

Susitna-Watana Hydroelectric Project Document

ARLIS Uniform Cover Page

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PART A - APPENDIX C: PHYSICAL, HYDROLOGICAL, AND
ENGINEERING INFORMATION

PART A - APPENDIX D: DETAILED STUDY SCHEDULE UPDATED
JULY 10, 2013

**Susitna-Watana Hydroelectric Project
(FERC No. 14241)**

**Study of Fish Passage Feasibility at Watana
Dam (9.11)**

**Part A - Appendix C
Physical, Hydrological, and Engineering Information

Initial Study Report**

Prepared for

Alaska Energy Authority



SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

[R2 Resource Consultants Inc. &

LGL Alaska Research Associates, Inc.]

June 2014

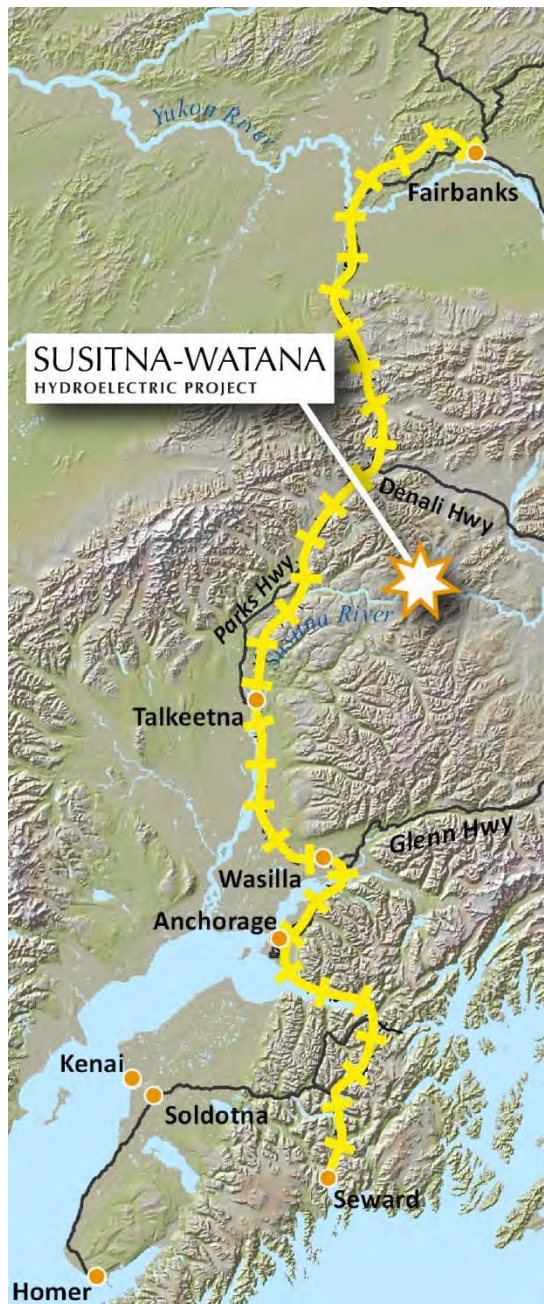
Table C-1. List of physical, hydrologic and engineering information needs. The available information as of January 8, 2014 follows in this appendix. Except where the noted initial compilation of information was provided to the FPTWG prior to Workshop #1 (April 9 and 10, 2013) and updates provided prior to the Site Visit (September 18 and 19, 2013).

No.	Item	Comments
P1	Water quality & water temperature under existing conditions, main stem & tributaries	1980 data exists. New data is being collected. Results from field data collection and model selection in 2012 report summary, see web for report and 2 appendices (http://www.susitna-watanahydro.org/wp-content/uploads/2013/03/2012_WaterQuality_TM.pdf). 2012-2013. Review data from Gold Creek. Note significant milestones from 2013 field season data. See current study plan (RSP 5.5 – Baseline Water Quality Study). Confirm with R. Plotnikoff that we can get modeled velocity data for reservoir, understand what info will be provided. Currents through reservoir, confirm data and presentation.
P2	Water quality & water temperature above & below proposed dam	Same as above. Look for surrogate sites, similar lakes, smaller tributaries, etc. D. Schmidt will investigate and report on status (exists, or no data). Goal by January 8, 2014.
P3	Tailwater Rating curves at dam and expected trap location	Forebay rating information is in Item P5 below. 1980's data. Use to start. Updates with new survey data will likely available by December, 2013. Draft tailwater rating curve provided to FPTWG on April 22, 2013.
P4	Flow duration by month, through turbines, spillways, other outlets	From operations modeling. J. Haapala provided summary of all duration flows with spreadsheet; presented May 21, 2013. Data provided for Operational Scenario (OS) OS-1. AEA to provide feedback on other run scenarios (i.e., run of river). When can we get other runs to fill in sideboards? (note action item for AEA).
P5	Reservoir elevation duration curves by month	From operations modeling. Have data for OS-1. Could have other data for other Operational Runs, see P4 also. Draft curves provided to FPTWG on April 22. To be posted to web.
P6	Other project operations data (rule curve, expected operating restrictions)	See Items P4 and P5 – relates to what operational scenarios are going to be run. Need input from AEA.
P7	Ice cover on river and tributaries in project area before project	Ice conditions annually Oct-May. See RSP 7.6 - Ice Processes in the Susitna River Study. Request more of an annual summary of typical seasonal ice issues, access, etc. at the tributaries of interest. Biological component to correlate with life cycle by species.
P8	Ice cover on reservoir and in river below dam	Dana S. to search for analogous reservoirs for Kokanee, etc. Will have ice model from WQ study, R. Plotnikoff will give update on model study, see action items. Pending.
P9	Water temperatures during upstream migration period	See WQ Study (P1), more data will be coming. Coordinate with climate change studies. Goal is to define range potentials in the future to assure fish passage design is flexible, can be expanded, can function over range, etc. So design won't be obsolete, etc. Add this item to several items, revisit off line.
P10	Water temperatures during downstream migration period	See WQ Study (P1), more data will be coming.
P11	Air temperature, wind, light, MET station info information by month (max, min, average)	Estimate fetch, etc. from available data. Some data likely available in the fall of 2013.

No.	Item	Comments
P12	Sediment information (transport rates, sediment gradation, sediment sources & their location)	2012 Report on Project website – Documents – 2012 Environmental Studies (http://www.susitna-watanahydro.org/wp-content/uploads/2013/03/SuWa-2012-Sediment-Report.pdf). Tributaries: modeling potential for perching and barrier potential at mouths. Model scheduled to be completed 2014. Sediment data being collected this summer. Be aware of ISR/USR, quarterly data updates. Ask B. Fullerton to send provisional data to this group. Prioritize tributary data.
P13	River morphology trends after project operation	Model results in 2014. Fluvial Geomorphology Modeling below Watana Dam Study (6.6) RSP (http://www.susitna-watanahydro.org/wp-content/uploads/2012/12/02-RSP-Dec2012_2of8-Sec-6-Geomorphology-v2.pdf).
P14	Topographic mapping of the project site and along river downstream. Tsusena Creek.	Fish passage will be sketched on these sheets. D. Dorratcague, D. Postlewait, D. Turner – to refine this data need. Request centerline profiles for any available tributaries upstream and downstream of dam. Use best available data. Check with J. Zablotney, GIS. Get available cross section data – D. Dorratcague.
P15	Current dam layout drawings, plans, elevations, and cross sections (include details of outlet works and spillways)	Fish passage will be sketched on these sheets. Prefer simplified, scale drawings with a plan, section, and elevation suitable for brainstorm sketching in 11x17 format. Any 3D drawings showing general arrangement would also be helpful. This is CEII information. FPTWG participants were asked to sign CEII forms for access to copies of this data. Data presented at this point in time, note overall dam design schedule.
P16	Makeup of project components – turbines (number & type), outlet valves & gates	See Aled Hughe's (MWH) presentation and updated plan view of Watana Dam provided by MWH on 9/4/2013. This is CEII information. FPTWG participants were asked to sign CEII forms for access to copies of this data.
P17	Projected operation of project turbines, gates, & valves	Turbines operate to meet Railbelt loads and minimum flow requirements. Fixed-cone valves operate to control floods up to about the 1 in 50 year event. The gated spillway operates for floods greater than about the 1 in 50 year event. Refinements to this operation are to be determined. Operations data presented based on 3 turbine arrangement.
P18	Site access or restrictions to access for operation and maintenance. Include entire project area at dam, along reservoir, and into tributaries (i.e., existing or planned access roads)	Three potential corridors are under study for access to the dam.
P19	Electrical power availability	FPTWG can provide more info later on load requirements. Substation will be on hill, right abutment.
P20	Amounts and types of debris expected in the reservoir	The Large Woody Debris component of the Geomorphology Study (RSP Section 6.5.4.9) will be assessing large woody debris loading in the Susitna River, including estimated input to the reservoir during project operation. Additional information can be provided as needed from Kathy Dubé.
P21	Amounts and types of debris expected below the dam	Same as Item P20. Potential for passing from reservoir above. LWD, etc. Potential to move LWD below dam, burn management, etc.

No.	Item	Comments
P22	Location downstream of any barrier and trap & haul locations, stress release ponds, adult release locations, etc.	Review mapping and identify any additional needs. Ask MWH dam designers for their opinions.
P23	Other data which you feel are important to fish passage	Possibility of establishing a natural fishway at Tsusena creek.
P24	Tributary flow data	Tributary stage data will be collected in 2013 field season. Rating curves to convert stage to flow will be developed in 2014 as part of RSP 8.5 Instream Flow.
P25	Tributary trap access data. Consider also for Adult release sites.	No roads or plans for roads exist. Understand planned roads at this point in time. This group can advise more on needs concurrent with brainstorm session.
P26	Seepage study, right abutment	Groundwater-related Aquatic Habitat Study (7.5) RSP - http://www.susitna-watanahydro.org/wp-content/uploads/2012/12/03-RSP-Dec2012_3of8-Sec-7-8-HydrologythroughInstreamFlowStudies-v2.pdf
P27	Glacier outburst floods	Glacial and Runoff Changes Study (7.7) RSP - http://www.susitna-watanahydro.org/wp-content/uploads/2012/12/03-RSP-Dec2012_3of8-Sec-7-8-HydrologythroughInstreamFlowStudies-v2.pdf
P28	Foundation condition, bank stability near ladders, etc.	Coordinate with geotechnical studies

INFORMATION ITEM P1:
WATER QUALITY AND WATER TEMPERATURE CURRENT
CONDITIONS



SUSITNA-WATANA HYDROELECTRIC PROJECT

Fish and Aquatics TWG Fish Passage Workshop 1

April 9, 2013

Water Quality

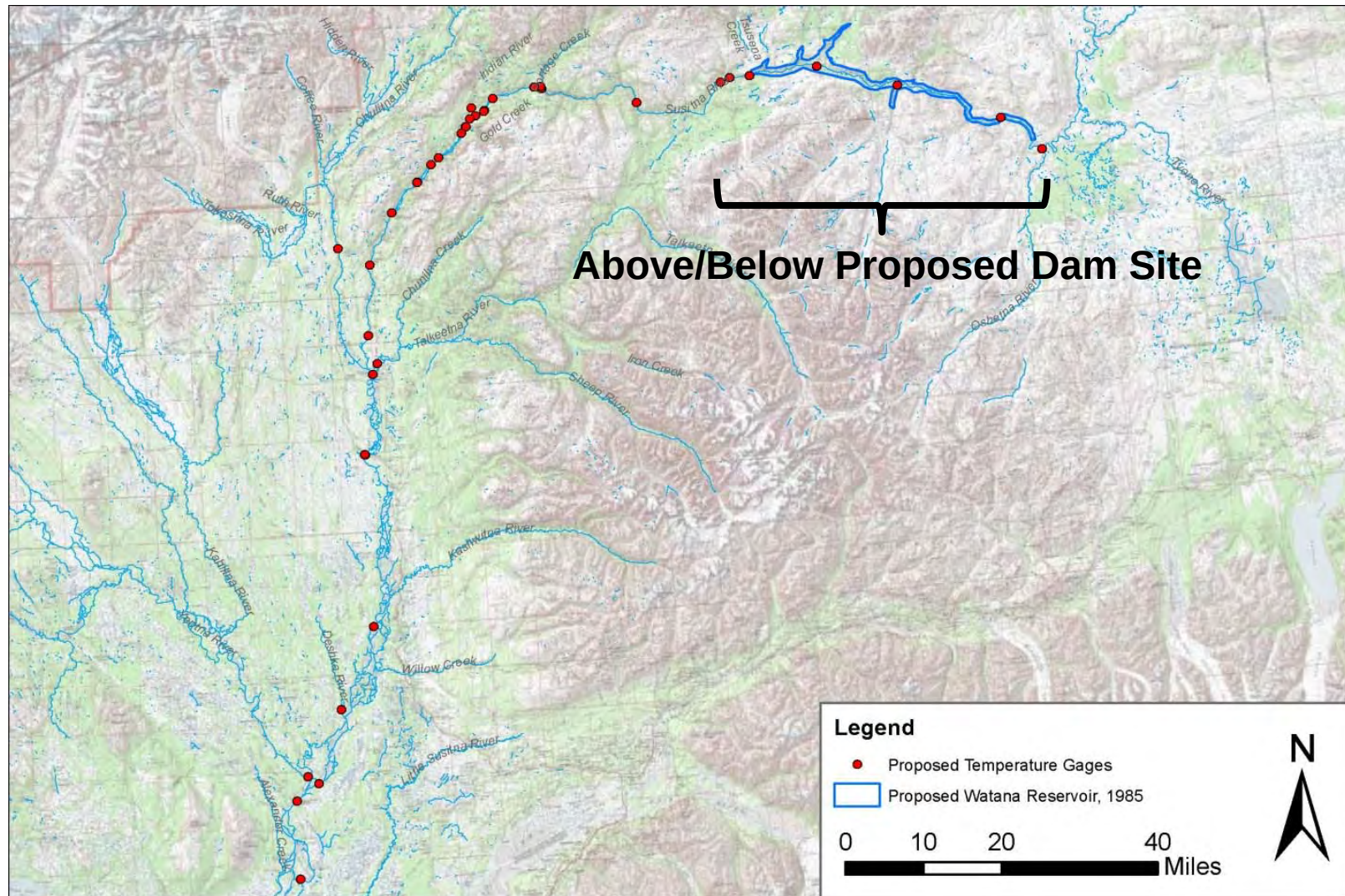




Water Resources Proposed Studies

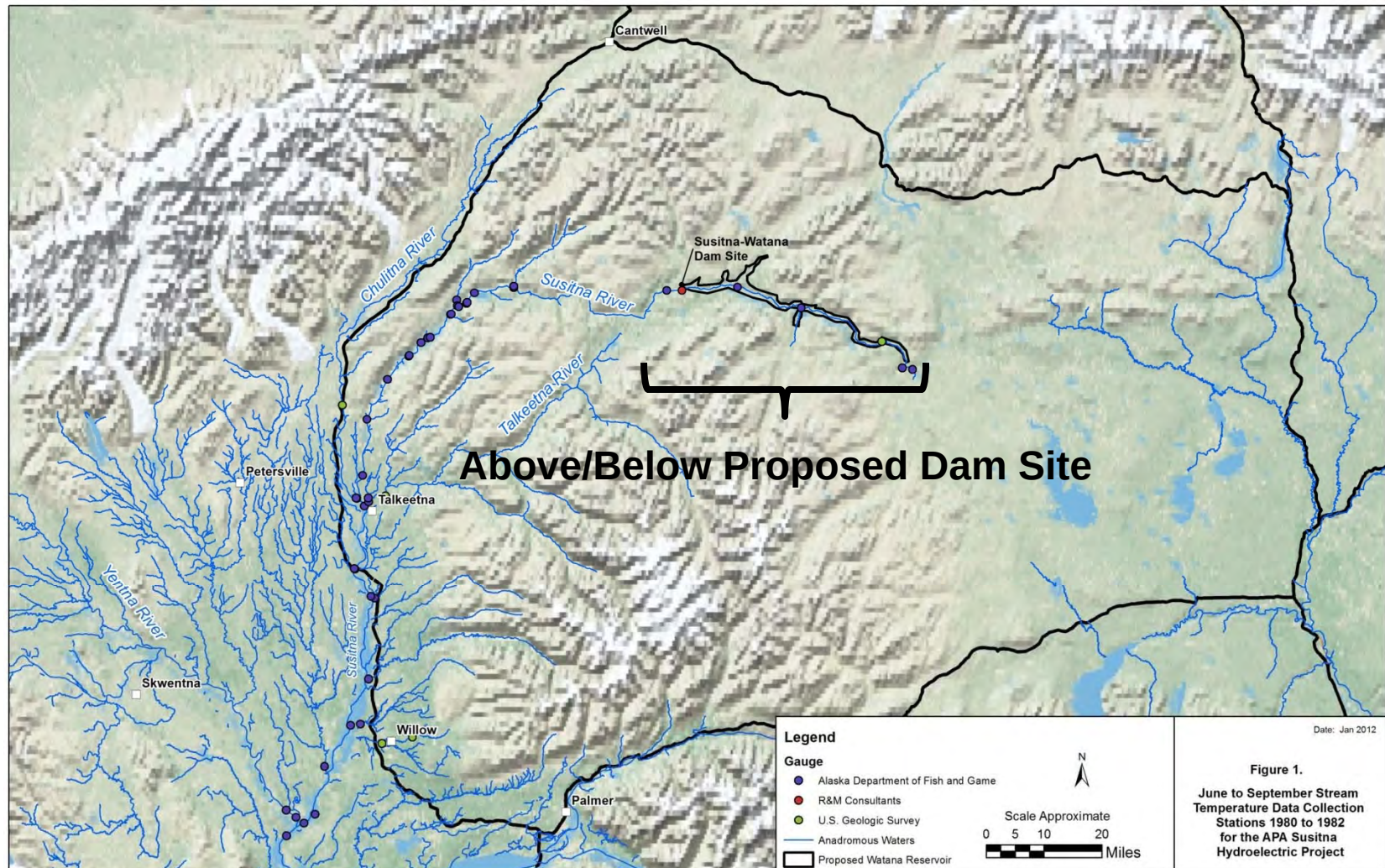
- Section 5.5 Baseline Water Quality Study
- Section 5.6 Water Quality Modeling Study
- Section 5.7 Mercury Assessment and Potential for Bioaccumulation Study

Water Quality Study Area 2012/2014



 **SUSITNA-WATANA**
HYDROELECTRIC PROJECT

Water Quality Study Area 1980/1982



Historic Water Quality

Station Name	Station Susitna River Mile	Most Recent Sample Date	Years of Record	Season	Temp (°C)	Suspended Sediment Discharge (ton/day)
Main stem Susitna at Watana Dam Site	184.2	10/16/85	1	Winter	NA	NA
	184.2	10/16/85	1	Spring	3.7-9.0	NA
	184.2	10/16/85	1	Summer	1.9-14.4	NA
	184.2	10/16/85	1	Fall	0-4.0	NA
Vee Canyon	223.1	7/30/86	24	Winter	0	19
	223.1	7/30/86	24	Spring	0-10	up to 175,000
	223.1	7/30/86	24	Summer	4.0-13	up to 196,000
	223.1	7/30/86	24	Fall	1-5.5	up to 2,070



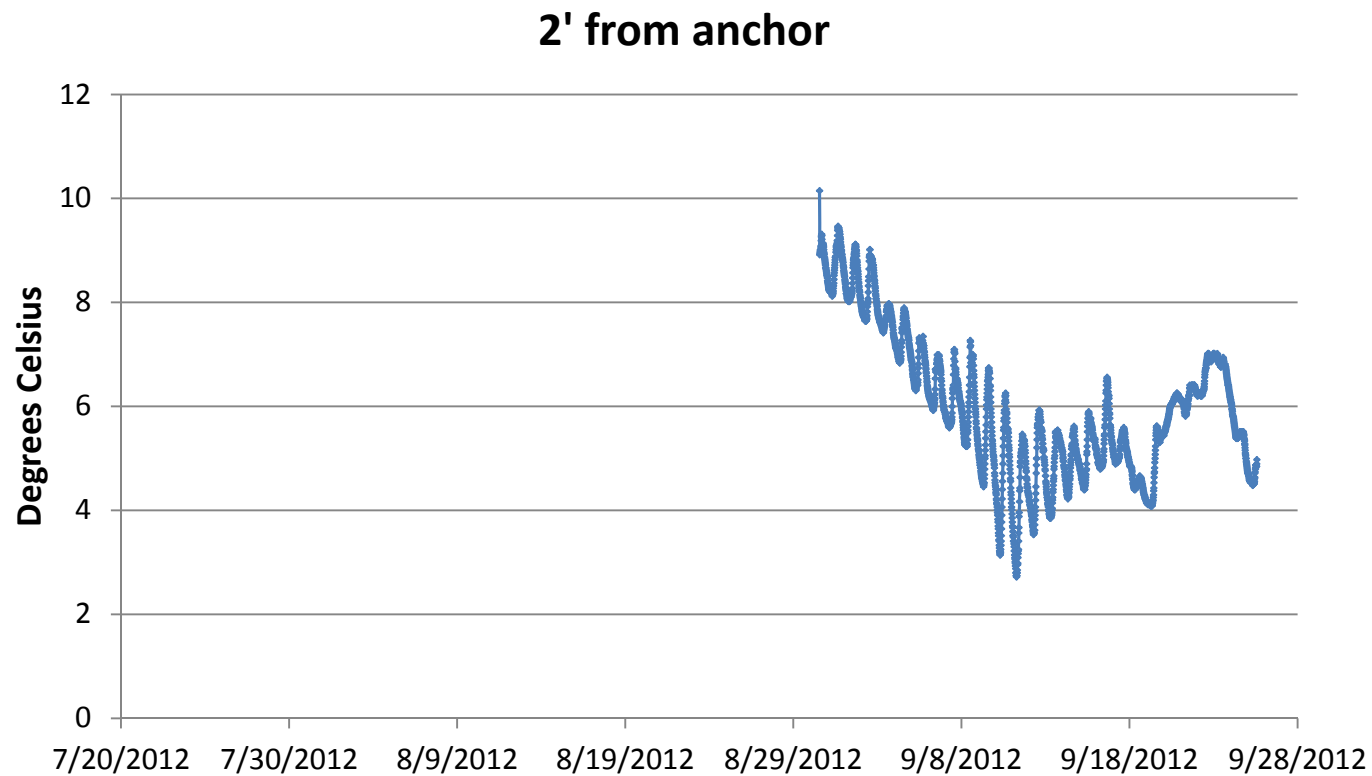
Current Water Quality

- Water Quality Monitoring Strategy
 - 39 sites from RM 15.1 to RM 233.4
 - Monthly site visits: June 2013- September 2013, December 2013, and March 2014
 - Parameter groups include: continuous temperature, in-situ, general water quality, and one-time surveys (e.g., bacteria, petroleum hydrocarbons, sediment, radionuclides, and toxic metals).
 - Media analyzed will include: surface water, sediment, and fish tissue

2012 Temperature Data: Above/Below Proposed Dam Site

Susitna River Mile	Site Description	Susitna River Slough ID	Latitude (decimal degrees)	Longitude (decimal degrees)
180.3 ¹	Susitna below Tsusena Creek	NA	62.8134	-148.6568
181.3 ³	Tsusena Creek	NA	62.8217	-148.6068
184.5 ¹	Susitna at Watana Dam site	NA	62.8226	-148.533
194.1	Watana Creek	NA	62.8296	-148.259
206.8	Kosina Creek	NA	62.7822	-147.94
223.7 ³	Susitna near Cantwell	NA	62.7052	147.538
233.4	Oshetna Creek	NA	62.6402	-147.383

Tributaries: RM206.8 Kosina Creek 2012 Temperature Data



RM206.8 Kosina Creek



Tributaries: RM233.4 Oshetna Creek

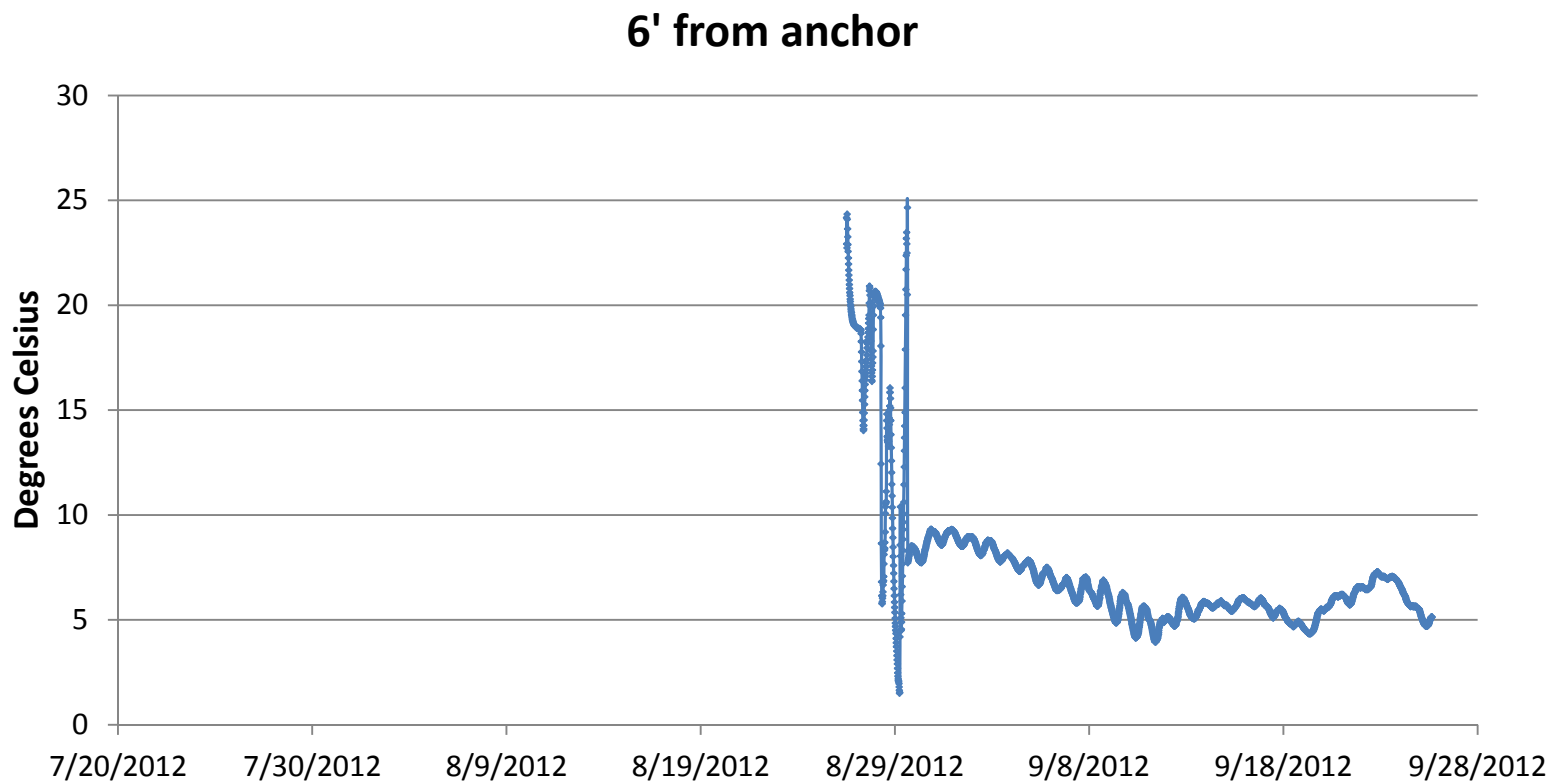
4' from anchor



RM233.4 Oshetna Creek



Mainstem: RM180.3 Susitna River below Tsusena Creek



RM180.3 Susitna River below Tsusena Creek





Water Quality Modeling: Approach and Output

- Reservoir Water Quality Model (EFDC)
 - 3-Dimensional Model
 - Prediction of vertical stratification in the reservoir when the dam is present
 - Nutrient and algae representation
 - Sediment transport (erosion, transport, settling/deposition)
 - Ability to represent metals concentrations
 - Integration between temperature and ice dynamics models



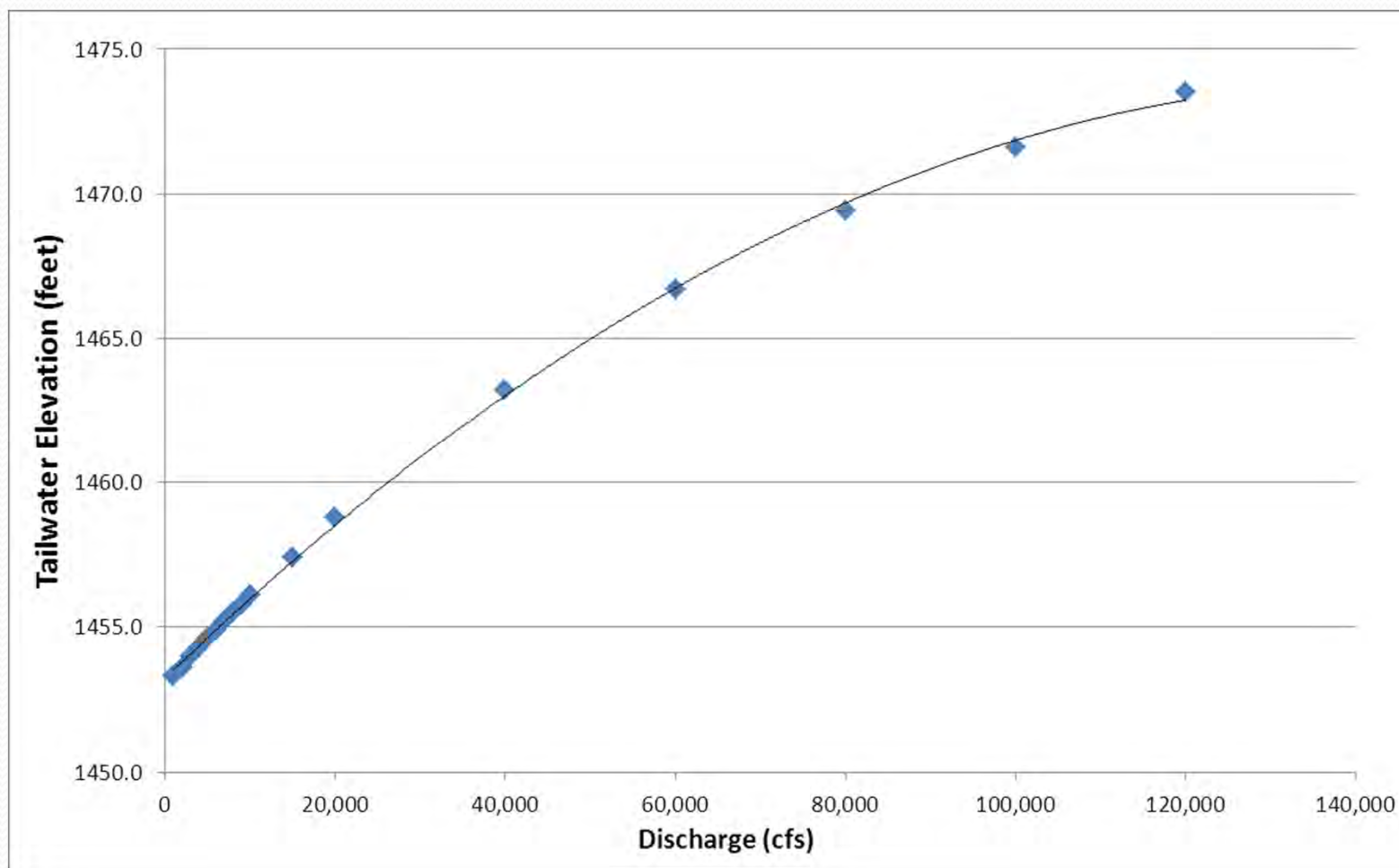
Water Quality Modeling: Approach and Output

- Riverine Water Quality Model (EFDC)
 - 2-Dimensional Model
 - Tightly coupled with the Reservoir Model
 - Boundary conditions of the Reservoir Model initial conditions for the Riverine Model
 - Riverine Model constructed/calibrated with and w/o the Reservoir Model
 - Output used by the following:
 - Ice Processes;
 - Productivity; and
 - Instream Flow studies

INFORMATION ITEM P2:
WATER QUALITY AND WATER TEMPERATURE FUTURE CONDITIONS
ABOVE AND BELOW WATANA DAM

INFORMATION ITEM P3:
TAILWATER RATING CURVES AT DAM
AND EXPECTED TRAP LOCATION

P3 – Tailwater Rating Curve Chart



From: March 2013, Fish Passage Workshop #1 Powerpoint by MWH

INFORMATION ITEM P4:
FLOW DURATION BY MONTH THROUGH TURBINES SPILLWAYS, AND
OTHER OUTLETS

Table 34: Calculated Flood Frequency for the Susitna River at Susitna Station

Return Period (Years)	Flow (cfs)
2	187,000
5	223,000
10	247,000
25	280,000
50	305,000
100	331,000
200	357,000
500	393,000
1,000	419,000
10,000	508,000

Peak flows were estimated for return periods up to 10,000 years at the Watana dam site by transposing peak flow analysis results at Gold Creek to Watana according to the following equation:

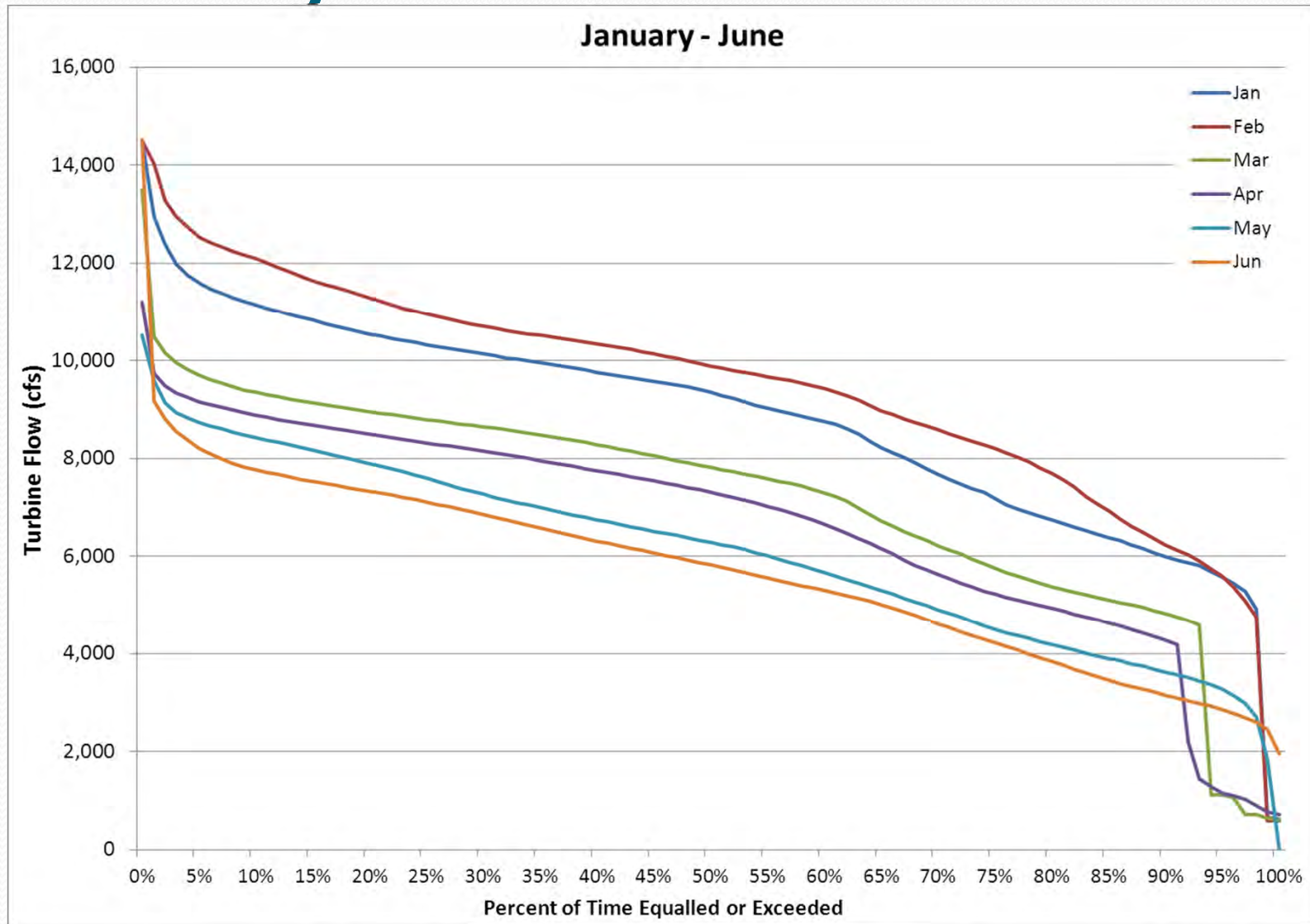
$$Q_{Watana} = Q_{Gold\ Creek} \times \left(\frac{A_{Watana}}{A_{Gold\ Creek}} \right)^{0.86}$$

where A is the drainage area for each site. The exponent in this equation was selected as the value that minimized the percent error between the calculated peak flows at Cantwell presented in Table 27 and the estimated peak flows that resulted from transposing the calculated peak flows at Gold Creek to Cantwell.

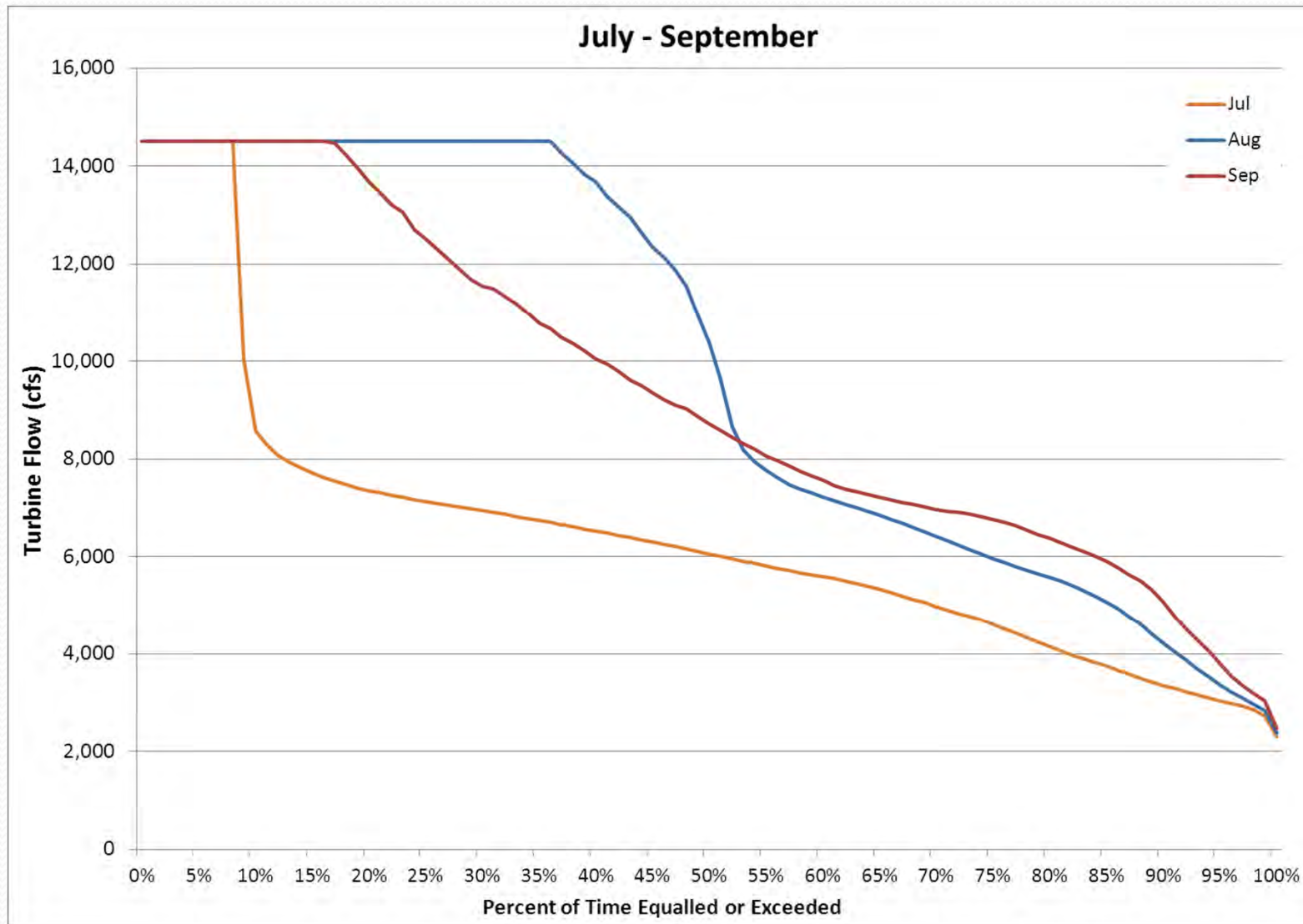
Table 35: Estimated Peak Annual Flows in the Susitna River at Watana

Return Period (Years)	Peak Flow (cfs)
2	37,900
5	49,200
10	57,400
25	68,500
50	77,400
100	86,600
200	96,300
500	110,000
1,000	120,000
10,000	155,000

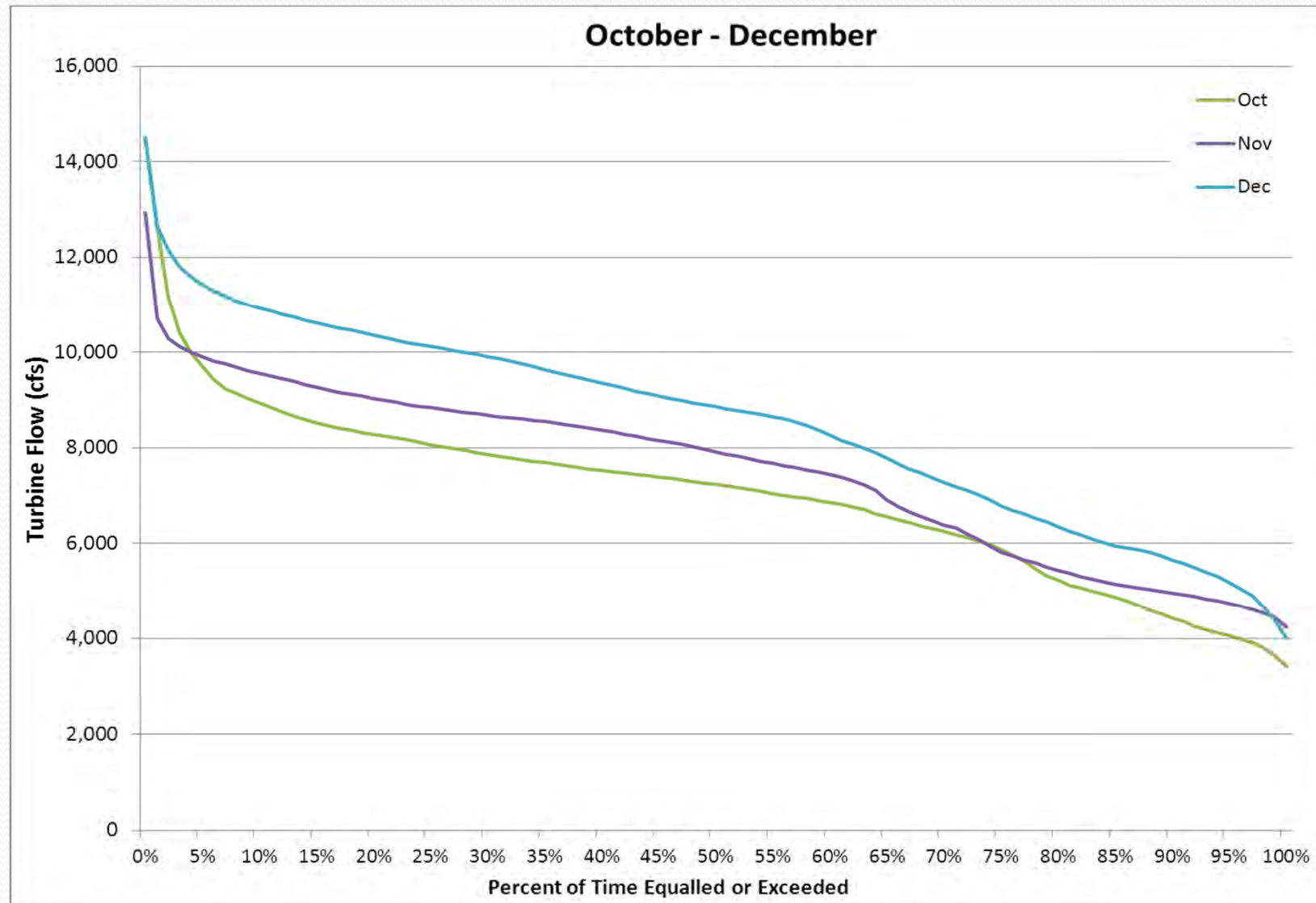
P4 – Monthly Flow Duration Curves – Turbines



P4 – Monthly Flow Duration Curves- Turbines



P4 – Monthly Flow Duration Curves - Turbines



Response to FERC Order

Susitna River Pre-Project and Maximum Load Following Operational Scenario 1 Stages

Open Water HEC-RAS Flow Routing Model *Version 1*

1 February 2013

Prepared by: R2 Resource
Consultants, GW Scientific,
Brailey Hydrologic,
and Geovera



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DRAFT – FOR DISCUSSION PURPOSES ONLY

Background

2

- A hydrologic routing model (HEC-ResSim) was previously developed to analyze stages in the Susitna River between Devils Canyon and Sunshine Gage .
- The HEC-ResSim model was used to analyze Pre-Project and Maximum Load Following Operational Scenario 1 (OS-1) conditions during calendar year 1984.
- Input to the HEC-ResSim model included hourly flow releases from the proposed Watana Dam site (Project River Mile (PRM) 187.2.
- Results were presented at the October 23-25, 2012 Technical Workgroup meetings.

Maximum Load Following OS-1

3

- Based on the assumption that the load fluctuation of the entire Railbelt would be provided by the Susitna-Watana Project, and that all other sources of electrical power in the Railbelt would be running at base load.
- This assumed condition is not realistic for an entire year, and the results of this condition should be conservative with respect to assessing downstream stage changes.

Current Update

4

- A hydraulic flow routing model (HEC-RAS) was developed of the Susitna River from the proposed Watana Dam site downstream to PRM 80.0 (7 miles downstream from Sunshine Gage).
- Version 1 of the HEC-RAS model was developed and calibrated using data collected in 2012.
- Results of the HEC-RAS model are shown using same 1984 Pre- and Post-Project dam release hydrographs that were used in the previous HEC-ResSim study.

Hydrologic Versus Hydraulic Flow Routing

5

- Hydrologic flow routing (as is used in HEC-ResSim) is used to route flows through a river and predict downstream flow hydrographs. A corresponding stage hydrograph can be developed at a particular location if a stage/discharge rating curve is available.
- Hydraulic flow routing (as is used in HEC-RAS) uses the momentum equation to route flows through a river and directly predict both flow and stage hydrographs at downstream locations of interest.

- The HEC-RAS flow routing model is appropriate for analyzing stage and flow fluctuations under ice-free conditions.
- An ice processes flow routing model is currently being developed to analyze stage and flow fluctuations under ice-affected conditions.
- Actual results during the winter may differ from those presented herein as a result of ice formation on the river.

Downstream Stages with 15-Minute Flow Routing Basis and Assumptions

7

- HEC-RAS model developed from 88 cross-sections surveyed on the Susitna River in 2012 from PRM 187.2 to PRM 80.0.
- Steady-state calibration focused on matching 170 pairs of flows and water surface elevations measured in 2012.
- Unsteady-state calibration focused on matching flow hydrographs during the week of August 11 to 17, 2012.
- Unsteady-state validation performed during the period from June 4 to October 14, 2012.

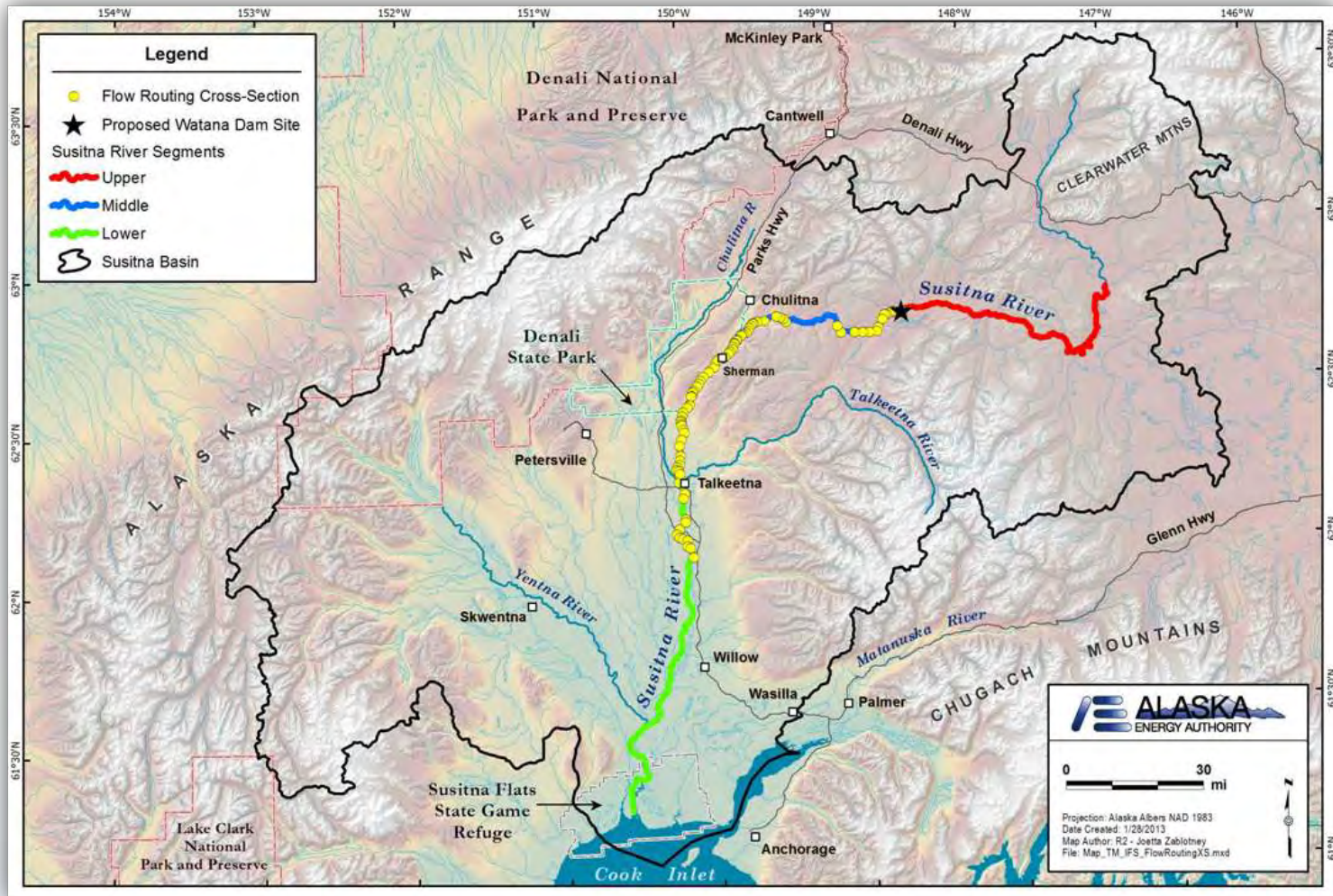
Open Water Flow Routing Model

8

- HEC-RAS model developed from 88 cross-sections surveyed on the Susitna River in 2012 from PRM 187.2 to PRM 80.0.
- Additional river cross-sections were interpolated for reasons of numerical stability under unsteady flows conditions (especially through Devils Canyon).

