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Managing Water in the West

Grand Canyon Sediment Augmentation Study

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Bureau of Reclamation

Sediment Augmentation Objectives

- Seasonally increase turbidity to provide cover for native fish.
- Annually increase sand supply to build larger sandbars, in conjunction with beach-building flows.

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Sediment Augmentation Plan

- Increase turbidity by continuously supplying silt- or clay-sized sediments from May through December to produce suspended sediment concentrations of 500 ppm (3 million tons per season).
- Annually supply 1 million tons of sand to Grand Canyon.

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Study Team

- Reclamation Engineers
  - Tim Randle (overall guidance)
  - Joe Lyons (team leader)
  - Ron Ferrari (Lake Powell survey)
  - Jim Yahnke (water quality)
  - Fred Tan (pipeline design)
  - Rick Christensen (sediment dredging)
  - Richard Fehr (pumping plant design)
  - Lisa Gamuciello (electrical power)
  - Larry Rossi (electrical controls)
  - Jerry Zander (cost estimation)

Study Team (continued)

- National Park Service
  - Norm Henderson (plan formulation)

Types of Sediment Augmentation Alternatives

- Alternative sediment sources
- Alternative points of delivery
- Alternative delivery methods

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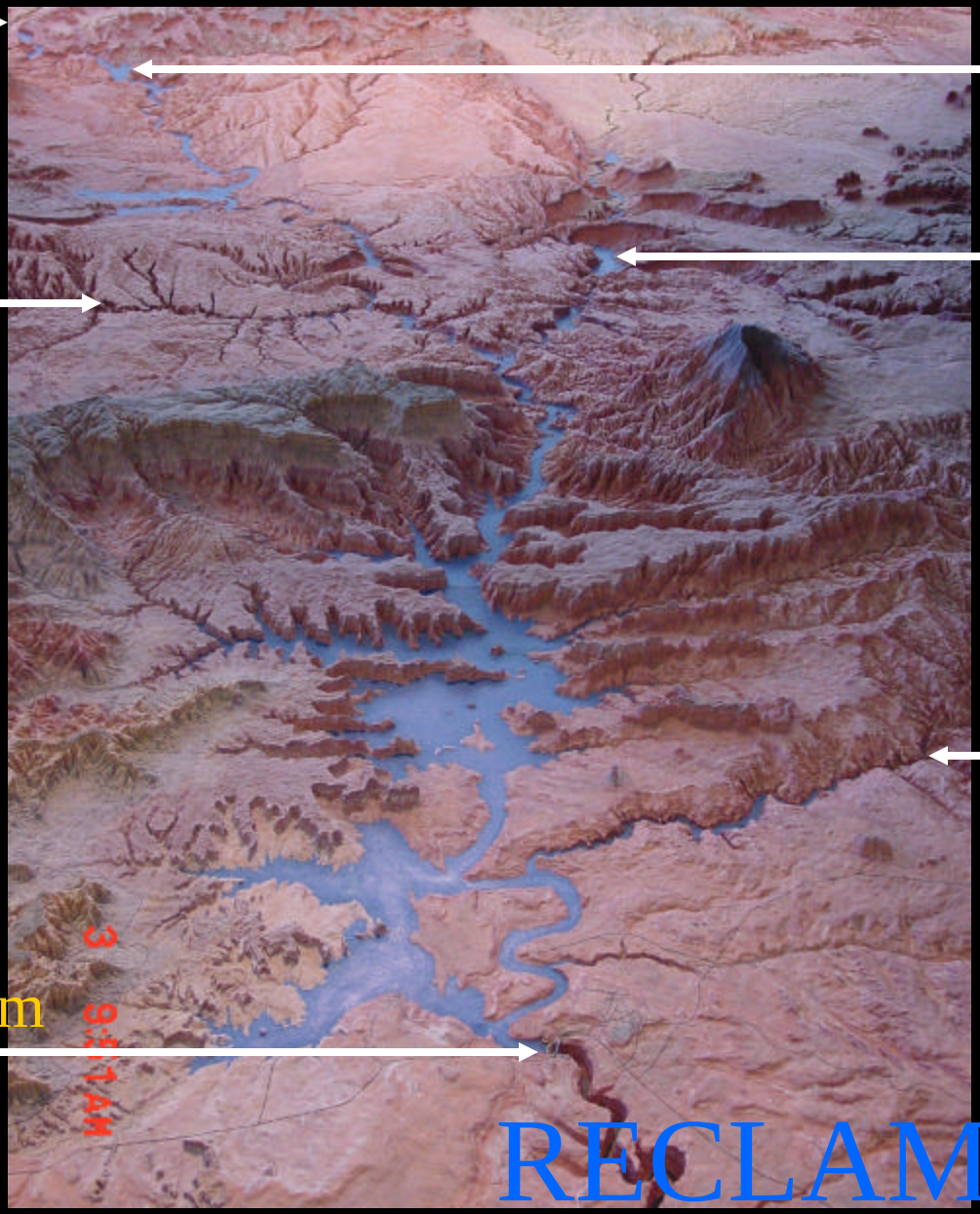
Alternative Sediment Sources

- Lake Powell Deltas
- Lake Mead Delta
- Other Terrestrial Site

Lake Powell Deltas



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Sediment Source near Glen Canyon

