Susitna-Watana Hydroelectric Project

(FERC No. 14241)

Characterization and Mapping of Aquatic Habitats

Study Plan Section 9.9

Supplement to Study Completion Report

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

R2 Resource Consultants, Inc.

October 2016

TABLE OF CONTENTS

1. Introduction 1

2. Macro- and Meso-habitat Key for Mainstem Susitna River Habitats 3

2.1. Mainstem Macrohabitats 3

2.2. Mainstem Mesohabitats 4

3. Literature CITED 6

LIST OF TABLES

Table 9-1. SCR Appendix A Aquatic Habitat mapbook imagery dates and associated flows at the USGS Gold Creek gage (PRM 140.0). 7

Table 9-2. Nested and tiered habitat mapping units and categories for macrohabitats and mainstem channel mesohabitats. 9

Table 9-3. Summary of map-based geomorphic reach attributes for Upper River Tributaries including tributary river mile, elevation, confinement and reach-scale gradient. 11

Table 9-4 Geomorphic Reach attributes including drainage area and ZHI gradient for all Middle River tributaries. 14

1. INTRODUCTION

As established in the Study Plan[1] (RSP Section 9.9.1), the goal of this study is to characterize and map all aquatic habitats with the potential to be altered and/or lost as the result of reservoir filling, hydropower operations, and associated changes in flow, water surface elevation, sediment regime, and temperature. This *Characterization and Mapping of Aquatic Habitats, Section 9.9 of the Revised Study Plan (RSP)* was approved by the Federal Energy Regulatory Commission (FERC or Commission) for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241 in their April 1, 2013 Study Plan Determination. This study focuses on describing the aquatic habitats of the Susitna River using a specific hierarchical and nested classification system based on historic and current data.

Following the first study season, FERC's regulations for the Integrated Licensing Process (ILP) require AEA to "prepare and file with the Commission an initial study report describing its overall progress in implementing the study plan and schedule and the data collected, including an explanation of any variance from the study plan and schedule." (18 CFR 5.15(c)(1)) The *Initial Study Report on Characterization and Mapping of Aquatic Habitats* was prepared in accordance with FERC's ILP regulations and details AEA's status in implementing the study, as set forth in the FERC-approved RSP and as modified by FERC's April 1 SPD and includes the *Characterization and Mapping of Aquatic Habitats Technical Memorandum* (HDR 2013) filed with the Commission on July 16, 2013 (collectively referred to herein as the "Study Plan").

A summary of the development of this study, together with the Alaska Energy Authority's (AEA) implementation of it through the 2013 study season, appears in Part A, Section 1 of the Initial Study Report (ISR) filed with FERC in June 2014. As required under FERC's regulations for the Integrated Licensing Process (ILP), the ISR describes AEA's "overall progress in implementing the study plan and schedule and the data collected, including an explanation of any variance from the study plan and schedule." (18 CFR 5.15(c)(1)). In October 2015, AEA filed a Study Completion Report (SCR) for Study 9.9 that summarized all baseline data collected for this study. The Study 9.9 SCR contains a comprehensive discussion of results of the Characterization and Mapping of Aquatic Habitats from the beginning of AEA's study program in 2012, through the end of calendar year 2014. It describes the methods and results of the Characterization and Mapping of Aquatic Habitats, and explains how all Study Objectives set forth in the Commission-approved Study Plan have been met. Accordingly, with this report, AEA has now completed all field work, data collection, data analysis, and reporting for this study.

In December 2015, FERC had agreed to collectively consider the ISR and SCR as a comprehensive ISR and in March of 2016, AEA held an ISR meeting and presented all study

[1] The FERC-approved Revised Study Plan (RSP) Section 9.9 for the Characterization and Mapping of Aquatic Habitats Study (AQHAB) as modified by FERC's Study Plan Determination (Study 9.9 SPD, April 1, 2013) and *Characterization and Mapping of Aquatic Habitats Technical Memorandum* (Study 9.9 TM, July 16, 2013) is collectively referred to as Study Plan Section 9.9.

material developed to date. The licensing participants filed comments with FERC pursuant to the comprehensive ISR.