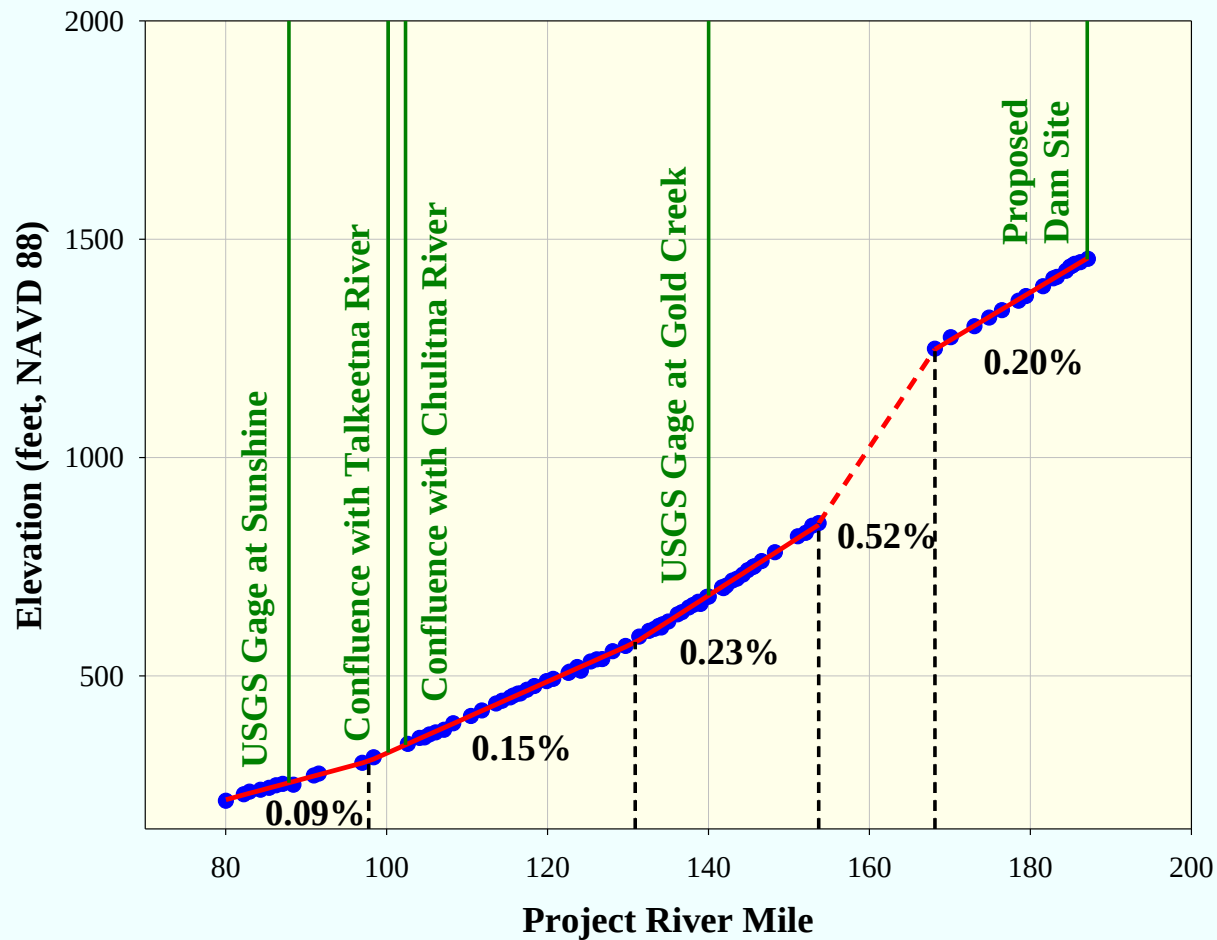
Cross-Sections Surveyed in 2012

9



Longitudinal Thalweg Profile

10

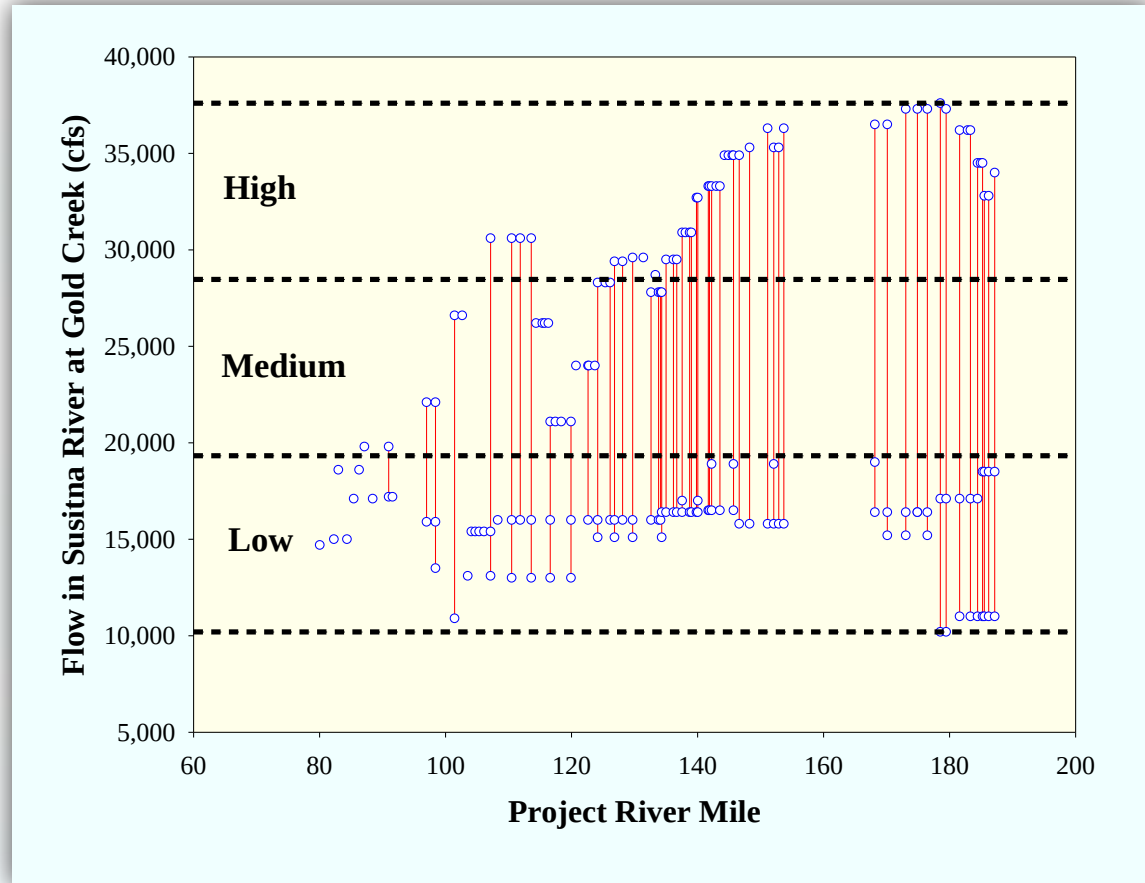


- Steady-state calibration focused on matching 170 pairs of flows and water surface elevations measured in 2012.
- Calibration was performed by selecting reasonable values of Manning's "n" and by adjusting the morphology of interpolated cross-sections.
- Predicted water surface elevations matched observed water surface elevations to within plus or minus 0.2 feet.

Flows Measured in 2012

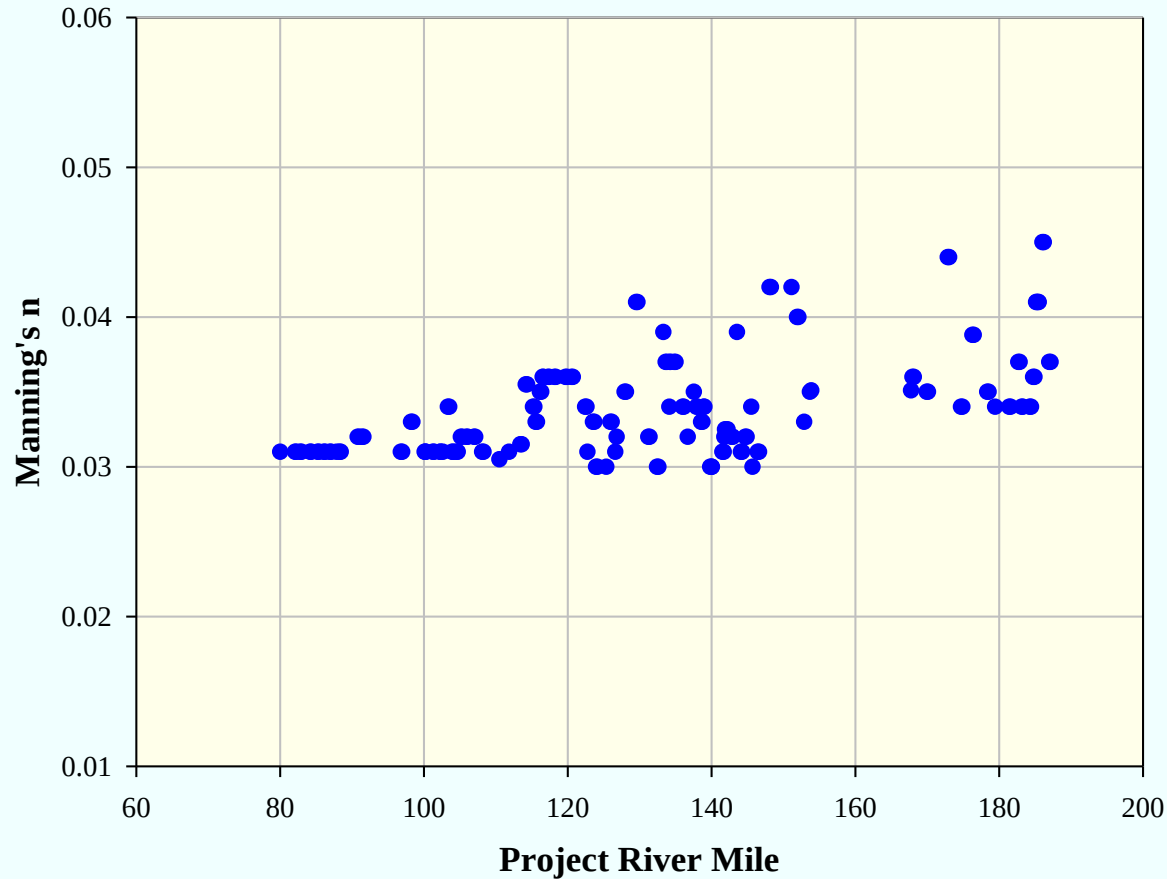
Classified as Low, Medium, or High Based on Concurrent Flows at Gold Creek

12



Steady State Calibration Hydraulic Roughness

13



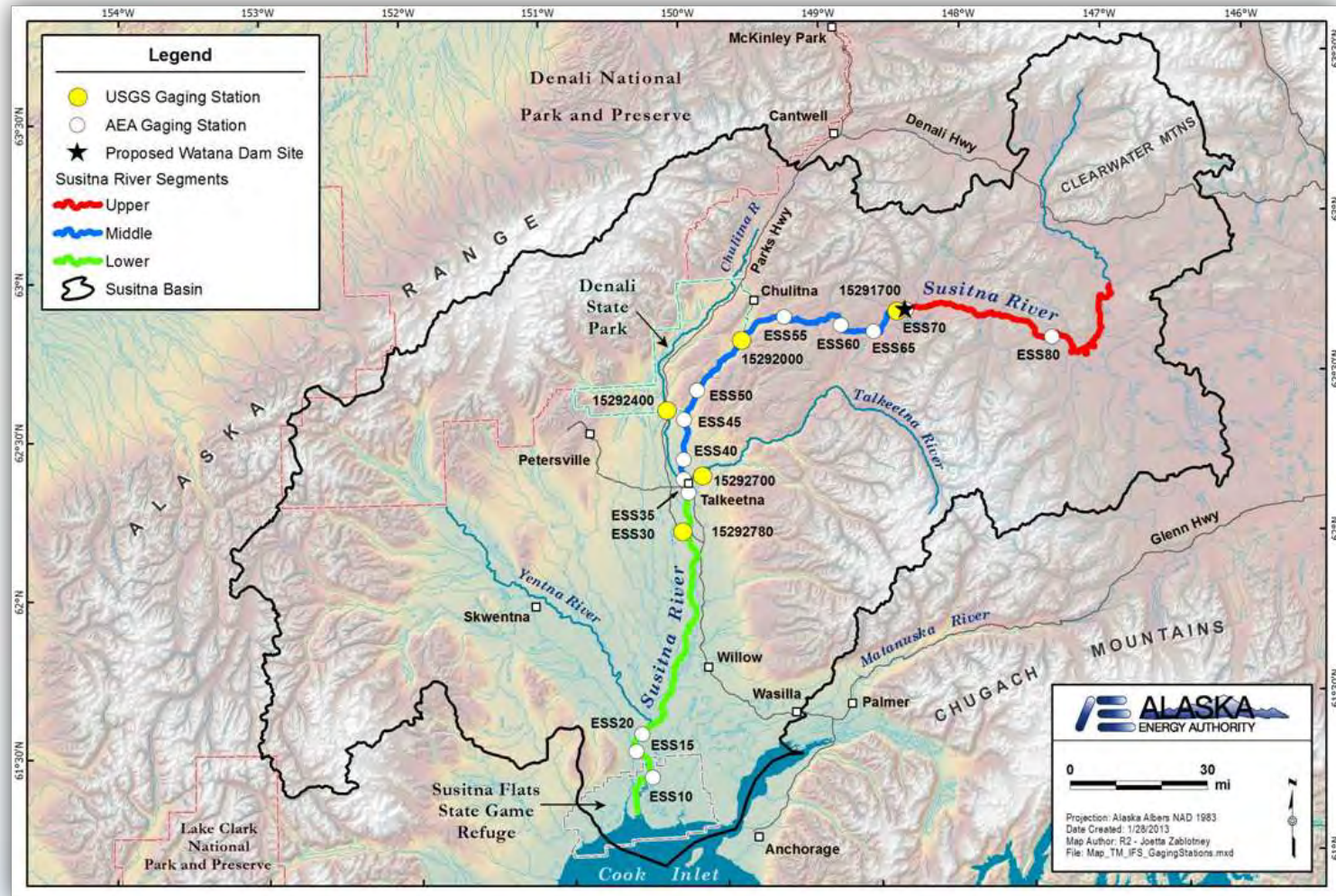
Unsteady-State Calibration

14

- Focused on week of August 11 to 17, 2012 when diurnal pulses occurred as a result of glacial melt
- Calibration relied on flows measured by the US Geological Survey
- Calibration was focused on matching the arrival time of pulses at Gold Creek and Sunshine
- To accelerate the arrival of pulses, upstream interpolated cross-sections were made narrower.
- To decelerate the arrival of pulses, upstream interpolated cross-sections were made wider.

Gaging Station Locations

15

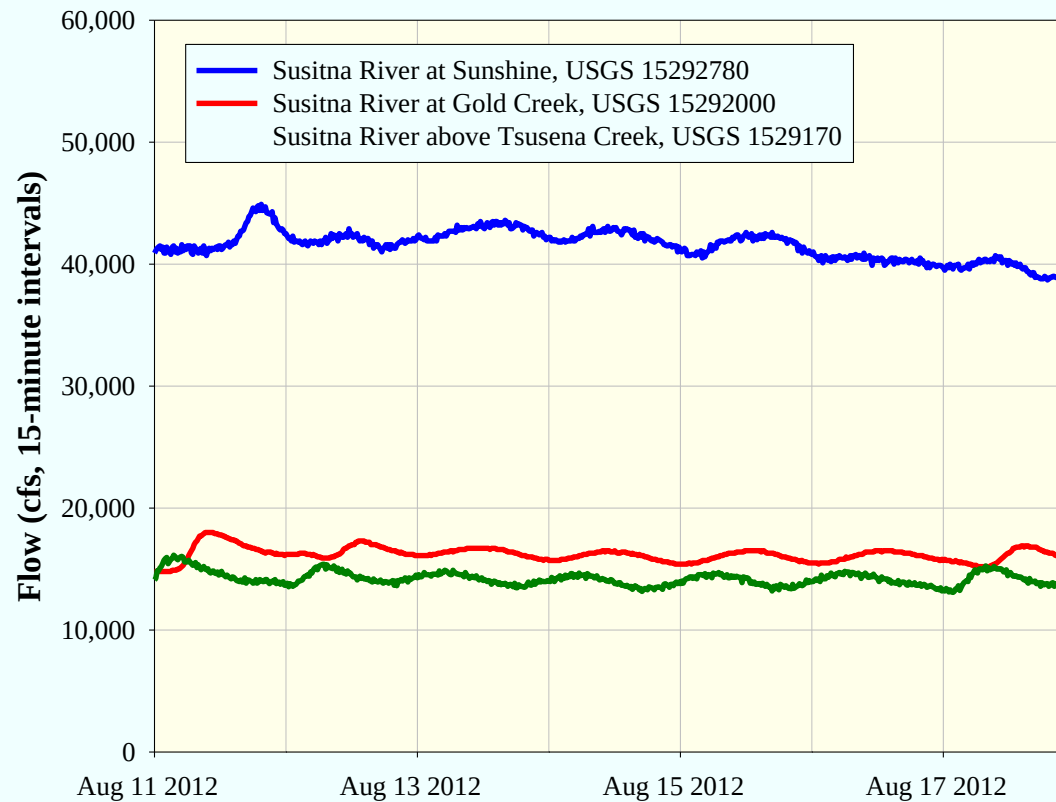


Unsteady-State Calibration

15-Minute Flows in Susitna River

August 11 to 17, 2012

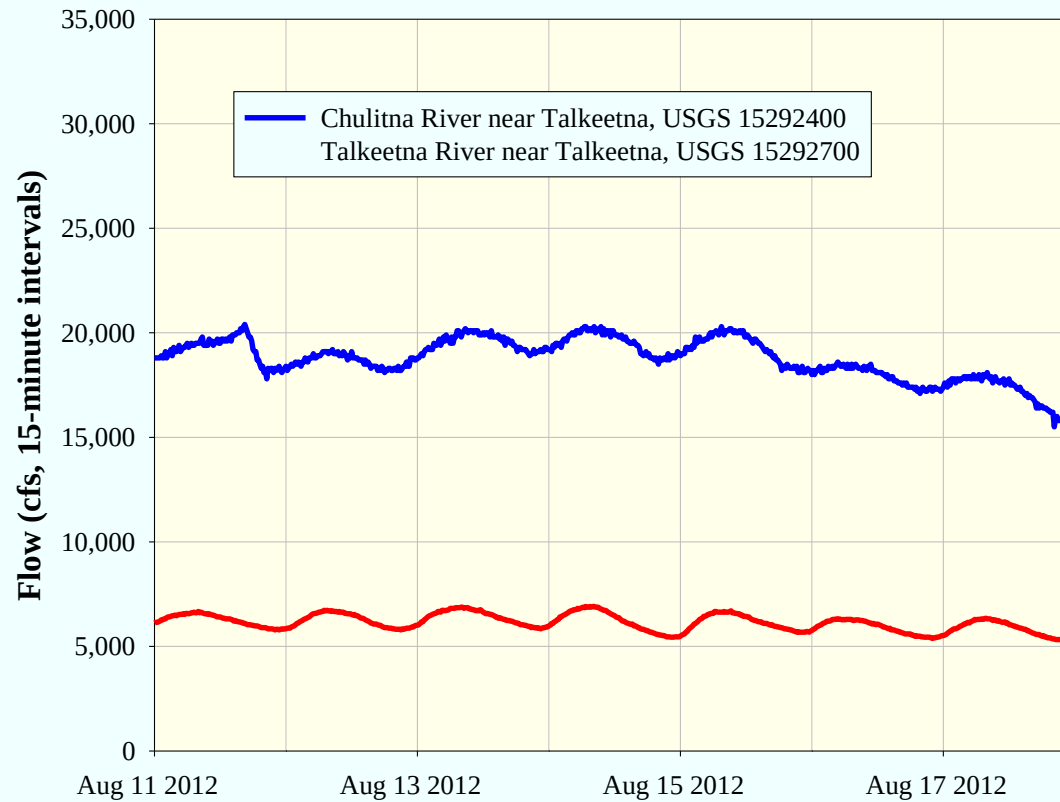
16



Unsteady-State Calibration

15-Minute Flows in Tributaries of the Susitna River – August 11 to 17, 2012

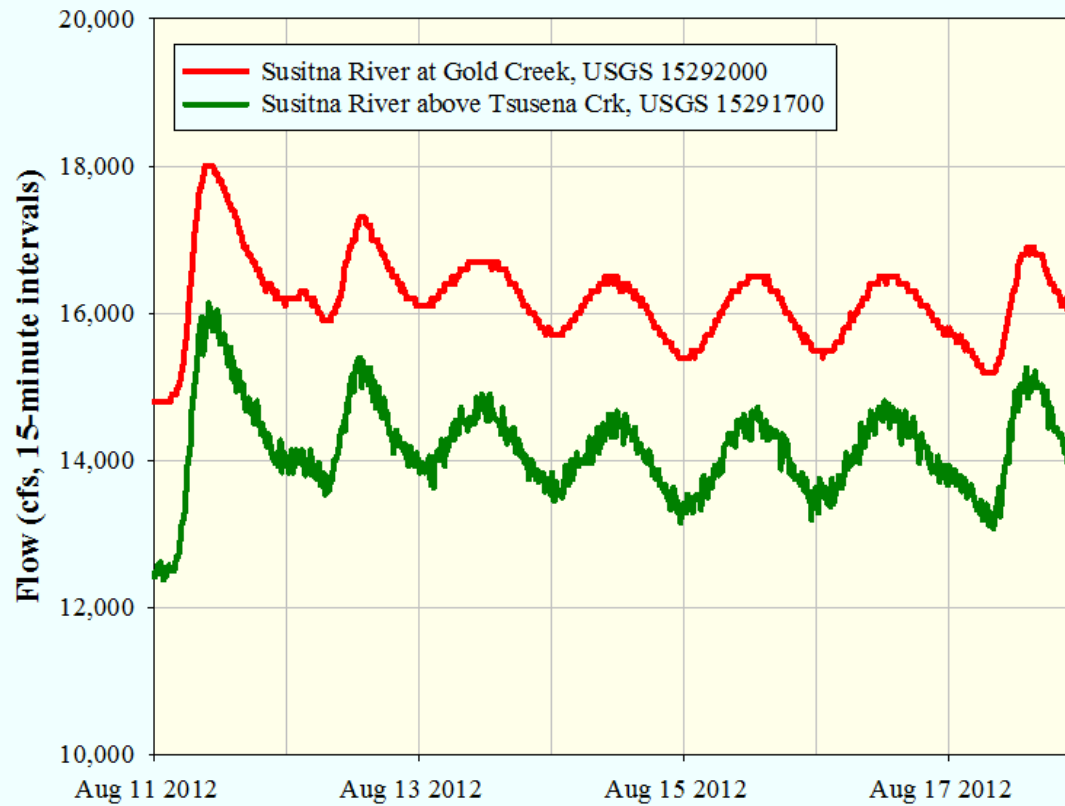
17



Unsteady-State Calibration

Flows above Tsusena Creek Shifted Forward by 6.4 Hours

18



Propagation of Diurnal Pulses Between Tsusena Creek and Gold Creek

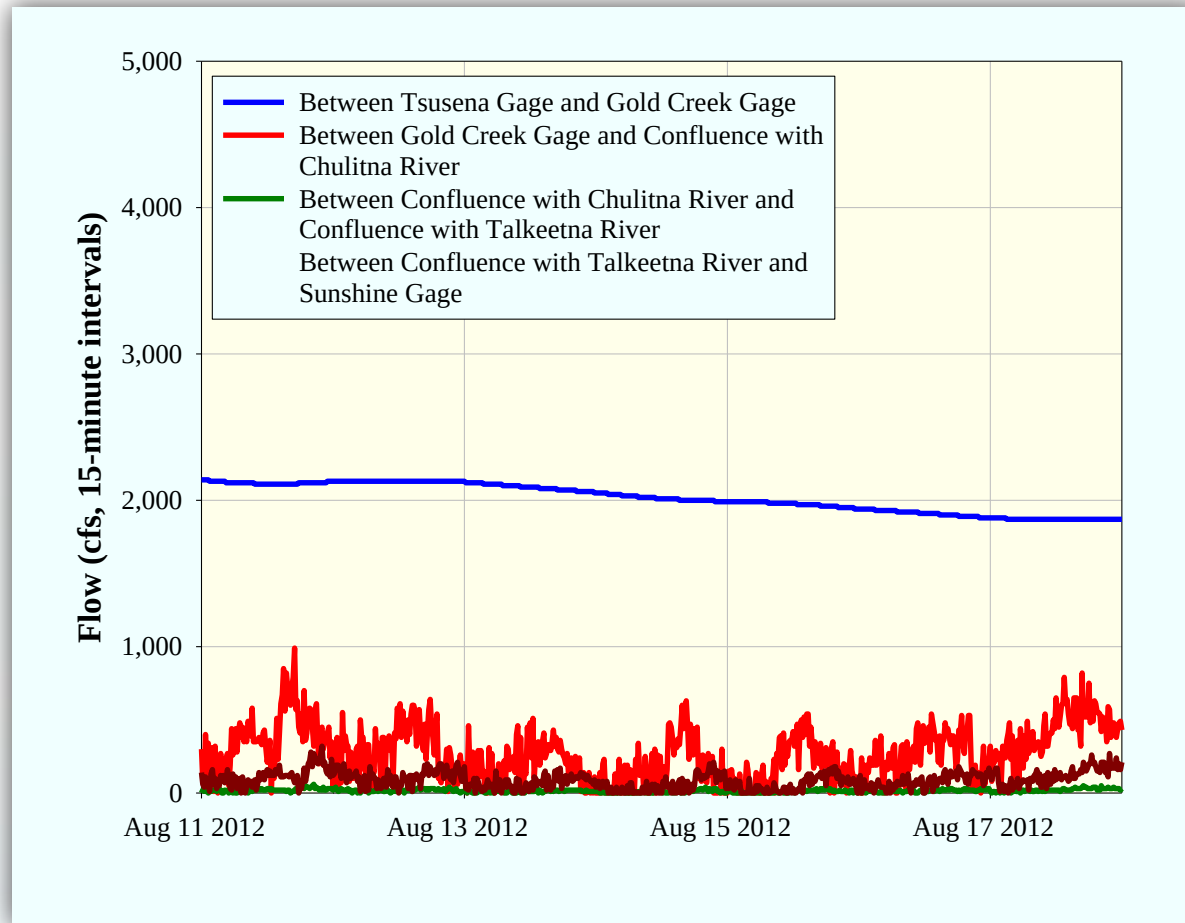
19

- Pulses traveled 47.2 miles in 6.4 hours
- Speed of propagation, or celerity, was 7.4 miles per hour or 10.8 feet per second
- Celerity should be 1.25 to 1.50 times the channel flow velocity (Linsley 1975)
- Equivalent to average flow velocity of 7 to 9 feet per second, consistent with what was measured in 2012

Unsteady-State Calibration

15-Minute Ungaged Accretion Flows to the Susitna River – August 11 to 17, 2012

20



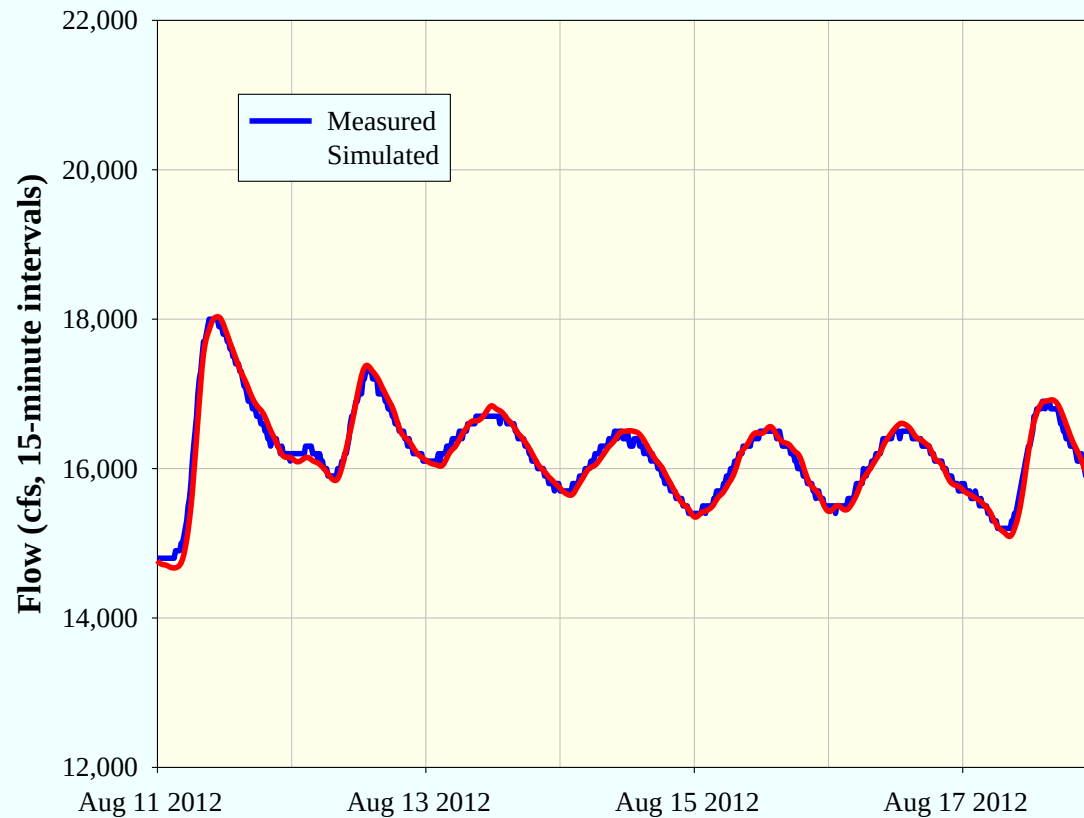
Selection of Computational Time Step

21

- For numerical stability and accurate results the computational time step should be less than the distance between cross-sections divided by the celerity
- Distance between cross-sections = 1,000 feet
- Celerity = 10.8 feet per second
- Time step should be less than 93 seconds
- Time step of one minute (60 seconds) was selected

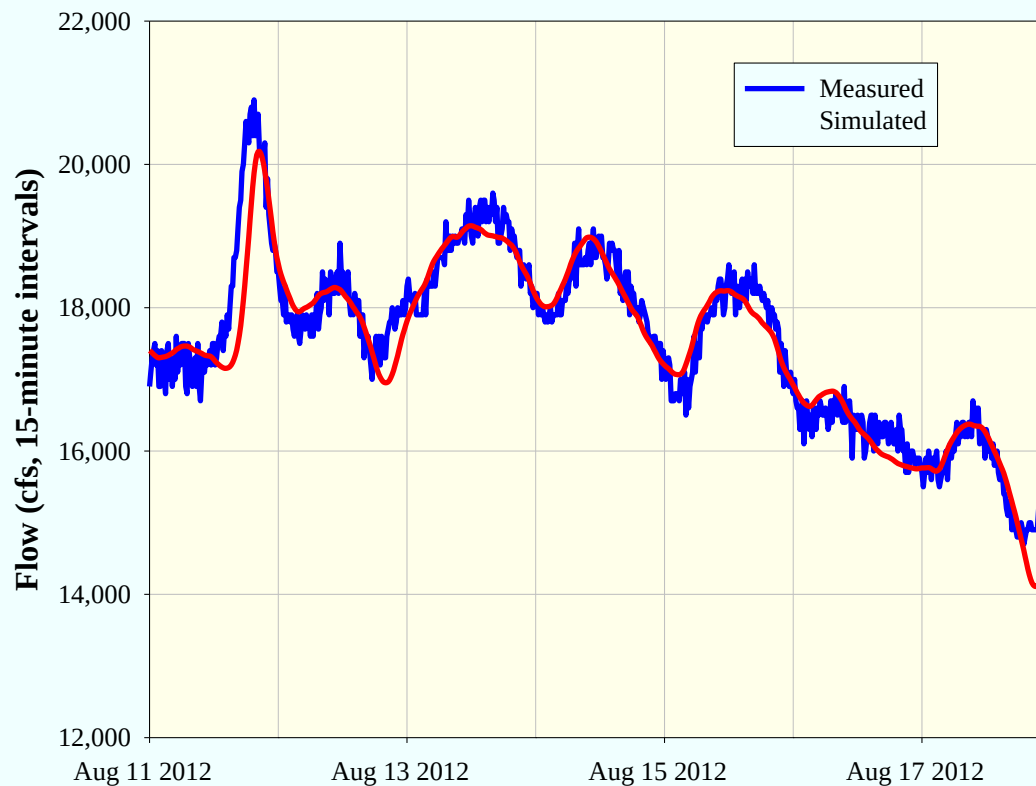
Unsteady Flow Calibration Results Susitna River at Gold Creek August 11 to 17, 2012

22



Unsteady Flow Calibration Results Susitna River at Sunshine August 11 to 17, 2012

23



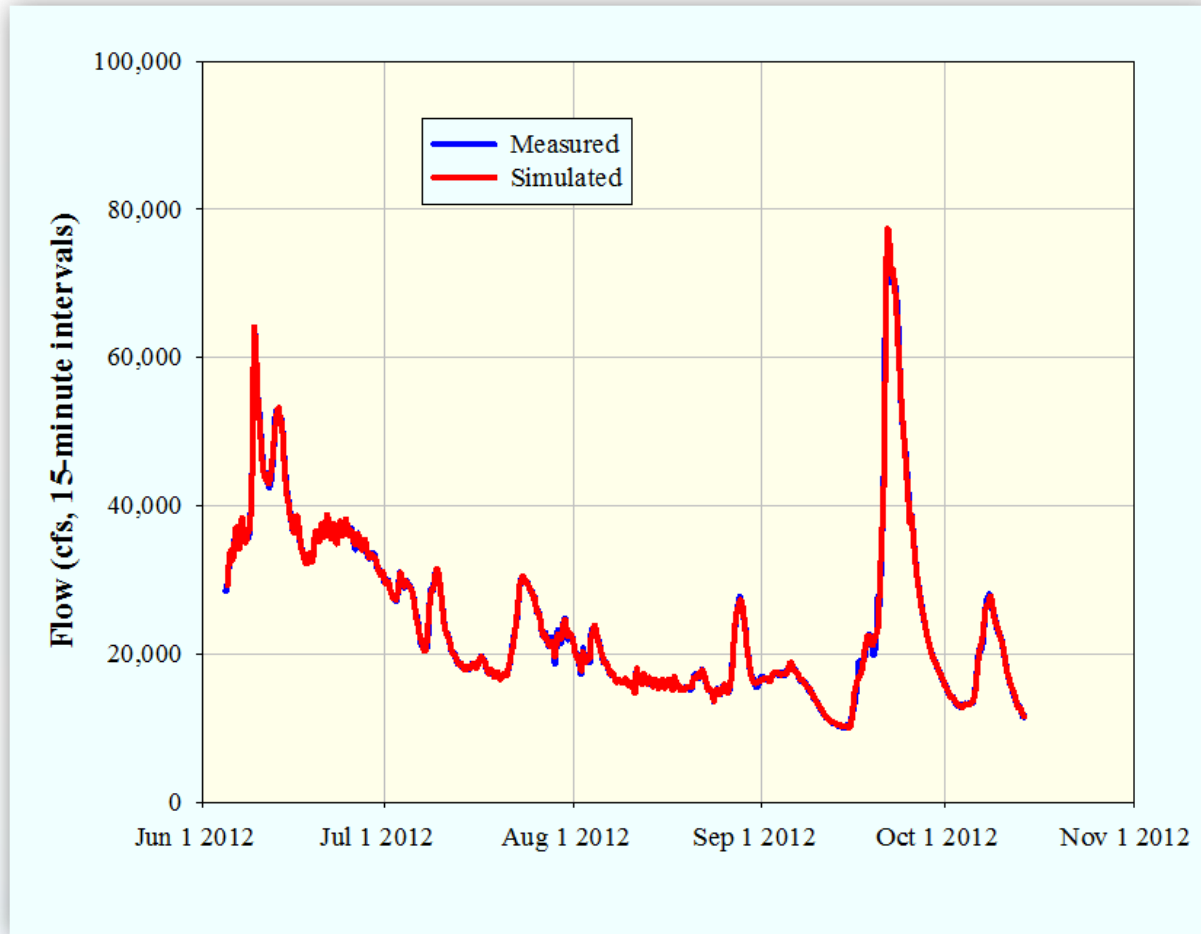
- The calibrated HEC-RAS model was then run for the period from June 4 to October 14, 2012.
- Good agreement between measured and simulated flow hydrographs was found for the Susitna River at Gold Creek Gage and Sunshine Gage over a wide range of flows (up to 200,000 cfs at Sunshine).

Model Validation

Susitna River at Gold Creek

June 4 to October 14, 2012

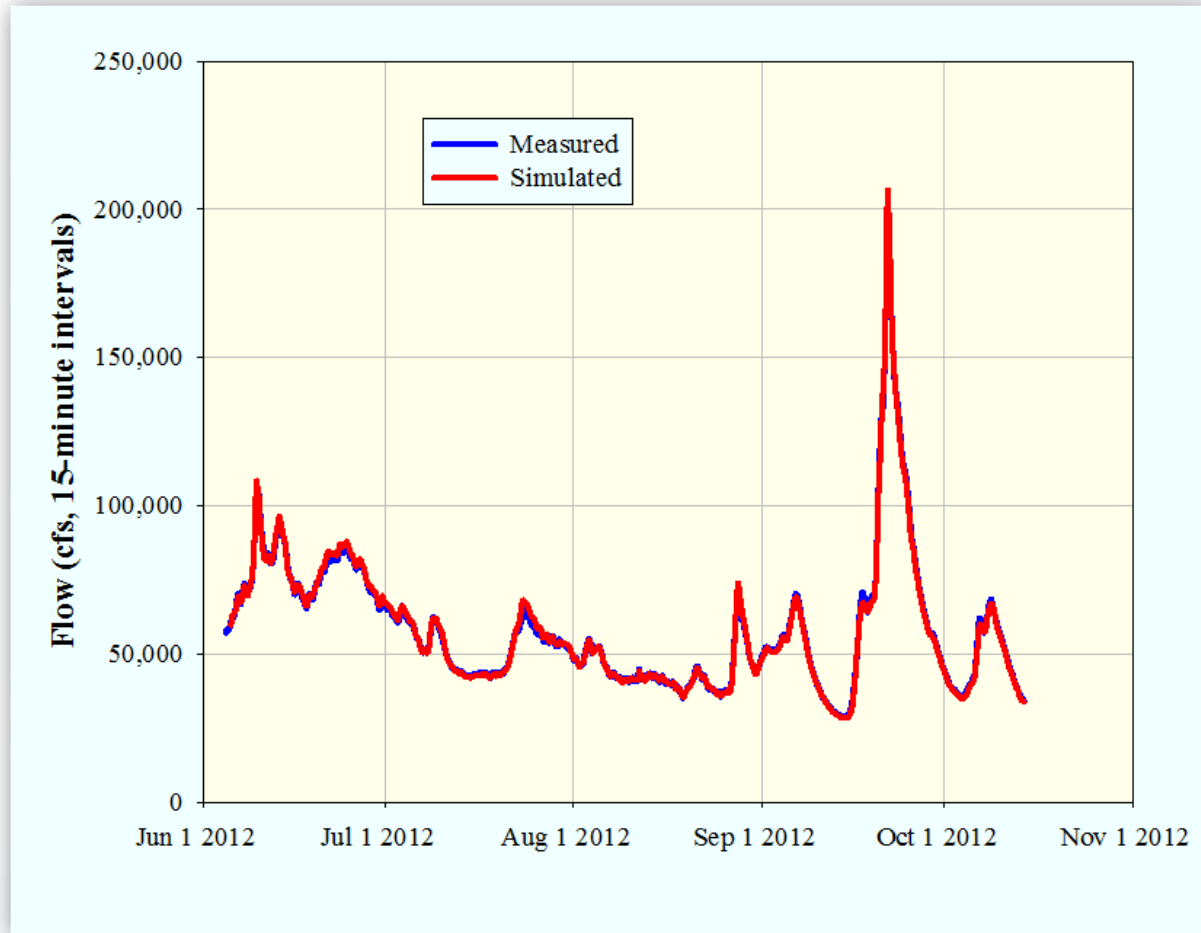
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Model Validation

Susitna River at Sunshine

June 4 to October 14, 2012



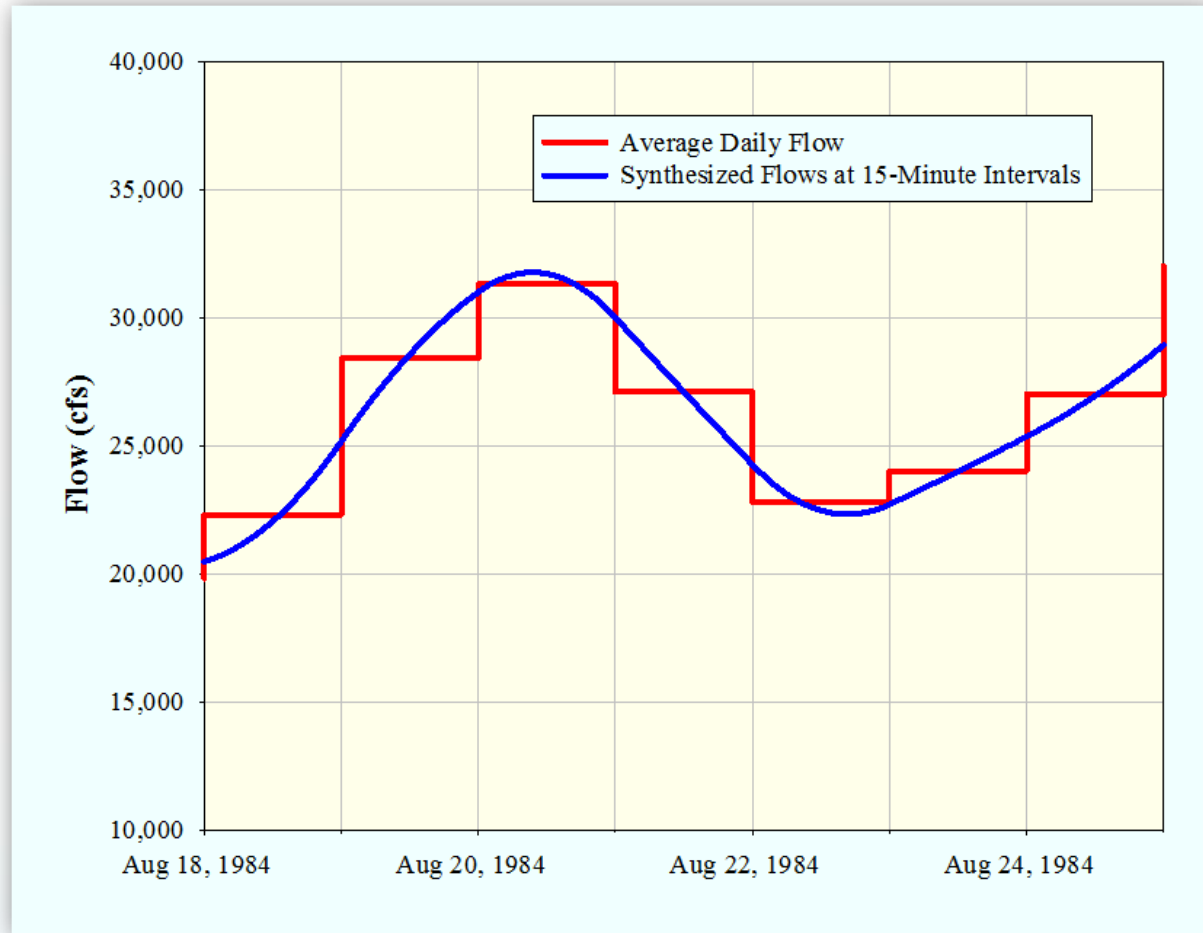
Effects of Proposed Project Operations

27

- The calibrated HEC-RAS model was then used to analyze Pre-Project and Maximum Load Following OS-1 conditions for calendar year 1984.
- Accretion flows downstream from the proposed dam site were derived from daily flows reported by the USGS.
- The daily flow hydrographs were converted to 15-minute flow hydrographs.
- The 15-minute flow hydrographs did not account for diurnal glacial melt fluctuations.
- During the winter, actual results may differ from those reported herein as a result of ice formation on the river

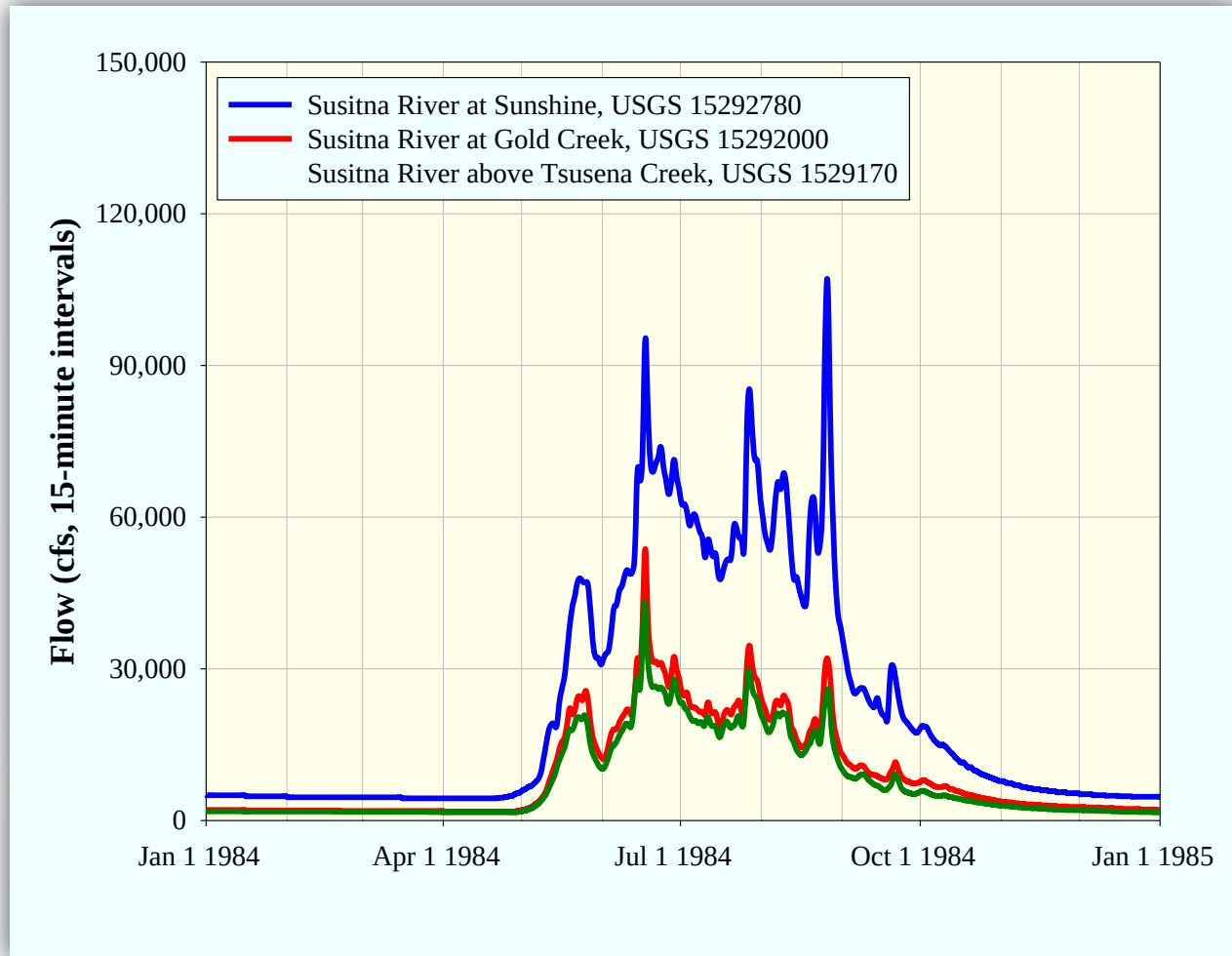
Derivation of 15-Minute Hydrograph from Daily Flows Reported for Chulitna River

28



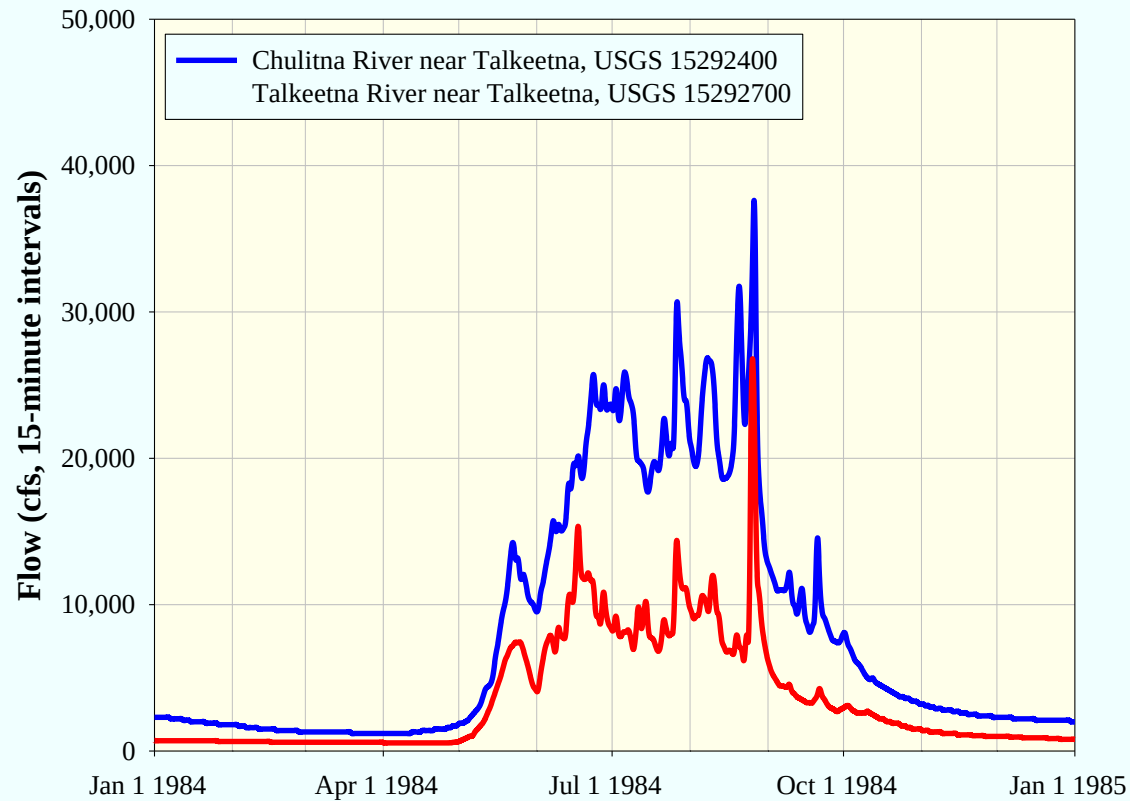
15-Minute Flows in Susitna River - 1984

29



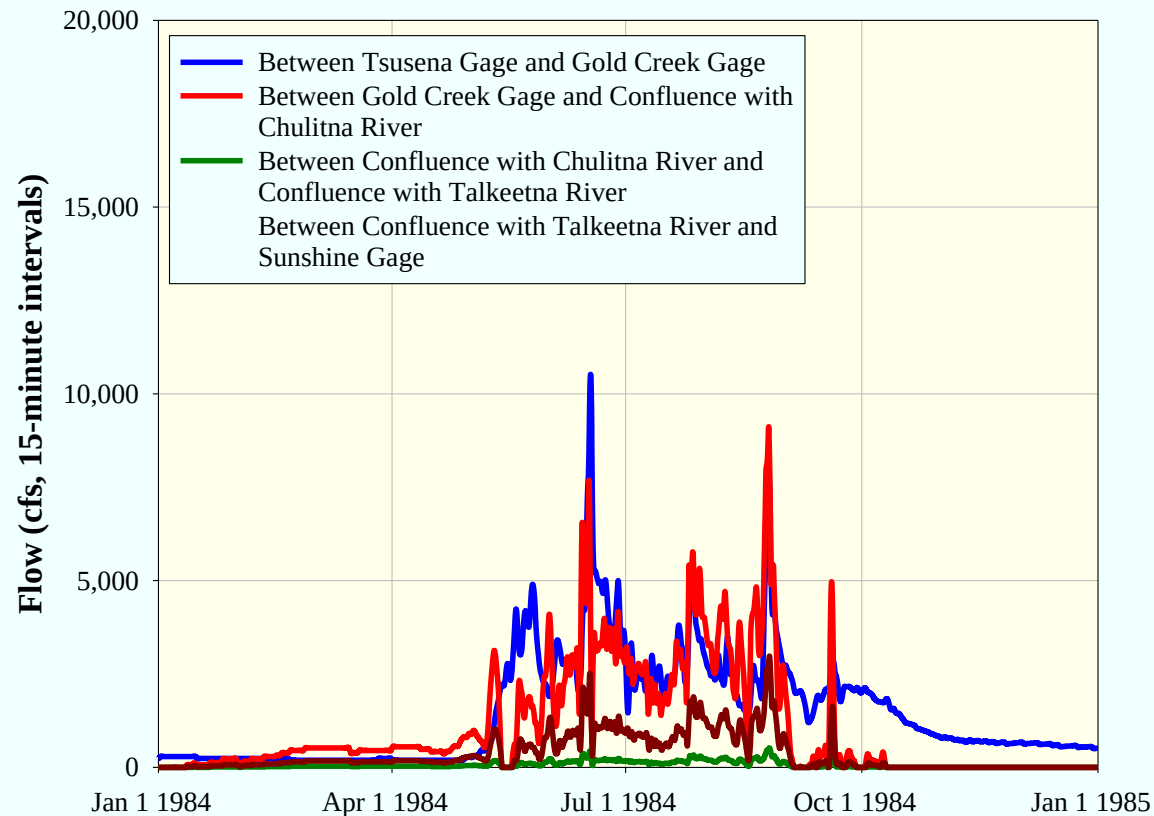
15-Minute Flows in Tributaries of the Susitna River - 1984

