Dam Removal Webinar Series

Part 2B:
Sediment Risk Assessment, Sediment Quality, Regulatory Issues

November 3, 2020

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- ERDC Environmental Laboratory

Sediment Risk Assessment, Sediment Quality, Regulatory Issues -Topics

- Quality – what are the sediment characteristics?
- Framework for risk analysis and management
- Regulatory

Marmot Dam on the Sandy River, OR

https://www.theintertwine.org/outside-voice/ten-years-free-flowing-sandy-river

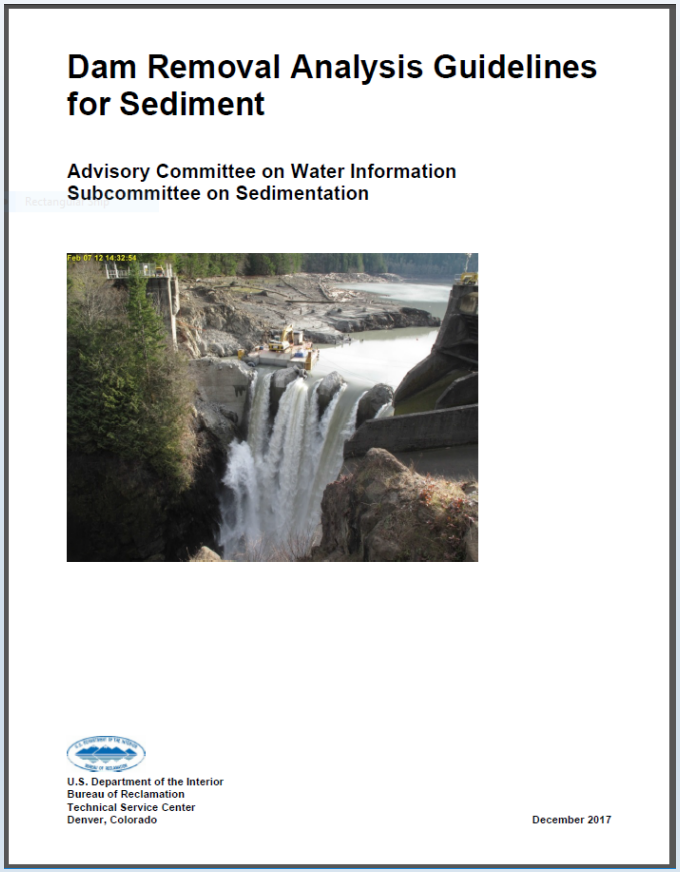
Sediment Quality Characteristics

- Physical
  - Grain size distribution
    - Turbidity
    - Grain size alteration/FSI
  - Level of cohesion
    - Erodibility
    - Channel evolution
- Chemical
  - Contaminants
  - Nutrients

https://whitesalmontimelapse.wordpress.com/page/2/#jp-carousel-381

Sediment Risk Analysis and Management

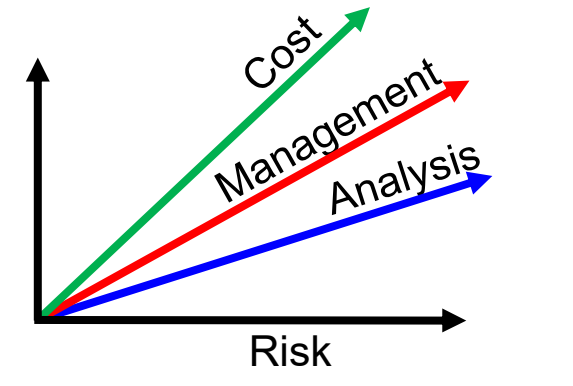
- Assess potential risk
- Develop management alternatives

