Sediment Transport Analysis

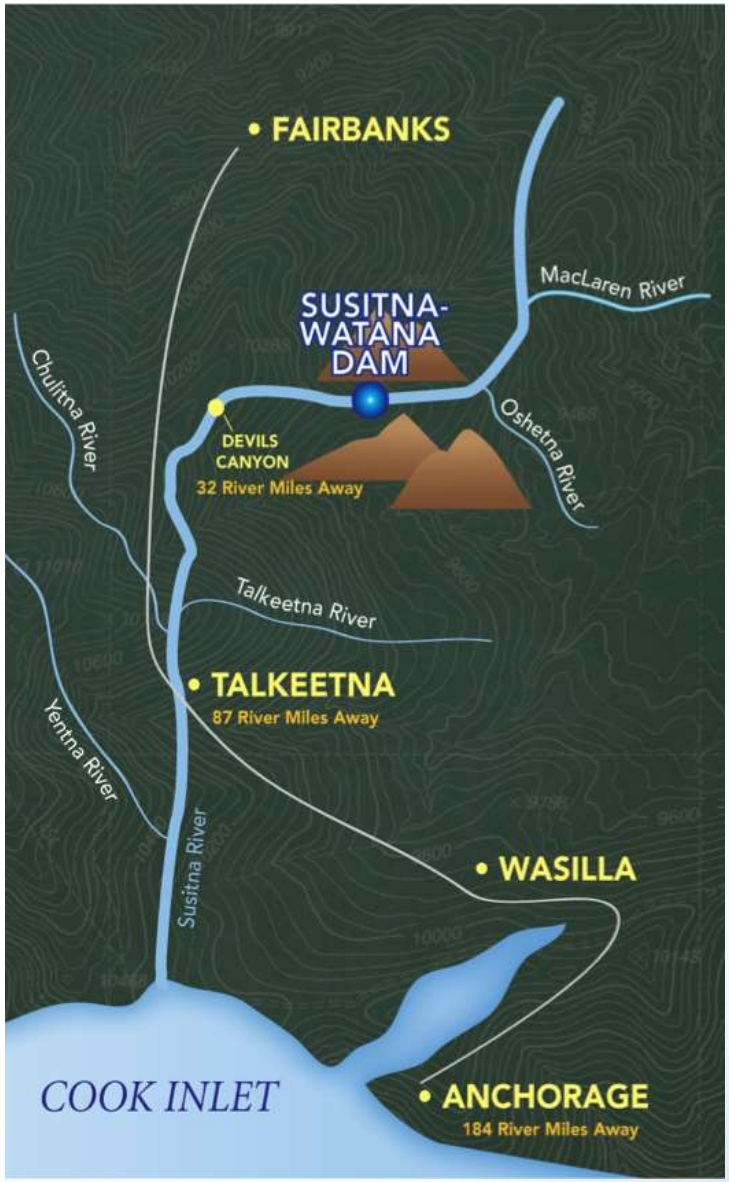
2012 Technical Memorandum:

Initial Sediment Balance for the Middle and Lower Susitna River for Existing and with Project Conditions

March 28, 2013

Technical Workgroup Meeting
March 28, 2012

Prepared by: Tetra Tech
Prepared for: Alaska Energy Authority



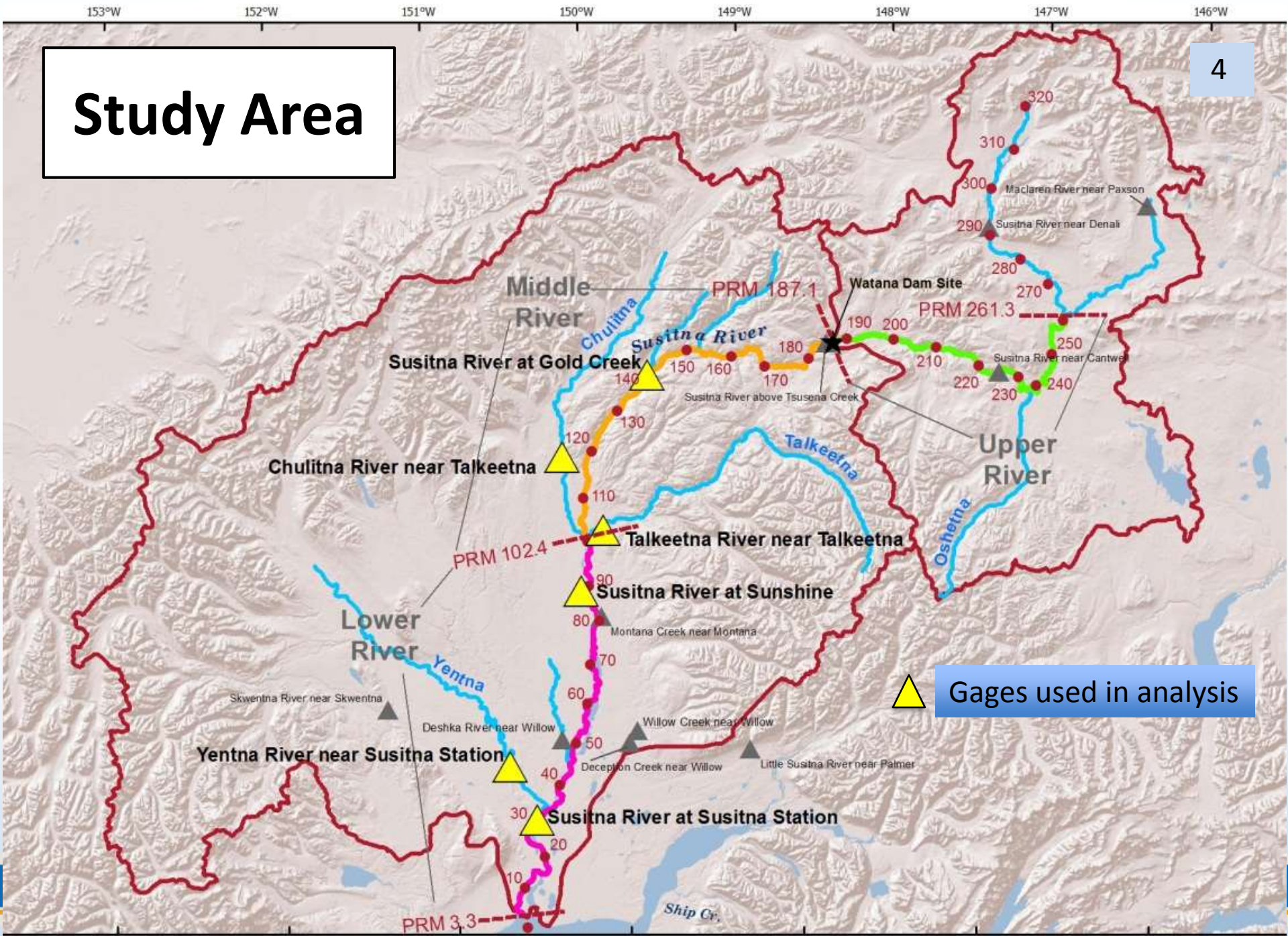
2012 Study Technical Memorandum:
Initial Sediment Balance for the Middle and Lower Susitna River for Existing and with Project Conditions
March 28, 2013

- Part of 2012 Study - G-S4: Reconnaissance-Level geomorphic and Aquatic Habitat Assessment of Project Effects on Lower River Channel
- Date Filed with FERC: 3/1/2013
- Date Posted to AEA website: 3/1/2013

Sediment Transport Analysis Study Objectives

- Assess suitability of previously published sediment transport relationships - update if necessary
- Select most appropriate sediment transport relationships
- Estimate annual loads under pre-Project and Maximum Load Following OS-1:
  - Silt and clay /wash load (suspended load)
  - Sand load (suspended and bedload)
  - Gravel load (bedload)
- Preliminary estimate of the overall sediment balance in the Middle and Lower Susitna River segments:
  - Pre-Project hydrologic conditions
  - Maximum Load Following OS-1 hydrologic conditions

Study Area


153°W
152°W
151°W
150°W
149°W
148°W
147°W
146°W
Middle River
Lower River
Upper River
Chulitna
Susitna River
Talkeetna
Oshetna
Yentna
PRM 187.1
PRM 261.3
PRM 102.4
PRM 3.3
Watana Dam Site
Susitna River at Gold Creek
Susitna River above Tsusena Creek
Chulitna River near Talkeetna
Talkeetna River near Talkeetna
Susitna River at Sunshine
Montana Creek near Montana
Skwentna River near Skwentna
Deshka River near Willow
Willow Creek near Willow
Yentna River near Susitna Station
Deception Creek near Willow
Little Susitna River near Palmer
Susitna River at Susitna Station
Maclaren River near Paxson
Susitna River near Denali
Susitna River near Cantwell
Ship Cr.
320
310
300
290
280
270
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
90
80
70
60
50
40
30
20
10
Gages used in analysis

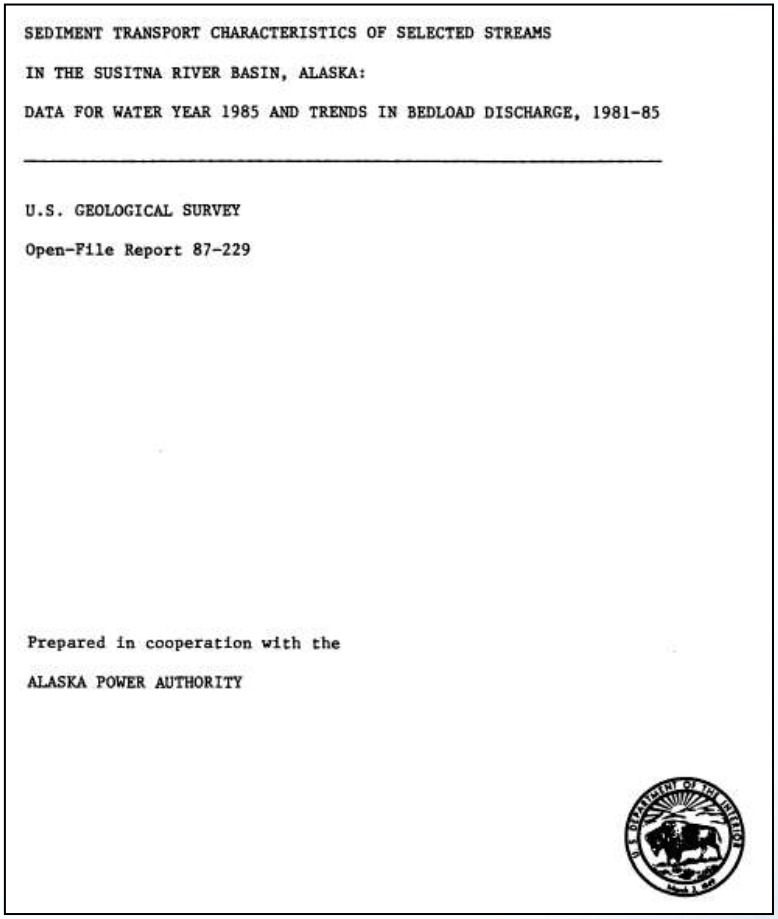
USGS Sediment Transport Data Summary

Gage Name	Number of Samples								Record
	Suspended Silt/Clay		Suspended Sand		Bed-load Sand		Bed-load Gravel		
	Pre-1985	Post-1985	Pre-1985	Post-1985	Pre-1985	Post-1985	Pre-1985	Post-1985	
Susitna River at Gold Creek	45	5	46	5	45	0	38	0	1962 - 1986
Chulitna River near Talkeetna	48	2	46	2	48	0	48	0	1973 - 1986
Talkeetna River near Talkeetna	53	23	56	22	45	0	40	0	1967 - 1995
Susitna River at Sunshine	52	2	53	2	50	0	50	0	1971 - 1986
Yentna River near Susitna Station	24	1	24	1	13	0	13	0	1981 - 1986
Susitna River at Susitna Station	37	9	35	9	13	5	13	3	1975 - 2003

Previous Study

USGS OFR 87-229

- Primarily used data from early- to mid-1980s
- Sediment load computed for single year (1985)
- Divided total sediment load into 4 components:
  - Suspended silt/clay
  - Suspended sand
  - Sand bedload
  - Gravel bedload



SEDIMENT TRANSPORT CHARACTERISTICS OF SELECTED STREAMS

IN THE SUSITNA RIVER BASIN, ALASKA:

DATA FOR WATER YEAR 1985 AND TRENDS IN BEDLOAD DISCHARGE, 1981-85

U.S. GEOLOGICAL SURVEY

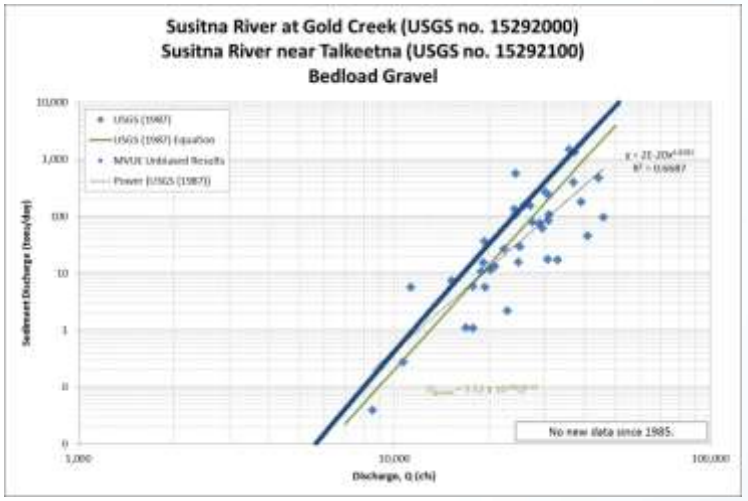
Open-File Report 87-229

Prepared in cooperation with the

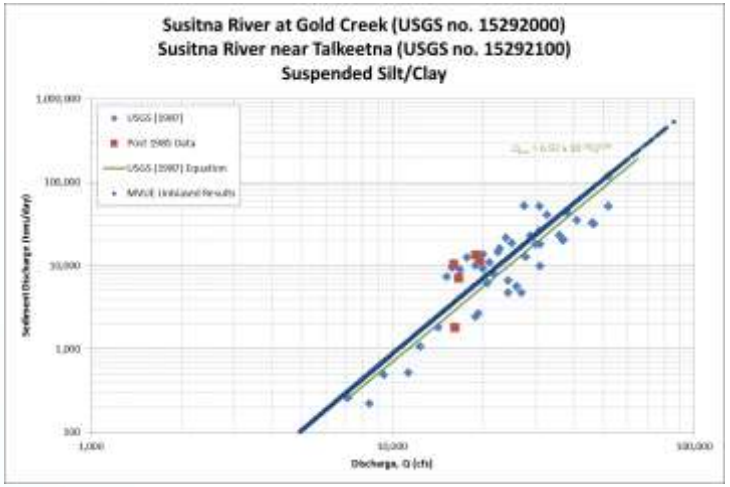
ALASKA POWER AUTHORITY

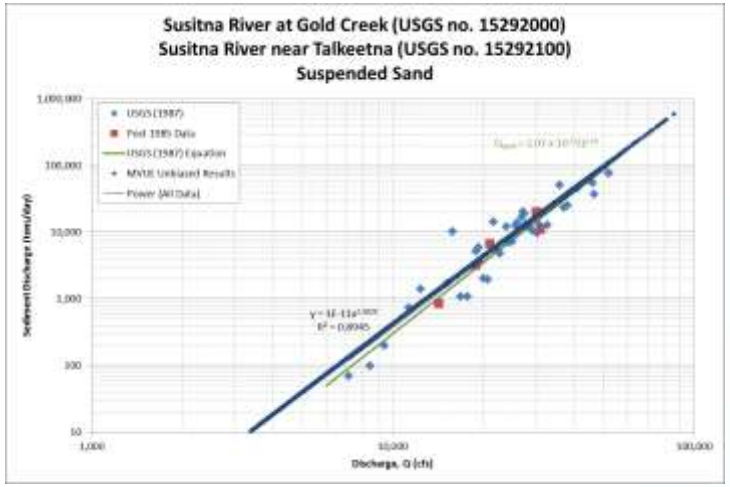
Current Study

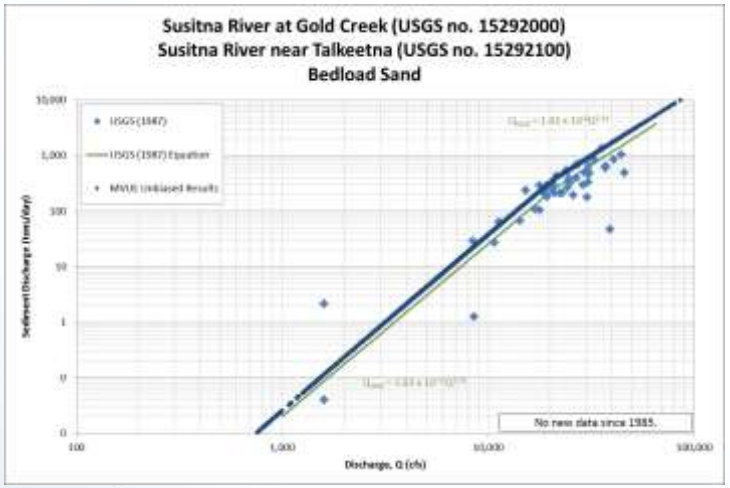
- Updated data sets to include newer data
- Updated sediment load rating curves where appropriate
- Annual loads: 61-year extended record
- Applied MVUE bias correction to rating curves
  - Increases loads by 15% to >200% compared to regression line, depending on scatter in base data set
- Divided load into 3 components:
  - Silt/clay (Suspended load)
  - Sand bed material (Combination of suspended and bedload)
  - Gravel (Bedload)