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Navajo Canyon Delta

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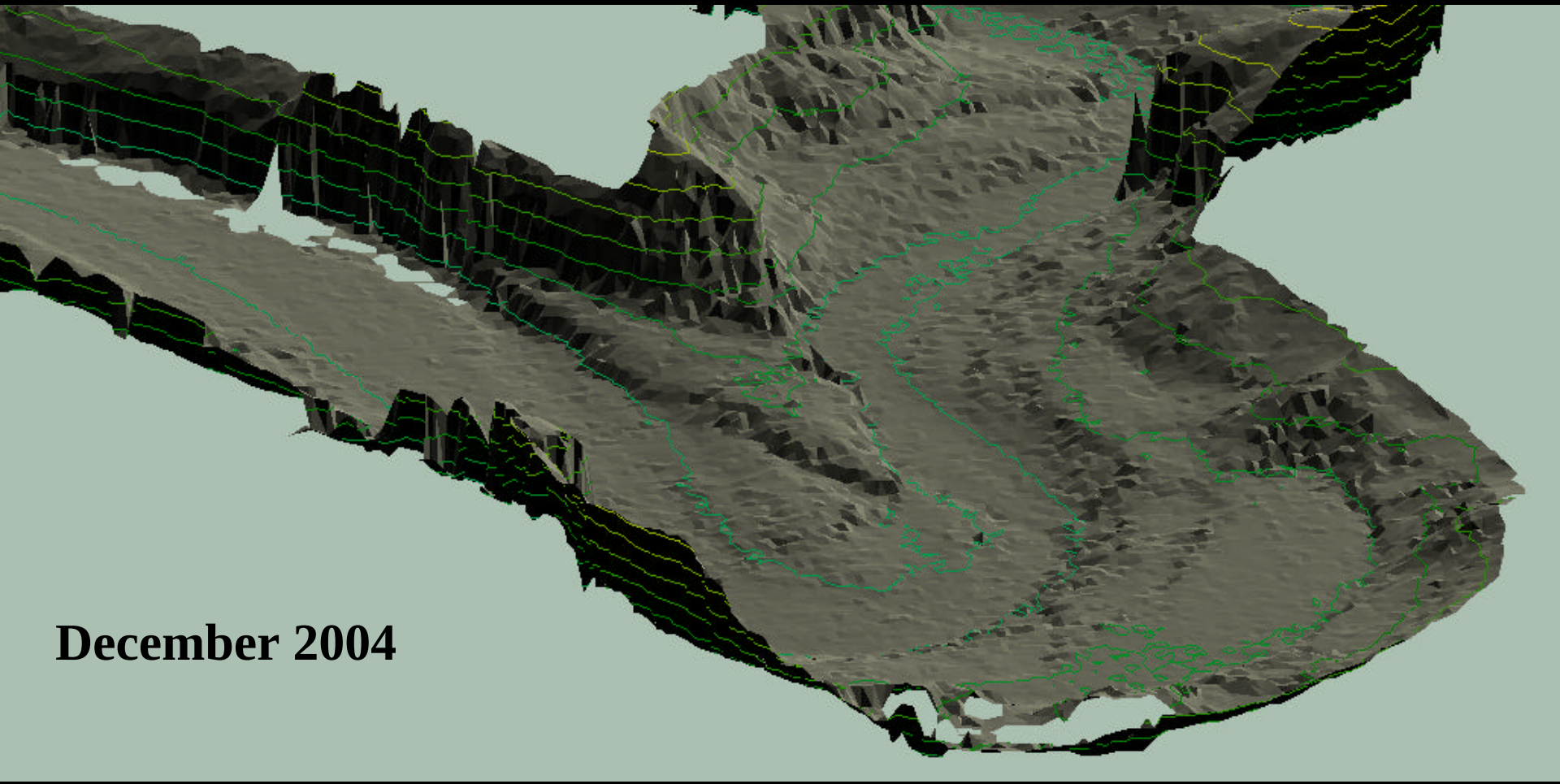
Navajo Canyon Survey



