Update on Fluvial Erosion Hazard Assessment and Geophysical Investigation: Suncook River

Shane Csiki – New Hampshire Geological Survey

July 28, 2011

TILTON
BELMONT
MIDDLETON
MILTON
FRANKLIN
NORTHFIELD
GILMANTON
ALTON
NEW DURHAM
FARMINGTON
CANTERBURY
BARNSTEAD
LOUDON
BOSCAWEN
ROCHESTER
PITTSFIELD
STRAFFORD
WEBSTER
CHICHESTER
CONCORD
EPSOM
NORTHWOOD
BARRINGTON
PEMBROKE
HOPKINTON
DEERFIELD
NOTTINGHAM
BOW
ALLENSTOWN
DUNBARTON
WEARE
HOOKSETT

JUL 21 2009

AUG 3 2009

AUG 10 2009

AUG 4 2009

AUG 2 2010

How can this information be used?

- Help identify areas where the river may go during the next decade and beyond
- Hazard mitigation plans
- The geomorphic condition data will be available in a database to assist future hazard mitigation and watershed planning activities
- Prioritization of problematic stream crossings for rehabilitation or replacement

Questions:

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Suncook River Design & Permitting Project

Assessment, design, and permitting for the protection of infrastructure and public safety

July 28, 2011

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Project Understanding

2006/7Floods

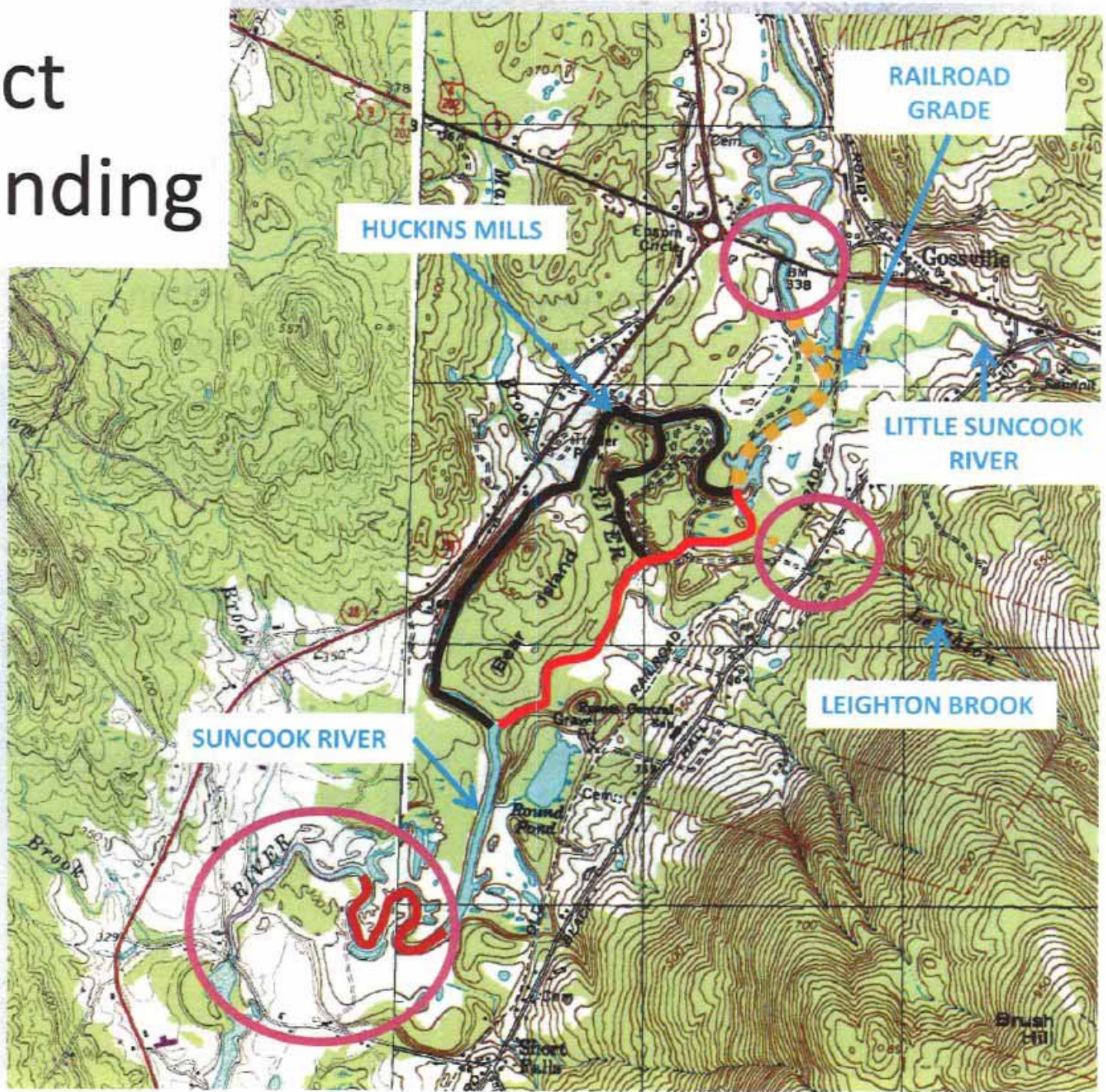
Channel Avulsion

Channel Abandonment

Migrating Knickpoints

Aggradation

Infrastructure



Design & Permit Project Approach

- Develop Contracts and Scopes of Work
- Geomorphic Assessment & Survey
- Hydrology & Hydraulics
- Sediment Transport
- Design (30% / 75%)
- Public Meetings
- Permitting

Design & Permit Project Approach

- Bank Stabilization
  - Near Grade Control Structures
  - Other areas as needed
- Options
  - Grade and shape
  - Soil encapsulation
  - Hard toe stabilization
  - Log cribbing

Geomorphic Assessment & Survey

- Geomorphic assessment
  - Natural grade controls
  - Constrictions, inneffective flow areas
  - Grains size/substrate evaluation
  - 2006 to 2011 comparisons
    - Headcut migration
    - Bank retreat
    - Floodplain formation
    - Armoring
    - Bar formation, local deposition

- Survey
  - Up to 10 cross sections to supplement and update previous surveys
  - Longitudinal profile
  - Ground shots to support cut and fill volume estimates, basemap construction

Grade Control

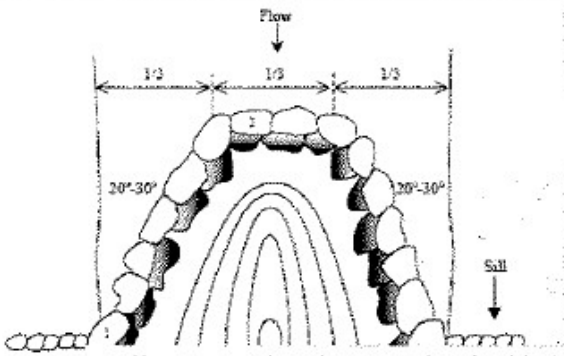


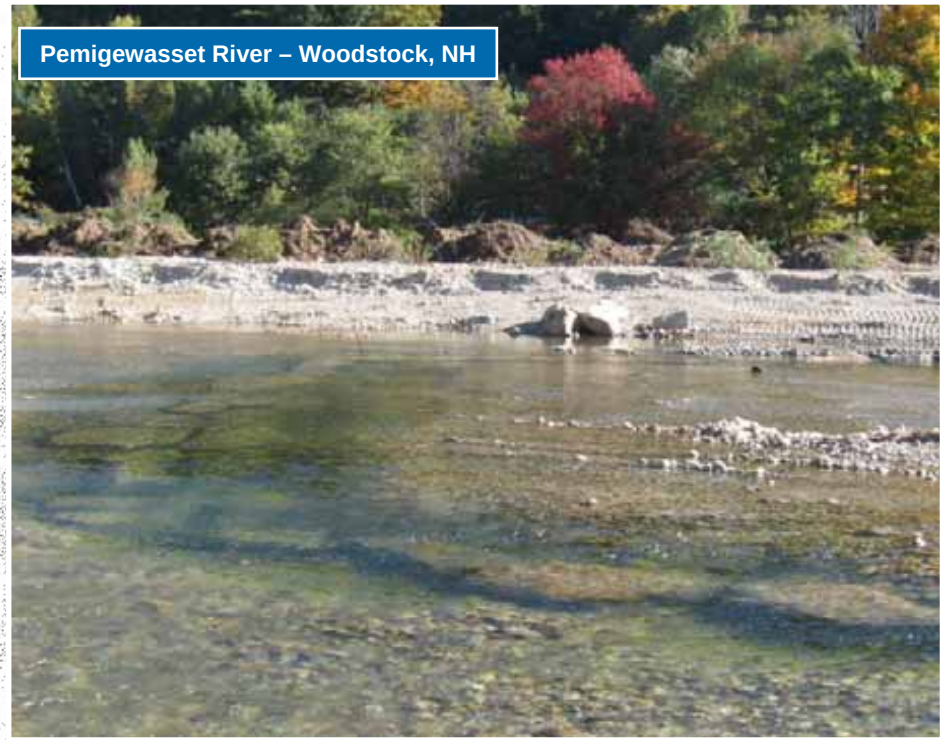
Table 1. Equations for predicting ratio of vane length/bankfull width (V_L) as a function of ratio of radius of curvature/width and departure angle, where W = bankfull width. (SI units).

Rc/W	Departure Angle (degrees)	Equation
3	20	$V_L = 0.0057\ W - 0.9462$
3	30	$V_L = 0.0089\ W - 0.5933$
5	20	$V_L = 0.0057\ W - 1.0462$
5	30	$V_L = 0.0057\ W - 0.8462$

Table 2. Equations for predicting ratio of vane spacing/width (V_S) as a function of ratio of radius of curvature/width and departure angle, where W = bankfull width (SI units)

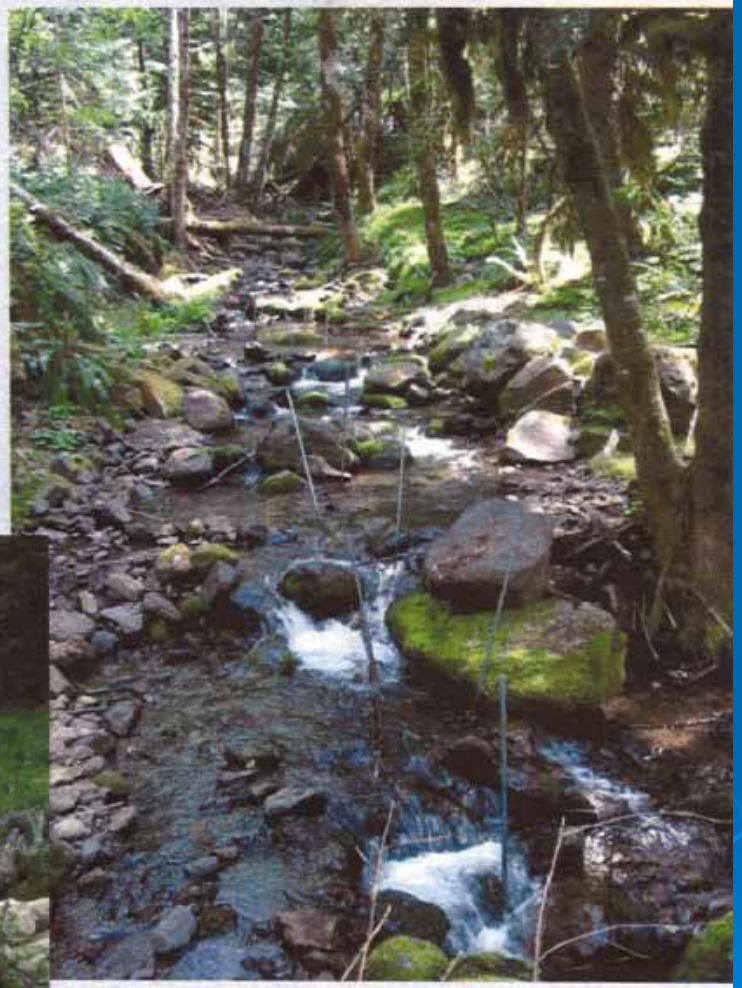
Rc/W	Departure angle (degrees)	Equation
3	20	$V_S = -0.006\ W + 2.4781$
3	30	$V_S = -0.0114\ W + 1.9077$
5	20	$V_S = -0.0057\ W + 2.5538$
5	30	$V_S = -0.0089\ W + 2.2067$

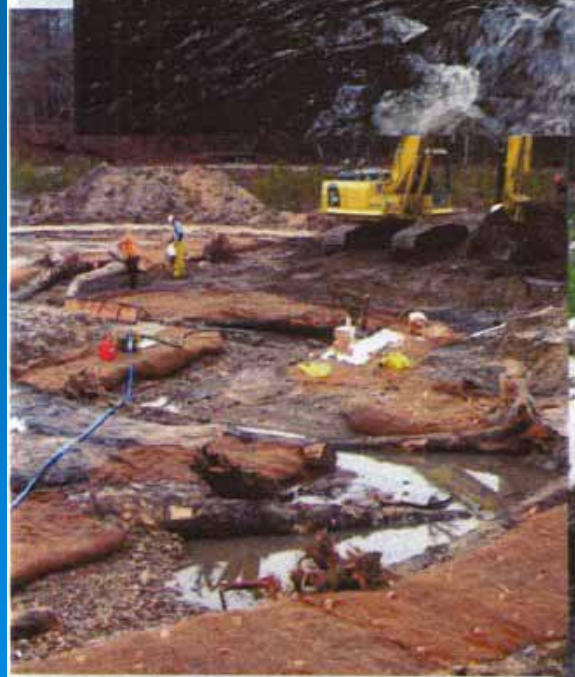
Cross Vanes

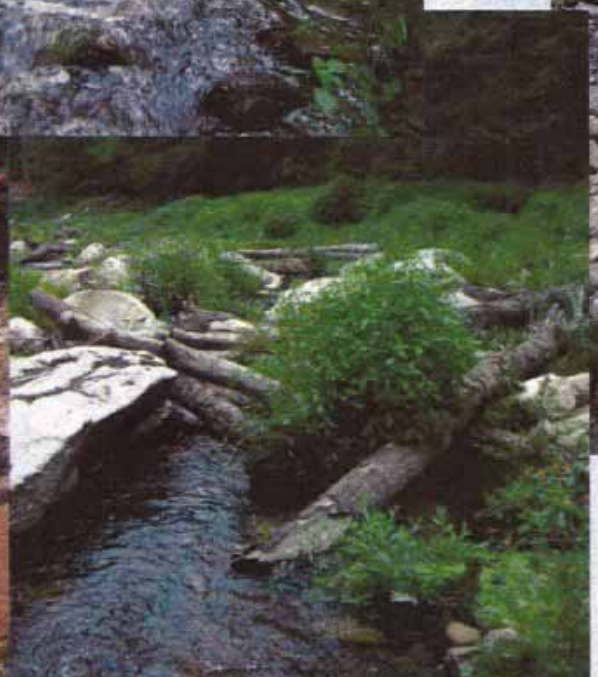


Grade control is essentially imposing an artificial geology on the system. When doing so, it's important to consider how such geologic features are formed and what makes them a control or constraint on various aspects of channel evolution (ie. how might they fail?)