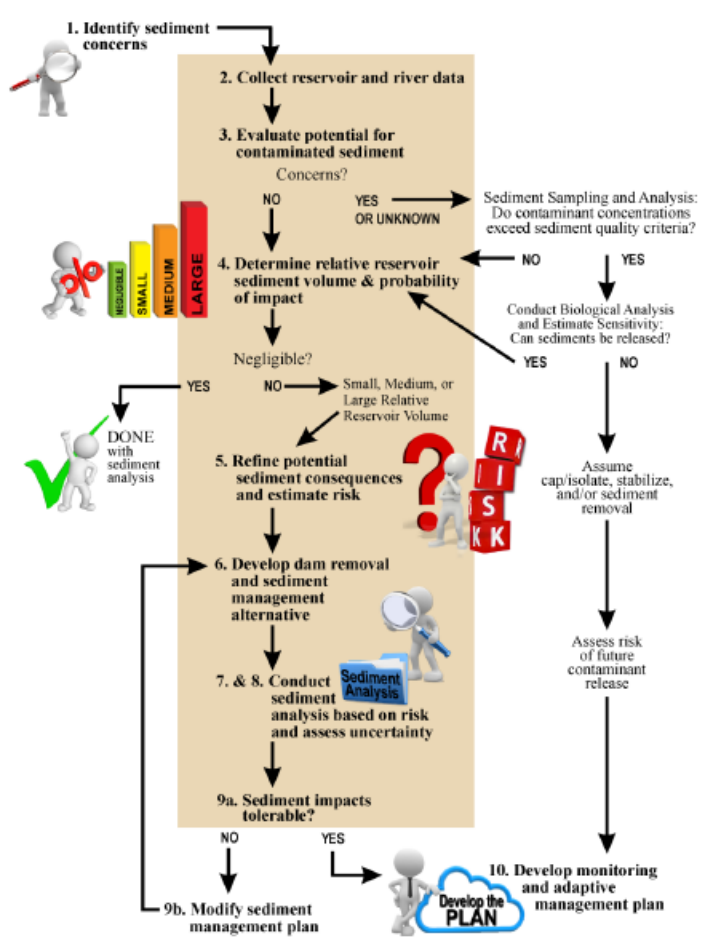


Sediment Risk Framework

- Iterative process
- Level of evaluation commensurate with potential risk

Risk = Probability of Impact x Magnitude of Consequences





Sediment analysis steps for dam removal (Randle and Bountry 2017).

Step 1. Identify Sediment Concerns

- Initial conceptual model based on readily available information
  - Upstream erosion
  - Downstream fate of eroded sediment
  - Potential for contaminants
  - Contaminant transport pathways
  - Receptors of concern
- Identify concerns
- Identify benefits

https://whitesalmontimelapse.wordpress.com/page/2/#jp-carousel-402

Step 1. Identify Sediment Concerns

Concerns

Upstream/Reservoir

- Aesthetics
- Revegetation
- Invasive species
- Chronic erosion
- Hillslope failure/bank erosion
- Knickpoint migration to infrastructure
- Exposure or burial of cultural resources
- Erosion of spawning areas
- Aquatic invasive species
- Fish stranding
- Odor of exposed sediment
- Loss of recreation areas

Downstream

- Release of contaminants
- Water quality (TSS or contaminants)
- Sedimentation in pipelines/canals
- Reduced well permeability or capacity
- Sediment deposition or burial
- Increased flood stage
- Streambank erosion and channel widening
- Burial of:
  - spawning areas
  - aquatic species
  - floodplain vegetation
- River aesthetics (landscape or water color)
- Increased wood loads (blockage)
- Burial or erosion of recreation areas
- Increased exposure to ice jams

Receiving Water

- Water quality (TSS/contaminants)
- Increased nutrient/pollutant loads
- Burial of aquatic habitat
- Sediment deposition blocking migration
- Expansion of estuary channels – loss of land/infrastructure
- Sedimentation in downstream reservoir
- Deposition along recreational areas
- Increased deposition affecting coastal seawalls, jetties, docks
- Tidal inundation of infrastructure

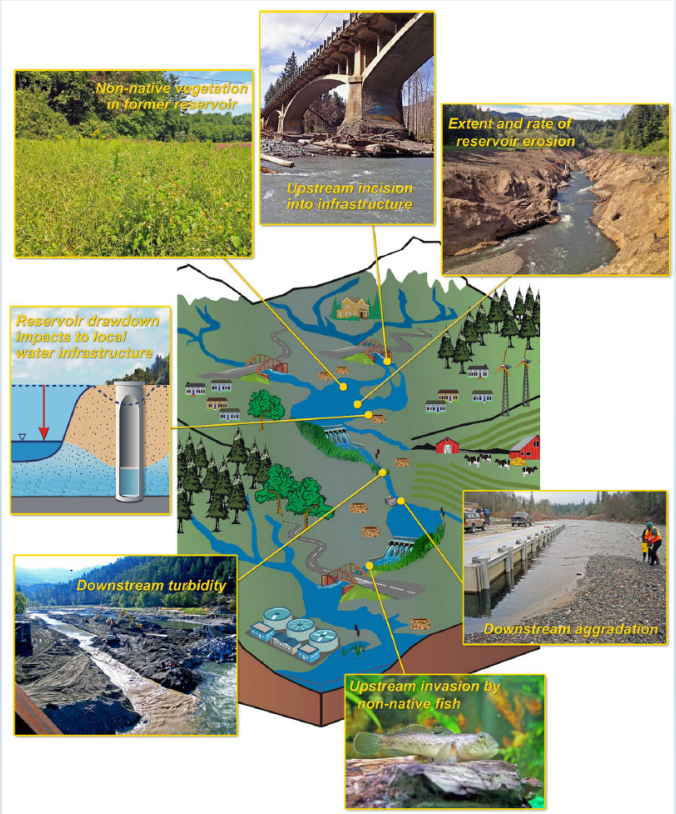
Benefits

- Restoration of riverine habitat
- Restoration of heterogeneous grain sizes and sediment bars
- Physical habitat features (spawning gravels, bars, islands)
- Growth of invertebrate communities
- Natural disturbance – riparian vegetation
- Sediment replenishment to beaches
- Benefits to estuaries
- Turbidity benefits to certain species (protection)
- Sediment supply to reconnect floodplains
- Restored connectivity of nutrients and organic matter
- Restoration of floodplain and sediment bars
- Enhanced river recreation
- Reduced chance of uncontrolled flow releases