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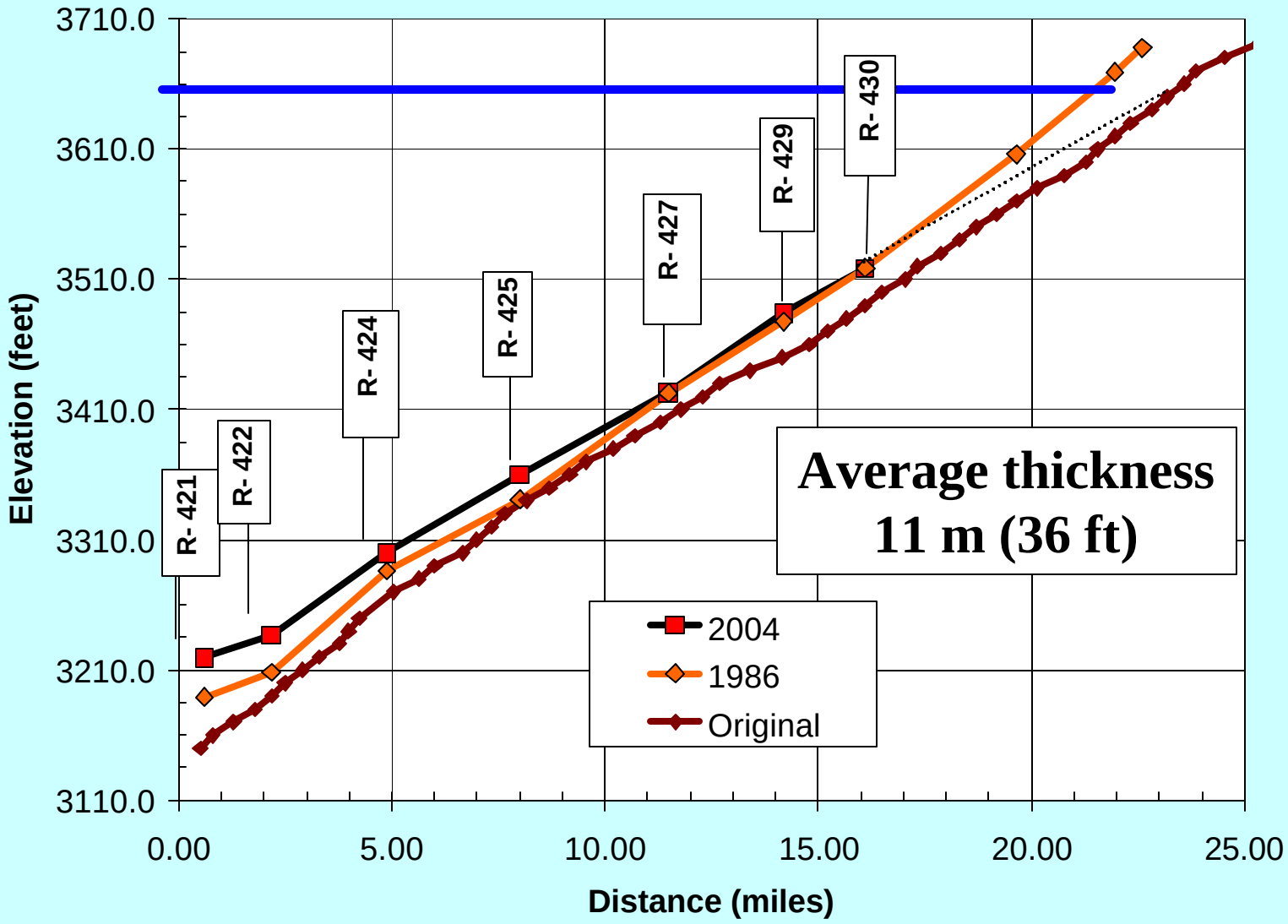
Navajo Canyon Profile



Navajo Canyon Sedimentation

- Maximum sedimentation volume of 40 million m^3 (30,000 acre-feet) since 1963
- Maximum sediment mass of 40 million tons
- Average annual sedimentation rate of 1 million tons per year

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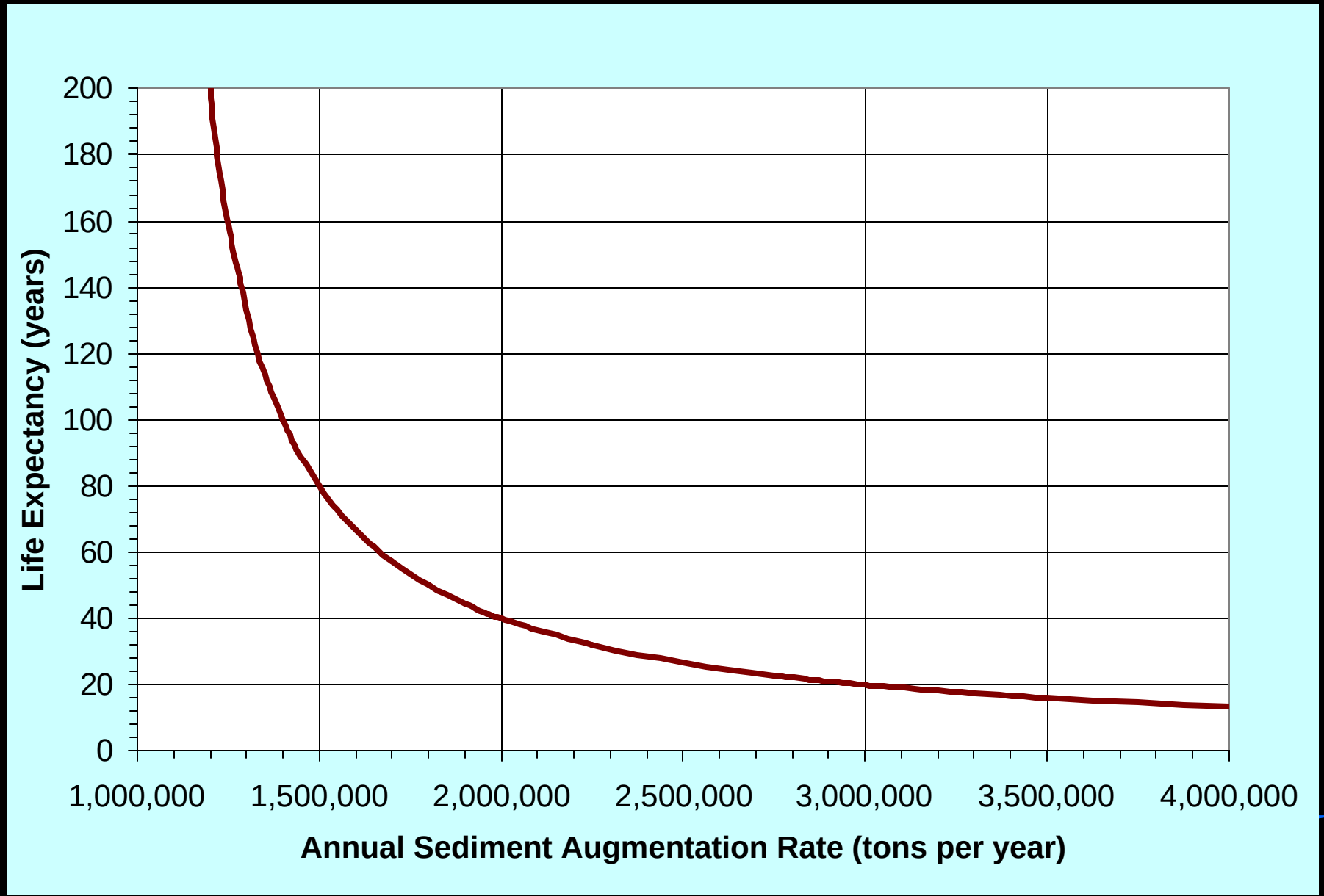
Navajo Canyon Sediment Sustainability



