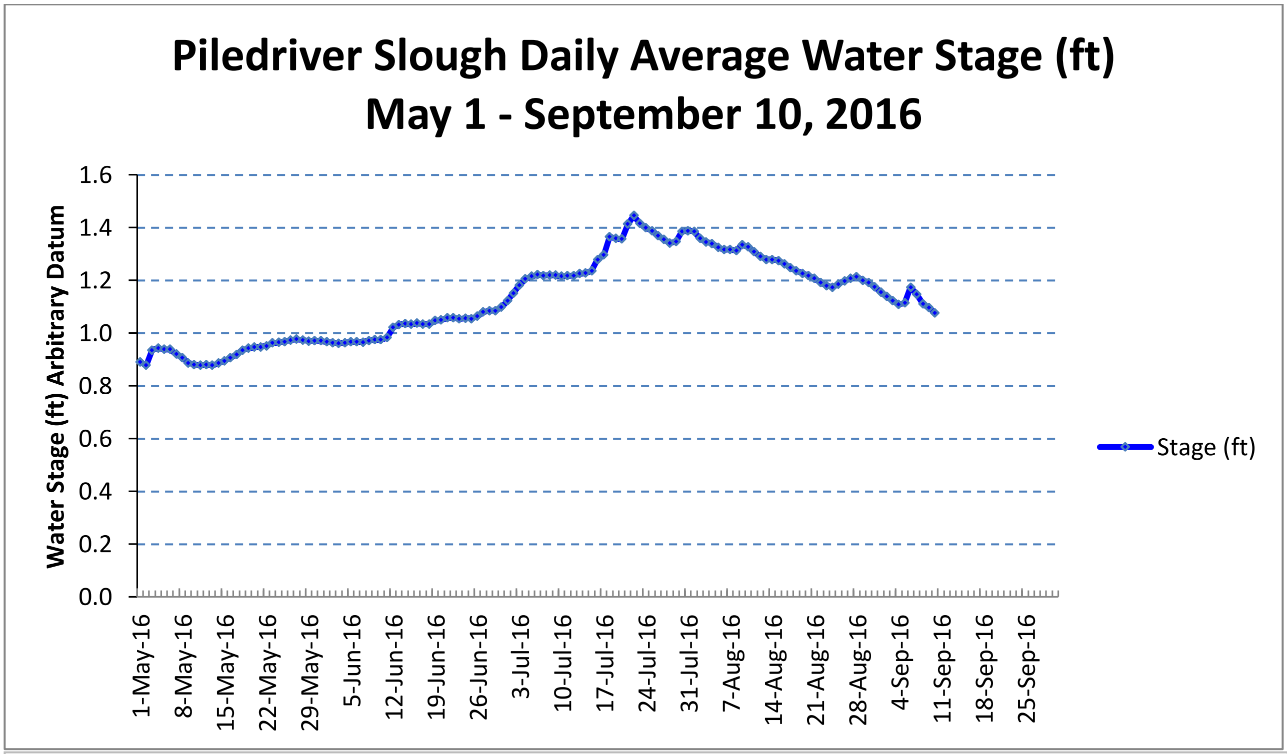


Figure C-1. Daily average water stage for Piledriver Slough stream gage at monitoring Site #4 near Xanthus Way bridge crossing, May 1 through September 10, 2016.