Step 1. Identify Sediment Concerns

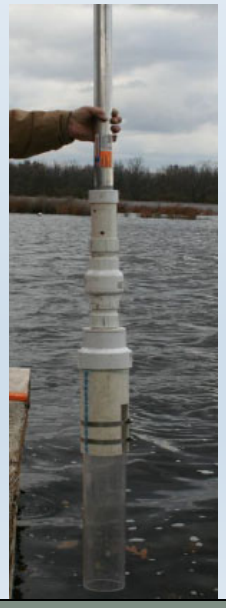
- Concerns
  - **Degree and rate of reservoir sediment erosion**
  - **Excessive channel incision upstream of reservoirs**
  - **Downstream sediment aggradation**
  - **Elevated turbidity**
  - Drawdown impacts to local water infrastructure
  - Non-native plant colonization of reservoirs
  - Expansion of non-native fish
- Benefits
  - Restoration of riverine habitat
  - Growth of invertebrate communities
  - Restoration of floodplain and sediment bars
  - Enhanced river recreation
  - Reduced chance of uncontrolled flow releases

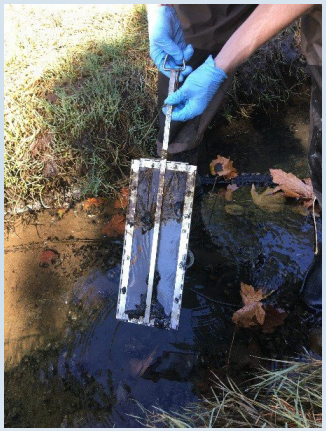
Common (Sediment) Management Concerns in Dam Removal Projects (Tullos et al. 2016, JAWRA)



Step 2. Collect Reservoir and River Data

- Compile existing data
  - Site reconnaissance
  - Conceptual site diagram
    - Identify data collection locations
  - Dam history and reservoir operations





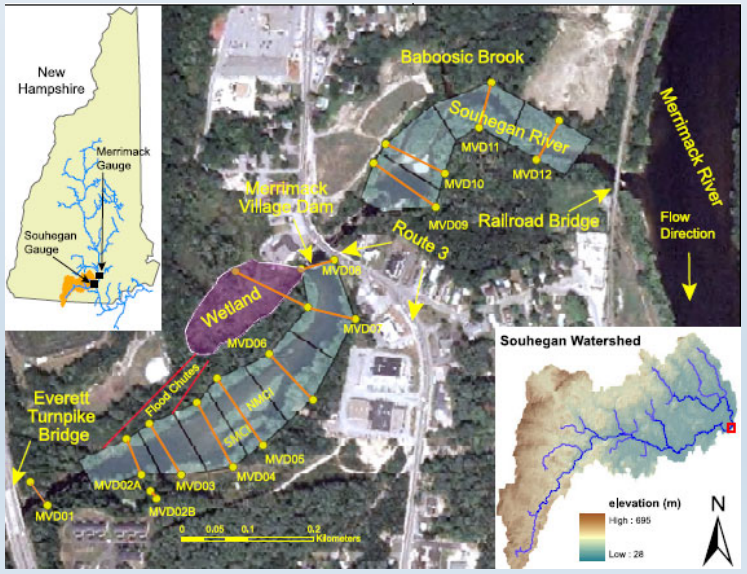
- Site Reconnaissance:
  - Spatial extent of reservoir
  - Sediment grain size (probing)
  - Vegetation/large wood
  - Geologic controls
  - Infrastructure
  - Tributary confluences
  - Sediment & wood sources
  - Downstream depositional zones
  - Wide floodplain reaches
  - Downstream river confluences
  - Downstream bridges, levees, recreation
  - Water intakes/effluent outfalls
  - Docks or marinas
  - Estuary and coastal zones

Step 2. Collect Reservoir and River Data

- Reservoir sediment survey
  - Topographic & bathymetric map
  - Predam topography & reservoir sediment volume
  - Sediment sizes and spatial distribution
  - Sediment mass

- Collect river data
  - River profile and slope
  - Streambed composition
  - Channel geometry
  - Extent of floodplain