Sediment Size and Quality of One Delta Sample

- 57 % silt and clay
- 43 % sand
  - 30 % very fine sand
  - 13 % medium sand

- Angular quartz particles have high potential for abrasion of pipes, valves, and pumps
- Sample was analyzed for 39 elements
  - no contaminants were found

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Alternative Points of Delivery

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Sediment Discharge Locations

- Below Glen Canyon Dam
  - Sand: continuous year-round discharge
  - Silt and clay: continuous, seasonal discharge
- Lees Ferry
  - Sand: stock pile and discharge before beach-building flow
  - Silt and clay: continuous, seasonal discharge

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Alternative Delivery Methods

- Barge and truck
- Sediment slurry pipeline

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Barge and Truck Alternative Eliminated

- Excessive barge traffic on Lake Powell
  - Barge size: 30 m x 10 m (100 ft x 30 ft)
  - 37 barge trips per day for sand
  - 135 barge trips per day for silt and clay
- Excessive truck traffic on highway between Page and Lees Ferry
  - 130 truck trips per day for sand
  - 500 truck trips per day for silt and clay

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Sediment Slurry Pipeline Alignments

- Overland from Navajo Canyon
- Submerged in Lake Powell

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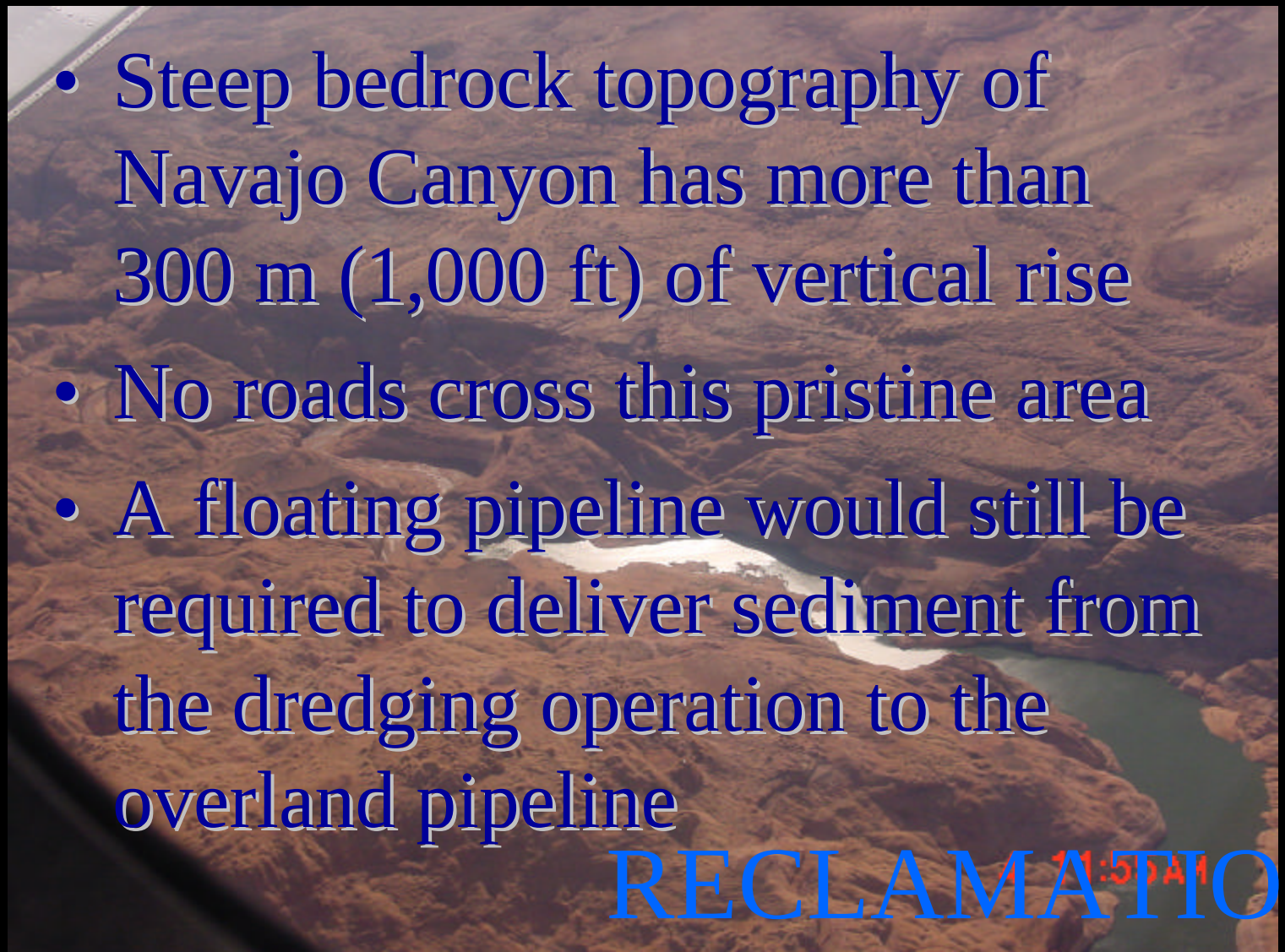
Overland Pipeline Alignment Eliminated