30



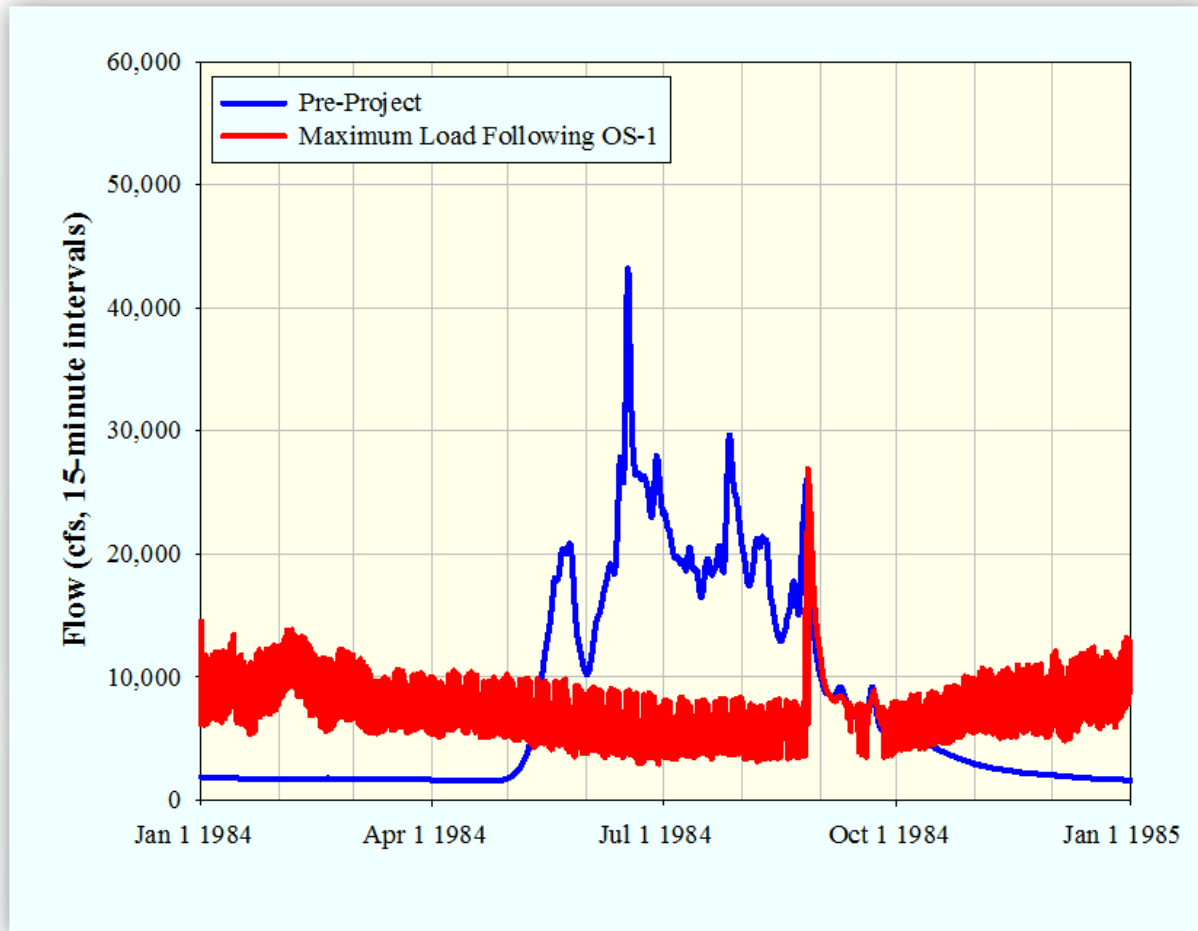
15-Minute Ungaged Accretion Flows to the Susitna River - 1984

31



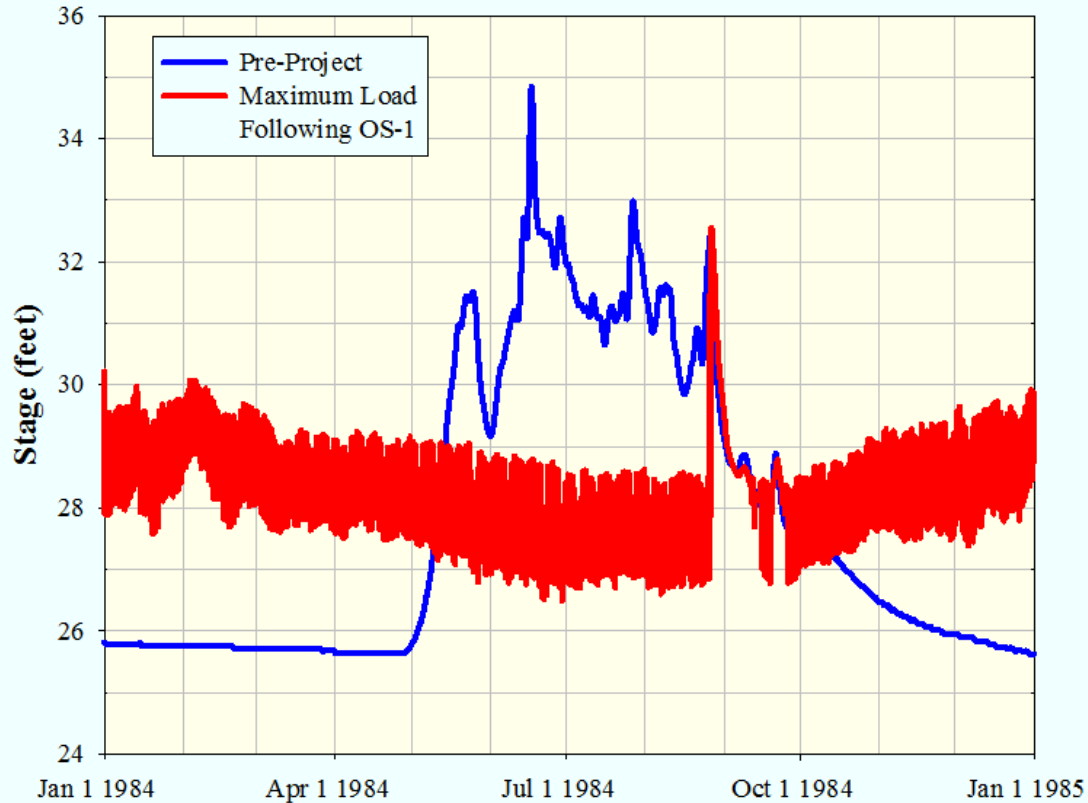
Effects of Proposed Project 15-Minute Flows in Susitna River Below Proposed Dam Site - 1984

32



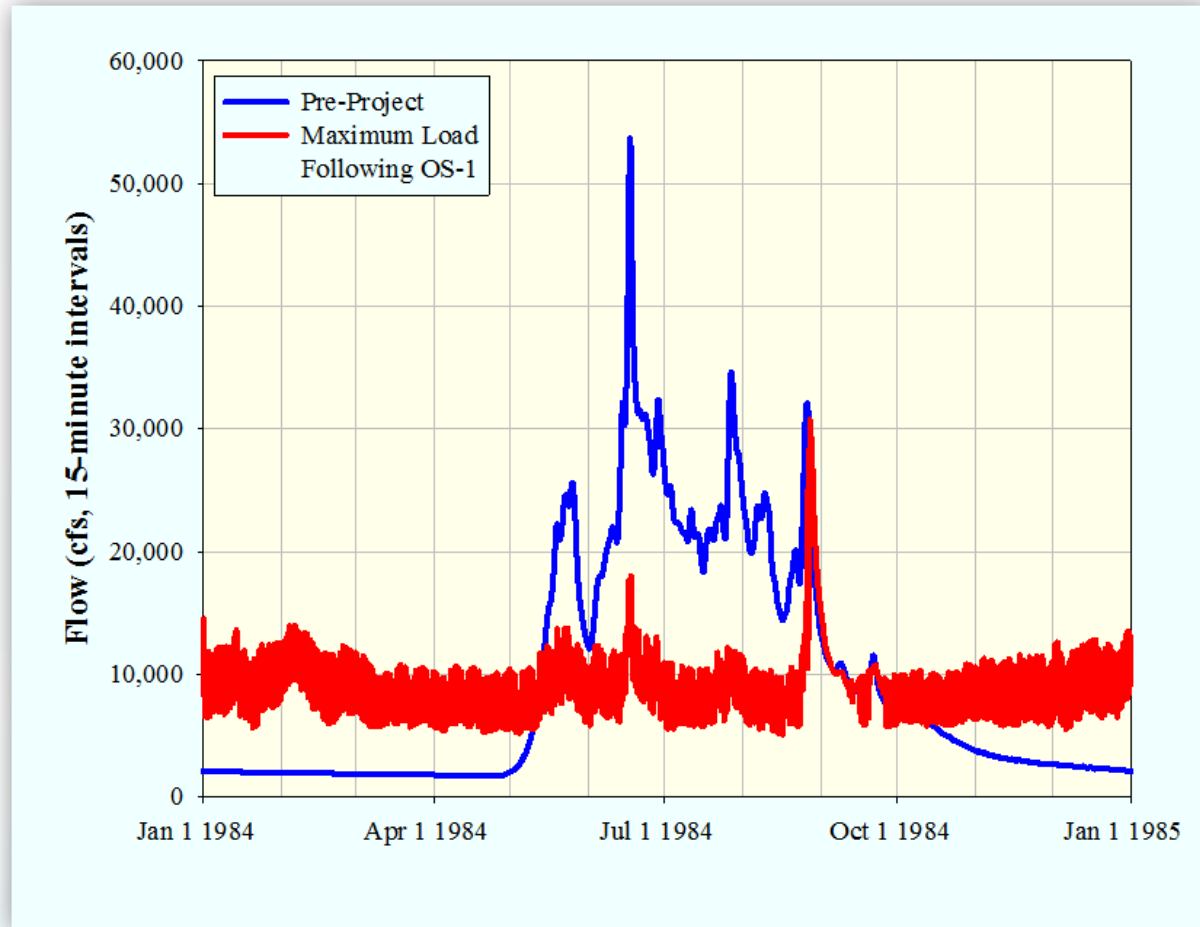
Effects of Proposed Project 15-Minute Stages in Susitna River Below Proposed Dam Site - 1984

33



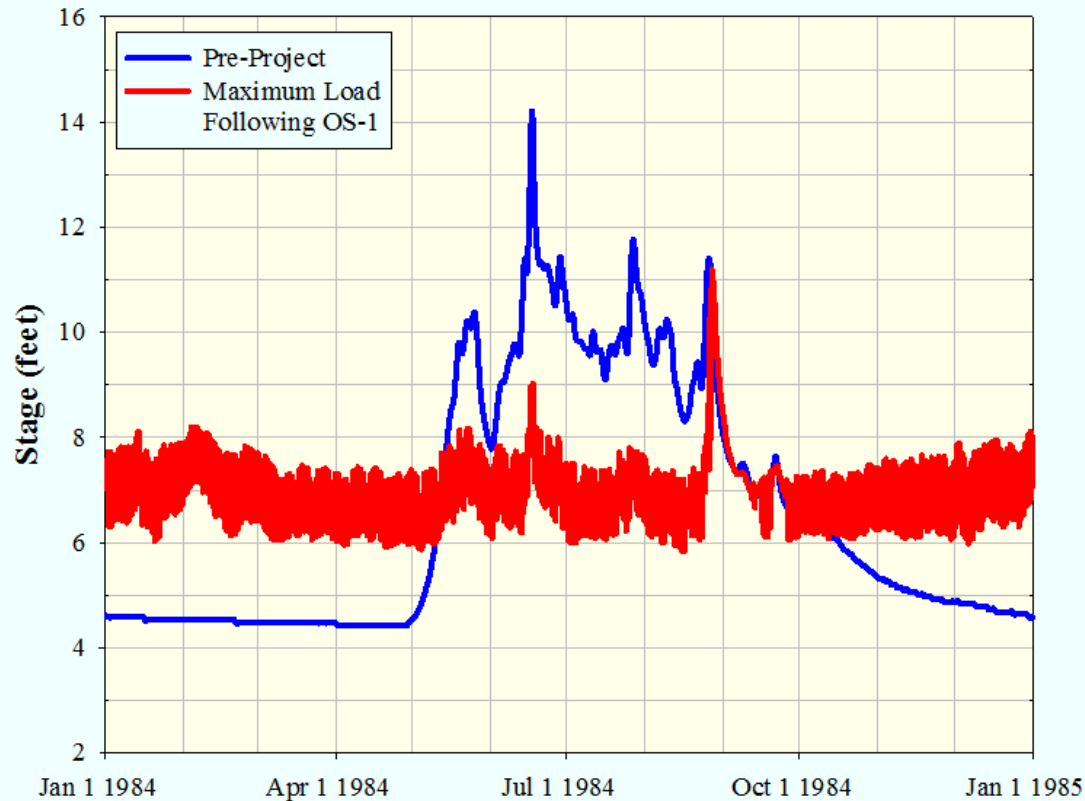
Effects of Proposed Project (HEC-RAS results) 15-Minute Flows in Susitna River at Gold Creek Gage - 1984

34



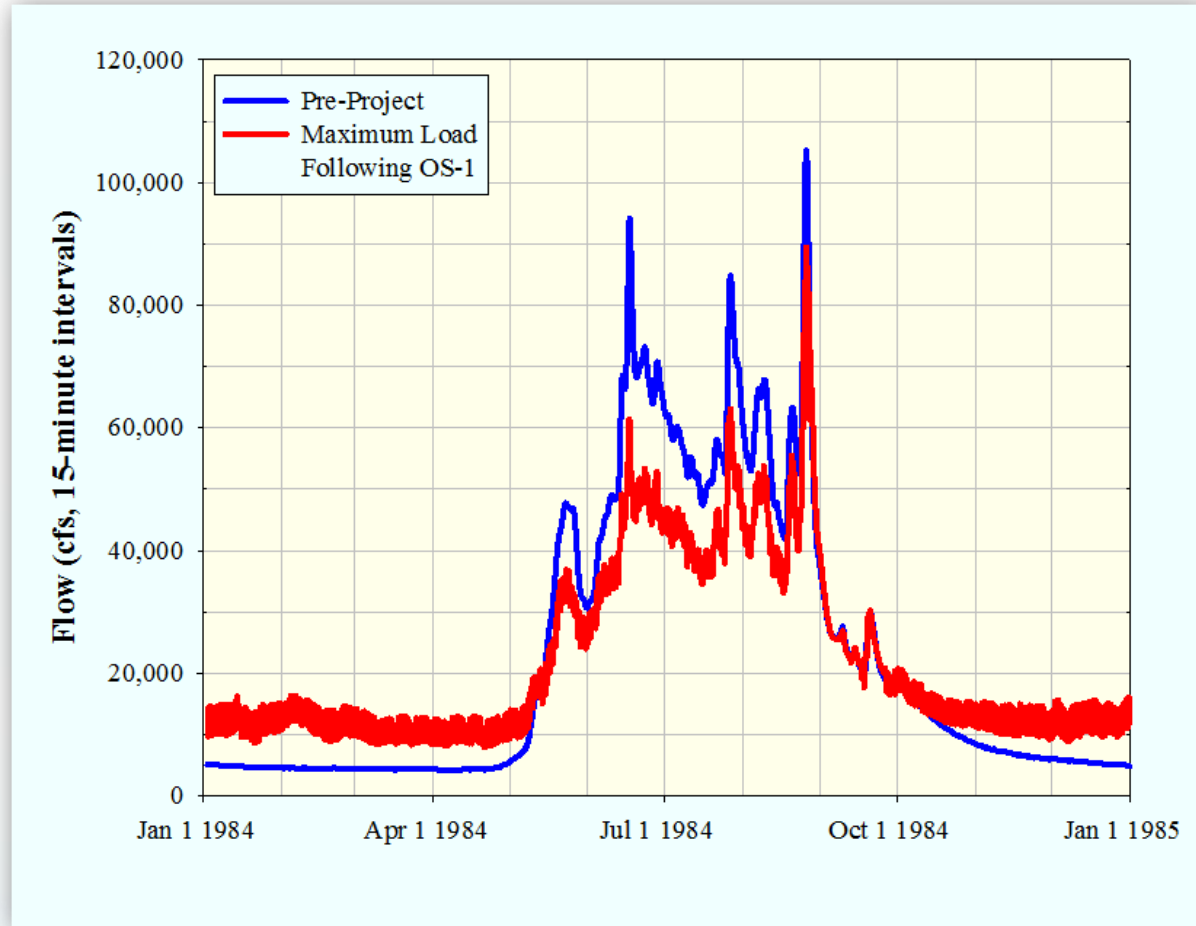
Effects of Proposed Project (HEC-RAS results) 15-Minute Stages in Susitna River at Gold Creek Gage - 1984

35



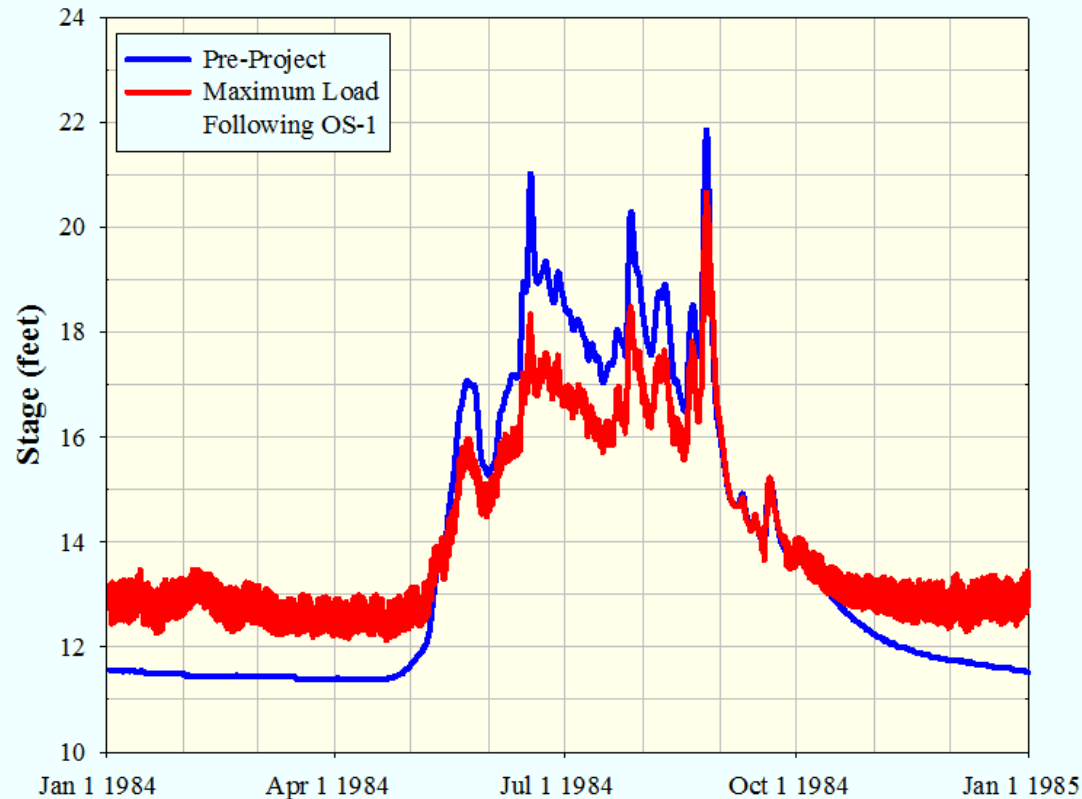
Effects of Proposed Project (HEC-RAS results) 15-Minute Flows in Susitna River at Sunshine Gage - 1984

36



Effects of Proposed Project (HEC-RAS results) 15-Minute Stages in Susitna River at Sunshine Gage - 1984

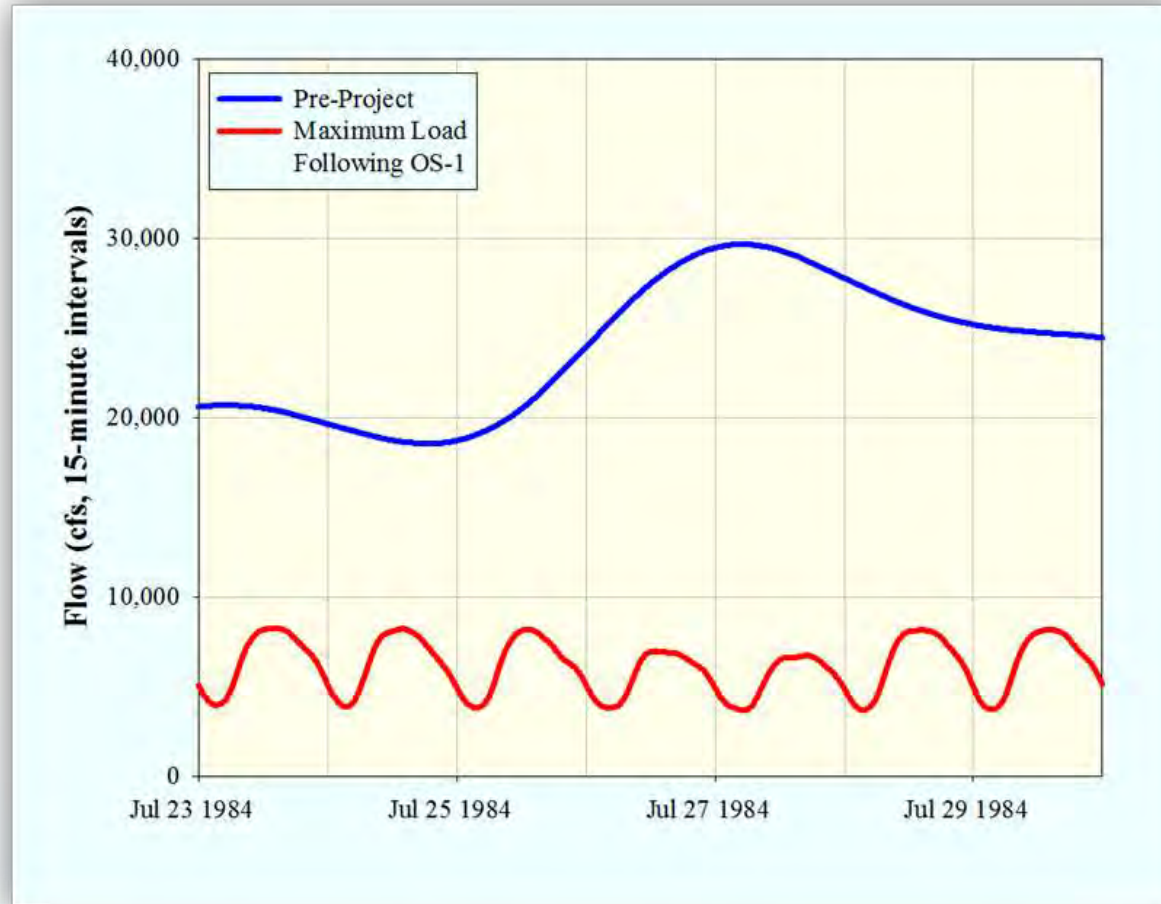
37



Effects of Proposed Project

15-Minute Flows in Susitna River Below Proposed Dam Site – July, 1984

(Pre-Project conditions do not account for diurnal glacial melt fluctuations)

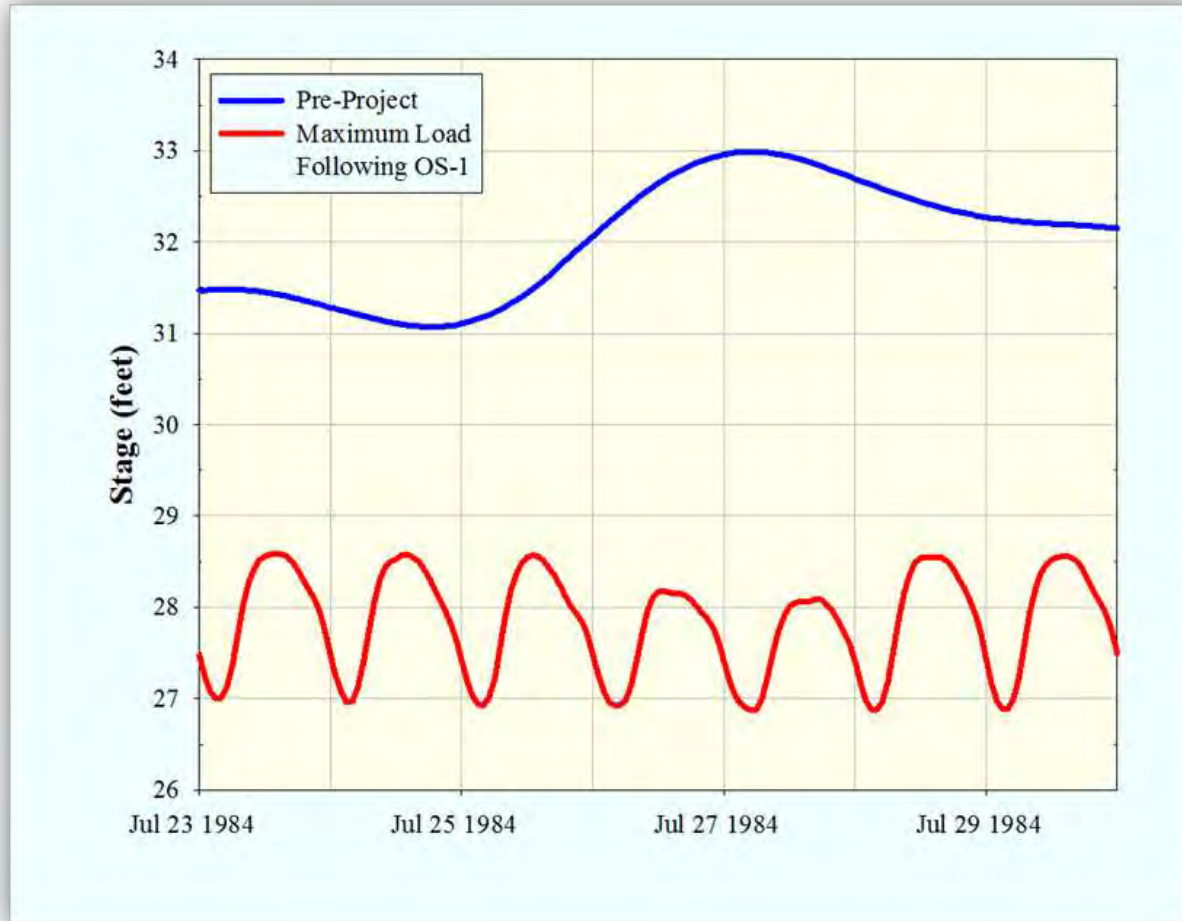


Effects of Proposed Project

15-Minute Stages in Susitna River Below Proposed Dam Site – July, 1984

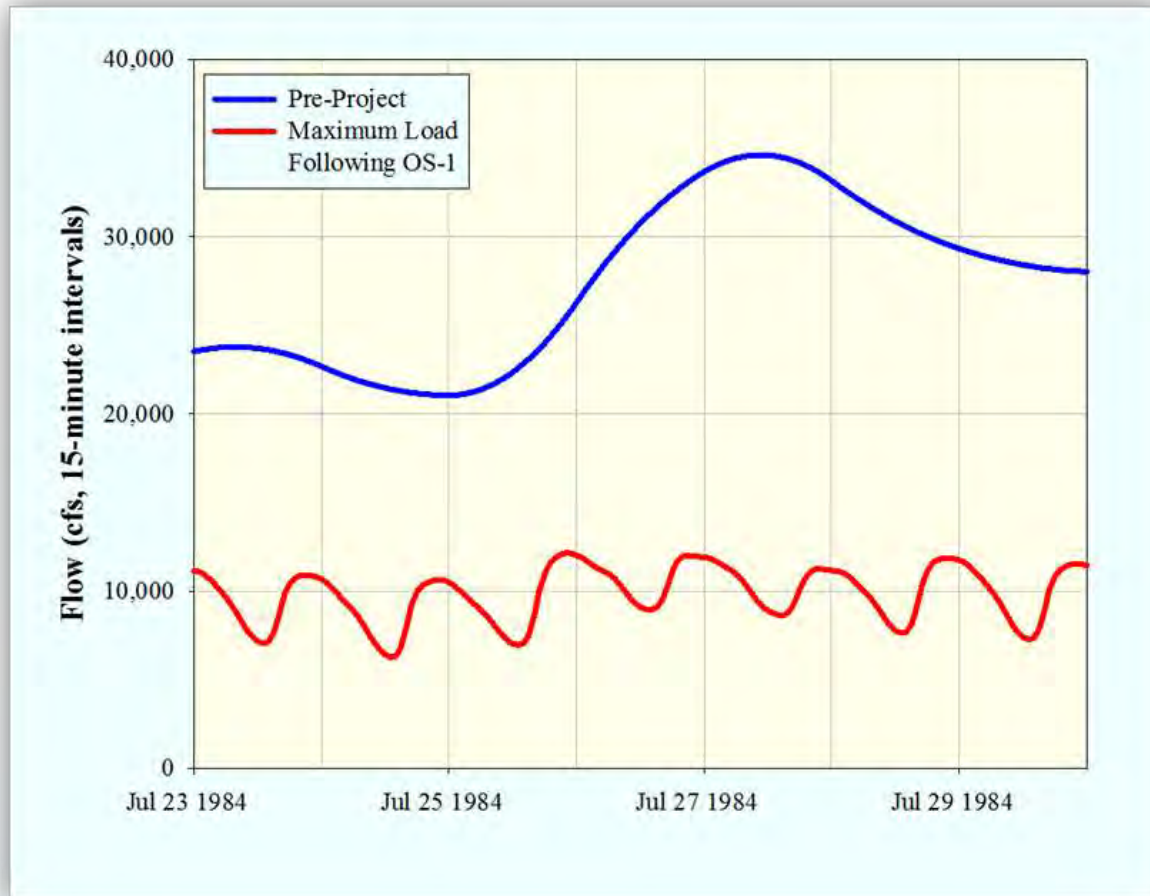
39

(Pre-Project conditions do not account for diurnal glacial melt fluctuations)



Effects of Proposed Project (HEC-RAS results) 15-Minute Flows in Susitna River at Gold Creek Gage – July, 1984

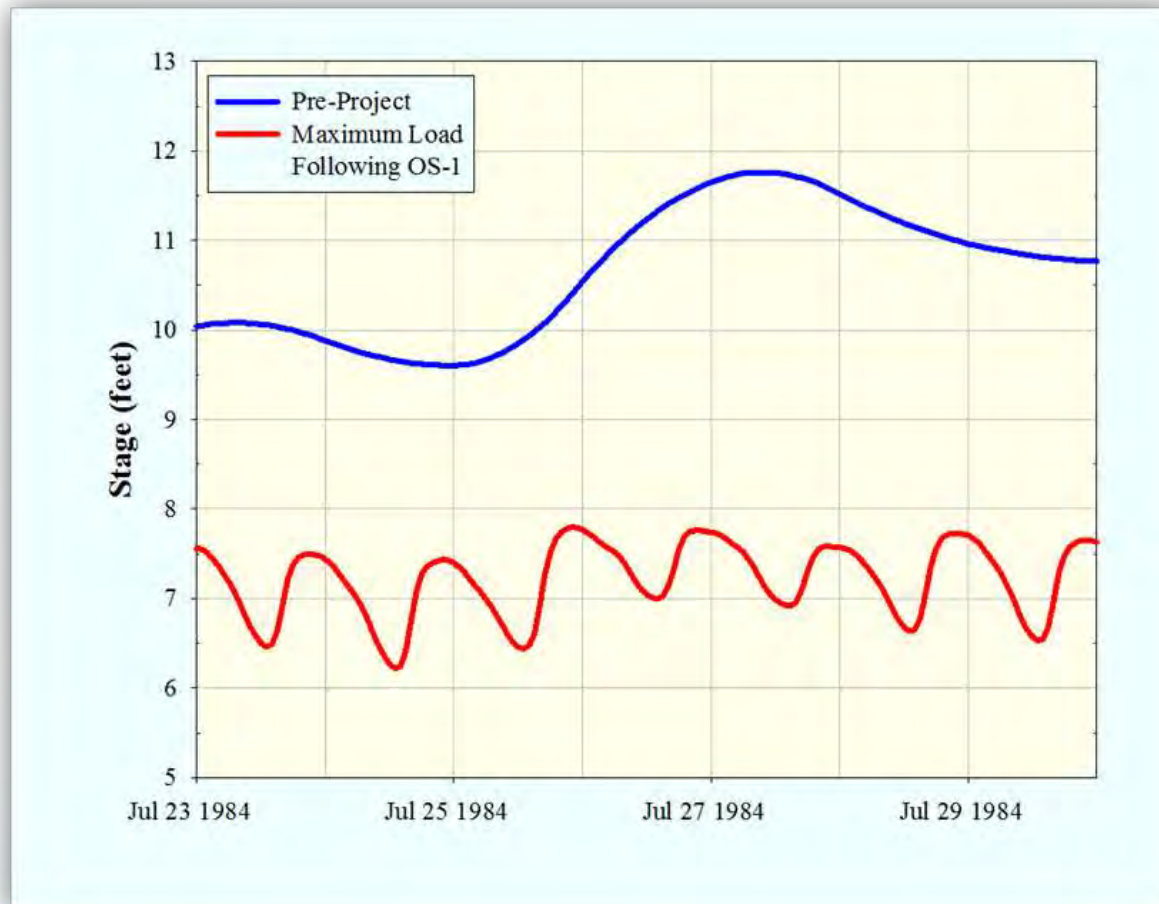
(Pre-Project conditions do not account for diurnal glacial melt fluctuations)



Effects of Proposed Project (HEC-RAS results) 15-Minute Stages in Susitna River at Gold Creek Gage – July, 1984

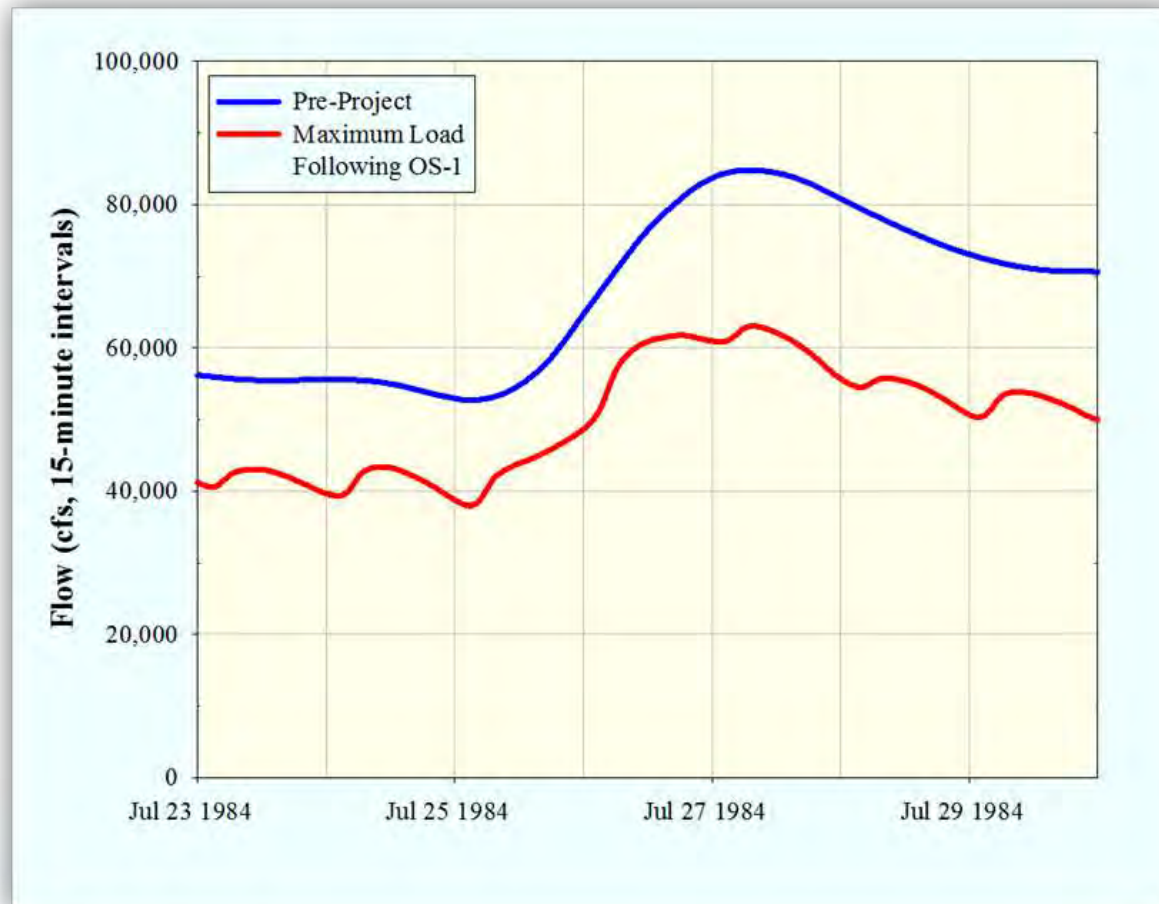
41

(Pre-Project conditions do not account for diurnal glacial melt fluctuations)



Effects of Proposed Project (HEC-RAS results) 15-Minute Flows in Susitna River at Sunshine Gage – July, 1984

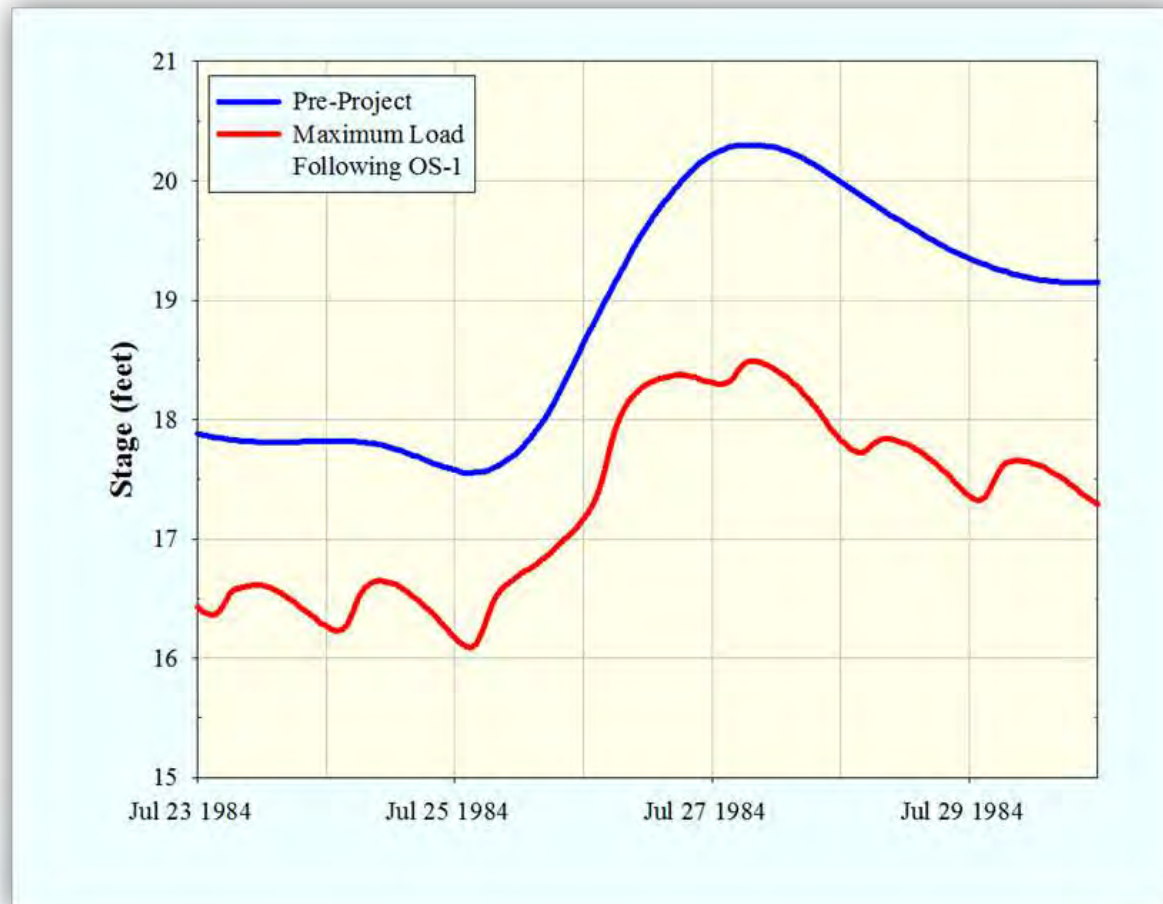
(Pre-Project conditions do not account for diurnal glacial melt fluctuations)



Effects of Proposed Project (HEC-RAS results) 15-Minute Stages in Susitna River at Sunshine Gage – July, 1984

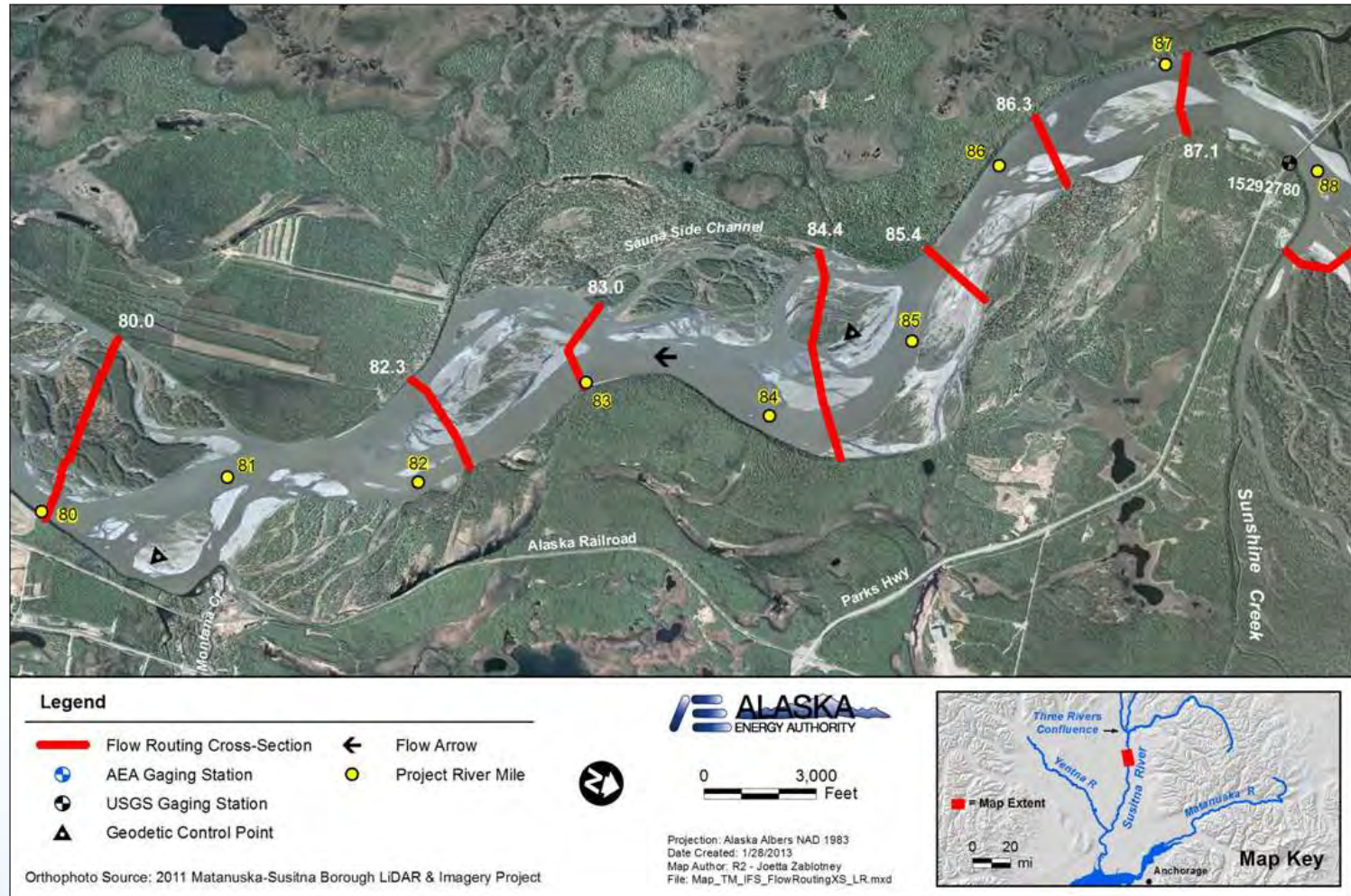
43

(Pre-Project conditions do not account for diurnal glacial melt fluctuations)



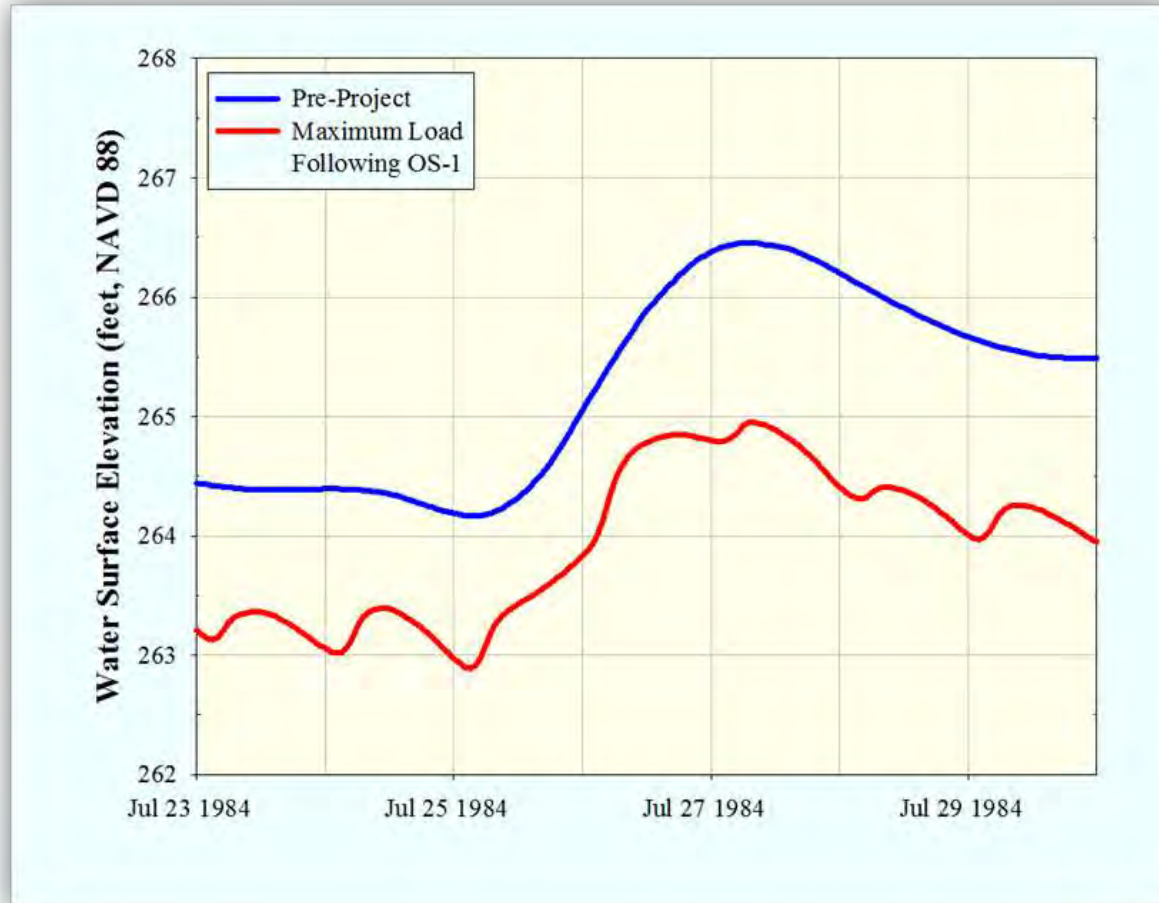
Sunshine Gage is Located at a Confined Single Channel - Not Representative of Local Conditions

44



Effects of Proposed Project (HEC-RAS results) 15-Minute Stages in Susitna River at PRM 87.1 (below Sunshine gage) – July, 1984

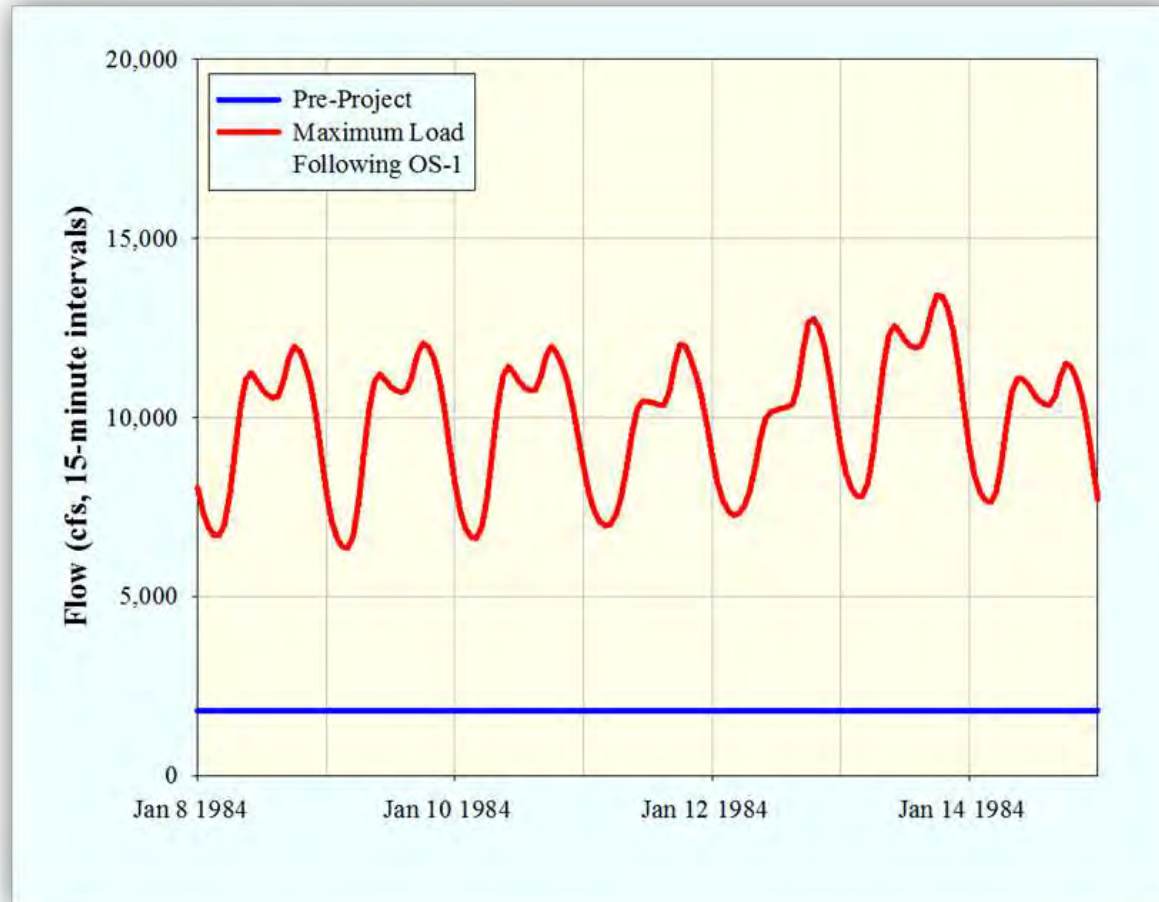
(Pre-Project conditions do not account for diurnal glacial melt fluctuations)



Effects of Proposed Project

15-Minute Flows in Susitna River Below Proposed Dam Site – January, 1984

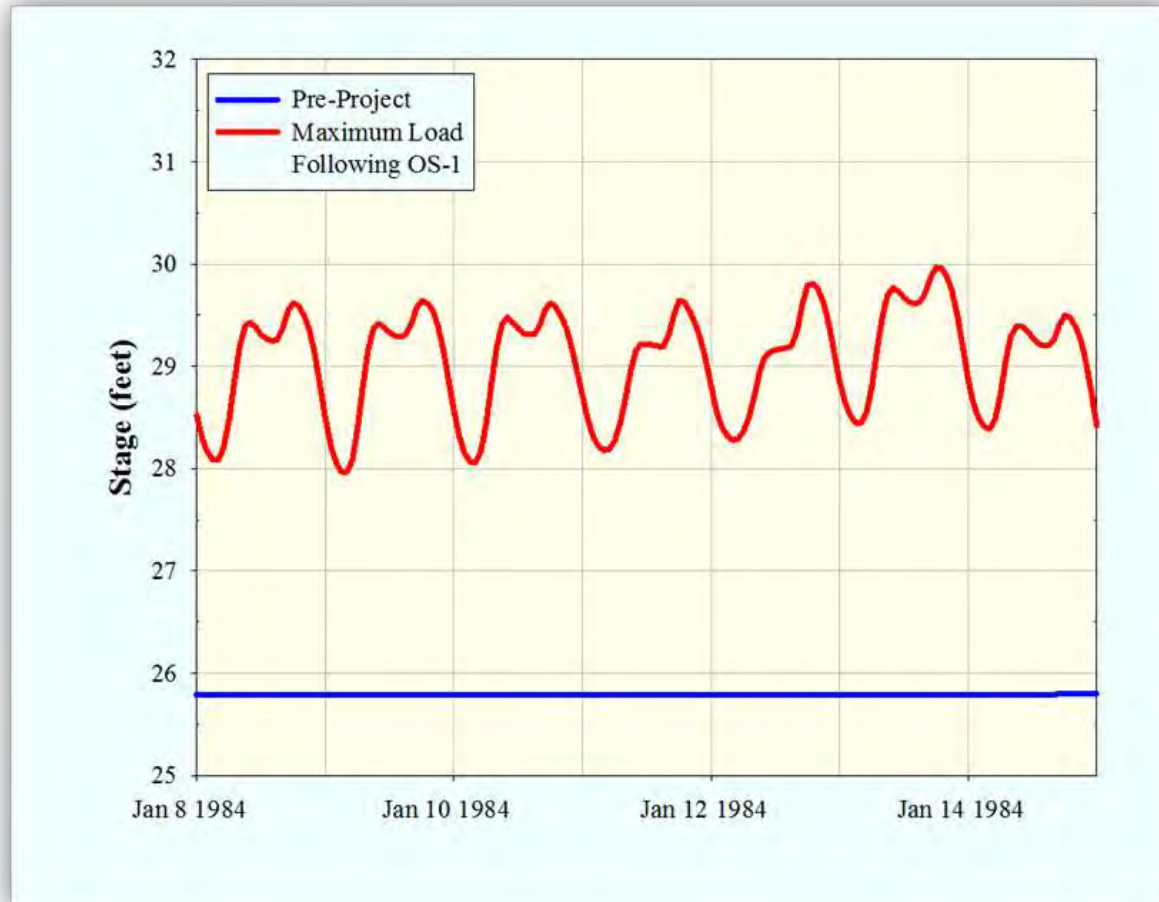
46



Effects of Proposed Project

15-Minute Stages in Susitna River Below Proposed Dam Site – January, 1984

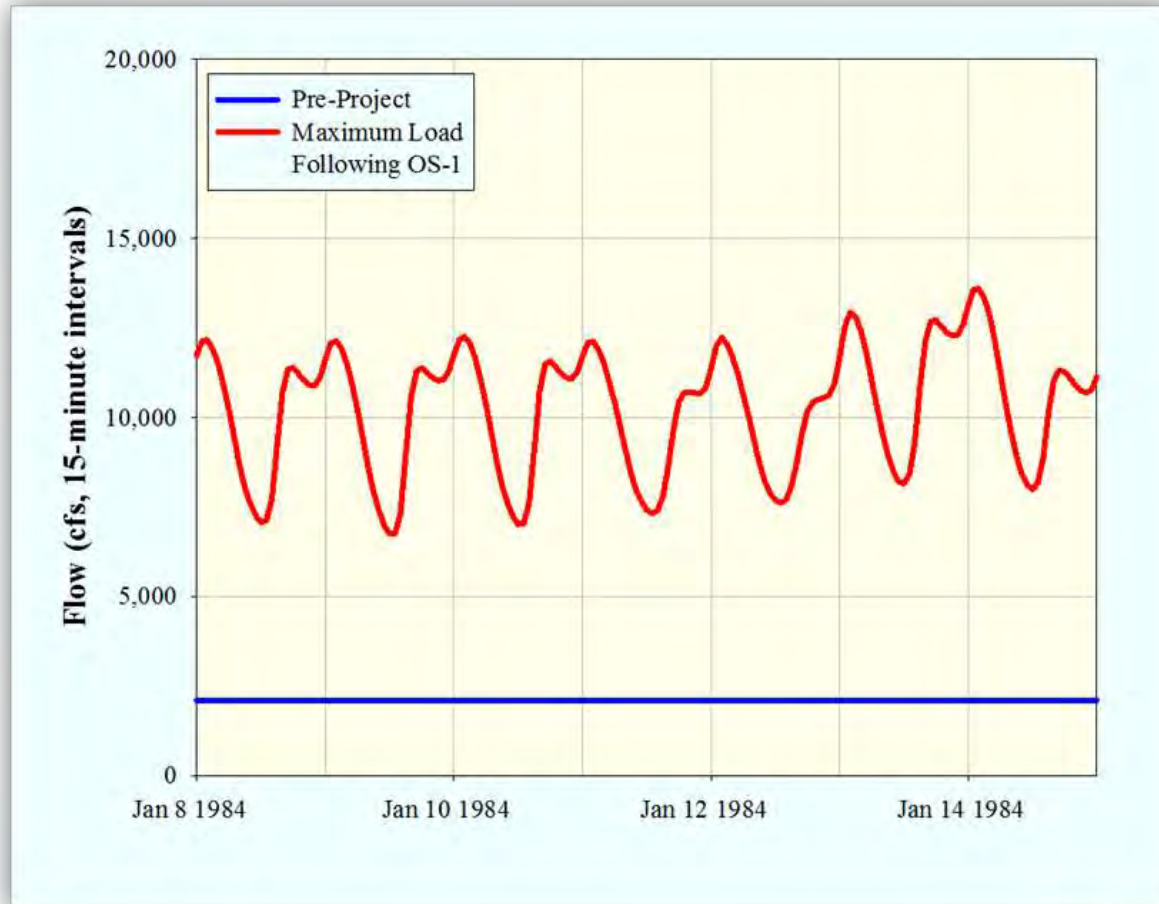
47



Effects of Proposed Project (HEC-RAS results) 15-Minute Flows in Susitna River at Gold Creek Gage – January, 1984