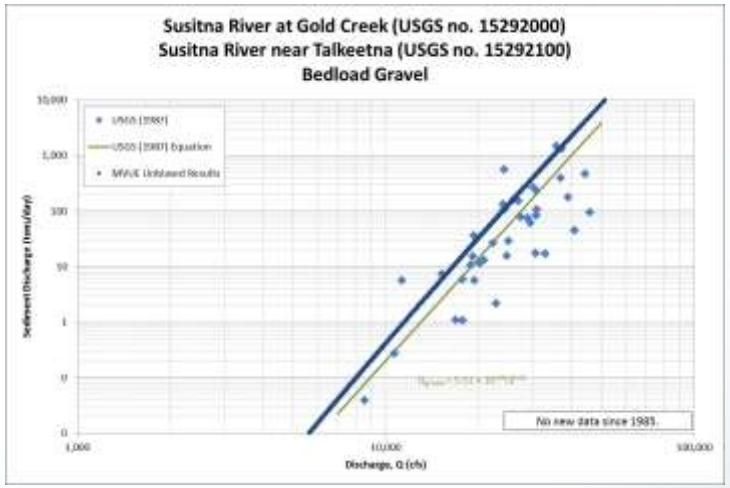


Susitna River at Gold Creek

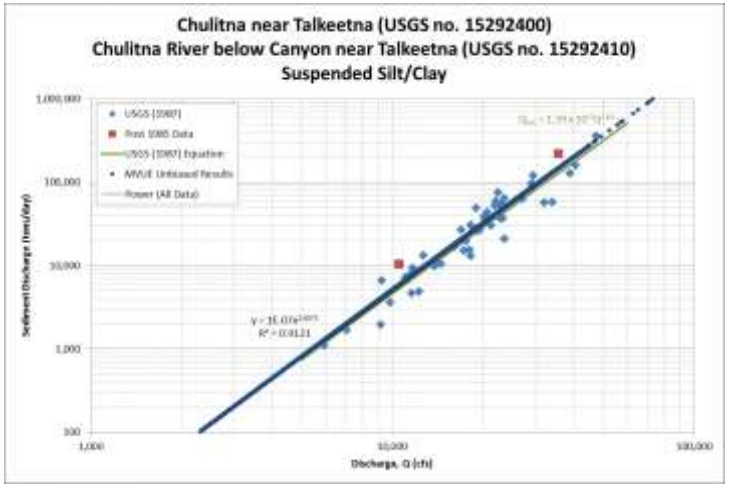


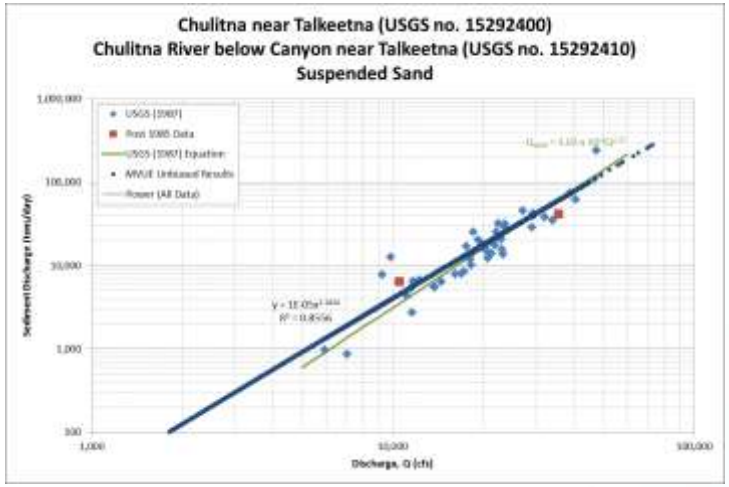


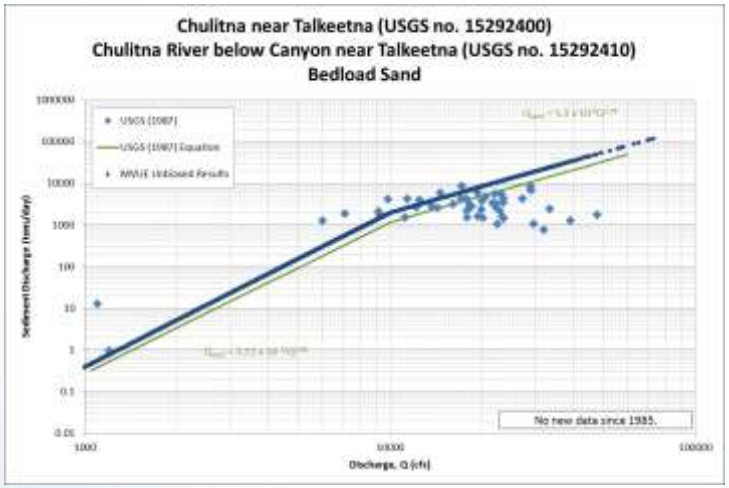


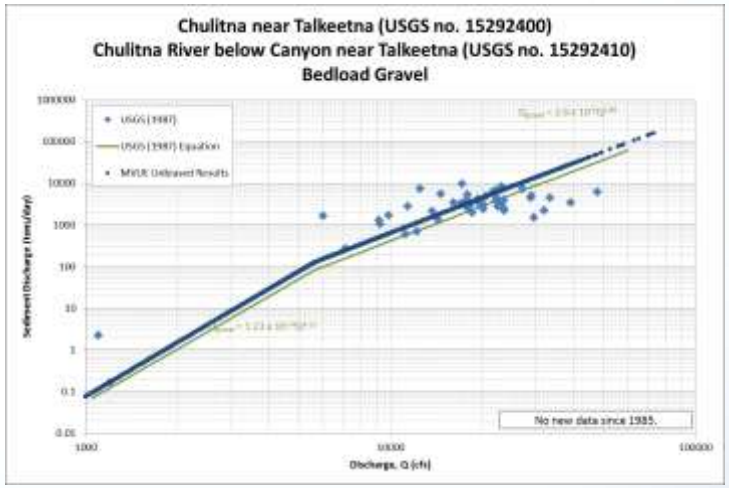


Chulitna River near Talkeetna

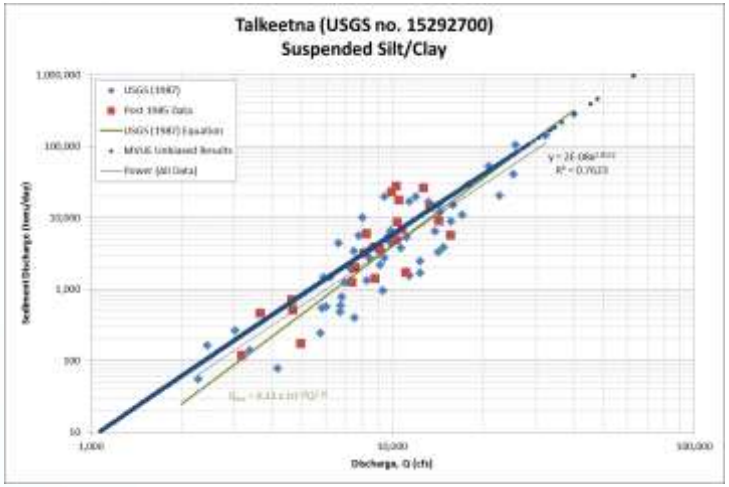


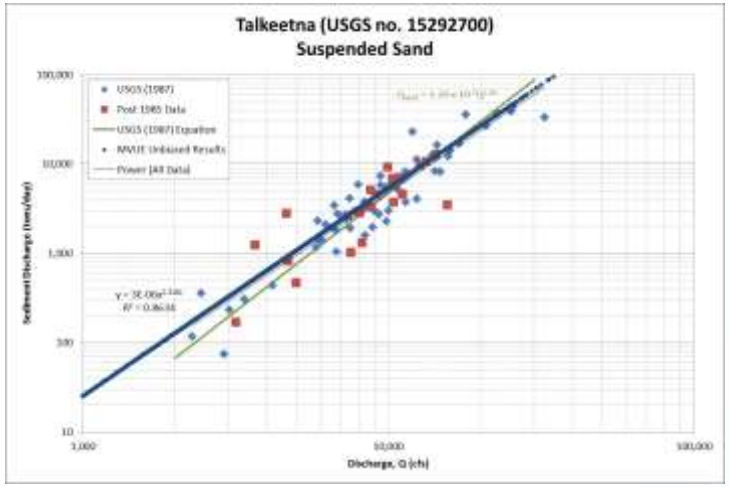


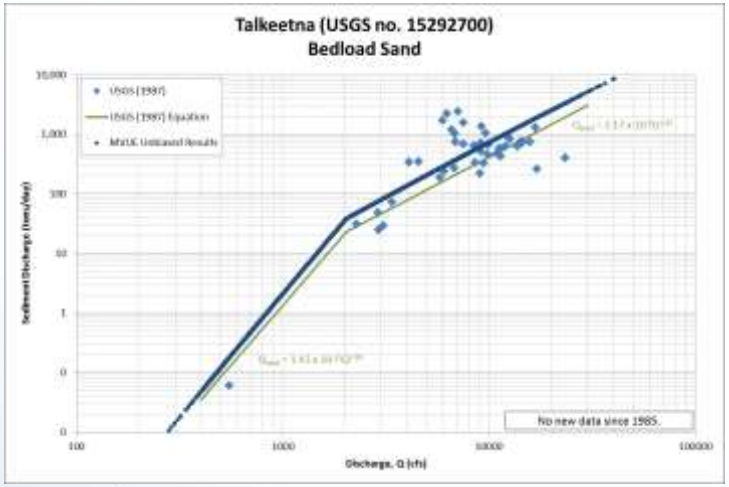


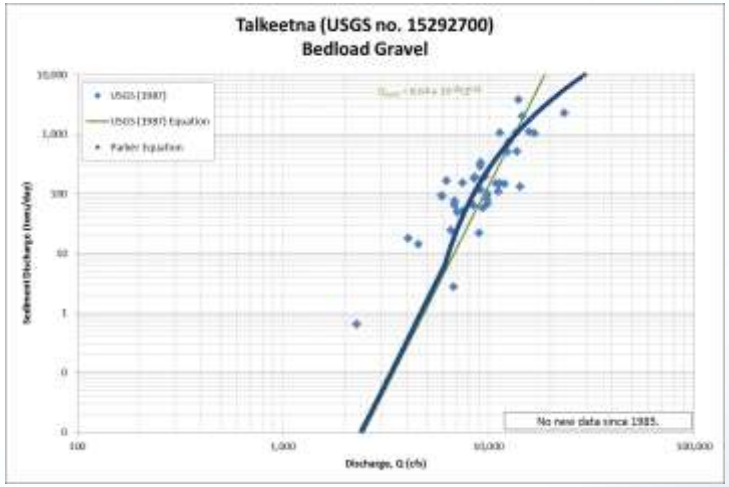


Talkeetna River near Talkeetna

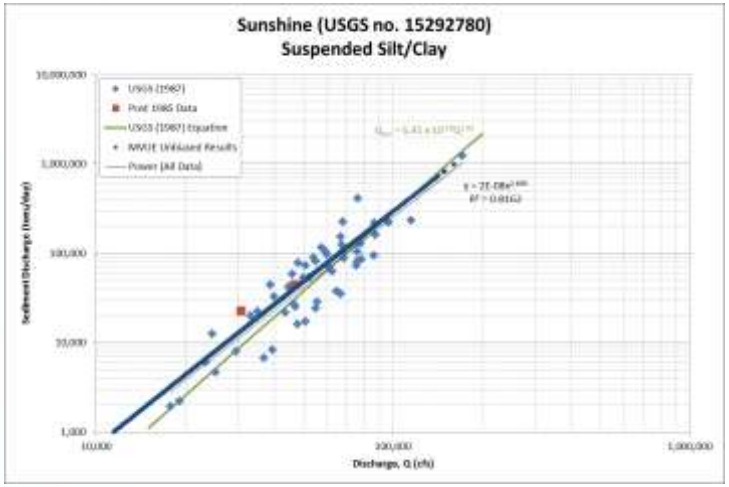


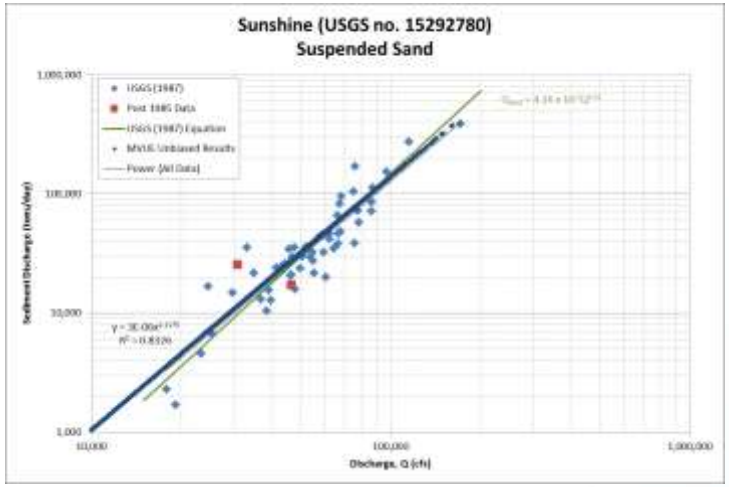


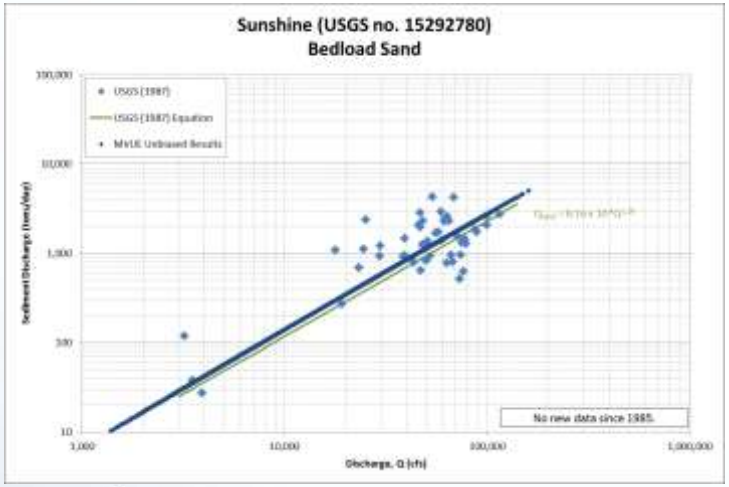


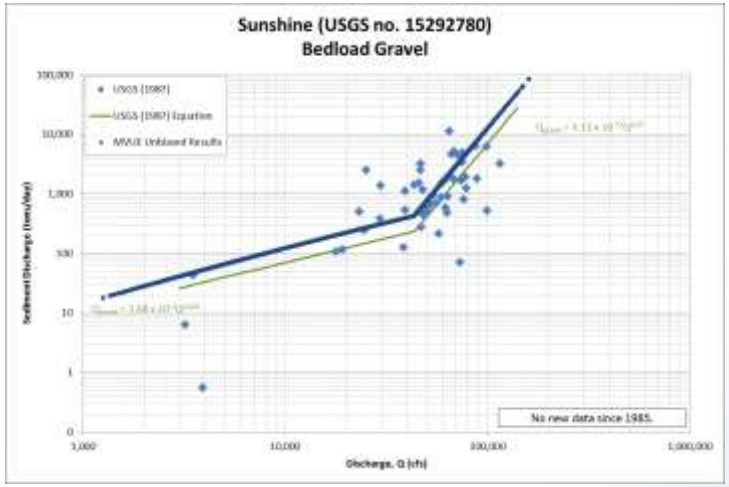


Susitna River at Sunshine

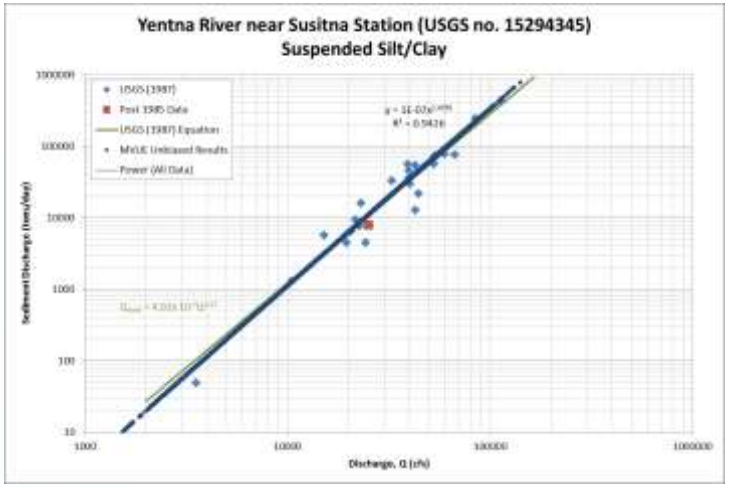


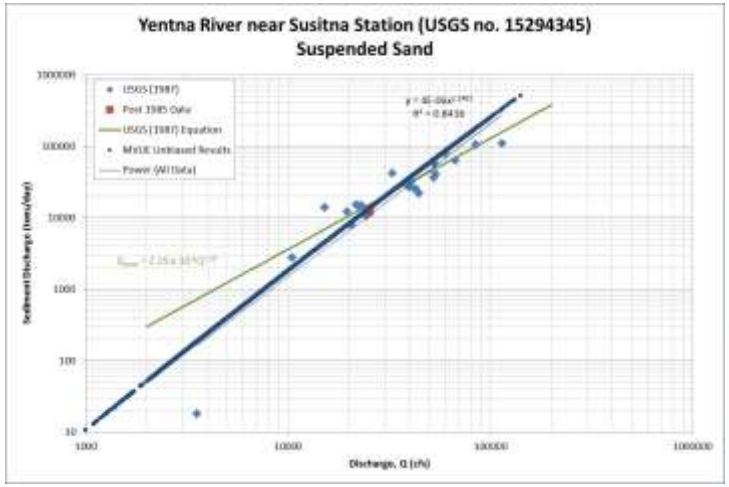


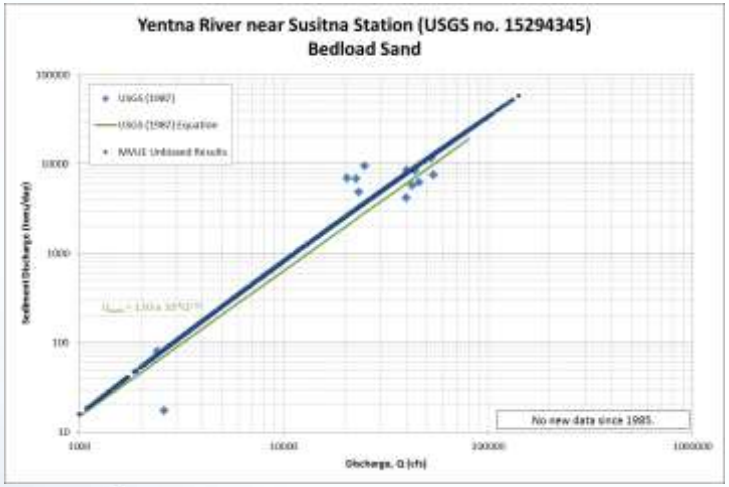


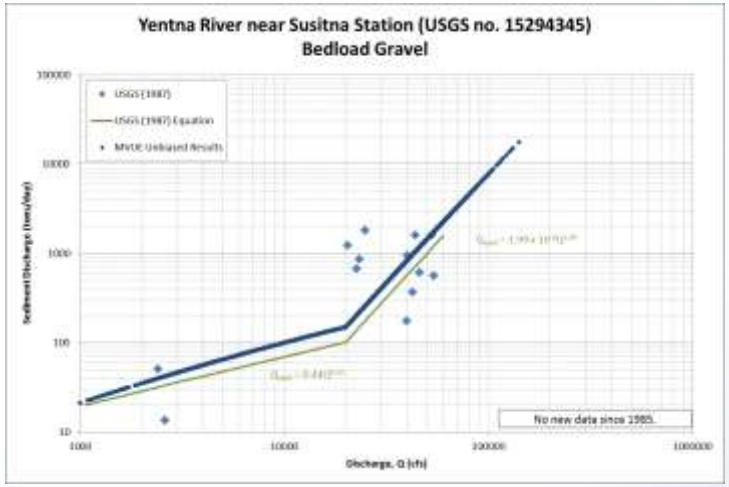


Yentna River near Susitna Station

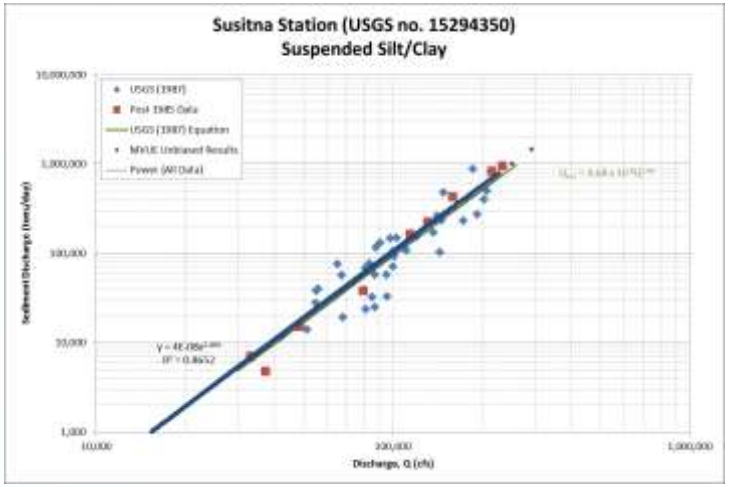


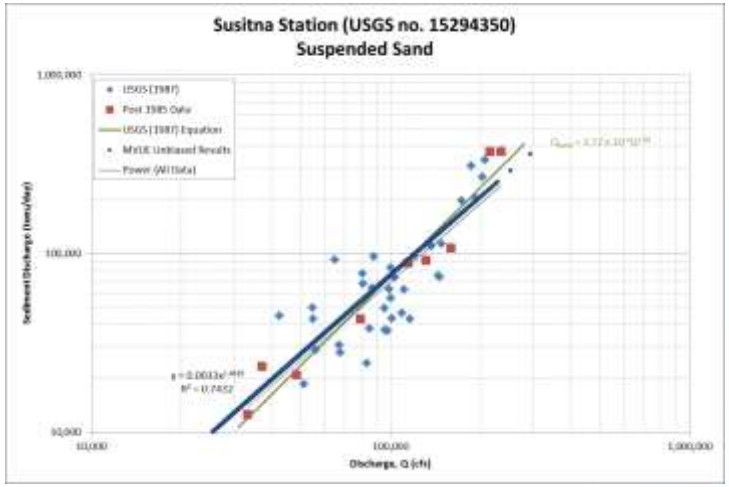


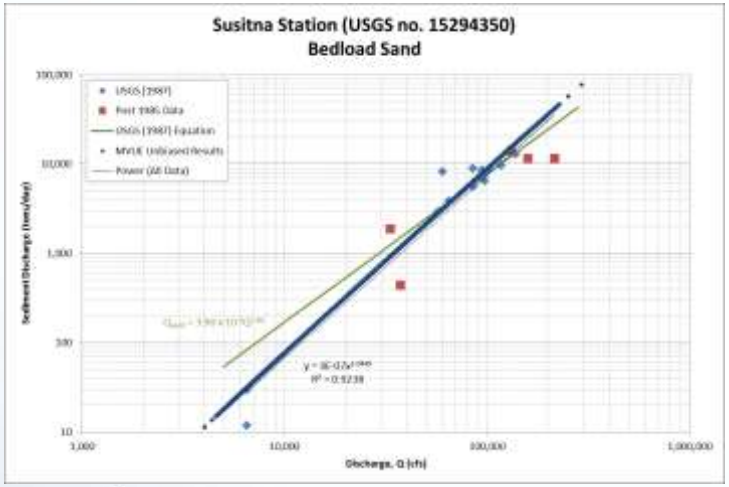


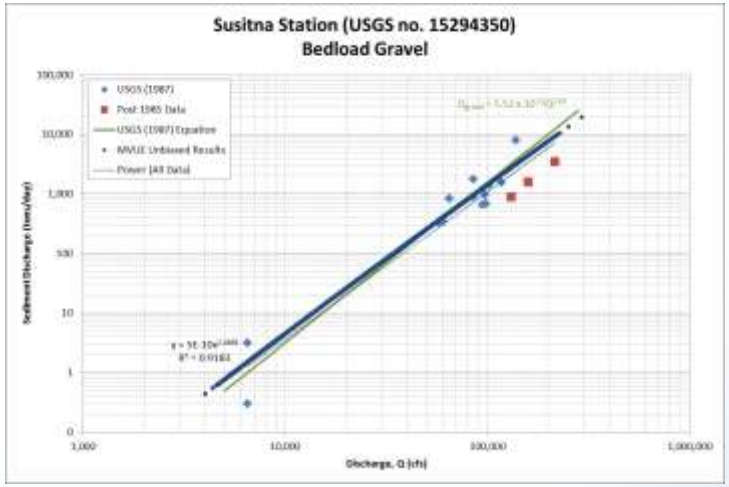


Susitna River at Susitna Station









Sediment Transport Relationships

Gage Name	Suspended Load		Bed Load	
	Silt/Clay	Sand	Sand	Gravel