- Steep bedrock topography of Navajo Canyon has more than 300 m (1,000 ft) of vertical rise
- No roads cross this pristine area
- A floating pipeline would still be required to deliver sediment from the dredging operation to the overland pipeline

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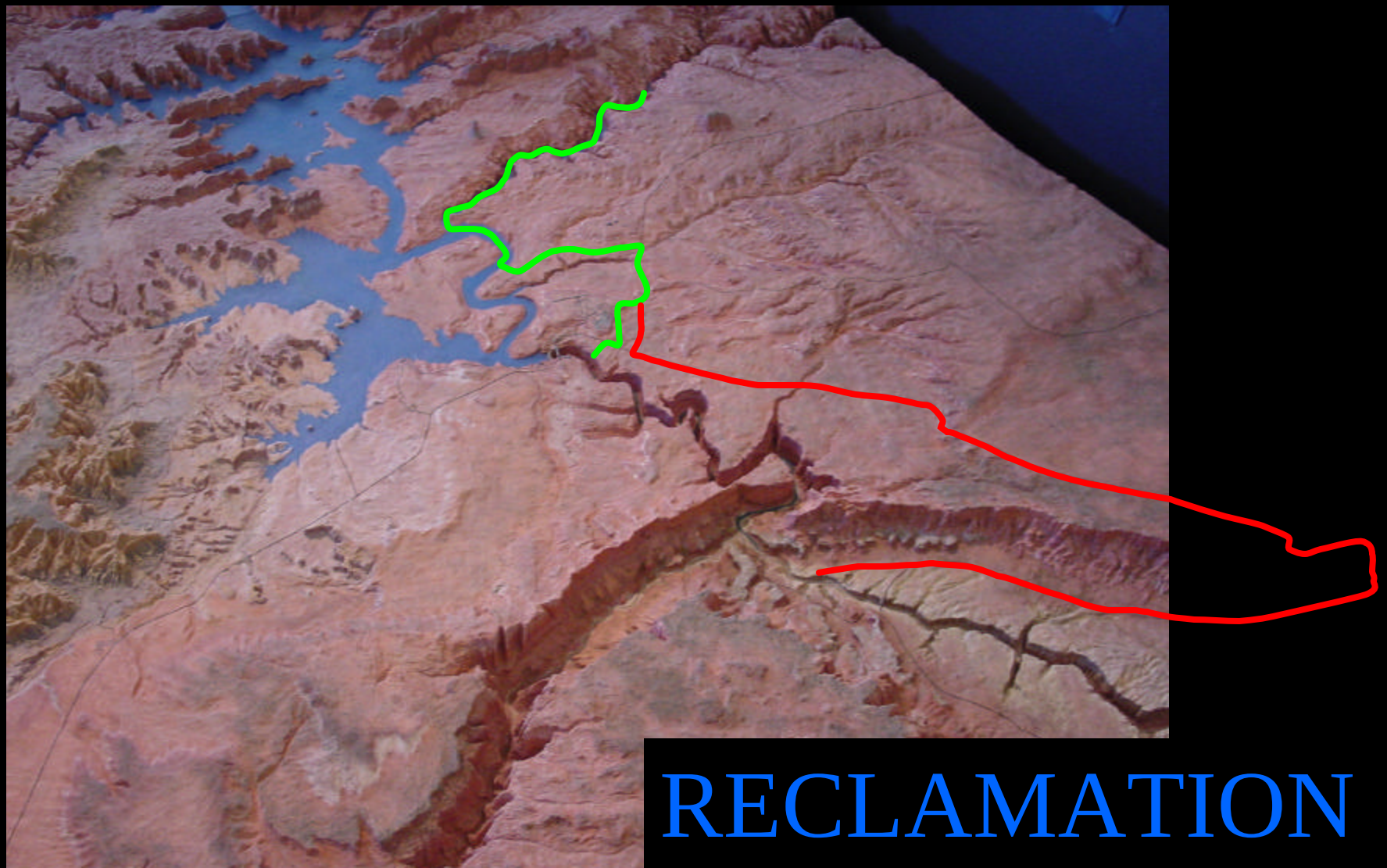
Lake Powell Slurry Pipeline Alignment