In comments on the ISR and ISR meeting filed by licensing participants in accordance with the ILP regulations (18 CFR 5.15(c)(4)) and FERC's ILP process plan and schedule issued on December 2, 2015, NMFS and USFWS submitted 12 and 11 study modification proposals, respectively, for Study 9.9. In addition, FERC and ADF&G requested clarification or additional information. In response, AEA has developed and provided this Supplement to the Study 9.9 Study Completion Report Characterization and Mapping of Aquatic Habitats.

In responding to comments from FERC, NMFS, and USFWS on the ISR and SCR for Study 9.9 Characterization and Mapping of Aquatic Habitats, AEA determined that the following supplemental materials would be beneficial and, thus, is providing these materials within this Supplement to the Study 9.9 Study Completion Report.

Table 9-1, Aquatic habitat mapbook imagery dates and associated flows at the USGS Gold Creek gage (PRM 140.0), are presented in support of AEA's response to the FERC request for background photo dates and flows for maps in Appendix A to SCR (FERC 2016).

Table 9-2, Nested and tiered habitat mapping units and categories for macrohabitats and mainstem channel mesohabitats are provided in response to FERC's request for a revised version of Table 4.1-1 from the Study 9.9 SCR with the footnote corrected (FERC 2016).

Table 9-3, Summary of map-based geomorphic reach attributes for Upper River Tributaries including tributary river mile, elevation, confinement and reach-scale gradient, is provided in response to the direct request for a table of tributary geomorphic reach attributes from the Services (NMFS 2016, USFWS 2016).

Table 9-4, Geomorphic Reach attributes including drainage area and ZHI gradient for all Middle River tributaries, is consistent with the reach classification recommended by FERC in the April 1, 2013 SPD and is provided in response to comments from the Services (NMFS 2016, USFWS 2016).

In addition, and to help clarify apparent misinterpretation by the Services of habitat classifications made by AEA field crews, the macro- and meso-habitat classification key used by Study 9.9 field crews is presented in Section 2.

2. MACRO- AND MESO-HABITAT KEY FOR MAINSTEM SUSITNA RIVER HABITATS

2.1. Mainstem Macrohabitats

1. Area of clear water at junction of a tributary with mainstem, below the ordinary high waterline?

   YES…**Tributary Mouth**

   NO → 2

2. Upstream connection to main channel flow?

   YES → 3

   NO → 5

3. Dominant or equal portion of flow (determined at upstream end of habitat unit) between 1, 2 or 3+ main channels, all with turbid water?

   YES → 4

   NO → **Side Channel -** Channel carries a non-dominant (< 10%) portion of mainstem flow; portion of flow should be determined at upstream end of habitat unit; separating island is likely permanently vegetated (not always, but can be a helpful decision point for cases on border of portion of flow criteria); turbid water

4. Number of channels

   1…**Single Main Channel** (1 channel)

   2...**Split Main Channel** (2 channels)

   3+…**Multiple Split Main Channel** (3+ channels)

5. Channel is disconnected from mainstem flow at upstream end of unit, may have clear water; off-channel habitats. Breached at high flows (no permanent vegetated berm at head)?

   YES…**Side Slough** – turbid water possible if recently breached (typically would be clear)

   NO…**Upland Slough -** Not breached at high flows – permanent vegetation at head; clear water (turbid water possible if mouth of slough has backwater mesohabitat

2.2. Mainstem Mesohabitats

1. Is there discharge from a tributary forming a pronounced area of clear water along the main channel shoreline?

   YES…**Clearwater Plume**

   NO →2

2. Water velocity is:

   a. fast – visible turbulence or disruption of flow on surface, protruding substrate elements →3

   b. moderate – little or no visible surface turbulence…**Run –** Generally uniform depth greater than maximum substrate size, generally deeper than riffles. Minimal surface turbulence over or around protruding boulders or no visible surface turbulence, generally uniform depth that is greater than the maximum substrate size, velocities are on the border of fast/slow water, gradients 0.5-2.0%.

   c. slow – smooth, laminar flow or no flow evident…**Pool** →4 for subtypes.

