U.S. Department of the Interior
U.S. Geological Survey

Project B: Riverbed and sandbar response to dam operations and high-flow experiments, FY 2025 to FY 2027

Glen Canyon Dam Adaptive Management Program
Budget Ad-hoc Group Meeting
April 23, 2024

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Project B: Sandbar and Sediment Storage Monitoring and Research

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GIS and website support: *Thomas Gushue and Erica Byerley*

Collaborators and cooperators: *David Topping and Project A, Erich Mueller (Southern Utah University), Scott Wright, Grand Canyon River Guides, Northern Arizona University*

- Project Elements in FY 2021 to 2024
  - B.1 Sandbar Monitoring
  - B.2 Bathymetric and topographic mapping for monitoring long-term trends in sediment storage
  - B.3 Control Network and Survey Support
  - B.5* Sediment and Sandbar Modeling
  - FY 2023 involvement in other projects:
    - O.2 (sediment dynamics in Western Grand Canyon)
    - L (overflight remote sensing)

photo: Geoff Gourley

** Funded with carryover and non-AMP supplemental sources.*

Project B: AMP goals addressed, and information provided

- LTEMP goal:
  - *"Increase and retain fine sediment volume, area, and distribution in the Glen, Marble, and Grand Canyon reaches above the elevation of the average base flow for ecological, cultural, and recreational purposes."*
- Question from HFE Protocol:
  - *"Can sandbar building during HFEs exceed sandbar erosion during periods between HFEs, such that sandbar size can be increased and maintained over several years?"*
- Project B address these questions by two monitoring efforts and modeling:
  - Annual sandbar and campsite monitoring (sandbar surveys and daily photographs)
    - Annual assessment of the effects of HFEs and other dam operations on selected sandbars and campsites.
    - Assessment of immediate response to HFEs by network of remote time-lapse cameras
  - Periodic channel mapping (Combined topographic and bathymetric mapping)
    - Evaluation of LTEMP performance by measuring long-term trends in sand area, volume, and distribution from a large sample of sandbars.
    - Measurement of long-term trends in sand storage on the riverbed.
  - Modeling to predict fine sediment transport and sandbar response

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B.1 Sandbar and campsite monitoring with topographic surveys and remote cameras

Budget Category	FY 2024	FY 2025	FY 2026	FY 2027
Salaries	$ 332,949	$ 223,503	$ 245,990	$ 263,209
Travel & Training	$ 2,000	$ 2,000	$ 2,000	$ 2,000
Operating Expenses	$ 10,000	$ 4,000	$ 4,000	$ 4,000
Logistics Expenses	$ 33,622	$ 27,391	$ 31,921	$ 32,895
Cooperative Agreements	$ 36,000	$ 38,550	$ 38,550	$ 38,550
To other USGS Centers	$ -	$ -	$ -	$ -
Total (Net)	$ 414,571	$ 295,444	$ 322,461	$ 340,654
Burden	$ 51,960	$ 57,159	$ 65,320	$ 71,849
Total (Gross)	$ 466,531	$ 352,603	$ 387,781	$ 412,503

Salary cost in B.1 went down by ~$100k owing to reallocation of personnel within Project B. Total net cost across elements B.1-B.3 increases only by projected salary and burden increases.

- ✓ Compliance: LTEMP/GCPA Goals for Sediment. LTEMP Sandbar Volume Metric
- ✓ Experimental trigger: Assessment of sandbar condition is part of HFE Planning and Implementation process.
- ✓ Experimental action monitoring and analysis: Effect of HFEs.

- Annual data collection needed because sandbars change on annual and shorter time scales.
- Monitoring is combined with Project C, Vegetation Monitoring

- The only budget flexibility that would not eliminate the project completely is in the cooperative agreement.
- Reducing that would be the first ~10% to go and would reduce ability to hire temporary student technicians for field work. More volunteers from TWG??