Grade Control – Leighton Brook



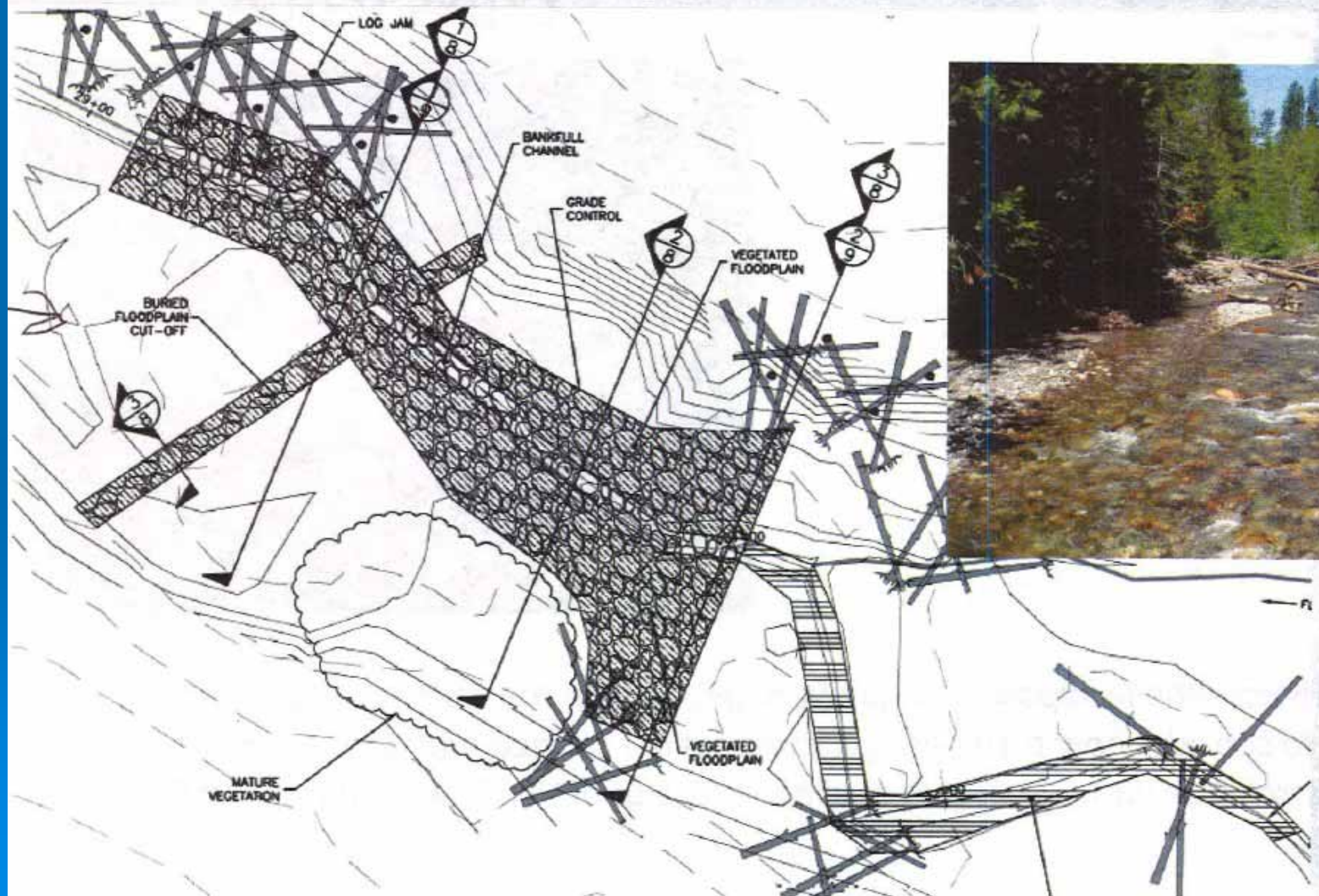




Constructed step pool

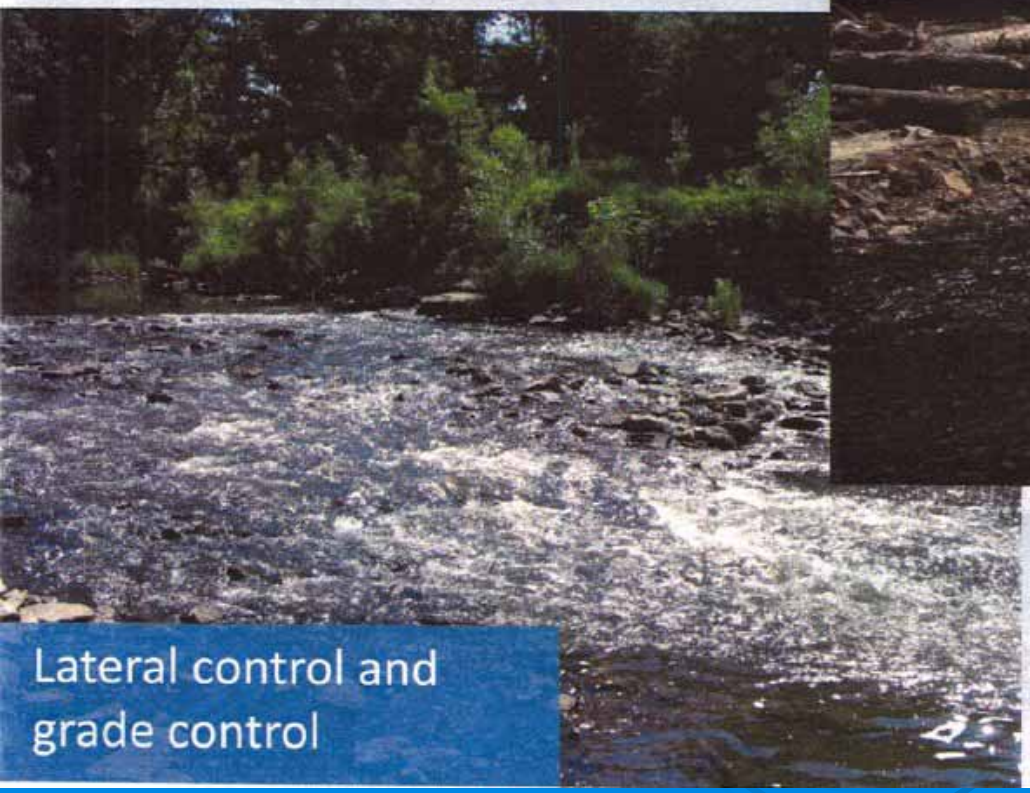
Grade Control

Partial Valley-Spanning Grade Control

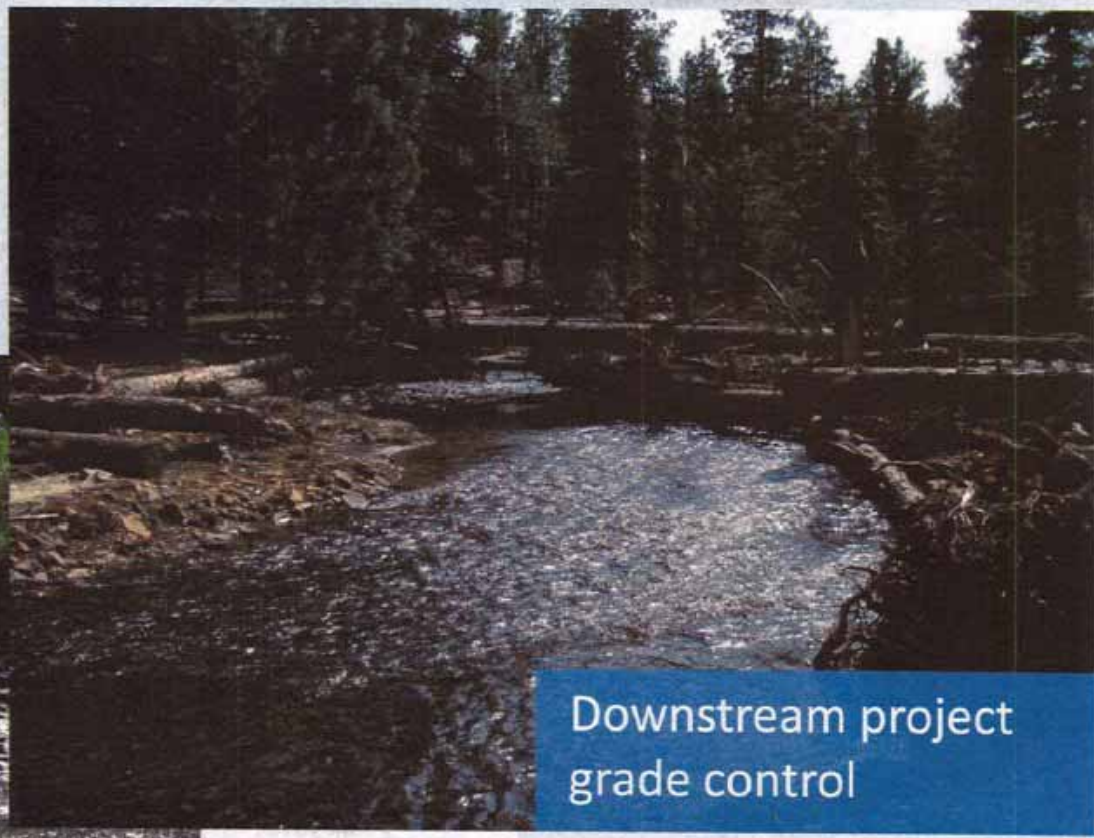


Grade Control

Grade-Controlling Riffles

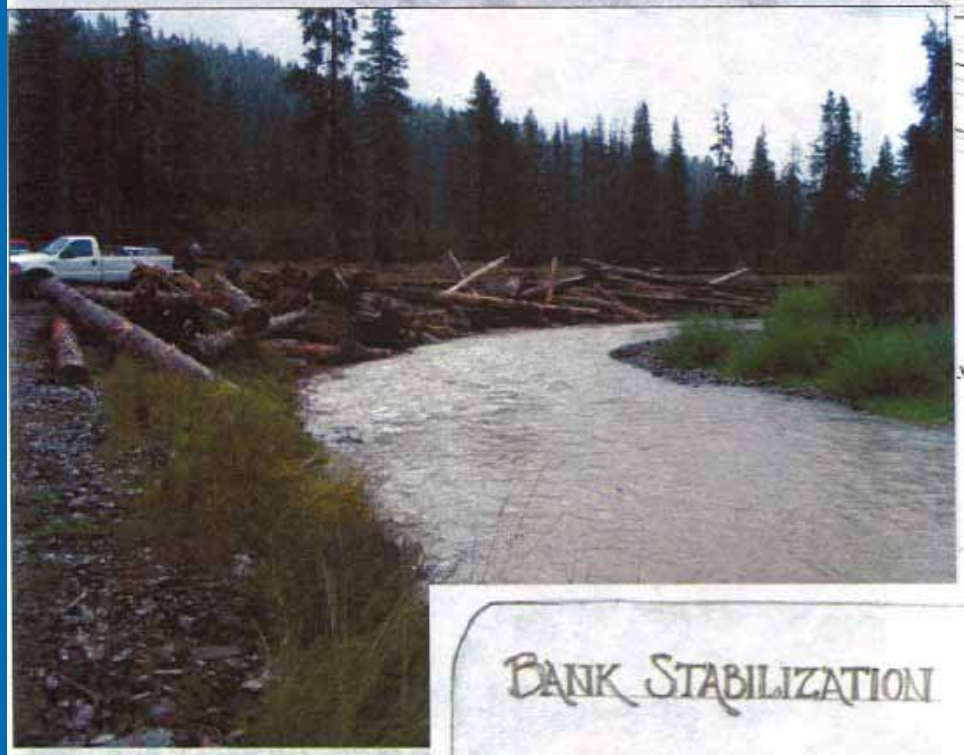


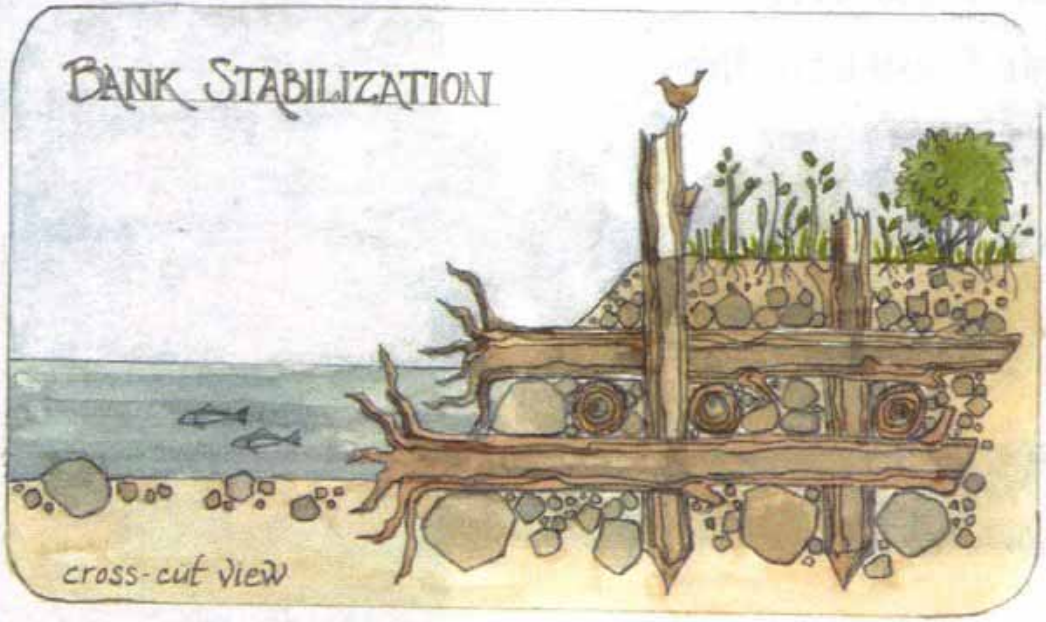
Lateral control and grade control



Downstream project grade control

Wood-based Options

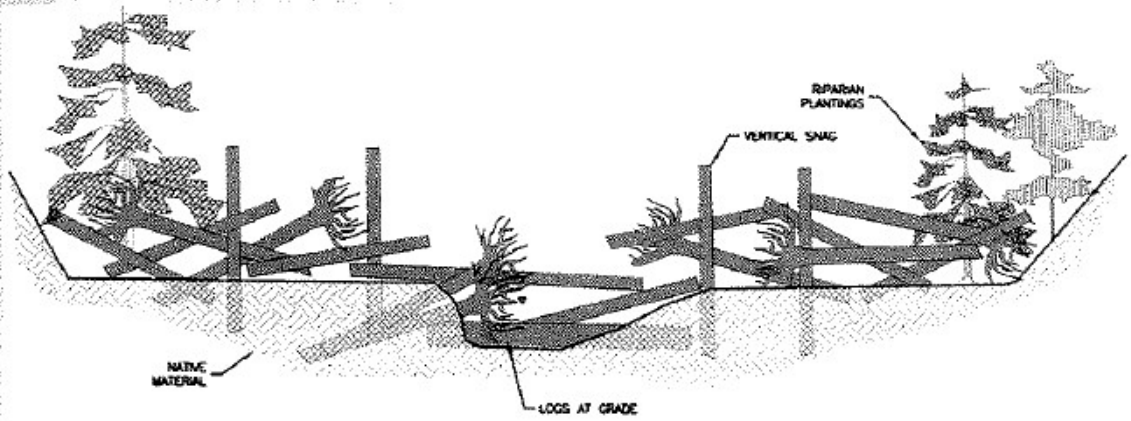




Floodplain Restoration

- Excavation
- Avulsion protection
- Wood-based Options
  - Log jams
  - Floodplain roughness
  - Alcoves, backwater channels
  - Re-vegetation

Mohawk River – Colebrook, NH



3/13 TYPICAL CROSS-SECTION TYPE 1 AND 2: VALLEY SPANNING LOG JAMS
NOT TO SCALE

Pemigewasset River in Woodstock, NH

Pemigewasset River in Woodstock, NH

Design & Permit Project Goals

- Halt upstream migration of headcuts on Suncook River and tributaries
- Control channel widening
  - Bank stabilization / floodplain creation
  - Establish vegetation
- Develop appropriate construction access and water control
- Restore floodplain and interaction between channel and floodplain