3. Exposed substrate components above the water surface generally boulders or boulder clusters, gradient moderate, 2-4%?

   YES…**Rapid**

   NO…**Riffle -** Gradient low 0.5-2%, shallow and broad, exposed substrate generally gravel and cobble

4. Water flow is smooth, laminar, or not obvious/evident, scour may be evident, pools and variants. Pool forming feature is below the unit?

   YES→7

   NO→5

5. Pool forming feature is above the habitat unit. Formed by mid-channel scour?

   YES…**Straight Scour Pool**

   NO→6

6. Formed by flow impinging against one bank or partial obstruction, asymmetric cross-section?

   YES…**Lateral Scour Pool -**Pool formed by scour below a complete or nearly complete channel obstruction; frequently shorter than average channel width?

NO…**Plunge Pool -** formed by scour below a complete or nearly complete channel obstruction; frequently shorter than average channel width

7. Source of backflow is from source other than Susitna mainstem?

   YES→8

   NO…**Backwater** – found along channel margins and generally within influence of active main channel – no independent source of inflow. Water typically not clear (but may be less turbid than main channel if tributary or groundwater influences are present). Typically occurs at the downstream end of side or upland sloughs as mainstem Susitna backs up into slough mouth at higher flows.

8. Pool formed by backflow around/due to a downstream obstruction or constriction (associated with beaver activity)?

   YES…**Beaver Complex** – pool forming feature is a beaver dam or other beaver activity, pool typically one in a sequence or arrangement across larger area
   NO…**Backwater Pool**

3. LITERATURE CITED

Federal Energy Regulatory Commission (FERC). 2016. *FERC to AEA, June 23, 2016*. Letter. Staff Comments on the Initial Study Report and Initial Study Report Meeting Summary for the Susitna-Watana Hydroelectric Project

National Marine Fisheries Service (NMFS). 2016. NMFS to FERC, June 22, 2016. Letter. Susitna-Watana Hydropower Project, FERC Project No. 14241-000; Review of Initial Study Reports.

US Fish and Wildlife Service (USFWS). 2016. USFWS to FERC, June 22, 2016. Letter. Susitna-Watana Hydropower Project, FERC Project No. 14241-000; Review of Initial Study Reports.

Table 9-1. SCR Appendix A Aquatic Habitat mapbook imagery dates and associated flows at the USGS Gold Creek gage (PRM 140.0).

AQHAB Mapbook Page	2011 Photo Date	Avg. Daily Flow (cfs) Gold Creek Gage	Range of PRMs
2	20111012	5,180	231.9 - 235.5
3	20111012	5,180	229.6 - 232.1
4	20111012	5,180	227.0 - 229.5
5	20111012	5,180	224.0 - 227.0
6	20111012	5,180	221.6 - 224.0
7	20111012	5,180	219.0 - 221.7
8	20111012, 20110909	5,180, 10,800	216.5 - 219.0
9	20111012, 20110909	5,180, 10,800	214.2 - 216.5
10	20110909	10,800	211.9 - 214.4
11	20110909	10,800	209.3 - 212.0
12	20110909	10,800	206.5 - 209.4
13	20110909, 20110812	10,800, 16,700	203.8 - 206.6
14	20110909, 20110816	10,800, 17,200	201.4 - 204.0
15	20110816	17,200	198.9 - 201.4
16	20110909, 20110816	10,800, 17,200	196.8 - 199.2
17	20110909, 20110816	10,800, 17,200	194.5 - 197.0
18	20110909, 20110816	10,800, 17,200	192.3 - 194.8
19	20110909, 20110816	10,800, 17,200	189.9 - 192.4
20	20110909, 20110816	10,800, 17,200	187.4 - 190.0
21	20110816	17,200	185.0 - 187.4
22	20110816	17,200	183.2 - 185.7
23	20110816, 20110812	17,200, 16,700	180.6 - 183.3
24	20110812	16,700	178.3 - 180.8
25	20110812	16,700	175.8 - 178.8
26	20110812	16,700	173.6 - 175.9
27	20110812	16,700	171.3 - 173.6
28	20110812	16,700	169.7 - 171.5
29	20110812, 20110721, 20110618	16,700, 18,300, 17,900	165.6 - 169.7
30	20110812, 20110721, 20110618	16,700, 18,300, 17,900	162.0 - 166.2
31	20110721	18,300	158.0 - 162.0
32	20110721, 20110618	18,300, 17,900	154.0 - 158.0
33	20110721, 20110618	18,300, 17,900	151.8 - 154.4
34	20110721, 20110618	18,300, 17,900	150.1 - 152.6
35	20110721	18,300	147.7 - 150.1
36	20110721, 20110618	18,300, 17,900	145.6 - 148.0
37	20110721, 20110618	18,300, 17,900	143.5 - 145.9