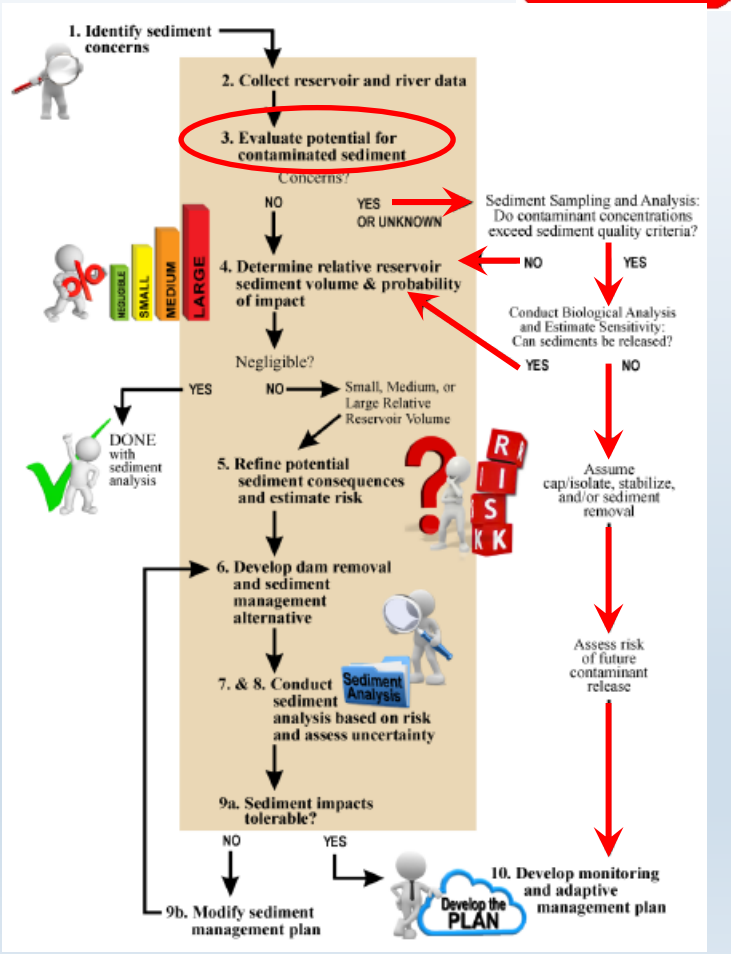
Merrimack Village Dam study area on Souhegan River



Pearson et al. 2011, Water Resources Research

Step 3. Evaluate Potential for Contaminated Sediment

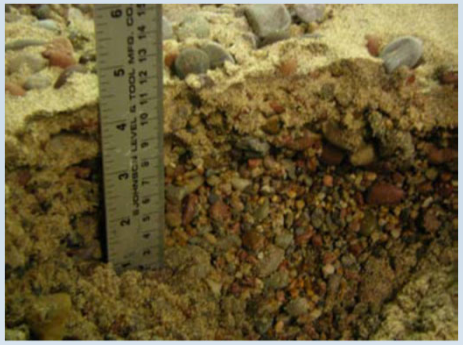
- "Reason to believe" presence of contaminants
  - Due diligence assessment
- If so, sampling & chemical analysis
  - Concentration > SQGs? > Background?
- Biological analysis
  - Bioassays
  - Bioaccumulation
  - Elutriate tests
- Pathways
  - Suspended sediment (water column)
  - Deposition



Sediment analysis steps for dam removal (Randle and Bountry 2017).

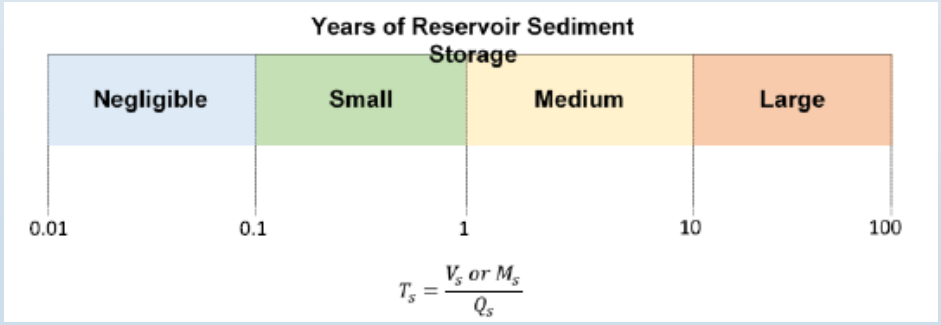
Step 3. Evaluate Potential for Contaminated Sediment

- Receptors
  - Aquatic invertebrates
  - Aquatic species (fish, mussels)
  - Benthic invertebrates
  - Birds/wildlife
  - Human
    - Fish consumption
    - Drinking water
- Management options
  - Stabilize in place
  - Removal
  - Cap/isolate