Design & Permit Project Goals

- Develop, submit, and secure all necessary regulatory permits for construction
- Develop bid documents and hold pre-bid meeting on-site with contractors
- Work toward 2013 construction season

Contact:

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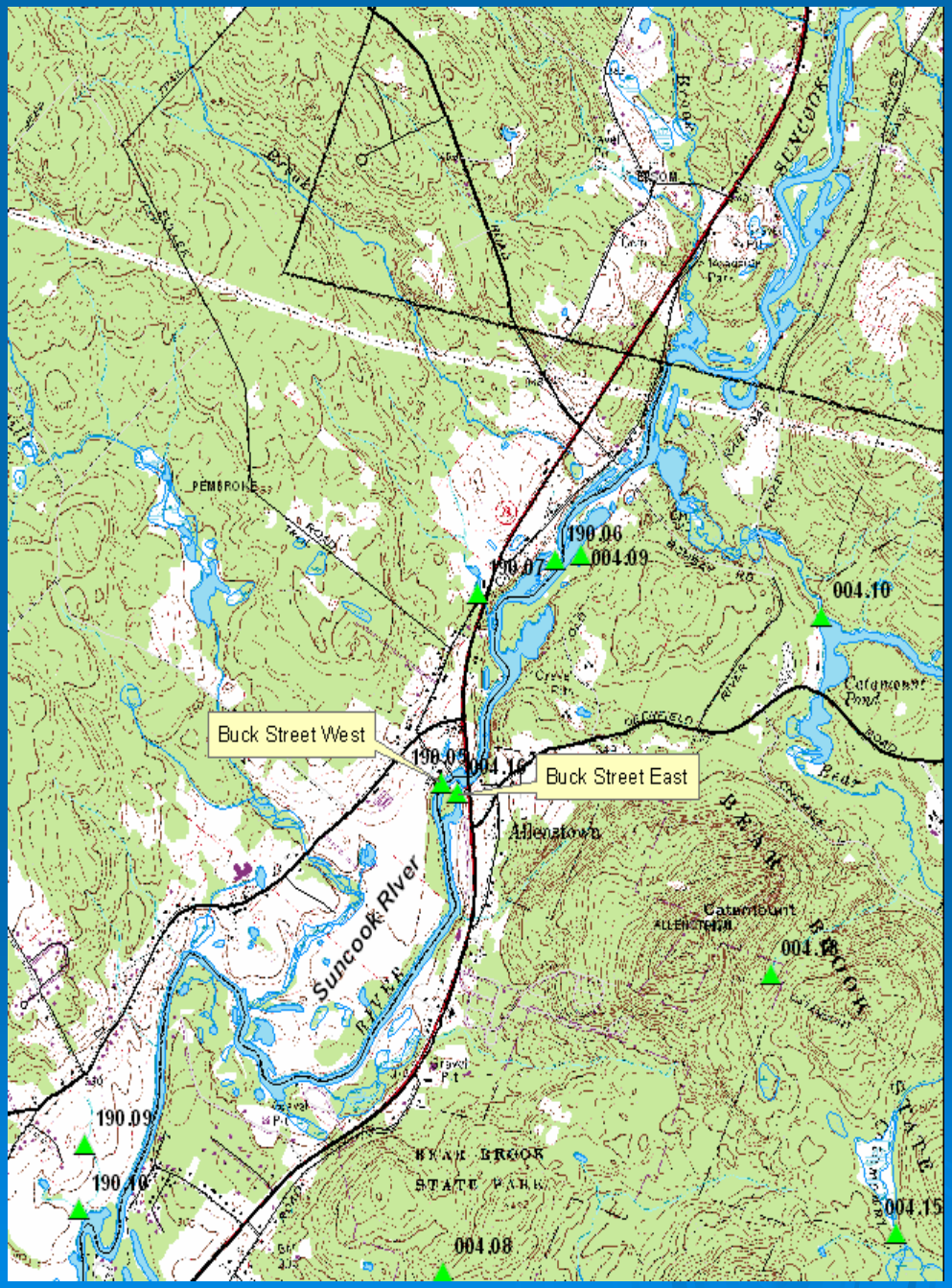
Removal of the Buck Street Dams

NH Dam Nos. 190.05 & 4.16
Pembroke/Allenstown, NH

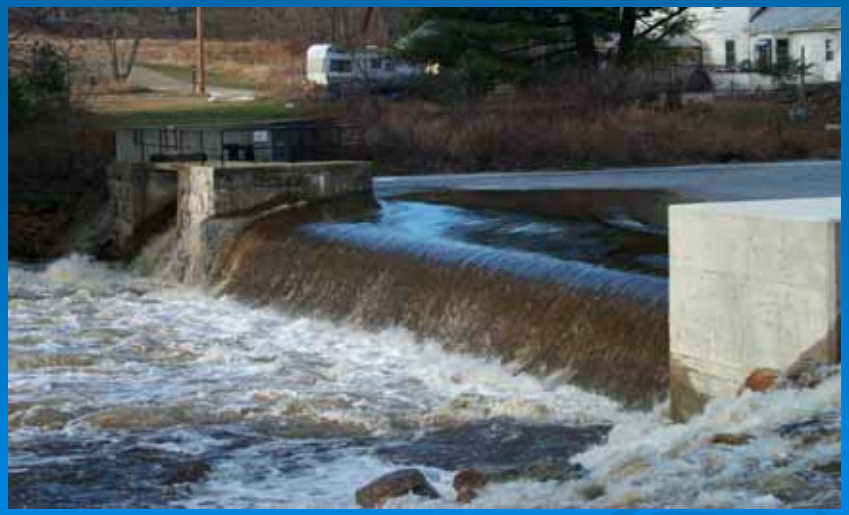
July 2011



Location on the Suncook River

- 5.5 miles upstream from confluence with Merrimack River.
- 6. 5 miles downstream of the avulsion site.
- West Dam is on main stem of Suncook River.
- East Dam is on man made channel.

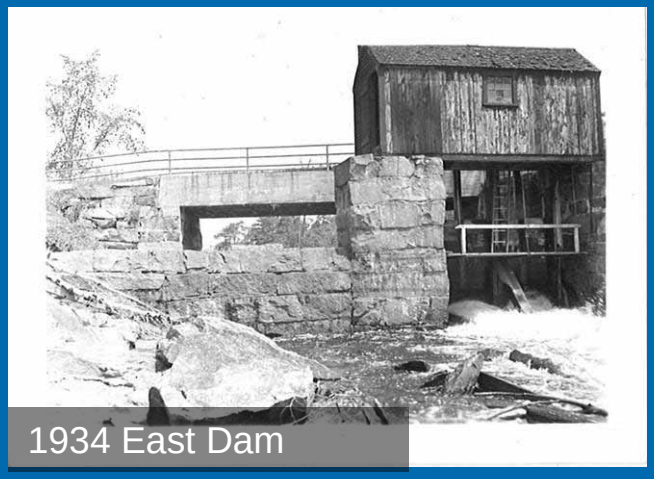
West Buck St Dam
NH Dam No. 190.05
Pembroke, NH



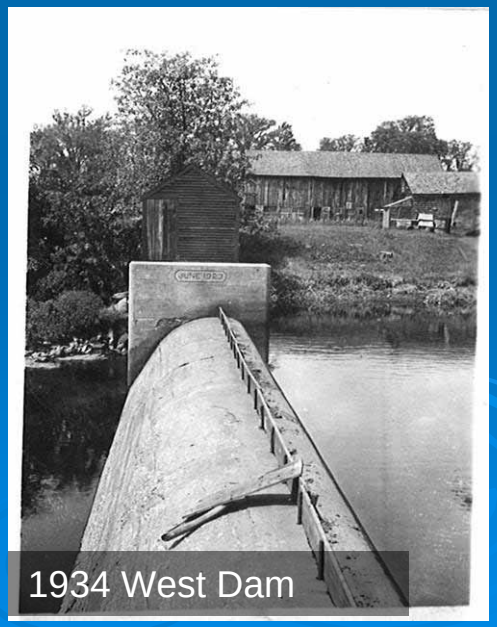
East Buck St Dam
NH Dam No. 4.16
Allenstown, NH

DES History of Dams

- 1904 - Pembroke Mill Purchases dams for regulating water for power generation.
- 1923- West Dam reconstructed with concrete spillway and stoplog bay structure.
- 1962-Dole-Suncook Corp. sells dams to State of NH for $1.
- 1964-West Dam - Repairs made to the gate section of the dam, the spillway patched and abutments refaced.
- 1974 – East Dam – concrete gate house replaced wooden one , concrete gate structure added.
- 1993- West Dam spillway resurfaced.
- 1999- West Dam - 50 foot wide auxiliary spillway with cutoff wall and 110 foot long riprap channel constructed on the eastern end of the dam.



1934 East Dam

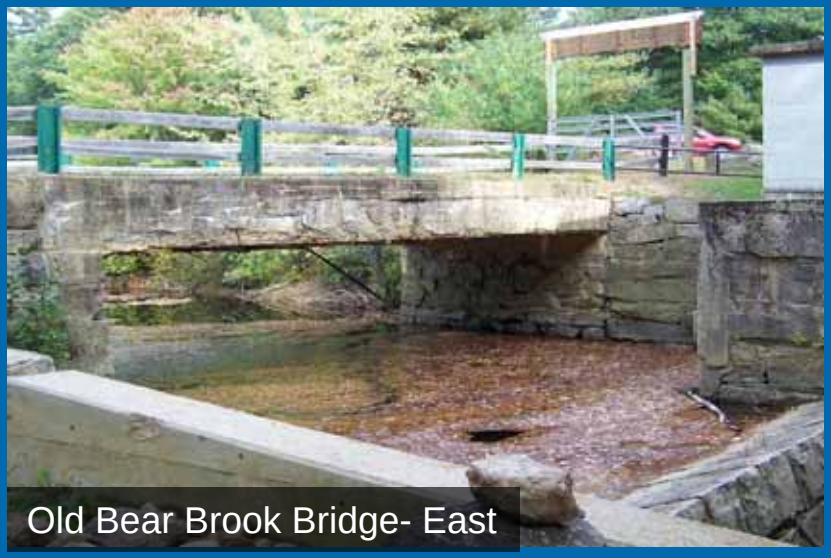


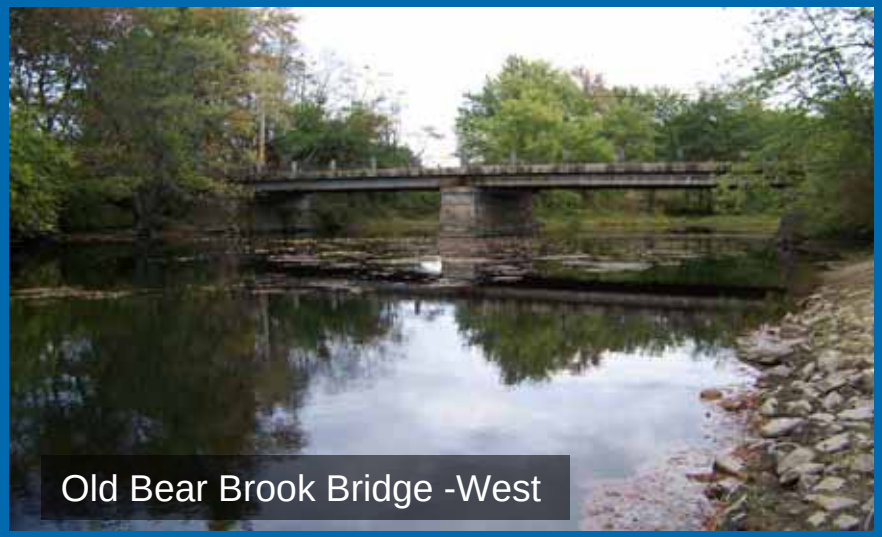
1934 West Dam

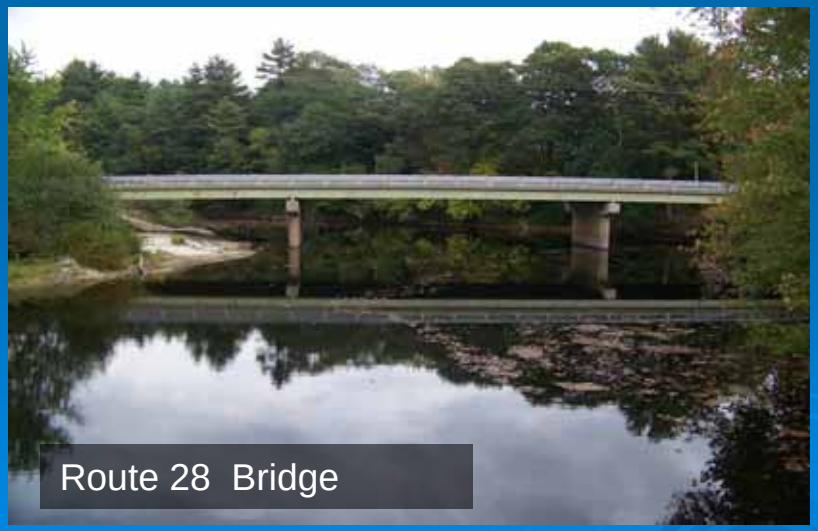
Why Remove?

