

RECLAMATION

Managing Water in the West

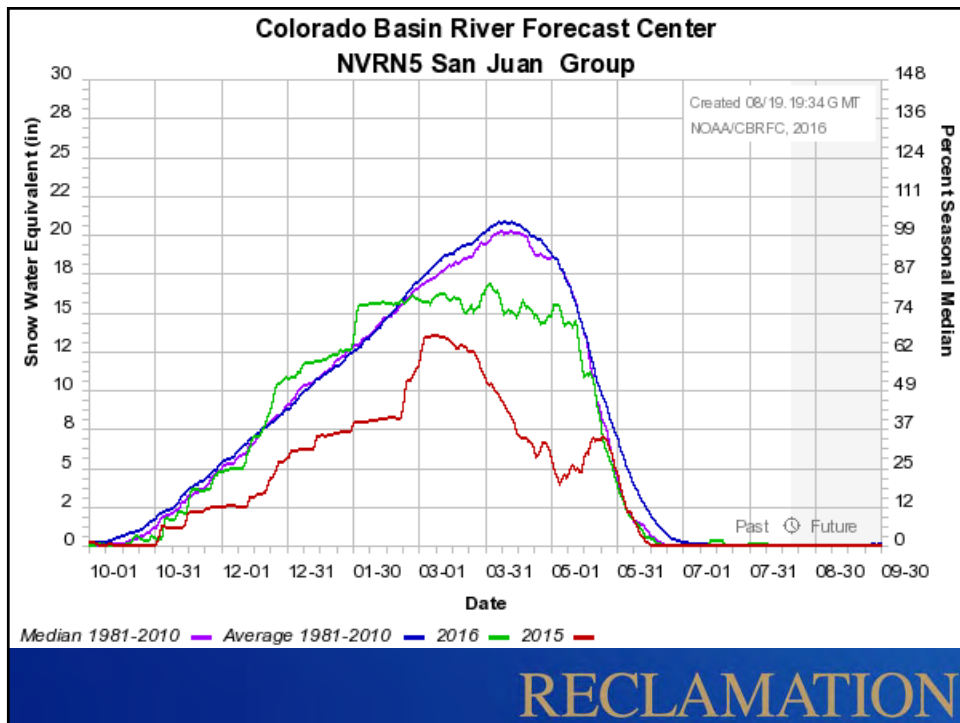
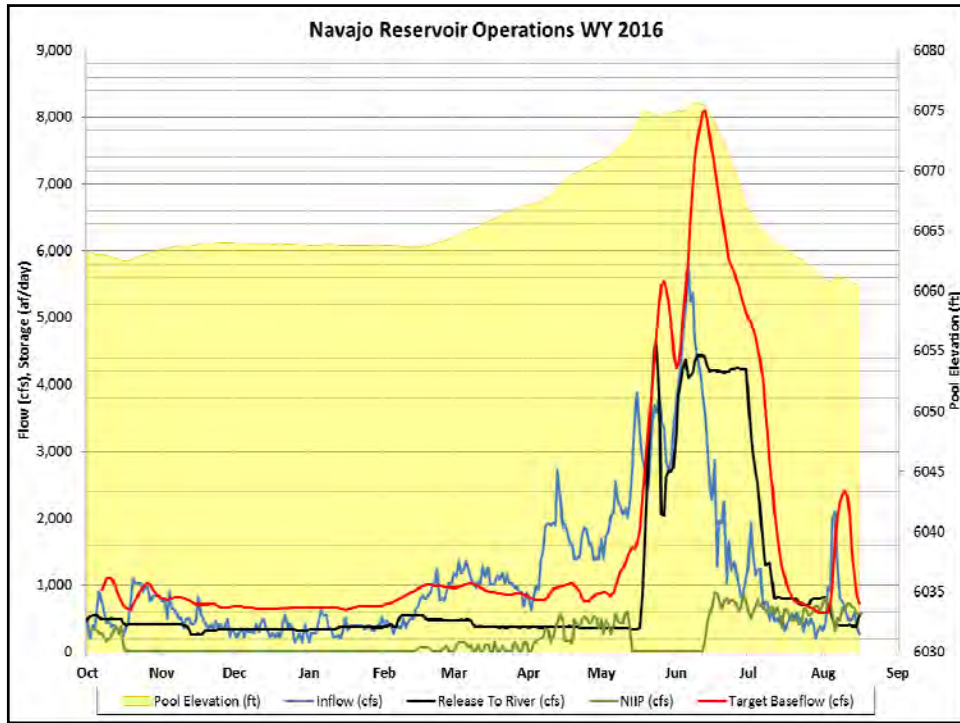


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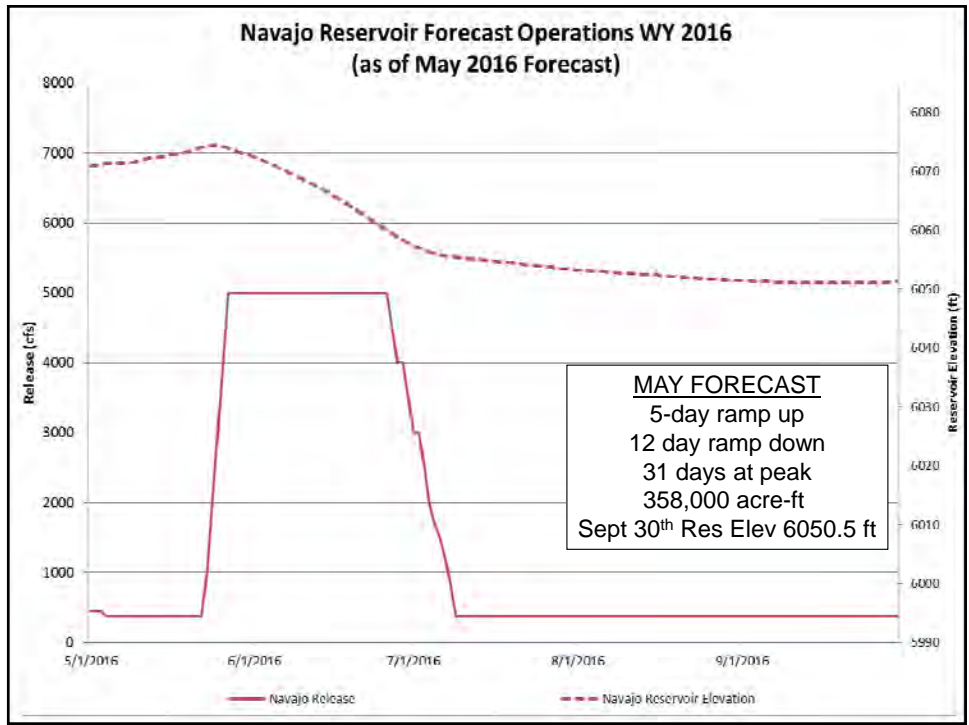
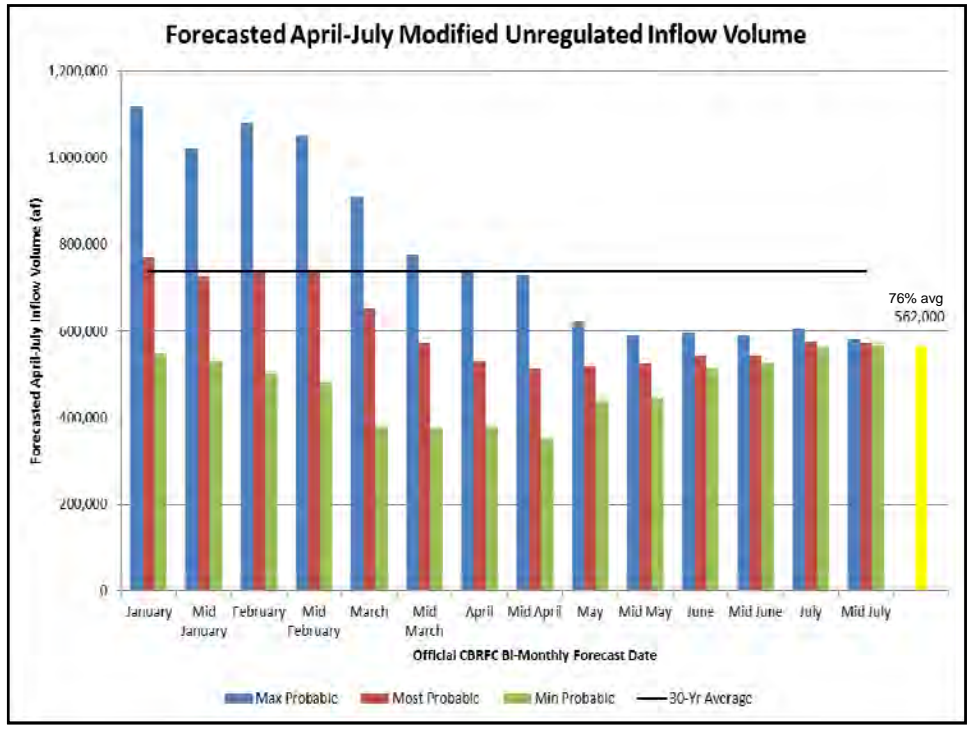
AGENDA

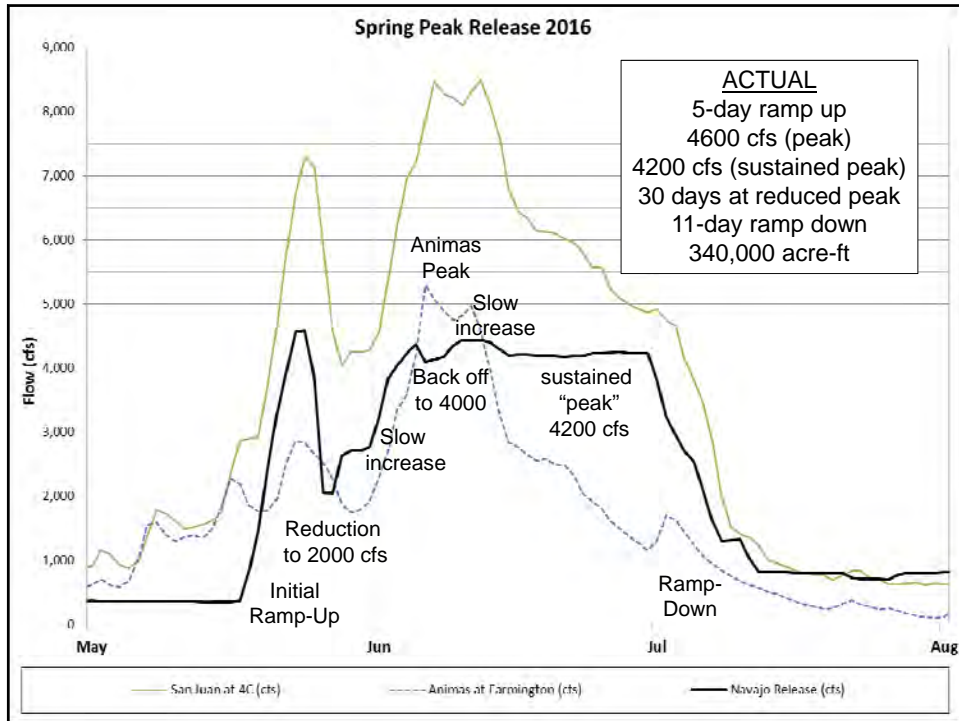
- Water Year 2016 Operations and WY 2017 Forecast
 - Susan Behery, Reclamation Western Colorado Area Office, Durango
- River Channel Processes and Flow Conveyance
 - Tim Randle, Reclamation Technical Service Center, Denver
- Channel Capacity Downstream of Navajo Dam
 - Ryan Gronewold, US Army Corps of Engineers, Albuquerque