Susitna River at Gold Creek	$6.97E\text{-}10\ Q^{3.00}$	$1.09E\text{-}11\ Q^{3.38}$	$4.49E\text{-}9\ Q^{2.46}$ $1.02E\text{-}11\ Q^{3.10}$	$1.89E\text{-}20\ Q^{4.84}$
Chulitna River near Talkeetna	$1.12E\text{-}7\ Q^{2.66}$	$1.01E\text{-}5\ Q^{2.14}$	$5.1E\text{-}6\ Q^{2.09}$ $3.51E\text{-}12\ Q^{3.63}$	$2.6E\text{-}9\ Q^{2.80}$ $1.23E\text{-}14\ Q^{4.22}$
Talkeetna River near Talkeetna	$2.33E\text{-}8\ Q^{2.81}$	$2.58E\text{-}6\ Q^{2.32}$	$2.17E\text{-}5\ Q^{1.82}$ $1.43E\text{-}12\ Q^{3.99}$	Parker Equation
Susitna River at Sunshine	$2.29E\text{-}8\ Q^{2.61}$	$3.28E\text{-}6\ Q^{2.12}$	$8.16E\text{-}4\ Q^{1.29}$	$3.11E\text{-}17\ Q^{4.07}$ $3.68E\text{-}2\ Q^{0.820}$
Yentna River near Susitna Station	$1.27E\text{-}7\ Q^{2.48}$	$4.10E\text{-}6\ Q^{2.14}$	$1.93E\text{-}4\ Q^{1.63}$	$1.99E\text{-}9\ Q^{2.49}$
Susitna River at Susitna Station	$4.49E\text{-}8\ Q^{2.46}$	$3.31E\text{-}3\ Q^{1.46}$	$4.45E\text{-}7\ Q^{2.04}$	$4.85E\text{-}10\ Q^{2.47}$

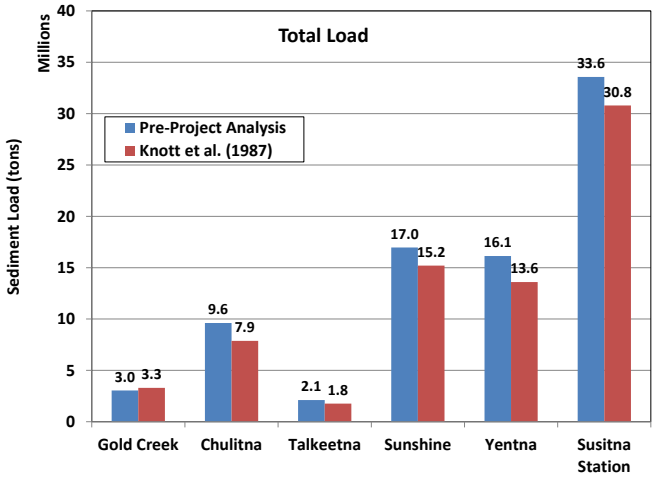
from Knott et al (1987)

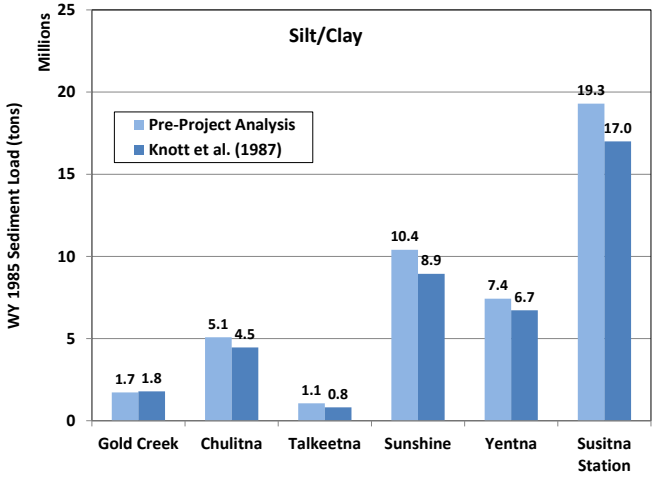
New Regression

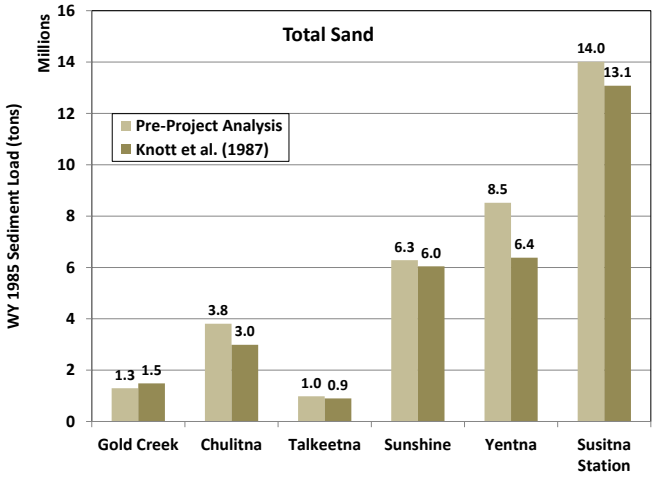
Q = Water discharge in cfs

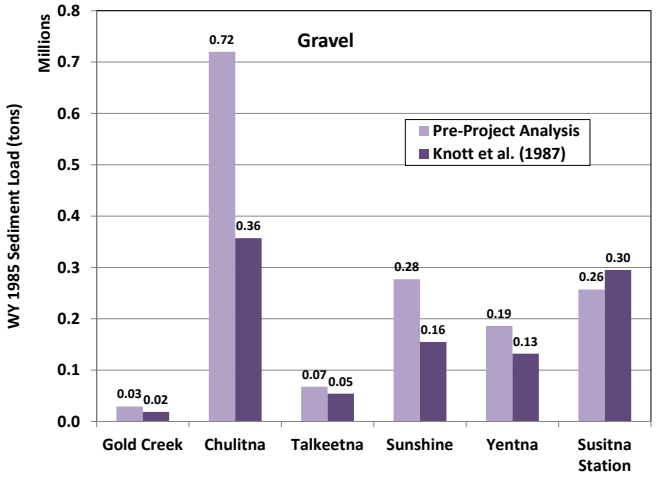
Sediment load in tons/day (tpd)