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B.2 Bathymetric and topographic mapping for monitoring sediment storage and riverbed dynamics

Budget Category	FY 2024	FY 2025	FY 2026	FY 2027
Salaries	$ 308,076	$ 408,725	$ 453,105	$ 513,470
Travel & Training	$ 2,000	$ 1,000	$ 1,000	$ 1,000
Operating Expenses	$ 10,000	$ 10,000	$ 10,000	$ 10,000
Logistics Expenses	$ 73,080	$ 84,138	$ 29,596	$ 86,680
Cooperative Agreements	$ -	$ 77,550	$ 77,550	$ 77,550
To other USGS Centers	$ -	$ -	$ -	$ -
Total (Net)	$ 393,155	$ 581,413	$ 571,251	$ 688,701
Burden	$ 52,840	$ 112,169	$ 113,903	$ 145,336
Total (Gross)	$ 445,995	$ 693,582	$ 685,154	$ 834,036

- Salary cost in B.2 went up by ~$100k owing to reallocation of personnel within Project B. Total net cost across elements B.1-B.3 increases only by projected salary and burden increases.
- Logistics is lower in FY 2026 because ground truthing for overflight is a shorter and lower cost trip.

✓ Compliance: LTEMP/GCPA Goals for Sediment. LTEMP Sand Supply Metric
❑ Experimental trigger: No
✓ Experimental action monitoring and analysis: LTEMP Sediment Goal Outcome

- Data collection is every other year.
- FY 2025 and 2027 data collection meets goal to resurvey segments in Marble Canyon every 5 to 10 years.
- FY 2026 data collection is for overflight. Will be removed if overflight is deferred.

The only budget flexibility that would not eliminate data collection or is in the cooperative agreement. Reducing that would be the first ~10% to go and would reduce ability to hire temporary student technicians for field work and data processing.

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B.3 Control network and survey support

Budget Category	FY 2024	FY 2025	FY 2026	FY 2027
Salaries	$ 70,640	$ 103,575	$ 110,825	$ 118,583
Travel & Training	$ 1,000	$ 1,000	$ 1,000	$ 1,000
Operating Expenses	$ 15,000	$ 15,000	$ 15,000	$ 15,000
Logistics Expenses	$ -	$ -	$ -	$ -
Cooperative Agreements	$ -	$ -	$ -	$ -
To other USGS Centers	$ -	$ -	$ -	$ -
Total (Net)	$ 86,640	$ 119,575	$ 126,825	$ 134,583
Burden	$ 11,644	$ 26,067	$ 28,663	$ 31,492
Total (Gross)	$ 98,285	$ 145,643	$ 155,488	$ 166,076

- The FY 2024 budget covered only ~ 50% of the cost of the Geodesist/Surveyor position (rest was in project elements).
- The FY 2025 – 2027 budget covers 80% of the cost of the position (rest is in project elements).

❑ Not related to compliance or experimental action.

- Needed for long-term data quality and integrity.
  - Ensures that geospatial data collected for AMP projects are accurately referenced, precisely defined, and can be reliably compared with past and future datasets
  - Maintain integrity and accuracy for network of more than 2900 monumented control points.
  - Data are collected in cooperation with other project elements (no dedicated logistics).

- The Geodesist/Surveyor position is currently vacant. Keith Kohl was with GCMRC for more than 20 years, but recently moved on to work with the National Geodetic Survey
- Not refilling the position would lower cost but compromise long-term data quality and integrity.

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B.4 Streamflow, sediment, and sandbar modeling

Budget Category	FY 2025	FY 2026	FY 2027
Salaries	$ 118,319	$ 94,590	$ 178,014
Travel & Training	$ 2,000	$ 2,000	$ 2,000
Operating Expenses	$ -	$ -	$ -
Logistics Expenses	$ -	$ -	$ -
Cooperative Agreements	$ 35,250	$ 35,250	$ -
To other USGS Centers	$ -	$ -	$ -
Total (Net)	$ 155,569	$ 131,840	$ 180,014
Burden	$ 27,287	$ 22,887	$ 42,123
Total (Gross)	$ 182,855	$ 154,727	$ 222,138

- Salary costs are lower in FY 2025 and 2026 because staff will be working on non-AMP Reclamation and NPS modeling projects.

❑ Compliance: No
✓ Experimental trigger: Modeling used for HFE planning and impleementation
❑ Experimental action monitoring and analysis: No

- Can reduce scope and cut cooperative agreements in FY 2025 and 2026.
- No flexibility in FY 2027 without eliminating project.