48

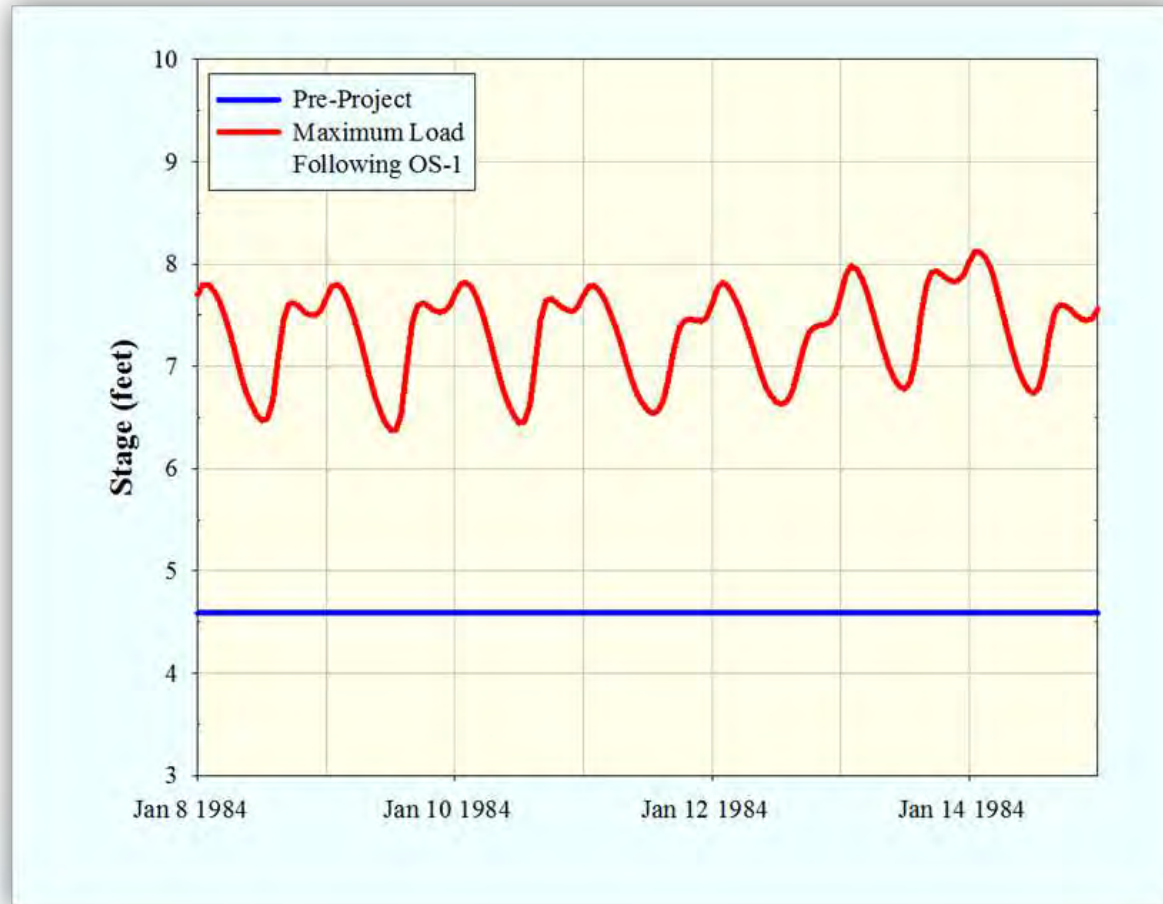
(Actual results may differ as a result of ice formation on the river)



Effects of Proposed Project (HEC-RAS results) 15-Minute Stages in Susitna River at Gold Creek Gage – January, 1984

49

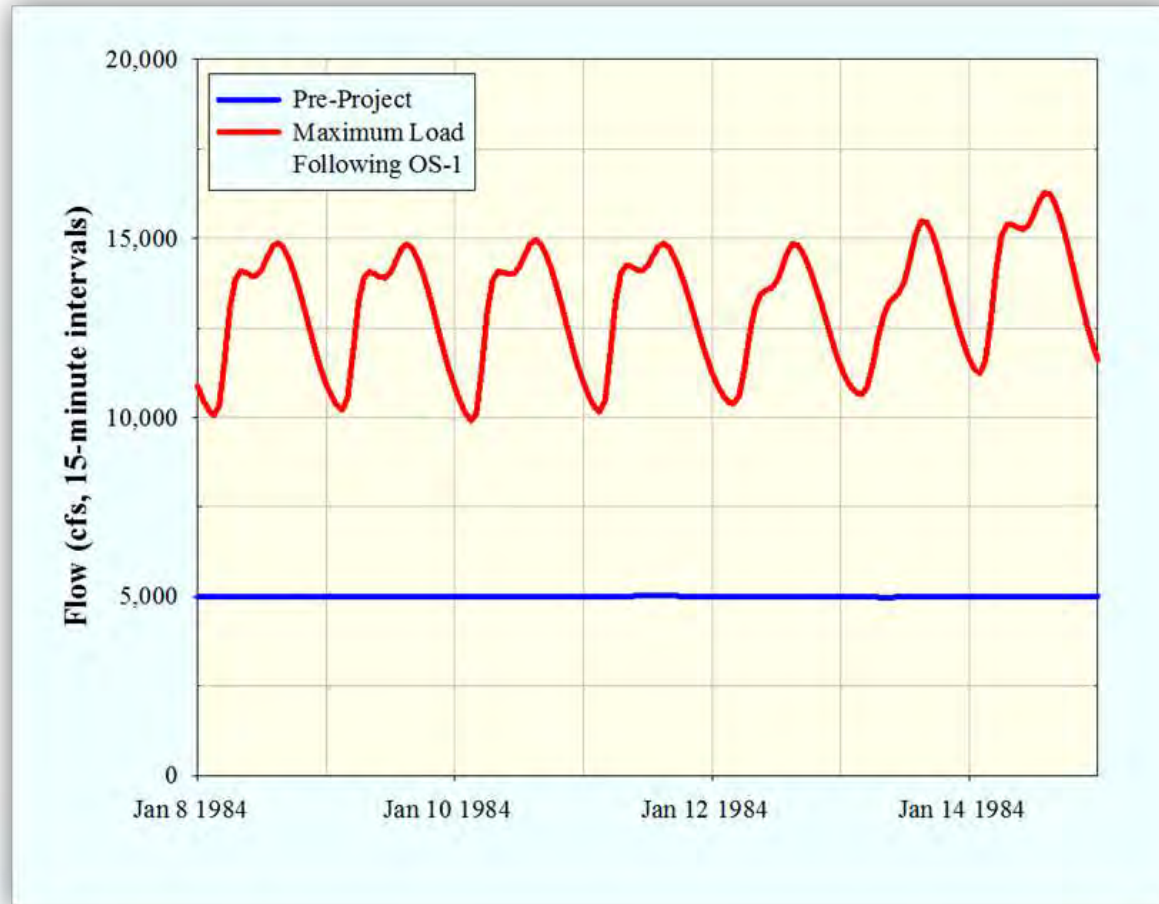
(Actual results may differ as a result of ice formation on the river)



Effects of Proposed Project (HEC-RAS results) 15-Minute Flows in Susitna River at Sunshine Gage – January, 1984

50

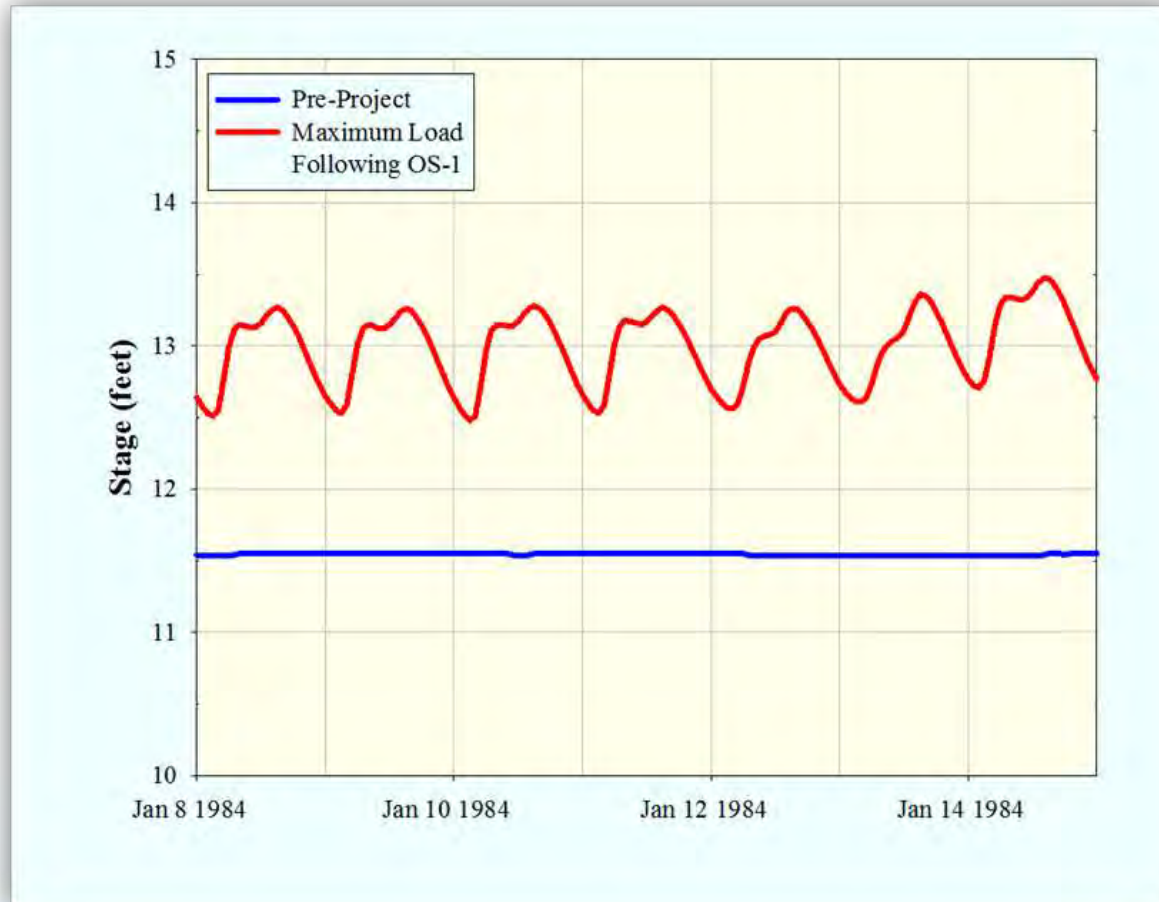
(Actual results may differ as a result of ice formation on the river)



Effects of Proposed Project (HEC-RAS results) 15-Minute Stages in Susitna River at Sunshine Gage – January, 1984

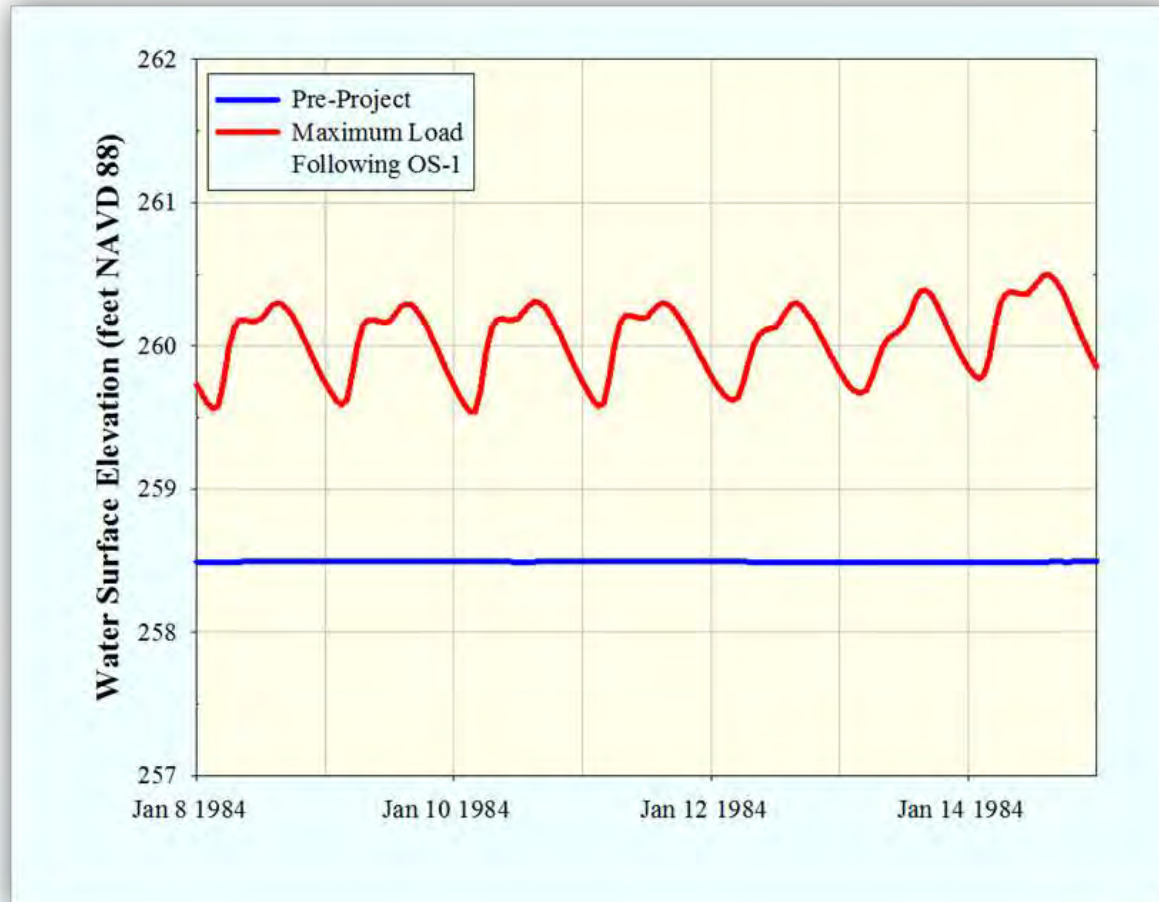
51

(Actual results may differ as a result of ice formation on the river)



Effects of Proposed Project (HEC-RAS results) 15-Minute Stages in Susitna River at PRM 87.1 (below Sunshine Gage) – January, 1984 (Actual results may differ as a result of ice formation on the river)

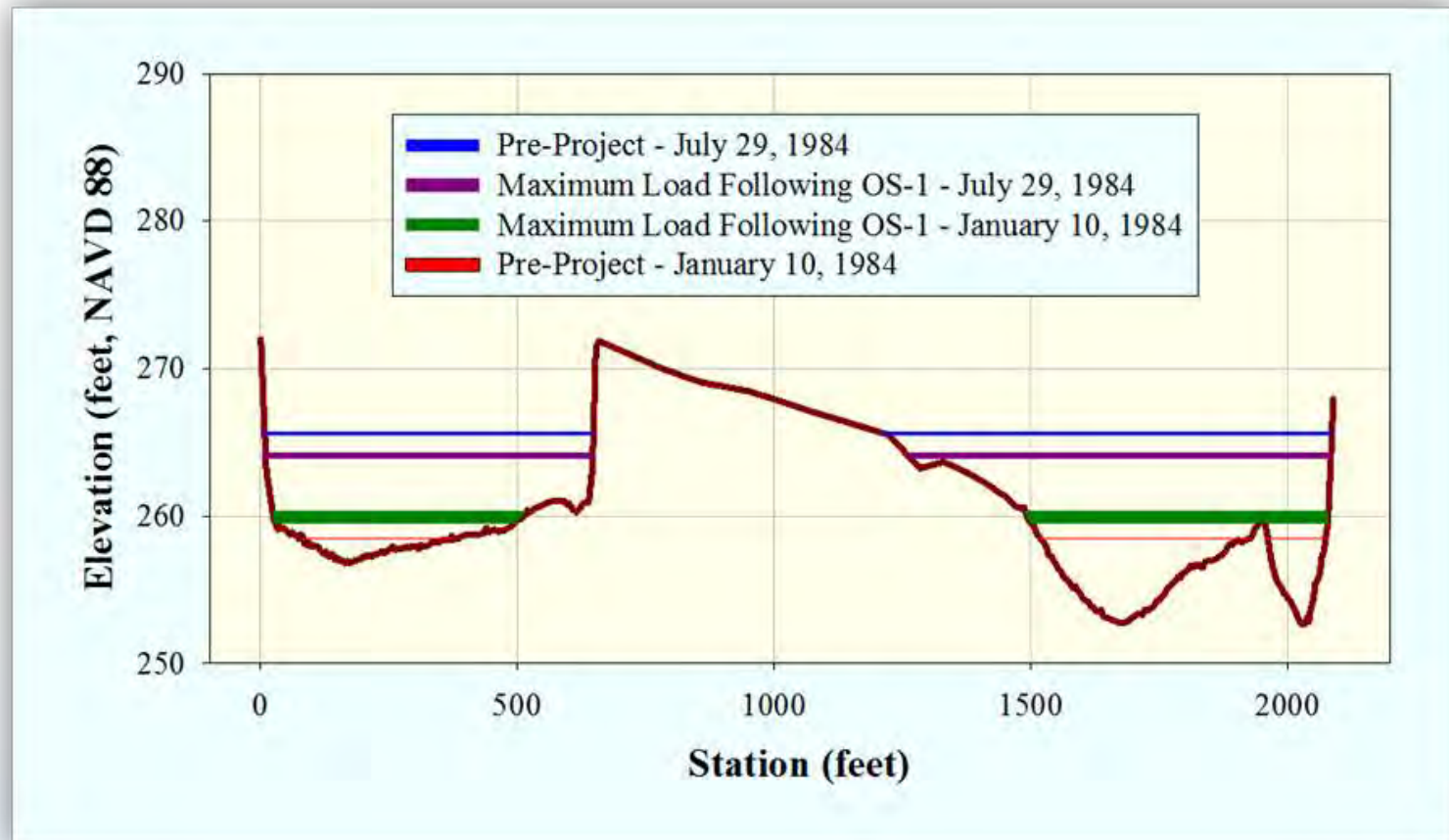
52



Effects of Proposed Project (HEC-RAS results) Surveyed Cross-Section of Susitna River at PRM 87.1

53

(Actual results may differ as a result of ice formation on the river)



Planned Improvements to Open-Water Flow Routing Model

54

- HEC-RAS: Version 2 will extend cross-section profiles to higher elevations using LiDAR, and ground-based RTK GPS surveys.
- Additional pairs of flow/water surface elevations will be measured and used in the model.
- Measured flows in tributaries will improve estimates of accretion flows.
- The model will include additional cross-sections surveyed in geomorphology study.
- Diurnal glacial melt fluctuations will be incorporated into summer hydrographs.

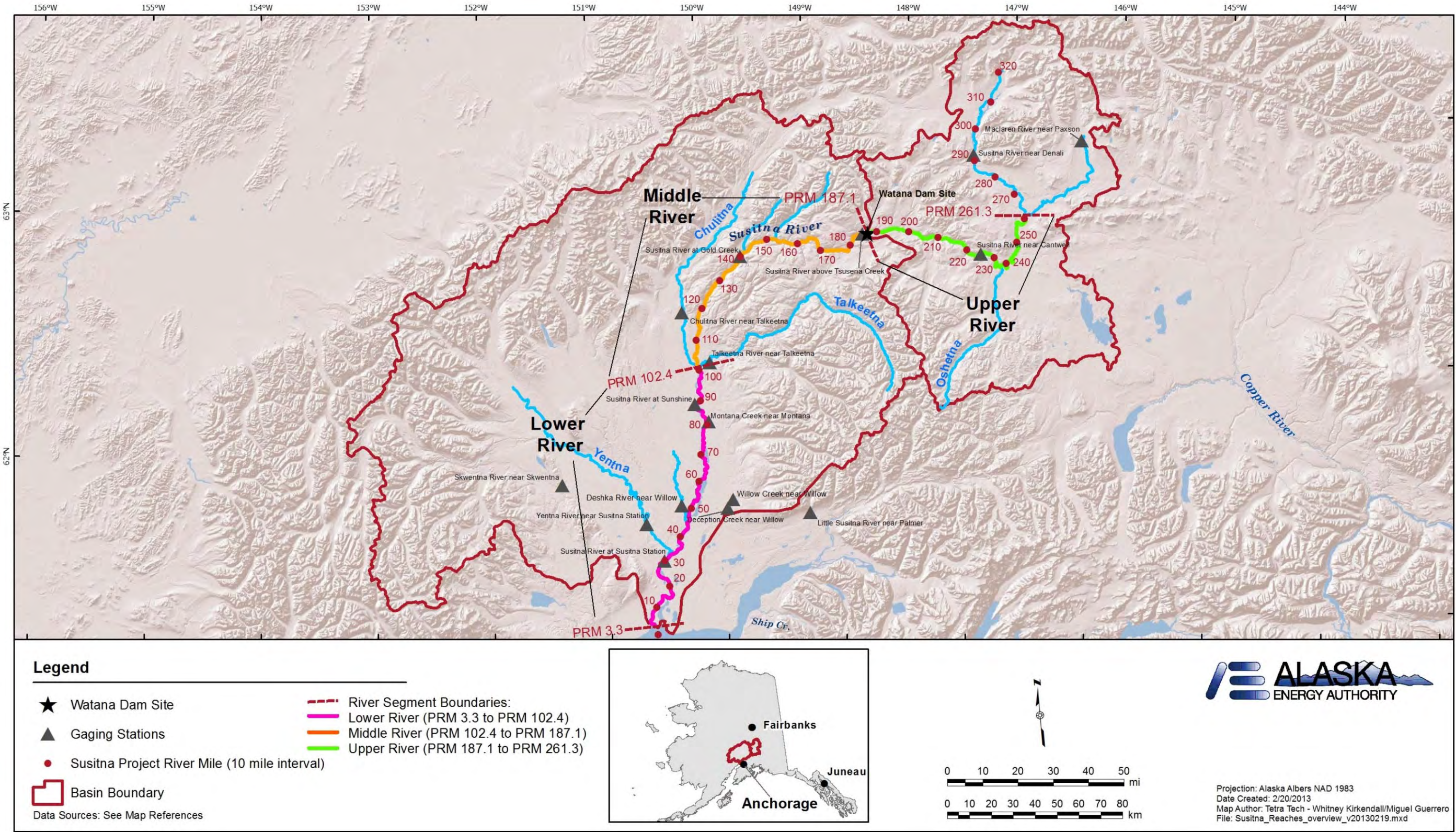
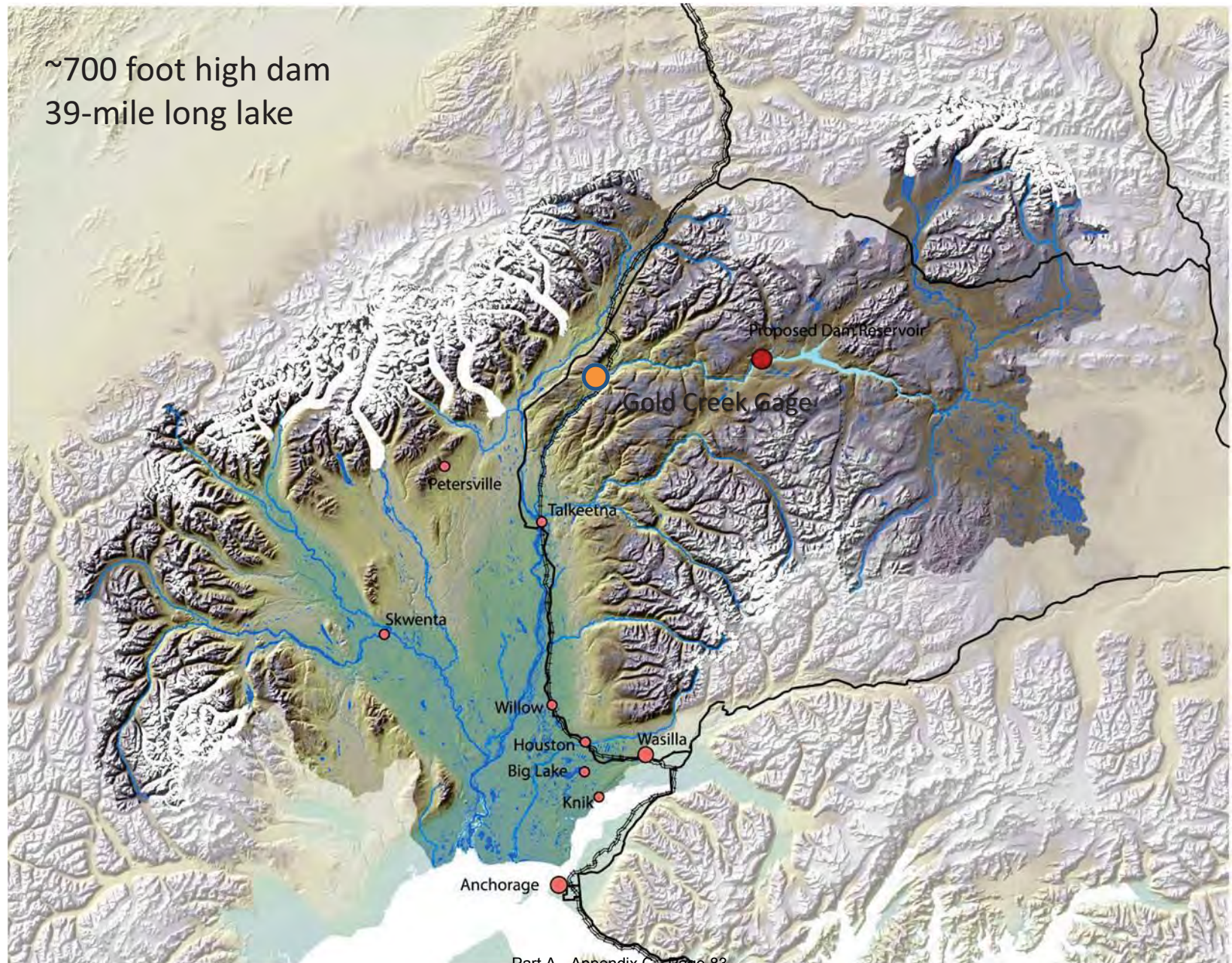
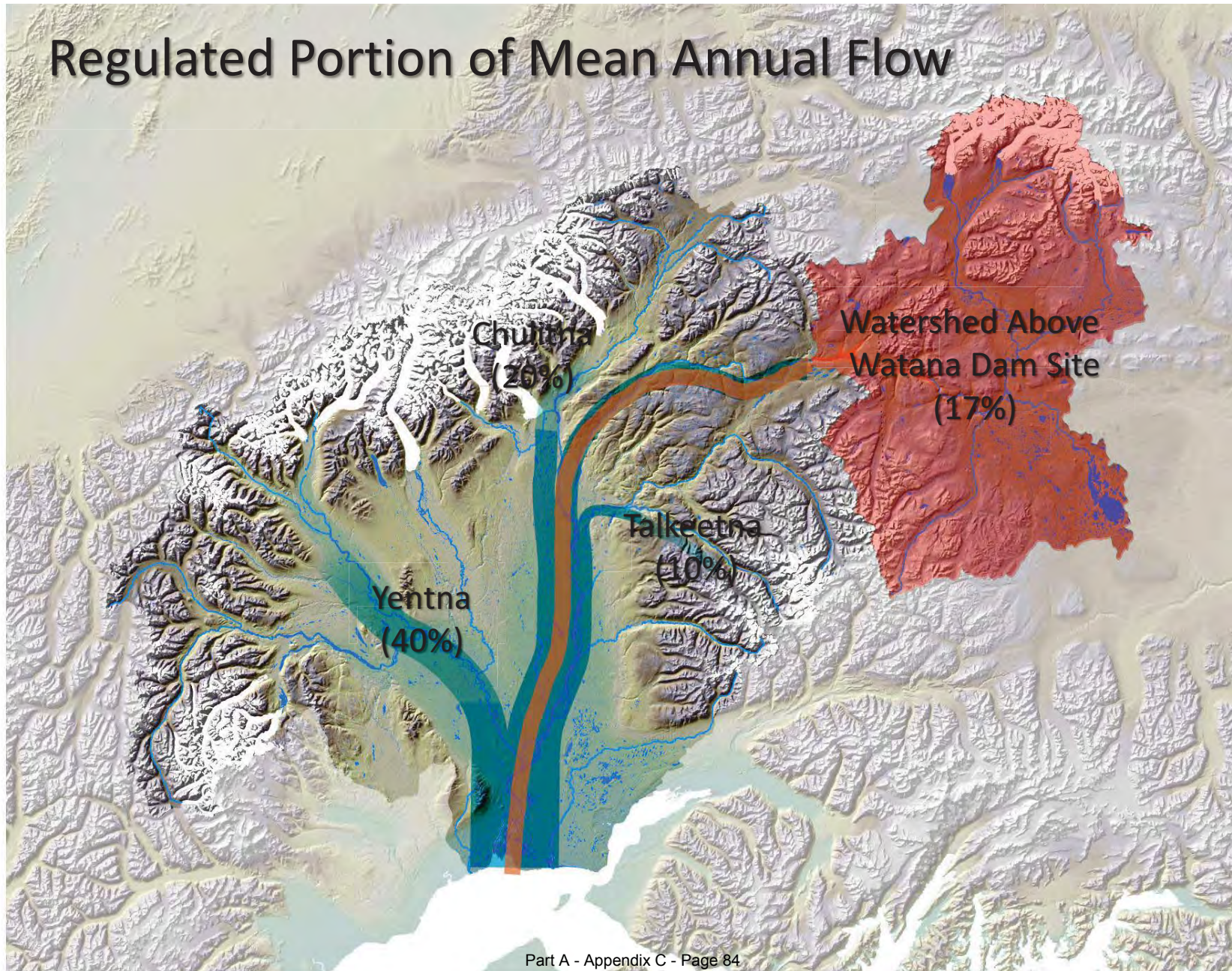


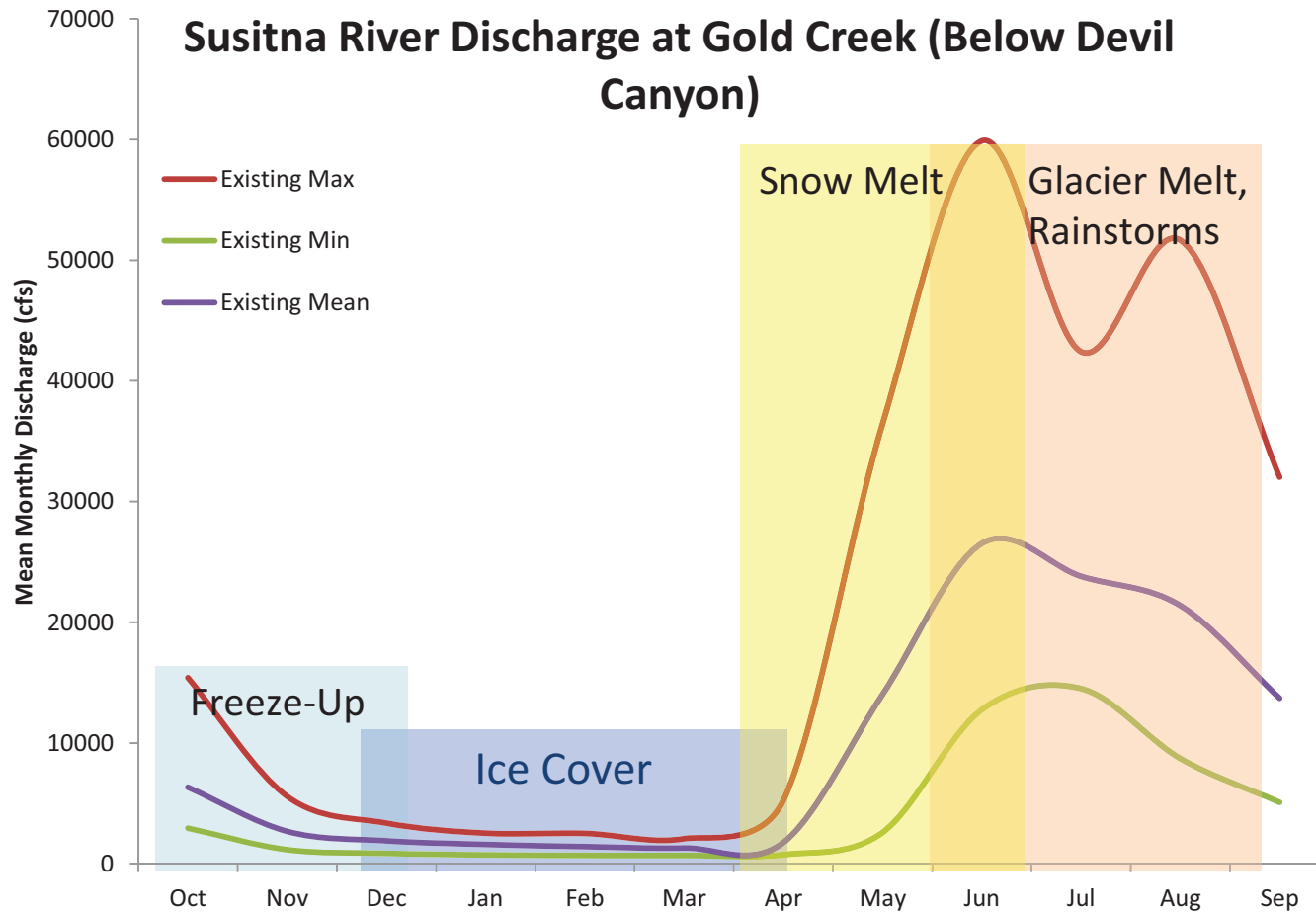
Figure 3.2-1. Susitna River study area and large-scale river segments.

~700 foot high dam
39-mile long lake

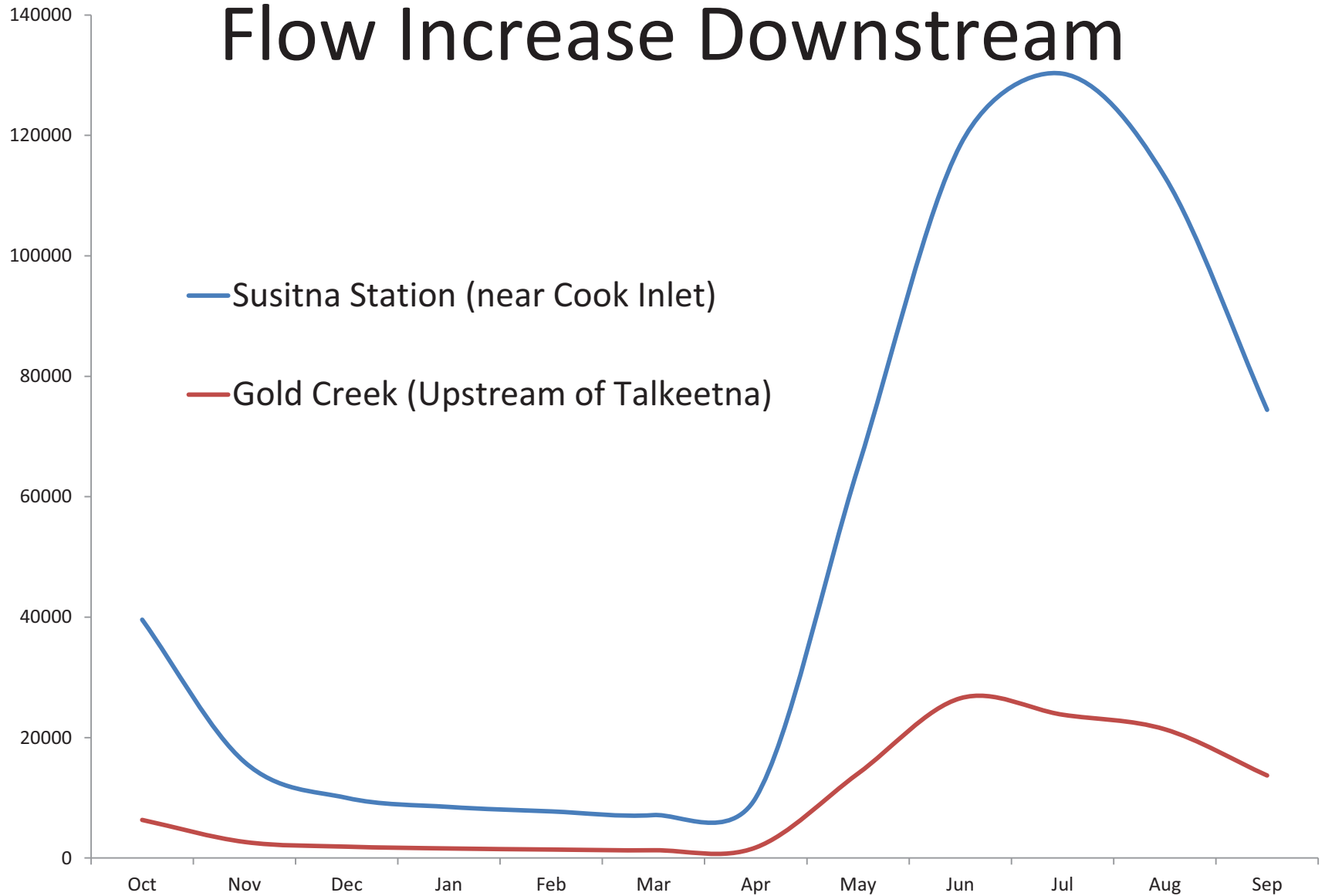


Regulated Portion of Mean Annual Flow



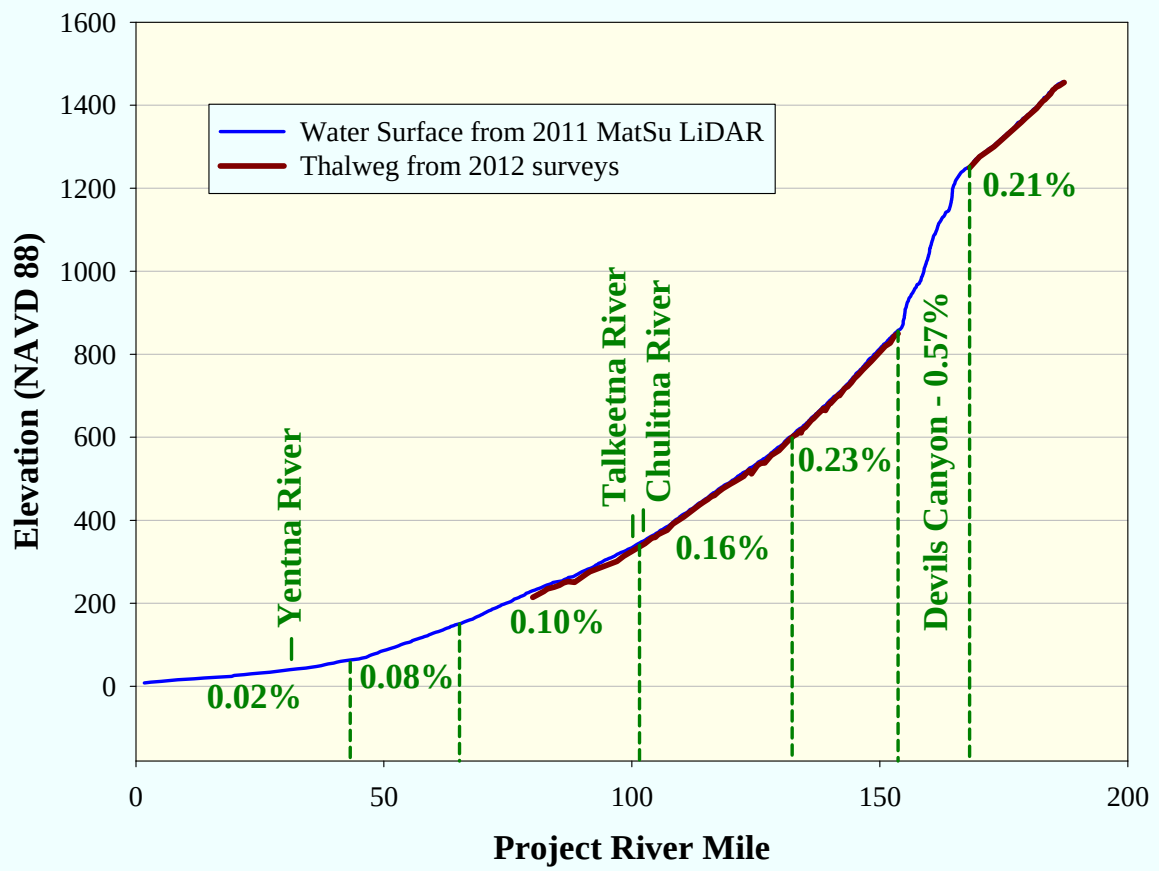


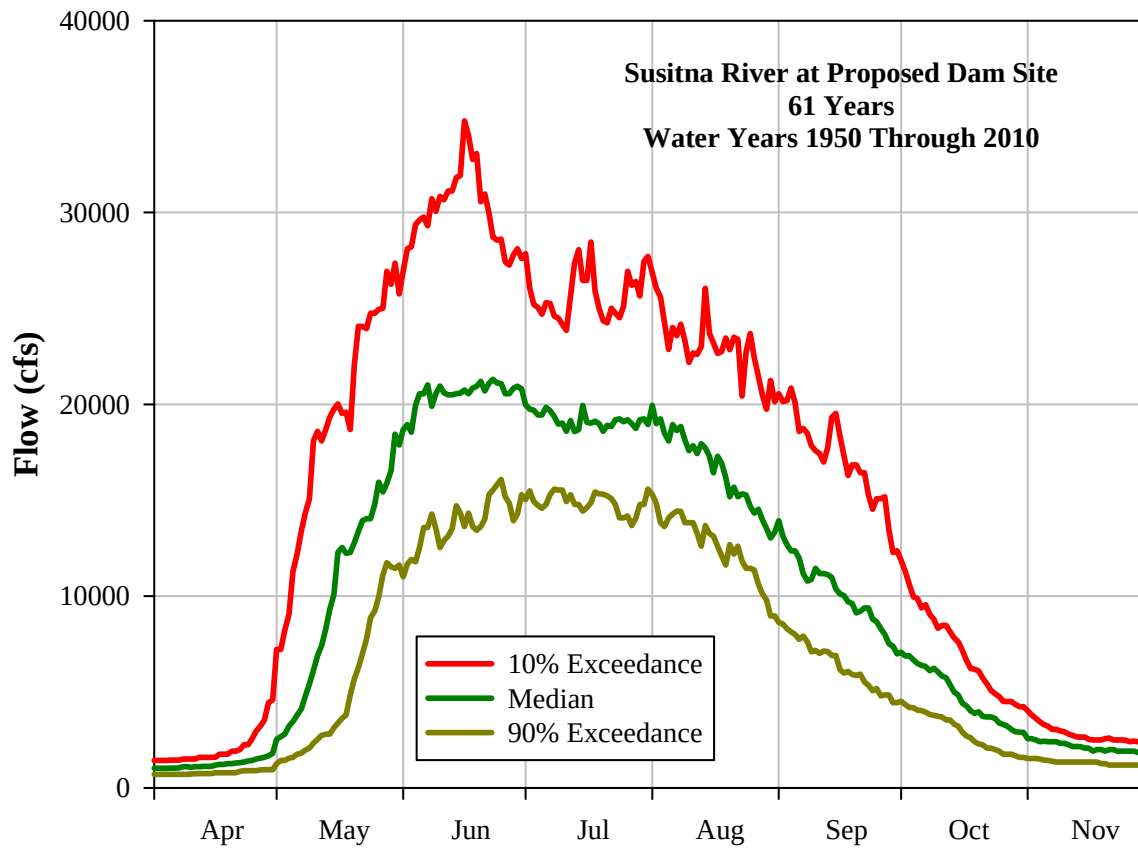
Flow Increase Downstream

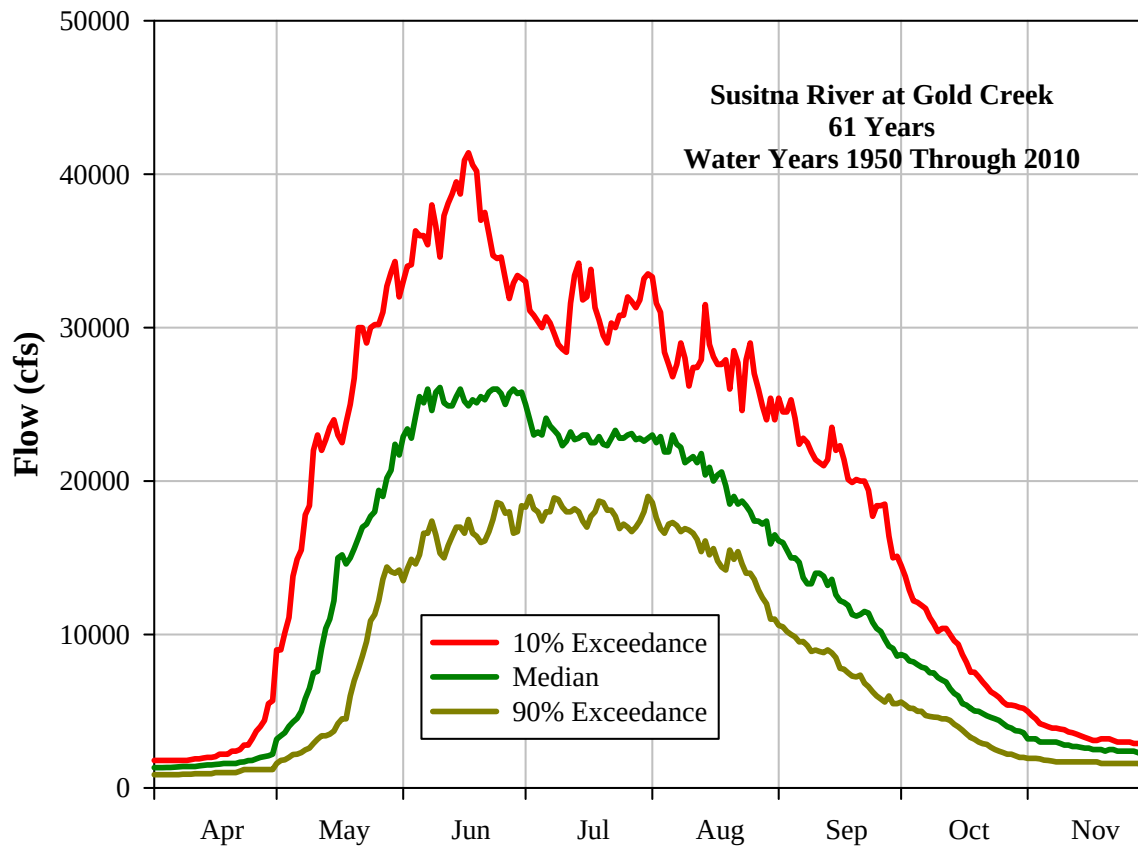


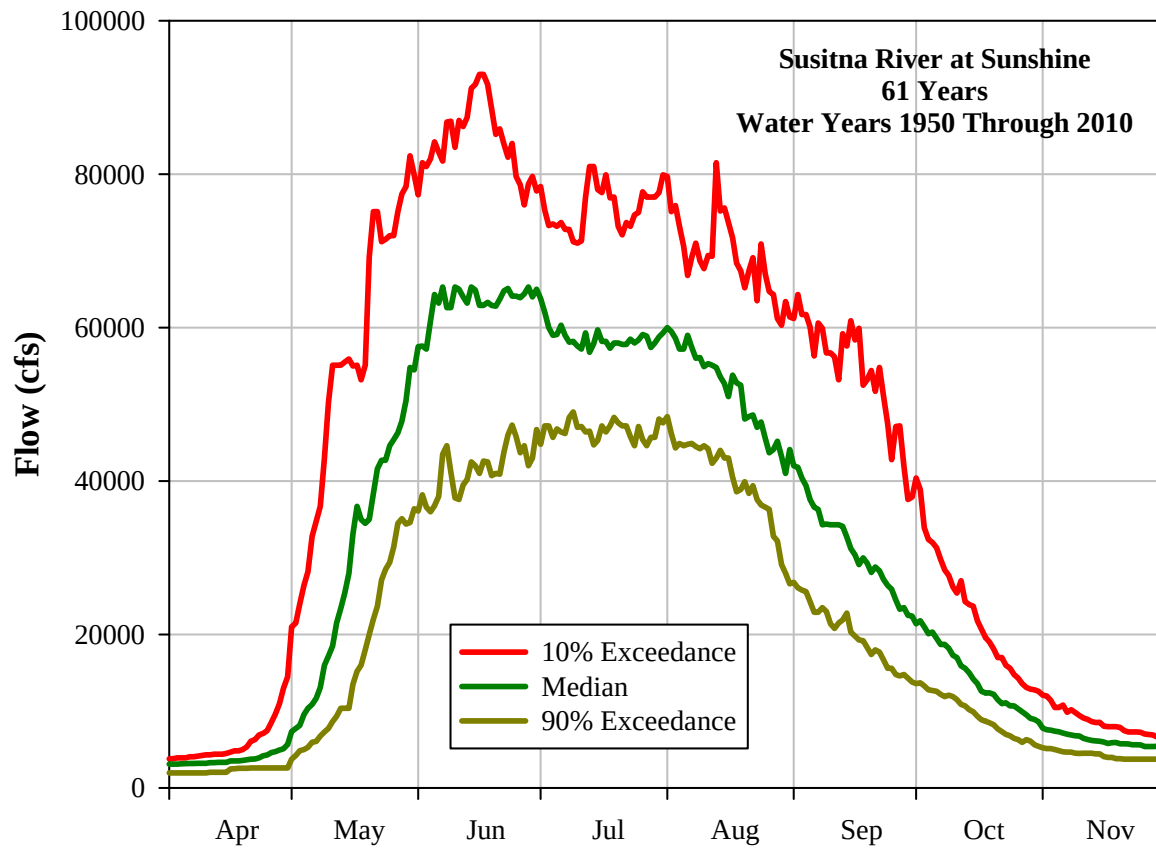
Average Monthly and Annual Flows (cfs)