WY 1985 Sediment Load Comparison



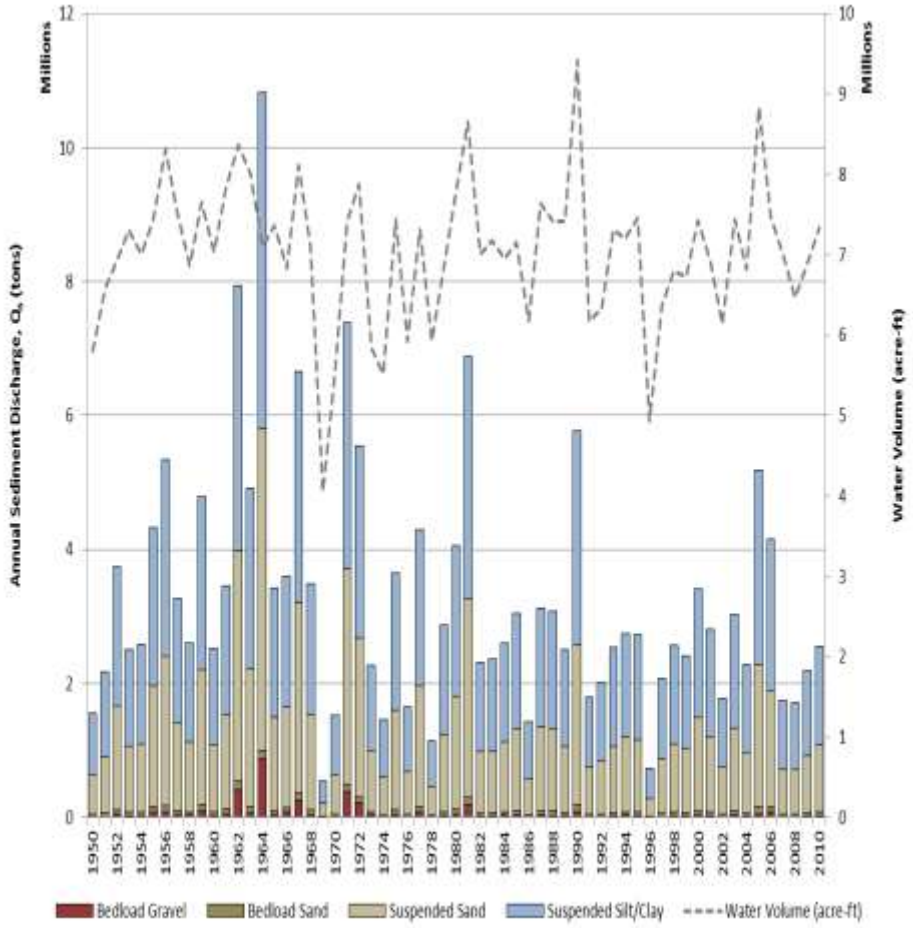




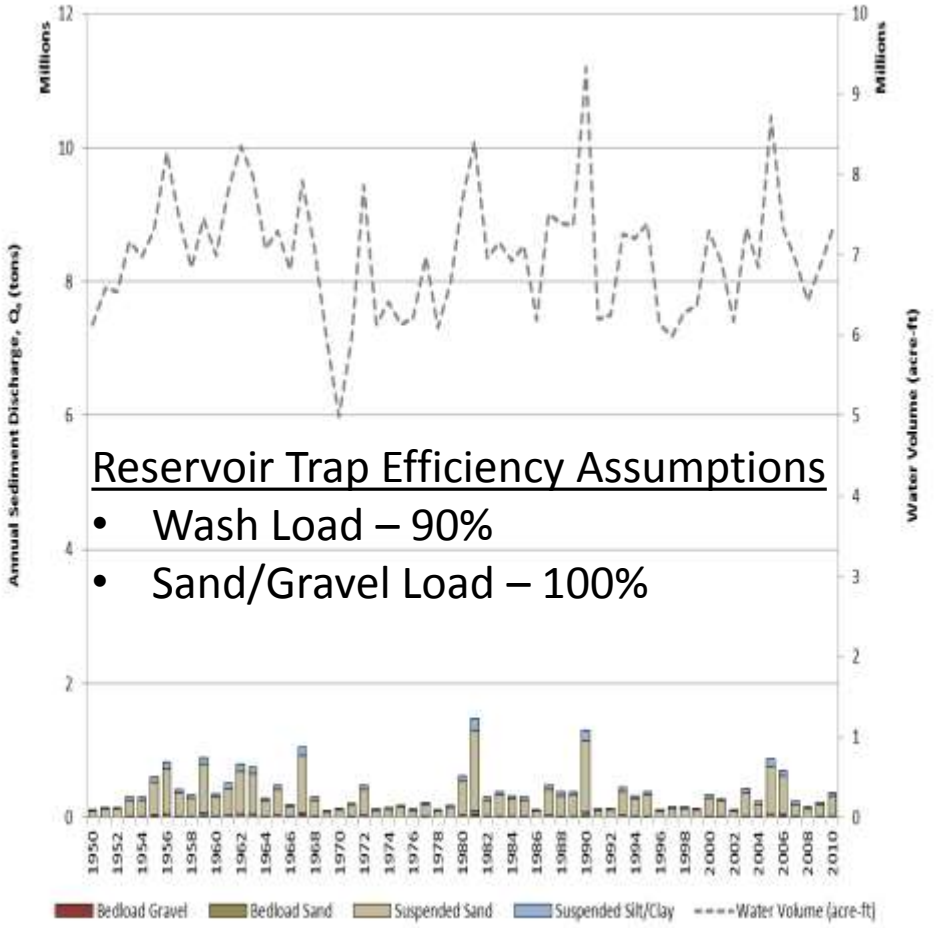


Gold Creek Annual Sediment Load

Pre-Project



Max LF OS-1

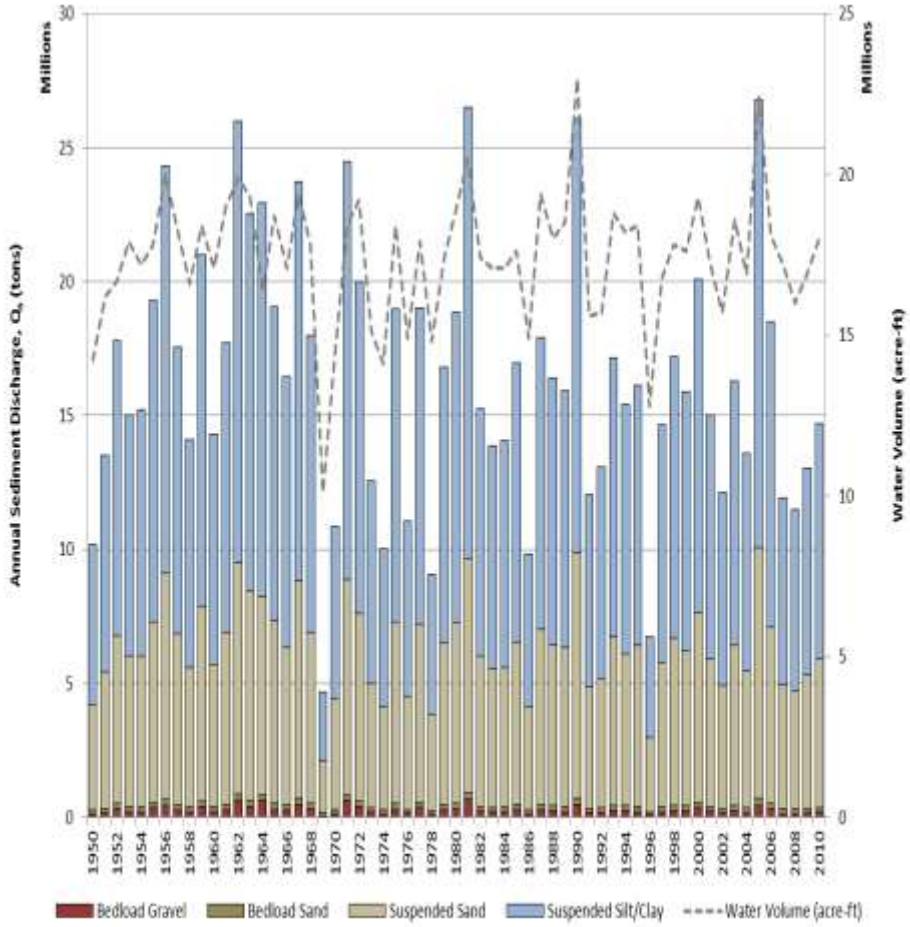


Reservoir Trap Efficiency Assumptions

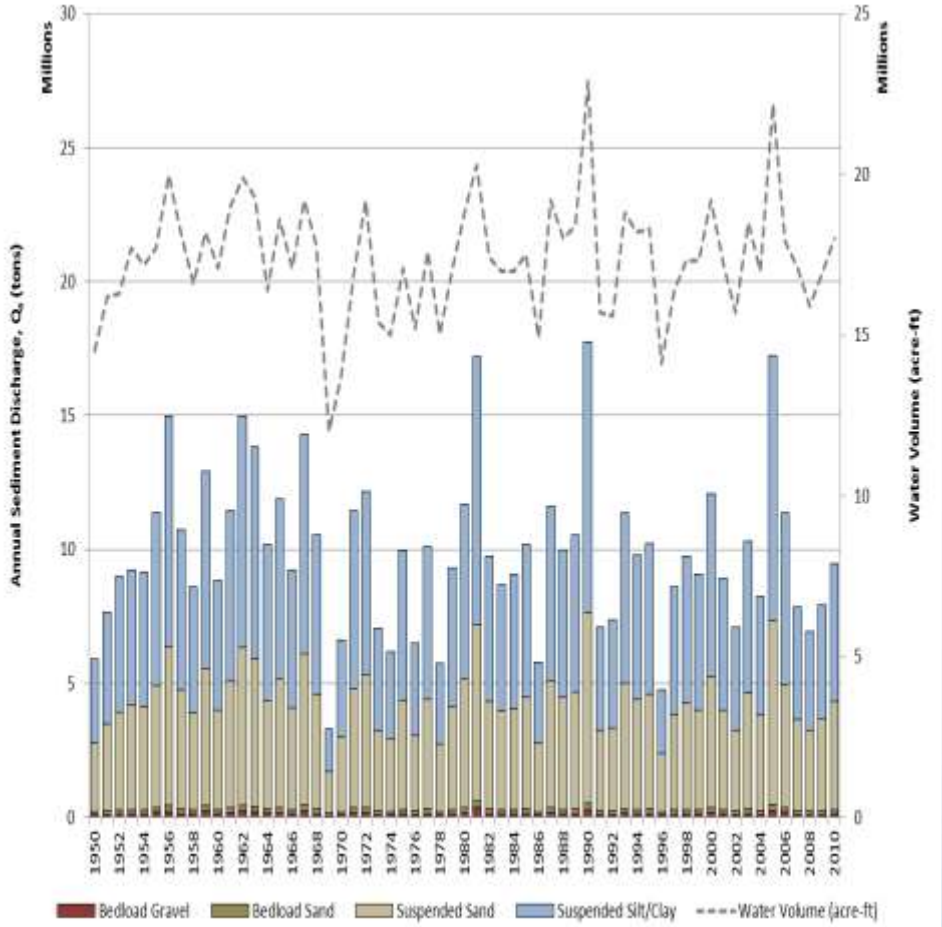
- Wash Load – 90%
- Sand/Gravel Load – 100%