- This is the only project that includes modeling for streamflow or sediment in the river. Without a streamflow and sediment modeling project, we have no capacity for predicting resource response to dam operations.

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Project B: Sandbar and Sediment Storage Monitoring and Research (FY 2021-23)

- Project Objectives
  - Track the effects of individual High Flow Experiments (HFEs) on sandbars – supports implementation of LTEMP.
  - Monitor the cumulative effect of successive HFEs and intervening dam operations on sandbars and fine sediment in Glen, Marble, and Grand canyons – supports evaluation of LTEMP.
  - Investigate and model interactions between dam operations, sand transport, and eddy sandbar dynamics – predictive modeling to support decision making.

- Project Elements
  - B.1 Sandbar and campsite monitoring
  - B.2 Bathymetric and topographic mapping for monitoring sandbars and fine sediment from Glen Canyon Dam to Pearce Ferry
  - B.3 Control Network and Survey Support
  - B.4 Sediment and Sandbar Modeling

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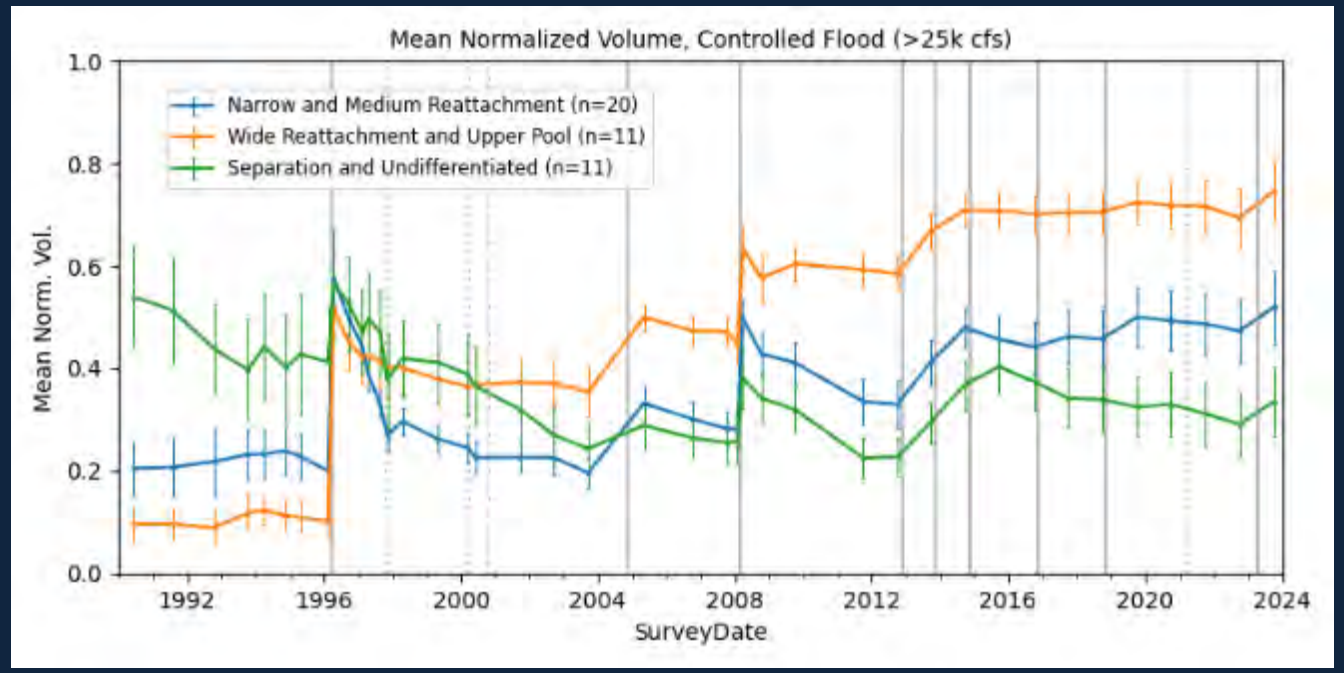
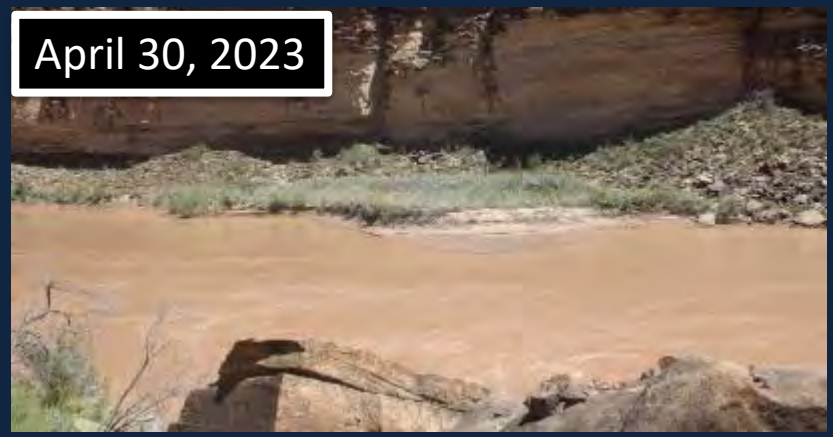
B.1 Sandbar and campsite monitoring with topographic surveys and remote cameras