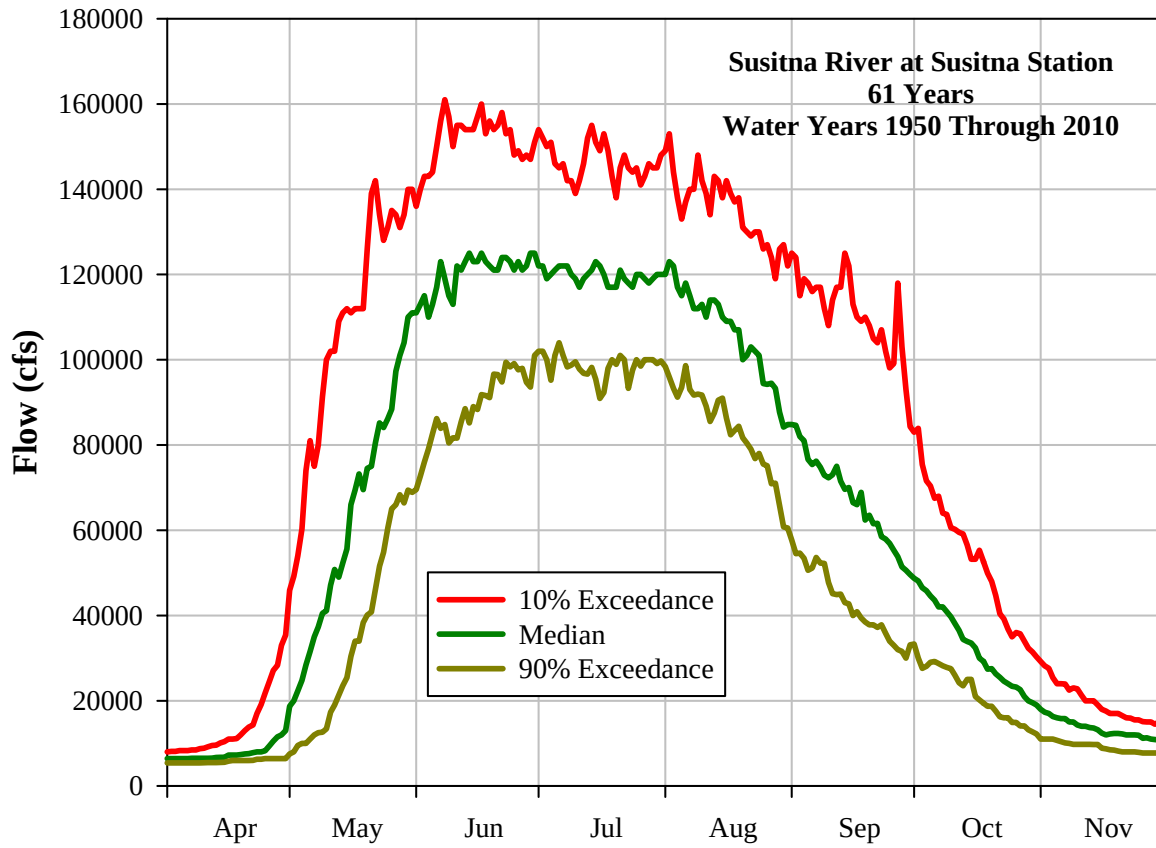
Period	Watana Dam (PRM 187)		Susitna River at Gold Creek (PRM 140)		Susitna River at Sunshine (PRM 87.9)		Susitna River at Susitna Station (PRM 29.9)	
	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1
JAN	1,280	8,840	1,590	9,140	3,720	11,300	7,910	15,500
FEB	1,130	9,450	1,420	9,750	3,260	11,600	7,080	15,400
MAR	1,040	7,170	1,300	7,460	2,960	9,190	6,510	12,700
APR	1,400	6,650	1,740	6,950	4,030	9,160	8,990	14,100
MAY	11,300	6,090	13,800	8,490	33,200	27,400	66,100	60,200
JUN	21,700	5,680	26,300	10,200	63,700	47,500	120,000	104,000
JUL	20,000	6,980	24,000	10,800	60,500	47,200	122,000	108,000
AUG	17,800	11,900	21,400	15,400	54,200	48,400	109,000	103,000
SEP	11,300	10,100	13,700	12,700	34,900	34,100	72,800	72,000
OCT	5,100	7,020	6,320	8,240	15,900	18,000	36,000	38,100
NOV	2,150	7,520	2,670	7,990	6,490	11,900	14,400	19,800
DEC	1,520	8,540	1,890	8,750	4,490	11,300	9,510	16,300
Annual	8,010	7,990	9,720	9,660	24,100	24,000	48,600	48,500

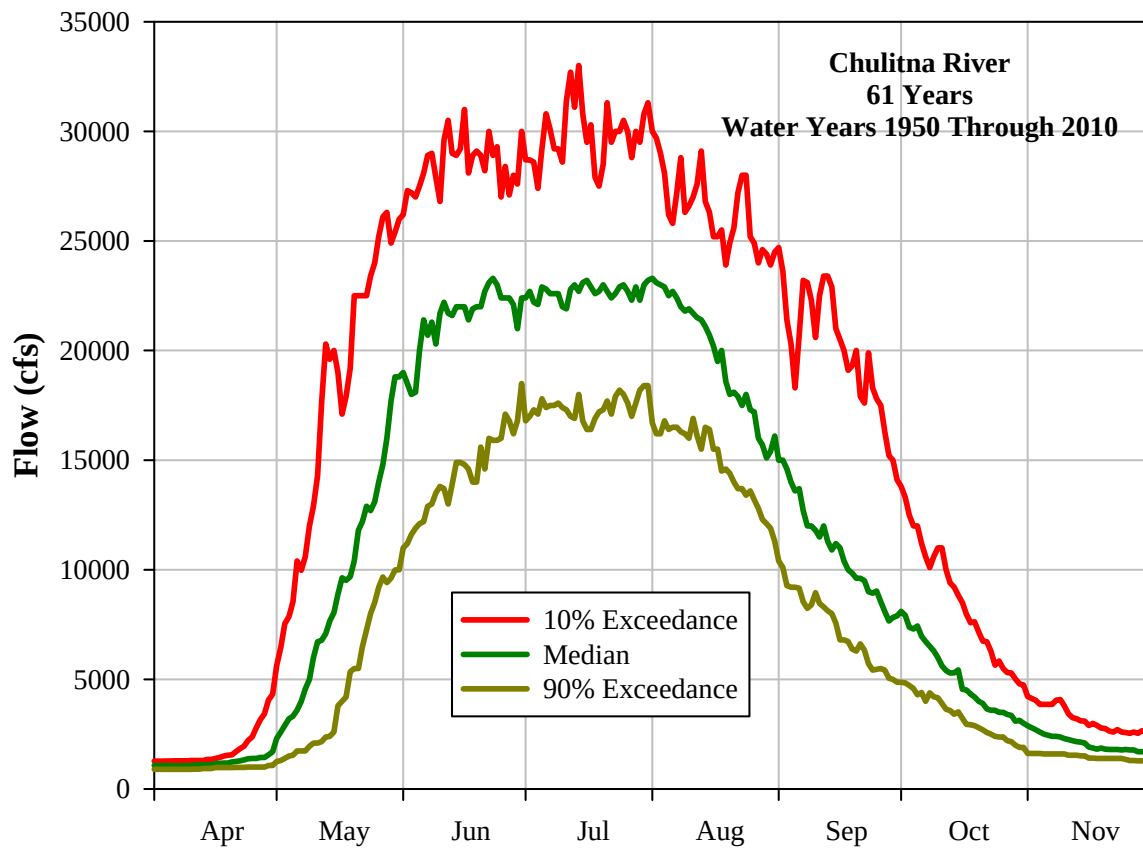


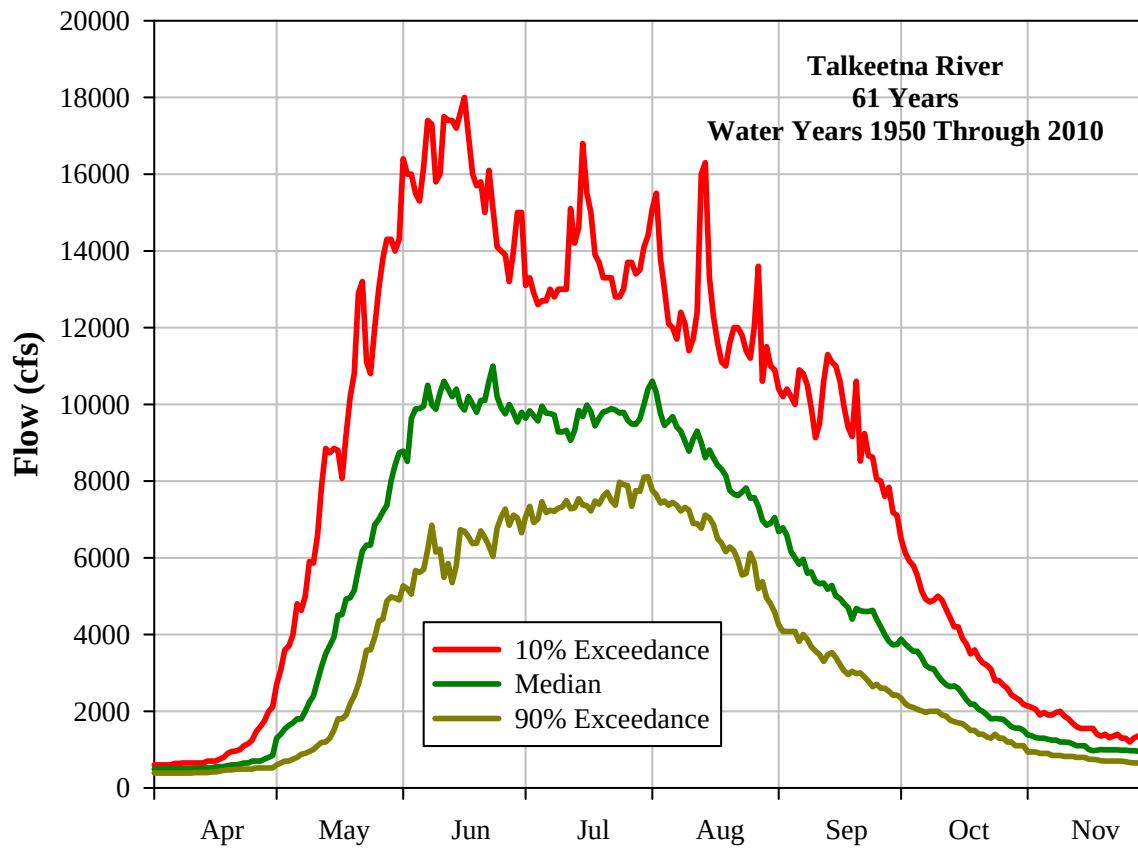


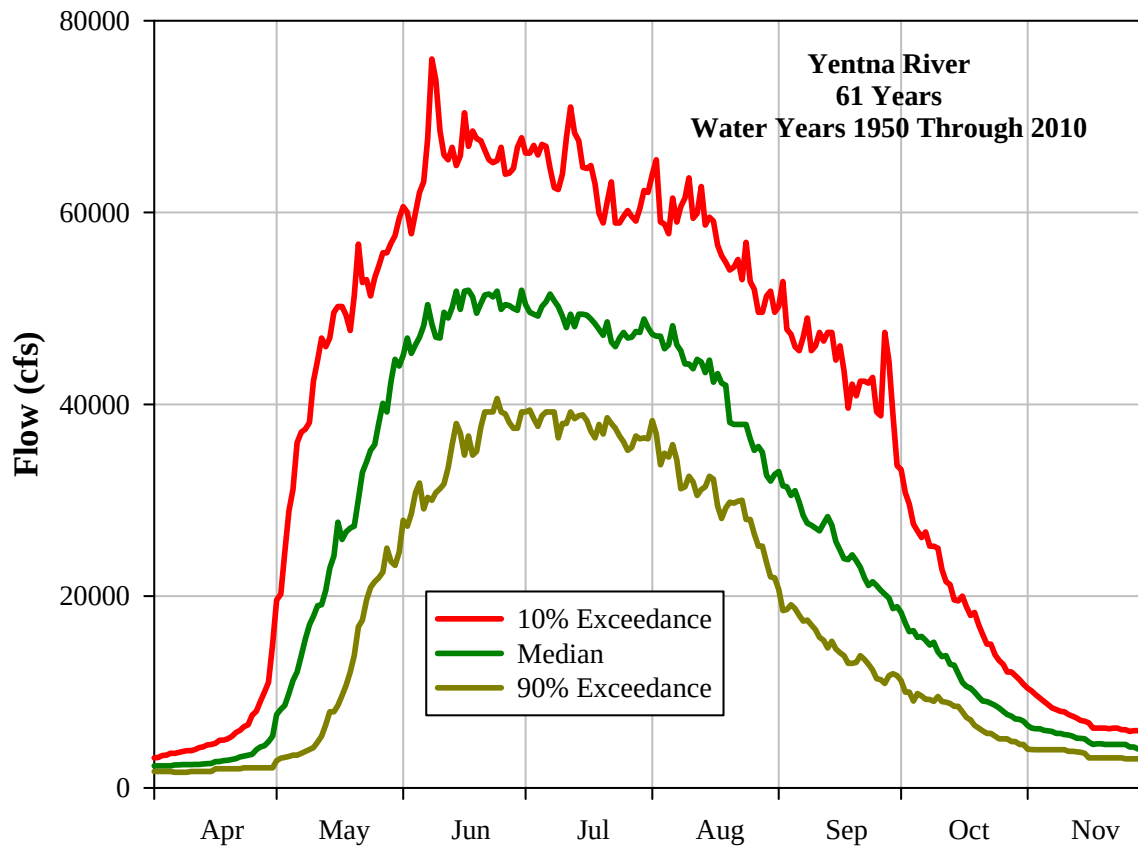










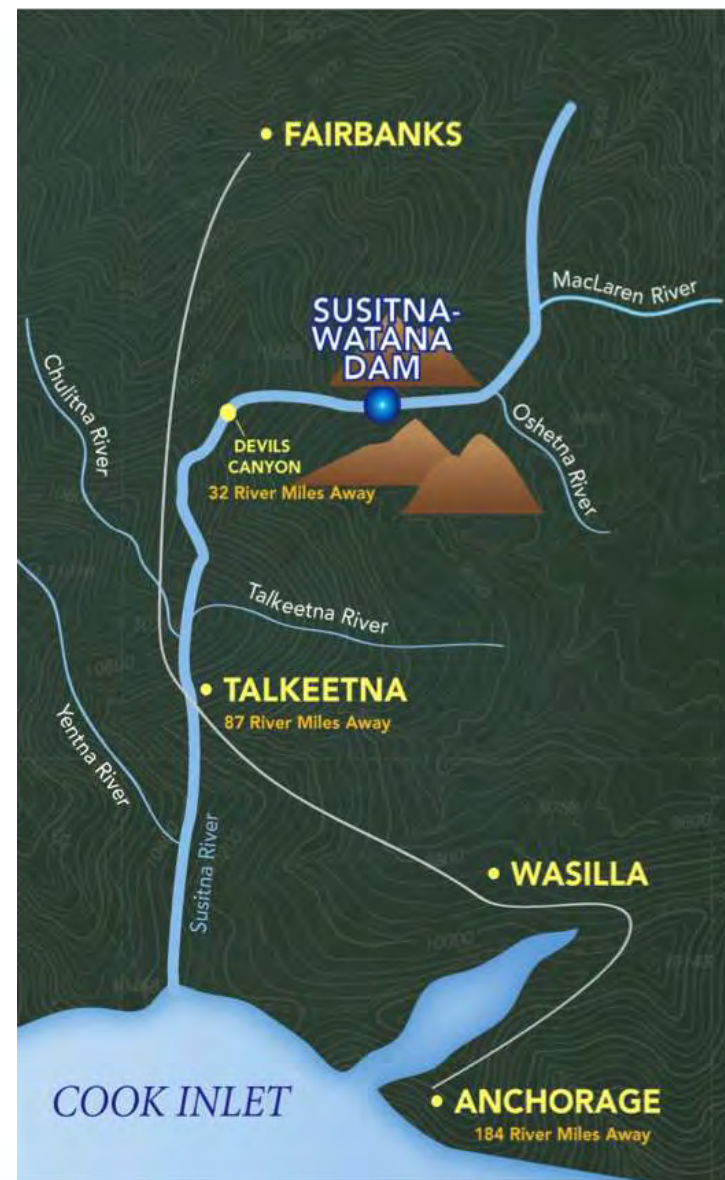


Hydrology Presentation: Existing and with-Project Hydrology

Technical Workgroup Meeting
February 14, 2013

Prepared by: Tetra Tech

Prepared for: Alaska Energy Authority



Background

2

- USGS developed 61 year extended discharge record
- HEC-ResSim model used to simulate operations for a maximum load following “bookend” scenario to develop hourly with-Project outflows (“Maximum Load Following Operation Scenario 1”)
- HEC-ResSim Muskingum-Cunge procedure with 1980s cross-sections used to route the flows downstream to Sunshine
- Both Pre-Project and Maximum Load Following OS-1 conditions analyzed
- Flow duration and peak flow analysis performed to provide initial comparison of the Maximum Load Following OS-1 scenario and Pre-Project conditions

Basis and Assumptions

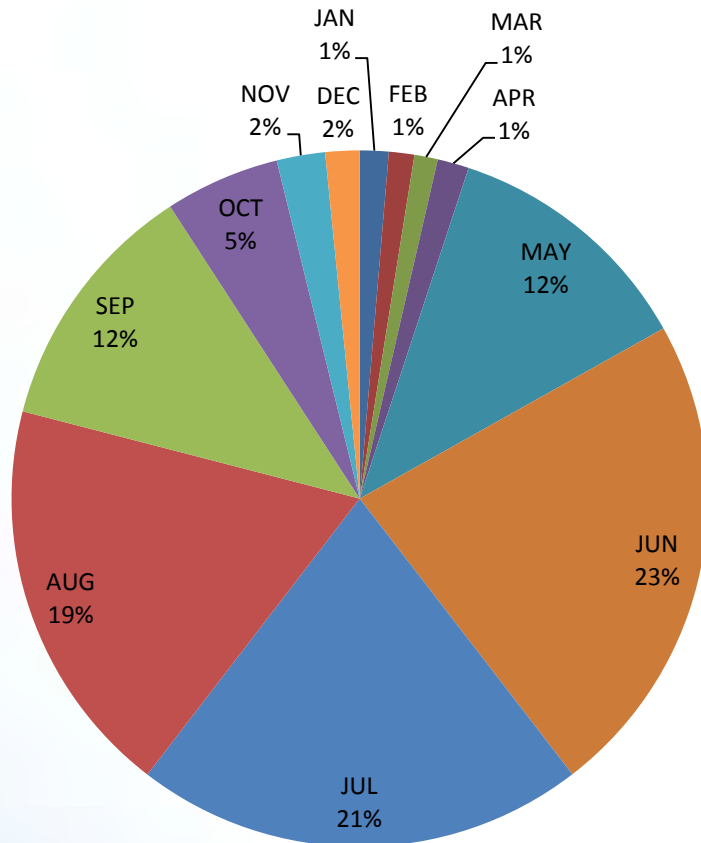
- Maximum Load Following OS-1 scenario assigns load fluctuation of the entire Railbelt to Watana
- Prepared for planning purposes – **Watana load is very conservative for any period of time and not realistic for an entire year**
- Hourly open-water flow routing results from HEC-ResSim
- Uses 1980s cross-sections and HEC-2 rating curves
- Railbelt generation loads from the 2010 Railbelt Integrated Resources Plan

Average Monthly and Annual Flows (cfs)

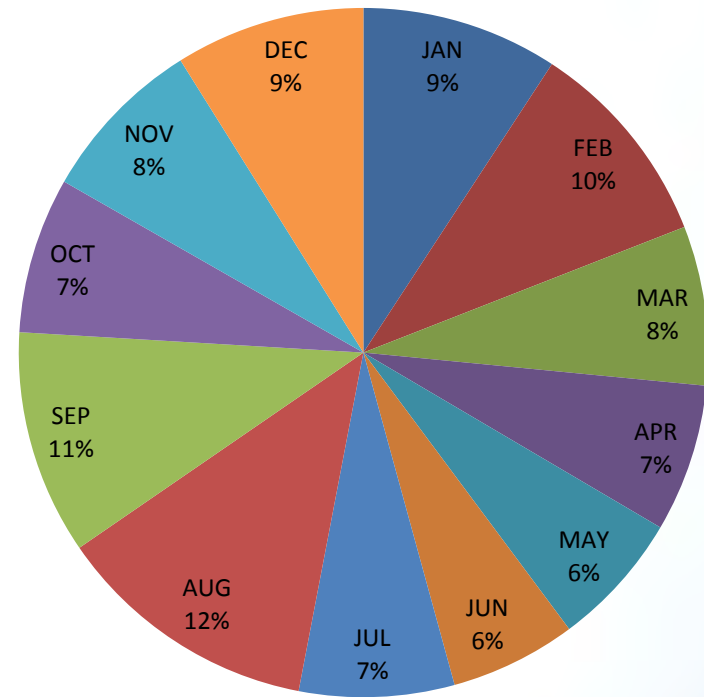
Period	Watana Dam (PRM 187)		Susitna River at Gold Creek (PRM 140)		Susitna River at Sunshine (PRM 87.9)		Susitna River at Susitna Station (PRM 29.9)	
	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1	Pre-Project	Max LF OS-1
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NOV	2,150	7,520	2,670	7,990	6,490	11,900	14,400	19,800
DEC	1,520	8,540	1,890	8,750	4,490	11,300	9,510	16,300
Annual	8,010	7,990	9,720	9,660	24,100	24,000	48,600	48,500

Monthly Average Flow Comparison (cfs) ⁵

Watana Dam (Pre-Project)

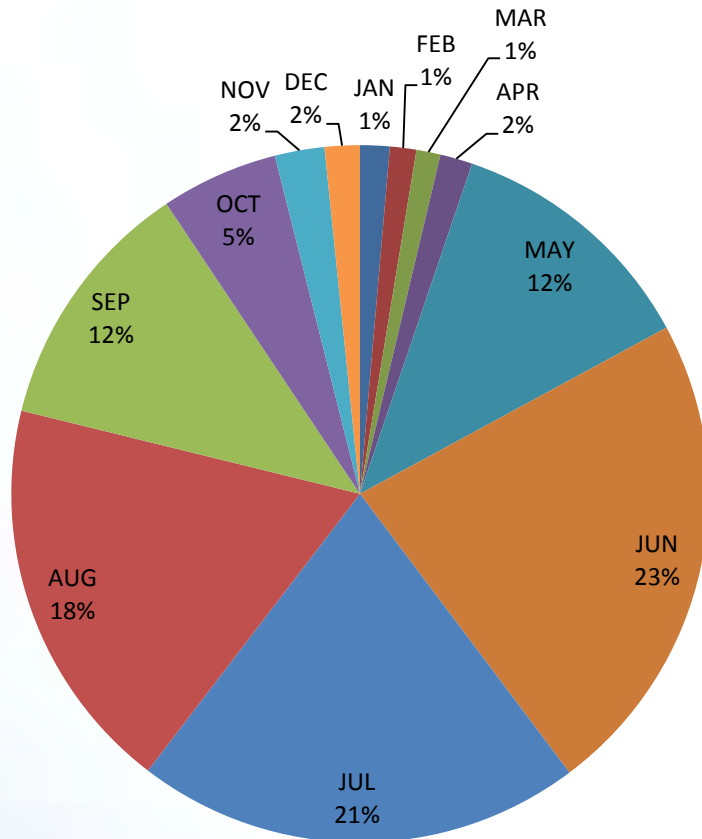


Watana Dam (Max LF OS-1)

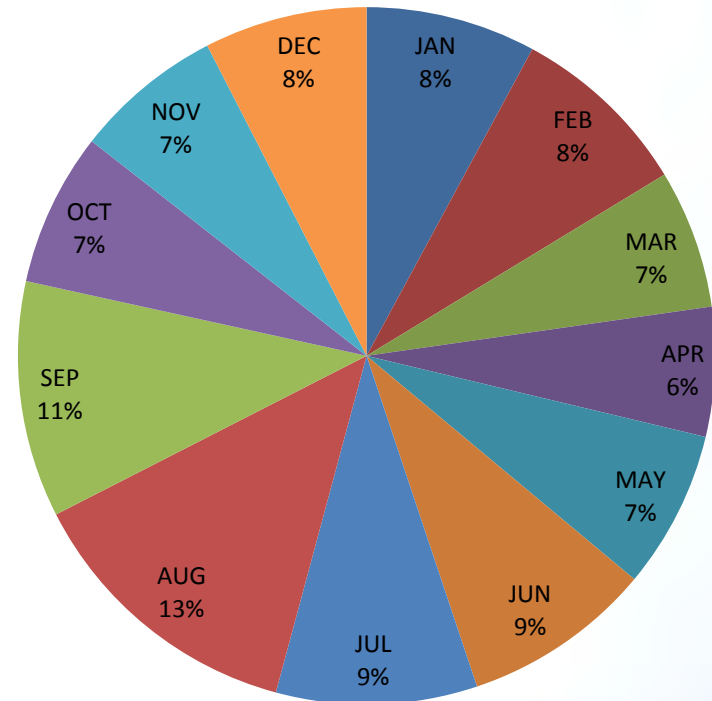


Monthly Average Flow Comparison (cfs) ⁶

Gold Creek (Pre-Project)

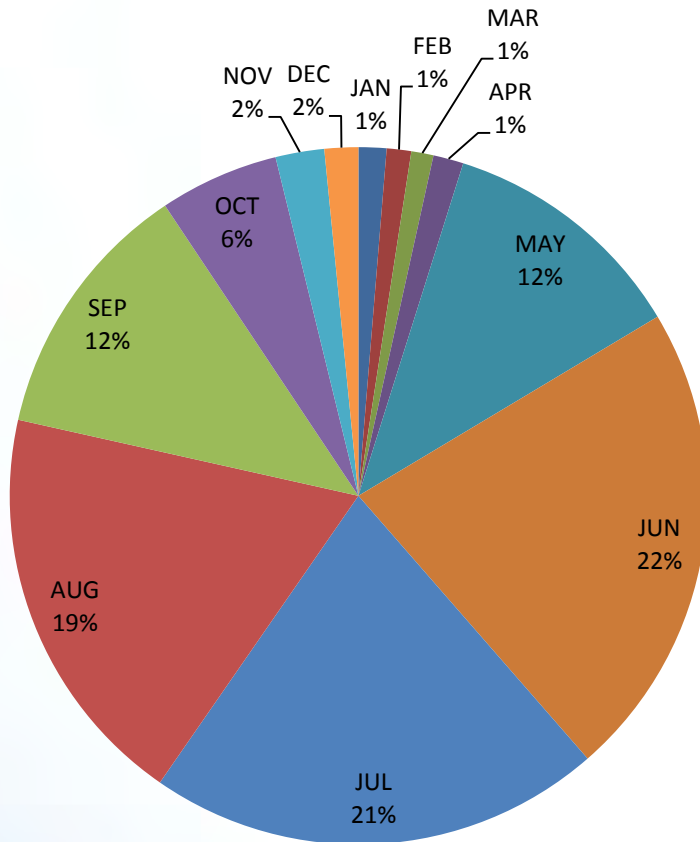


Gold Creek (Max LF OS-1)

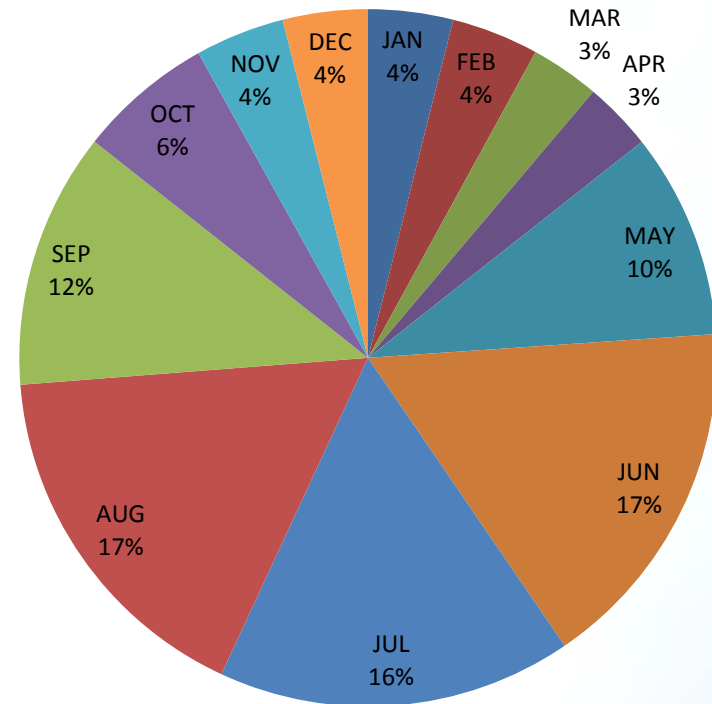


Monthly Average Flow Comparison (cfs) ⁷

Sunshine (Pre-Project)

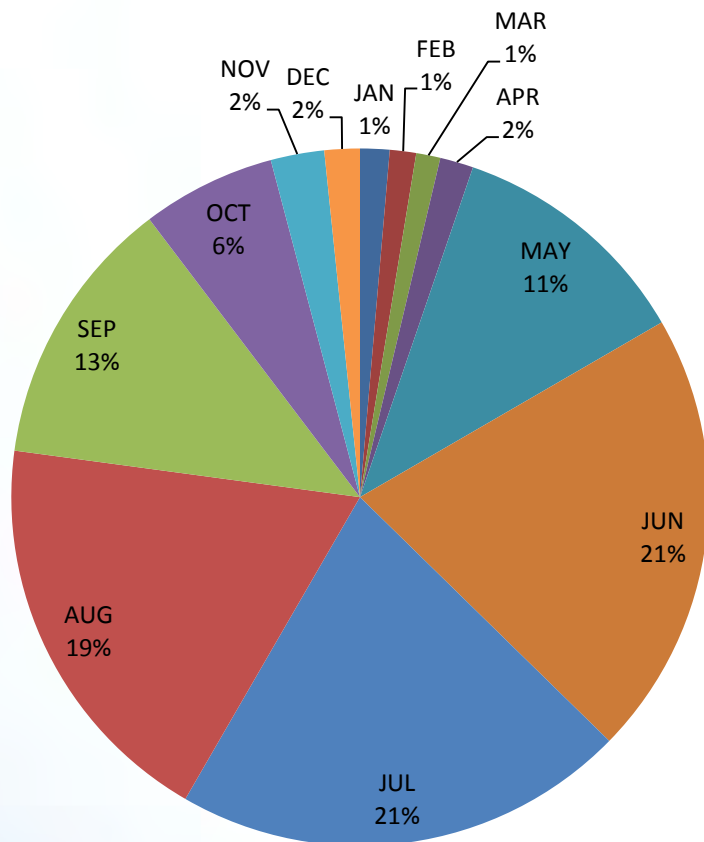


Sunshine (Max LF OS-1)

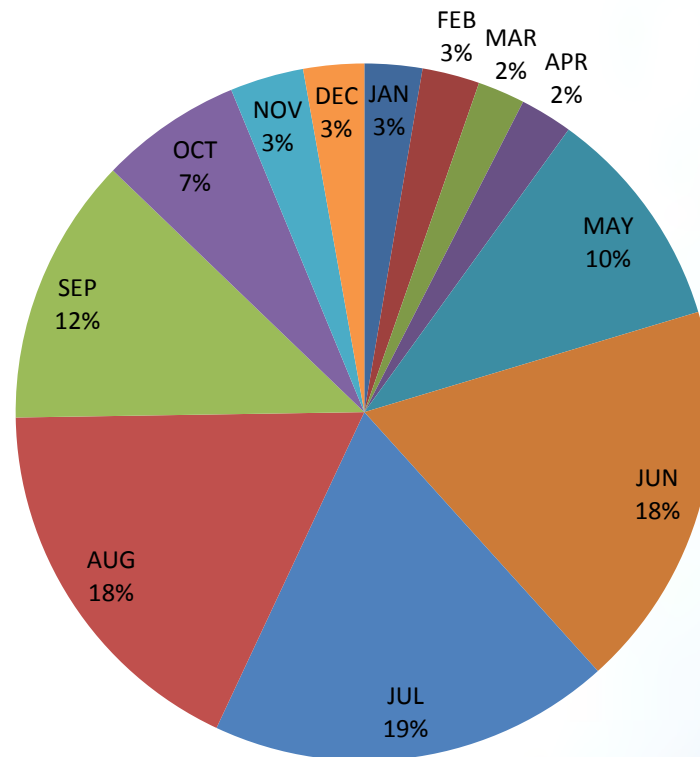


Monthly Average Flow Comparison (cfs) ⁸

Susitna Station (Pre-Project)



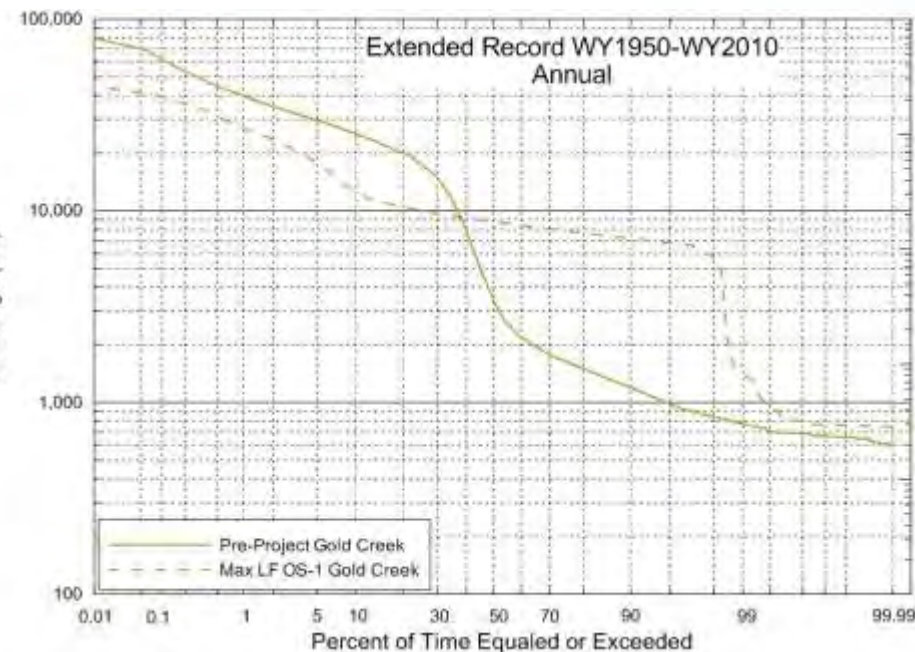
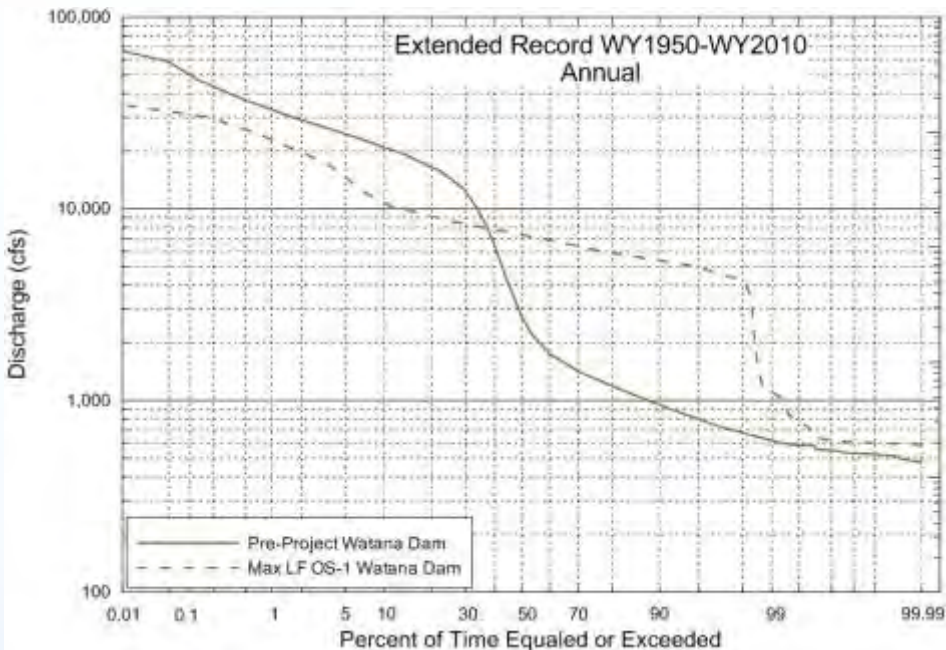
Susitna Station (Max LF OS-1)



Annual Flow Duration

Watana Dam (PRM187)

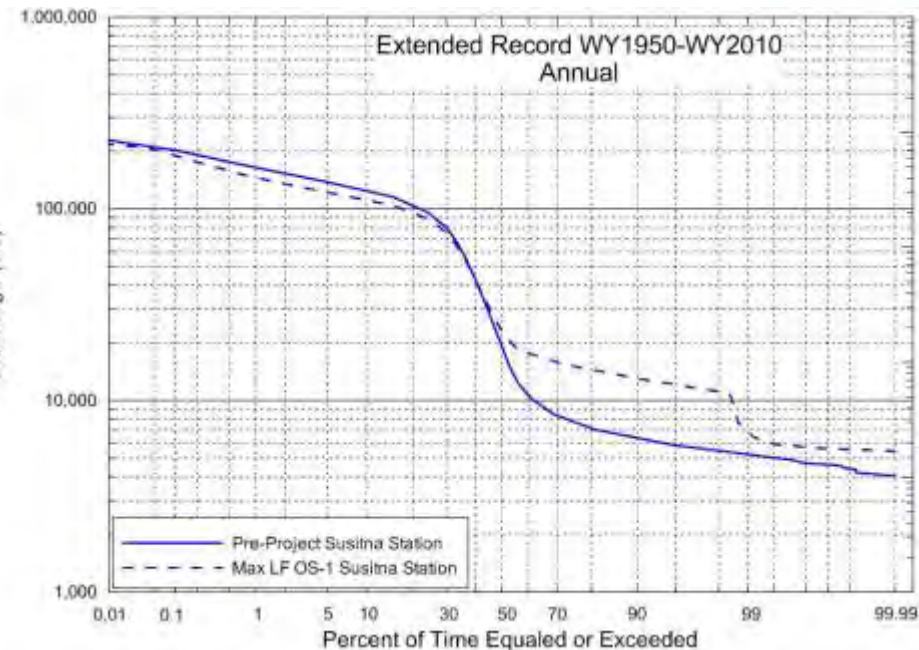
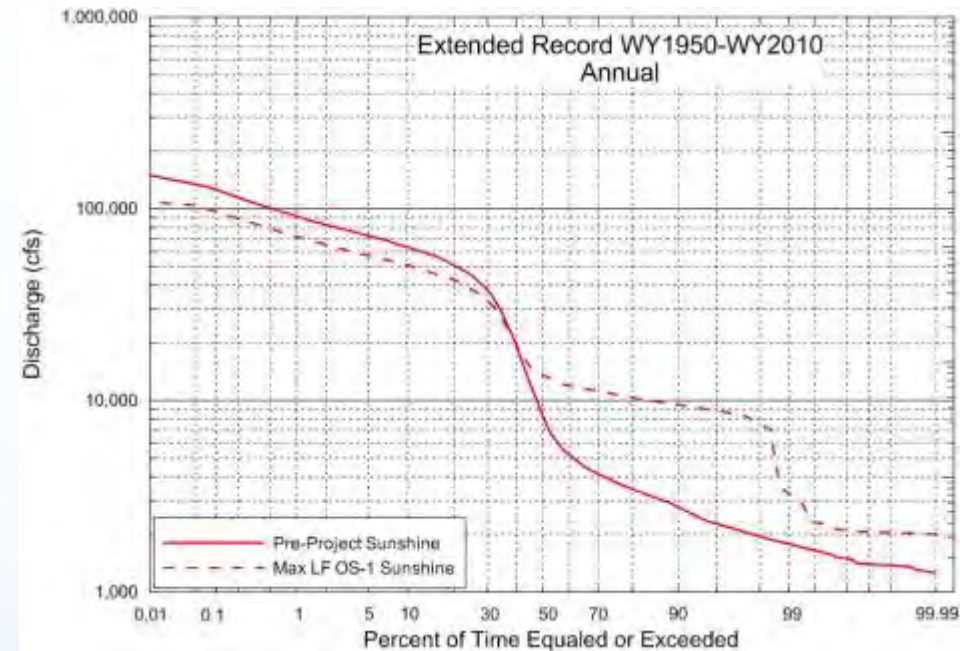
Gold Creek (PRM 140)



Annual Flow Duration

Sunshine (PRM 87.9)

Susitna Station (PRM 29.9)

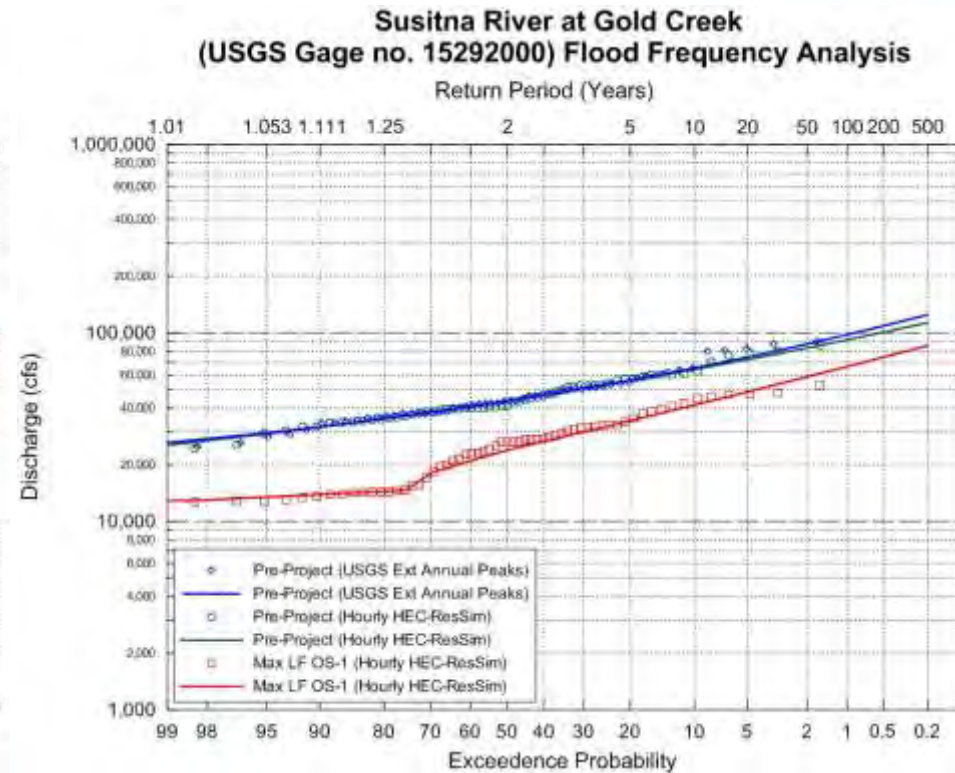
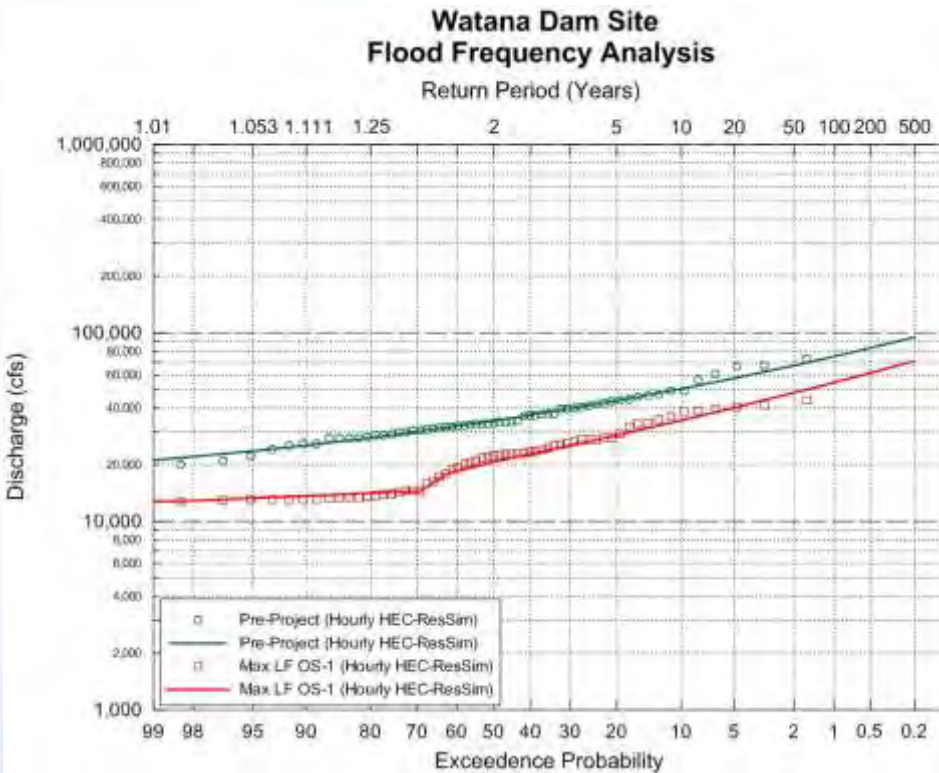


Flood Frequency

Pre-Project and Max LF OS-1

Watana Dam (PRM 187)

Gold Creek (PRM 140)



Flood Frequency

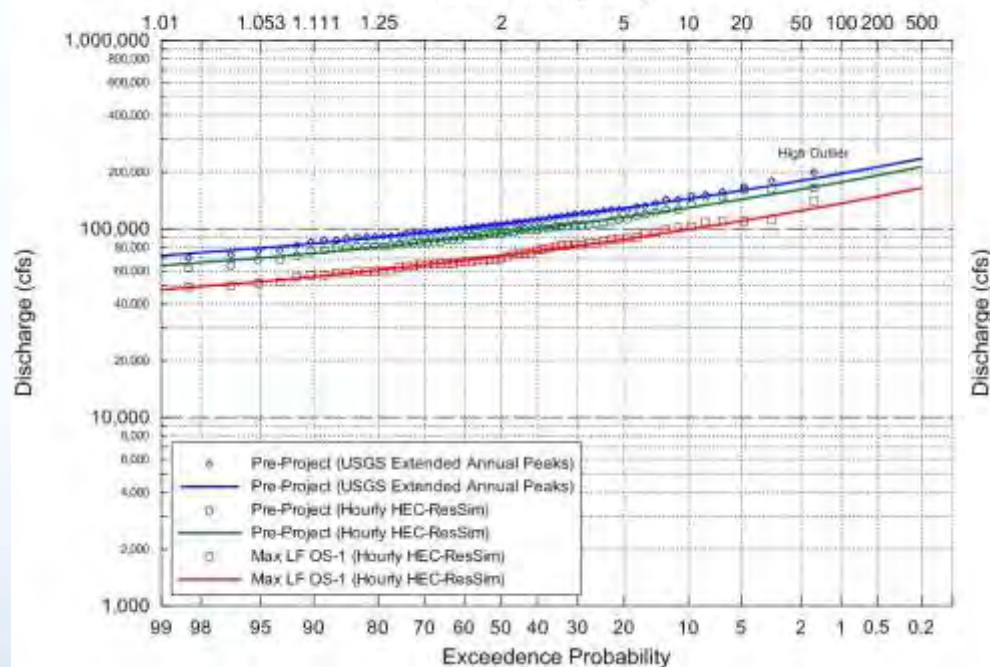
Pre- Project and Max LF OS-1

12

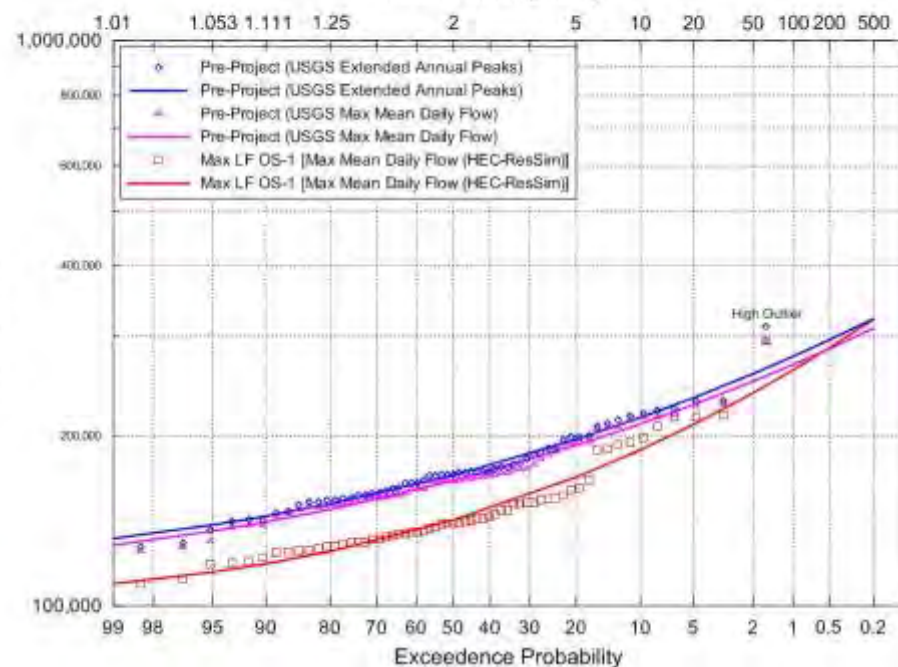
Sunshine (PRM 87.9)

Susitna Station (PRM 29.9)

**Susitna River at Sunshine
(USGS Gage no. 15292780) Flood Frequency Analysis**



**Susitna River at Susitna Station
(USGS Gage no. 15294350) Flood Frequency Analysis**



Annual Peak Flow Comparison: Watana Dam Site (PRM 187)

Return Period (Years)	Watana Dam Site			
	Pre-Project Flow (cfs)	Max LF OS-1 Flow (cfs)	Difference (cfs)	Difference (%)
1.01	21,100	12,800	-8,300	-39%
1.25	27,800	14,100	-13,700	-49%
1.5	30,700	15,800	-14,900	-49%
2	34,200	20,700	-13,500	-39%
5	43,700	28,700	-15,000	-34%
20	57,600	40,200	-17,400	-30%
50	67,300	48,200	-19,100	-28%
100	75,100	54,600	-20,500	-27%

SUSITN

Annual Peak Flow Comparison: Gold Creek (PRM 140)

Return Period (Years)	Gold Creek			
	Pre-Project Flow (cfs)	Max LF OS-1 Flow (cfs)	Difference (cfs)	Difference (%)
1.01	25,400	12,900	-12,500	-49%
1.25	35,100	14,400	-20,700	-59%
1.5	39,000	19,100	-19,900	-51%
2	43,700	23,900	-19,800	-45%
5	55,800	34,300	-21,500	-39%
20	72,300	48,800	-23,500	-33%
50	83,400	58,600	-24,800	-30%
100	92,100	66,400	-25,700	-28%

SUSITNA

Annual Peak Flow Comparison: Sunshine Station (PRM 87.9)

Return Period (Years)	Sunshine			
	Pre-Project Flow (cfs)	Max LF OS-1 Flow (cfs)	Difference (cfs)	Difference (%)
1.01	64,000	47,600	-16,400	-26%
1.25	80,200	60,500	-19,700	-25%
1.5	87,000	65,800	-21,200	-24%
2	94,700	72,000	-22,700	-24%
5	115,400	88,200	-27,200	-24%
20	143,600	110,400	-33,200	-23%
50	162,500	125,100	-37,400	-23%
100	177,300	136,700	-40,600	-23%

SUSITNA

Annual Peak Flow Comparison: Susitna Station (PRM 29.9)

Return Period (Years)	Susitna Station			
	Pre-Project Flow (cfs)	Max LF OS-1 Flow (cfs)	Difference (cfs)	Difference (%)
1.01	131,700	109,500	-22,200	-17%
1.25	151,600	124,900	-26,700	-18%
1.5	160,400	132,900	-27,500	-17%
2	170,300	141,900	-28,400	-17%
5	197,000	168,900	-28,100	-14%
20	233,500	209,400	-24,100	-10%
50	257,600	238,200	-19,400	-8%
100	276,300	261,400	-14,900	-5%

SUSITNA

Shift in Return Period of Peak Flows

Pre-Project vs. Max LF OS-1

Watana Dam Site (187)			Gold Creek (PRM 140)		
Discharge (cfs)	Pre-Project Return Period (years)	Max LF OS-1 Return Period (years)	Discharge (cfs)	Pre-Project Return Period (years)	Max LF OS-1 Return Period (years)
21,100	1.01	2	25,400	1.01	2
27,800	1.25	4	35,100	1.25	5
30,700	1.5	6	39,000	1.5	8
34,200	2	10	43,700	2	12
43,700	5	30	55,800	5	39
57,600	20	136	72,300	20	166

Shift in Return Period of Peak Flows

Pre-Project vs. Max LF OS-1

Sunshine (PRM 87.9)			Susitna Station (PRM 29.9)		
Discharge (cfs)	Pre-Project Return Period (years)	Max LF OS-1 Return Period (years)	Discharge (cfs)	Pre-Project Return Period (years)	Max LF OS-1 Return Period (years)
64,000	1.01	1.4	131,700	1.01	1.5
80,200	1.25	3	151,600	1.25	3
87,000	1.5	5	160,426	1.5	4
94,700	2	7	170,300	2	5
115,400	5	27	197,000	5	13
143,600	20	149	233,500	20	43

Ratio 100-year to 2-year Peak Flows

Location	Pre-Project Ratio	Max LF OS-1 Ratio
Watana Dam (PRM 187)	2.2	2.6
Gold Creek (PRM 140)	2.1	2.8
Sunshine (PRM 87.9)	1.9	1.9
Susitna Station (PRM 29.9)	1.6	1.8

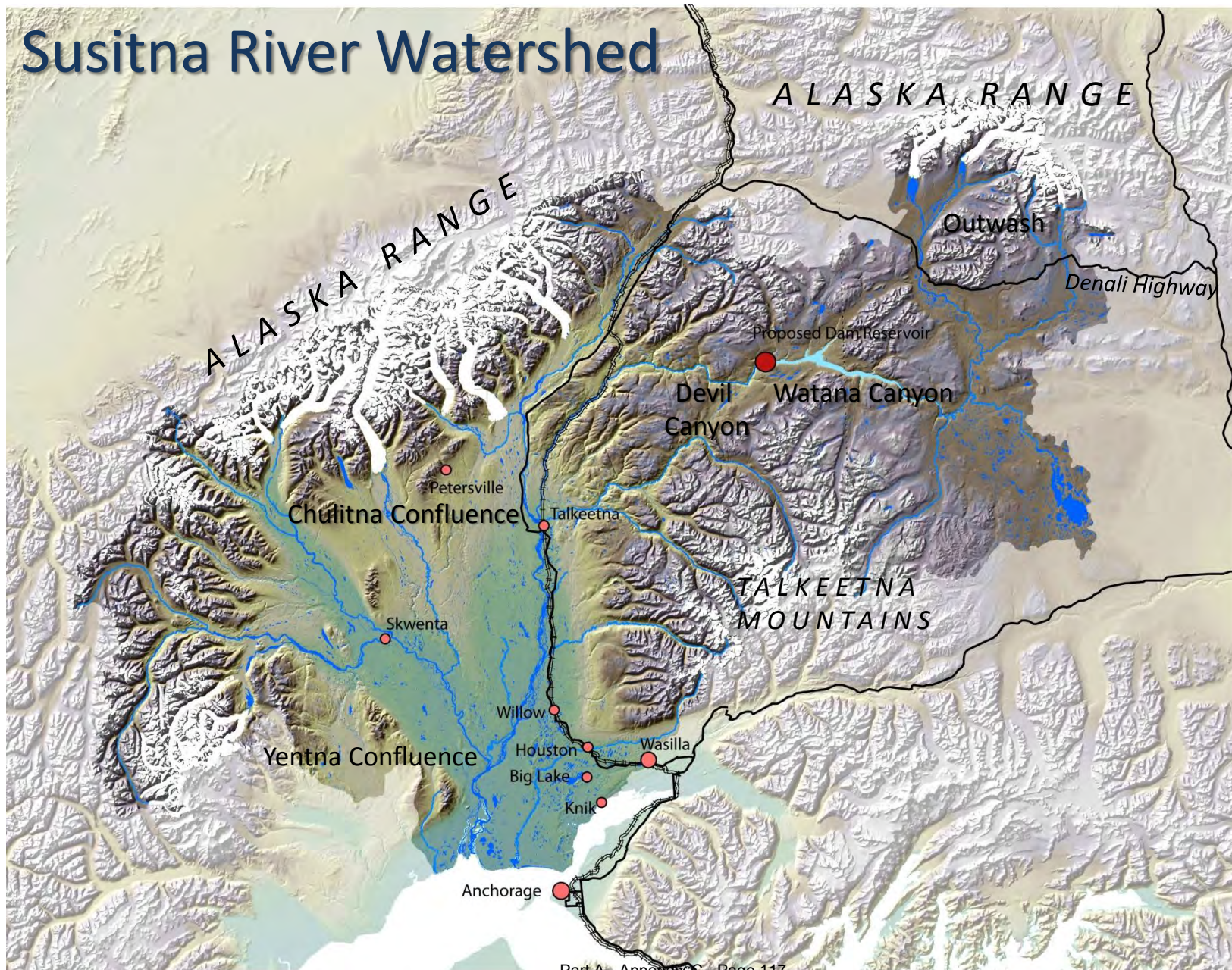
The Analysis is an Initial Assessment

- Performed to assist in study planning
- **Watana load is very conservative for any period of time & not realistic for an entire year**
- Models will be upgraded in 2013
 - Replace HEC-ResSim Muskingum-Cunge routing
 - 2012 X-sections, additional 2013 X-sections
 - Refine tributary inflows and accretion flows
 - Additional calibration

Hydrology of the Susitna River

Robin Beebee, HDR Alaska, Inc.