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2016 Spring Peak Release

- Total volume over base release = 340,000 af
- Resulting Flows at Four Corners Gage
 - 52 days > 2,500 cfs
 - 35 days > 5,000 cfs
 - 8 days > 8,000 cfs
 - Max instantaneous flow 8,730 cfs
 - Max daily average flow 8,490 cfs

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2016 Spring Peak Release Agency Coordination

- Reclamation
- US Army Corps of Engineers, Albuquerque
- National Weather Service
- Colorado River Basin Forecast Center
- San Juan County NM OEM
- US Fish and Wildlife Service (SJRIP)
- Navajo Nation EPA
- Navajo Nation OEM
- San Juan County UT OEM
- City of Farmington Utilities (Power Plant)
- USGS

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Navajo Current Conditions

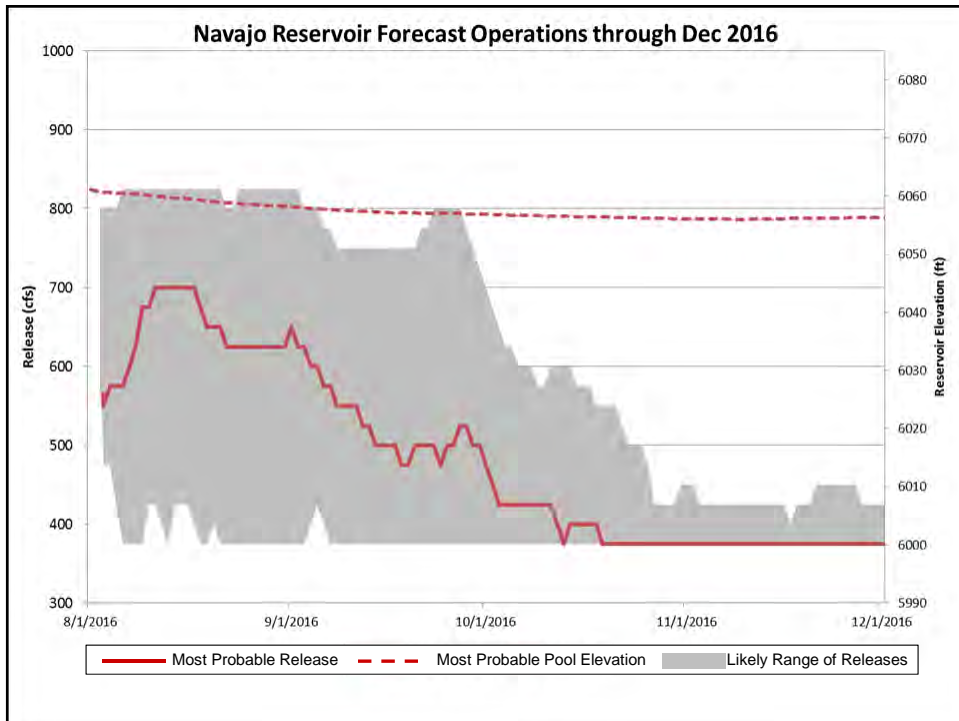
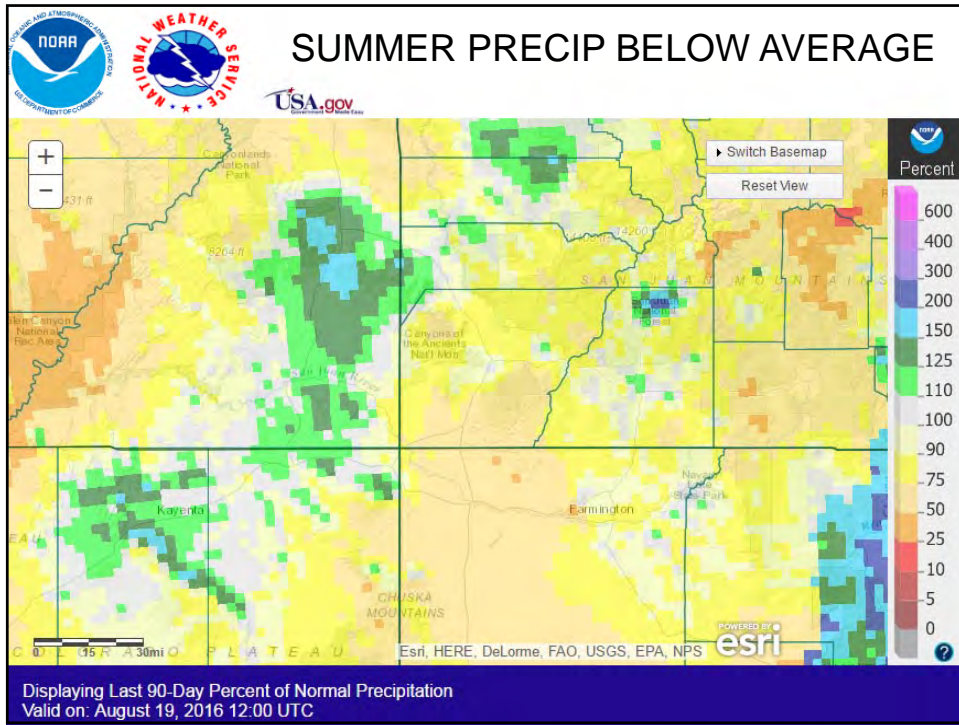
(as of 8/22/16)

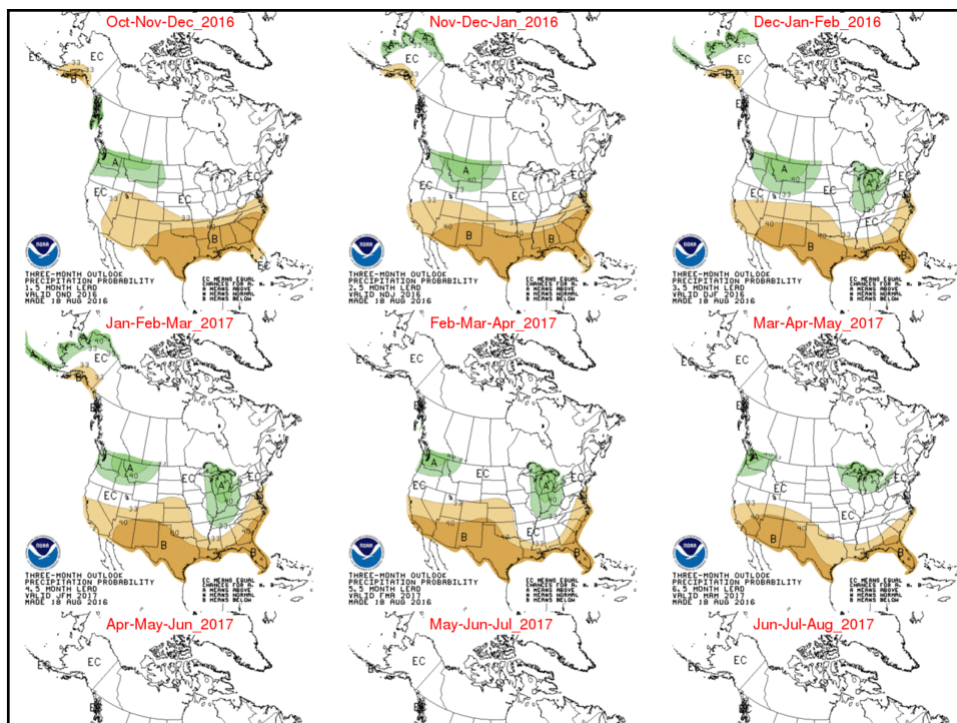
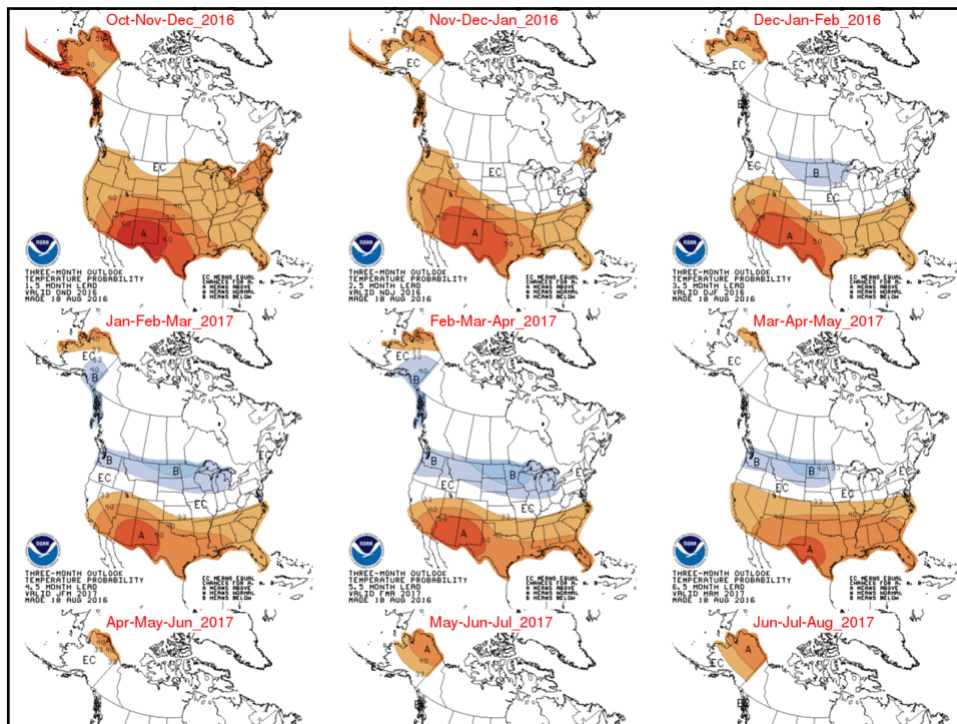
- Inflow = 485 cfs
- Release = 680 cfs