AQHAB Mapbook Page	2011 Photo Date	Avg. Daily Flow (cfs) Gold Creek Gage	Range of PRMs
38	**20110721**, 20110618	**18,300**, 17,900	141.2 - 143.6
39	20110721, 20110618	18,300, 17,900	138.5 - 141.4
40	20110721, 20110618	18,300, 17,900	136.3 - 138.7
41	20110721, 20110618	18,300, 17,900	134.1 - 136.6
42	20110721	18,300	131.6 - 134.1
43	20110721	18,300	129.2 - 131.6
44	20110721	18,300	127.4 - 129.8
45	20110721	18,300	125.0 - 127.4
46	20110721	18,300	122.5 - 125.0
47	**20110721**, 20110618, 20110525	**18,300**, 17,900, 30,600	120.1 - 122.5
48	20110721, 20110618, **20110525**	18,300, 17,900, **30,600**	117.7 - 120.1
49	20110525	30,600	115.3 - 117.6
50	20110525	30,600	112.9 - 115.5
51	20110525	30,600	110.5 - 112.9
52	20110525	30,600	108.0 - 110.4
53	20110525	30,600	105.4 - 108.1
54	20110525	30,600	103.7 - 106.2
55	20110525	30,600	102.3 - 105.0

Notes:

* Some map sheets have multiple photo dates incorporated into the orthophoto mosaic. Bold text indicates the most likely photo used due to overall photo coverage along the Susitna River.

Table 9-2. Nested and tiered habitat mapping units and categories for macrohabitats and mainstem channel mesohabitats.

Level	Unit	Grouping	Category	Definitions
1	Major Hydrologic Segment	Segments	Upper, Middle, Lower River	*Upper River* – PRM –187.1 – 261.3 (habitat mapping extended up to mainstem PRM 235.1 and included the Oshetna River. *Middle River* - PRM –102.4 – 187.1 *Lower River* - PRM 0 – 102.4
2	Geomorphic Reach	Upper River Segment	6 reaches	Geomorphic reaches that uniquely divide the Major Hydrologic Segments based on geomorphic characteristics.
		Middle River Segment	8 reaches	
		Lower River Segment[1]	6 reaches	
3	Macrohabitat	Main Channel Habitat	Single Main Channel	Single dominant main channel.
			Split Main Channel	Two dominant channels.
			Multiple Split Main Channel	Three or more distributed dominant channels.
			Side Channel	Channel that is turbid and connected to the active main channel but represents non-dominant proportion of flow[1]
			Tributary Mouth	Clear water areas that exist where tributaries flow into Susitna River main channel or side channel habitats (upstream Tributary habitat will be mapped as a separate effort).
		Off-Channel Habitat[2]	Side Slough	Overflow channel contained in the floodplain, but disconnected from the main channel.
			Upland Slough	Similar to a side slough, but contains a vegetated bar at the head that is rarely overtopped by mainstem flow. Has clear water.[1.]
		Tributary Habitat	Single Channel	Single dominant channel
			Split Channel	Two dominant channels
			Channel complex	Three or more distributed dominant channels
4	Mesohabitat	Fast water	Rapid	Swift, turbulent flow including small chutes and some hydraulic jumps swirling around boulders. Exposed substrate composed of individual boulders, boulder clusters, and partial bars. Lower gradient and less dense concentration of boulders and white water than Cascade. Moderate gradient; usually 2.0-4.0 percent slope.
			Riffle	A fast water habitat with turbulent, shallow flow over submerged or partially submerged gravel and cobble substrates.