Susitna River Watershed



Upper Susitna River and Susitna Glacier



Robin Beebee Photo



Alaska Energy Authority Photo

Watana Canyon of the Susitna



Devil Canyon of the Susitna



National Geographic Photo





Near Gold Creek



Chulitna Confluence Near Talkeetna







Lower Susitna River



Mark Meyers Photo

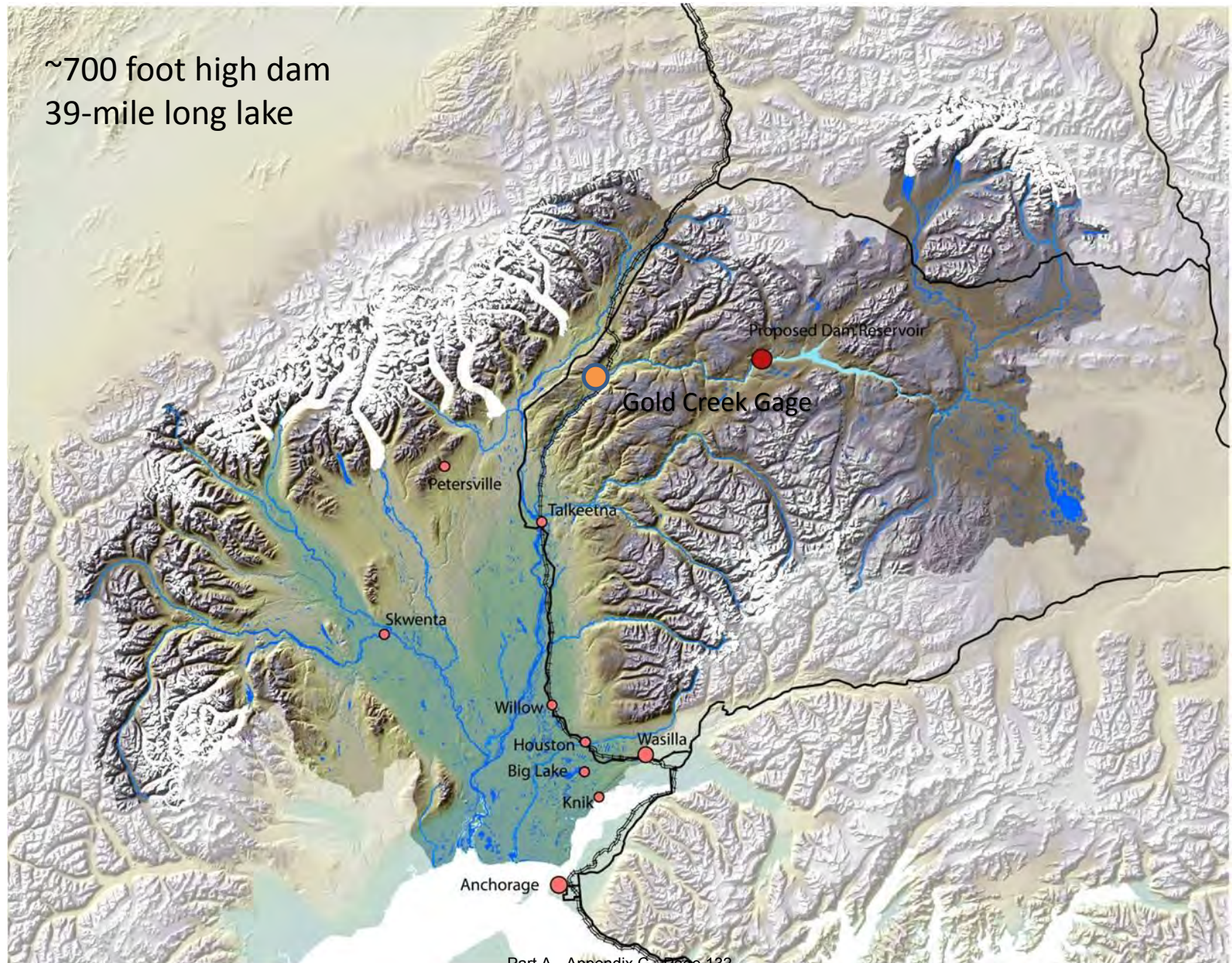


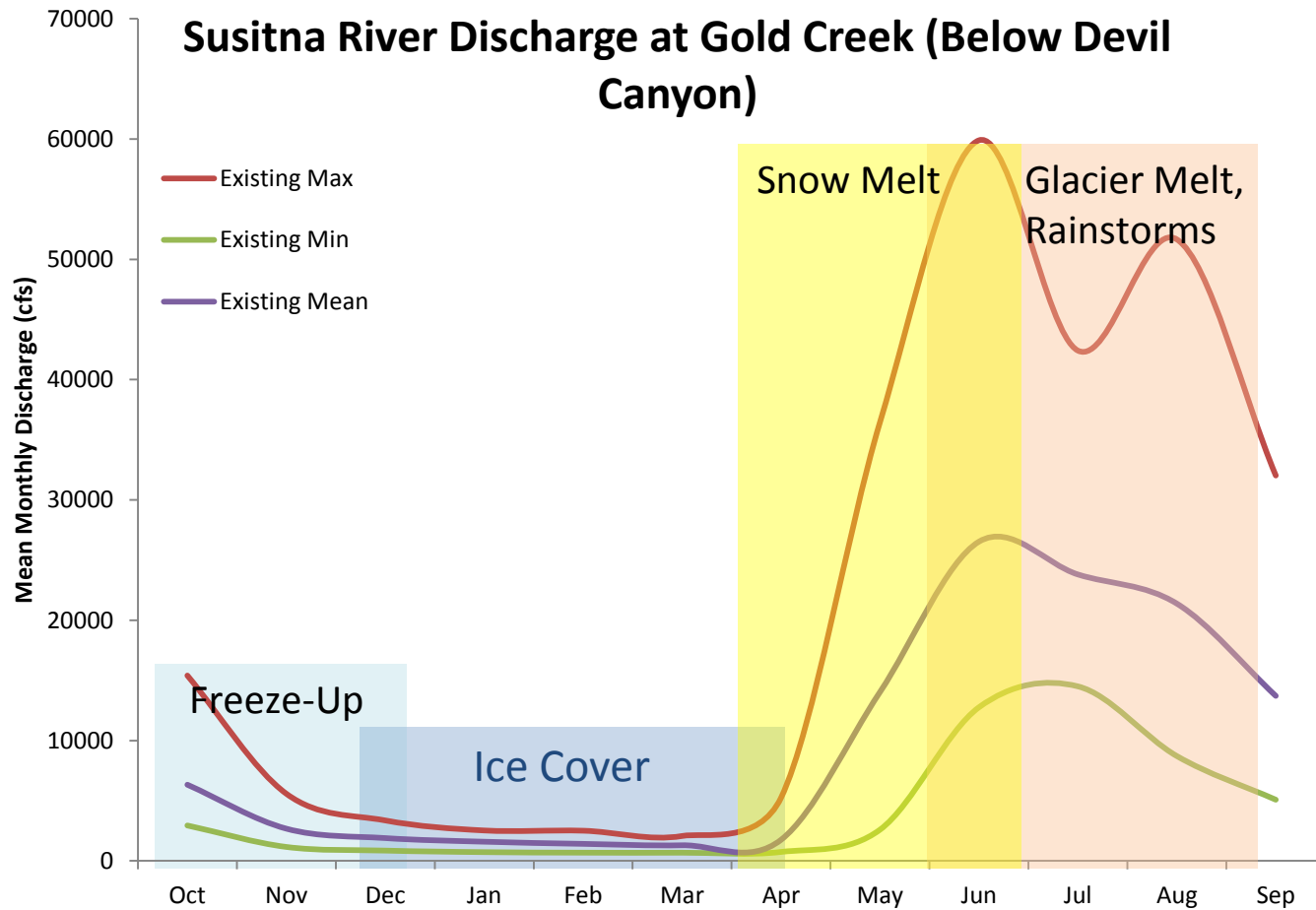
Near Yentna Confluence



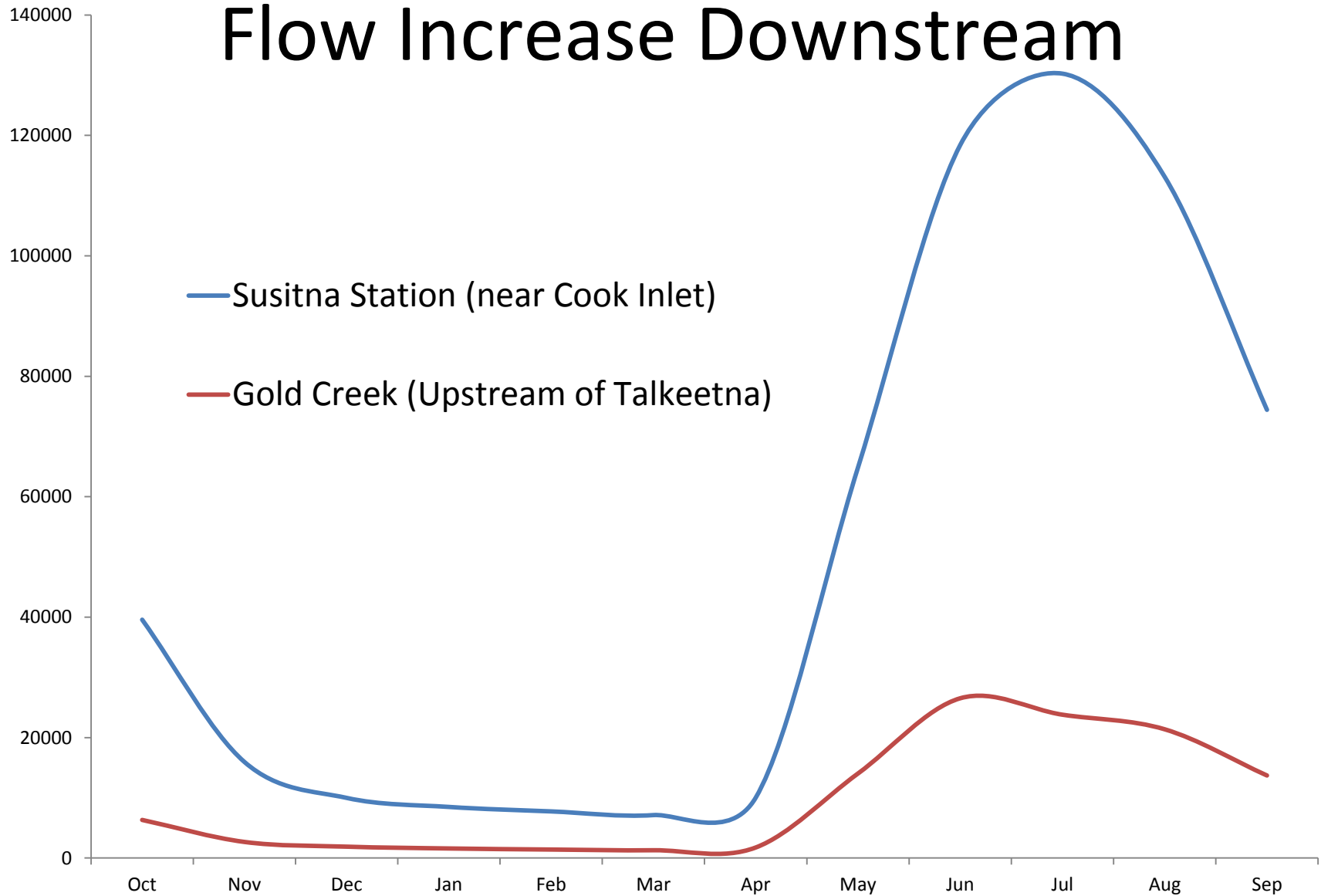


~700 foot high dam
39-mile long lake

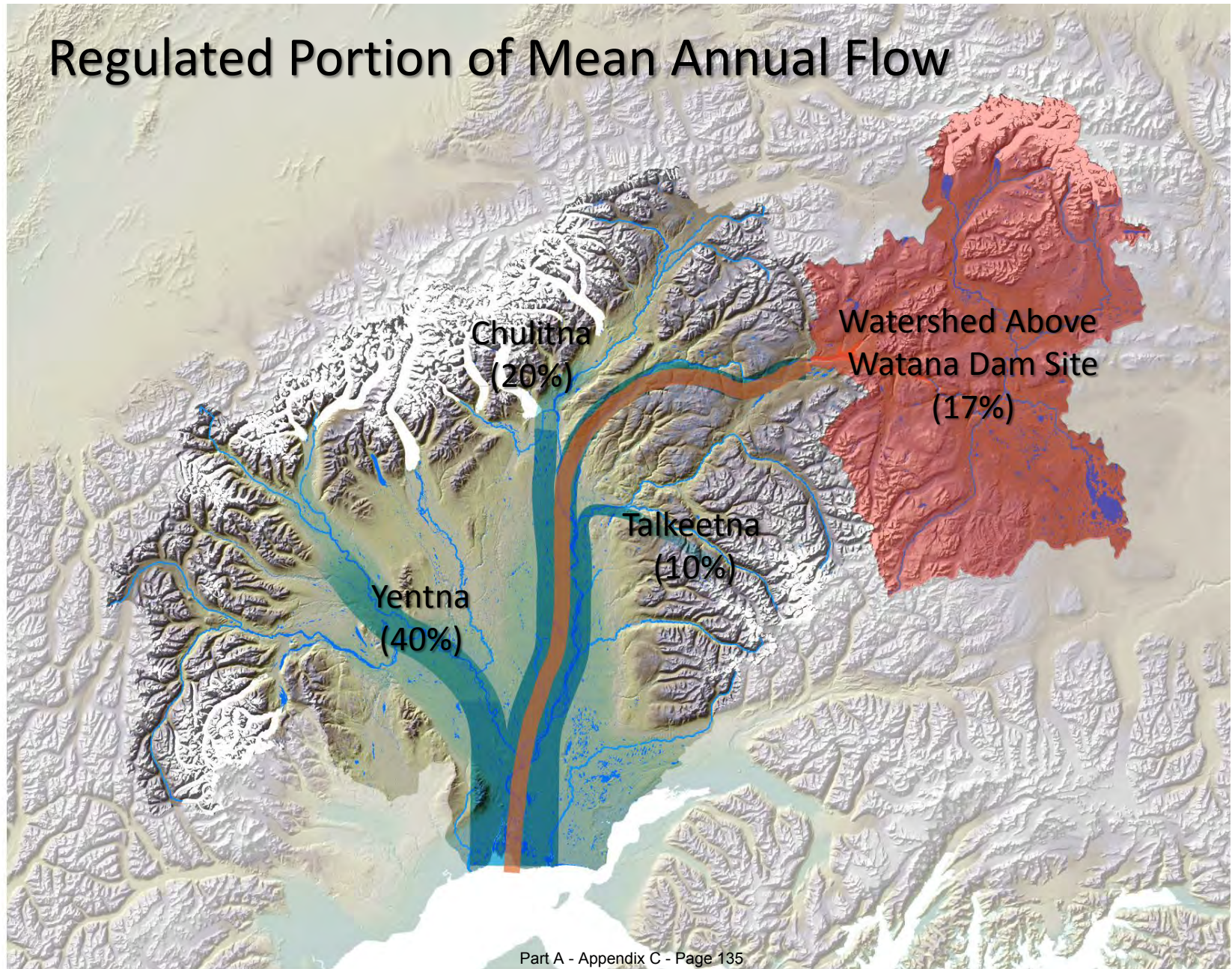


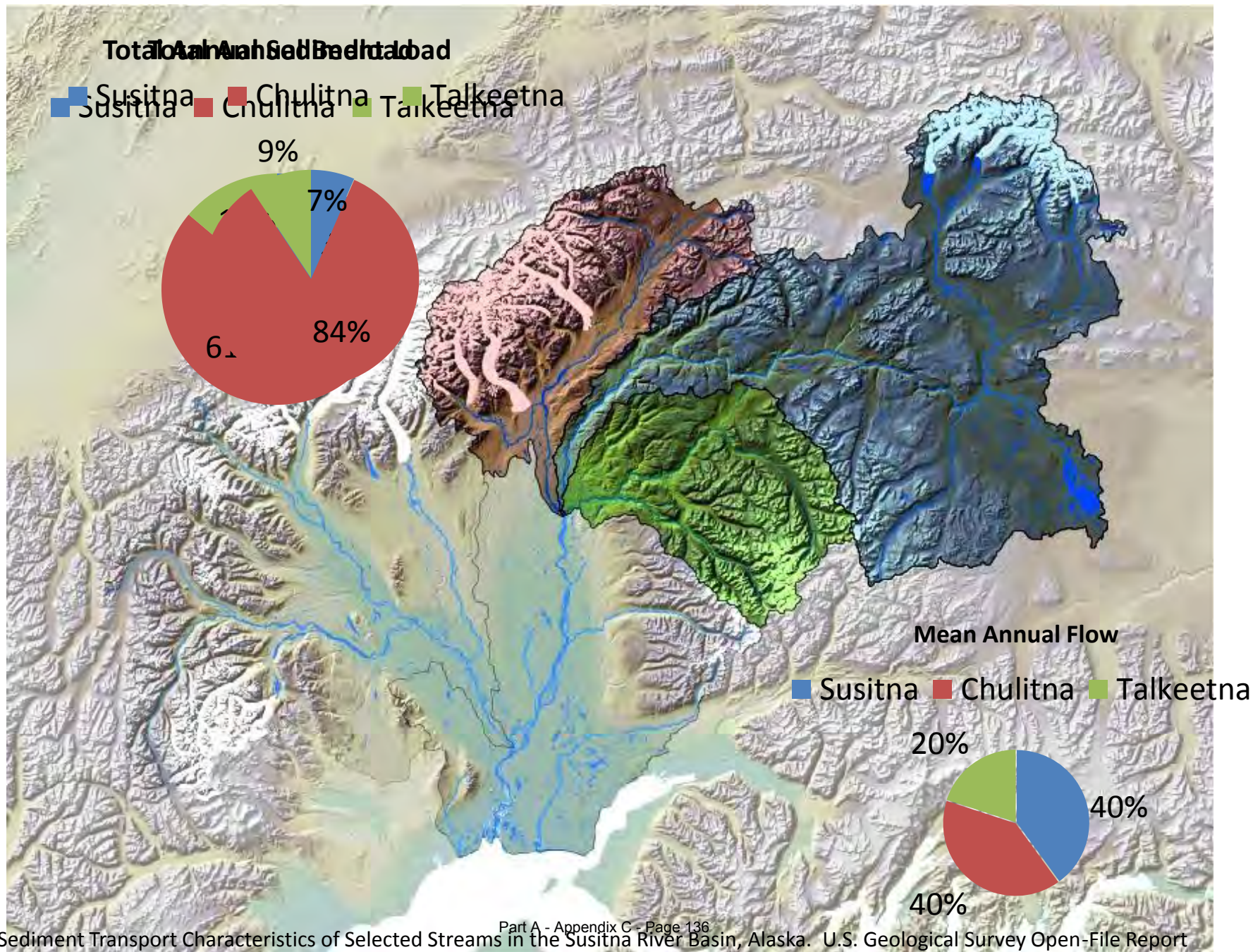


Flow Increase Downstream



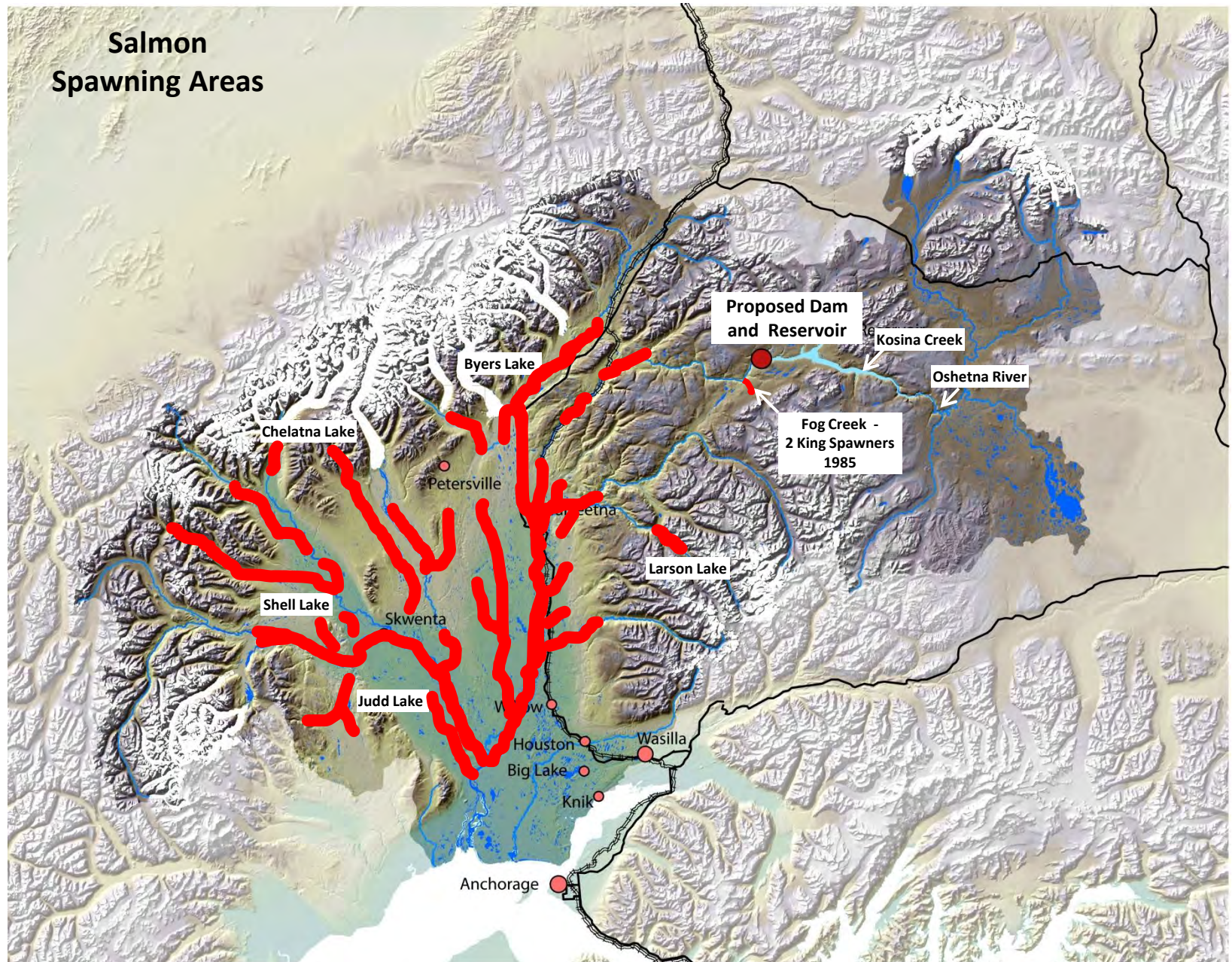
Regulated Portion of Mean Annual Flow







Salmon Spawning Areas



Slough 20				
	81	82	83	84
Chum	14	30	63	280
Sockeye	2	0	0	0
Pink	0	64	0	85

Slough 19				
	81	82	83	84
Chum	3	0	3	45
Sockeye	23	0	5	11
Pink	0	1	0	0

Slough 17				
	81	82	83	84
Chum	38	21	90	66
Sockeye	6	0	6	16
Pink	0	0	0	1

Slough 16				
	81	82	83	84
Chum	3	0	0	15

Gold Creek				
	81	82	83	84
Chinook	-	21	23	23
Pink	0	11	7	82
Coho	0	1	0	0

Indian River				
	81	82	83	84
Chinook	422	1053	1193	1456
Chum	40	1346	722	2247
Pink	2	738	886	9066
Coho	85	101	53	465
Sockeye	0	0	1	1

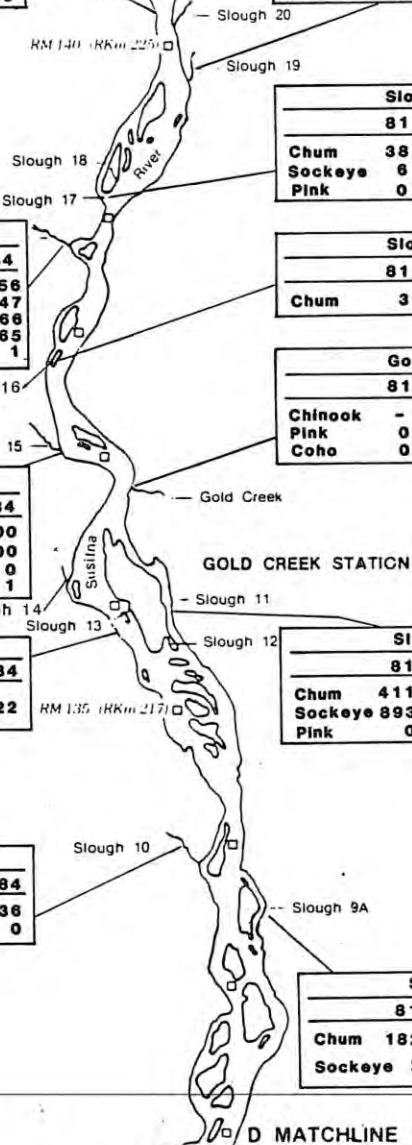
Slough 15				
	81	82	83	84
Chum	1	1	2	100
Pink	1	132	0	500
Coho	0	14	0	0
Sockeye	0	0	0	1

Slough 13				
	81	82	83	84
Chum	4	0	4	22

Slough 10				
	81	82	83	84
Chum	0	2	1	36
Sockeye	-	-	1	0

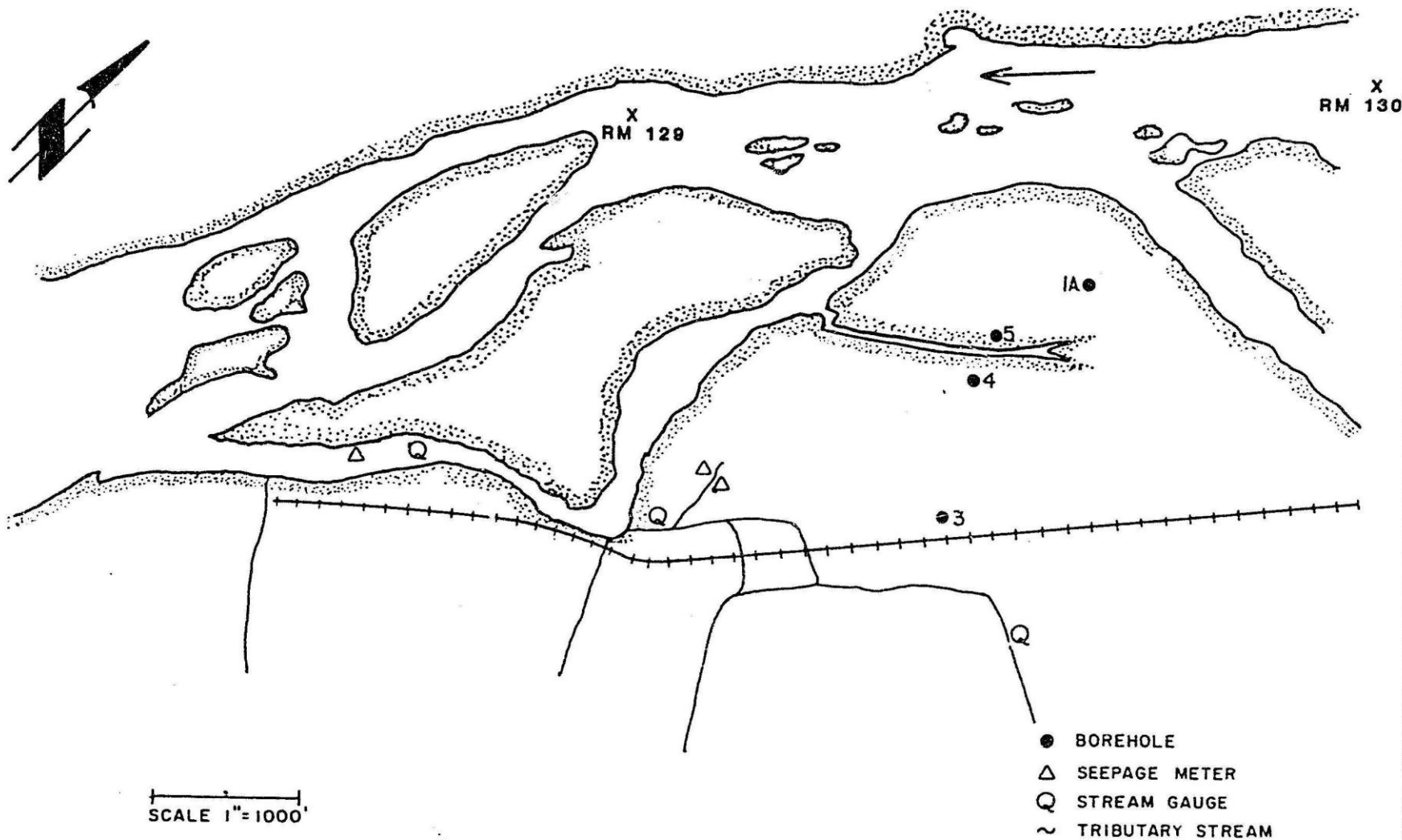
Slough 11				
	81	82	83	84
Chum	411	459	23	
Sockeye	893	456	24	
Pink	0	131		

Slough 9A				
	81	82	83	84
Chum	182	118	10	
Sockeye	2	1		



SLOUGH AND TRIBUTARY INDEX AREA PEAK SPAWNING COUNTS

SOURCE: ADF & G 1981a, 1983a, 1984b, 1985b



PREPARED BY:

R&M

R&M CONSULTANTS, INC.

ENGINEERS GEOLOGISTS HYDROLOGISTS SURVEYORS

Figure 3.3 SLOUGH 9

PREPARED FOR:

HARZA-EBASCO

SUSITNA JOINT VENTURE



Potential Effects of the Dam – River Flow, Sediment Transport, Ice Processes



Learn More!

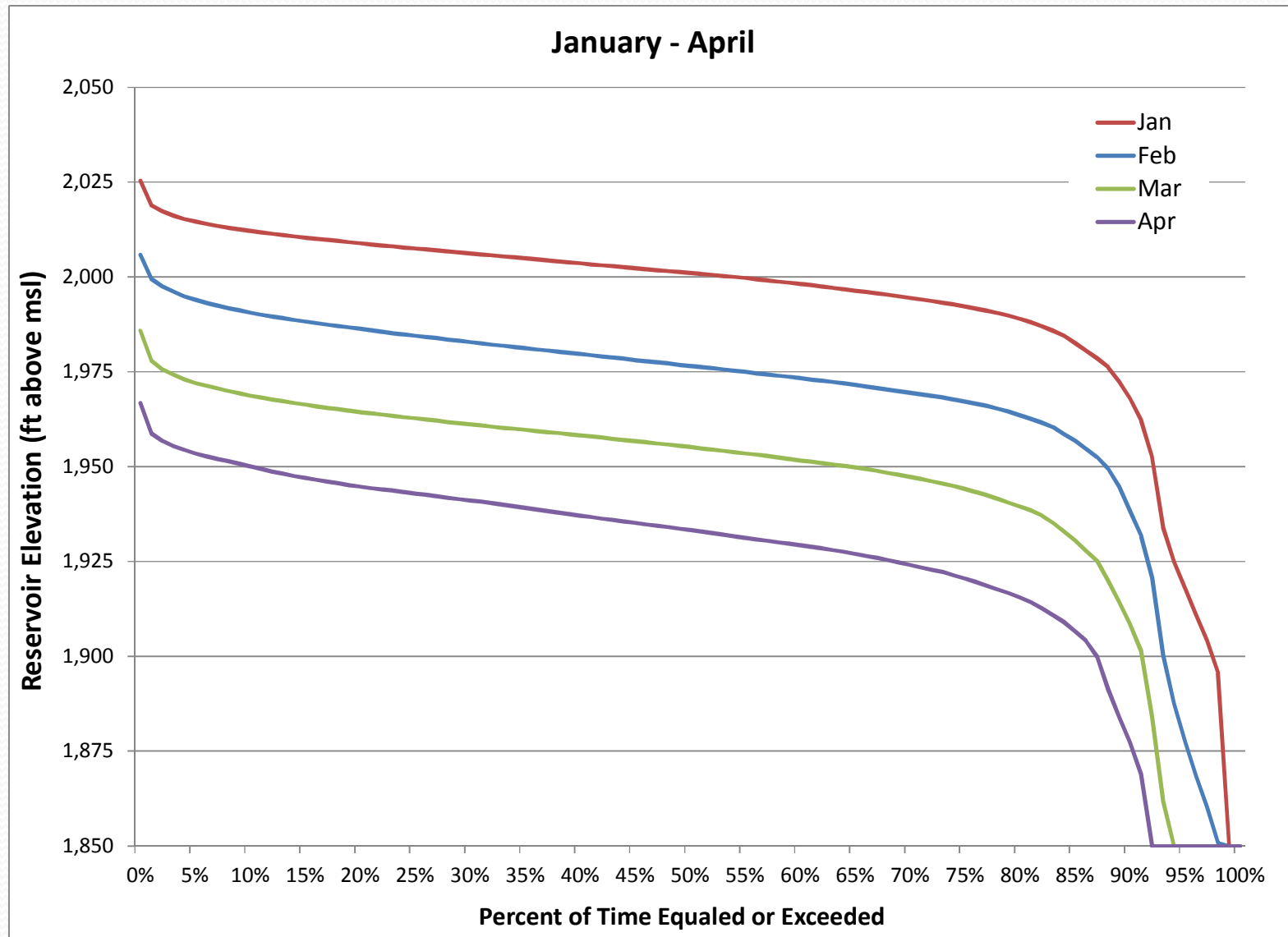


Acknowledgements

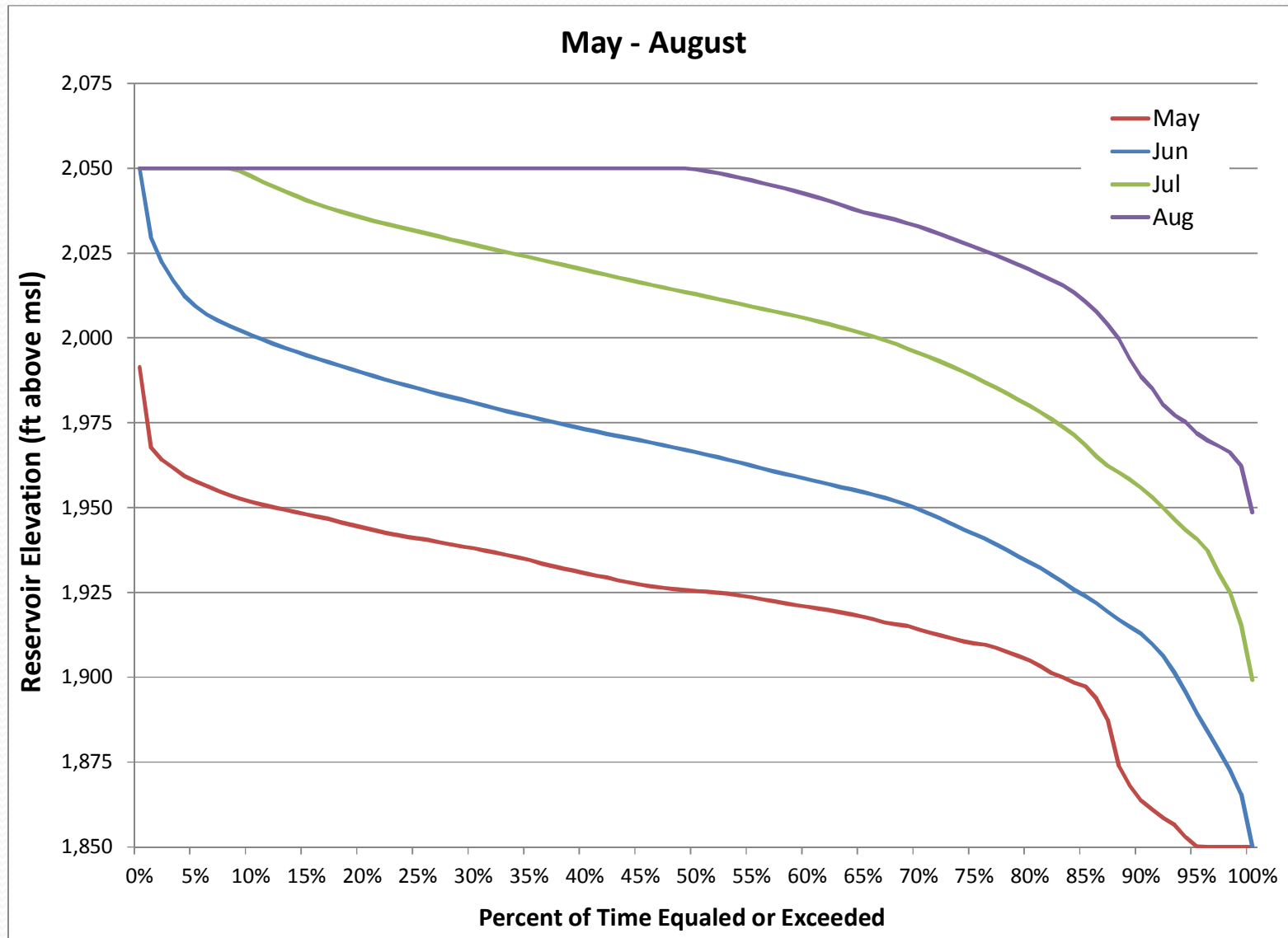
Information collected from numerous studies conducted by the Alaska Power Authority in the 1980s, from USGS mapping and streamflow records, and from studies conducted with funding from the Alaska Energy Authority and Alaska Department of Transportation and Public Facilities. Opinions are, of course, my own.

INFORMATION ITEM P5:
RESERVOIR ELEVATION DURATION CURVES BY MONTH

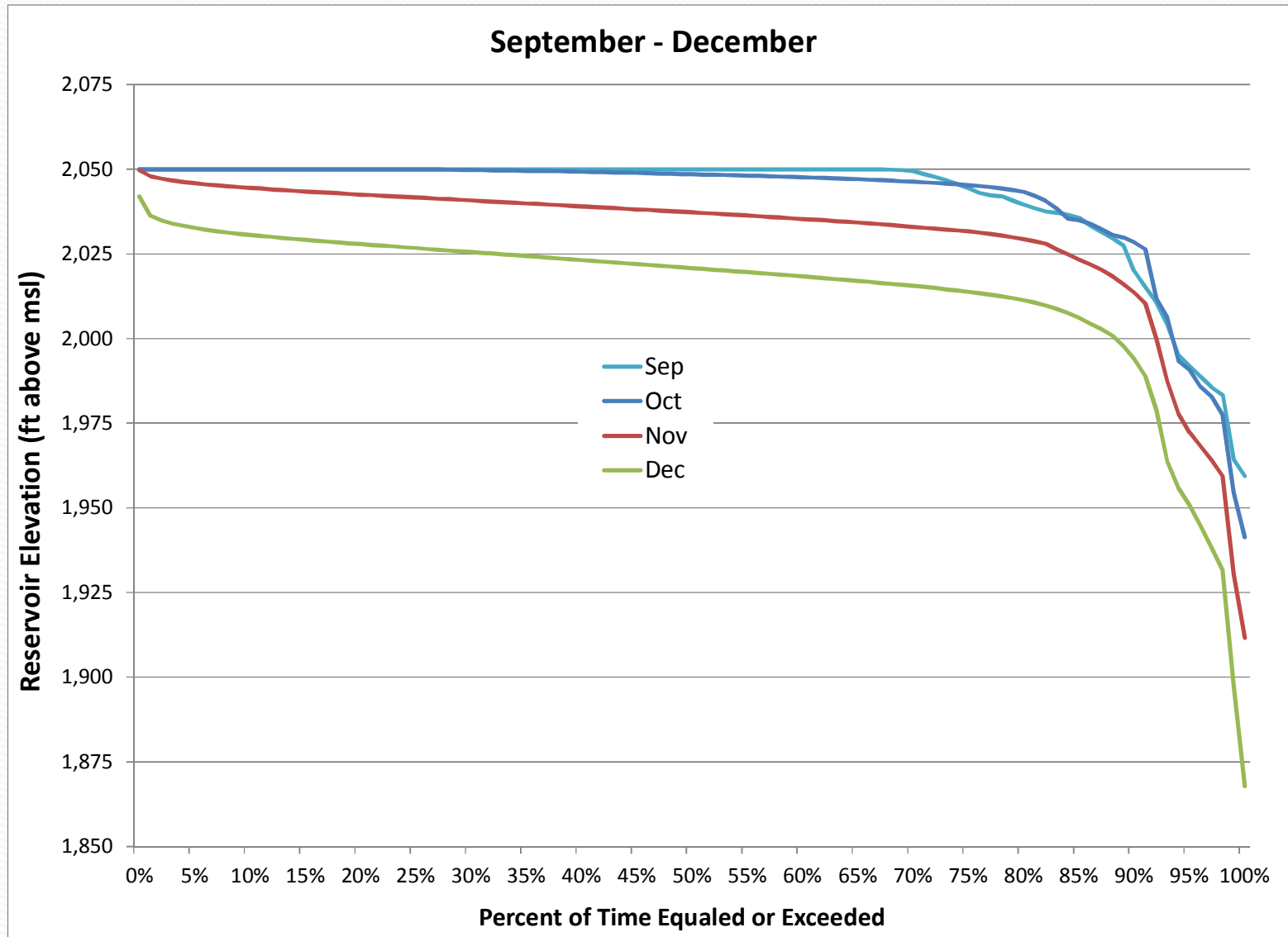
P5 – Monthly Elevation Duration Curves



P5 – Monthly Elevation Duration Curves



P5 – Monthly Elevation Duration Curves



INFORMATION ITEM P6:
OTHER PROJECT OPERATIONS DATA

INFORMATION ITEM P7:
EXISTING ICE COVER ON RIVER AND TRIBUTARIES

Existing Information

- All measurements and observation locations are compiled into an Access database and are sorted by river mile.
 - Freeze-up and breakup progression observations, 1980-1985 (Upper River observed in 1980 and 1985)
 - Freeze-up bridging has occurred at RM 170, RM 186, RM 194. Freeze-up jam and breakout around RM 186.
 - Major breakup jam recurred near damsite.
 - 34 Ice thickness measurements between Devil Canyon and Vee Canyon – 2 ft – 4 feet average, maximum of 6-plus feet.
- Model predictions of post-project ice cover progression, ice thickness and elevation, and the open-water lead downstream of the dam site.



Susitna River Freeze Up Process – Frazil Production

- River cools to 32 degrees
- Frazil appears, flows downstream
- Border ice grows
- Significant anchor ice grows upstream of Devil Canyon, but is transient.



Susitna River Freeze Up Process – Frazil Production and Border Ice Growth



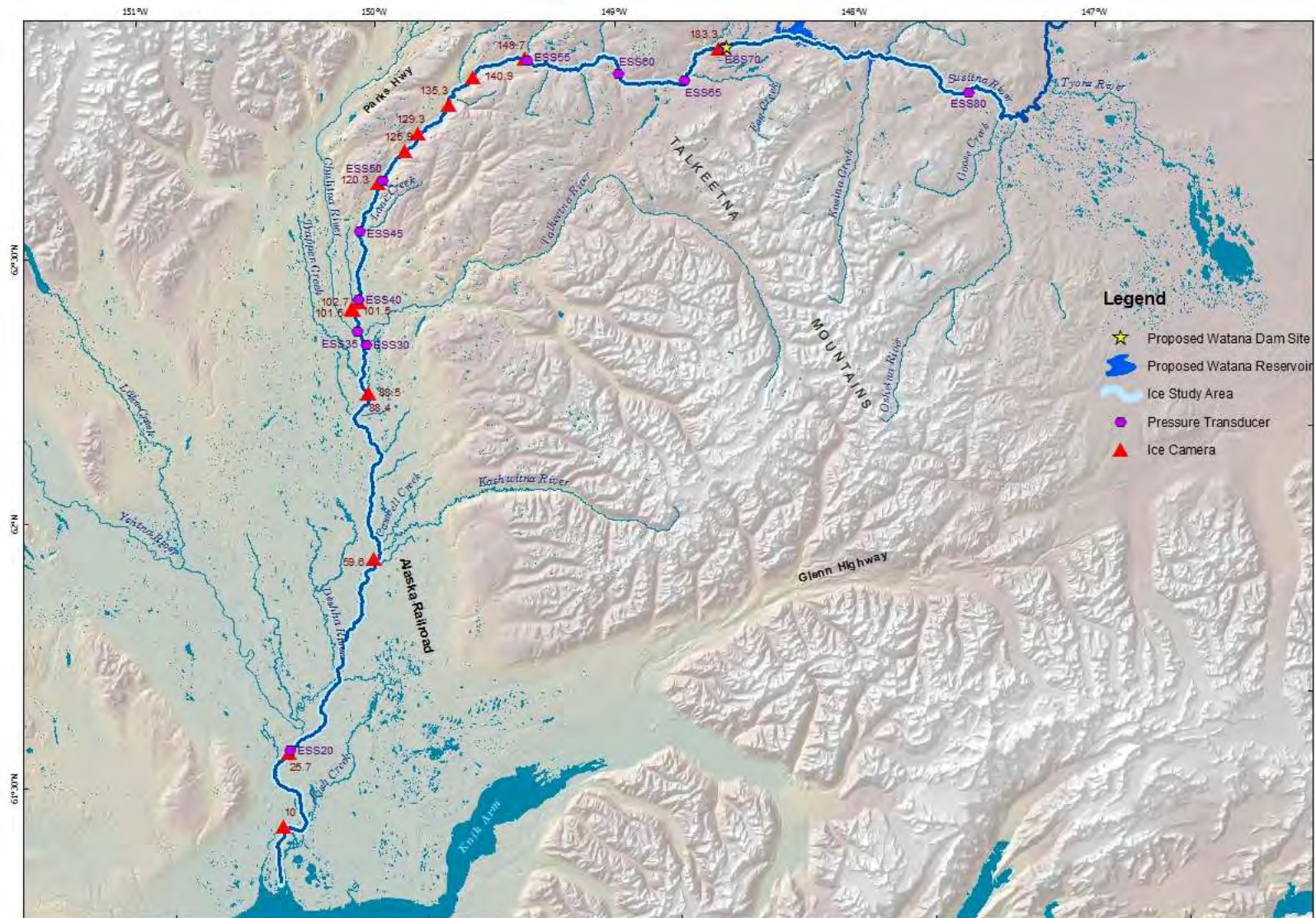
R&M 1984

FIGURE 5.4

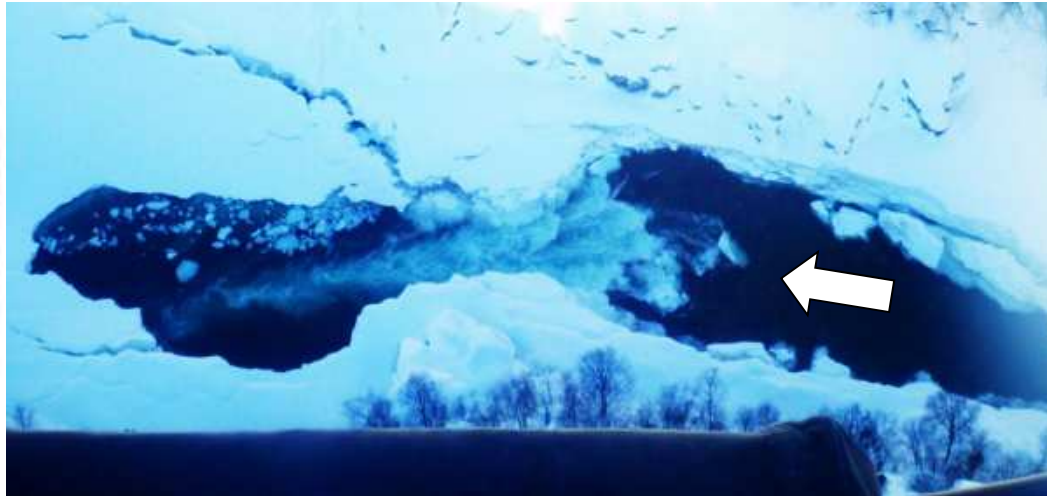
October 17, 1983. Low air temperatures and minimal solar radiation influence the water surface in the upper river canyons. These factors together with high turbulence generates large volumes of frazil slush in October. This is near the mouth of Jay Creek, looking downstream.



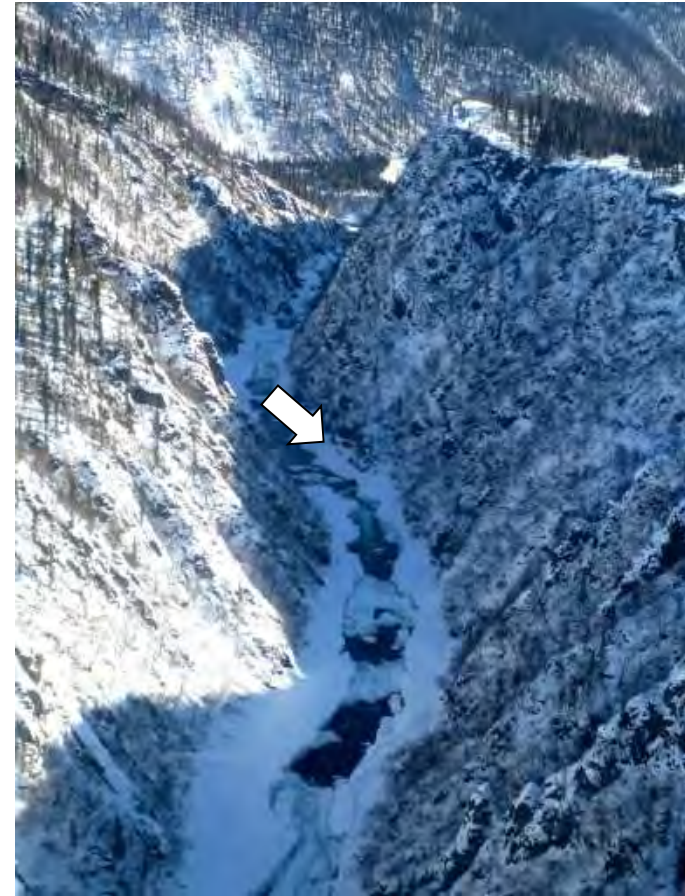
2012 Study Area



2012 Open Leads – Middle River Velocity



Devil Canyon, RM 152, PRM 156



2012 Open Leads – Middle River above Devil Canyon



RM 170 Velocity lead opening up, April 2012



2012 Open Leads – Upper River



Vee Canyon, RM 222, PRM 224

Oshetna Confluence, RM 232, PRM 234



2012 Breakup – Devil Canyon



Leads opening, April 27th



Remains of ice shelf,
May 2. Ice cover
Composed of rounded
fine slush balls.