- Pool Elevation = 6059.64 ft
- Storage = 1,343,234 acre-feet

- NIIP = 452 cfs
- San Juan Chama = 15 cfs

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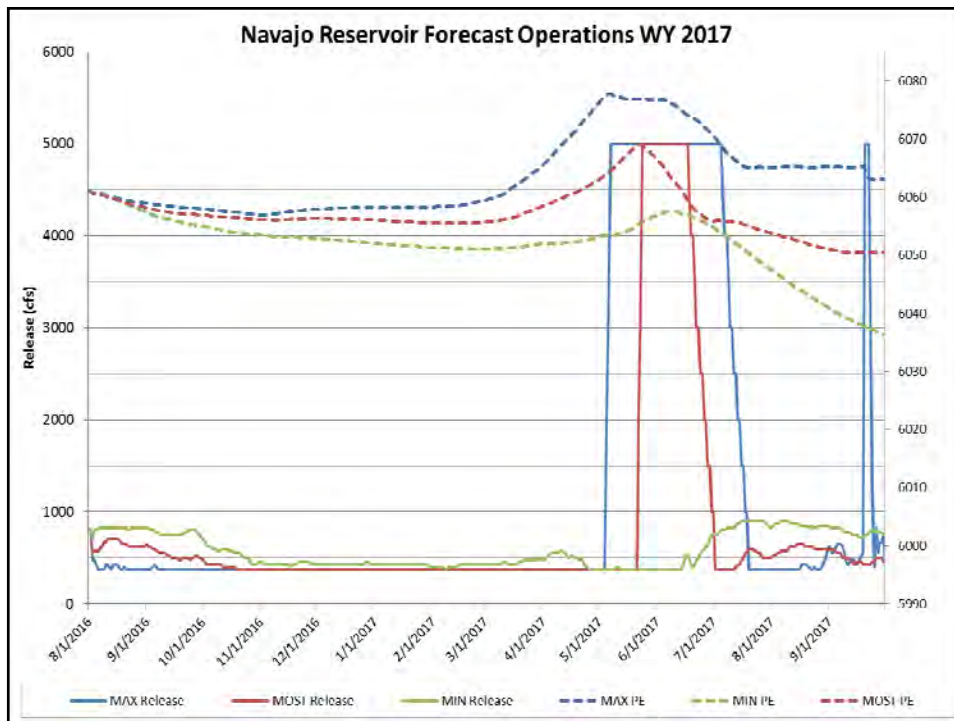


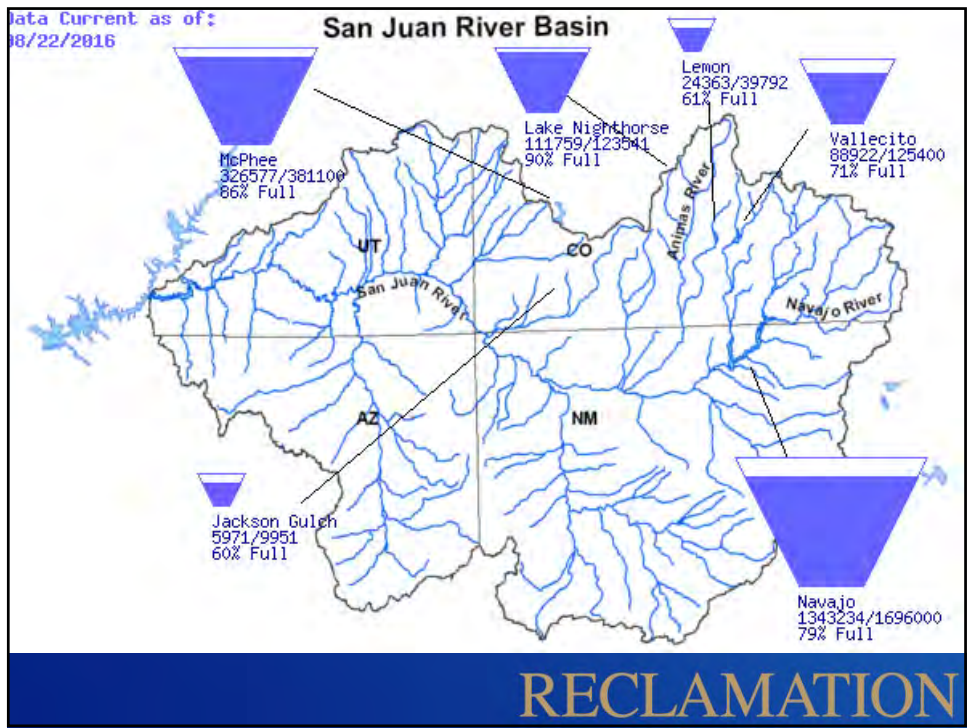
Water Year 2017 Forecasts

(as of August CBRFC Forecast)

Forecast	Water Year		April-July	
	Volume (kaf)	% of Avg	Volume (kaf)	% of Avg
MIN	455	40%	284	40%
MOST	915	85%	655	90%
MAX	1,530	140%	1,100	150%

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AGENDA

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REPORTS FROM OTHER AGENCIES



Public Outreach

- ANNUAL COORDINATION MEETINGS

- Jan-Apr-Aug
- Open to the Public

Public Meeting
2016 Spring Peak Release
Tonight 6pm

- RELEASE NOTICES

- Email list
(to be added, email rswickard@usbr.gov)
- Website
(http://www.usbr.gov/uc/wcao/water/rsvrs/notice/nav_rel.html)
- Contact Us Directly
Susan Behery 970-385-6560 (sbehery@usbr.gov)
WCAO Main Office 970-385-6500

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Summary

- Spring Peak Release began May 18th and ended July 11th. Total volume over base was 340,000 acre-ft.
- The peak of 5,000 cfs was not reached during the Spring Peak Release this year due to safety concerns in the channel.
- Reclamation has been working closely with the US Army Corps of Engineers, Reclamation's Technical Service Center, and San Juan County Office of Emergency Management to evaluate channel capacity issues
- Summer and fall releases will likely range between 400 cfs and 700 cfs.
- Expected end of year reservoir elevation under the August Most Probable forecast is 6055 ft.
- Next Operations Meeting: Tuesday, January 24, 2017

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How You Can Access Information

Bureau of Reclamation
www.usbr.gov/uc

USGS
<http://water.usgs.gov/nwis>

Colorado Basin River Forecast Center
www.cbrfc.noaa.gov



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Managing Water in the West

River Channel Processes and Flow Conveyance

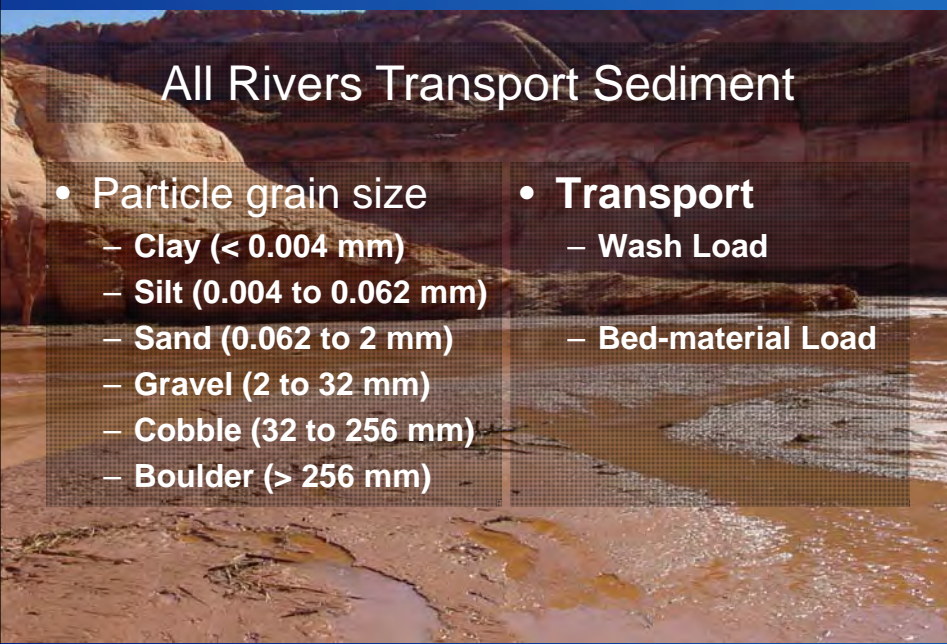
Tim Randle, Ph.D., P.E., D.WRE, Civil Engineer and Group Manager

David Varyu, M.S., P.E., Civil Engineer

Sedimentation and River Hydraulics Group



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All Rivers Transport Sediment

- Particle grain size
 - Clay (< 0.004 mm)
 - Silt (0.004 to 0.062 mm)
 - Sand (0.062 to 2 mm)
 - Gravel (2 to 32 mm)
 - Cobble (32 to 256 mm)
 - Boulder (> 256 mm)
- Transport
 - Wash Load
 - Bed-material Load

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VDR1

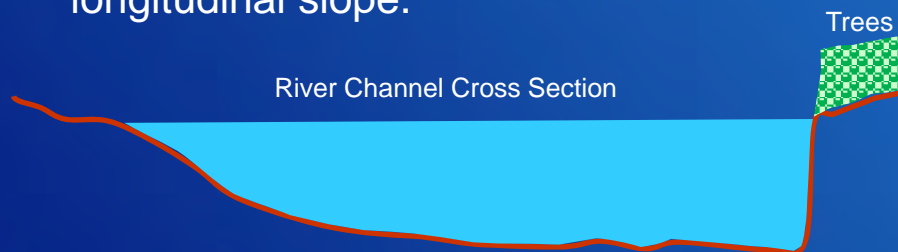
River Flow Conveyance

- Channel conveyance capacity is the maximum flow rate that can pass without overtopping the channel banks.

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River Flow Conveyance

- River stage is a function of the flow rate, channel geometry, roughness, and the longitudinal slope.



$$\text{Flow rate} = (\text{Flow Velocity}) \times (\text{Cross-Sectional Flow Area})$$

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River Flow Conveyance

- River stage is a function of the flow rate, channel geometry, roughness, and the longitudinal slope.

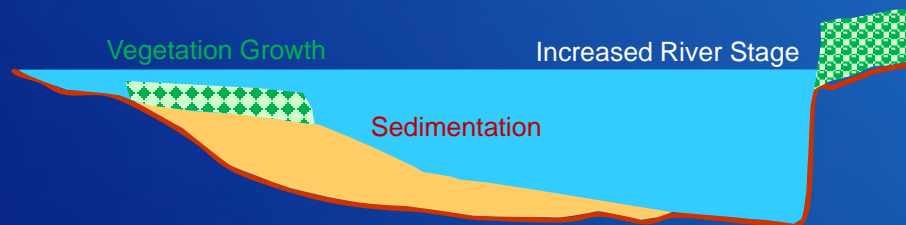


$$\text{Flow rate} = (\text{Flow Velocity}) \times (\text{Cross-Sectional Flow Area})$$

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River Flow Conveyance

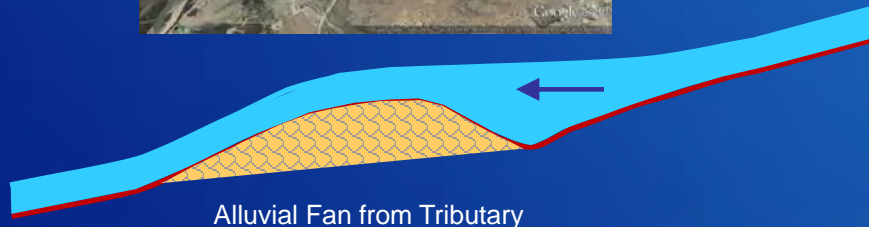
- River stage is a function of the flow rate, channel geometry, roughness, and the longitudinal slope.



$$\text{Flow rate} = (\text{Flow Velocity}) \times (\text{Cross-Sectional Flow Area})$$

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Coarse sediments from tributaries can locally increase water surface.