Project Purpose

- Sandbar monitoring: document response to sandbars to dam operations, including HFEs
  - LTEMP Sandbar Volume Metric





Hazel and others (2022); www.usgs.gov/apps/sandbar

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B.1 Sandbar and campsite monitoring with topographic surveys and remote cameras

- Annual monitoring of 45 sites with topographic surveys – Consider replacing sites that are no longer sensitive to dam operations with other sites that may be more responsive.
- Campsite area surveys at 36 sites
- Maintain remote cameras – begin to update with new system.
- Data processing, analysis, and reporting.
- Database and website (for data and photos)
- Logistics for one rowing trip each year (joint trip with Project C)
- Grand Canyon River Guides Adopt-a-Beach program (cooperative agreement)
- Student technicians for field work (cooperative agreement with Northern Arizona University)

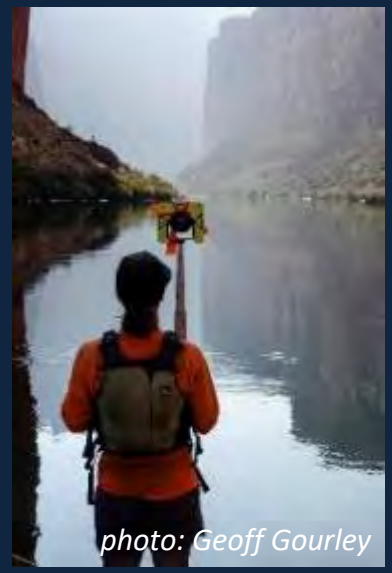
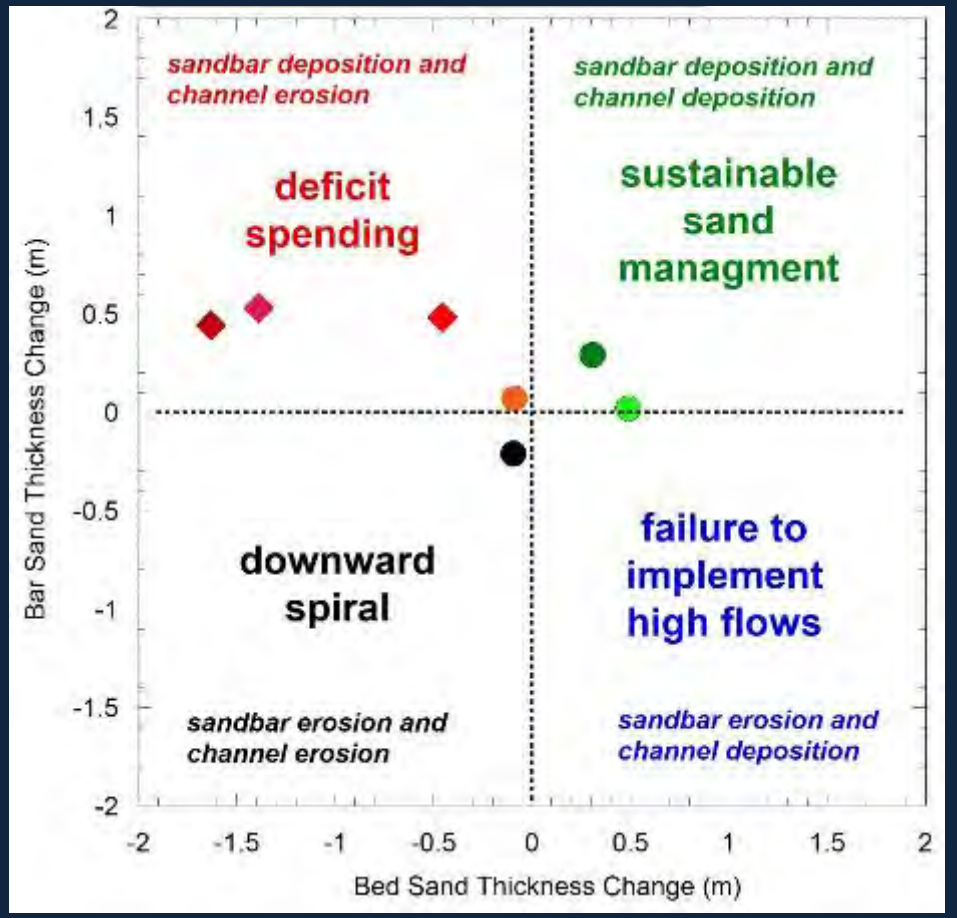