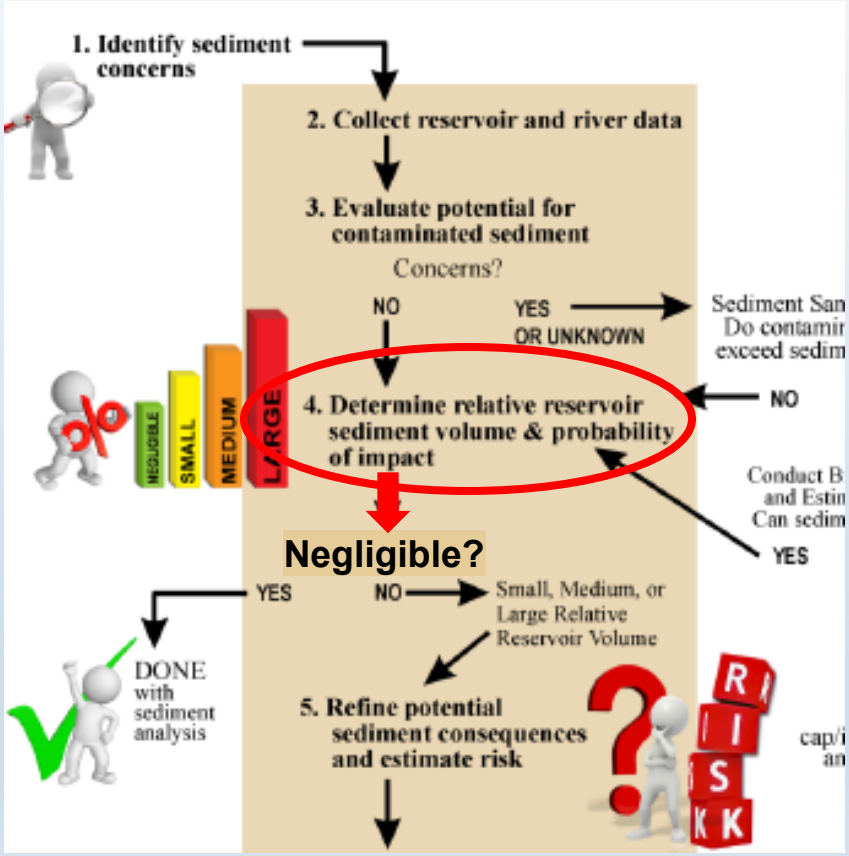


Step 4. Determine Relative Reservoir Sediment Volume and Probability of Impact

- Relative reservoir sediment volume
  - $T_s = V_s$ (or M_s) / Q_s
  - Number of years of sediment load stored
- Probability of impact



(Randle and Bountry 2017)



(Randle and Bountry 2017)

Step 5. Refine Potential Sediment Consequences and Estimate Risk

- Identify consequences
- Rank consequences as small, medium or large
  - Qualitative
- Categorize the risk:

Risk = Probability of Impact x Magnitude of Consequences

Probability of fine or coarse sediment impact	Consequence of Sediment Impact		
	Small	Medium	Large
Small	Low Risk	Low Risk	Moderate Risk
Medium	Low Risk	Moderate Risk	High Risk
Large	Moderate Risk	High Risk	High Risk

Matrix to estimate the risk of sediment impacts (Randle and Bountry 2017)

Step 6. Develop Dam Removal and Sediment Management Alternatives

- Dam removal plan
  - Full or partial
  - Rapid or phased
  - Timing
  - Barriers to erosion
  - Reservoir drawdown
- Sediment management alternatives
  - No action
  - River/Natural erosion
  - Mechanical removal
  - Stabilization

See Part 1 of Webinar Series (recorded)

Photograph courtesy of National Park Service, January 14, 2012

Photograph courtesy of Tim Randle, Bureau of Reclamation, October 2011

Step 7. Conduct sediment analysis based on risk

- Predict sediment effects
  - Level of effort based on risk

See
Part 3 and Part 4
of Webinar Series:
Assessment Methods - Nov 10
Modeling Techniques – Nov 19