Alluvial Fan from Tributary

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VDR2

Changes in channel alignment will affect the longitudinal slope.



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River Flow Conveyance (continued)

- Even for a given flow rate, river stage will change with changes in channel geometry, roughness, and the longitudinal slope.
 - Sediment deposits on the channel bottom, bars, and the floodplain will increase river stage.
 - Increased roughness from vegetation will increase river stage and promote sediment deposition.

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River Flow Conveyance (continued)

- Even for a given flow rate, river stage will change with changes in channel geometry, roughness, and the longitudinal slope.
 - Longer flow paths from river meandering will slow velocity and increase river stage.

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VDR5


River Width, Depth, and Flow Alignment

- The width, depth, and alignment of a river are a function of the water flow, sediment load, vegetation, and geologic and human-built constraints.
- Rivers are naturally dynamic and change with time, especially during floods.

Google Earth
Imagery Date: 3/16/2016 -76°44'23.097"N 110°24'51.263"W elev: 5678 ft eye alt: 18965 ft

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Rio Grande Example

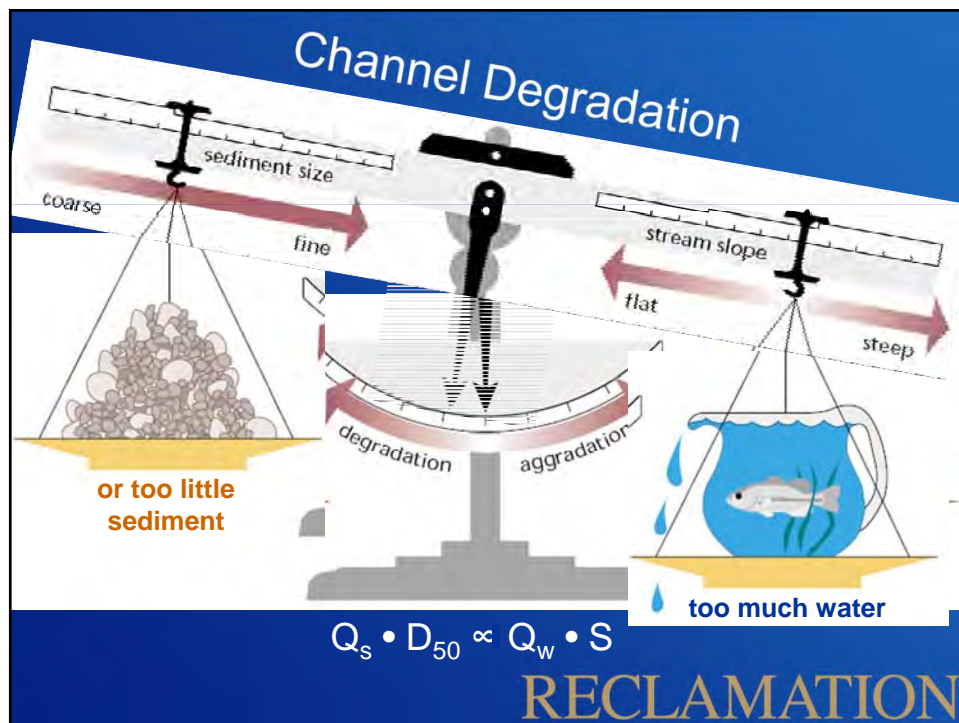
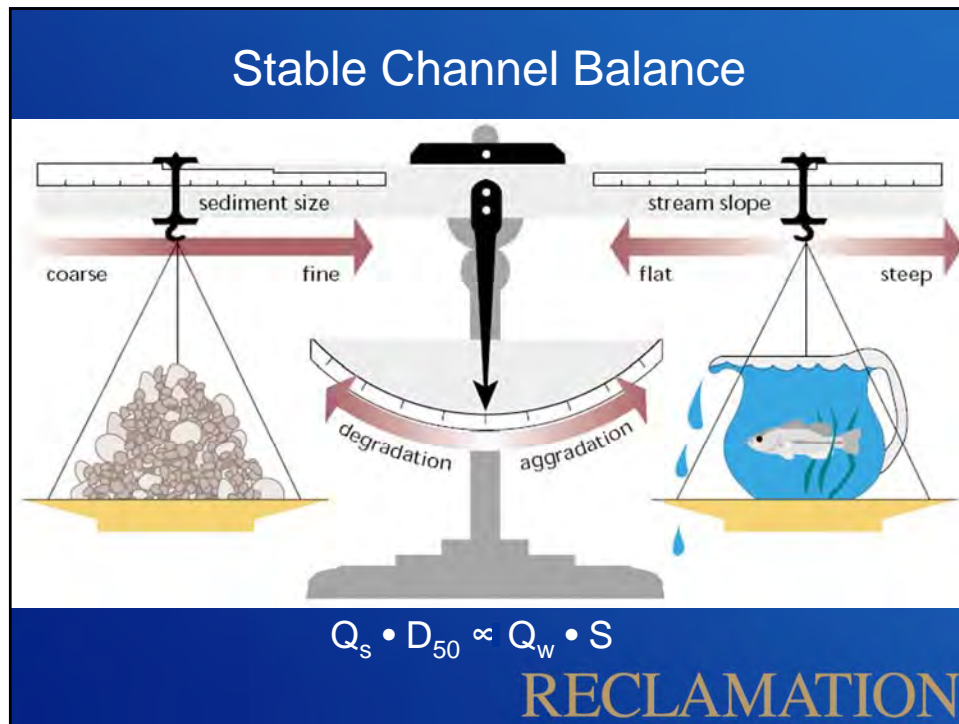


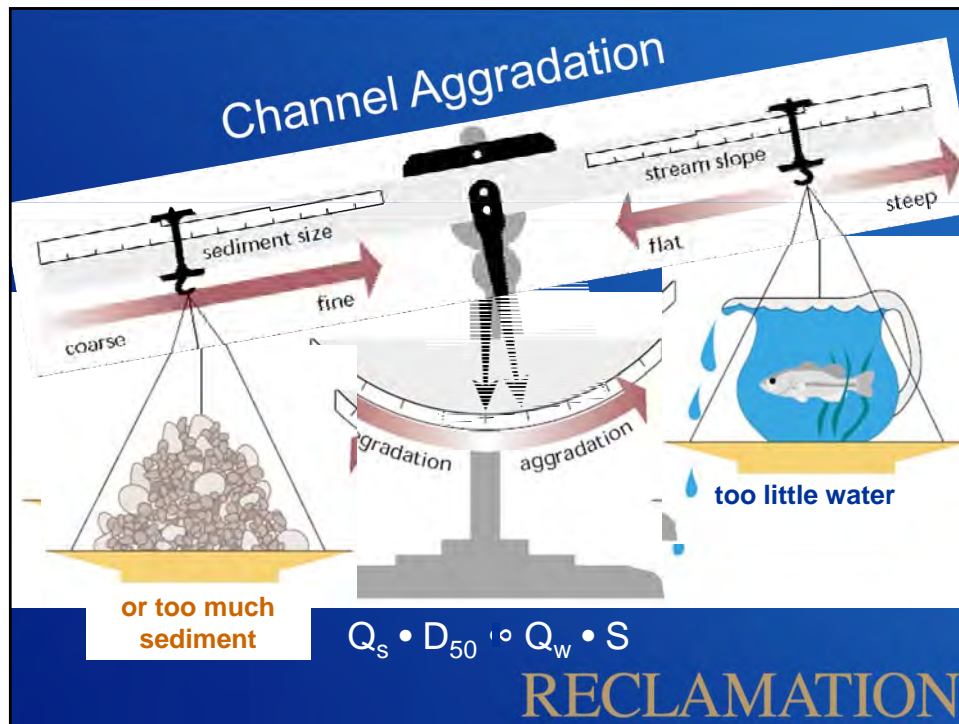
1953

2013

RM 101 (looking downstream)

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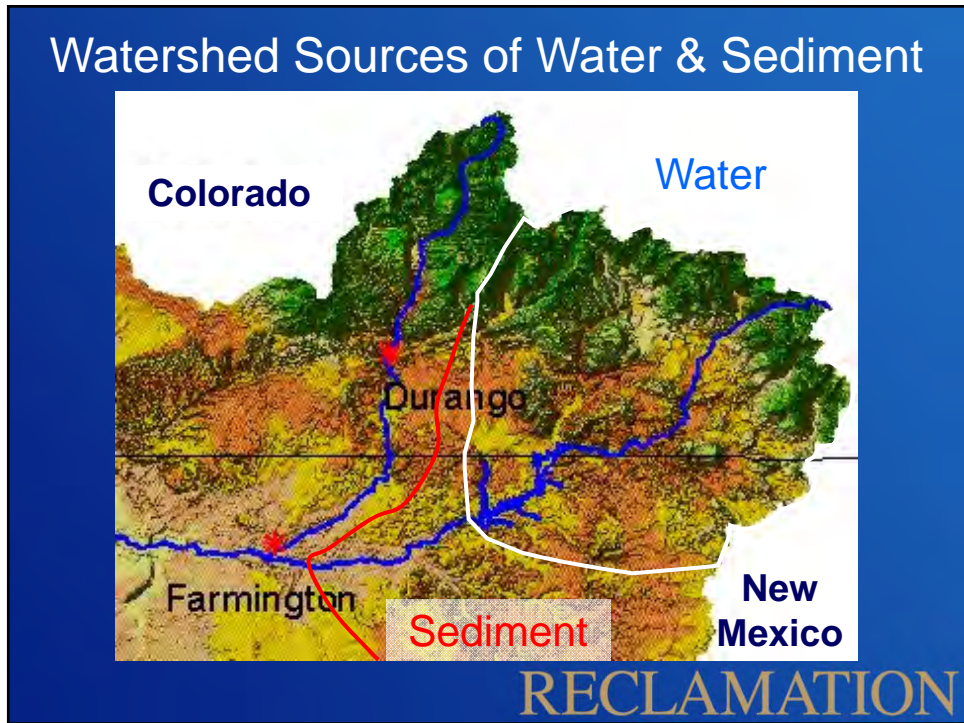
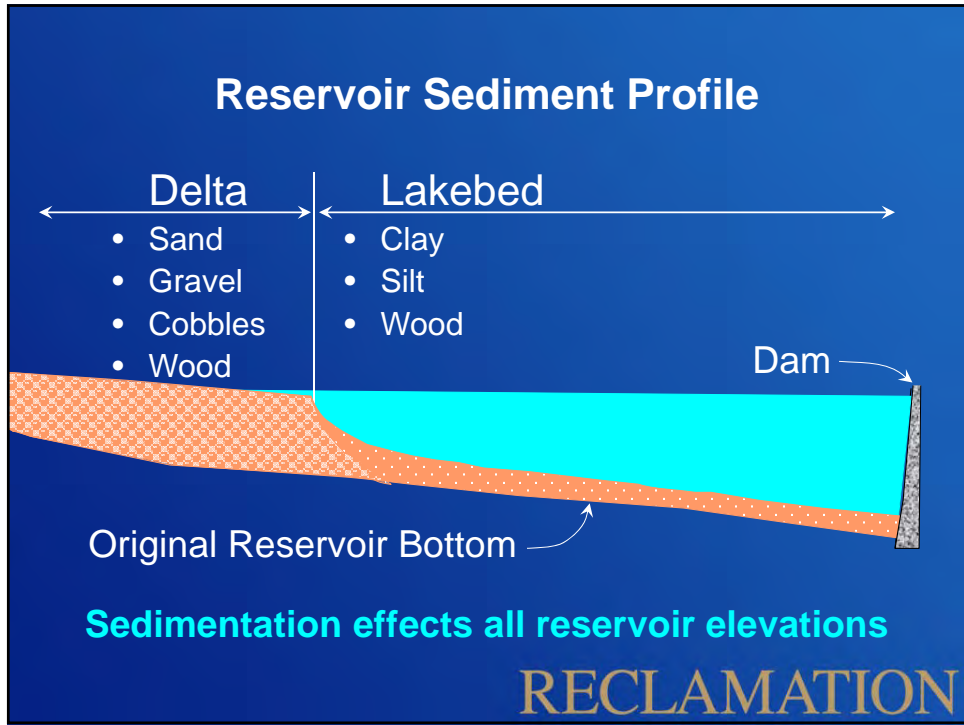