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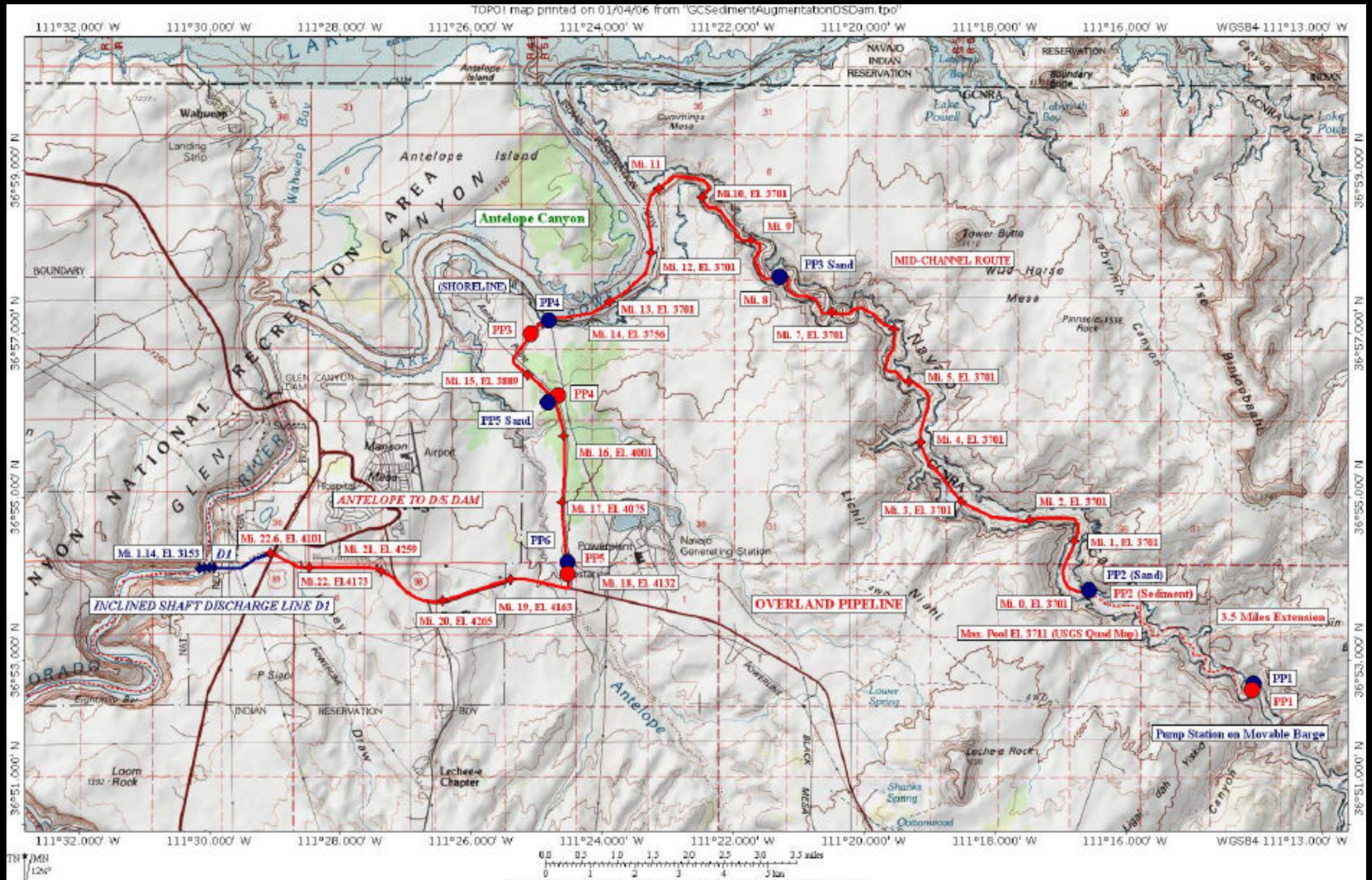
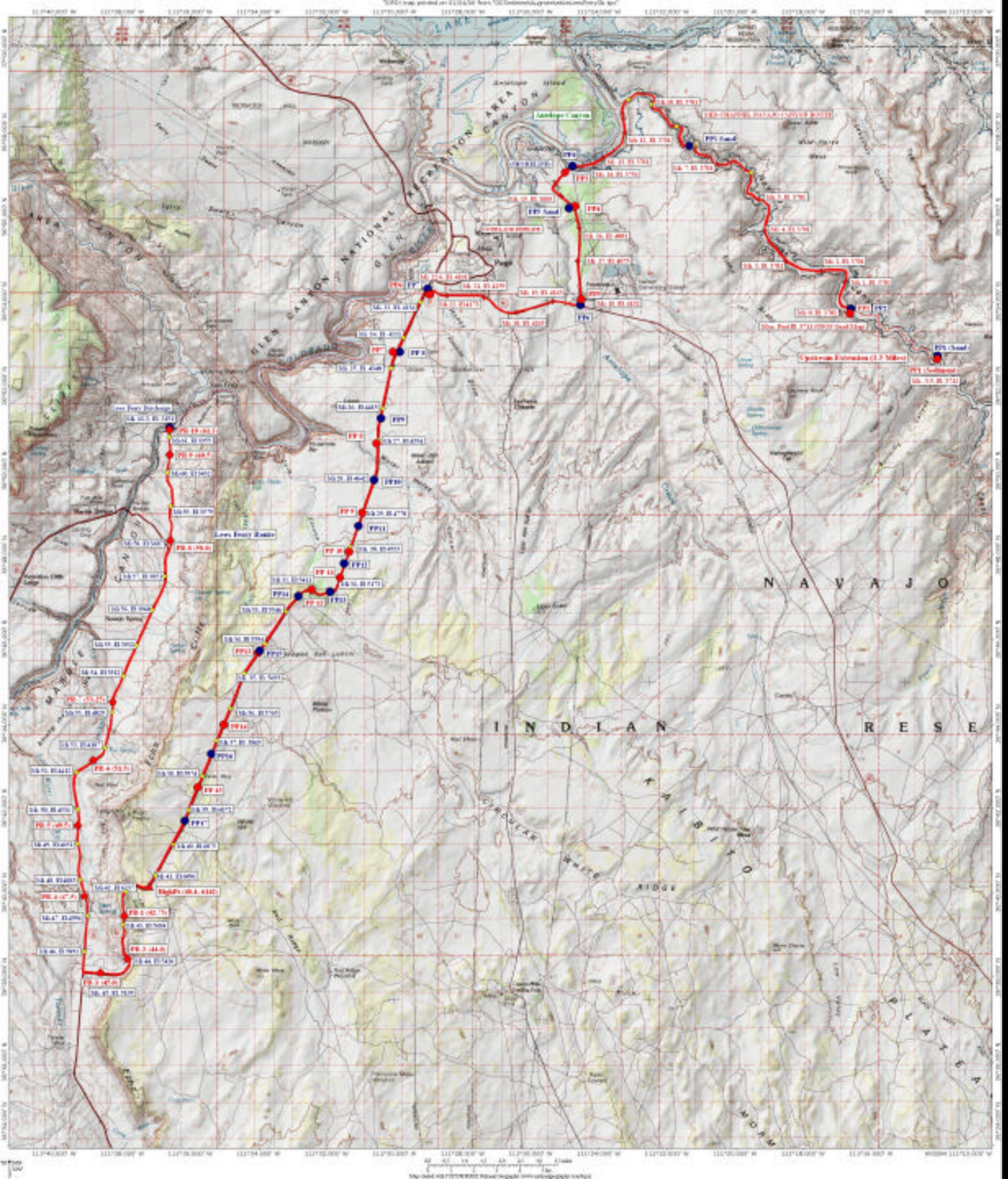
Sediment Slurry Pipeline Alignment