photo: Geoff Gourley


photo: Jeff Behan

B.2 Bathymetric and topographic mapping for monitoring sediment storage and riverbed dynamics

- Monitoring large sample of “above baseflow” sandbars:
  - LTEMP Sandbar Volume metric
- Monitoring sediment storage change in channel – used for independent verification Project A mass balance:
  - LTEMP Sand Supply metric.
- Riverbed dynamics in Western Grand Canyon
  - Continue evaluation of riverbed response to dam operations in Western Grand Canyon –
  - Develop a sediment budget for reach and study stability of Pearce Ferry Rapid (and what happens if rapid goes away).



Schmidt and Grams, 2011; Grams et al. 2018; and Preliminary results. Do not cite.

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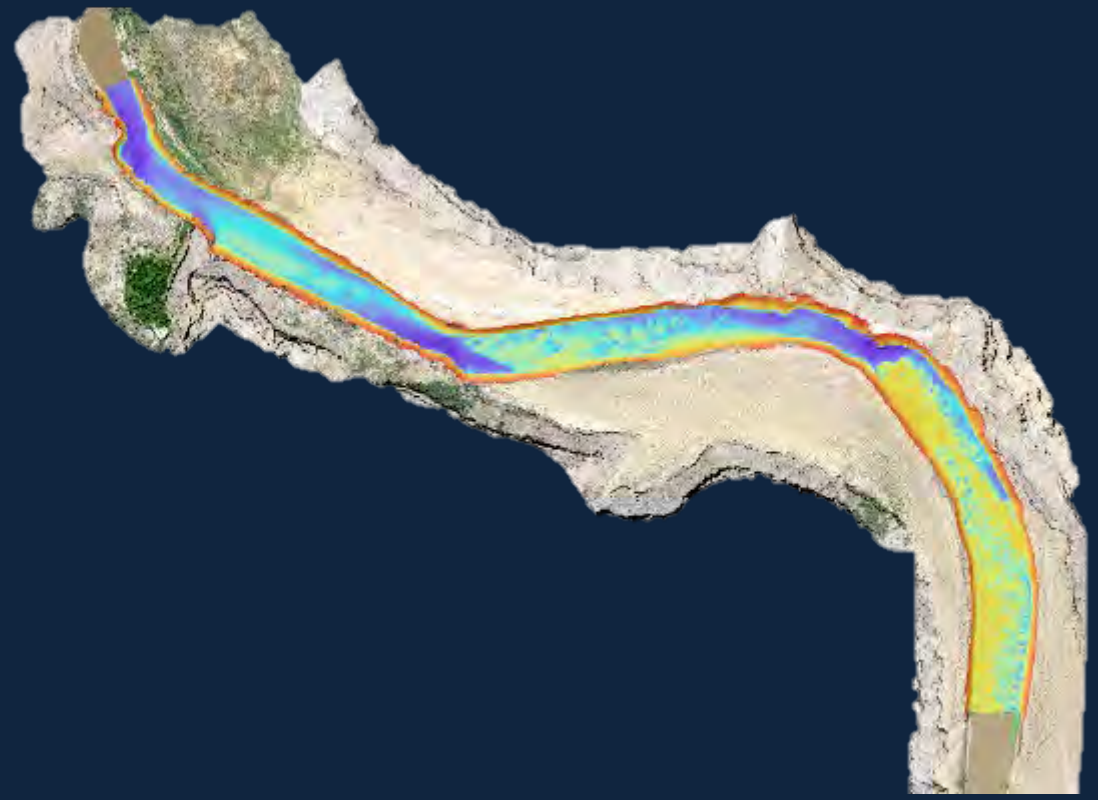
B.2 Bathymetric and topographic mapping for monitoring sediment storage and riverbed dynamics