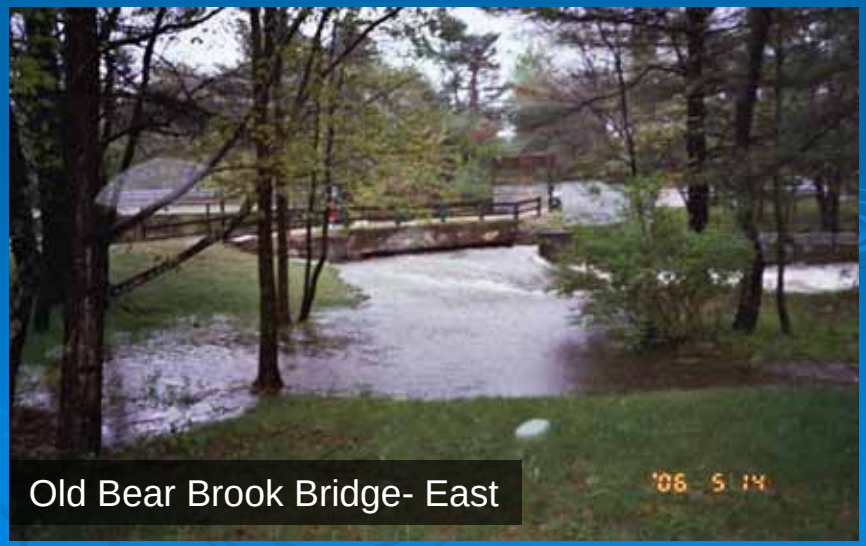
Flooding

Upstream Bridges

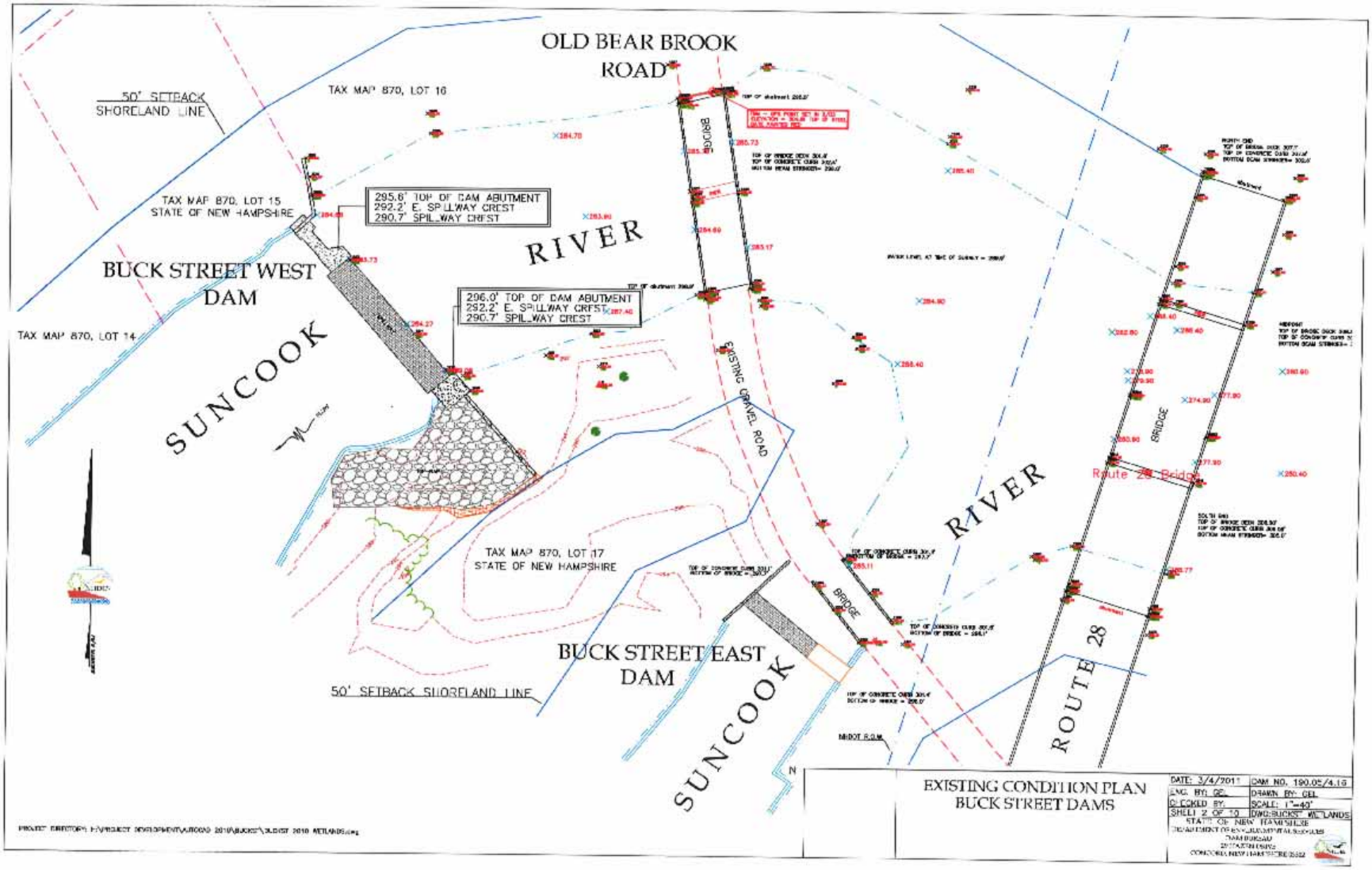

Old Bear Brook Bridge- East


Old Bear Brook Bridge -West

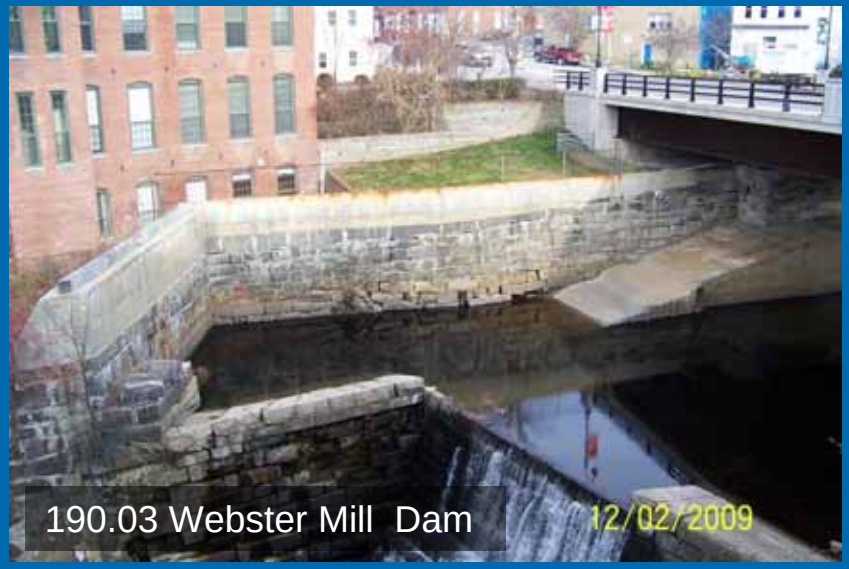

Route 28 Bridge


Old Bear Brook Bridge- East

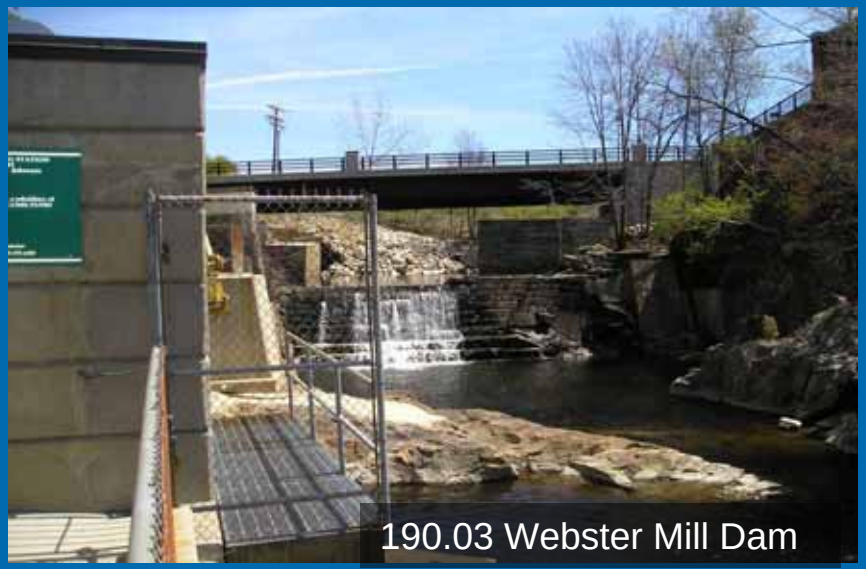
Location of Bridges Upstream from Dams

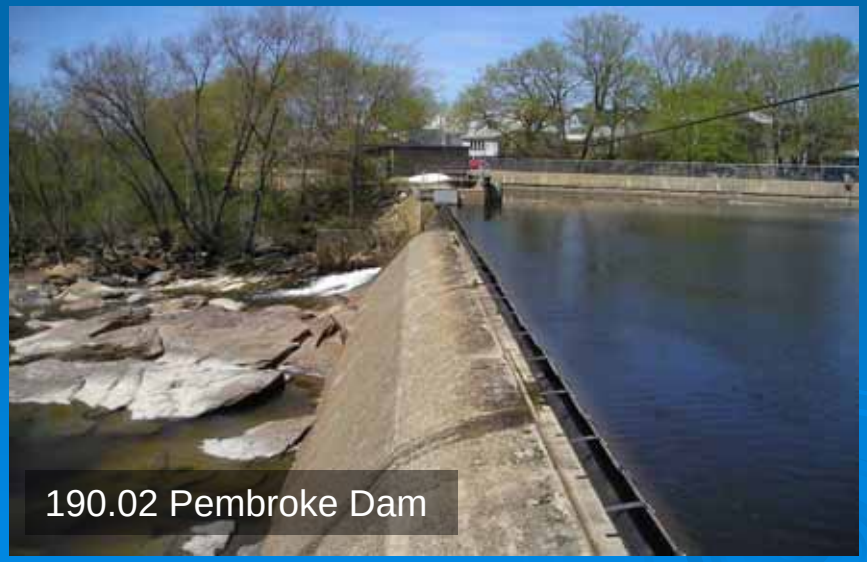


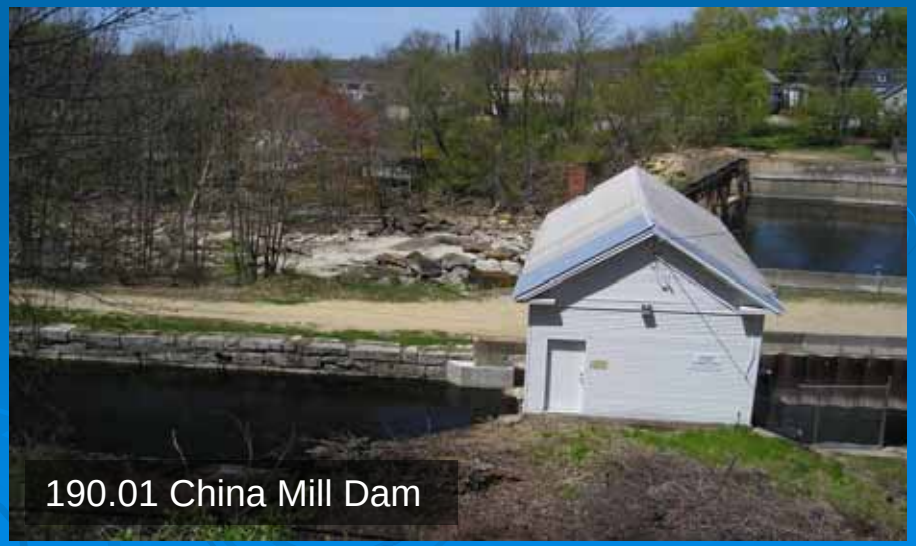
Downstream Dams



190.03 Webster Mill Dam

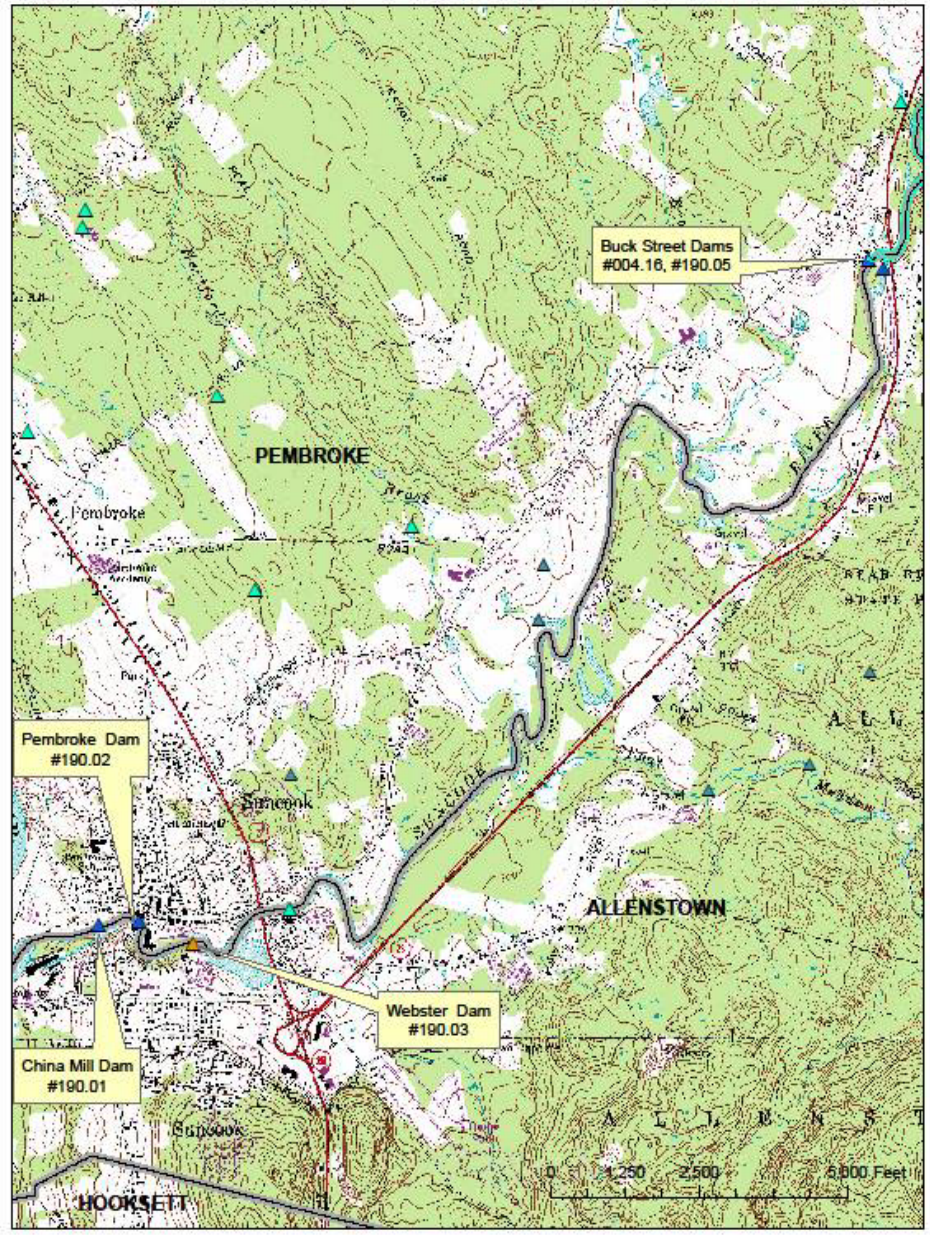

190.03 Webster Mill Dam

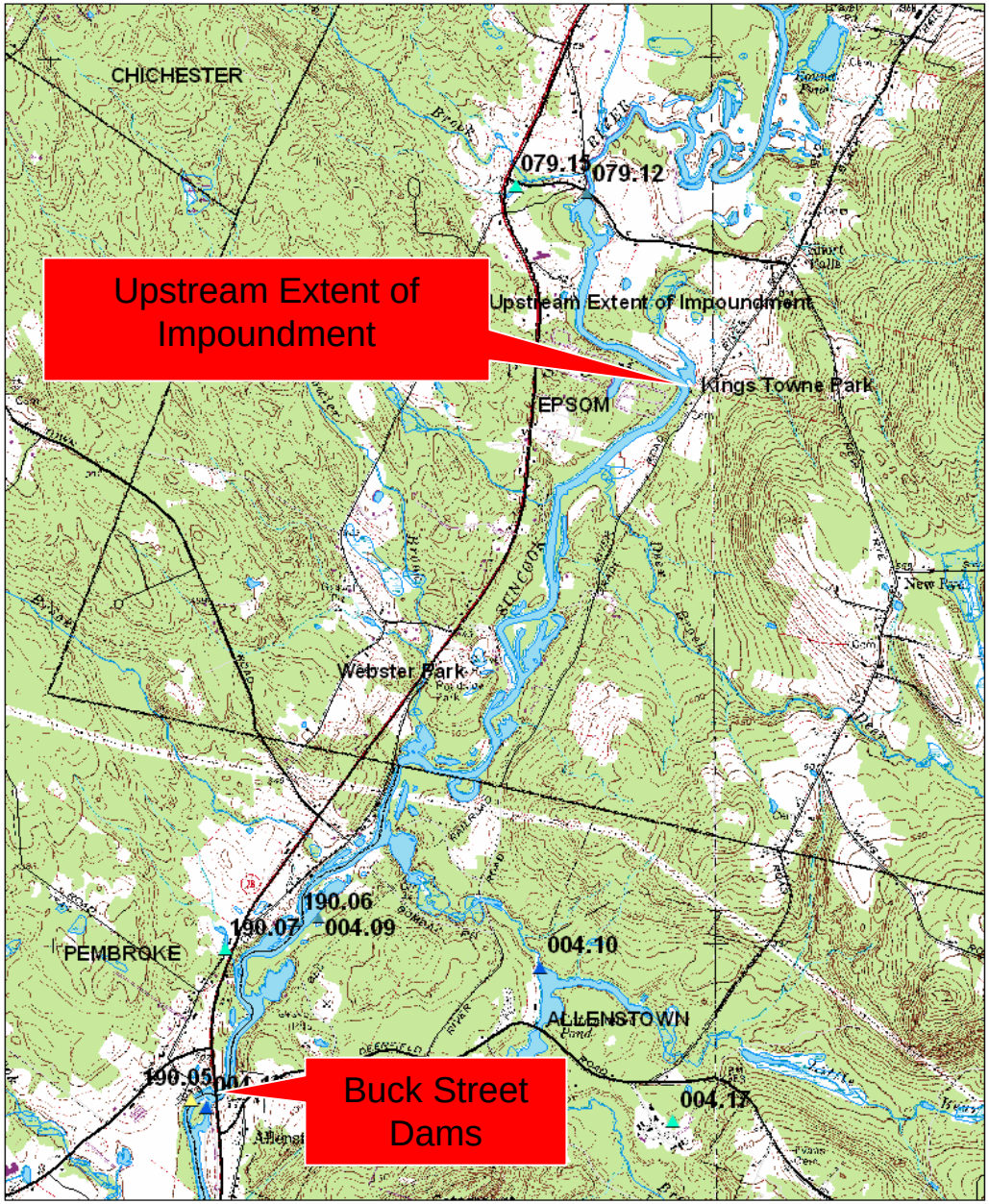

190.02 Pembroke Dam


190.01 China Mill Dam

Dams on Suncook River Downstream from Buck Street Dams

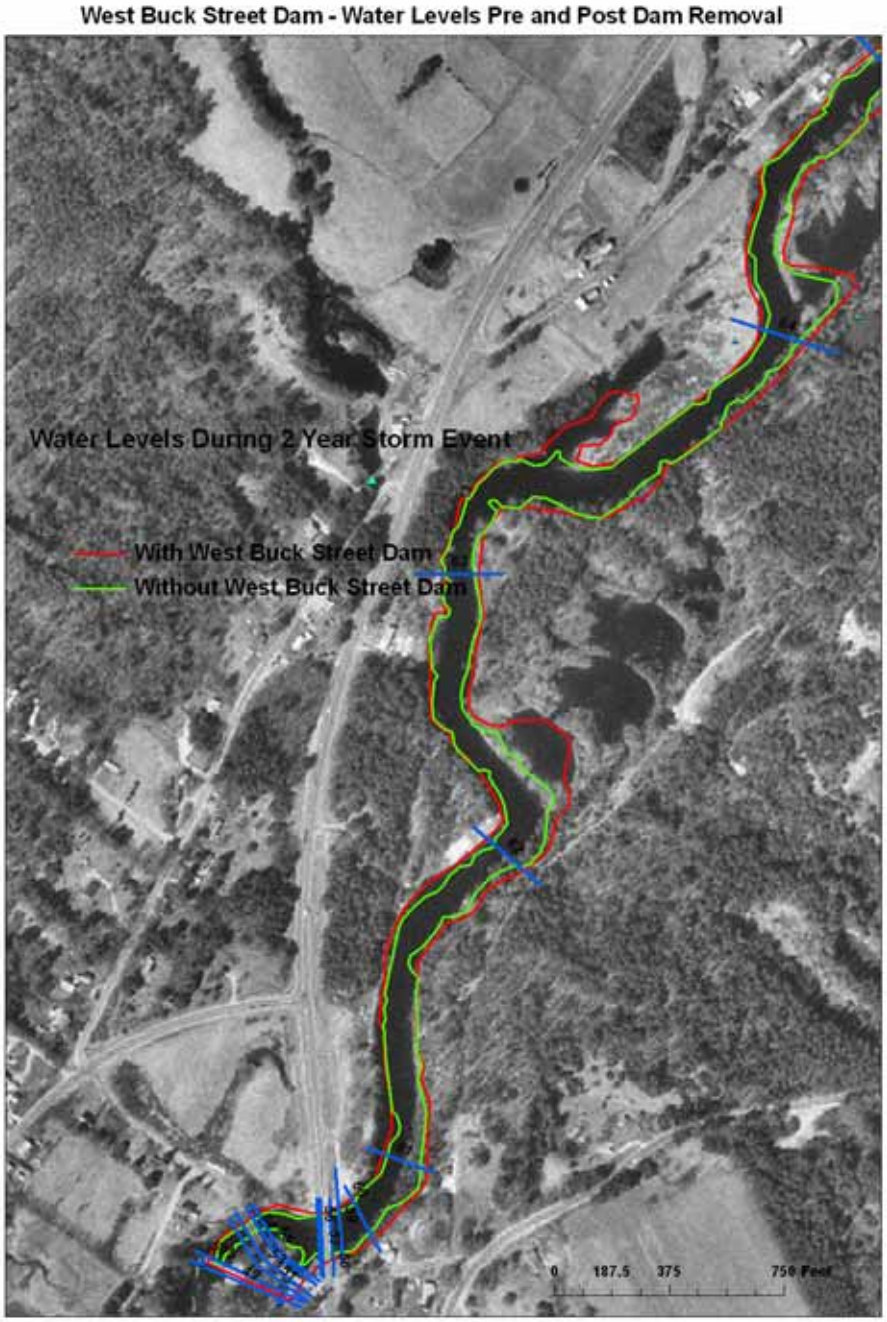
- Located 4.5 miles downstream
- Webster Dam – 18’ high, 250 ‘ long –operation by Algonquin Power Systems
- Pembroke Dam – 26’ high, 108 ‘ long – operated by Algonquin Power Systems