Sunshine Annual Sediment Load

Pre-Project

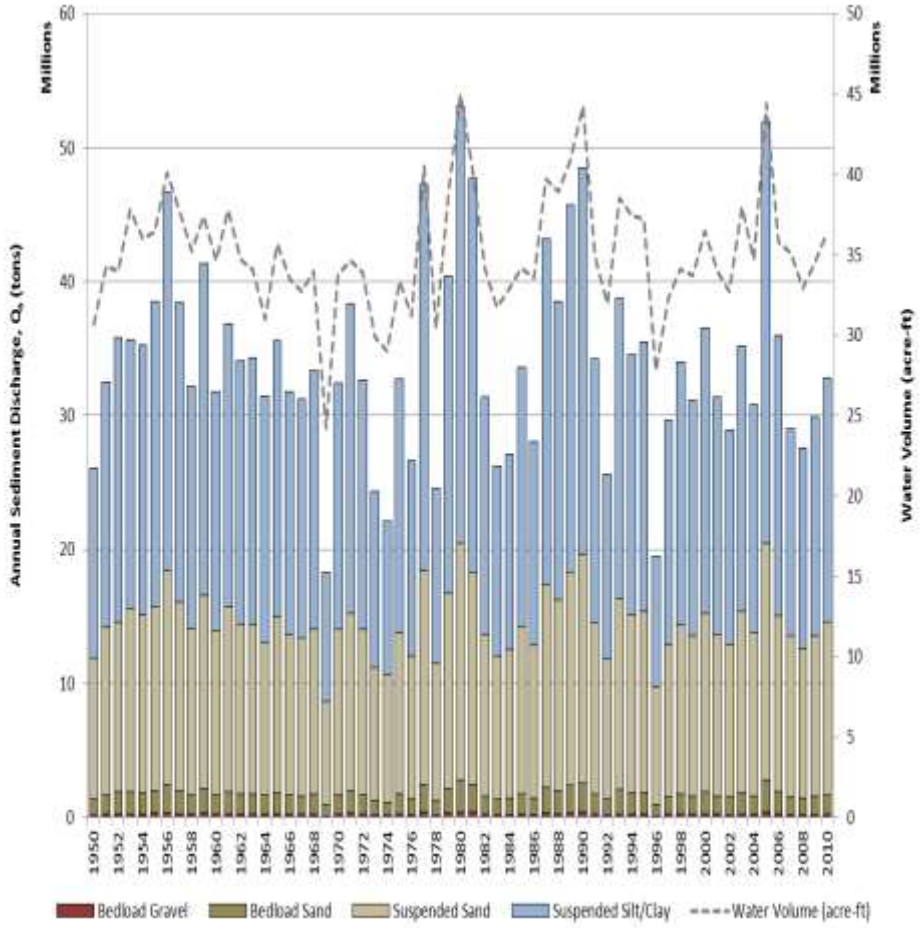


Max LF OS-1

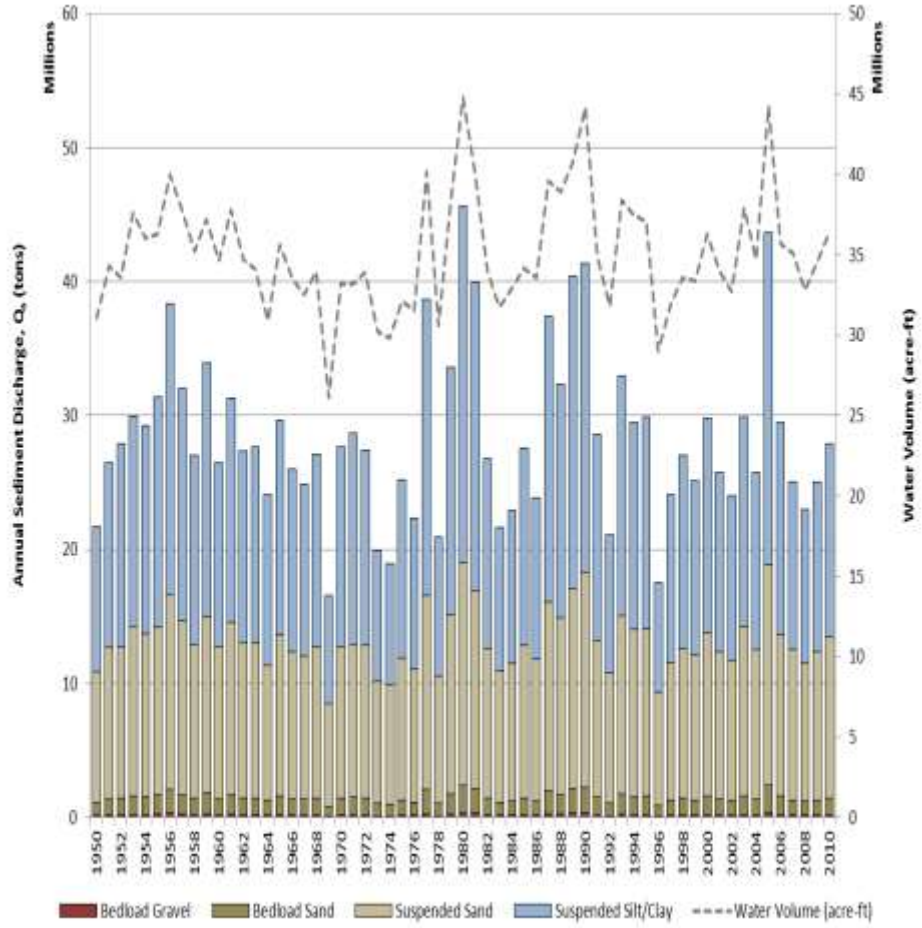


Susitna Station Annual Sediment Load

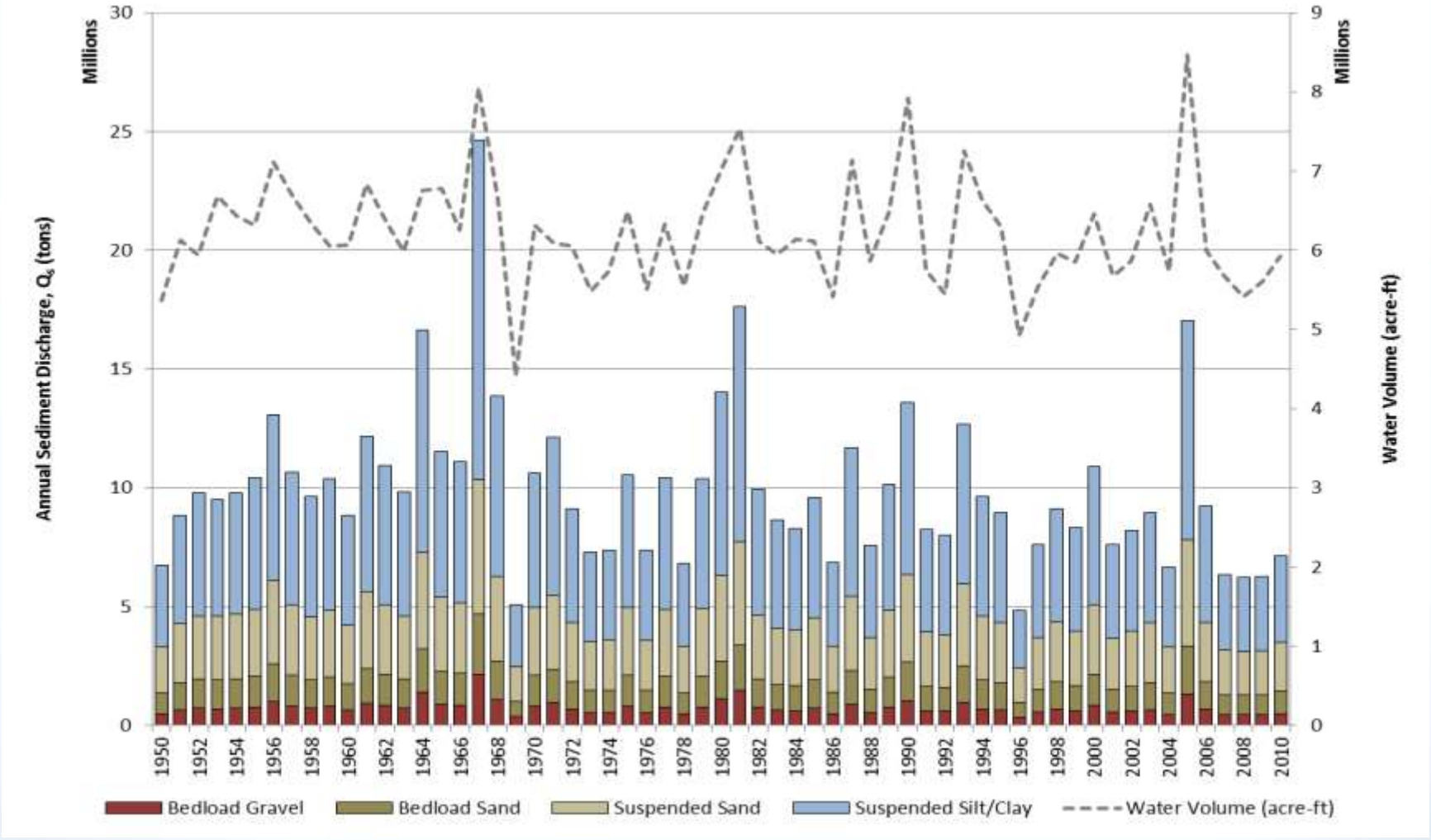
Pre-Project



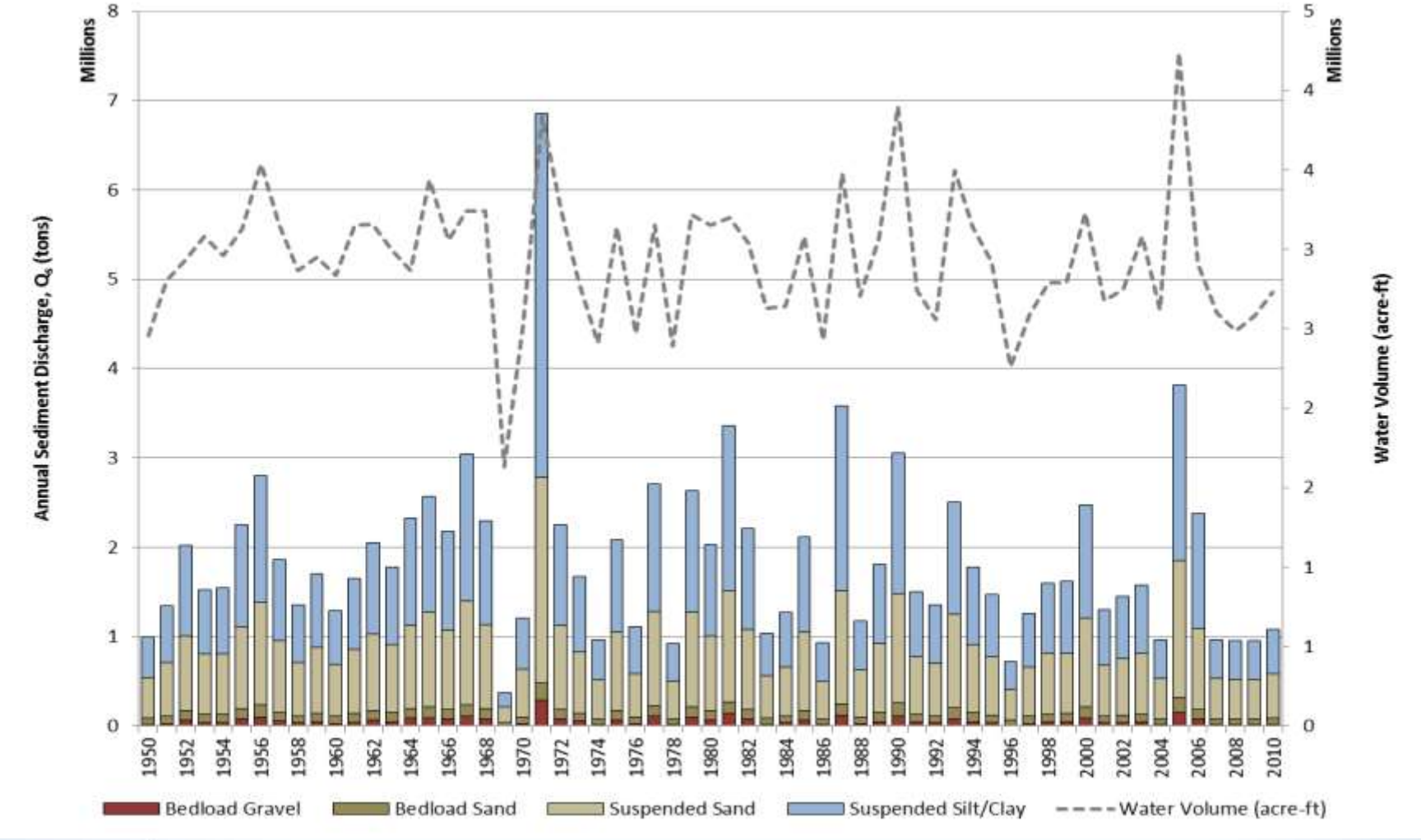
Max LF OS-1



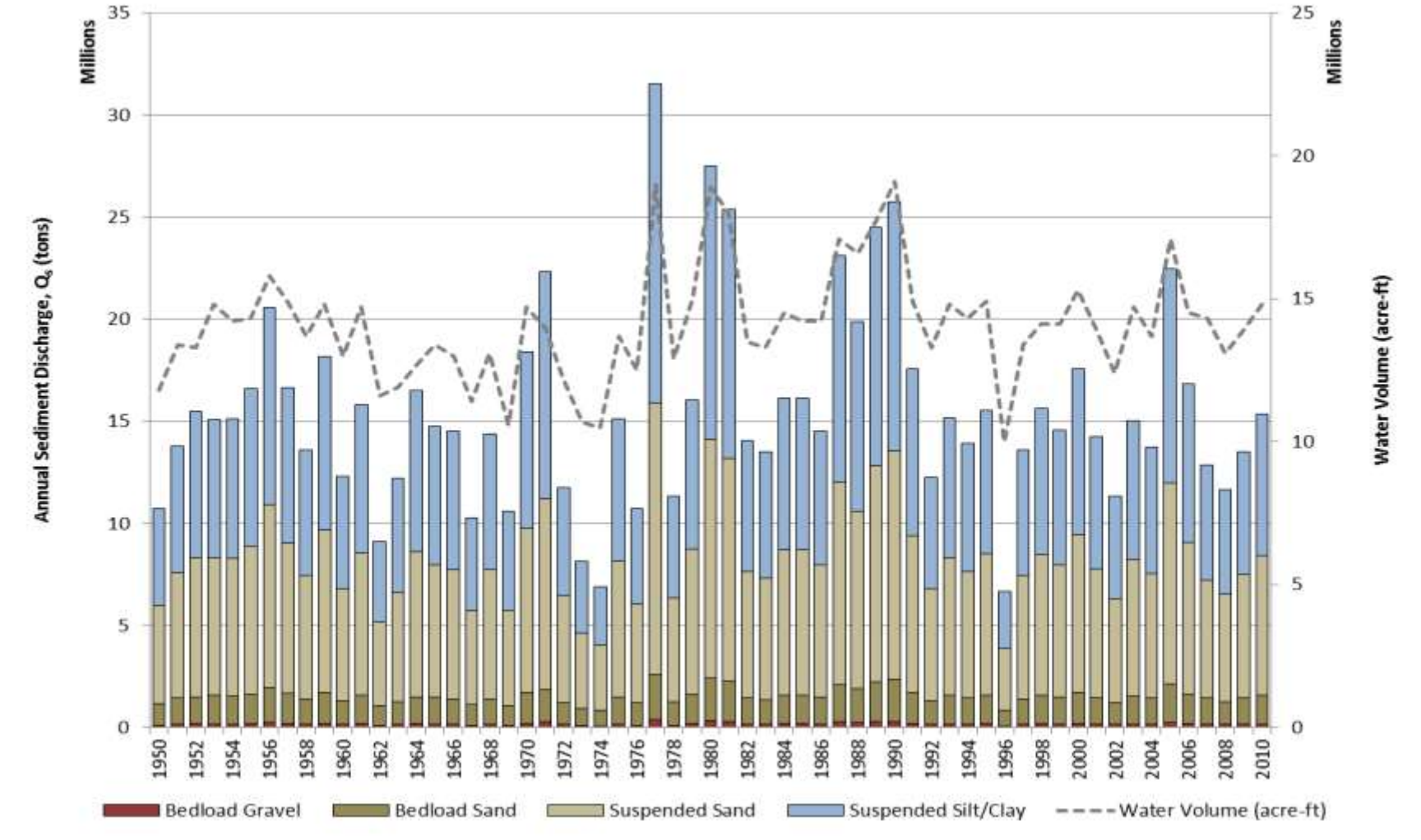
Chulitna Annual Sediment Load



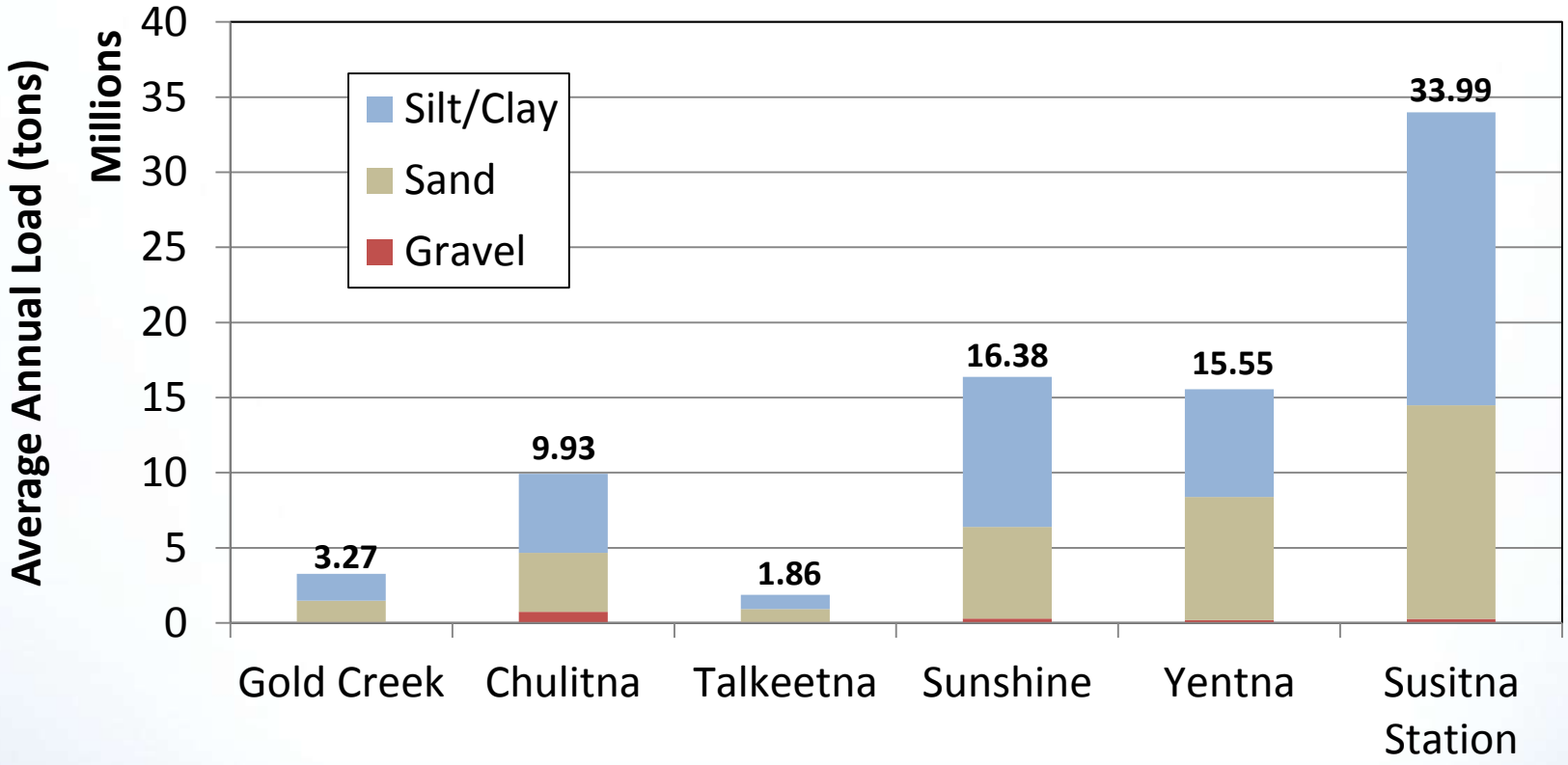
Talkeetna Annual Sediment Load



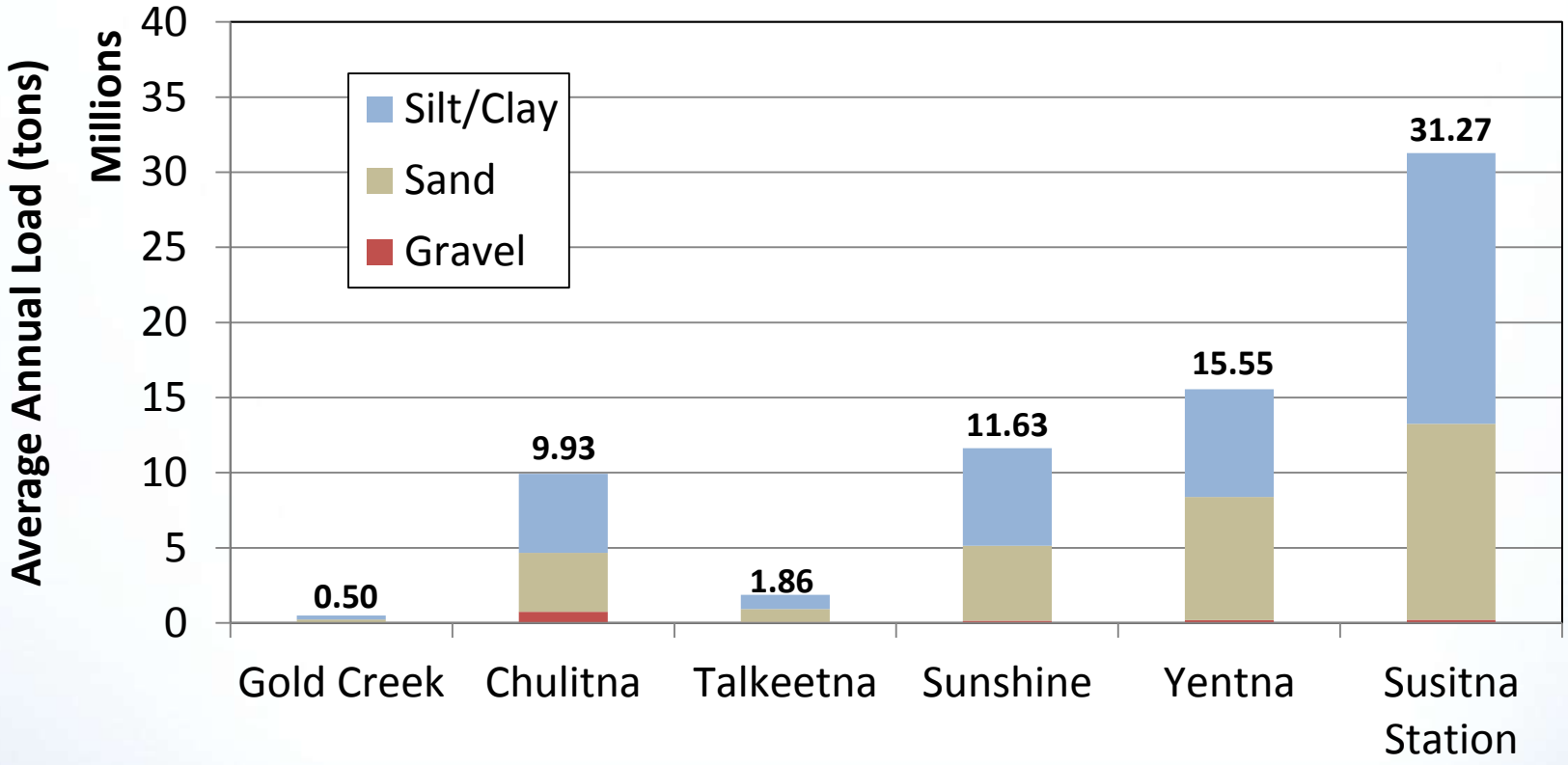
Yentna Annual Sediment Load



Average Annual Load
Pre-Project

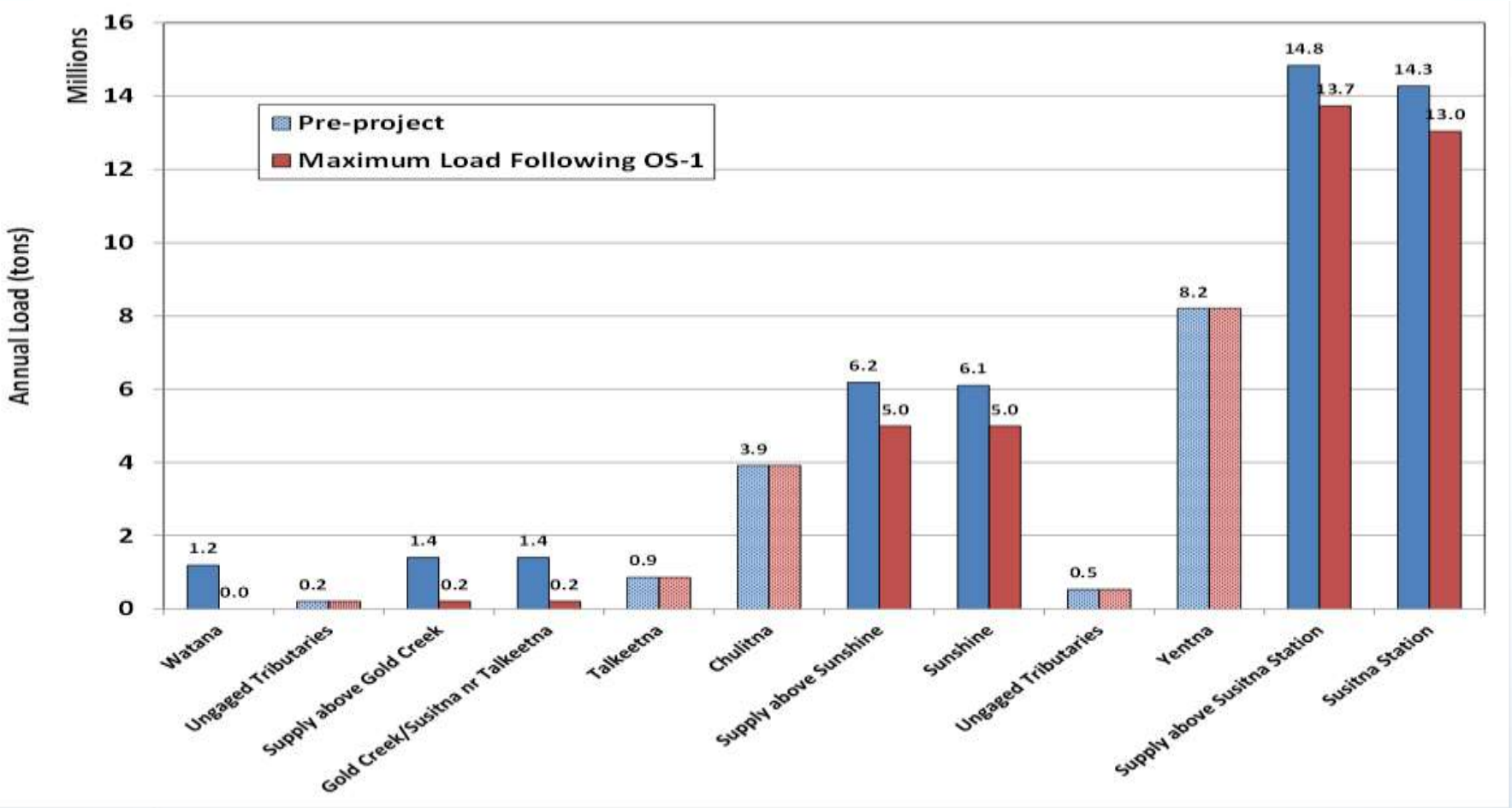


Average Annual Load
Max LF OS-1



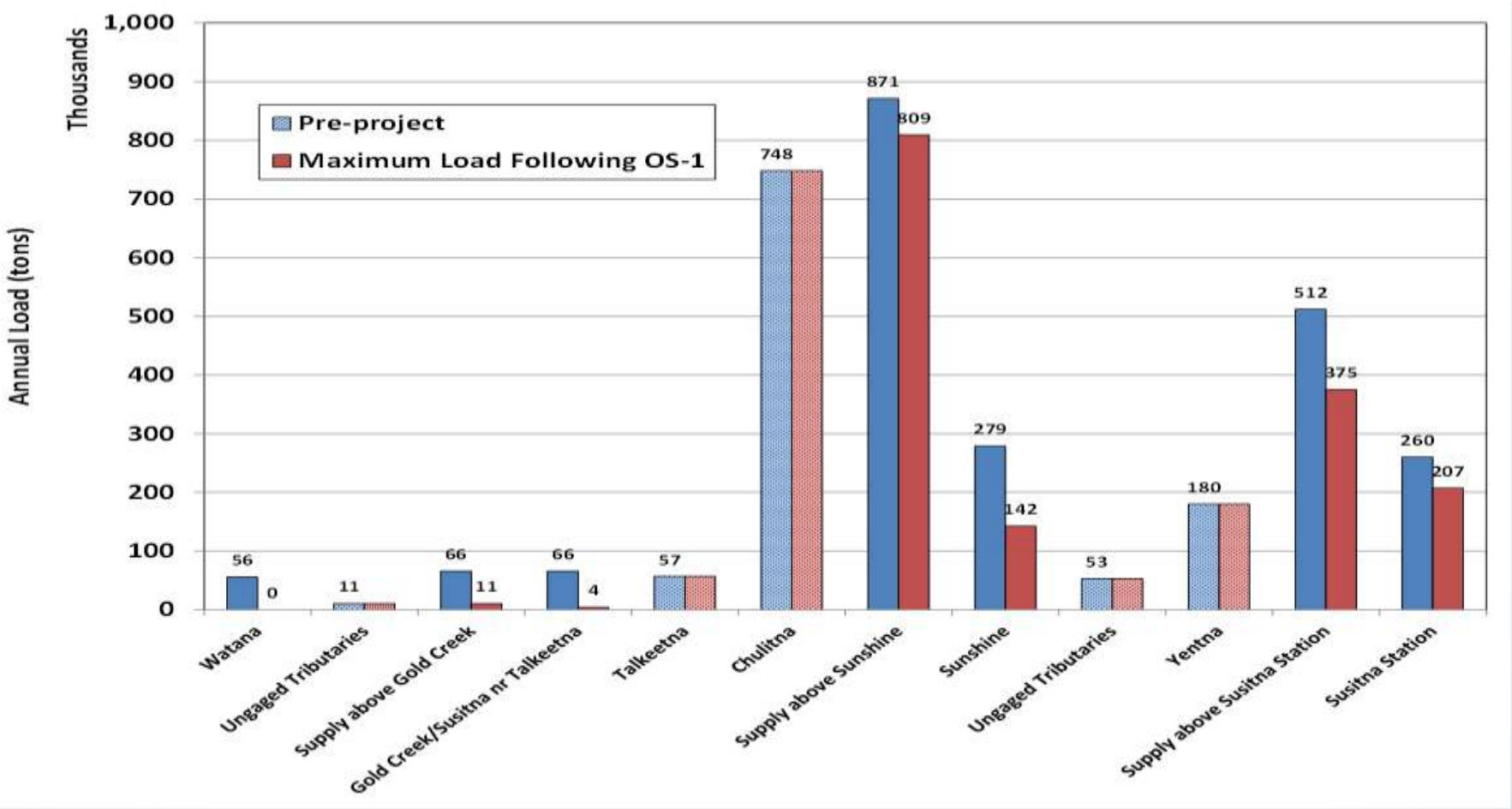
Average Annual Sand Load

(Including estimated annual sand load from ungaged tributaries)



Average Annual Gravel Load