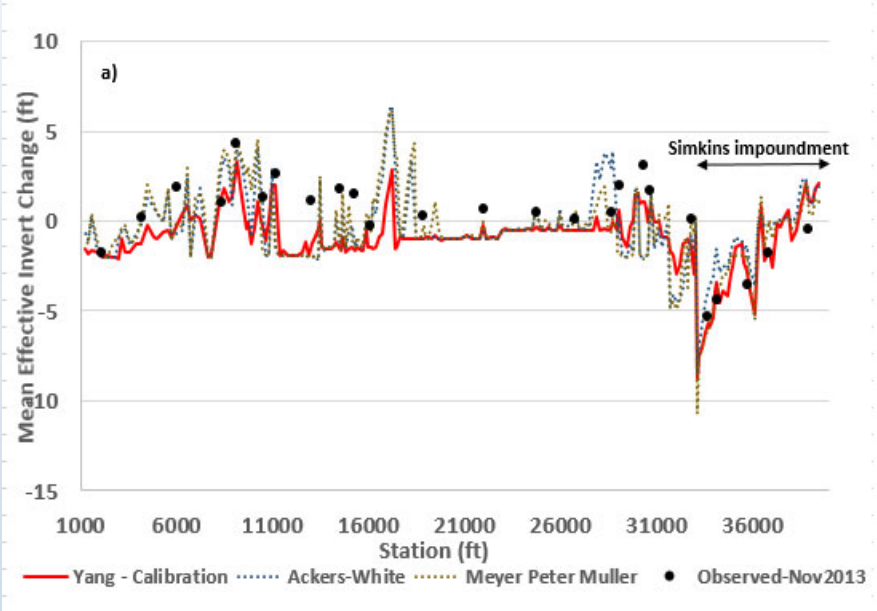
Sediment analysis and modeling options

Sediment Risk Category			
Negligible	**Low**	**Moderate**	**High**
Simple Computations	Conceptual Model →		
	Total Stream Power Calculations →		
	Mass Balance Calculations →		
		Geomorphic Analysis →	
		Sediment Wave Model →	
		Sediment Transport Capacity →	
			Numerical Sediment Model
			Laboratory Model
			Field Test

(Randle and Bountry 2017)

Step 8. Assess uncertainty of predictions

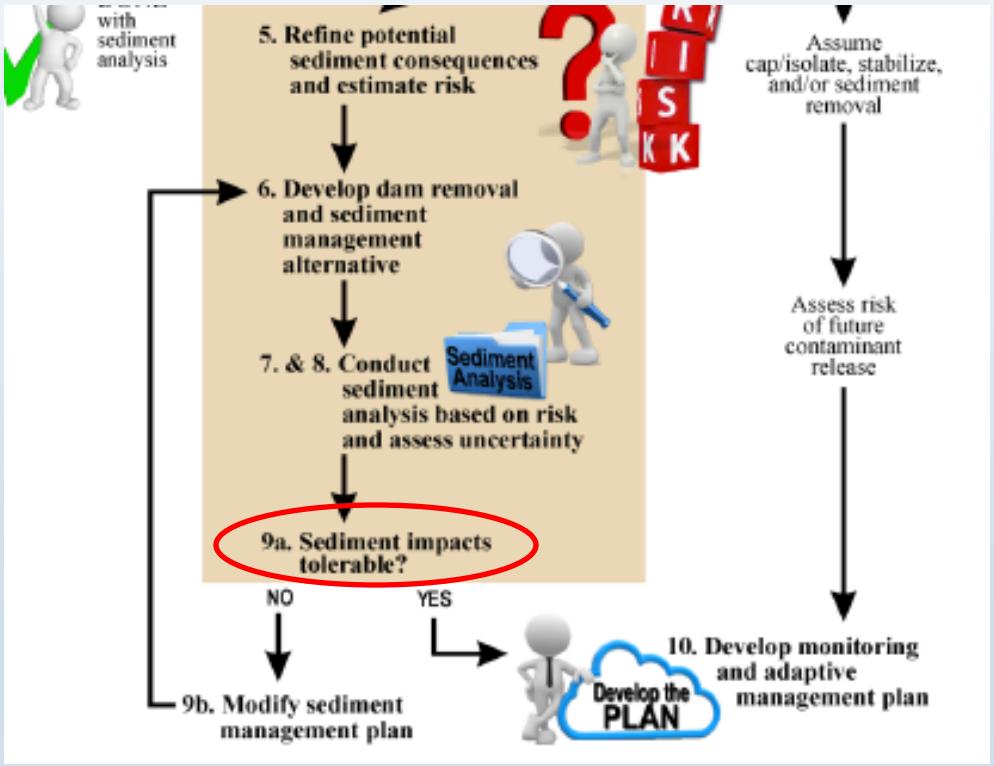
- Observational uncertainty
  - Reservoir sediment volume
  - Sediment grain size
  - Contaminant
  - Stream flow hydrograph
- Parameter uncertainty
  - E.g. hydraulic roughness, reference shear stress, active layer thickness
- Model structural uncertainty



Echevarria-Doyle et al., in prep.