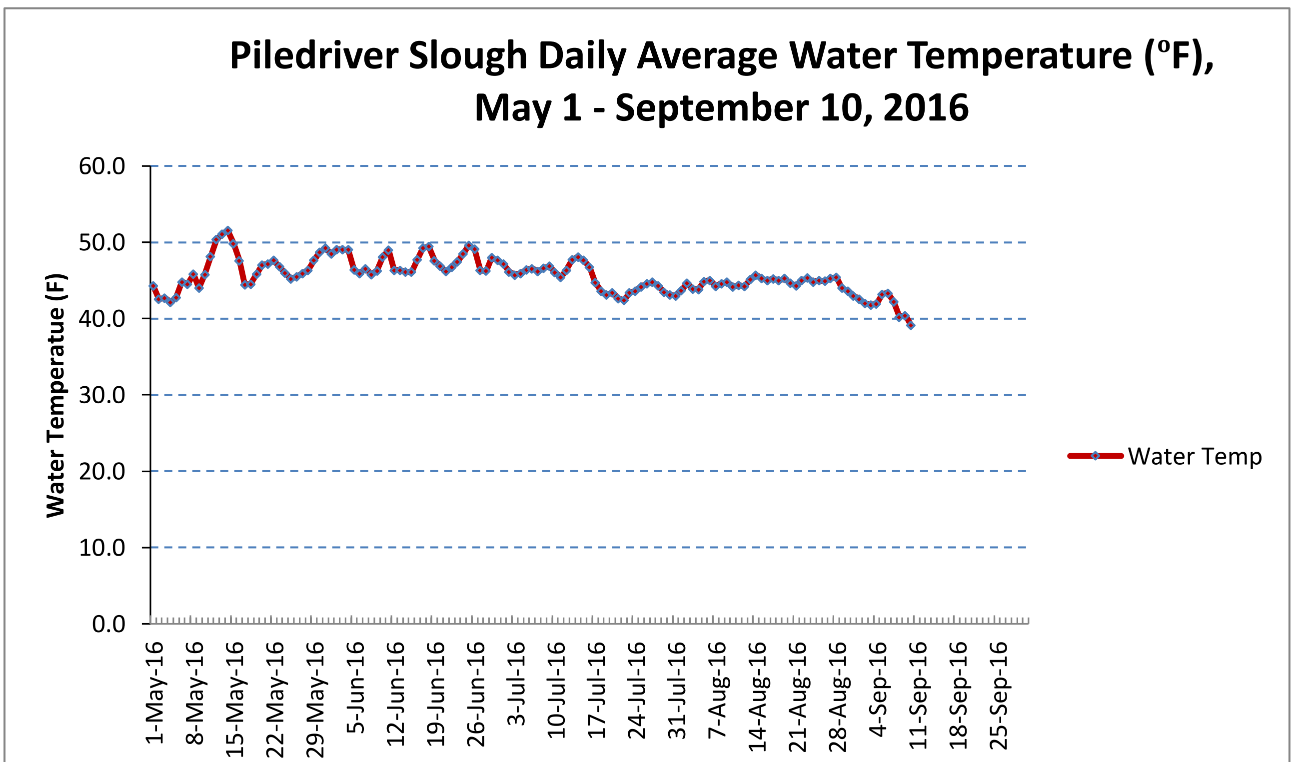


Figure C-2. Daily average water temperature for Piledriver Slough stream gage at monitoring Site #4 near Xanthus Way bridge crossing, May 1 through September 10, 2016.

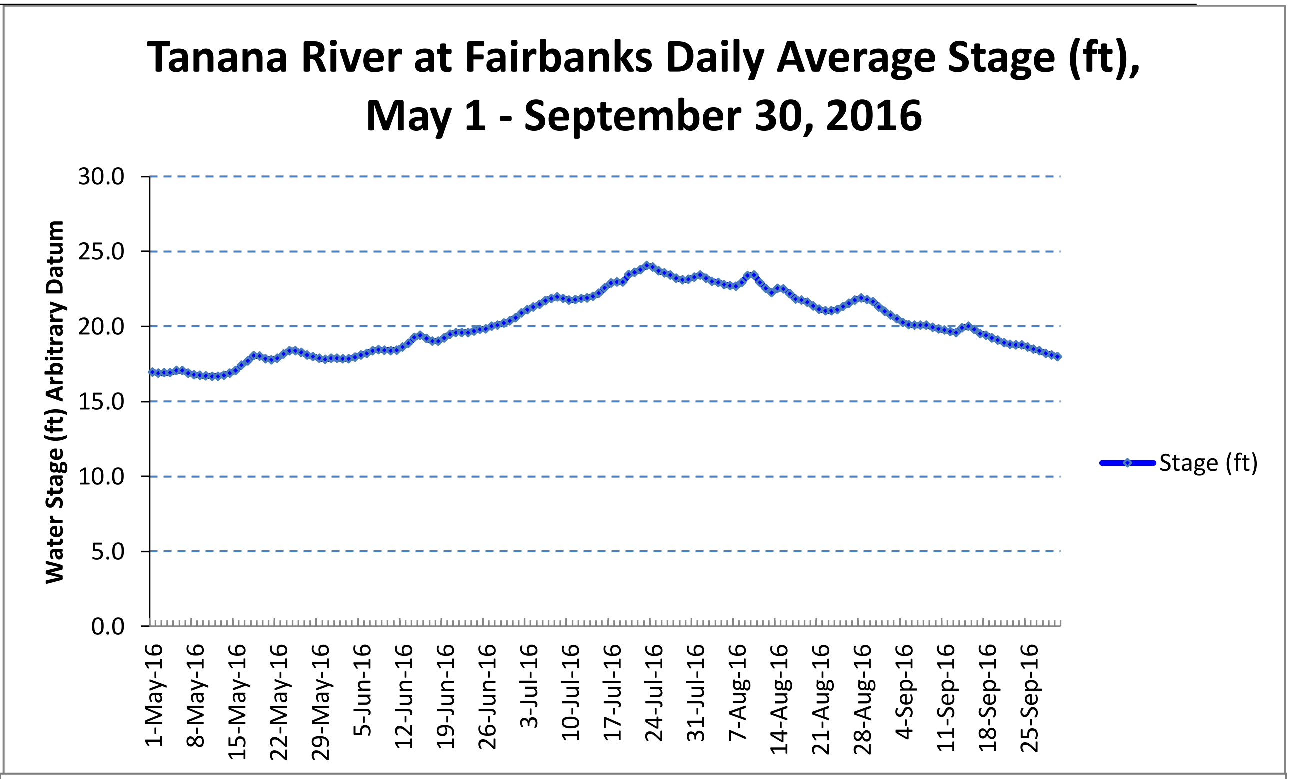


Figure C-3. Daily average water stage for USGS Tanana River at Fairbanks stream gage #15485500, May 1 through September 30, 2016.