Level	Unit	Grouping	Category	Definitions
				Generally broad, uniform cross-section. Low gradient; usually 0.5-2.0 percent slope.
			Run/Glide	A habitat area with minimal surface turbulence with generally uniform depth that is greater than the maximum substrate size. Velocities are on border of fast and slow water. Gradients are approximately 0 to less than 2 percent. Generally deeper than riffles with few major flow obstructions and low habitat complexity.
4(cont)		Slow Water	Pool	Slow water habitat with minimal turbulence and deeper due to a strong hydraulic control.
			Pool Subtypes	Straight Scour Pool: Formed by mid-channel scour. Generally with a broad scour hole and symmetrical cross-section.
				Plunge Pool: Formed by scour below a complete or nearly complete channel obstruction (logs, boulders, or bedrock). Pool must be Substrate is highly variable. Frequently, but not always, shorter than the active channel width.
				Lateral Scour Pool: Formed by flow impinging against one stream bank or partial obstruction (logs, root wad, or bedrock). Asymmetrical cross-section. Includes corner pools in meandering lowland or valley bottom streams.
				Backwater Pool: Found along channel margins; created by eddies around obstructions such as boulders, root wads, or woody debris. Part of active channel at most flows; scoured at high flow. Substrate typically sand, gravel, and cobble. Generally not as long as the full channel width.
				Isolated Pool: Areas of puddled or stranded water
		Special Habitat Feature	Clearwater Plume	Discharge from a tributary that forms a pronounced area of clearwater, in contrast to the turbid water of the main channel, along the main channel shoreline. The length, breadth, and depth of the clearwater plume depend on the relative discharge between the tributary and the main channel, relative turbidity, and on mixing conditions along the shoreline. A clear water plume will be mapped as if it were a separate mesohabitat type.
			Backwater	Found along channel margins and generally within the influence of the active main channel with no independent source of inflow. Water is not clear. A backwater will be mapped as if it were a separate mesohabitat type.
			Beaver Complex	Complex ponded water body created by beaver dams. A beaver dam will be mapped as if it were a separate mesohabitat type.
		Tributary Mesohabitat		Tributary mesohabitats were typed using the classification system described in Table 4.1.2

Notes:

[1]All habitat within this designation received an additional designation of whether water was clear or turbid within the database.

[2]The terms Side Channel, Slough, and Upland Slough are similar but not necessarily synonymous with the terms for macrohabitat type as applied by Trihey (1982) and ADF&G (1983).

Table 9-3. Summary of map-based geomorphic reach attributes for Upper River Tributaries including tributary river mile, elevation, confinement and reach-scale gradient.