- China Mill Dam – 29’ high, 275’ long – operated by NH Hydro Associates.





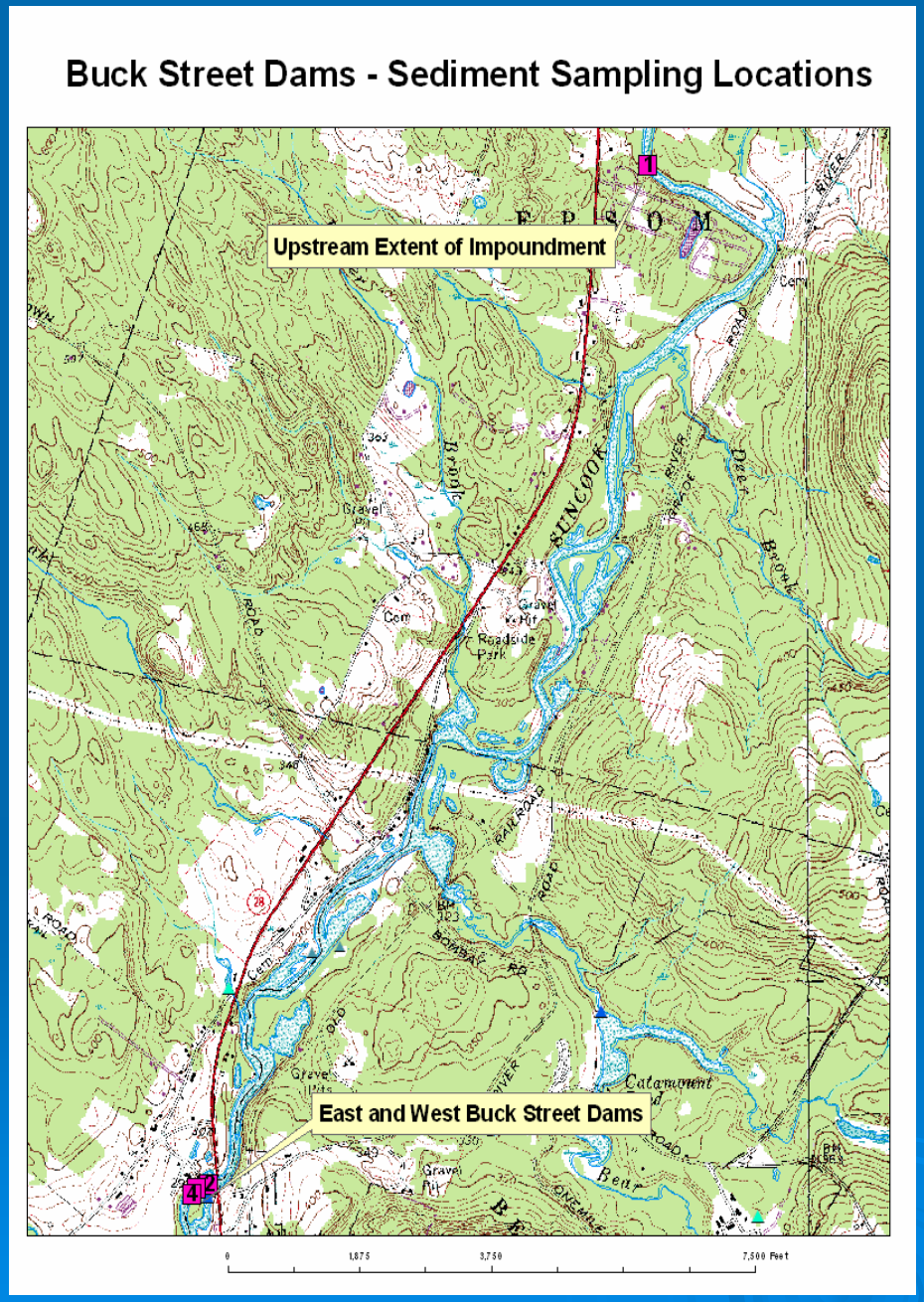
Upstream Extent of Impoundment

- Upper Extent 3.4 miles, just below the Short Falls Bridge.
- Water level has been draw down since Spring of 2007 following second major flooding event.



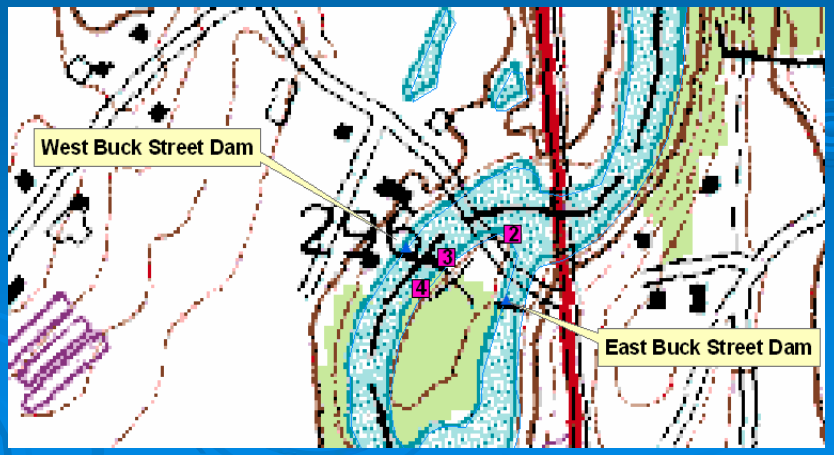
Water Level Changes Pre- and Post Removal

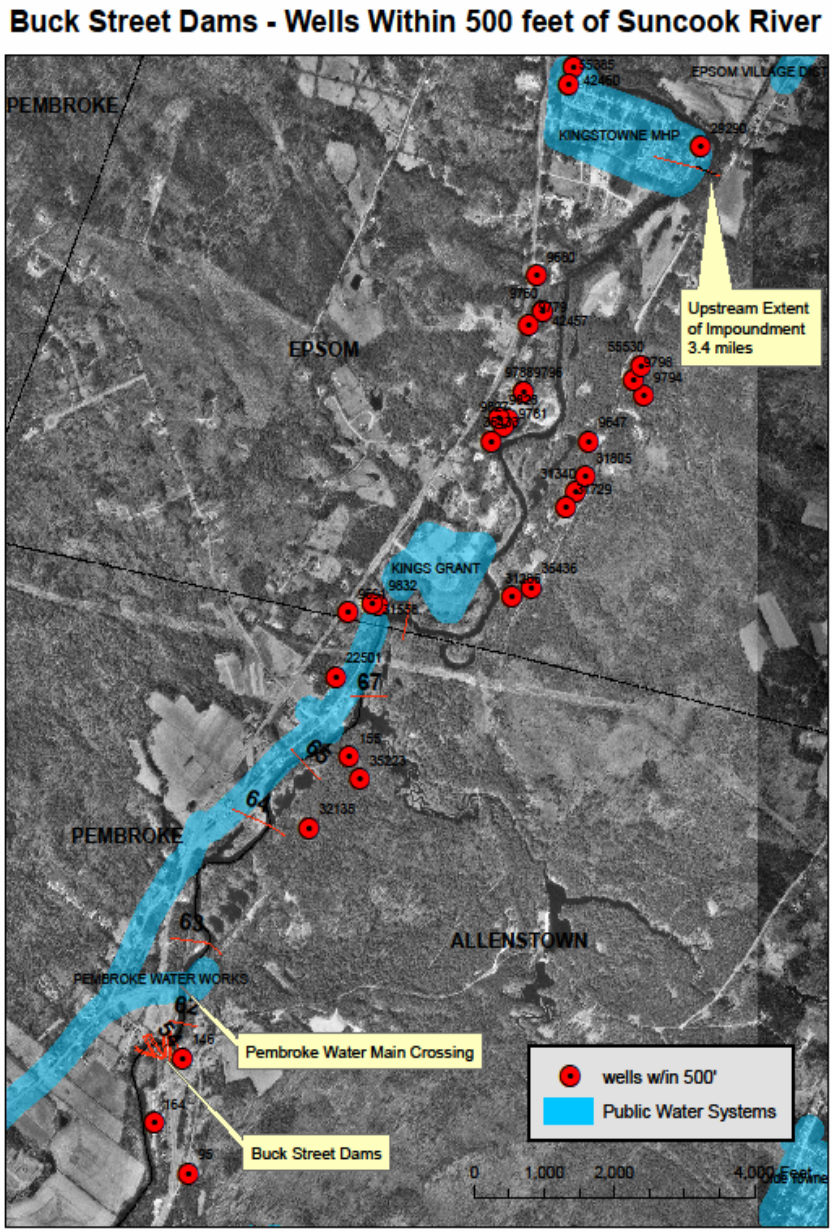
Location	River Mile	Flood Event Reoccurrence Interval	Change in Water Levels (ft)
Upper Extent of Impoundment	8.9	2 year	1.0
		100 year	0.35
		500 year	0.08
Batchelder Road	6.8	2 year	2.85
		100 year	1.01
		500 year	0.19
Upstream of Dams	5.5	2 year	6.11
		100 year	2.25
		500 year	1.04



Sediment Sampling

- 4 samples taken
- Analyzed for TOC, PAH's, PCB's, Pesticides, Selected metals, VOC's, and SVOC's.
- Results were below regulated thresholds.