VDR4

Navajo Dam and San Juan River

- Prior to Navajo Dam construction in 1963, the waters of the San Juan River were often muddy with high sediment loads. Today, the water below the dam runs cold and clear which is ideal habitat for brown, rainbow, and cutthroat trout.

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Seasonal Channel Changes

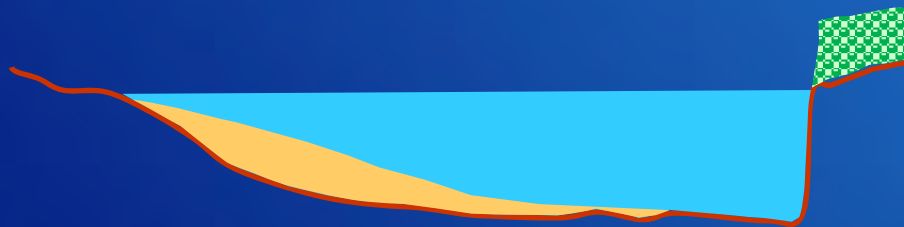
- Initial conditions.



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Seasonal Channel Changes

- High flow releases from Navajo Dam.



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Seasonal Channel Changes

- After high flow releases.



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Seasonal Channel Changes

- Tributary monsoon floods bring sediment.



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Seasonal Channel Changes

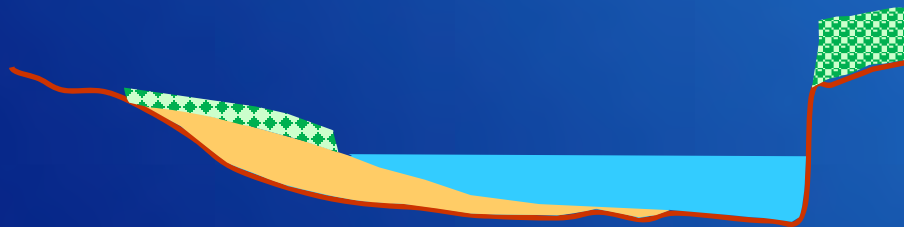
- End of year conditions.



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Seasonal Channel Changes

- If there were no high flow releases from Navajo Dam.



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Seasonal Channel Changes

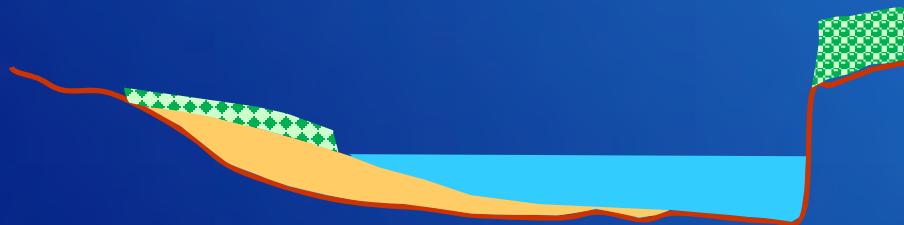
- and only small tributary monsoon flows.



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Seasonal Channel Changes

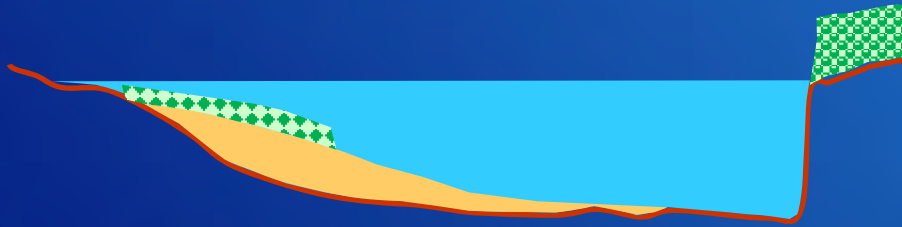
- End of year conditions.



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Seasonal Channel Changes

- Next year high flow releases from Navajo Dam with a small reduction in safe channel capacity.



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Seasonal Channel Changes

- After high flow releases.



RECLAMATION

Seasonal Channel Changes

- If there were no high flow releases from Navajo Dam.



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Seasonal Channel Changes

- and tributary monsoon floods bring a lot of sediment.



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Seasonal Channel Changes

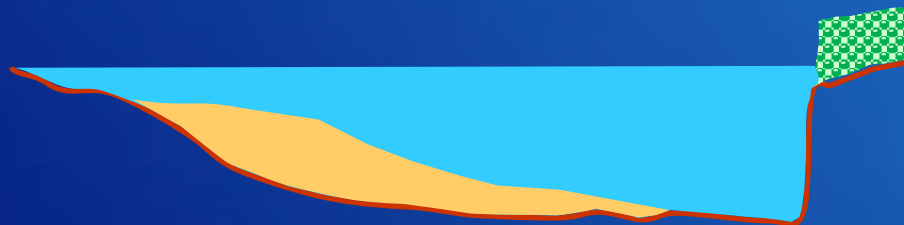
- End of year conditions with more sediment deposition.



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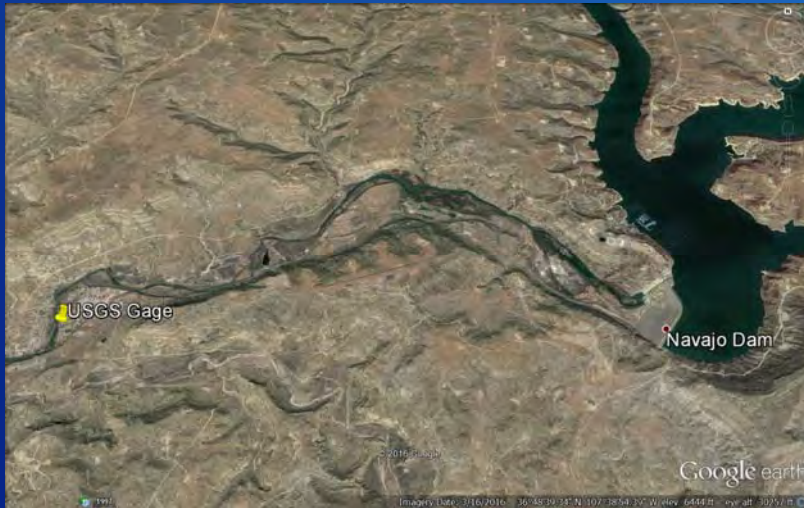
Seasonal Channel Changes

- Subsequent year high flow releases from Navajo Dam could begin to exceed the channel capacity.



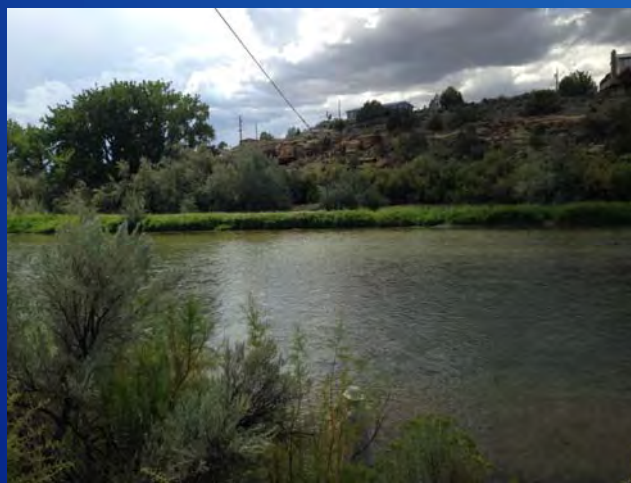
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Tributaries Between Navajo Dam and USGS Stream Gage at Archuleta