2012 Breakup – Upper River



Vee Canyon, RM 221.5, PRM 223.4 April 27th



RM 221, PRM 223, May 9th



2012 Breakup – Upper River



Kosina, May 9th



Oshetna, May 9th



2012 Breakup – Watana Dam Site Area



Stranded ice chunks, above and
“bulldozed” soil, right.
May 9, RM 183, PRM 186

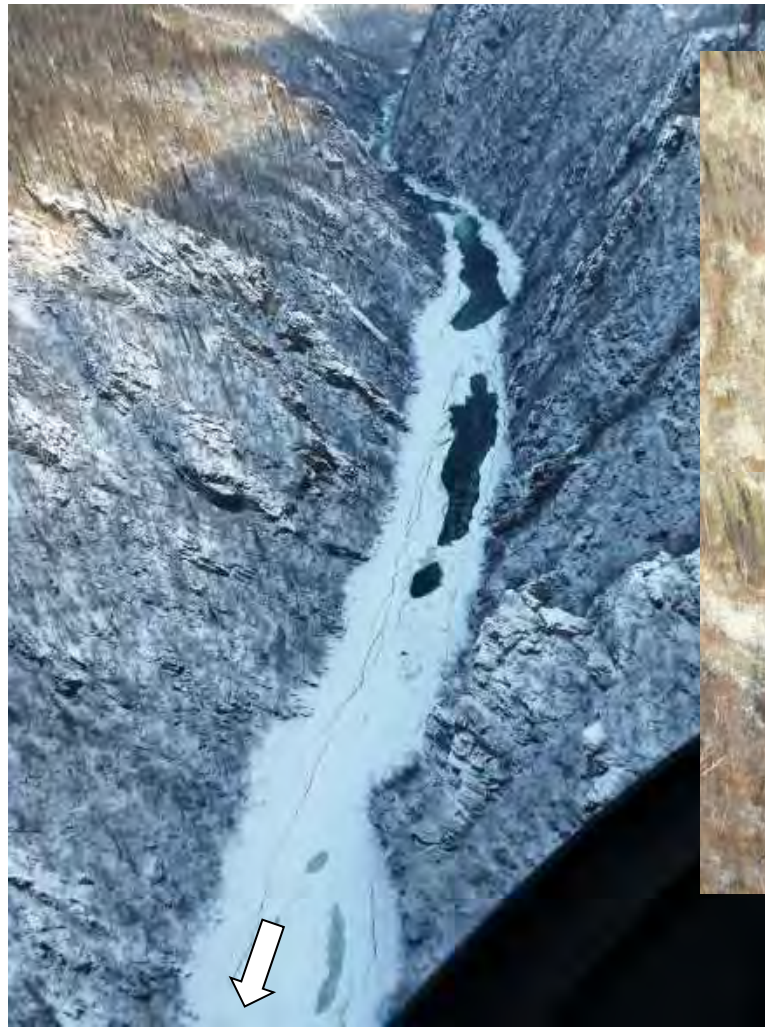


2012 Freeze-up Conditions

- Much higher than average flows during early ice formation (October 12th flows were twice average at Gold Creek and Sunshine, and near proposed project flows)
- Colder than average November, warmer December and January
- Unusually high water as ice front reached Talkeetna
- Progression followed patterns observed in the 1980's.



2012 Freeze-up – Devil Canyon October 22



Lower Devil Canyon Ice Bridge, RM 151, PRM 155



Middle Devil Canyon Ice Bridge, RM 155, PRM 158.5



Anchor Ice, Middle River Above Devil Canyon



RM 172, PRM 175, November 15th , 2012



2012 Freeze-up – Dam Site



October 26



November 15

2012 Freeze-up – Dam Site



November 20



2012 Freeze-up – Dam Site



December 19

2012 Freeze-up Observations – Upper River



Above, Upper River ice bridge, RM 194, PRM 196.6, November 15th



Right, Upper River ice front, RM 215, PRM 217.5, November 15th



2012 Freeze-up Observations – Upper River Tributaries



Oshetna River breakout flood, November 15th



2012 Freeze-up Observations – Upper River Tributaries



Oshetna River frozen over, December 19th



2012 Freeze-up Observations – Upper River Tributaries



Jay Creek, November 15th



Deadman Creek, November 15th

2012 Freeze-up Observations – Upper River Tributaries



Kosina Creek, November 15th



1985 Modeling Results and Predicted Project Effects (Middle River – Watana Only)

- The dam would release above-freezing water, creating an open reach extending 40-50 miles downstream of the dam (ice cover would end just downstream of Gold Creek in warm years, downstream of Portage Creek in cold years)
- The formation of an ice cover at Talkeetna would be delayed by 2-4 weeks (3 weeks on average).
- Within the open-water reach, stages would be lower than or equal to natural ice-covered conditions.
- Within the ice-covered reach, stages would be 2-7 feet higher than natural conditions.
- The increased stage may result in breaching of slough berms in the ice-covered reach of the Middle River.
- Breakup would occur 2-3 weeks earlier, and breakup jams in the Middle River would be decreased in severity.



INFORMATION ITEM P8:
ANTICIPATED ICE COVER ON RESERVOIR AND BELOW DAM
FOLLOWING PROJECT CONSTRUCTION

INFORMATION ITEM P9:
WATER TEMPERATURES DURING UPSTREAM MIGRATION PERIOD

INFORMATION ITEM P10:
WATER TEMPERATURES DURING DOWNSTREAM MIGRATION
PERIOD

INFORMATION ITEM P11:
AIR TEMPERATURE, WIND, LIGHT, AND MET STATION DATA

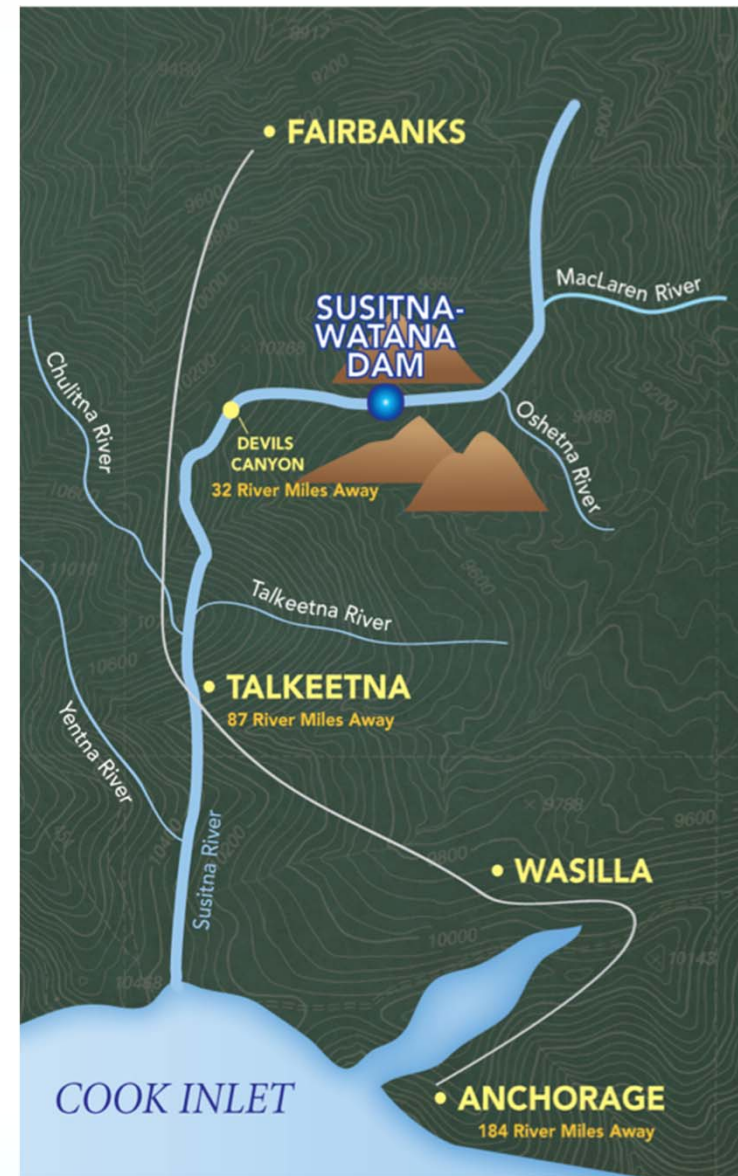
INFORMATION ITEM P12:
SEDIMENT INFORMATION

INFORMATION ITEM P13:
RIVER MORPHOLOGY TRENDS AFTER PROJECT CONSTRUCTION

Fish Passage Workshop 1: *Relevant Information from the Geomorphology Studies*

Technical Workgroup Meeting
Fish and Aquatics
April 9, 2013

Prepared by: Tetra Tech
Prepared for: Alaska Energy Authority



Overall Goal – Geomorphology Studies

- Two studies
 - Geomorphology Study
 - Fluvial Geomorphology Modeling Study
- The overall goal of the geomorphology studies is to assess the potential effects of the proposed Project on the fluvial geomorphology of the Susitna River, with particular focus on providing information to assist in predicting Project impacts to aquatic and terrestrial habitat.

2012 Geomorphology Study Tech Memos

- *Stream Flow Assessment*
- *Initial Geomorphic Reach Delineation and Characterization, Middle and Lower Susitna River Segments*
- *Development of Sediment Transport Relationships and an Initial Sediment Balance for the Middle and Lower Susitna River Segments*
- *Reconnaissance Level Assessment of Potential Channel Change in the Lower Susitna River Segment*



SUSITNA-WATANA HYDRO Clean, reliable energy for the next 100 years.

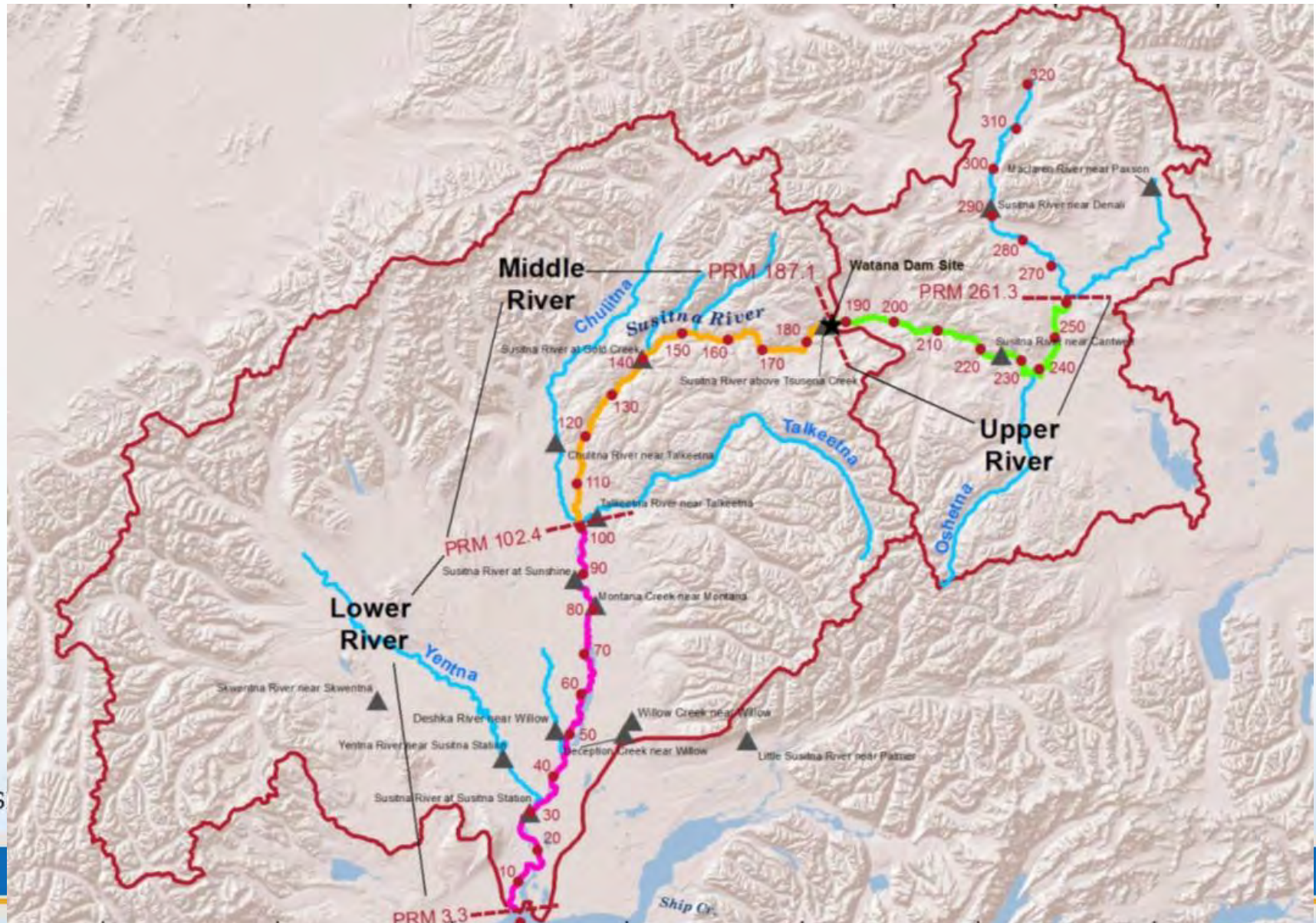
2012 Geomorphology Study Tech Memos

- *Mapping of Aquatic Macrohabitat Types at Selected Sites in the Middle and Lower Susitna River Segments from 1980s and 2012 Aerials*
- *Mapping of Geomorphic Features within the Middle and Lower Susitna River Segments from 1980s and 2012 Aerials*
- *Synthesis of the 1980s Lower Susitna River Segment Aquatic Habitat Information*

River Segments

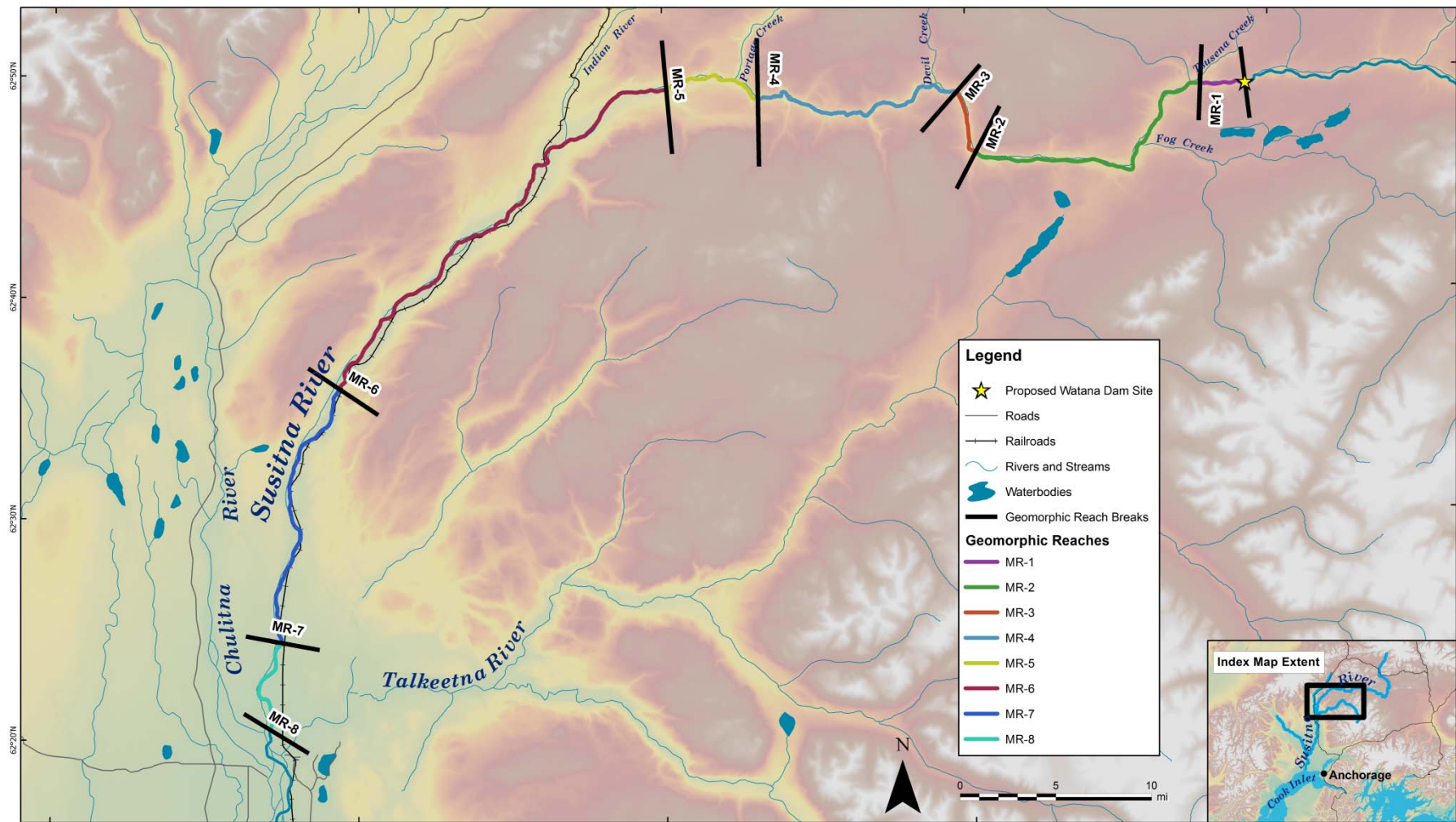
5

Upper, Middle & Lower River Segments



Middle River Geomorphic Reaches

6



Geomorphic Characteristics - MR

7

Reach	Length (mi)	Gradient (ft/mi)	Sinuosity	Average Width (feet)		Entrenchment Ratio ^{1,3}	Median Bed Material Size (mm)	Number of Bed Material Samples	Channel Branching ⁴ (Average Number Channels)
				Active Channel	Valley Bottom ¹				
MR-1	2.5	9.4	1.03	655	782	1.2			1.2
MR-2	15.0	10.9	1.06	715	1,512	2.1			1.4
MR-3	3.5	11.0	1.02	594	781	1.3			1.1
MR-4	12.2	30.6	1.03	312	370	1.2			1.0
MR-5	5.5	12.1	1.03	512	851	1.7	70	NA	1.2
MR-6	25.7	10.8	1.09	985	2,350	2.4	50	17	2.4
MR-7	14.9	8.5	1.05	845	2,050	2.4	40	7	1.8
MR-8	5.4	7.3	1.19	1,132	8,960	7.9	63	18	2.7

¹ Effects of manmade features, including railroad grade, levees, etc. not considered in valley bottom width.

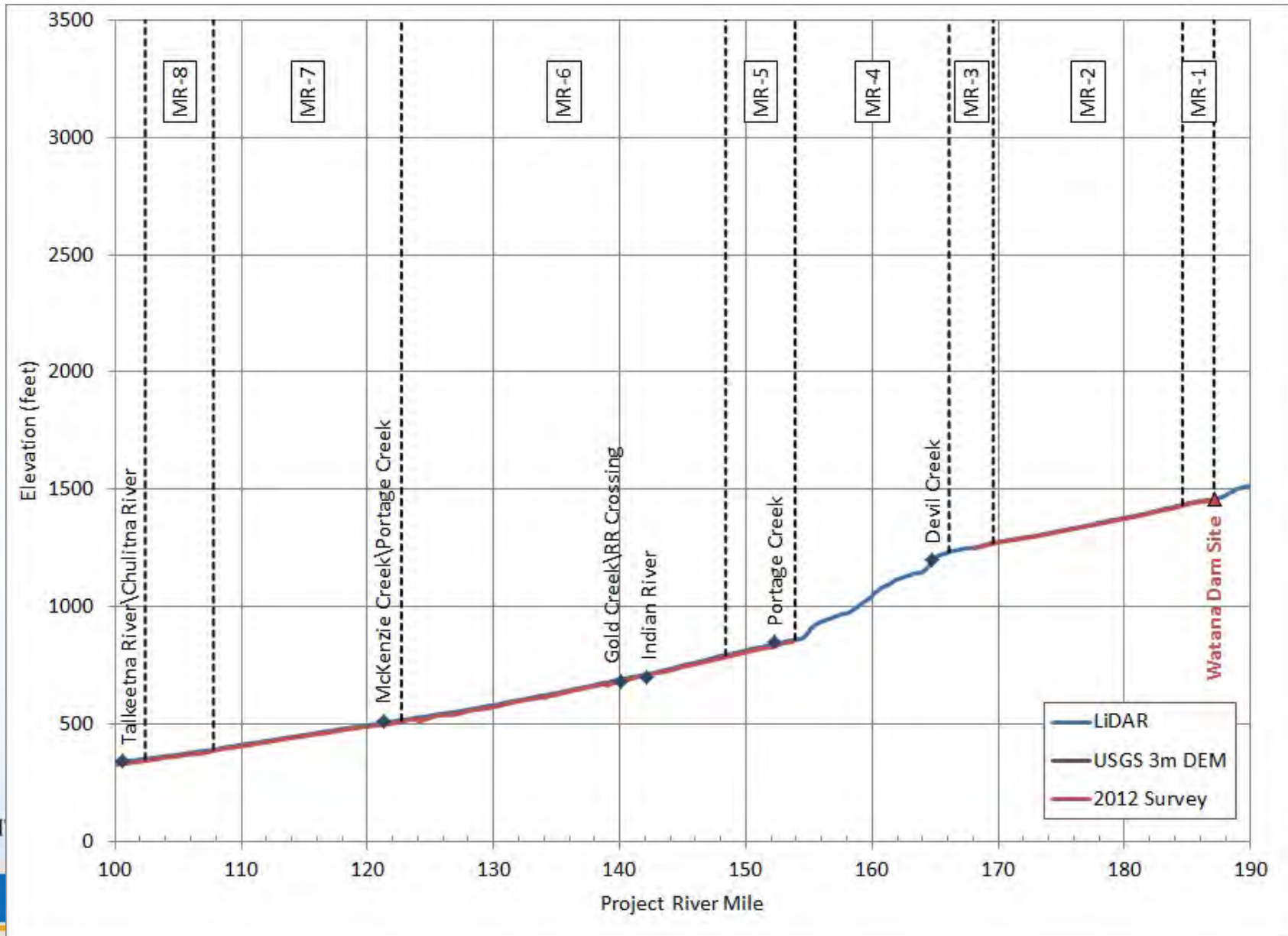
² Valley bottom width reflects confining effects of manmade features, including railroad grade, levees, etc.

³ Ratio of valley bottom width to active channel width.

⁴ Number of channels separated by relatively stable, vegetated islands.

Bed Profile - Middle River

8



Middle River Geomorphic Reaches

9



Reach 1 (2.5 miles)

- Channel Type = SC2
- Gradient = 9.4 ft/mi
- Active channel width = 655 ft
- Entrenchment Ratio (ER) = 1.2
- Branching Index (BI) = 1.2

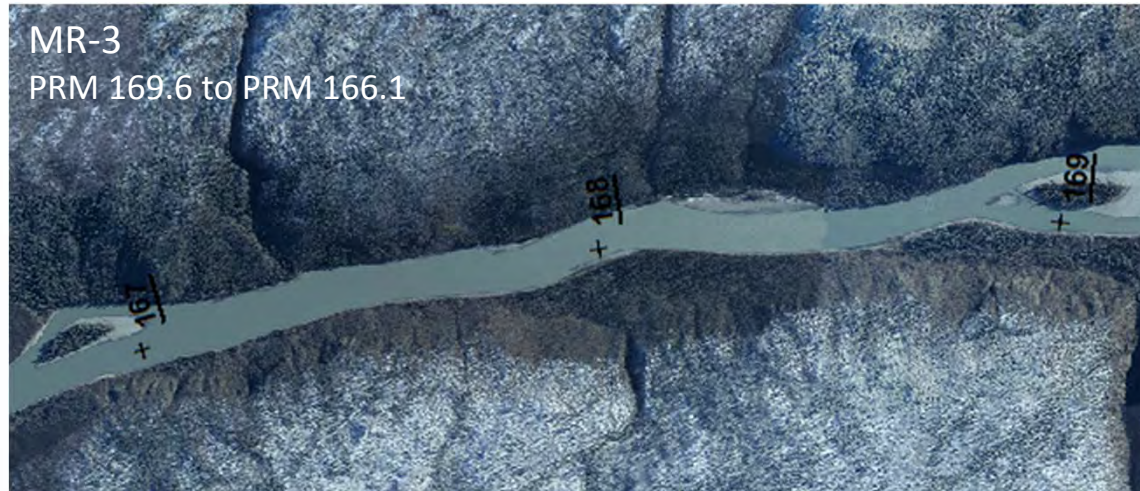


Reach 2 (15.0 miles)

- Channel Type = SC2
- Gradient = 10.9 ft/mi
- Active channel width = 715 ft
- ER = 2.1
- BI = 1.4

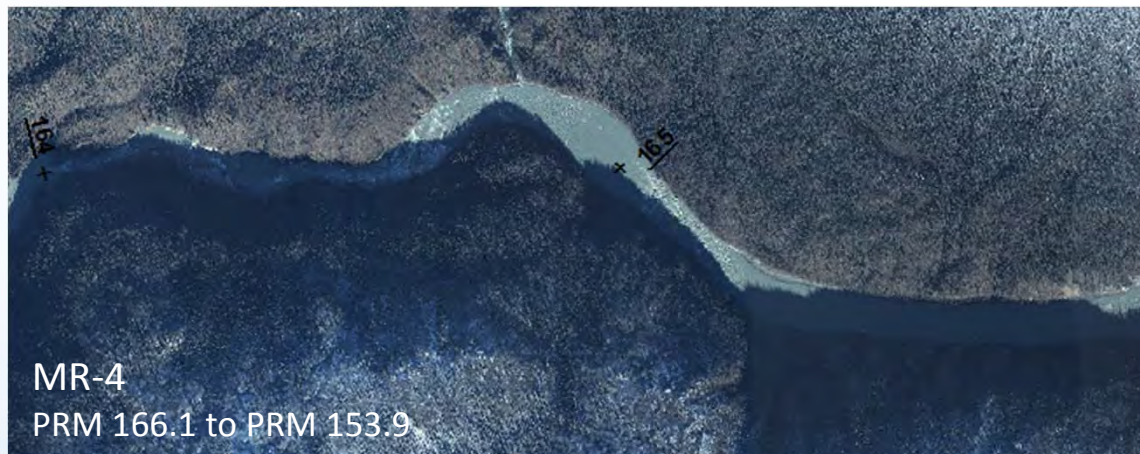
Middle River Geomorphic Reaches

10



Reach 3 (3.5 miles)

- Channel Type = SC2
- Gradient = 11.0 ft/mi
- Active channel width = 594 ft
- ER = 1.3
- BI = 1.1



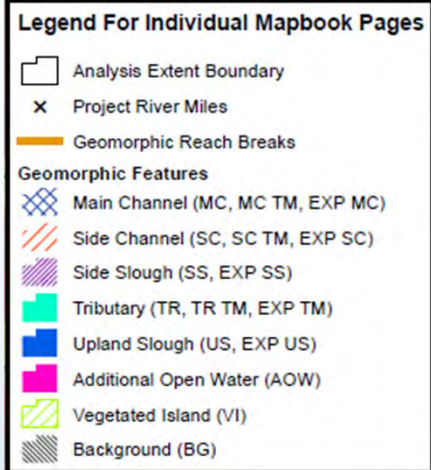
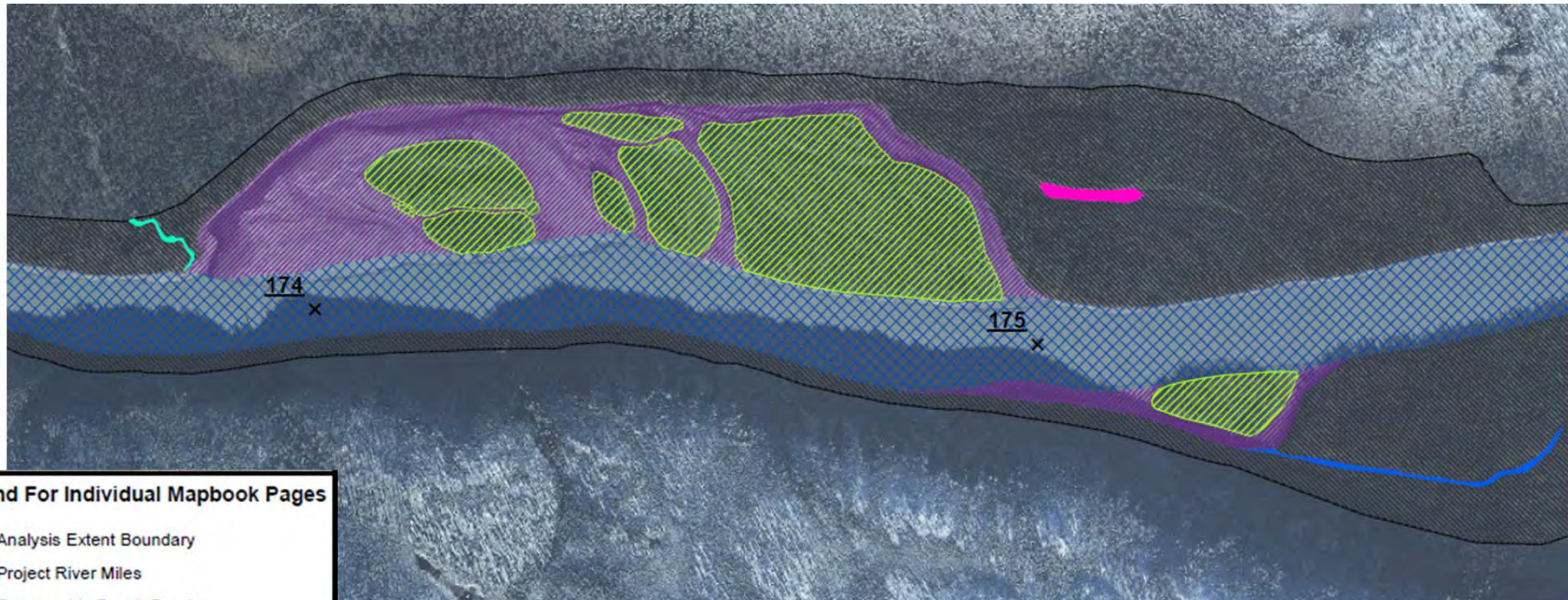
Reach 4 (12.2 miles)

- Channel Type = SC1
- Gradient = 30.6 ft/mi
- Active channel width = 312 ft
- ER = 1.2
- BI = 1.0

Middle Susitna River Segment – MR-2

2012 Geomorphic Features

11



Location:	Imagery Date:	Discharge (Gold Creek)
PRM 102.4 - 143.6:	09/10/2012,	12,900 cfs
PRM 143.6 - 187.1:	09/30/2012,	17,000 cfs

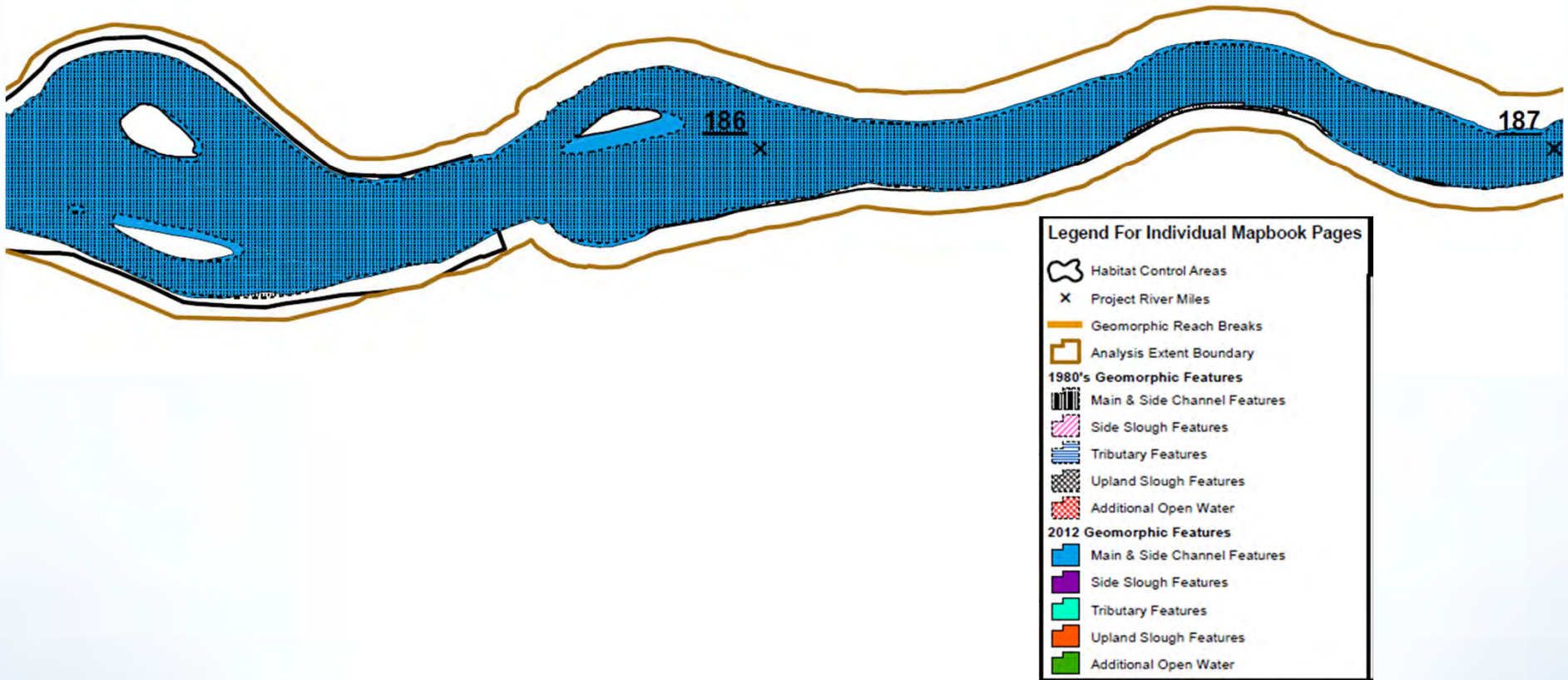
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Clean, reliable energy for the next 100 years.

Middle Susitna River Segment – MR-1

1980's – 2012 Channel Change

1



Location:	Imagery Date:	Discharge (Gold Creek)	Location:	Imagery Date:	Discharge (Gold Creek)
PRM 102.4 - 143.6:	09/10/2012,	12,900 cfs	PRM 102.4 - 154.0	09/11/1983	12,500 cfs
PRM 143.6 - 187.1:	09/30/2012,	17,000 cfs	PRM 154.0 - 187.1	07/19-20/1980	31,600 - 35,800 cfs

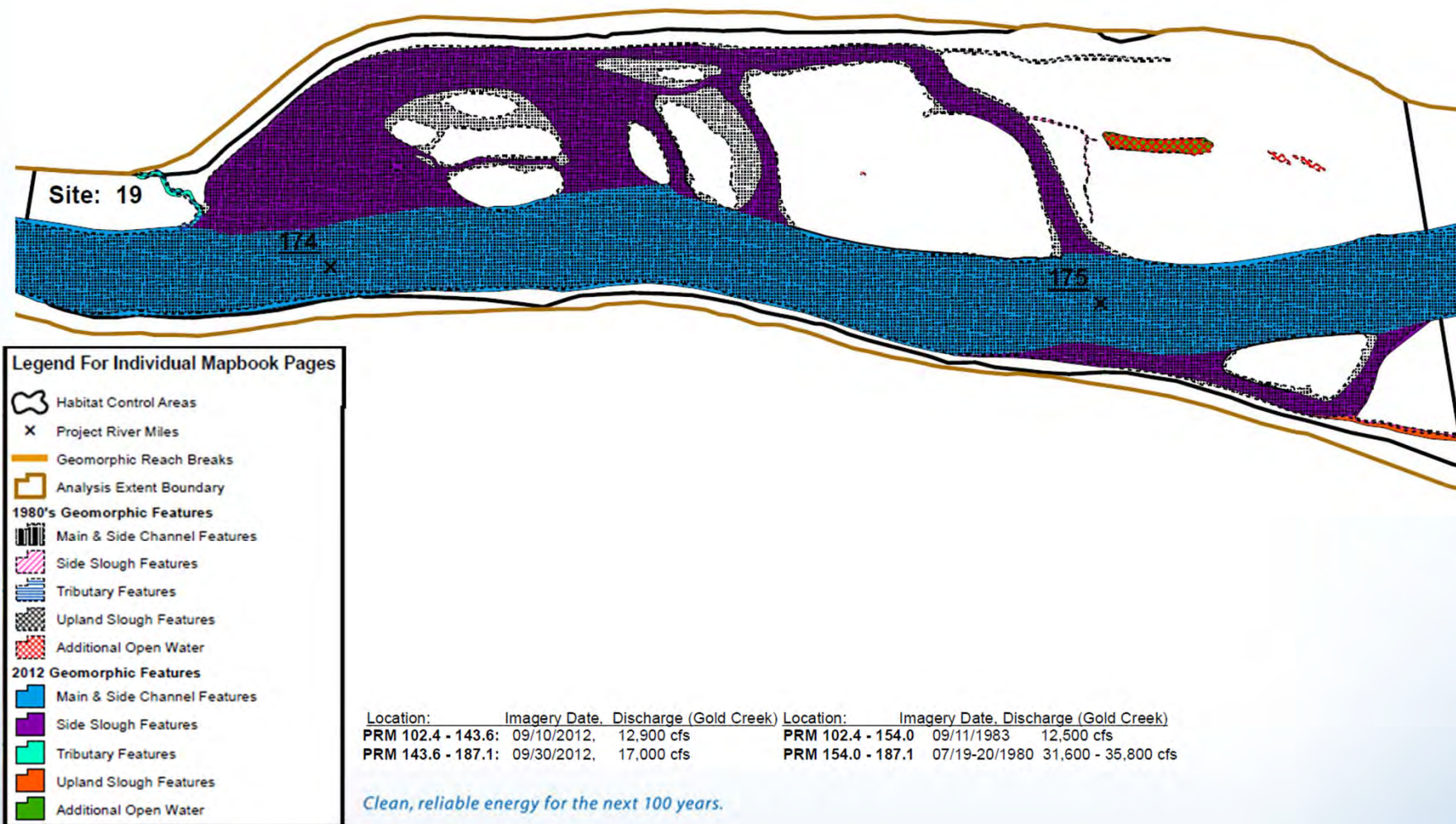
SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Middle Susitna River Segment – MR-2

1980's – 2012 Channel Change

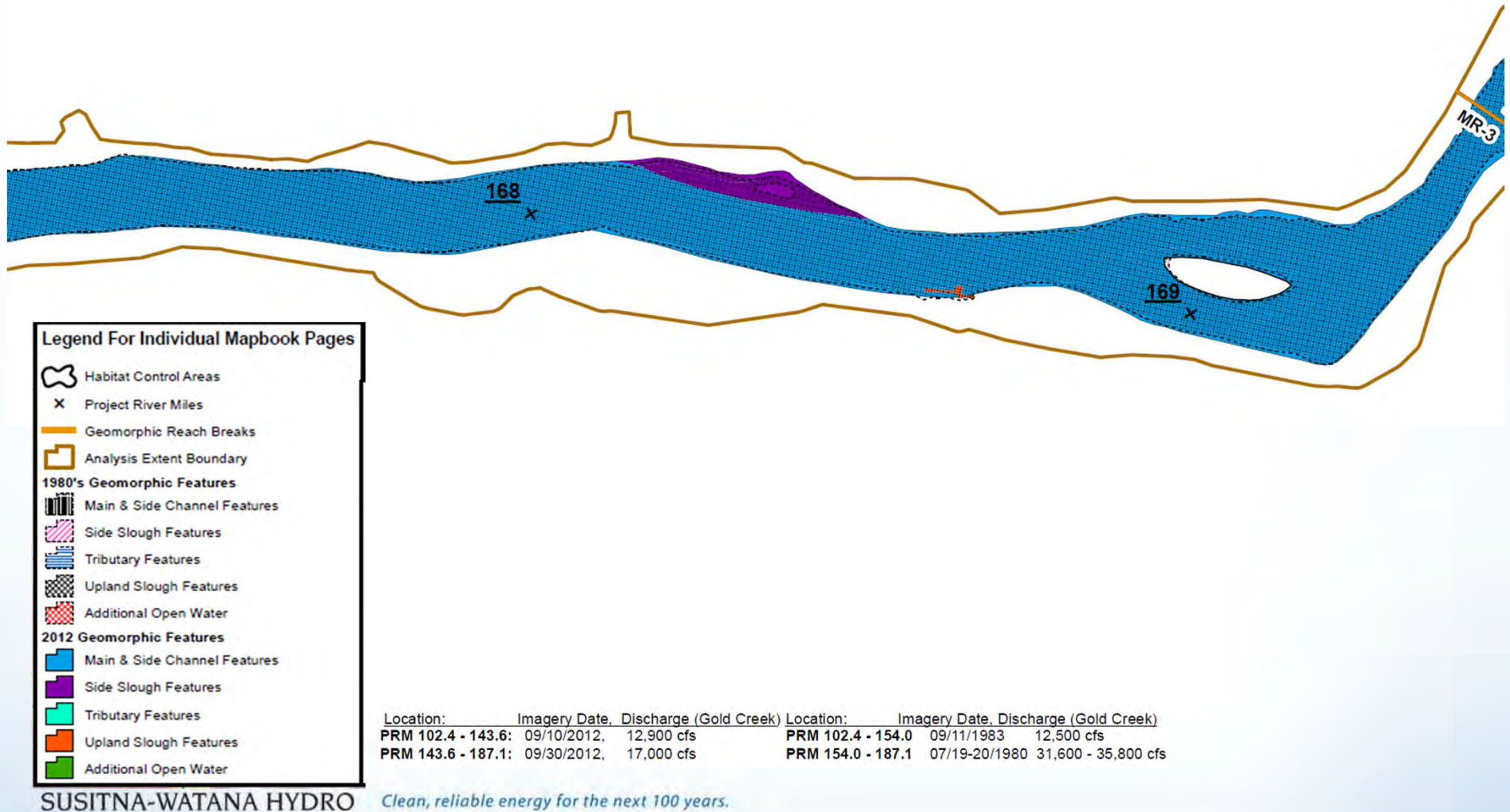
13



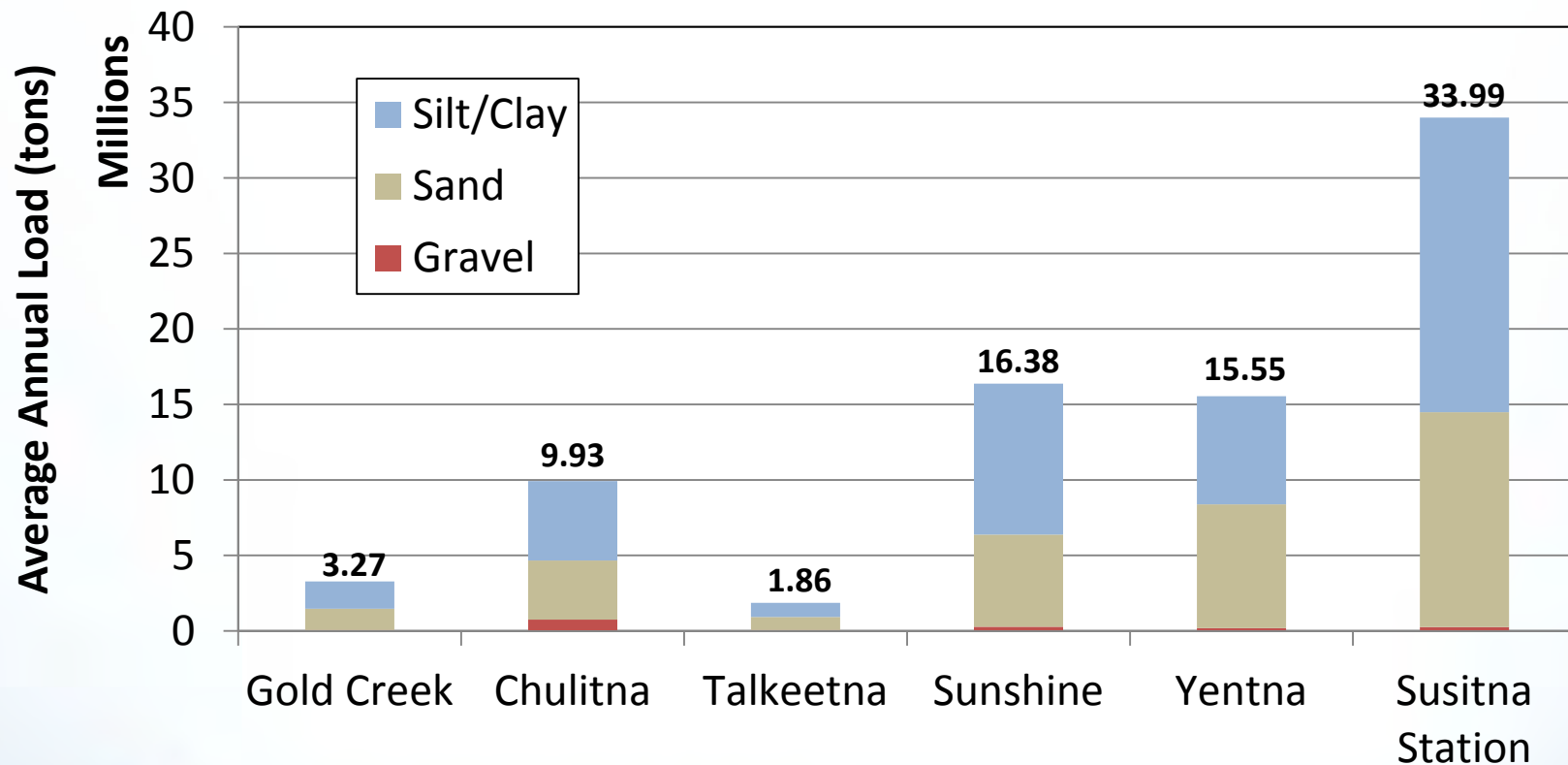
Middle Susitna River Segment – MR-3

1980's – 2012 Channel Change

14

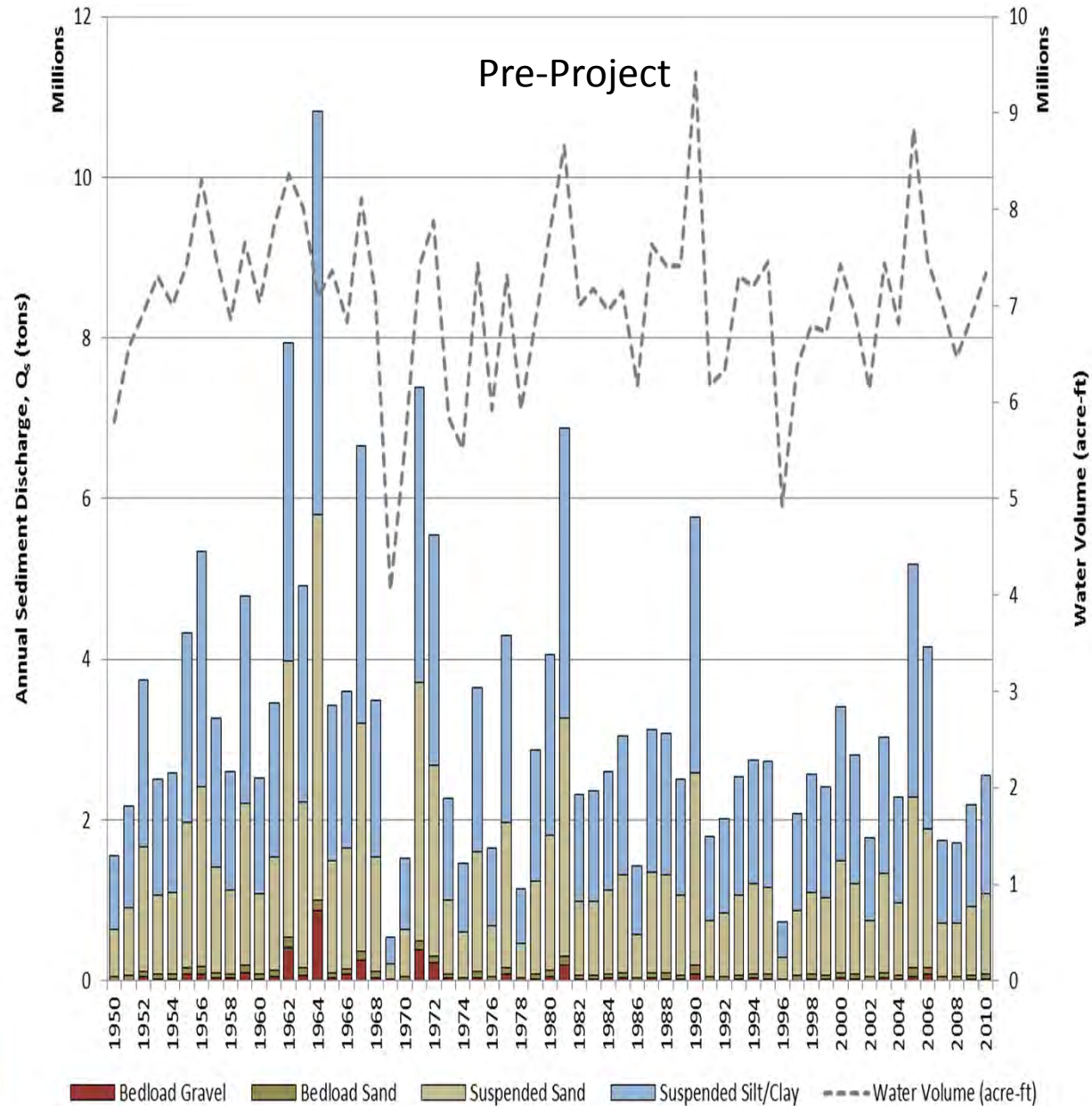


Average Annual Load Pre-Project



Gold Creek Annual Sediment Load

16



SUSITNA-WATANA HYD

Overview of the Geomorphology Studies

Overall Goal – Geomorphology Studies

- Two studies
 - Geomorphology Study
 - Fluvial Geomorphology Modeling Study
- The overall goal of the geomorphology studies is to assess the potential effects of the proposed Project on the fluvial geomorphology of the Susitna River, with particular focus on providing information to assist in predicting Project impacts to aquatic and terrestrial habitat.