Mainstem Geomorphic Reach	Tributary Name	Selection Category	Tributary Category[2]	Tributary Geomorphic Reach	Confluence Project River Mile	End of Survey Elev. (ft)	Approx. Drainage Area (mi²)	Approx. Length (mi)	Down-stream RM	Up-stream RM	Down-stream Elevation	Up-stream Elevation	Reach Gradient (%)	Confinement
UR-2	Oshetna River[1]	Above Inundation Zone	1	Oshetna-1	235.1	3000	556.4	53.9	0	7.2	2120	2470	0.9	Confined
				Oshetna-2					7.2	8.4	2470	2540	1.1	Unconfined
				Oshetna-3[3]					8.4	25.6	2540	3000	0.6	Confined
UR-2	Black River[1]	Above Inundation Zone	2	Black-1	12.6 (LB)	3000	162.9	32.5	0	2.1	2680	2780	0.9	Unconfined
				Black-2					2.1	3.5	2780	2880	1.4	Confined
				Black-3[3]					3.5	5.9	2880	3000	0.9	Unconfined
UR-3	Goose Creek[1]	Above Inundation Zone	1	Goose-1	232.8	3000	106.5	25.1	0	4.5	2060	2580	2.2	Moderately Confined
				Goose-2					4.5	7.7	2580	2880	1.8	Unconfined
				Goose-3[3]					7.7	10.15	2880	3000	0.9	Unconfined
Proposed reservoir full pool (2050' NAVD88)														
UR-3	Unnamed 230.2	small primary	1	H230.2-22H	230.2	2200	0.54	1.5	0	0.1	2030	2200	36.6	Confined
UR-3	Unnamed 230.1	small primary	1	H230.1-22H	230.1	2200	3.11	1.6	0	0.1	2008	2200	29.1	Unconfined
UR-3	Unnamed 228.5	small primary	1	H228.5-22H	228.5	2200	46.89	14.1	0	0.6	1984	2200	6.5	Moderately Confined
UR-3	Unnamed 226.2	small primary	1	H226.2-22H	226.2	2200	3.99	2.2	0	0.2	1944	2200	21.2	Unconfined
UR-4	Unnamed 219.6	small primary	1	H219.6-22H	219.6	2200	3.66	1.7	0	0.5	1822	2200	13.9	Unconfined
UR-4	Unnamed 214.4	small primary	1	H214.4-22H	214.4	2200	1.07	0.9	0	0.4	1740	2200	22.2	Unconfined
UR-4	Jay Creek[1]	Inundation Zone	1	Jay-1	211	3000	62.37	19.6	0	1.2	1700	1880	2.8	Moderately and Unconfined
				Jay-2					1.2	4.2	1840	2340	2.9	Confined
				Jay-3					4.2	7.8	2340	2620	1.5	Unconfined
				Jay-4[3]					7.8	13.3	2620	3000	1.3	Unconfined
UR-4	Kosina Creek[1]	Inundation Zone	1	Kosina-1	209.1	3000	402.51	39.4	0	0.7	1680	1750	1.9	Unconfined
				Kosina-2					0.7	8.6	1750	2610	2	Confined
				Kosina-3					8.6	19.1	2610	3000	0.7	Confined
UR-4	Tsisi Creek[1]	Inundation Zone	2	Tsisi-1[3]	7.2 (LB)	3000	85.46	22.3	0	3.5	2500	2900	2.2	Moderately Confined
				Tsisi-2[3]					3.5	6	2900	3000	0.9	Unconfined

Mainstem Geomorphic Reach	Tributary Name	Selection Category	Tributary Category[2]	Tributary Geomorphic Reach	Confluence Project River Mile	End of Survey Elev. (ft)	Approx. Drainage Area (mi^2)	Approx. Length (mi)	Down-stream RM	Up-stream RM	Down-stream Elevation	Up-stream Elevation	Reach Gradient (%)	Confinement
UR-4	Unnamed 208.6	small primary	1	H208.6-22H	208.6	2200	1.58	1.3	0	0.4	1694	2200	24.5	Confined
UR-5	Unnamed 207.4	small primary	1	H207.4-HW1	207.4	HW	0.79	0.5	0	0.4	1780	2128	17.5	Confined
UR-5	Unnamed 207.4 RB-1	small primary	2	H207.4-HW2	207.4	HW	0.17	0.4	0	0.5	1654	2032	14.6	Confined
UR-5	Unnamed 206.3	Inundation Zone	1	206.3-1	206.3	3000	11.66	7.3	0	0.1	1650	1720	13.3	Confined
				206.3-2					0.1	0.9	1720	2260	12.8	Confined
				206.3-3					0.9	3.6	2260	3000	5.2	Confined
UR-5	Unnamed 204.5	Inundation Zone	1	204.5-1	204.5	3000	12.1	6.1	0	0.3	1640	1780	8.8	Confined
				204.5-2					0.3	2.5	1780	3000	10.5	Confined
UR-6	Unnamed 198.9	small primary	1	H198.9-22H	198.9	2200	0.61	1.1	0	1.1	1604	2200	11.9	Confined
UR-6	Unnamed 198.4 LB -1	small primary*	2	H198.4-HW	198.4	HW	1.05	0.5	0	0.5	1816	2132	13.1	Confined
UR-6	Unnamed 197.7	Inundation Zone	1	197.7-1	197.7	3000	13.66	5.2	0	0.8	1570	1710	3.3	Confined
				197.7-2					0.8	1.9	1710	2200	8.3	Confined
				197.7-3					1.9	5	2200	2280	0.5	Unconfined
UR-6	Unnamed 197.7 RB-1	small primary*	2	H197.7-22T	197.7	2200	8.35	5.6	0					
UR-6	Watana Creek[1]	Inundation Zone	1	Watana-1	196.9	3000	176.39	26.9	0	9.3	1555	2140	1.1	Unconfined
				Watana-2					9.3	14.3	2140	2640	2.0	Unconfined
				Watana-3[3]					14.3	21.4	2640	3000	1	Unconfined
UR-6	Watana RB-1	small primary*	2	H196.9-HW1	196.9	HW	0.6	0.2	0	0.2	1616	1782	14	Confined
UR-6	Watana LB-1.1.1	small primary*	4	H196.9-HW2	196.9	HW	0.34	0.1	0	0.1	2024	2034	1.4	Confined
UR-6	Watana Tributary[1]	Inundation Zone	2	Watana Trib-1[3]	8.7 (RB)	3000	68.35	9.2	0	6	2060	2500	1.4	Unconfined
				Watana Trib-2[3]					6	8.3	2500	3000	4.1	Confined
UR-6	Unnamed 194.8	Inundation Zone	1	194.8-1	194.8	HW	23.22	7	0	0.5	1545	1620	2.8	Confined
				194.8-2					0.5	2.2	1620	1980	4.0	Confined
				194.8-3					2.2	3.7	1980	2050	0.9	Unconfined
				194.8-4					3.7	6.1	2050	2380	2.6	Confined