- FY 2025
  - Repeat map of sandbars and river channel for Lower Marble Canyon (RM 30 to 61), last surveyed in 2019 (repeat after 6 years).
- FY 2026
  - Water surface and bed profile during overflight (ground truth water surface and topographic survey).
- FY 2027
  - Repeat map of sandbars and river channel for Eastern Grand Canyon (RM 61 to 87), last surveyed in 2019 (repeat after 8 years).
- Evaluation of riverbed response to dam operations in Western Grand Canyon
  - One survey per year
  - Possible additional surveys around HFEs if they occur.



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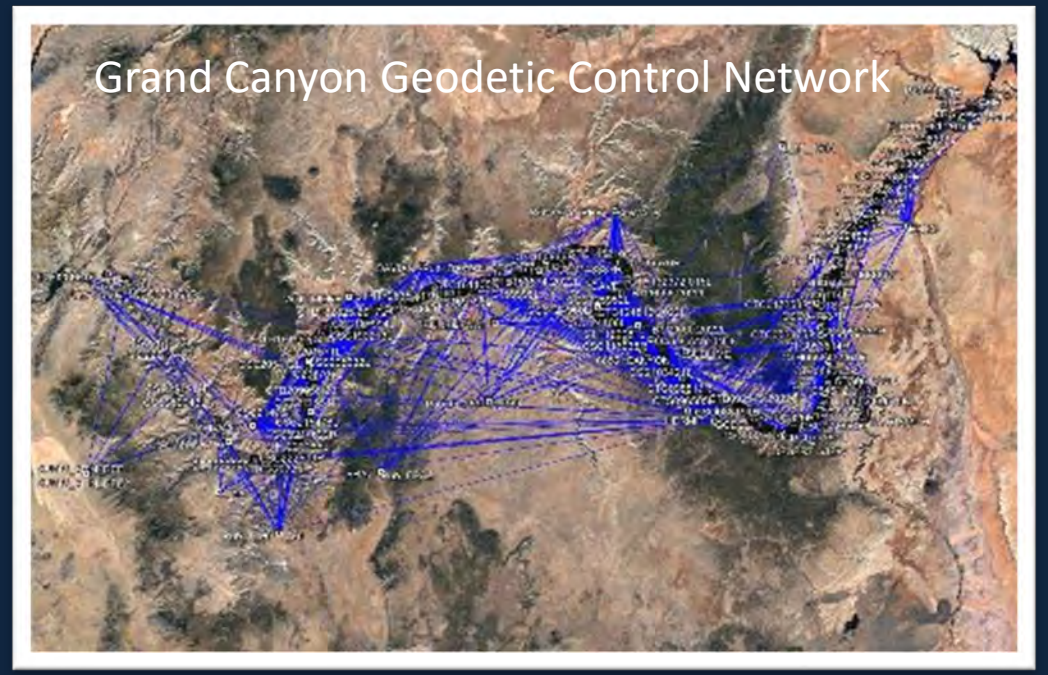
B.3 Control network and survey support

Objectives

- Ensure that geospatial data collected for AMP projects are accurately referenced, precisely defined, and can be reliably compared with past and future datasets
- Maintain integrity and accuracy for network of more than 2900 monumented control points that are referenced by:
  - > 9000 GNSS vectors
  - ~ 9000 classical survey measurements
- Support ground-based referencing for remote sensing missions
- Manage and maintain large inventory of survey equipment