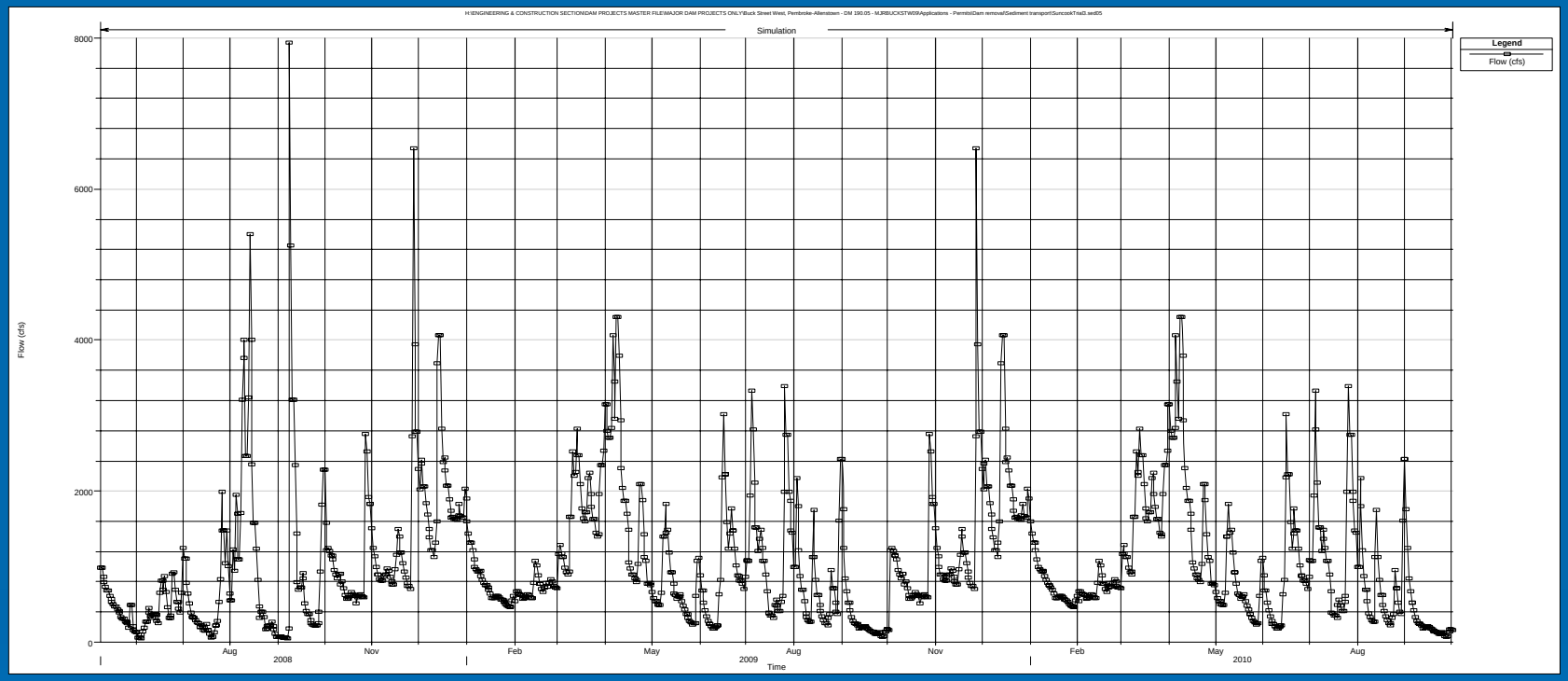




Groundwater Impacts

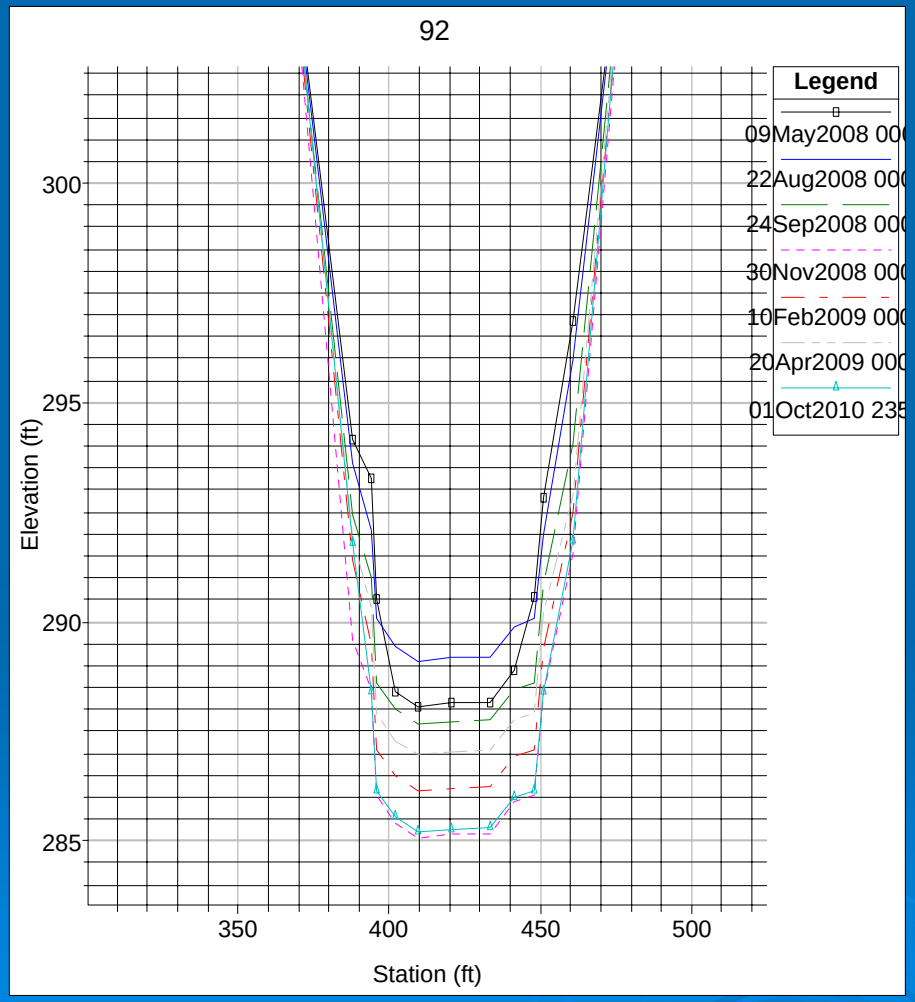
- Water levels drawn down since 2007. Dry summer 2010. Most problems have been investigated.
- Meeting held on 2/17/2011 with officials re: groundwater issues.
- River's influence on wells- DES study shows less than 250 feet from river at Epsom Circle.
- Mainly gravel packed wells w/in 500 feet of river.
- Few shallow dug wells in Epsom were identified. Those in Pembroke were connected to the Pembroke Water System.
- Maple Grove Campground in Allenstown– Emergency hookup with Pembroke in 2010.
- Pembroke water main crossing- no decrease in bed elevation with sediment transport.
- Met with Epsom Fire Chief. Epsom may install dry hydrant at Route 4 following grade control work.

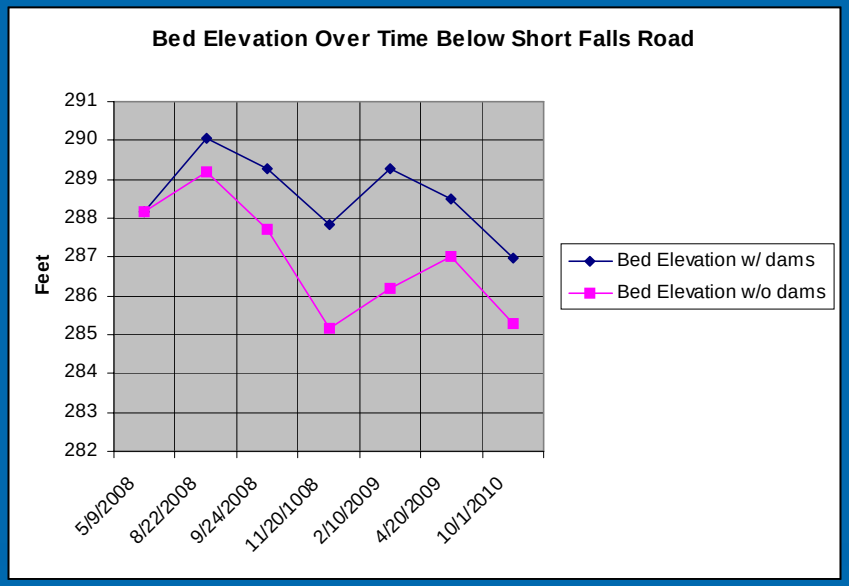
Sediment Transport Model



- USGS collected data from the river over 400 days from 5/8/2008 to 6/11/2009. This data was used for model calibration.
- USGS modeled the movement of sediment in 15.9 mile reach of the Suncook River for the period 5/8/2008 to 10/1/2010.

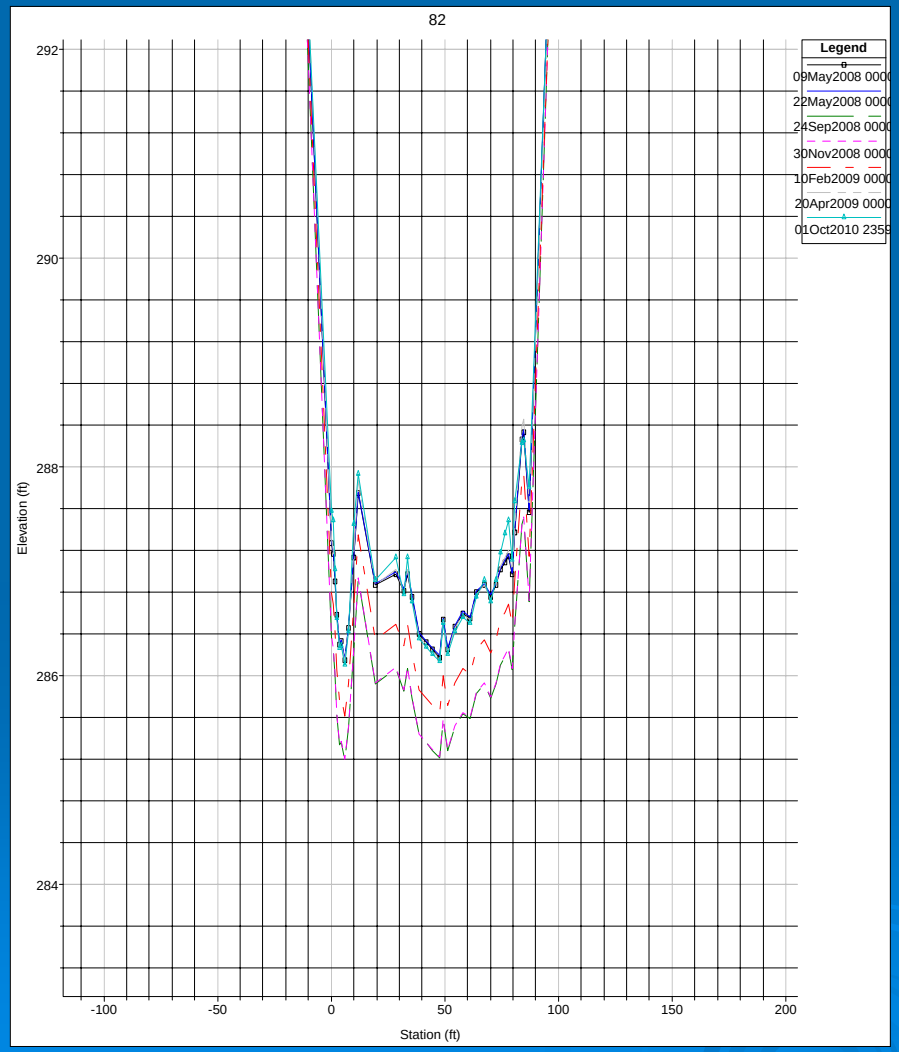
Changes to Bed Elevation Below Short Falls Bridge Subsequent to High Flow Events

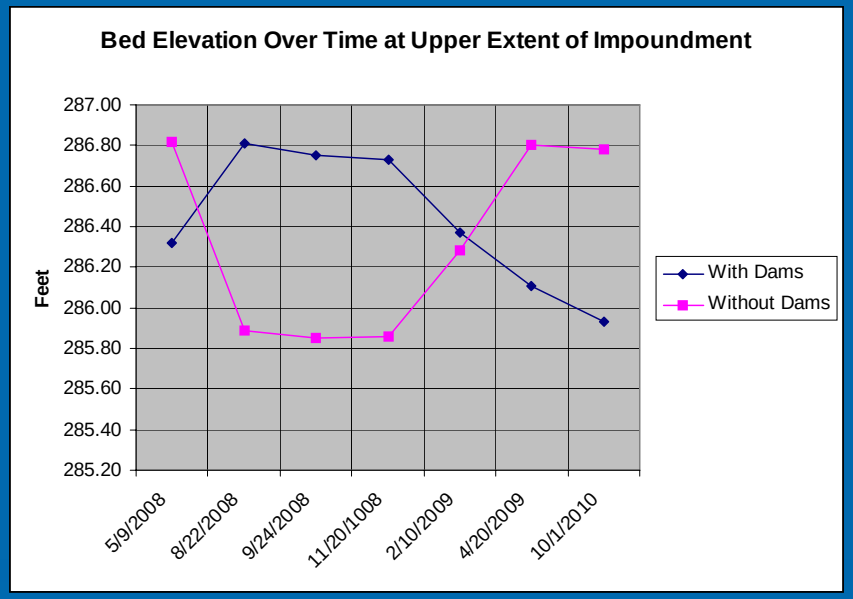




- More sediment moves downstream in response to storms events with out dams.
- Average bed elevation change without dams = -1.19’

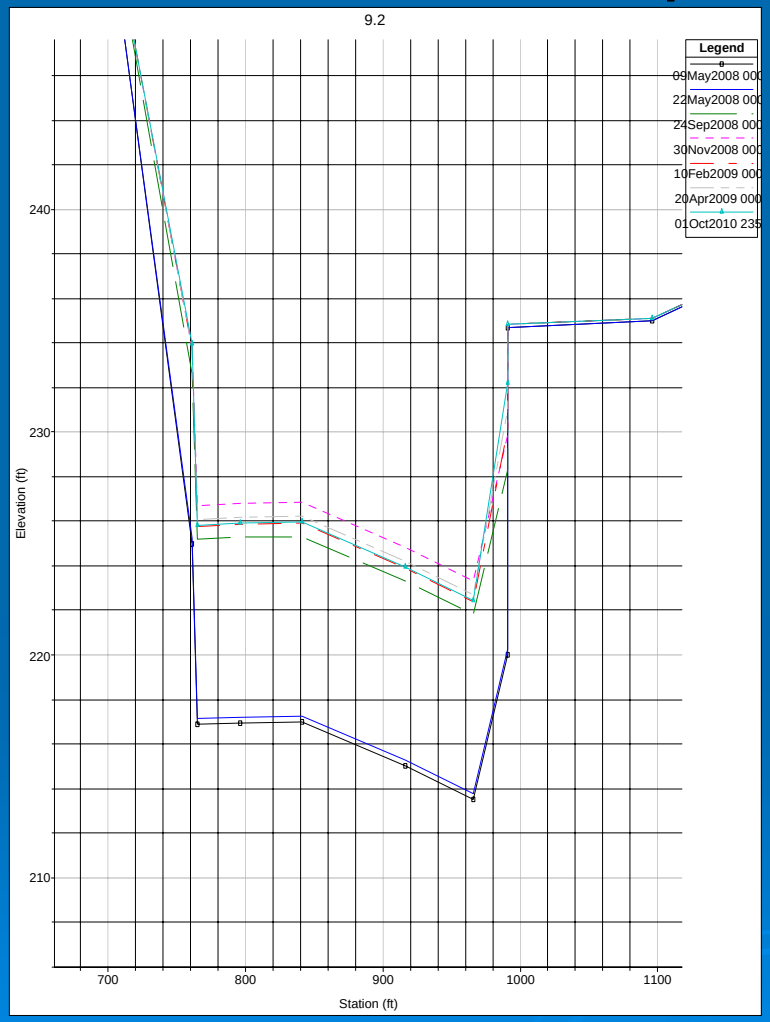
Changes to Bed Elevation at Upstream Extent Subsequent to High Flow Events