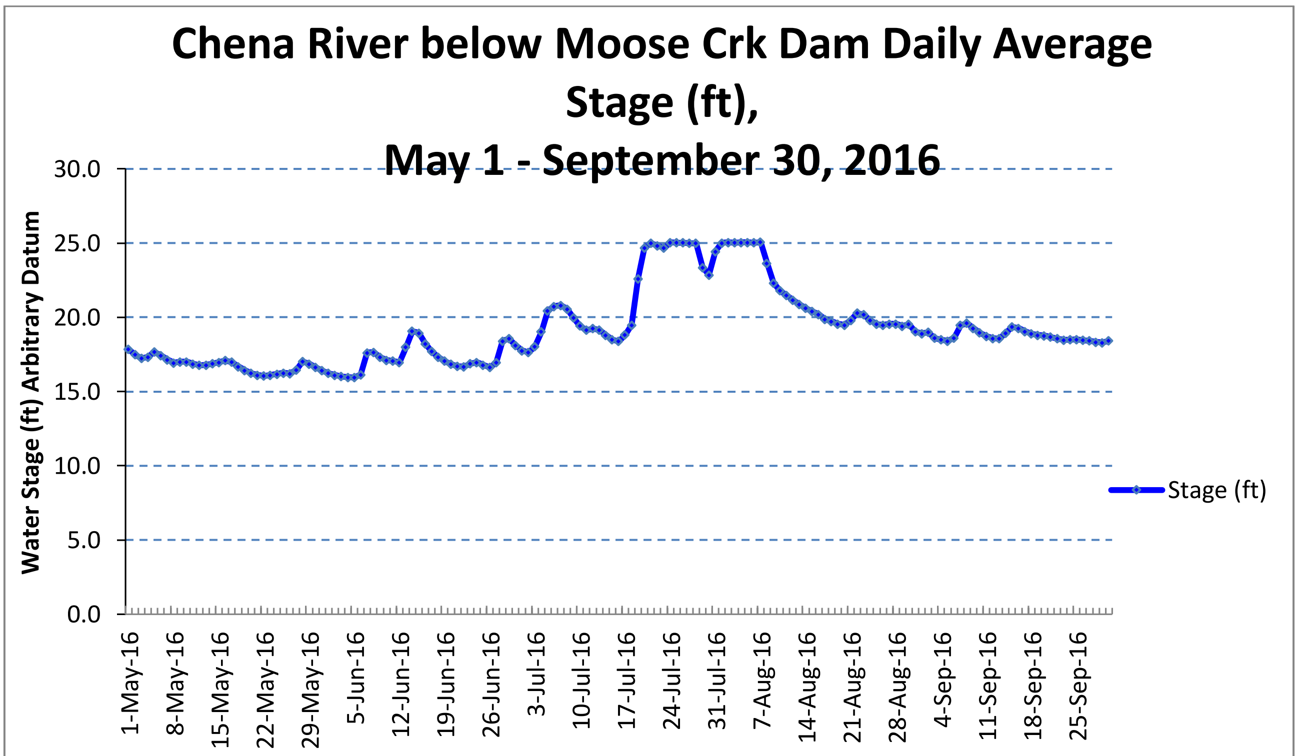


Figure C-4. Daily average water stage for USGS Chena River below Moose Creek Dam stream gage #15493700, May 1 through September 30, 2016.

APPENDIX D

Site Photos

Site 2 September 10th From center of channel looking upstream (south)

Site 2 September 10th From center of channel looking downstream (north)

Site 3 September 10th From center of channel looking upstream (south)

Site 3 September 10th From center of channel looking downstream (north)

Site 3 September 10th Left (west) bank from center of transect

Site 3 September 10th Algae growth on streambed

Site 3 September 10th Algae and large woody debris

Site 4 September 10th From center of channel looking upstream (south)

Site 4 September 10th From center of channel looking downstream (north)

Site 4 September 10^{th} Benchmark on bridge right (east) abutment, upstream side

Site 5 September 10th From center of channel looking upstream (south)

Site 5 September 10th From center of channel looking downstream (north)