Sediment Slurry Pipeline: Navajo Canyon to Lees Ferry

Sediment Slurry Pipeline Lengths

- Navajo Canyon to Glen Canyon Dam
  - 28.2 km (17.5 miles) of submerged pipeline
  - 13.8 km (8.6 miles) of buried pipeline
- Navajo Canyon to Lees Ferry
  - 28.2 km (17.5 miles) of submerged pipeline
  - 79.3 km (49.3 miles) of buried pipeline

Submerged Pipelines

Sand pipelines

Submerged powerline

Silt/clay pipelines

Pulleys and counterweights

Mooring cables

Anchors

Sediments

Sand Slurry Pipeline Dimensions

- Three, 12-inch (0.30 m), pipes
  - HDPE (High Density Polyethylene)
- Total flow rate of 4.4 ft^3/s (0.12 m^3/s)
- 15 % sand concentration
- Annual water volume of 3,000 acre-feet per year (4 million m^3/yr)

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Silt/clay Slurry Pipeline Dimensions

- Three, 24-inch (0.61 m), pipes
  - HDPE (High Density Polyethylene)
- Total flow rate of 27 ft^3/s (0.76 m^3/s)
- 20 % silt/clay concentration
- Annual water volume of 13,000 acre-feet per year (16 million m^3/yr)

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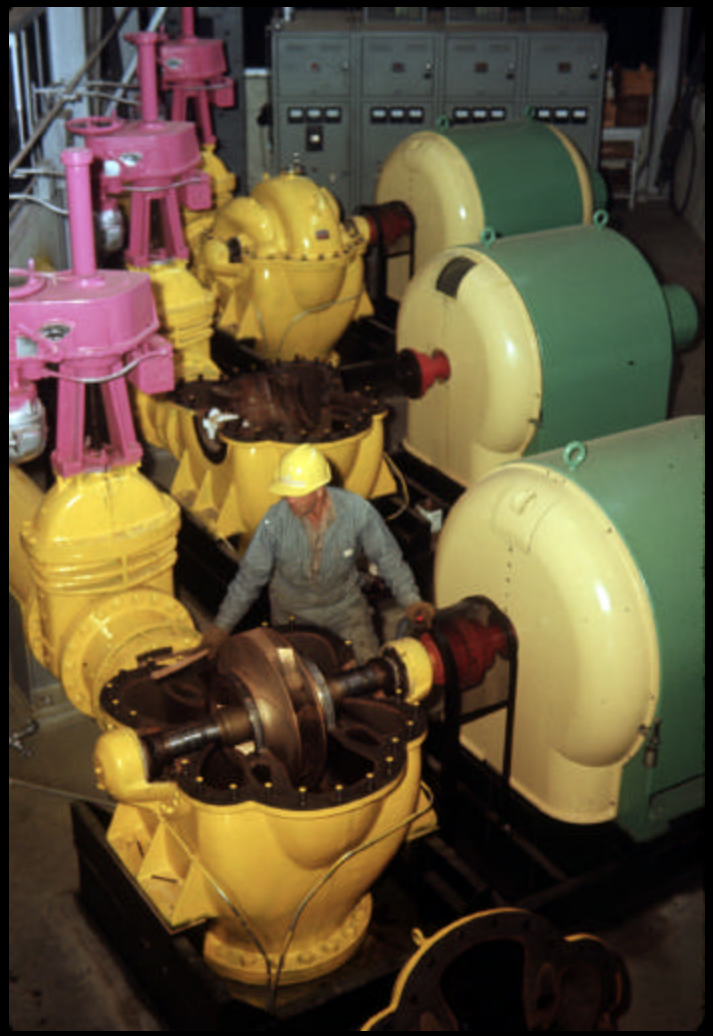
Land-based Pumping Plants



Building size:

- **9 m (30 ft) wide**
- **18 m (60 ft) long**
- **3 m (10 ft) high**

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Floating Pumping Plants

Modular barge size:

- **3 m (10 ft) wide**
- **12 m (40 ft) long**
- **2 m (7 ft) deep**

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Sediment Slurry Pumping Plants

- Navajo Canyon to Glen Canyon Dam
  - 3 floating pumping plants
  - 4 land-based pumping plants
- Navajo Canyon to Lees Ferry
  - 3 floating pumping plants
  - 17 land-based pumping plants

Navajo Canyon Dredging Operation

Near continuous operation
of clamshell dredge

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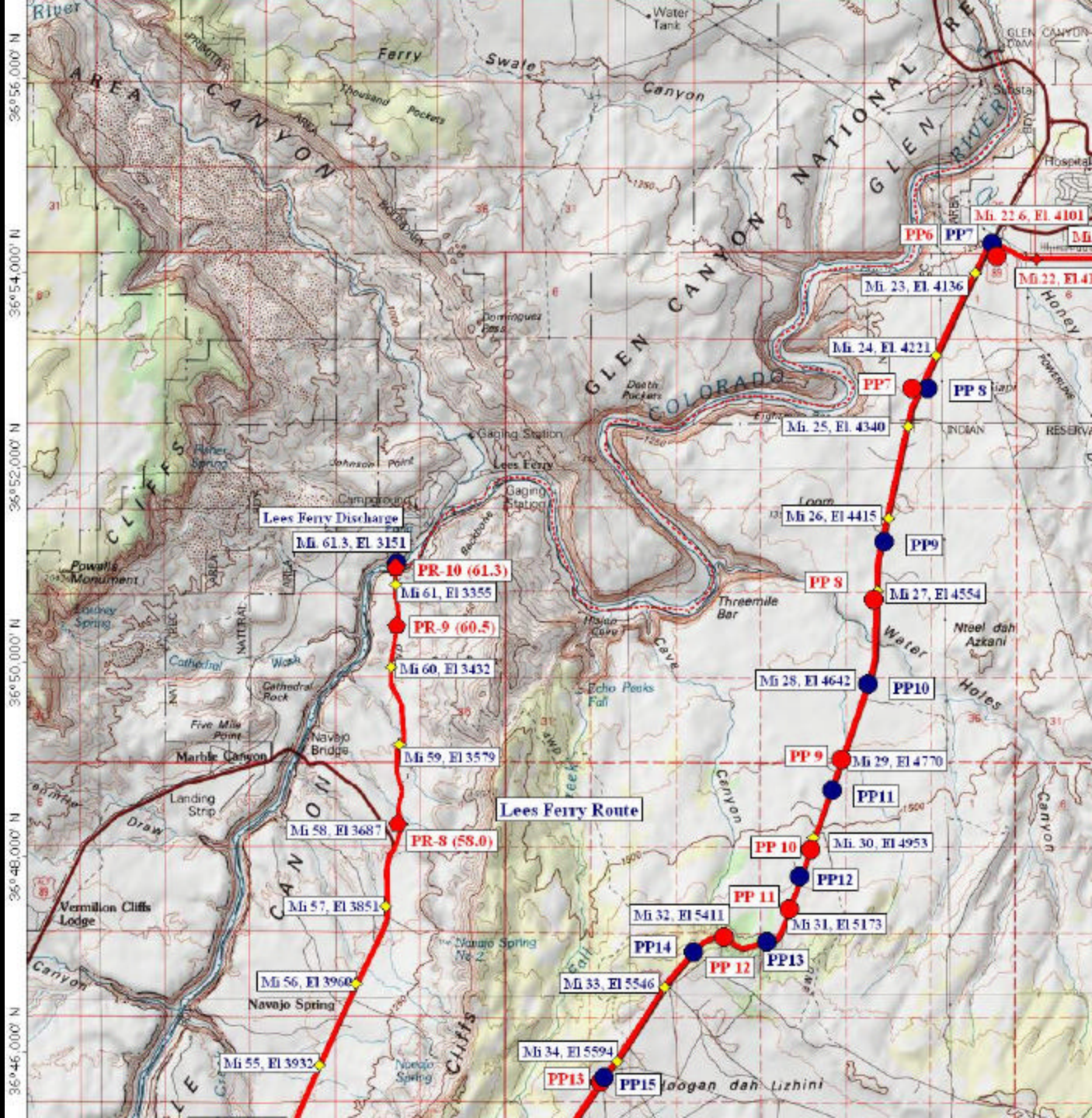
Sediment Slurry Pipeline

Navajo Canyon to Lees Ferry



Sand Storage near Lees Ferry

- Two basins would alternatively be used to settle the sand from the slurry pipeline.
- Each basin would be 275 m by 75 m (900 feet by 250 feet) and would fill in about one month.

Sand Storage near Lees Ferry

- Bulldozers, loaders, and trucks would remove the sand from each basin.
- 1 million tons of sand would be stored near the Colorado River.
- Sand storage volume
  - 190 m by 190 m (630 ft by 630 ft)
  - 15 m (50 ft) high
- Pushed into river by bulldozers (D-10)

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Costs

- Appraisal-level cost estimates are in progress?

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Conclusions

- A sediment slurry pipeline is technically feasible.
- No environmental problems have been identified at this time.
- Attempts have been made to avoid cultural resources impacts.
- Augmentation of fine sediment should be considered with selective withdrawal.

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Next Steps

- Cost estimates are in progress
- Finalize the report
- If there is stakeholder interest:
  - More sampling and testing of sediments
  - Feasibility design to Congress
  - Congressional authorization
  - Final design
  - Construction bids

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