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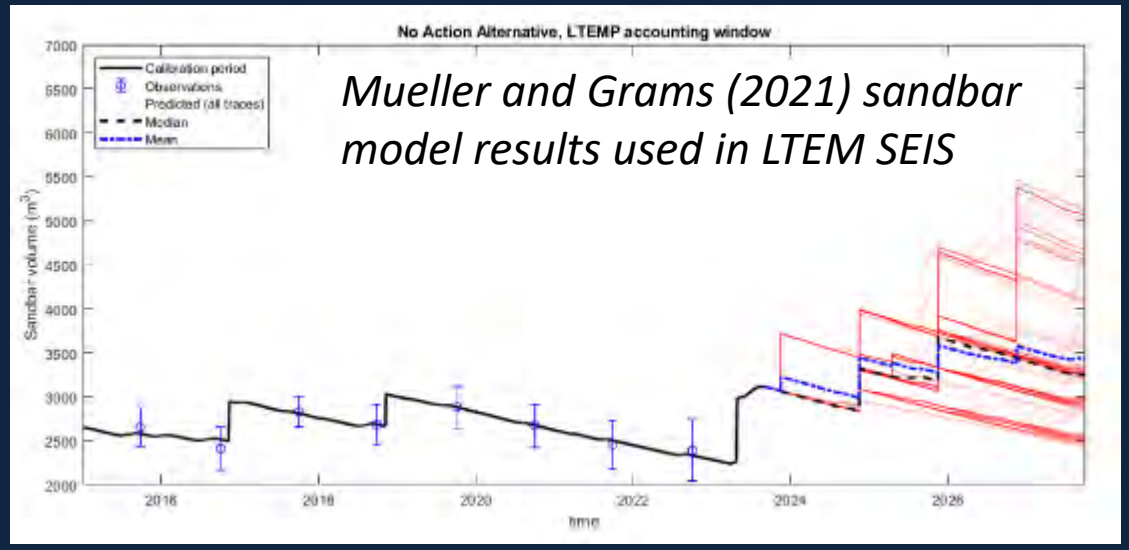
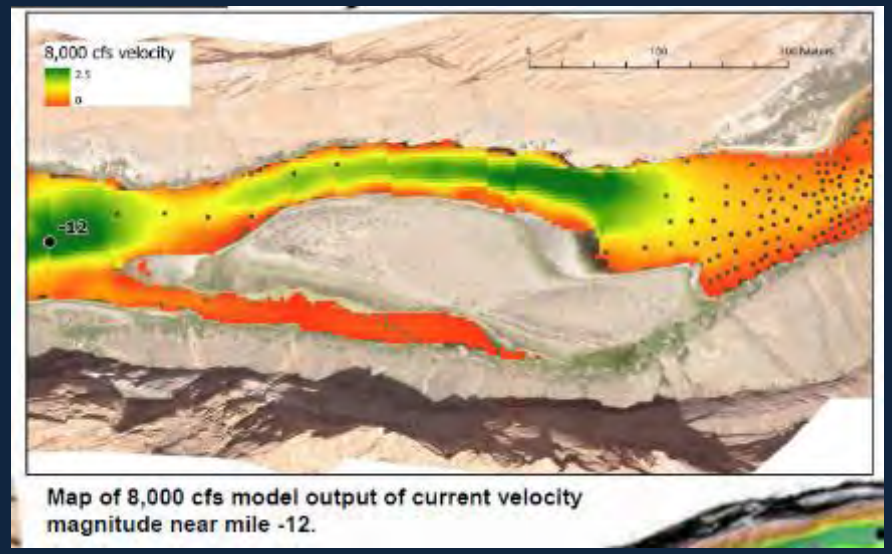
B.4 Streamflow, sediment, and sandbar modeling

- Needs for predictive modeling
  - Predictions of turbidity and fine sediment (mud) storage for fish habitat and nutrient dynamics – Continue work on fine sediment (mud) routing model
  - Improve sandbar modeling to better predict sandbar erosion – Improve sandbar model to include more sites and improve parameterization of erosion.
  - Predictions of flow depth and velocity for fish habitat in Marble Canyon – Develop two-dimensional streamflow models for Upper Marble Canyon and Lower Marble Canyon.





Wright et al. (2024) flow model for Glen Canyon