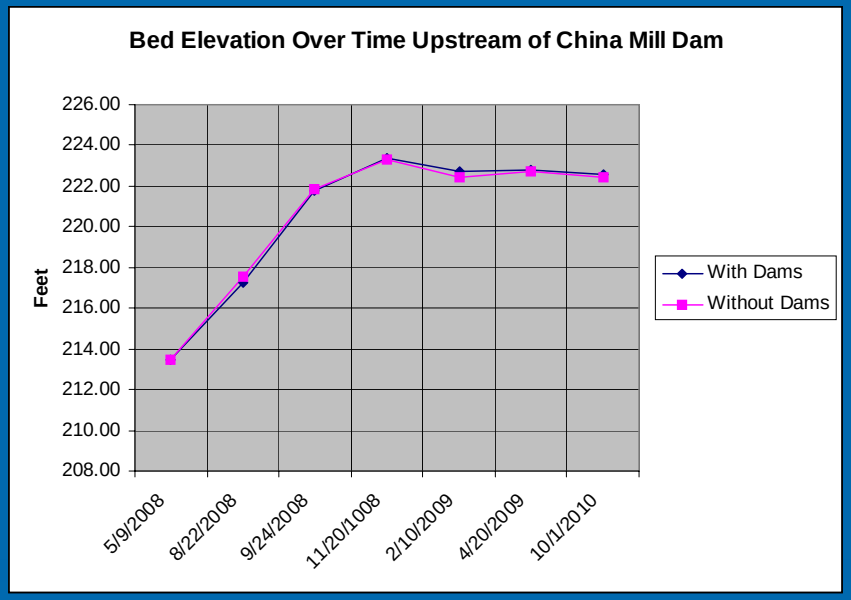




- Sediment moves downstream in response to storms events.
- Average bed elevation change without dams = 0.01’

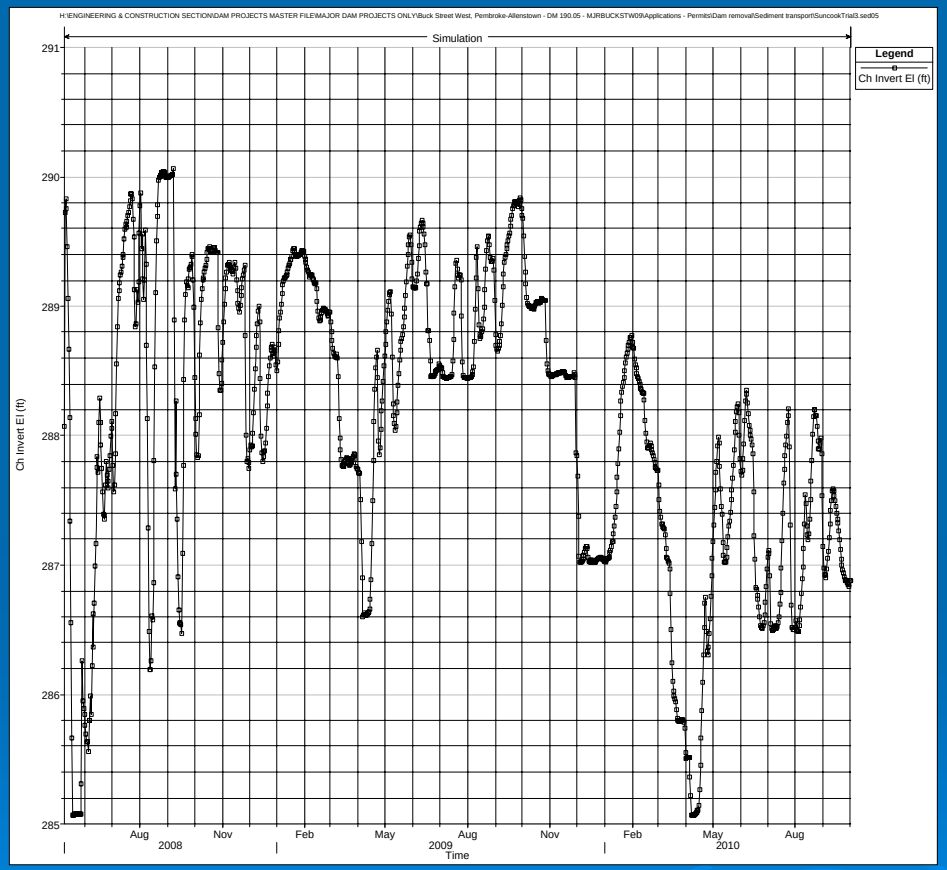
Changes to Bed Elevation at Downstream Extent Subsequent to High Flow Events



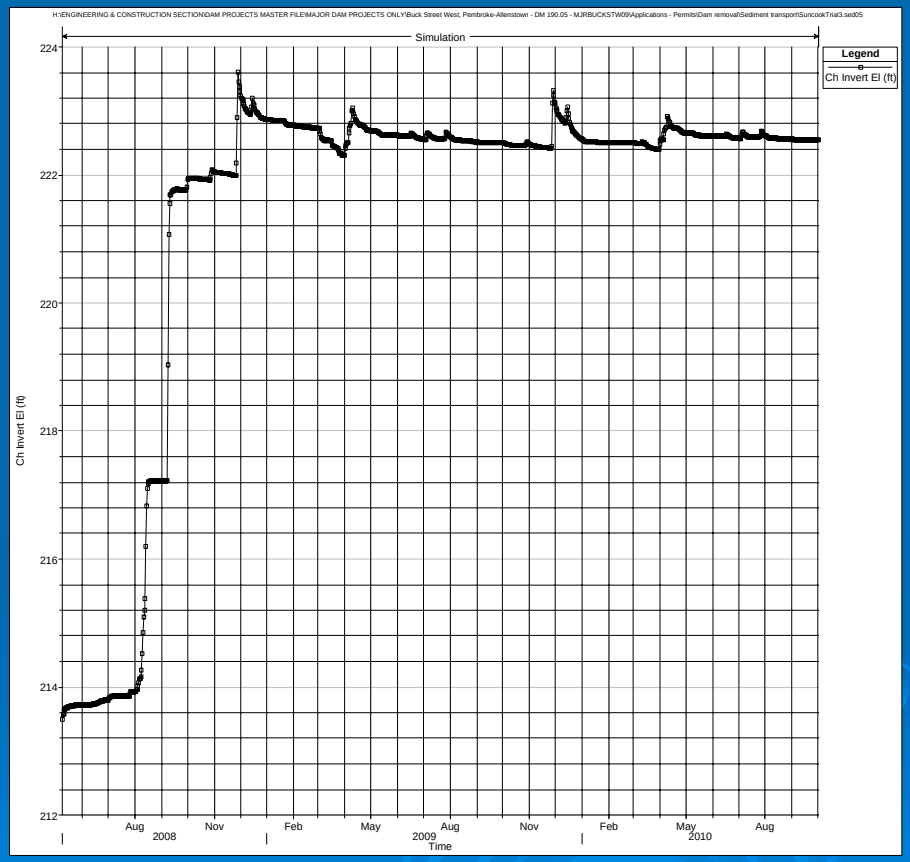


- Sediment continues to move downstream regardless of the dams.
- Aggradation of 8.95’ behind China Mill Dam.

Channel Invert Elevation over time



Upstream Extent - Degradation



Downstream Extent - Aggradation

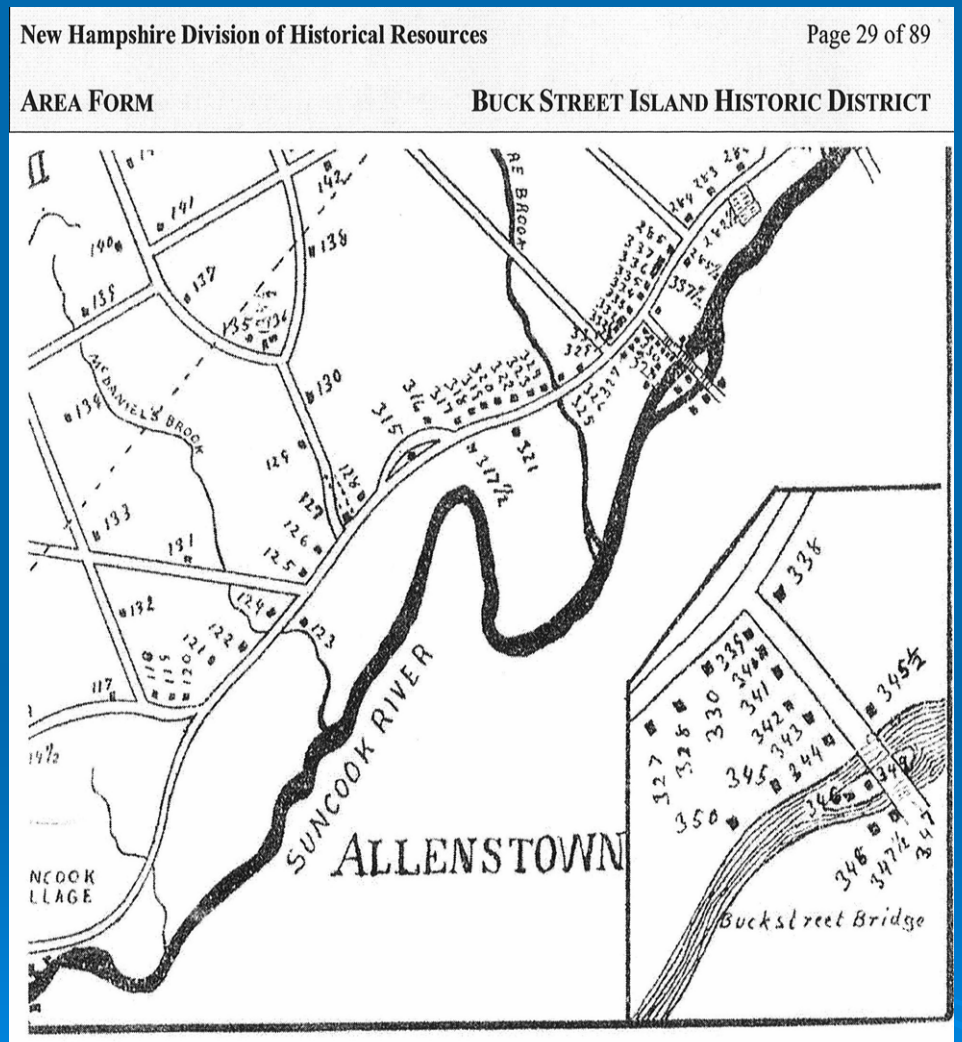
Sediment Transport Trends

- Sediments are moving downstream during storm events from the upstream avulsion site and are passing through the dam site.
- Dams tend to slow down this movement but sediment eventually reaches sinks behind Webster, Pembroke and China Mill dams.
- No head-cutting behind dams is expected since dams and bridges are founded on bedrock. However sandy material stored along the banks of the impoundment is expected to pass downstream.

Wildlife Impacts

- No state or federal endangered species in vicinity of dams.
- NHF&G support removal – free-flowing river for American eel, salmon and alewife.
- May improve state endangered dwarf wedge mussel habitat.
- DES “Impaired waters for aquatic life use” designation may be removed.
- Bio-monitoring will be initiated before and after dam removal by DES and NHF&G.

Cultural Resources



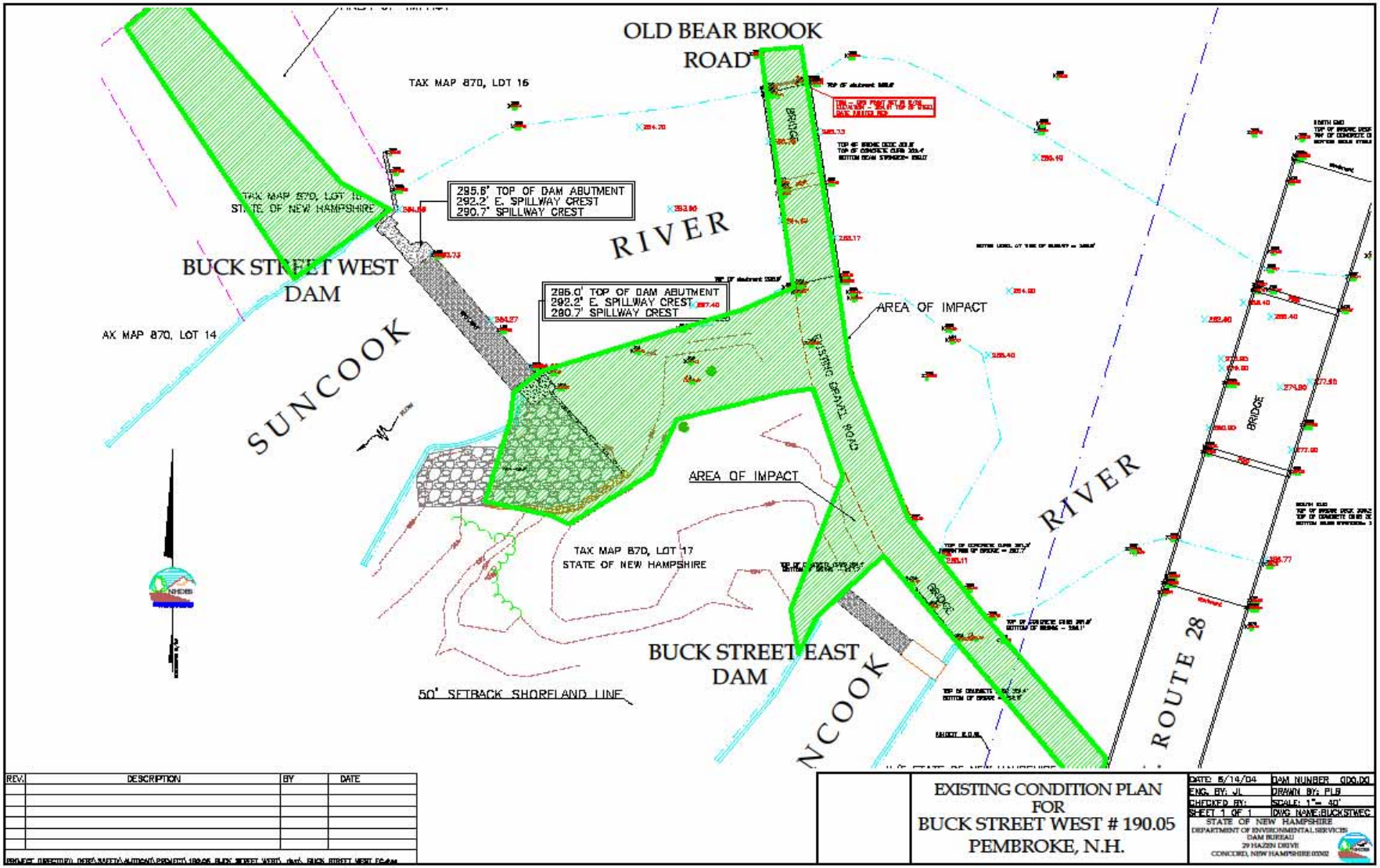
Detail – Carter's 1895 map

- Archeological Phase I Study completed by Monadnock Archeology.
- Architectural study completed by the Preservation Company resulting in recommendation that the Buck St Island be listed as an Historic District.
- Agreement in progress that lists actions that will be taken to mitigate the loss of the resource.