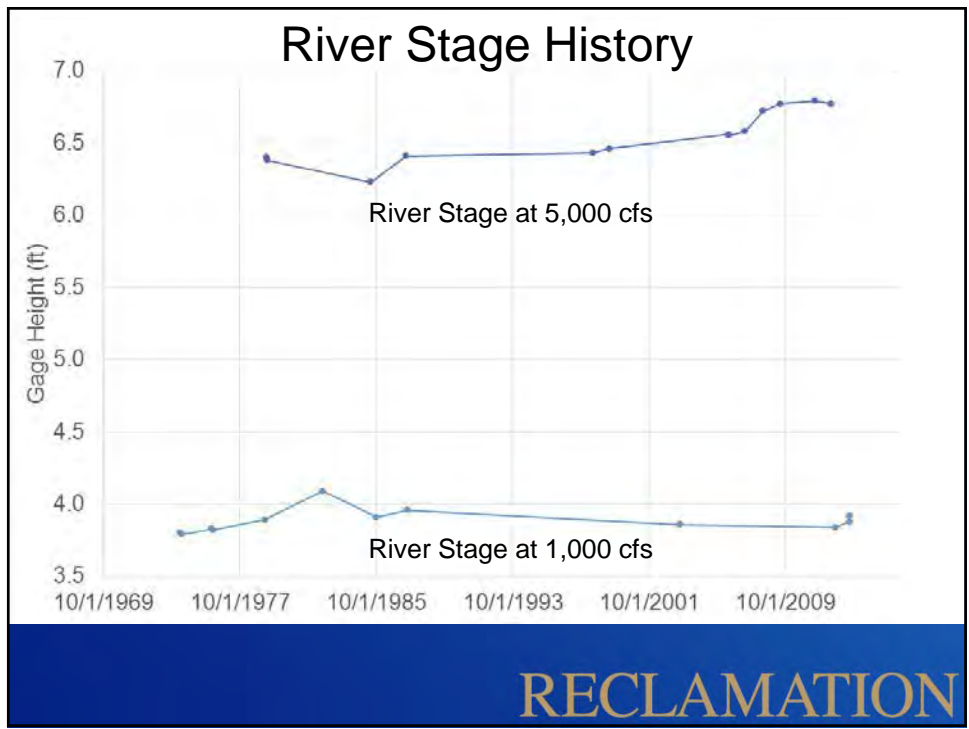
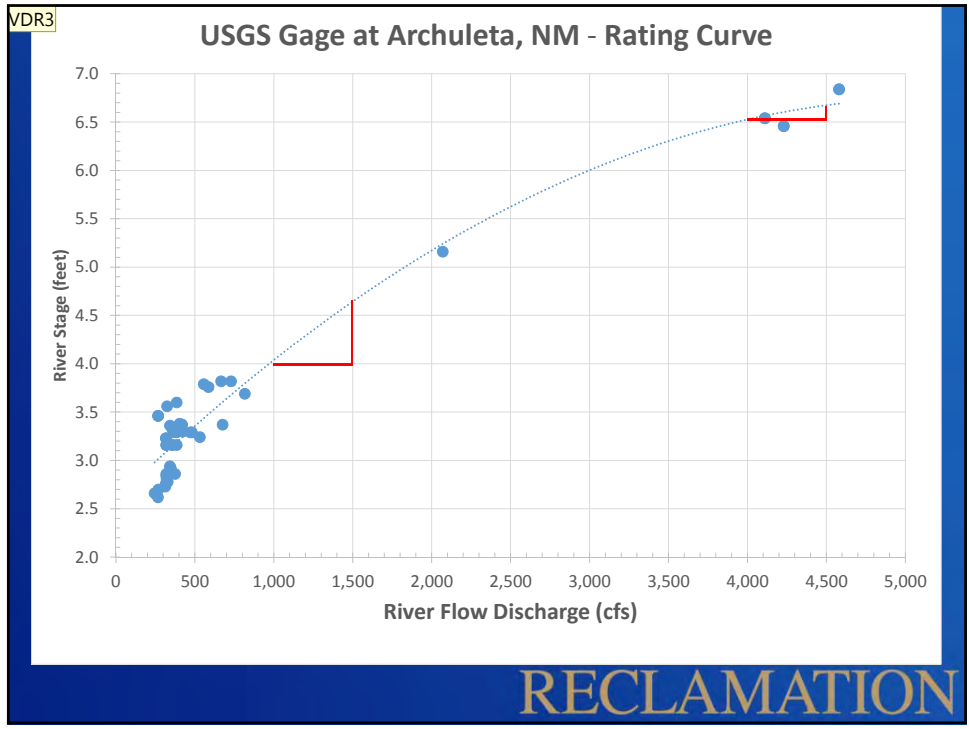


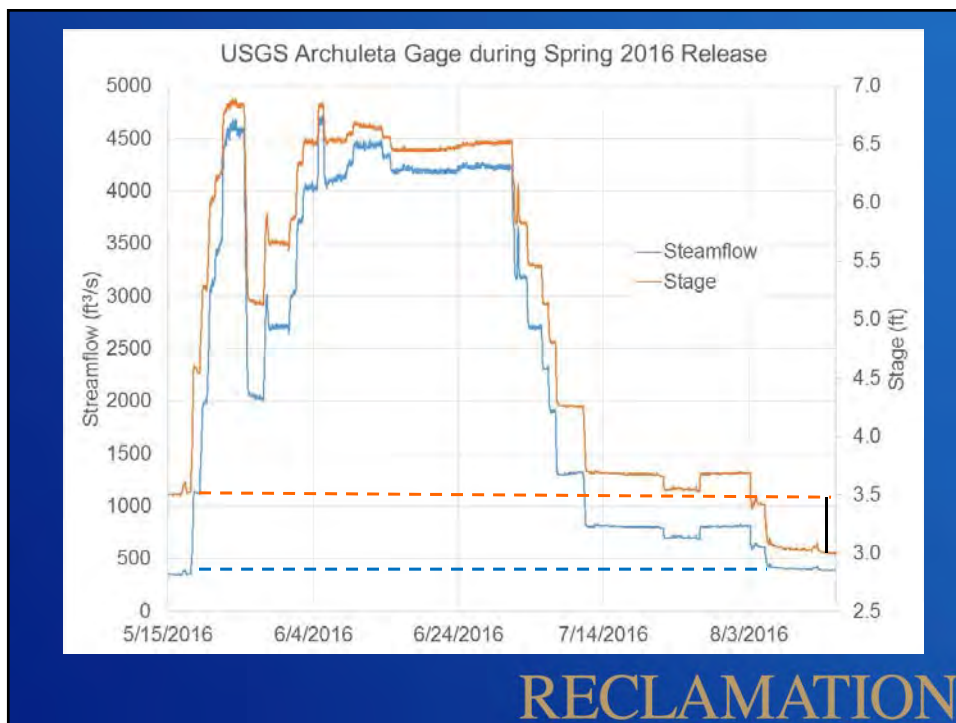
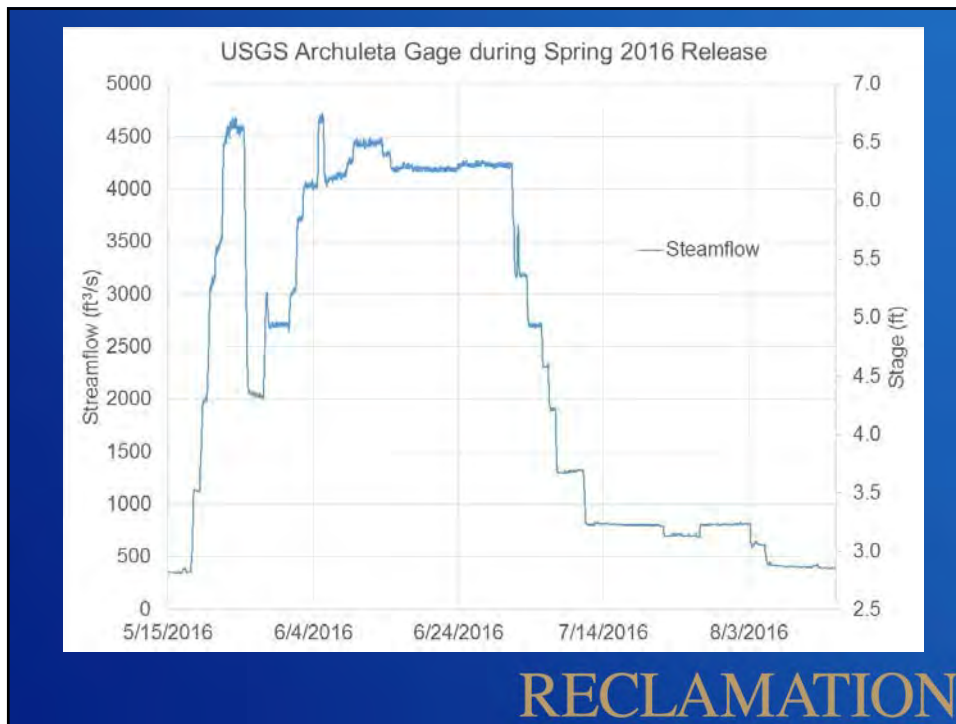
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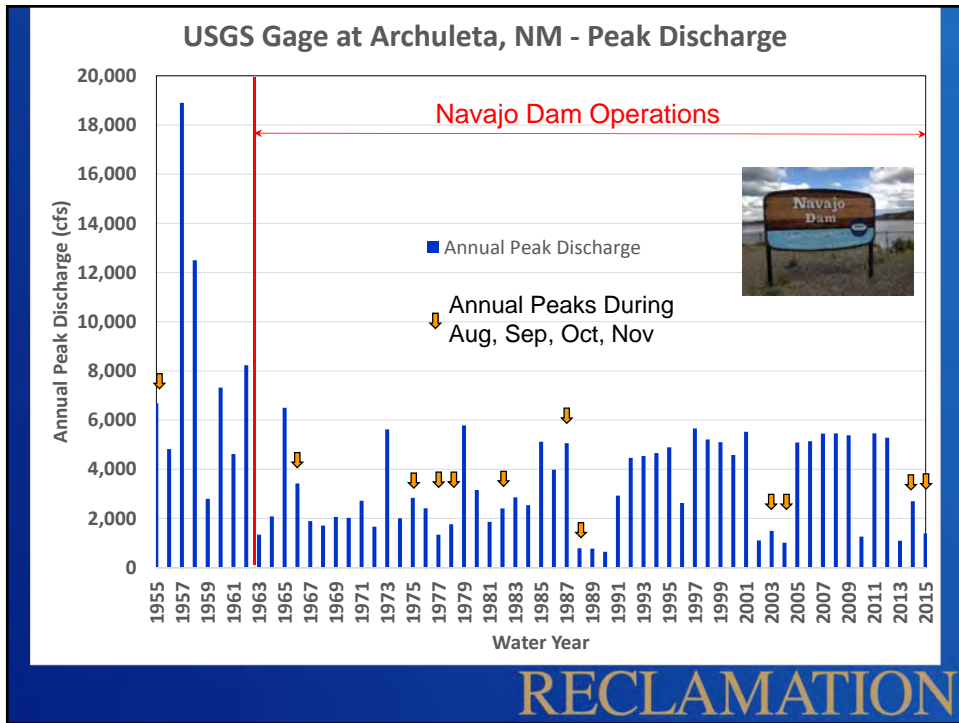
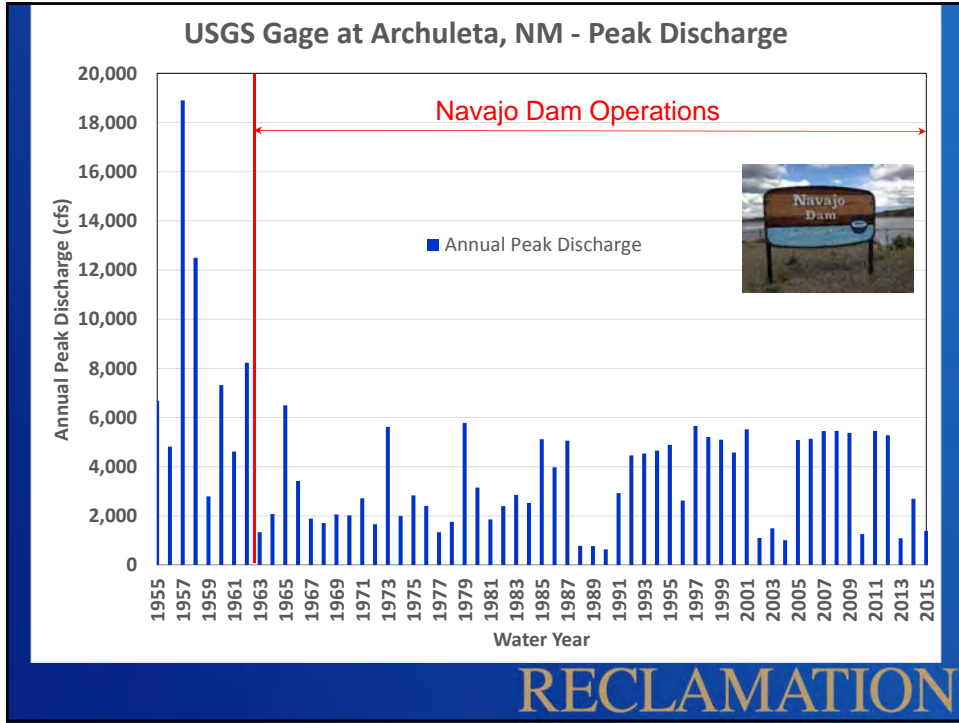
USGS Stream Gage at Archuleta