Step 9. Determine if sediment impacts are tolerable and modify sediment management plan

- Compile predicted effects and associated uncertainty.
- Assess impacts to resources of concern
- If uncertainty is too high, consider additional data collection and analysis.
- If predicted impacts are not tolerable, consider revising dam removal and sediment management plans
- Consider mitigation alternatives



(Randle and Bountry 2017)

Step 10. Develop a monitoring and adaptive management plan

- Purpose
  - Permit compliance
  - Implementation
  - Ecological effectiveness
  - Effectiveness
  - Adaptive management
- Monitoring design
  - Questions of interest
  - Budget
  - Correspond to level of risk
- Parameters, methods, reporting standards
  - Reservoir surveys
  - Channel cross-section surveys
  - Channel longitudinal profile surveys
  - Stage recorders to detect changes in water surface elevation
  - Time lapse photography
  - Geomorphic mapping using repeat orthophotography
  - Bed material grain size distribution
  - Stratigraphic observations of sediment deposits
  - Suspended sediment and bed load measurements
  - Turbidity measurements

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How do these (and other) factors influence permitting decisions?

- Ecological Factors
  - Sediment discharge
    - USACE for Clean Water Act Section 404 permit
  - Water quality
    - Clean Water Act section 401 by state, tribe or U.S. EPA
  - Air quality
    - U.S. EPA Clean Air Act
  - Endangered species
    - U.S. FWS Endangered Species Act
- Other Factors
  - Navigation
    - Section 10 of the Rivers and Harbors Act of 1899
  - Historical sites
    - Federal, State agencies or Tribe governments
  - Floodplain impacts
    - FEMA
  - Demolition and waste disposal
    - State, County or City governments
  - Dam classification
    - Nationwide Permit 53 for low-head dam removal

Regulatory Issues

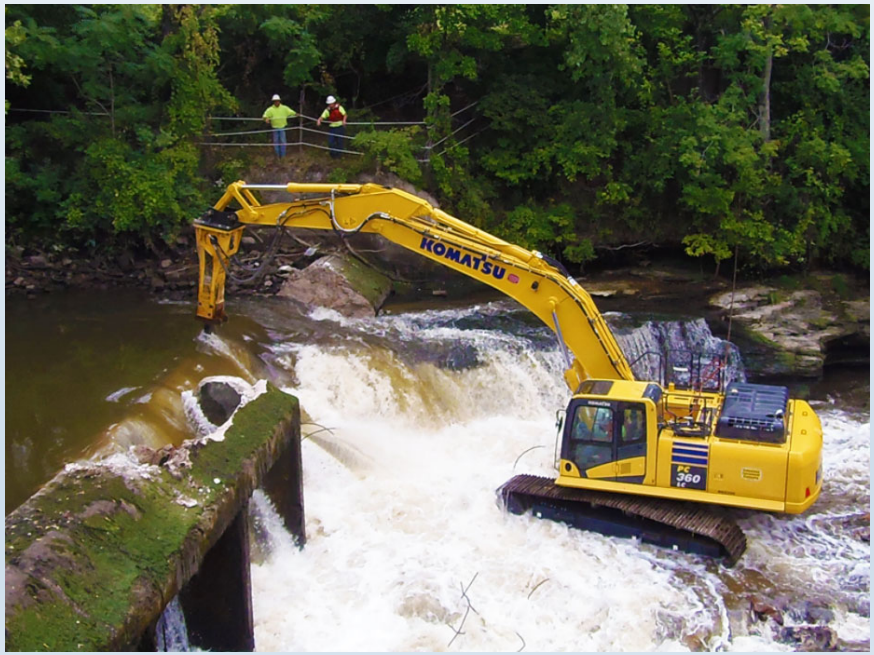
- Federal Permits
- Federal Consultations
- State Permits
- Local Permits

Kim Couranz / NOAA

Credit Mary Andrews

Federal Permits

- Clean Water Act (CWA) Section 404 Dredge and Fill Permit
- Rivers and Harbors Act Section 10 Permit
- FERC License Surrender or Non-Power License Approval
- National Environmental Policy Act (NEPA) Review



https://www.enviroscienceinc.com/new-nationwide-permits-take-effect-march-19th/

Nationwide Permits

- **NWP No. 53 Removal of Low Head Dams**
- NWP No. 13 for Bank Stabilization
- NWP No. 27 for Aquatic Habitat Restoration, Enhancement, and Establishment Activities
- NWP 33 for Temporary Construction, Access, and Dewatering

https://www.ohioriverfdn.org/stewardship/ecosystem_restoration/documents/OEPAWestMiltonDamphotos.pdf

Federal Consultations

- Endangered Species Act Section 7
  - T&E species
  - USFWS or NMFS
- Magnuson-Stevenson Act
  - Essential Fish Habitat (EFH)
  - NMFS
- National Historic Preservation Act
  - Historic properties
  - SHPO

https://www.americanrivers.org/wp-content/uploads/2016/06/Dam_Removal_and_Historic_Preservationa3eb.pdf Photo: Leviathor