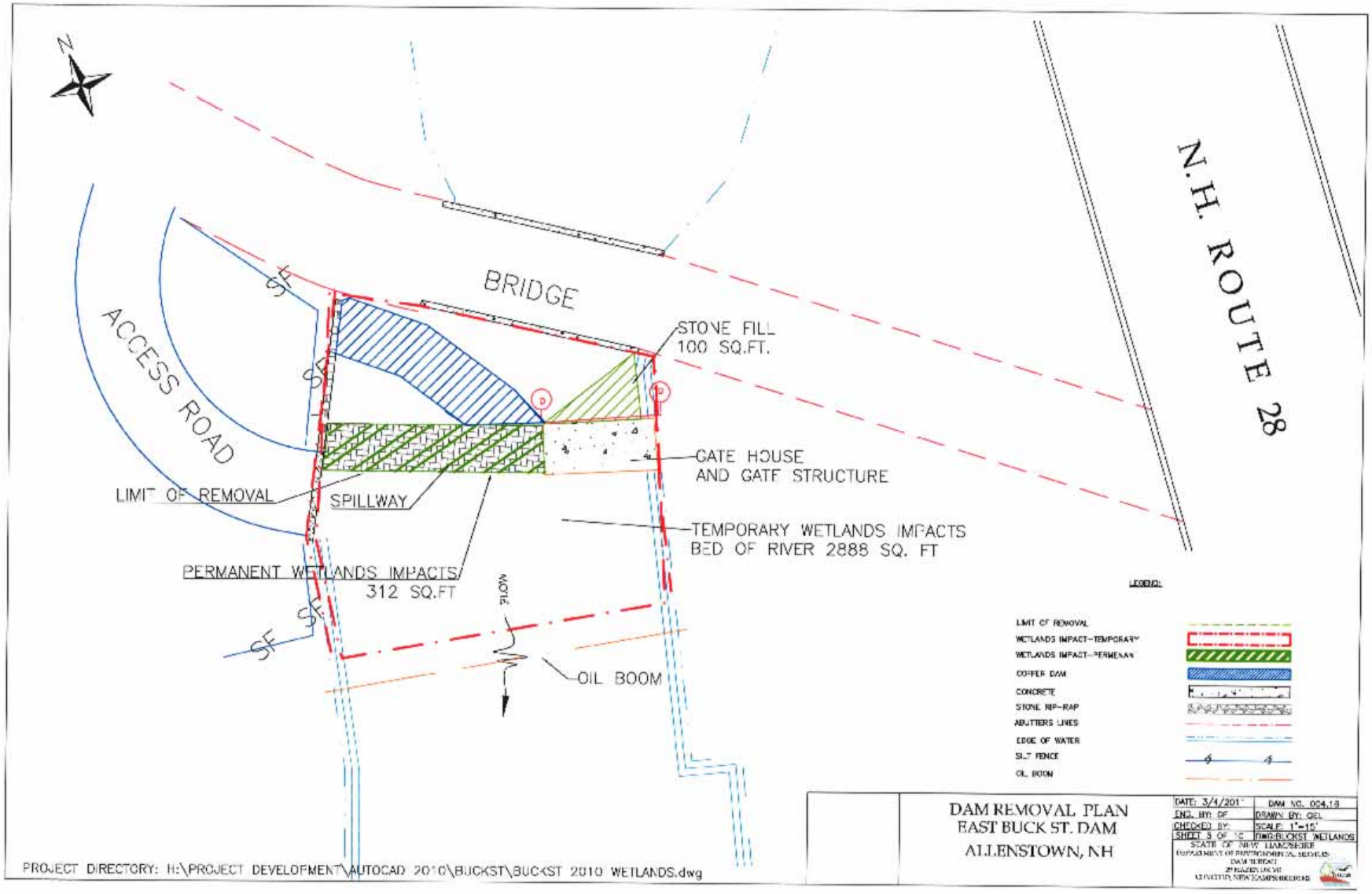
Interesting Historical Facts

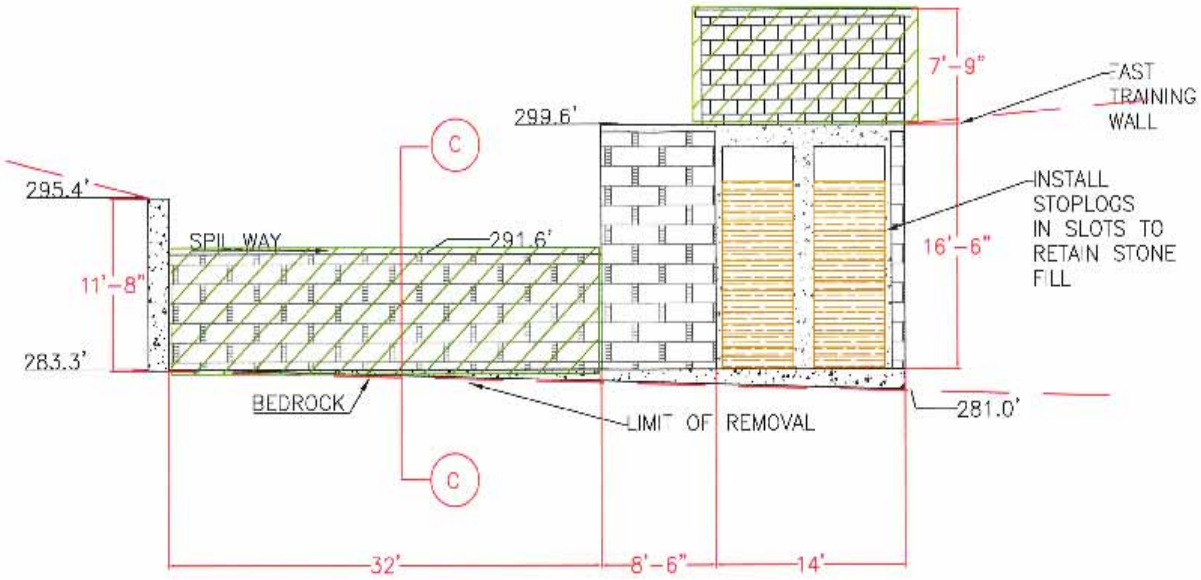
- The Buck Street Island was once the nucleus of the Pembroke /Allenstown community.
- The dams dates back to 1767. Late 1800s wooden dams were reconstructed with stone.
- 1869 Suncook Valley Railroad ran along east bank of river.
- 1896 – Robert Frost visited island and wrote a poem about a mill accident, entitled “The Self Seeker.”

Areas of Impact

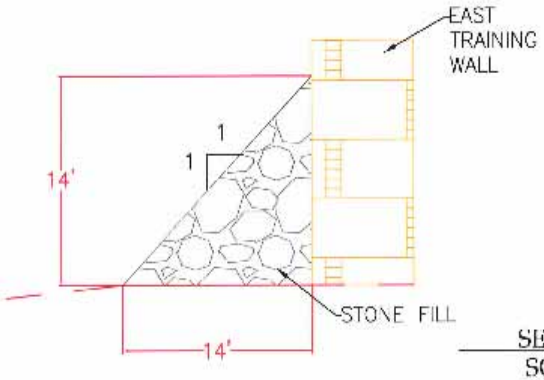


East Buck Street Dam

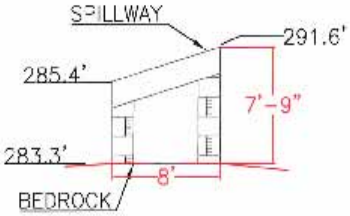




ELEVATION VIEW LOOKING UPSTREAM
SCALE 1"=8'



SECTION D-D
SCALE 1"=8'



SECTION C-C
SCALE 1"=8'

SECTIONS THROUGH
EAST BUCK STREET DAM

DATE: 3/4/2011	DAM NO. 004.10
ENG. BY: GEL	DRAWN BY: GEL
CHECKED BY:	SCALE: AS NOTED
SHEET 7 OF 10	DWG:BUCKST WETLANDS

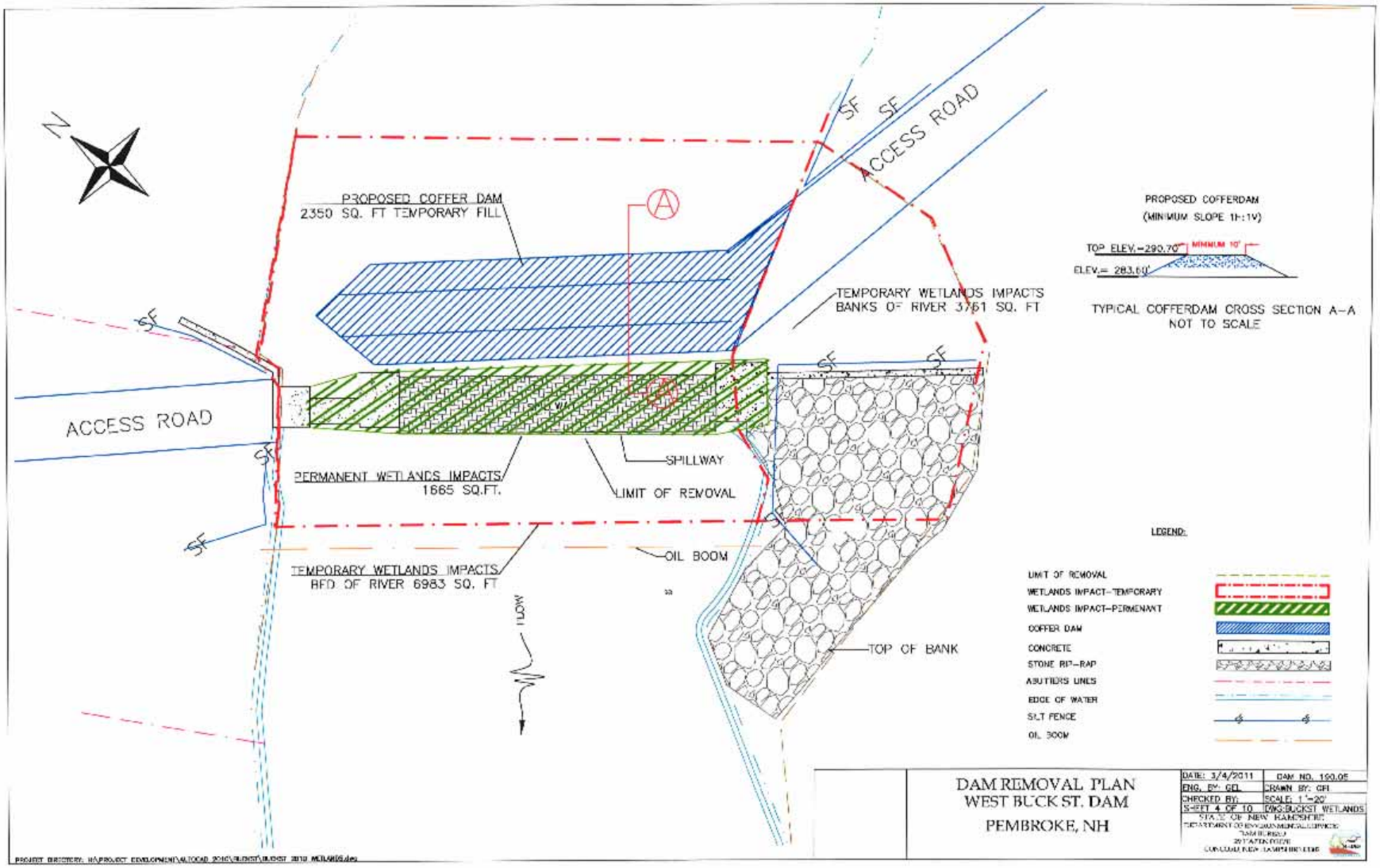
STATE OF NEW HAMPSHIRE
DEPARTMENT OF ENVIRONMENTAL SERVICES
DAM BUREAU
29 HAZEN DRIVE
CONCORD, NEW HAMPSHIRE 03302

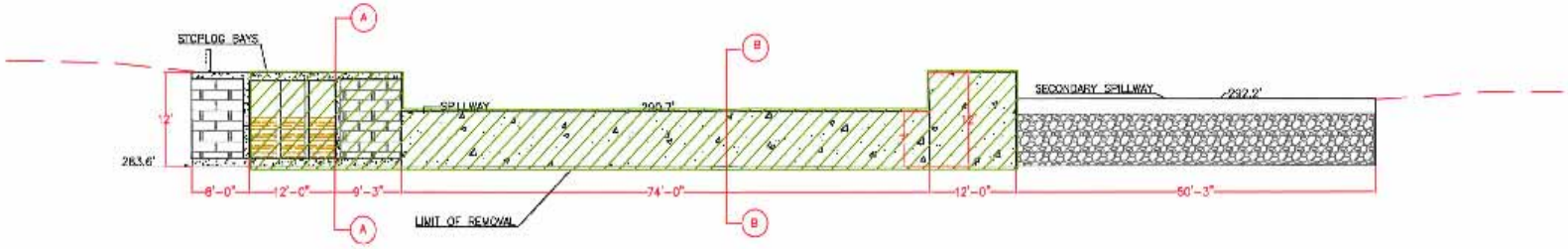
PROJECT DIRECTORY: H:\PROJECT DEVELOPMENT\AUTOCAD 2010\BUCKST\BUCKST 2010 WETLANDS.dwg

Sequence of Construction- East Dam

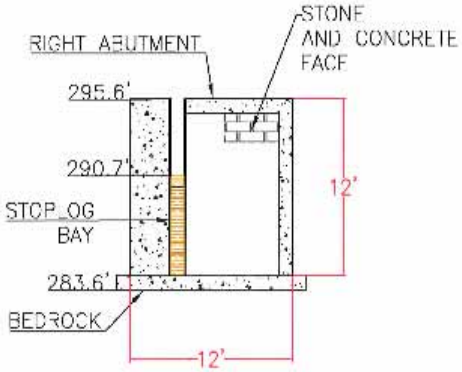
- Install oil boom and erosion control measures.
- Establish equipment pad on western abutment.
- Construct stone coffer dam upstream of spillway.
- Remove granite block spillway leaving gate structure and right concrete abutment wall intact.
- Remove concrete block gate house.
- Dispose of concrete block at approved off site location. Place granite block at an approved location- state property.
- Install steel stop logs in gate housing.
- Install stone fill upstream of gate house.
- Install safety railing along top of gate structure that remains.
- Remove coffer dam.
- Loam and seed disturbed areas.
- Remove erosion control measures.

West Buck Street Dam

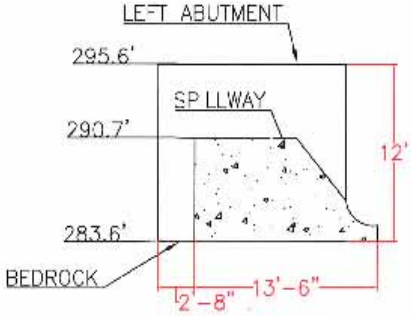




ELEVATION VIEW LOOKING UPSTREAM
SCALE 1" = 15'



SECTION A-A
SCALE 1"=8'



SECTION B-B
SCALE 1" = 8'

SECTIONS THROUGH
WEST BUCK STREET DAM

DATE: 3/4/2011	DAM NO. 190.05
ENG. BY: GCL	DRAWN BY: GC
CHECKED BY:	SCALE: AS NOTED
SHEET 6 OF 10	DWG:BUCKST WETLANDS

STATE OF NEW HAMPSHIRE
DEPARTMENT OF ENVIRONMENTAL SERVICES
DAM BUREAU
29 HAZEN DRIVE
CONCORD, NEW HAMPSHIRE 03302

PROJECT DIRECTORY: H:\PROJECT DEVELOPMENT\AUTOCAD 2010\BUCKST\BUCKST 2010 WETLANDS.dwg

Sequence of Construction- West Dam

- Install oil boom and erosion control measures.
- Establish equipment pad on eastern abutment.
- Construct stone coffer dam upstream of spillway.
- Remove stop log bay structure leaving right (western) wall intact. Remove all concrete and rebar downs to bedrock.
- Remove spillway and left pier.
- Dispose of concrete and rebar at approved off site location.
- Remove coffer dam.
- Install safety railing along western abutment wall that remains.
- Loam and seed disturbed areas.
- Remove erosion control measures.

What's Next?

- Sign the MOA with USACOE and State Historic Preservation Officer.
- Begin construction in early September 2011.
- Work is expected to last 8 weeks.

- Questions? Please contact :

For overall project concerns:
Grace Levergood, Project Manager
(603) 271-8346, **grace.levergood@des.nh.gov**
For dam removal issues:
Deb Loiselle, River Restoration Coordinator
(603) 271-8870, **deborah.loiselle@des.nh.gov**
For cultural resource issues:
Kent Finemore, Asst. Chief Engineer
(603) 271-0566, **kent.finemore@des.nh.gov**

NHDES Water Division, Dam Bureau
29 Hazen Drive
Concord, NH 033020-0095