Geomorphology Study Objectives¹⁹

- Characterize the geomorphology of the Susitna River & define geomorphic reaches
- Determine sediment supply and transport
- Assess historical geomorphic stability/change Middle and Lower Susitna River
- Conduct a reconnaissance-level geomorphic assessment of potential Project effects

Geomorphology Study Objectives²⁰

- Watana Reservoir:
 - Trap efficiency
 - Shoreline erosion
 - Tributary delta development
- Conduct assessment of large woody debris recruitment, transport and their influence on geomorphic forms

Fluvial Geomorphology Modeling

Study Objectives

21

- Develop calibrated models to predict the magnitude and trend of geomorphic response to the Project
 - 1-D (Middle and Lower River)
 - 2-D (Focus Areas)
- Apply the developed models to estimate the potential for channel change for with-Project operations compared to existing conditions

Fluvial Modeling Geomorphology Study ²²

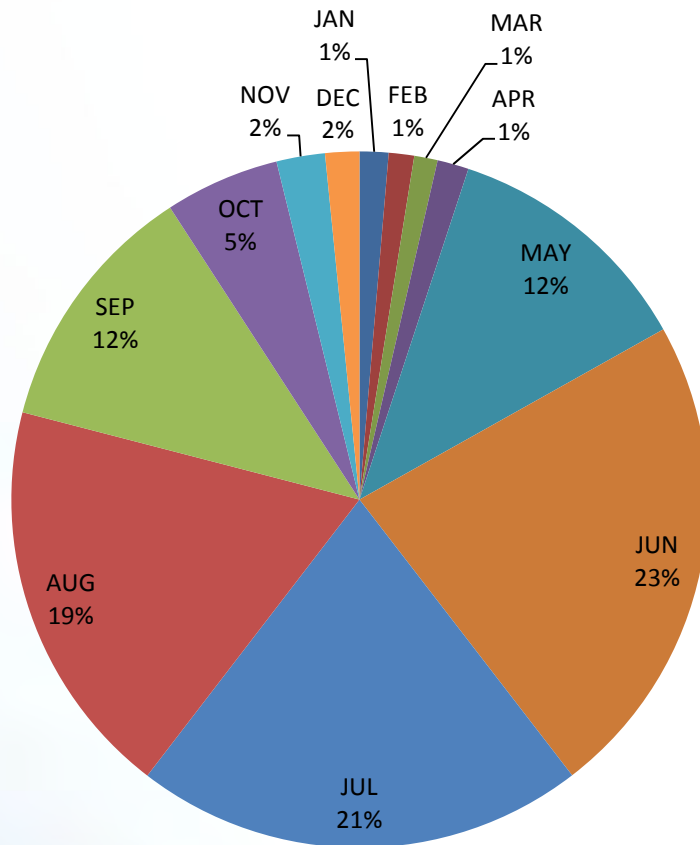
Objectives

- Support the evaluation of Project effects by other studies by providing channel output data and assessment of potential changes in the geomorphic features that help comprise the aquatic and riparian habitats of the Susitna River

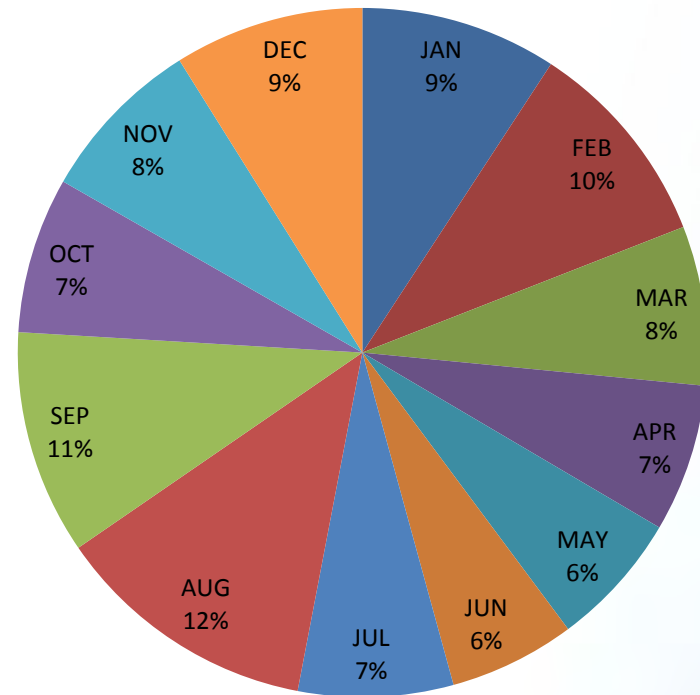
Post Project Conditions Max LF OS-1

Monthly Average Flow Comparison (cfs) ²⁴

Watana Dam (Pre-Project)

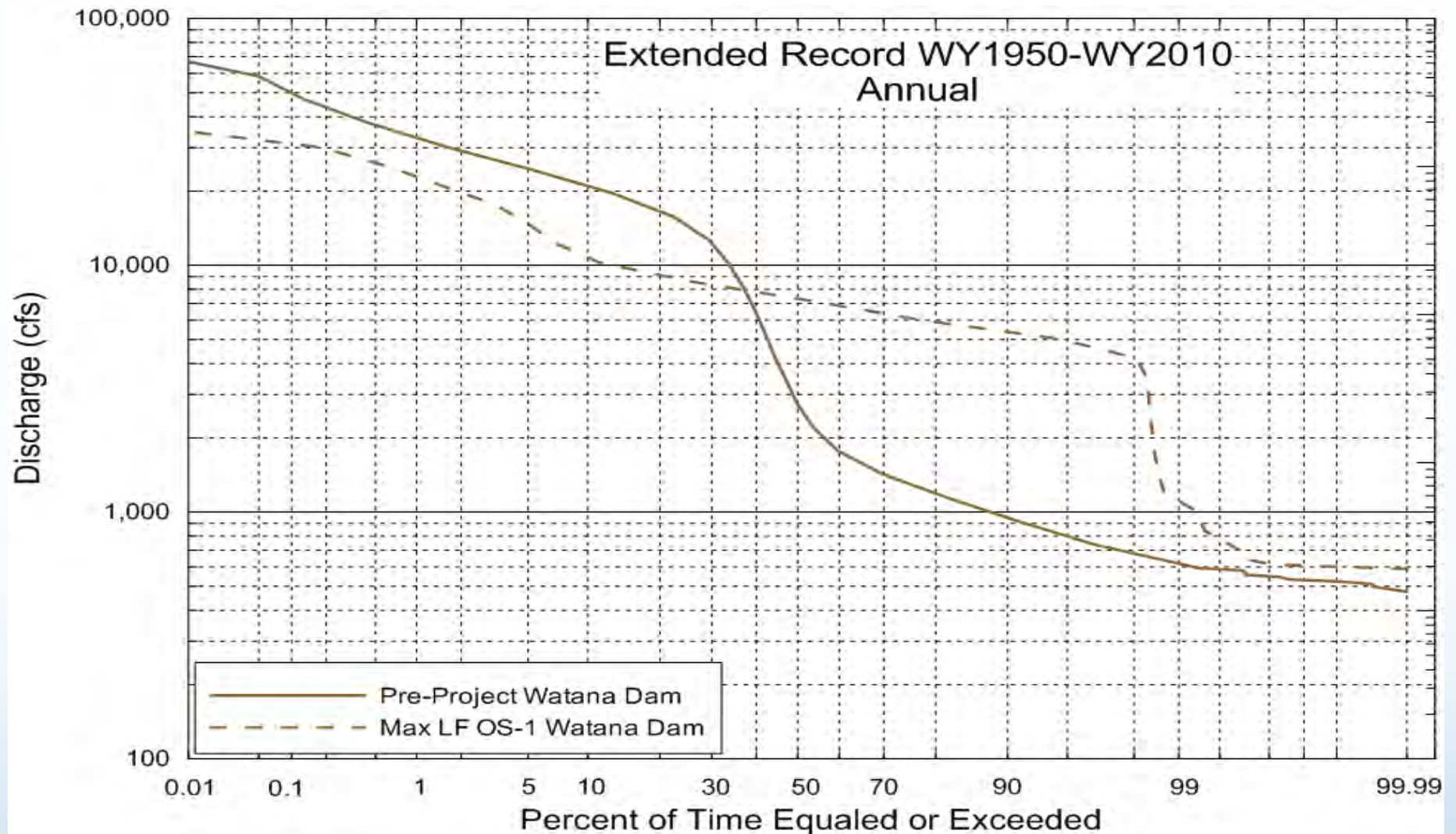


Watana Dam (Max LF OS-1)



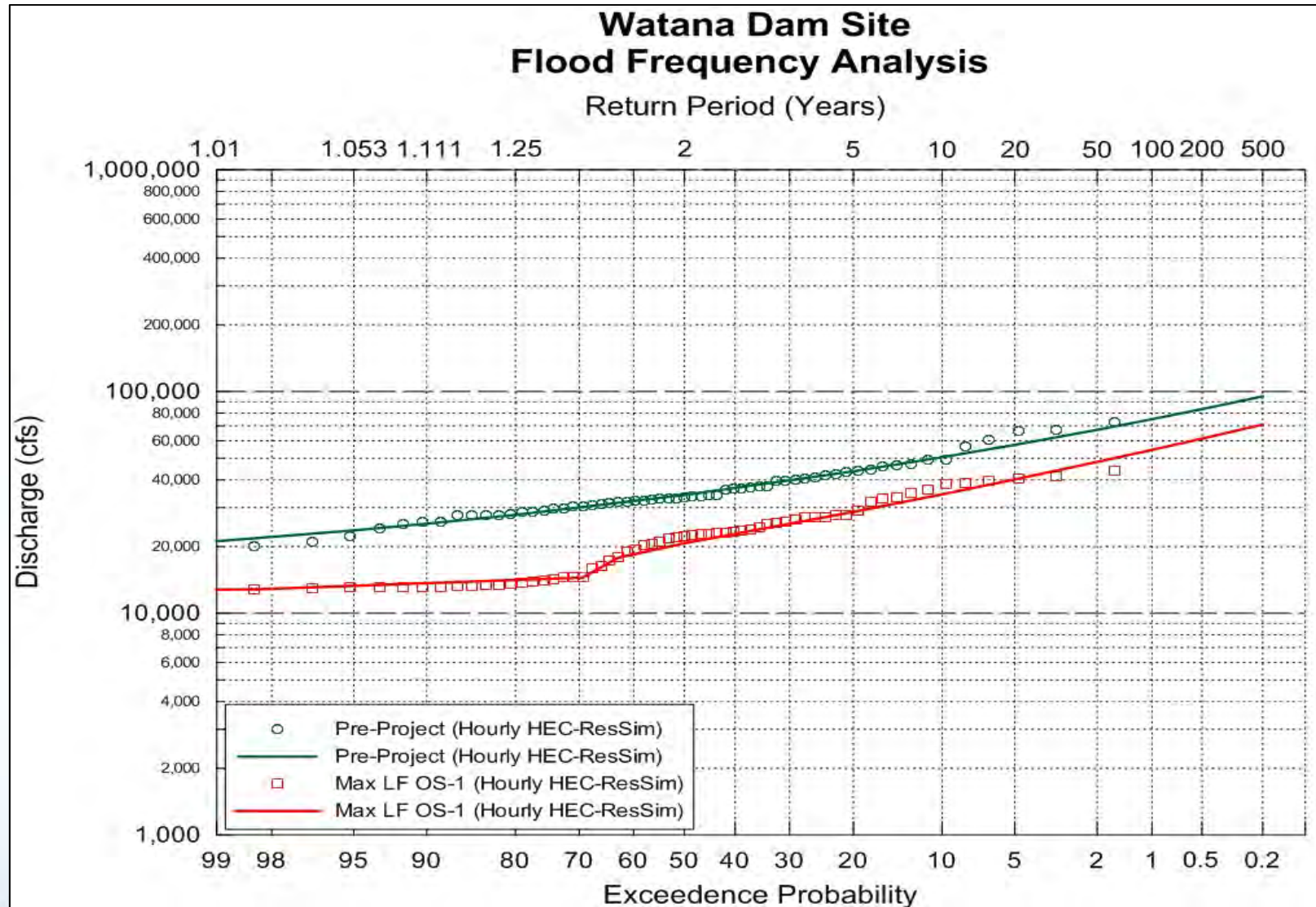
Annual Flow Duration Watana Dam

25



Flood Frequency

26



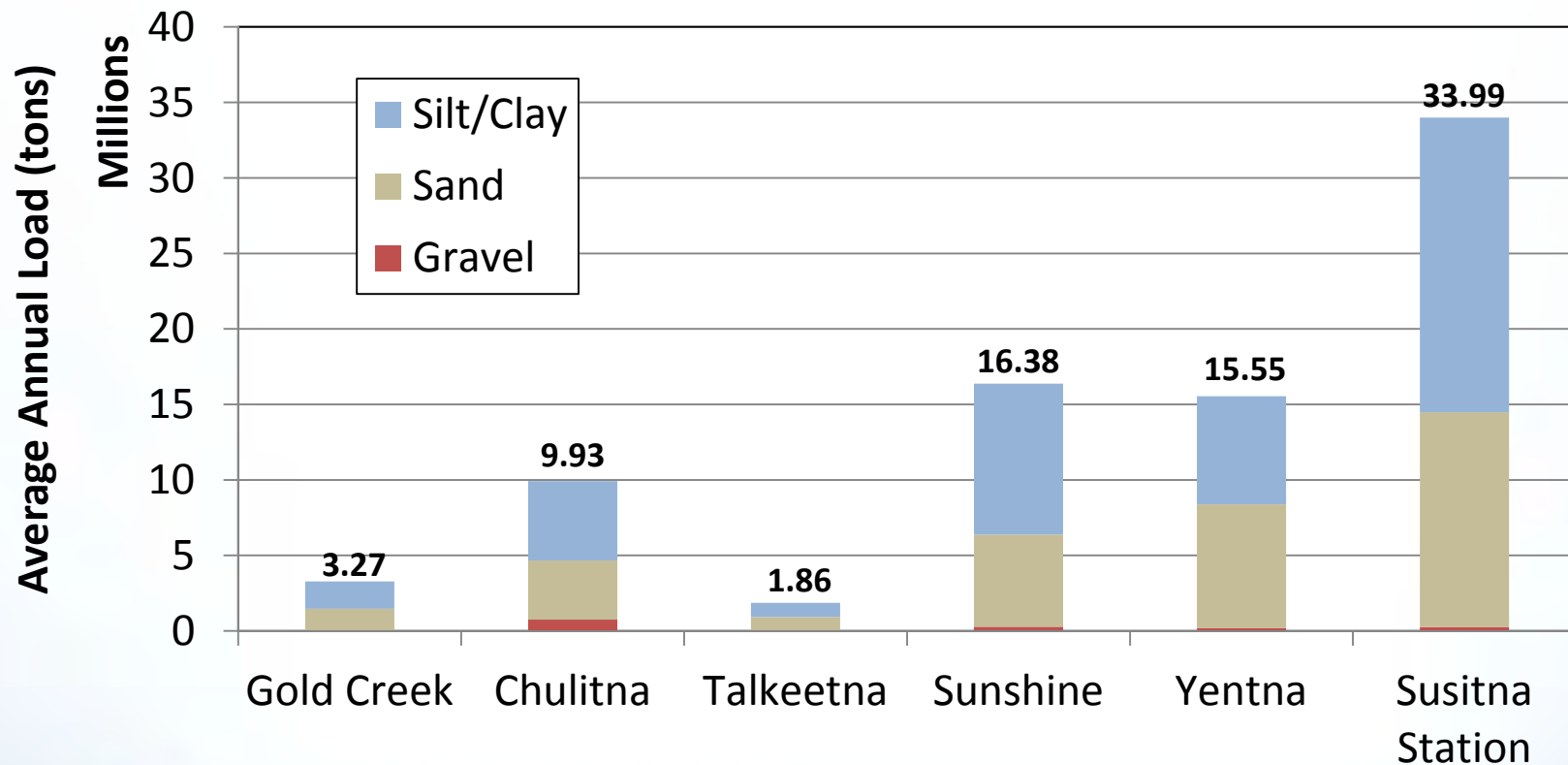
SUSITNA-WATANA HYDRO *Clean, reliable energy for the next 100 years.*

Annual Peak Flow Comparison: Watana Dam Site (PRM 187)

Return Period (Years)	Watana Dam Site			
	Pre-Project Flow (cfs)	Max LF OS-1 Flow (cfs)	Difference (cfs)	Difference (%)
1.01	21,100	12,800	-8,300	-39%
1.25	27,800	14,100	-13,700	-49%
1.5	30,700	15,800	-14,900	-49%
2	34,200	20,700	-13,500	-39%
5	43,700	28,700	-15,000	-34%
20	57,600	40,200	-17,400	-30%
50	67,300	48,200	-19,100	-28%
100	75,100	54,600	-20,500	-27%

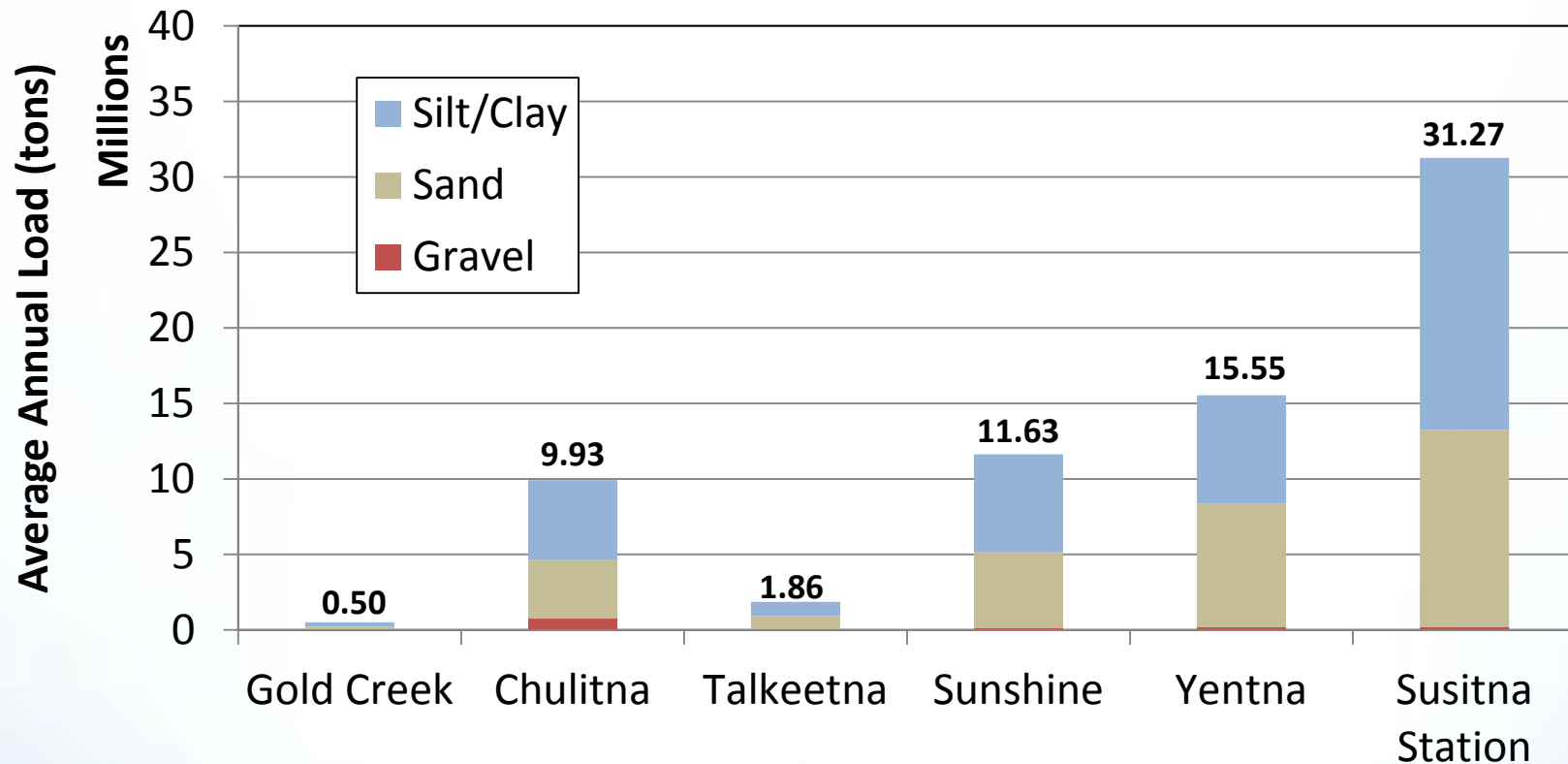
SUSITN

Average Annual Load Pre-Project



Average Annual Load

Max LF OS-1

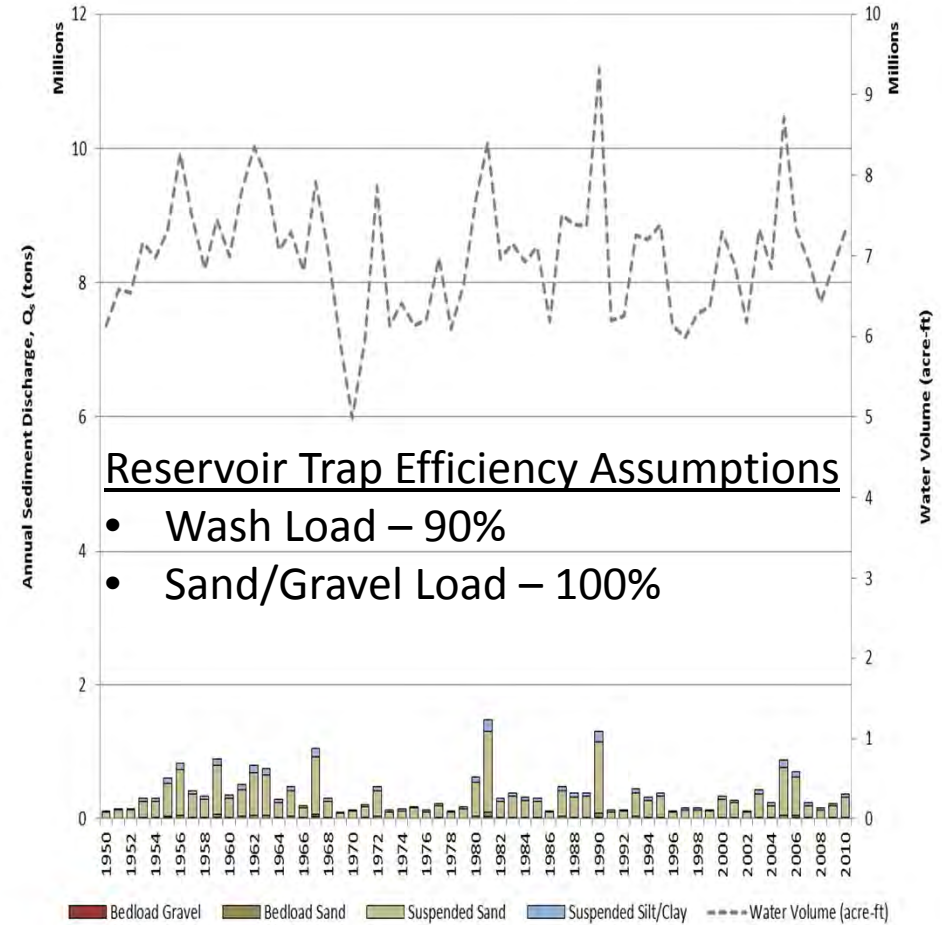
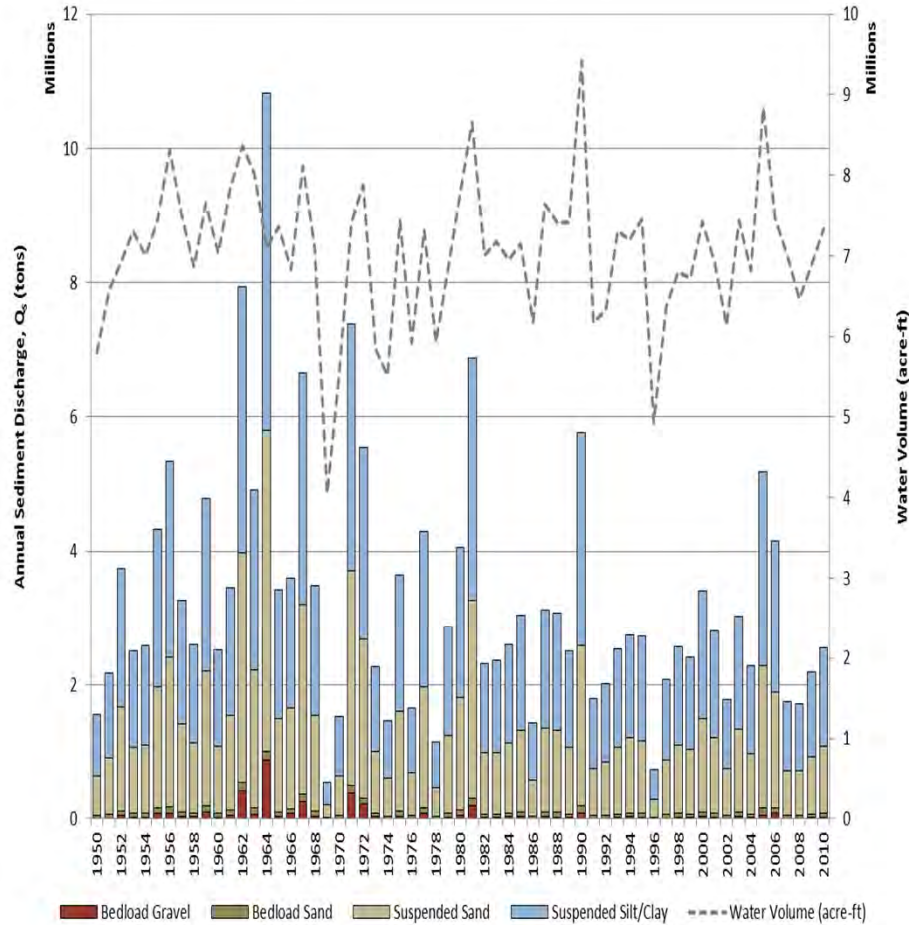


Gold Creek Annual Sediment Load

30

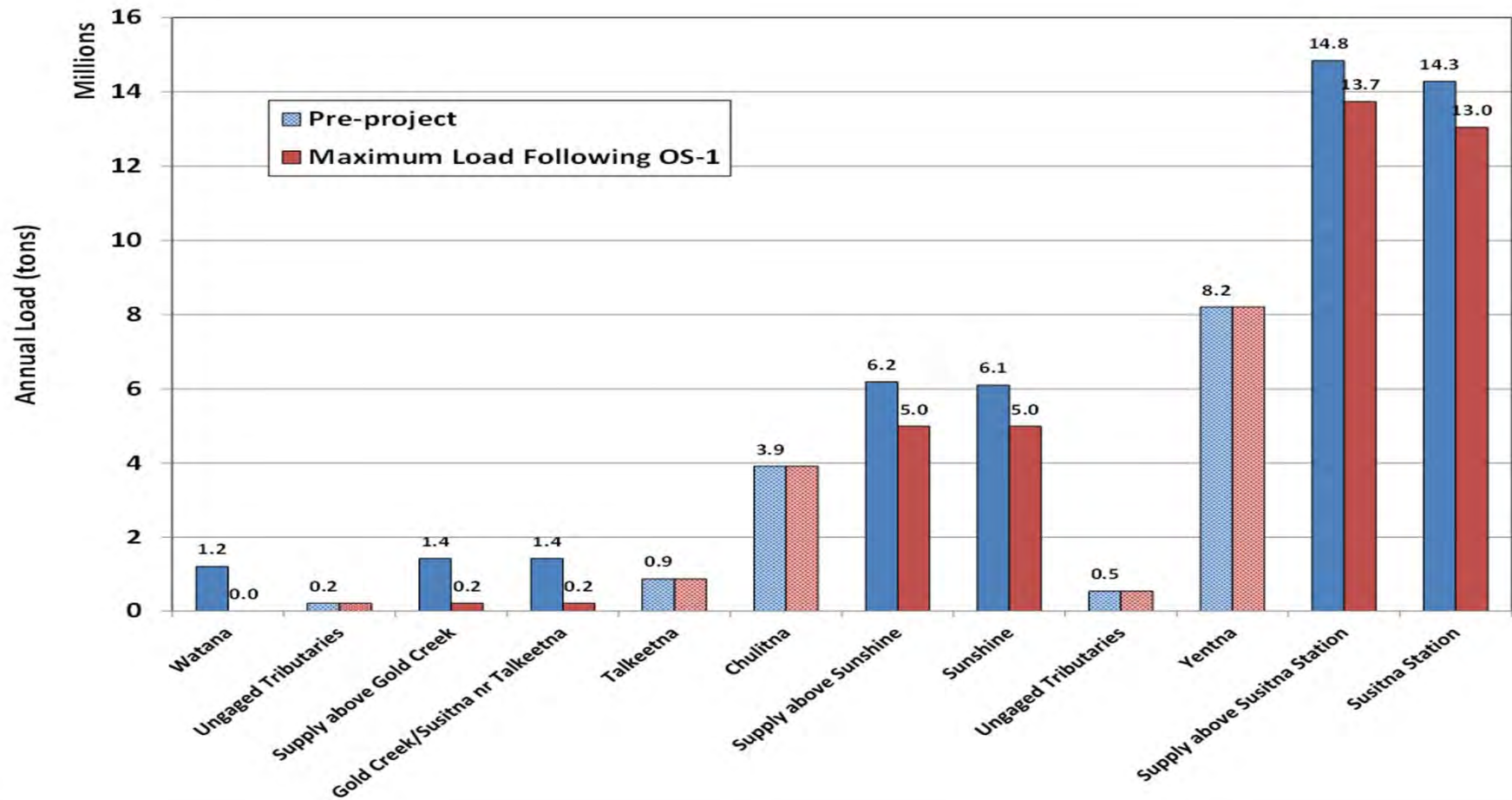
Pre-Project

Max LF OS-1



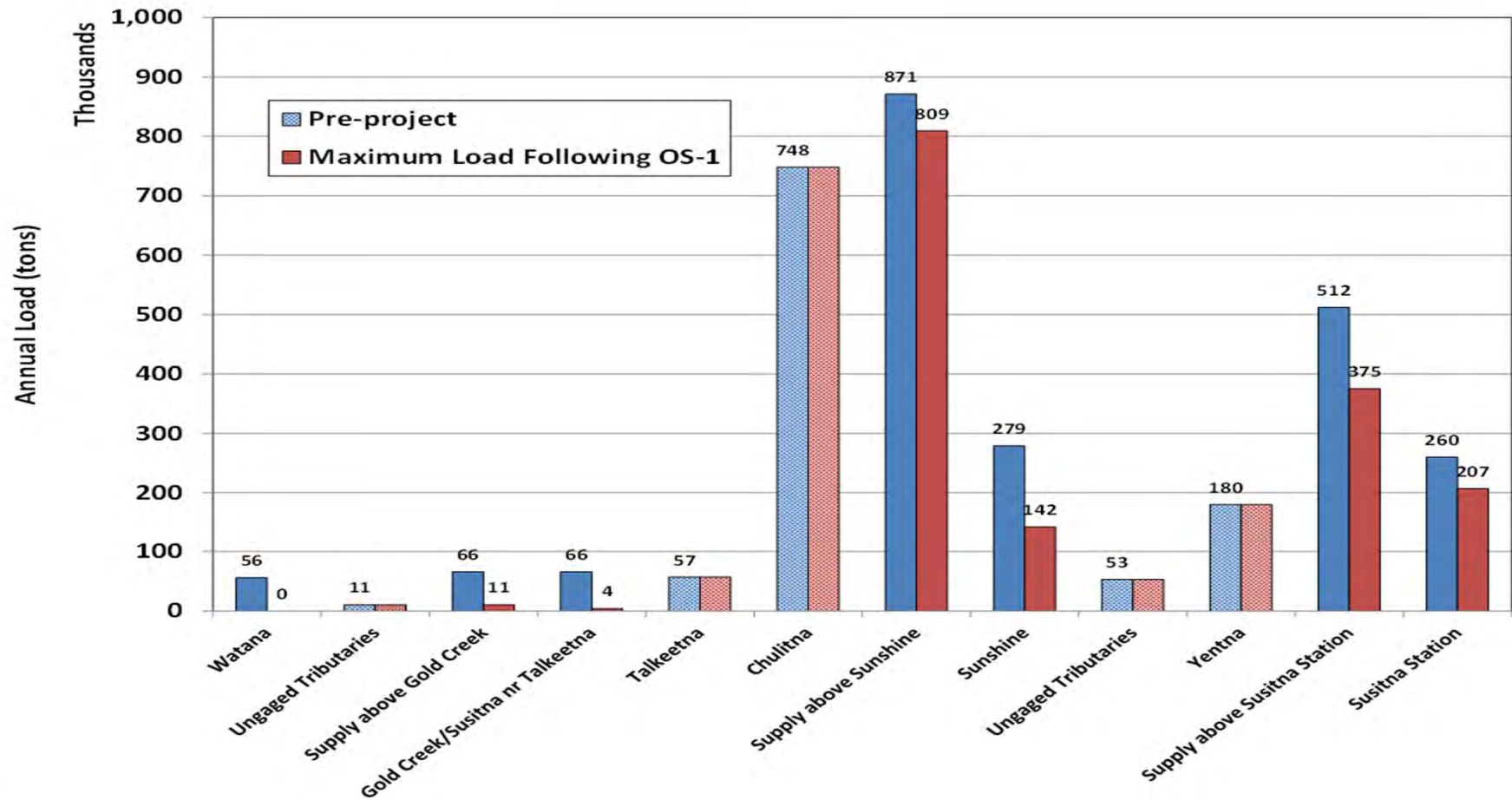
Average Annual Sand Load

(Including estimated annual sand load from ungaged tributaries)



Average Annual Gravel Load

(Including estimated annual gravel load from ungaged tributaries)



Project Effects – Suspended Sediment³³ and Turbidity (1980s Docs)

- Reservoir Trap Efficiency
 - 80 to 90 percent of total sediment load
 - 100 percent of silt, sand and gravel
 - Only particles on the order of 3 to 10 microns or smaller pass through the reservoir

Project Effects – Suspended Sediment³⁴ and Turbidity (1980s Docs)

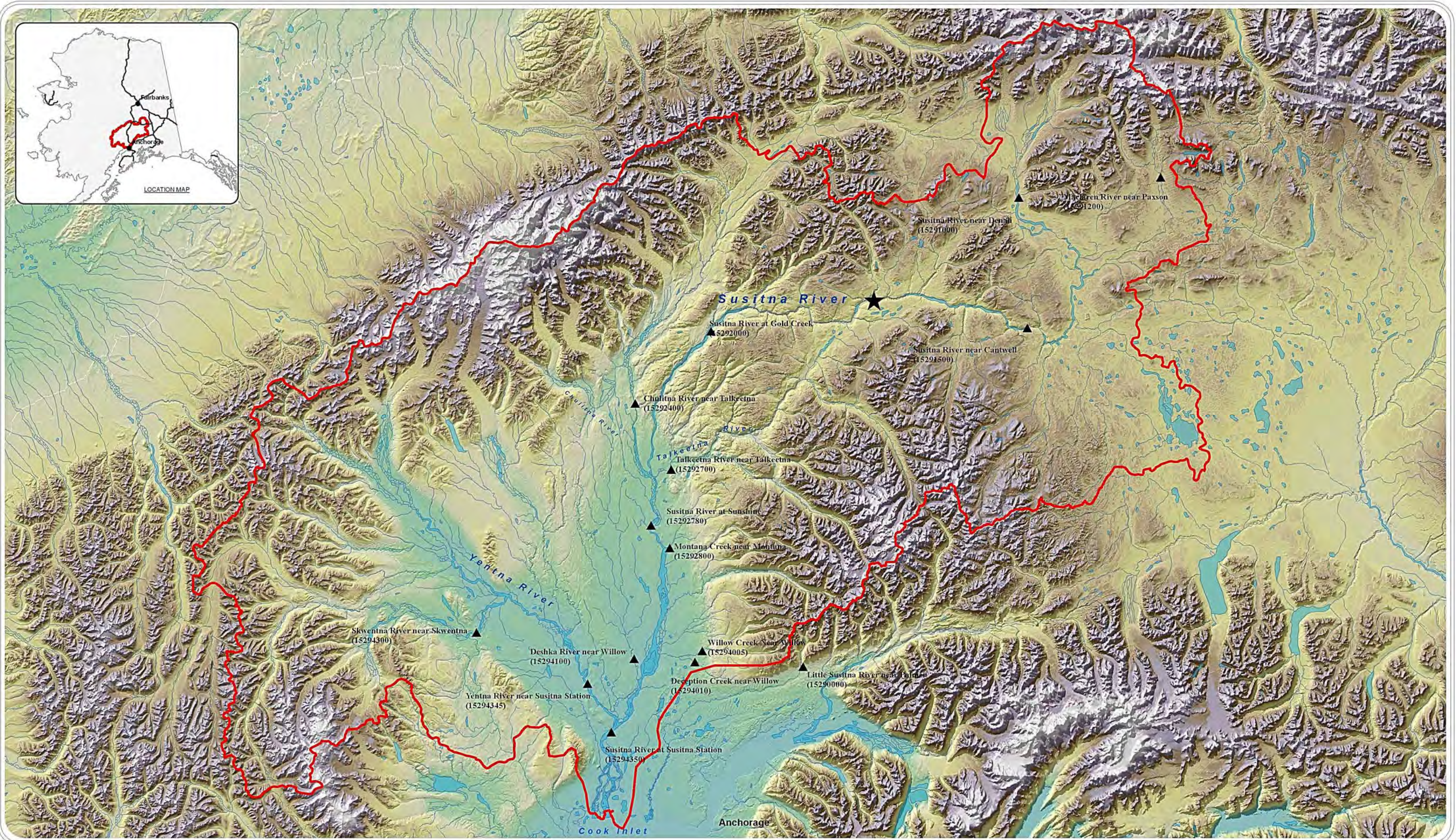
- Suspended Sediment (typical)
 - Winter
 - Pre-Project: <10 mg/l
 - Post-Project: 30 to 70 mg/l
 - Summer
 - Pre-Project: 700 mg/l (over 2,500 mg/l occur)
 - Post-Project: 100 to 200 mg/l

Project Effects – Suspended Sediment³⁵ and Turbidity (1980s Docs)

- Turbidity
 - Winter
 - Pre-Project: < 1 NTU
 - Post-Project: 10 NTU minimum
 - Summer
 - Pre-Project: 100 to 700 NTU
 - Post-Project: 50 NTU maximum

END

INFORMATION ITEM P14:
TOPOGRAPHIC MAPPING OF PROJECT SITE AND DOWNSTREAM



LEGEND:

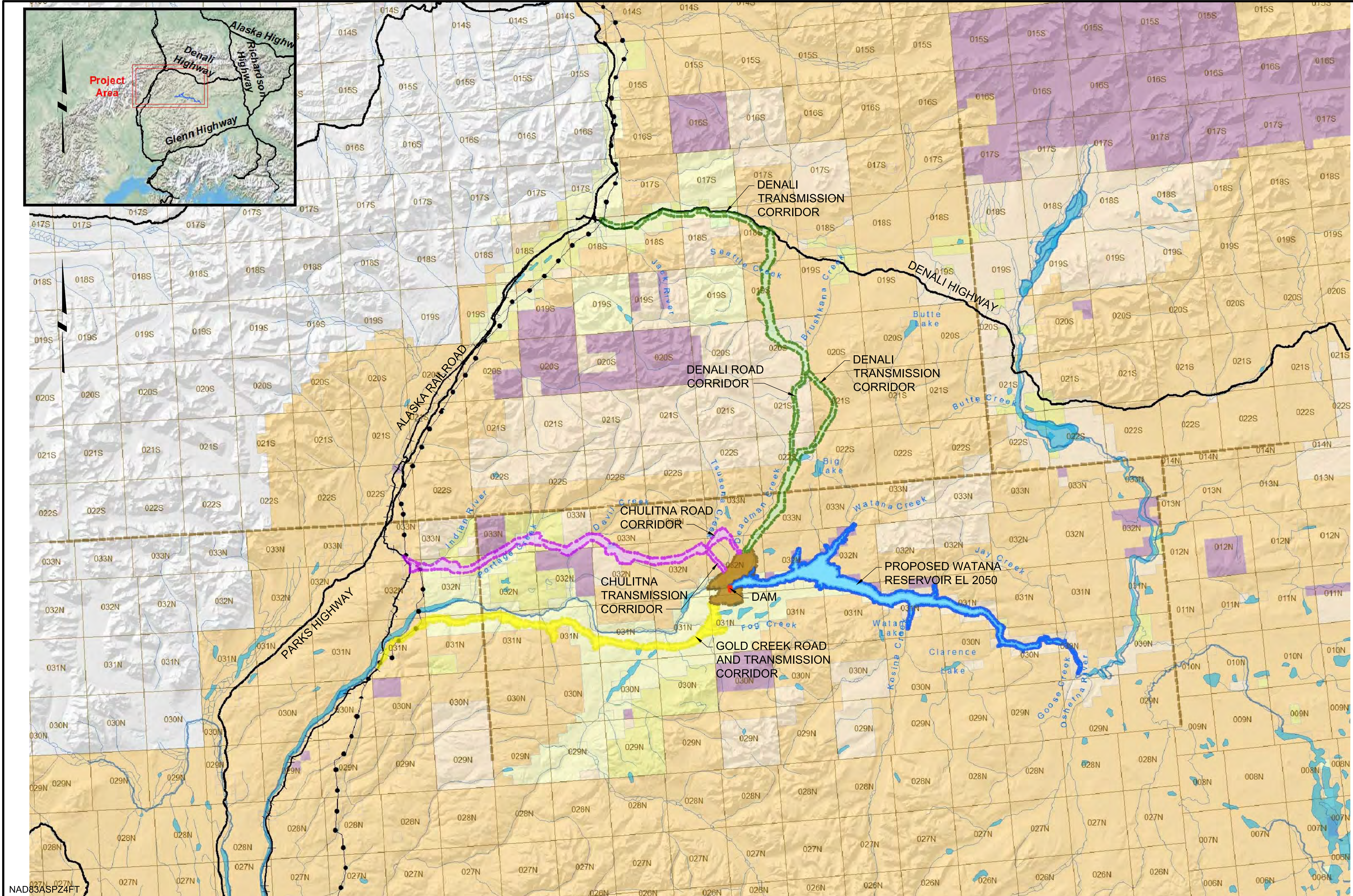
- ★ Watana Dam Site
- ▲ Gaging Station
- Basin Boundary

NOTES:

1. Spatial Reference: NAD83 Alaska Albers, meters
2. Topography: USGS National Elevation Dataset (NED), 2-Arc Second
3. Basin boundary based on modified USGS HUCs 19020501-5

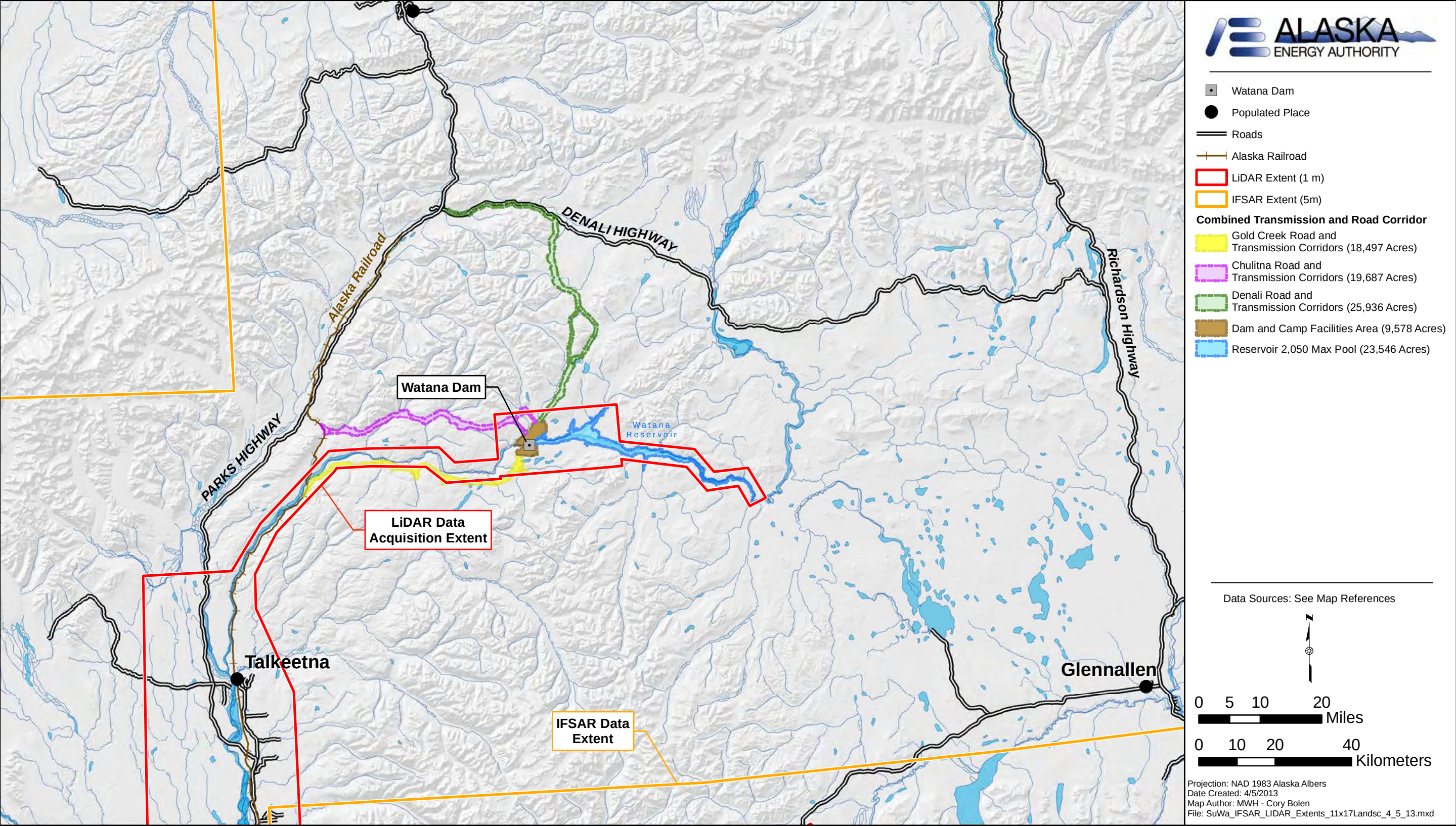
**SUSITNA RIVER DRAINAGE BASIN BOUNDARY
AND
STREAMFLOW GAGE LOCATIONS**

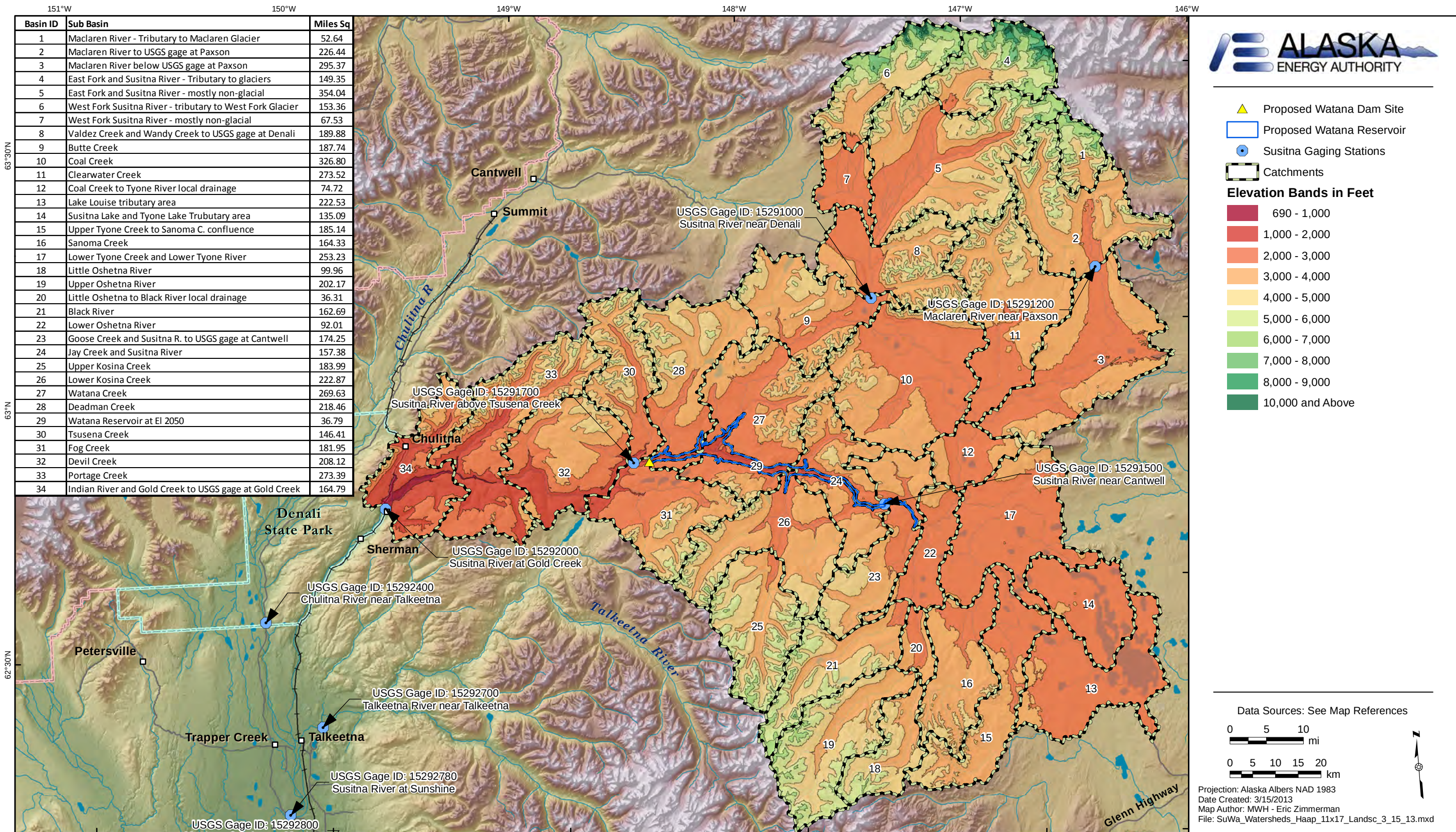
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NAD83/ASPZ4FT

DRAFT				SCALE NO SCALE ANSI D FULL SIZE		WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE		Project No. 10500200 Date 12/21/2012 Designed K GILBERT Drawn E ZIMMERMAN Approved B SADDEN		CONCEPTUAL DESIGN PHASE NOT FOR CONSTRUCTION This document is designated "interim" and not suitable for construction. As an interim document, it may contain data that is incomplete or define and locate structures that remain to be optimized.		MWH		STATE OF ALASKA ALASKA ENERGY AUTHORITY ALASKA ENERGY AUTHORITY		SUSITNA-WATANA HYDRO Clean, reliable energy for the next 100 years.		SUSITNA-WATANA HYDROELECTRIC PROJECT GENERAL OVERALL AREA PLAN		Sheet No. 01-00G000 SHEET OF	
REV	DESCRIPTION	BY	DATE																		





INFORMATION ITEM P15:
WATANA DAM LAYOUT DRAWINGS, PLANS, ELEVATIONS AND
CROSS SECTIONS
(CEII PROTECTED INFORMATION FILED AS SEPARATE DOCUMENT)

INFORMATION ITEM P16:
PROJECT COMPONENT DETAILS (TURBINES, OUTLET VALVES,
GATES, ETC.)
(CEII PROTECTED INFORMATION FILED AS SEPARATE DOCUMENT)

INFORMATION ITEM P17:
PROJECT OPERATIONS

INFORMATION ITEM P18:
SITE ACCESS OR CONSTRAINTS TO DAM, RESERVOIR, AND
TRIBUTARIES

INFORMATION ITEM P19:
ELECTRICAL POWER AVAILABILITY

INFORMATION ITEM P20:
AMOUNTS AND TYPES OF DEBRIS EXPECTED IN RESERVOIR

INFORMATION ITEM P21:
AMOUNTS AND TYPES OF DEBRIS EXPECTED BELOW WATANA DAM

INFORMATION ITEM P22:
POTENTIAL LOCATIONS FOR ANY BARRIER, TRAP AND HAUL,
STRESS RELEASE PONDS, ADULT RELEASE PONDS, OR OTHER
FACILITIES

INFORMATION ITEM P23:
OTHER PERTINENT MISCELLANEOUS INFORMATION

INFORMATION ITEM P24:
TRIBUTARY FLOW DATA

INFORMATION ITEM P25:
TRIBUTARY ACCESS FOR JUVENILE COLLECTORS OR ADULT
RELEASE SITES

INFORMATION ITEM P26:
SEEPAGE INFORMATION AT WATANA DAM SITE

INFORMATION ITEM P27:
GLACIER OUTBURST FLOODS

INFORMATION ITEM P28:
GEOTECHNICAL AND STREAM BANK INFORMATION NEAR
POTENTIAL PASSAGE FACILITIES

**Susitna-Watana Hydroelectric Project
(FERC No. 14241)**

**Study of Fish Passage Feasibility at Watana
Dam (9.11)**

**Part A - Appendix D
Detailed Study Schedule Updated July 10, 2013**

Initial Study Report

Prepared for

Alaska Energy Authority



SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

[R2 Resource Consultants Inc. &

LGL Alaska Research Associates, Inc.]

June 2014

ID	Task Name	Duration	Start	Finish	2013												2014												2015											
					D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J					
1	Begin Study	0 days	Wed 1/2/13	Wed 1/2/13	1/2																																			
2	Task 1 - Establish FPTWG, Input to Feasibility Assessr	39 days	Wed 1/2/13	Fri 2/22/13	2/22 (Completed)																																			
3	Prepare for FPTWG Meeting #1	19 days	Wed 1/2/13	Mon 1/28/13																																				
4	Prepare list of information needs	10 days	Wed 1/2/13	Tue 1/15/13																																				
5	FPTWG Meeting #1 - Kickoff	1 day	Fri 2/22/13	Fri 2/22/13																																				
6	Task 2 - Prepare for Feasibility Study	176 days	Wed 1/2/13	Tue 9/3/13																																				
7	Prepare Physical and operations data	60 days	Wed 1/2/13	Mon 3/25/13																																				
8	Prepare Biological data	60 days	Wed 1/2/13	Mon 3/25/13																																				
9	FPTWG Mt #2 - Regular update (web call)	1 day	Wed 3/20/13	Wed 3/20/13	3/20 (Completed)																																			
10	Distribute background Info, 1st draft	0 days	Tue 3/26/13	Tue 3/26/13	3/26 (Completed)																																			
11	Prepare for FPTWG Workshop #1	10 days	Tue 3/26/13	Mon 4/8/13																																				
12	FPTWG Workshop #1 - Review background info	2 days	Tue 4/9/13	Wed 4/10/13	Workshop #1, 4/9 & 4/10 (Completed)																																			
13	Update background material	29 days	Thu 4/11/13	Tue 5/21/13																																				
14	Prepare draft criteria	60 days	Thu 4/11/13	Wed 7/3/13																																				
15	FPTWG Mtg #3 - Regular update (web call)	1 day	Tue 5/21/13	Tue 5/21/13	5/21 (Completed)																																			
16	Update background material as needed	75 days	Wed 5/22/13	Tue 9/3/13																																				
17	FPTWG Mtg #3a - Regular update (web call)	1 day	Tue 7/9/13	Tue 7/9/13	7/9 (Completed)																																			
18	Distribute update to backgnd info	0 days	Tue 9/3/13	Tue 9/3/13	9/3																																			
19	Task 3 - Conduct Site Reconnaissance	13 days	Wed 9/4/13	Fri 9/20/13																																				
20	Prepare for Site Recon FPTWG Mtg #4	10 days	Wed 9/4/13	Tue 9/17/13																																				
21	FPTWG Mtg #4 - Site Recon (ANK)	4 days	Tue 9/17/13	Fri 9/20/13	9/17 - 9/20 Site Reconnaissance Trip																																			
22	Task 4 - Develop Fish Passage Concepts	262 days	Thu 8/1/13	Fri 8/1/14																																				
23	Prep Bio Performance Tool & Update Info	115 days	Thu 8/1/13	Wed 1/8/14																																				
24	Submit 2013 Information Updates	0 days	Wed 1/8/14	Wed 1/8/14	1/8																																			
25	Prepare initial concepts for brainstorm	49 days	Wed 1/8/14	Mon 3/17/14																																				
26	AEA Submit ISR to FERC	0 days	Mon 2/3/14	Mon 2/3/14	2/3 AEA Submit ISR to FERC for 2013																																			
27	FPTWG Workshop #2 - Brainstorm Concept Alts	2 days	Tue 3/18/14	Wed 3/19/14	Wksp #2, 3/18 & 3/19/14																																			
28	Organize and clarify concepts	20 days	Thu 3/20/14	Wed 4/16/14																																				
29	Develop draft evaluation criteria	70 days	Thu 1/9/14	Wed 4/16/14																																				
30	Update biological performance tool	53 days	Mon 2/3/14	Wed 4/16/14																																				
31	Prep for FPTWG Mtg #5	10 days	Thu 4/17/14	Wed 4/30/14																																				
32	FPTWG Mtg #5 - Reg update (1d, fatal flaw, ID alts)	3 days	Tue 4/29/14	Thu 5/1/14																																				

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Last Update: 7/10/13

[illegible]

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