Mainstem Geomorphic Reach	Tributary Name	Selection Category	Tributary Category[2]	Tributary Geomorphic Reach	Confluence Project River Mile	End of Survey Elev. (ft)	Approx. Drainage Area (mi^2)	Approx. Length (mi)	Down-stream RM	Up-stream RM	Down-stream Elevation	Up-stream Elevation	Reach Gradient (%)	Confinement
UR-6	Deadman Creek[1]	Inundation Zone	1	Deadman-1	189.4	3000	175.38	41.9	0	0.3	1515	1560	2.8	Confined
				Deadman-2					0.3	1	1560	1900	9.2	Confined
				Deadman-3					1	3.2	1900	2250	3.0	Confined
				Deadman-4					3.2	8.1	2250	2550	1.2	Unconfined
				Deadman-5					8.1	11	2550	2900	2.3	Confined
				Deadman-6					11	18.8	2900	3000	0.2	Unconfined

Notes

[1]Tributary mapped using aerial videography.

[2]Tributary category indicates ranked distance from the mainstem Susitna River (i.e. 1 = primary tributary to the Susitna River, 2 = tributary to a number 1 tributary).

[3]Tributary Geomorphic Reach only partially video-mapped or not video mapped. See Table 4.1-3 for spatial range of videography survey.

* private land CIRWG.

Table 9-4 Geomorphic Reach attributes including drainage area and ZHI gradient for all Middle River tributaries.