(Including estimated annual gravel load from ungaged tributaries)



Sediment Transport Analysis Conclusions

- Dam will trap all sand/gravel load and most (~90%) silt/clay load.
- Impacts to sediment balance:
  - Greatest in Middle River
  - Diminish in downstream direction

Approximate Sediment Loads under Max Load Following OS-1 as % of Pre-Project Load			
Location	Silt/Clay	Sand	Gravel
Below Watana Dam	10%	0%	0%
Gold Creek	16%	15%	7%
Sunshine	82%	82%	51%
Susitna Station	92%	91%	80%

Sediment Transport Analysis Conclusions

- Timing of effects:
  - Discharge - immediate for all sizes
  - Silt/clay supply - Immediate
  - Sand supply - Near- to intermediate-term (less than decade?)
  - Gravel supply – Decades(?) in lower part of Middle River and Lower River

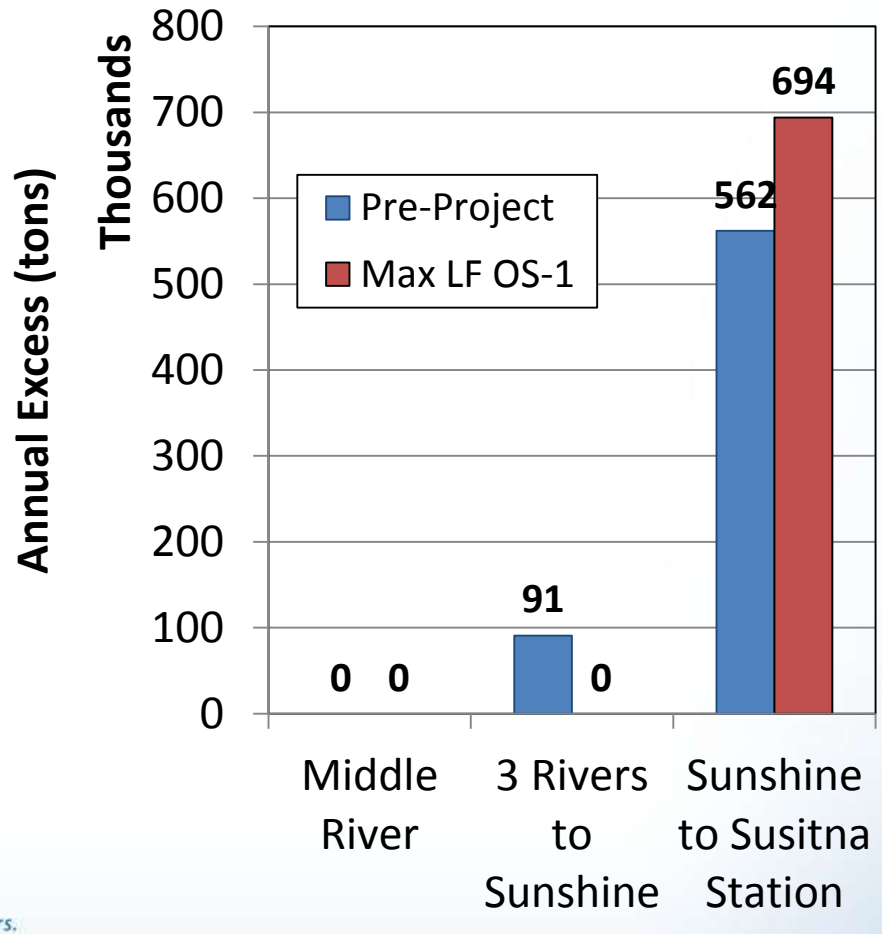
Sediment Transport Analysis Conclusions

- Sediment Transport Balance
  - Silt/clay load supply-limited
  - Sand load supply-limited to at least Sunshine
  - Gravel load capacity-controlled

Sediment Transport Analysis Conclusions

Sand Load

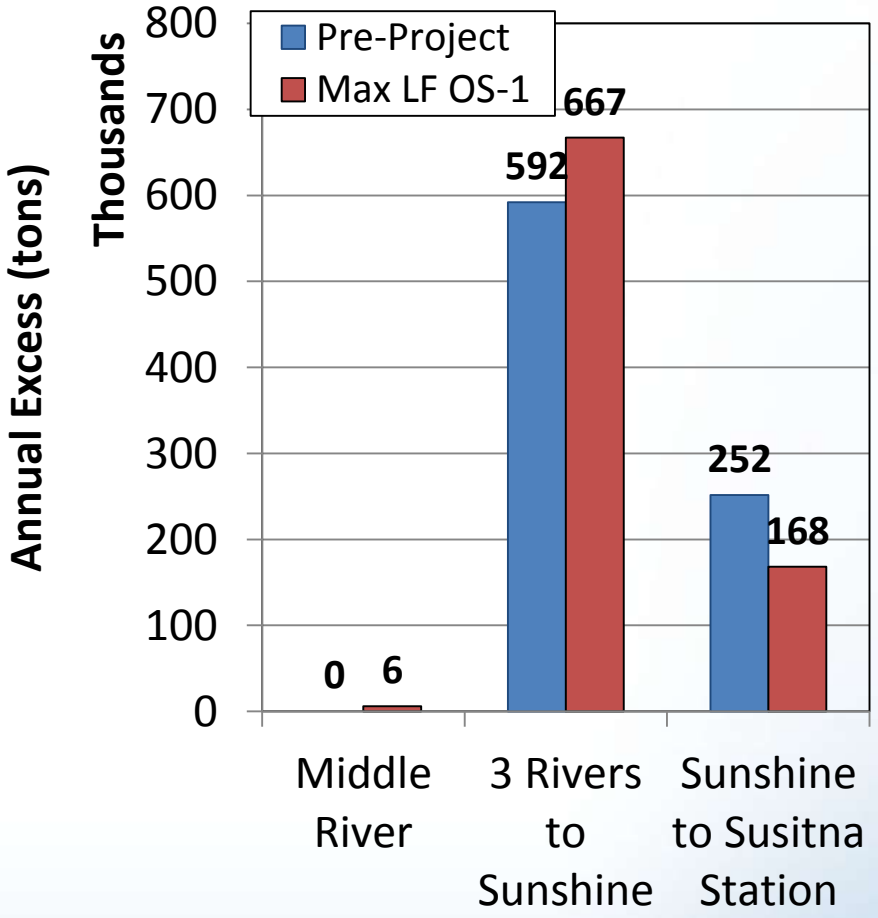
- Approximately in balance through Sunshine
- Excess load
  - Sunshine to Susitna Station:
    - Increase from ~560k tons to ~690k tons



Sediment Transport Analysis Conclusions

Gravel Load

- Approximately in balance through Sunshine
  - Slight increase under Max LF OS-1
- Excess load
  - ➢ 3 Rivers to Sunshine:
    - Increase from ~590k tons to ~670k tons
  - ➢ Sunshine to Susitna Station:
    - Decrease from ~250k tons to ~170k tons



END