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Recent San Juan River Observations



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Recent San Juan River Observations



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Recent San Juan River Observations

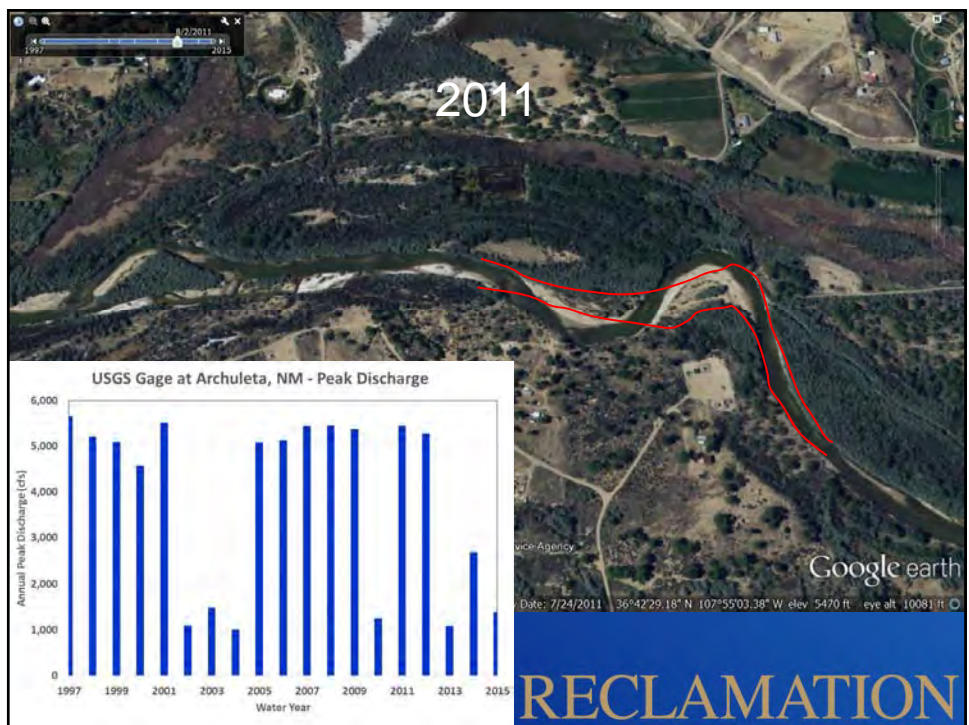
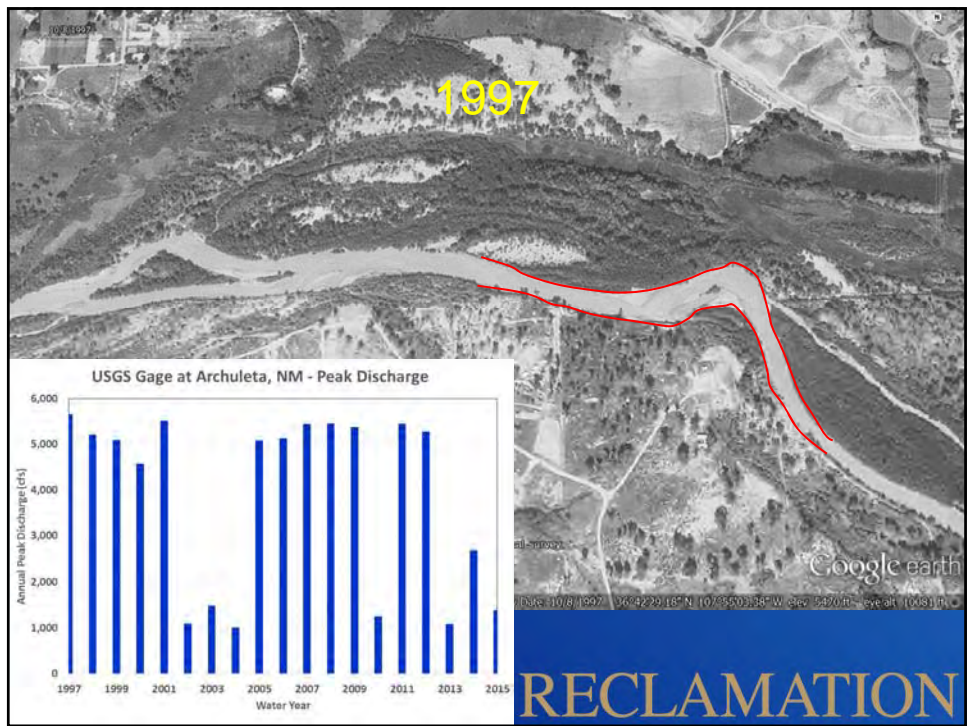


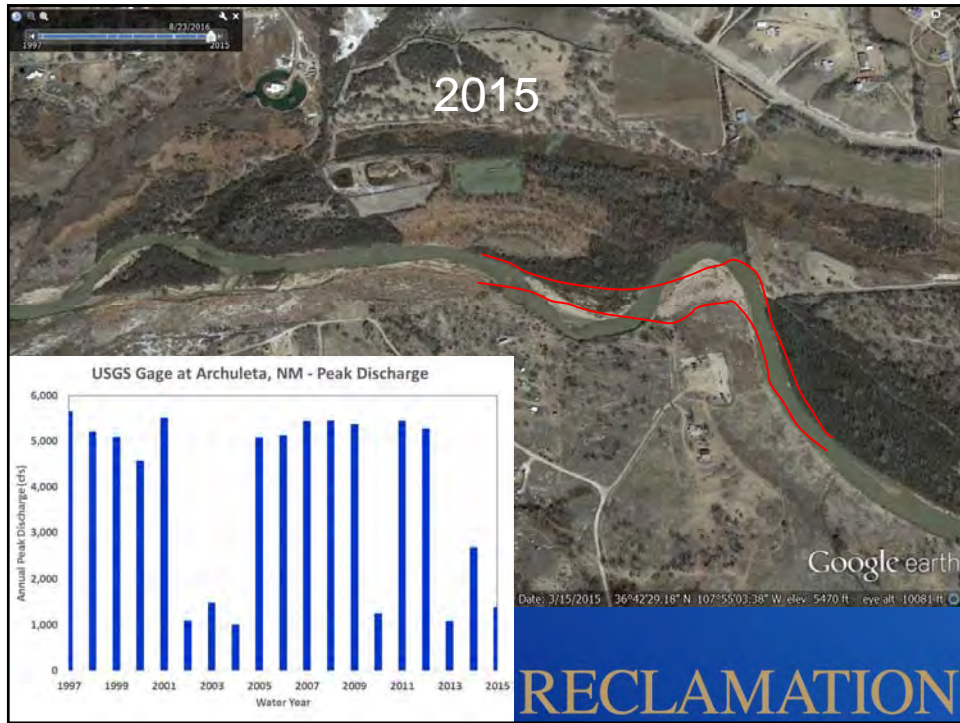
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Recent San Juan River Observations



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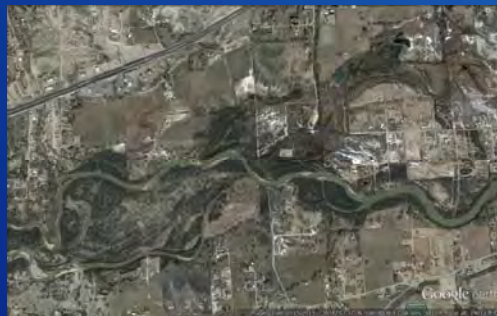
Conclusions

- Long-term maintenance of the channel capacity means that sediment loads from downstream tributaries be balanced with Navajo Dam flow releases.
- Stream bank erosion and channel migration are natural processes. Rates of channel migration can be accelerated by woody vegetation removal.

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Conclusions

- Structures built in the floodplain are subject to flood inundation, erosion, and sediment deposition, even from tributary floods.



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The End



Navajo Dam & Reservoir

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Channel Capacity Downstream of Navajo Dam

Presented to
Navajo Operations Coordination Meeting
23 August 2016

Ryan Gronewold, P.E
Chief of Reservoir Control
Curtis McFadden
San Juan Basin Coordinator



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US Army Corps of Engineers
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Channel Capacity Downstream of Navajo Dam

- Navajo Dam and Reservoir
- Channel Capacities San Juan
 - Historical Channel Capacities
- Water Operations of Navajo Reservoir (1977-2016)
- Flood Risk Management



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Navajo Dam and Reservoir

Reclamation Owned and Operated

- Authorized for
 - ▶ Irrigation
 - ▶ Municipal & Industrial
 - ▶ Flood Control
 - ▶ Hydropower
 - ▶ Sediment Control
- USACE responsibilities
 - ▶ Flood Control Operation according to Section 7 of the Flood Control Act of 1944
 - ▶ Established Channel Capacities and Flood Control Plan for San Juan River