Tributary	Project River Mile	Drainage Basin Area (square miles)	ZHI Gradient Category (<1%, 1-2%, 2-4%, 4-8%, 8+%)
Tsusena Creek	184.6	145.4	1-2%
Unnamed 184.0	184.0	44.2	2-4%
Unnamed 182.1	182.1	5.6	4-8%
Unnamed 181.9	181.9	5.1	2-4%
Unnamed 181.0	181.0	1.6	8+%
Unnamed 179.7	179.7	0.5	–
Fog Creek	179.3	149.7	1-2%
Unnamed 178.5	178.5	0.2	<1%
Unnamed 178.1	178.1	0.2	4-8%
Unnamed 178.0	178.0	1.9	–
Unnamed 177.7	177.7	0.1	–
Unnamed 177.2	177.2	10.4	4-8%
Unnamed 176.8	176.8	7.0	2-4%
Unnamed 175.9	175.9	5.5	4-8%
Unnamed 175.8	175.8	3.3	<1%
Unnamed 175.5	175.5	0.2	–
Unnamed 174.3	174.3	4.6	–
Unnamed 173.8	173.8	8.1	1-2%
Unnamed 172.0	172.0	1.0	–
Unnamed 170.5	170.5	1.7	<1%
Unnamed 170.1	170.1	0.2	8+%
Unnamed 169.6	169.6	9.5	–
Unnamed 169.1	169.1		4-8%
Unnamed 168.7	168.7	0.2	2-4%
Unnamed 168.3	168.3	0.5	4-8%
Unnamed 168.1	168.1	1.1	–
Unnamed 167.4	167.4	1.5	–
Unnamed 166.8	166.8	1.5	–
Devil Creek	164.8	74.4	–
Unnamed 162.6	162.6	4.0	–
Chinook Creek	160.5	24.0	–
Unnamed 158.7 (LB)	158.7	0.3	–
Unnamed 158.7 (RB)	158.7	1.6	–
Unnamed 158.3	158.3	0.9	–
Unnamed 157.9	157.9	10.1	–
Unnamed 156.8	156.8	7.2	–
Cheechako Creek	155.9	34.4	–
Unnamed 155.4	155.4	1.5	–
Unnamed 154.6	154.6	0.3	8+%
Unnamed 153.9	153.9	0.1	–
Unnamed 153.7	153.7	0.5	–
Portage Creek	152.3	179.1	<1%

Tributary	Project River Mile	Drainage Basin Area (square miles)	ZHI Gradient Category (<1%, 1-2%, 2-4%, 4-8%, 8+%)
Unnamed 151.9	151.9	0.1	–
Jack Long Creek	148.3	20.6	2-4%
Unnamed 148.0	148.0	0.6	–
Unnamed 146.6	146.6	2.7	–
Unnamed 144.6	144.6	4.6	–
Unnamed 143.7	143.7	2.3	–
Indian River	142.1	81.9	1-2%
Unnamed 140.9	140.9	2.6	–
Gold Creek	140.1	24.6	2-4%
Unnamed 136.3	136.3	2.3	–
Unnamed 135.2	135.2	1.4	8+%
Fourth of July Creek	134.3	22.6	2-4%
Sherman Creek	134.1	7.2	4-8%
Unnamed 133.2	133.2	1.4	–
Unnamed 132.0	132.0	0.7	–
Unnamed 131.6	131.6	1.6	2-4%
Unnamed 130.8	130.8	1.7	4-8%
Unnamed 130.4	130.4	0.8	–
Skull Creek	128.1	4.3	<1%
Fifth of July Creek	127.3	7.0	4-8%
Unnamed 126.9	126.9	1.1	–
Unnamed 126.1	126.1	1.0	–
Unnamed 125.2	125.2		–
Deadhorse Creek	124.4	5.3	2-4%
Unnamed 124.4	124.4	1.5	4-8%
Unnamed 122.8	122.8	1.5	4-8%
Unnamed 122.7	122.7	4.8	4-8%
Little Portage Creek	121.4	2.5	2-4%
McKenzie Creek	120.2	2.2	4-8%
Lower McKenzie Creek	119.9	2.1	–
Unnamed 119.4	119.4	0.1	2-4%
Unnamed 119.0	119.0	2.0	–
Unnamed 117.4	117.4	1.1	4-8%
Lane Creek	117.2	11.5	2-4%
Unnamed 115.4	115.4	0.2	<1%
Gash Creek	115.0	2.2	4-8%
Slash Creek	114.9	1.4	1-2%
Unnamed 113.7	113.7	2.2	4-8%
Unnamed 112.4	112.4	0.3	–
Chase Creek	110.5	4.3	<1%
Whiskers Creek	105.1	18.2	<1%

Notes:– ZHI calculations were not possible for Devils Canyon tributaries due to the density of the nodes of the routing model. In addition, tributary mouths are considered mainstem habitat features and several tributaries have mouths that extend beyond the ZHI, so no tributary gradients were contained within the ZHI.