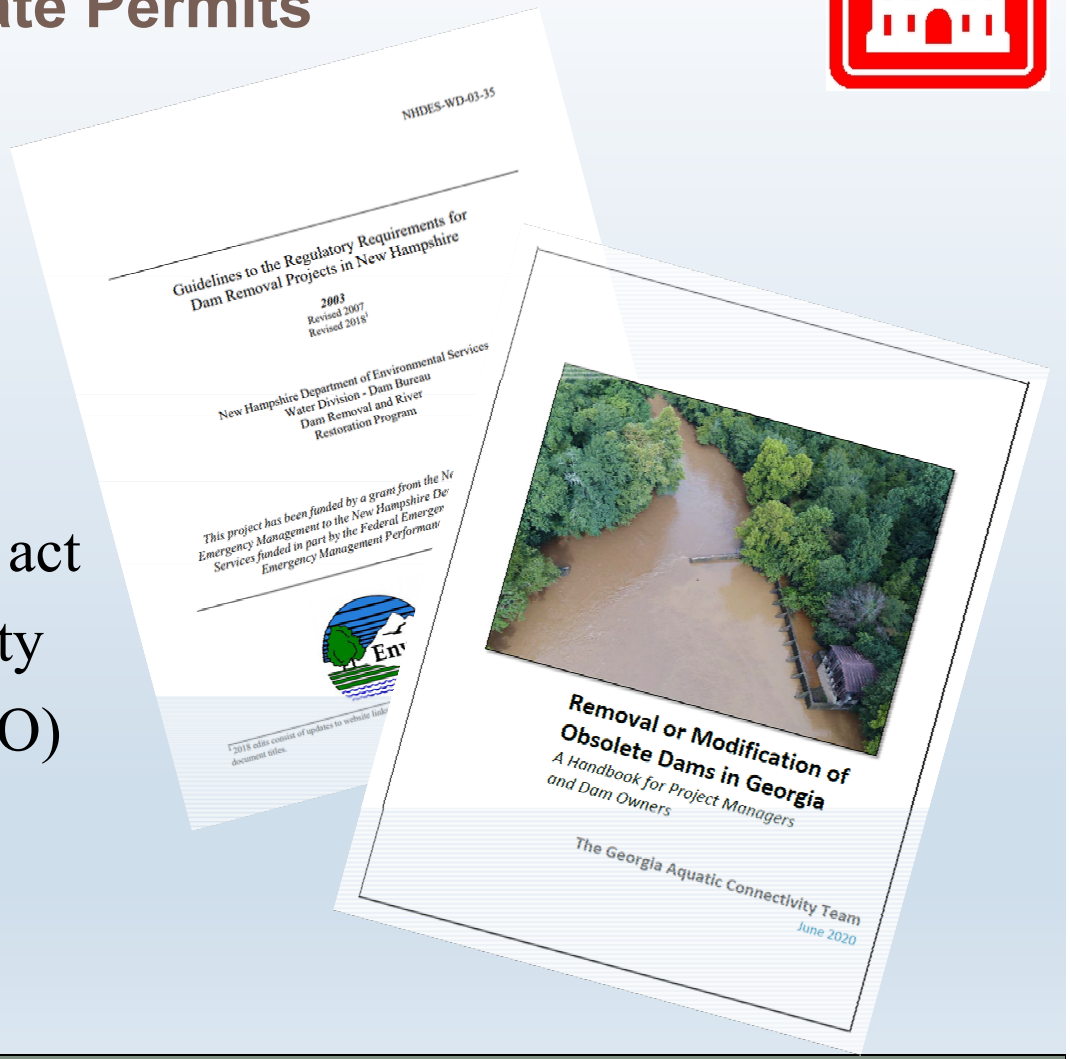
State Certifications

- Water Quality Certification (CWA Section 401)
- Coastal Zone Management Act Certification

The Elwha River flows into the Strait of Juan de Fuca, carrying sediment once trapped behind dams. The gradual release has rebuilt riverbanks and created estuary habitat for Dungeness crabs, clams, and other species.
Photograph by Elaine Thompson

State Permits

- Varies State to State
- Storm water (NPDES)
- Waterways development
- Dam safety
- State environmental policy act
- General construction activity
- Historic preservation (SHPO)
- Resetting the floodplain



Local Permits

- Demolition Permits
- Building Permits
- Riparian Ordinances

https://roanoke.com/gallery/a-look-back-at-pigg-river-dam-demolition/collection_a09c8723-3159-579a-b61b-be7eeff1f858.html

Mitigation

- Mitigation for impacts from dam removal activities
  - Impacts to wetlands around the dam
  - Distinction between natural and man-made wetlands?

- Mitigation credit
  - USACE RGL No. 18-01
    - Determination of Compensatory Mitigation Credits for the Removal of Obsolete Dams and Other Structures from Rivers and Streams.

Questions

Type your questions in the chat box.

http://archive.vcstar.com/news/matilija-dam-others-across-nation-featured-in-new-film-ep-459265401-351467581.html