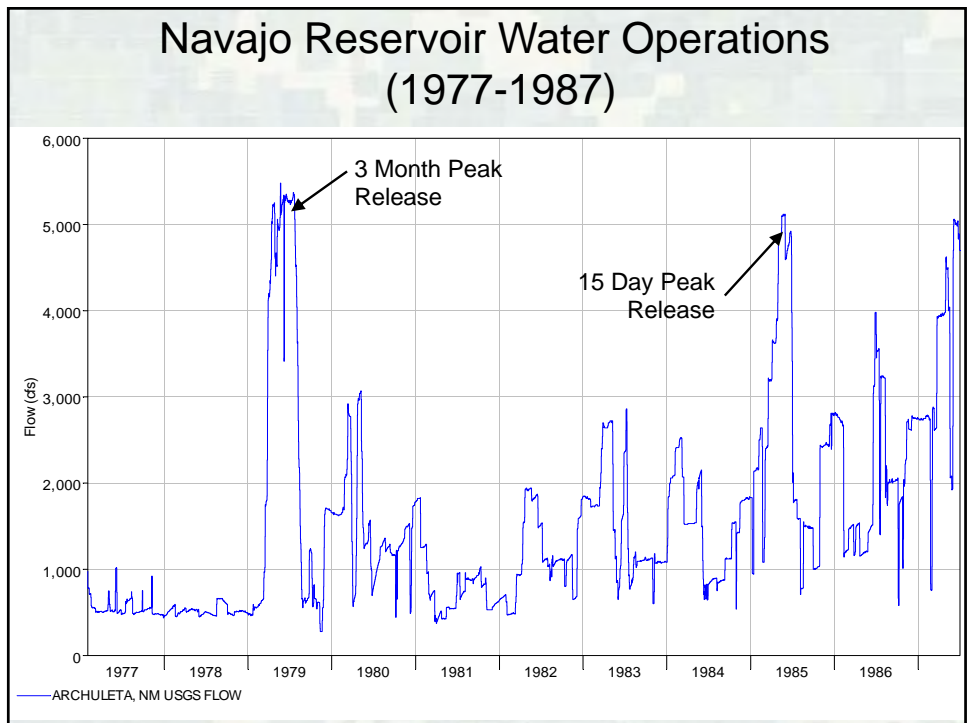
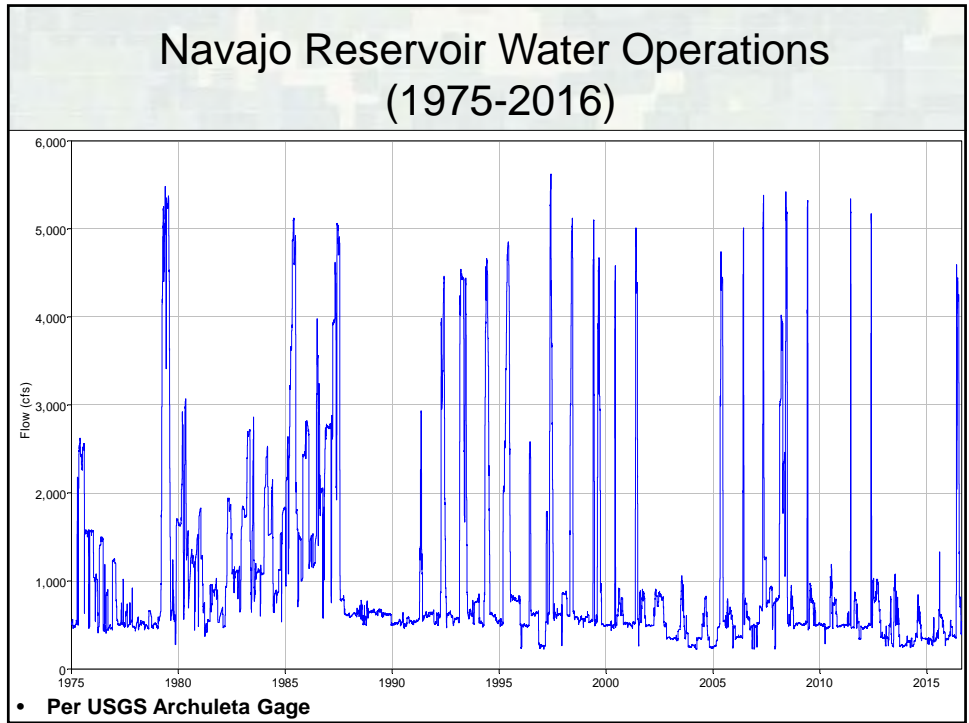
Navajo Dam

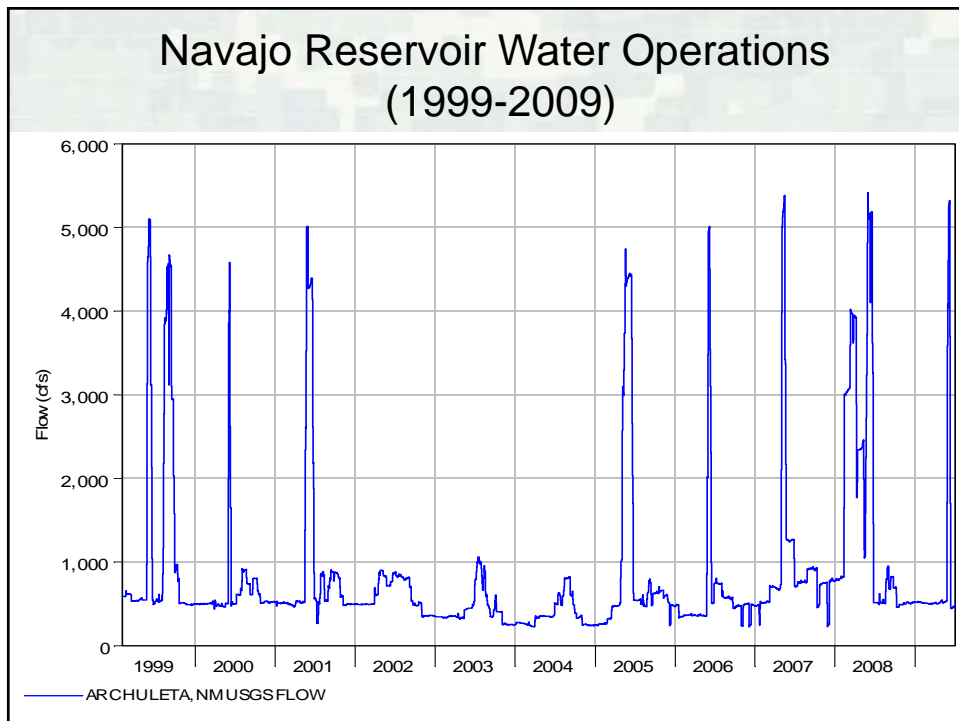
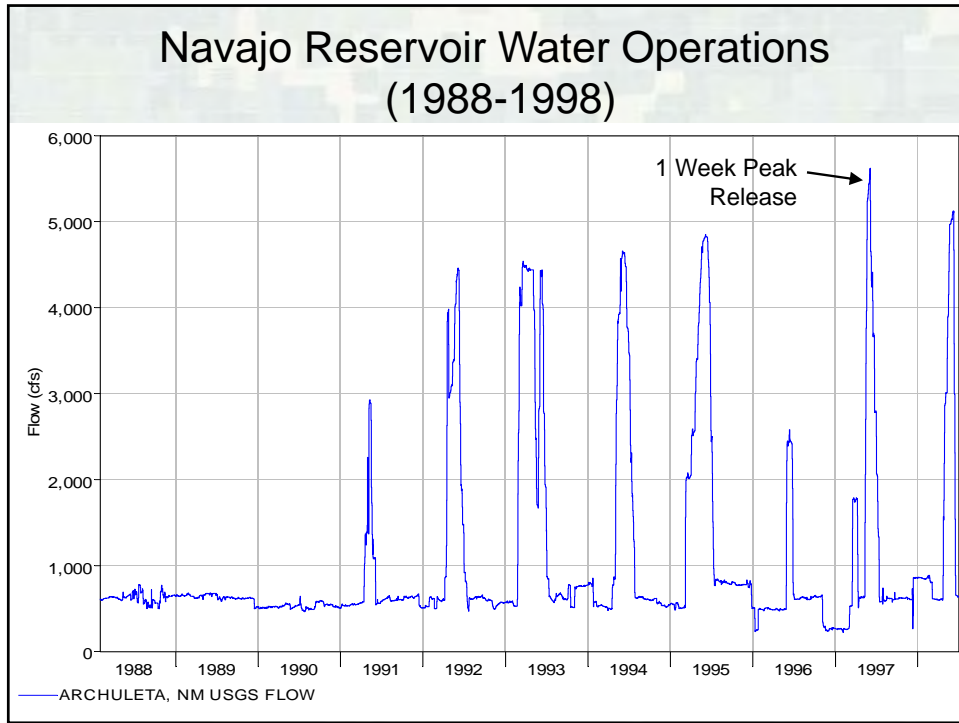


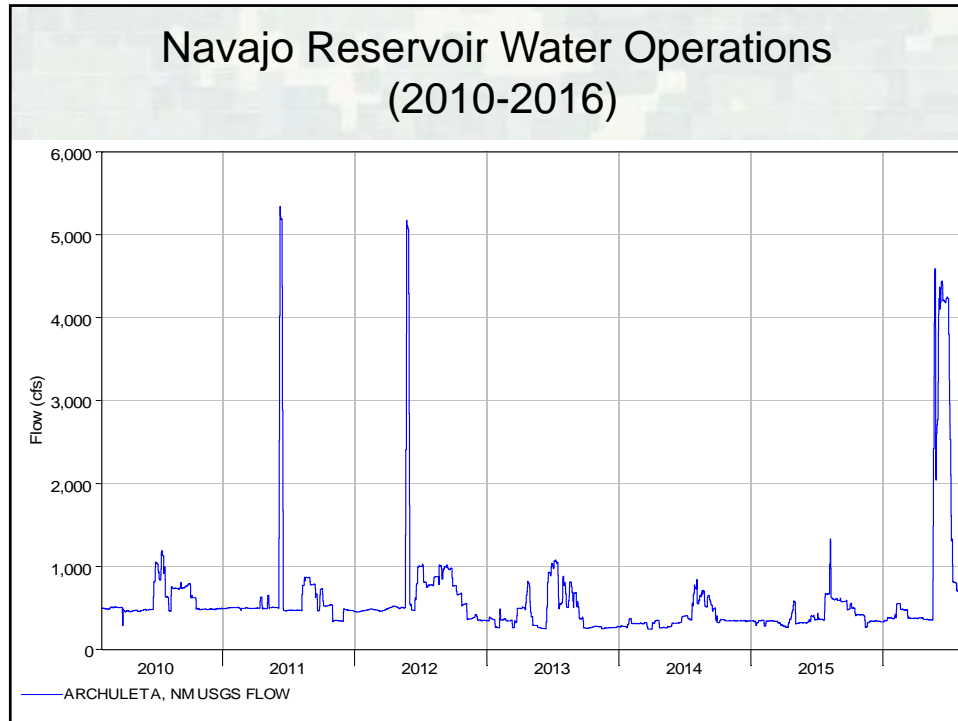
Historical Channel Capacities of San Juan River

<u>Date</u>	<u>River Locations</u>		
	<u>Blanco (cfs)</u>	<u>Farmington (cfs)</u>	<u>Shiprock (cfs)</u>
1958 (Benefits of Flood Control)	20,000	21,000	22,000
1970 (USACE WCM)	16,000	16,800	17,600
1984 (USACE Feasibility Study)	-	14,000	-
1985 (USBR Navajo SOP)	5,000	12,000	12,000









Flood Risk Management and Channel Capacity

- Current Water Control Plan requires 5,000cfs releases
- Channel Capacity needed to avoid uncontrolled spill
- Reduced Channel Capacity and Dam Safety



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Navajo Dam Flood Control Diagram

