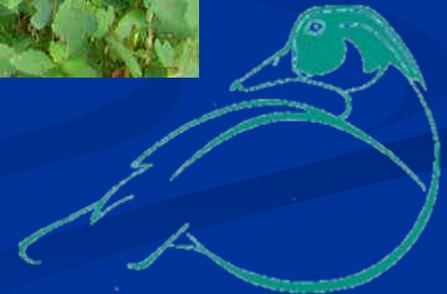


# Once There Were Beavers: A Stream Flow Restoration Project for the Potomac Headwaters



Cacapon Institute  
High View, WV



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**The “Once There Were Beavers” project began in this room eight years ago, with an observation by Kent Mountford (Chesapeake Bay Program) :**

- Colonial era maps show that many once perennial streams became intermittent, ephemeral, or disappeared completely during the colonial period.

# The comment led to a question

## Why?

Research in the West indicates that beavers may maintain perennial flow in headwater streams.

Before the fur trade decimated beaver population early colonial times, beavers were abundant on streams throughout the Mid-Atlantic region.



Could the loss of beavers in the East have led to the loss of perennial streams?

## Today . . .

- People in the Eastern Panhandle have noticed that, in recent years, many streams rapidly go dry during periods with little rain



- Even farmers are concerned that the poultry industry may be “sucking the rivers dry.”
- New wells must be drilled deeper to get good yields

# Our bright idea

Can we address the current issue of streams rapidly going dry  
– and the underlying cause - by reproducing the long-lost  
hydrologic impacts of beaver dams on headwater streams?

We are assessing the feasibility of restoring watershed hydrologic functions that may have existed when beavers were abundant by installing **structures** in headwater streams that mimic the hydrologic effects of small beaver dams in a way that is:

- low-cost
- easily replicable
- environmentally sensitive
- culturally acceptable.

# Primary testable hypotheses:

- We can build low cost structures that raise the water level in sections of a stream, require little maintenance, and do not destabilize the stream.
- The structures will elevate the local alluvial water table.
- The structures will increase surface flow in local streams during base flow periods.

**What do we mean by structures?**

The bank-to-bank beaver dam provides the hydrologic context for our project.

Below Sleepy Creek Dam



But beaver dams require frequent maintenance and create large surface pools over time.

Our intent is not to create large surface pools, as beaver dams do. We simply want to raise the level of water in the stream channel so that water can seep into the banks more readily at many conditions of flow (i.e.: increase bank storage).

The emerging techniques of natural stream restoration provides the structures we need.



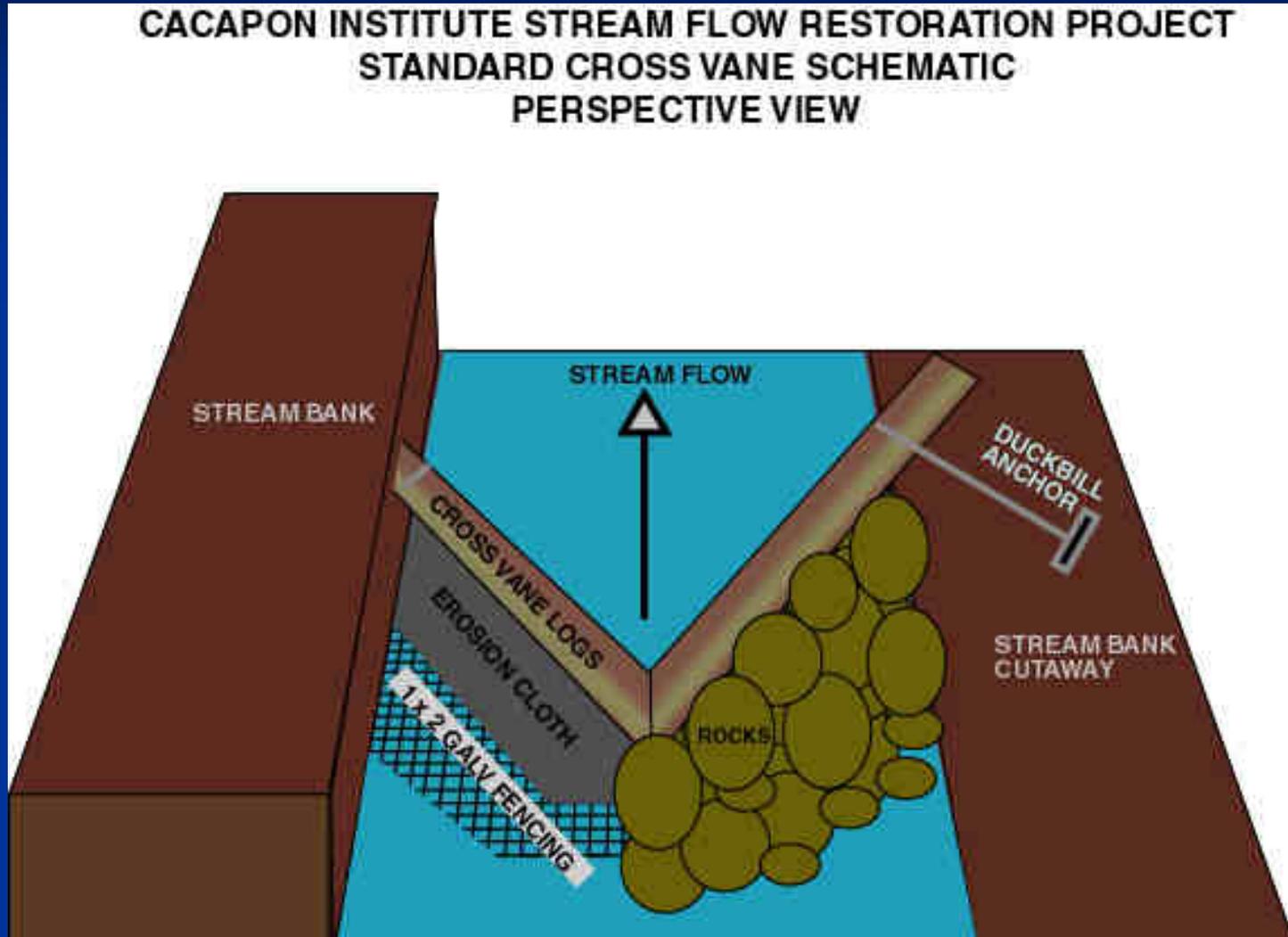
This **rock cross vane** from Big Bear, PA meets all of our requirements save one – they are very expensive!

This log cross vane from Big Bear, PA was installed by two men in one day using a chain saw, a come-along, a bit of cable and fence. It has withstood many high water events without significant damage.



It was cheap to build, required little maintenance, and has not destabilized the stream.

We selected a variant of the Big Bear log cross vane for our structures.



**What a structure looks like.  
Before construction.**



# During construction



# Completed structure – 1st Day



# Structures

**Structures** are installed longitudinally in series in a stream to create a progression of small pools, rather than single isolated structures.

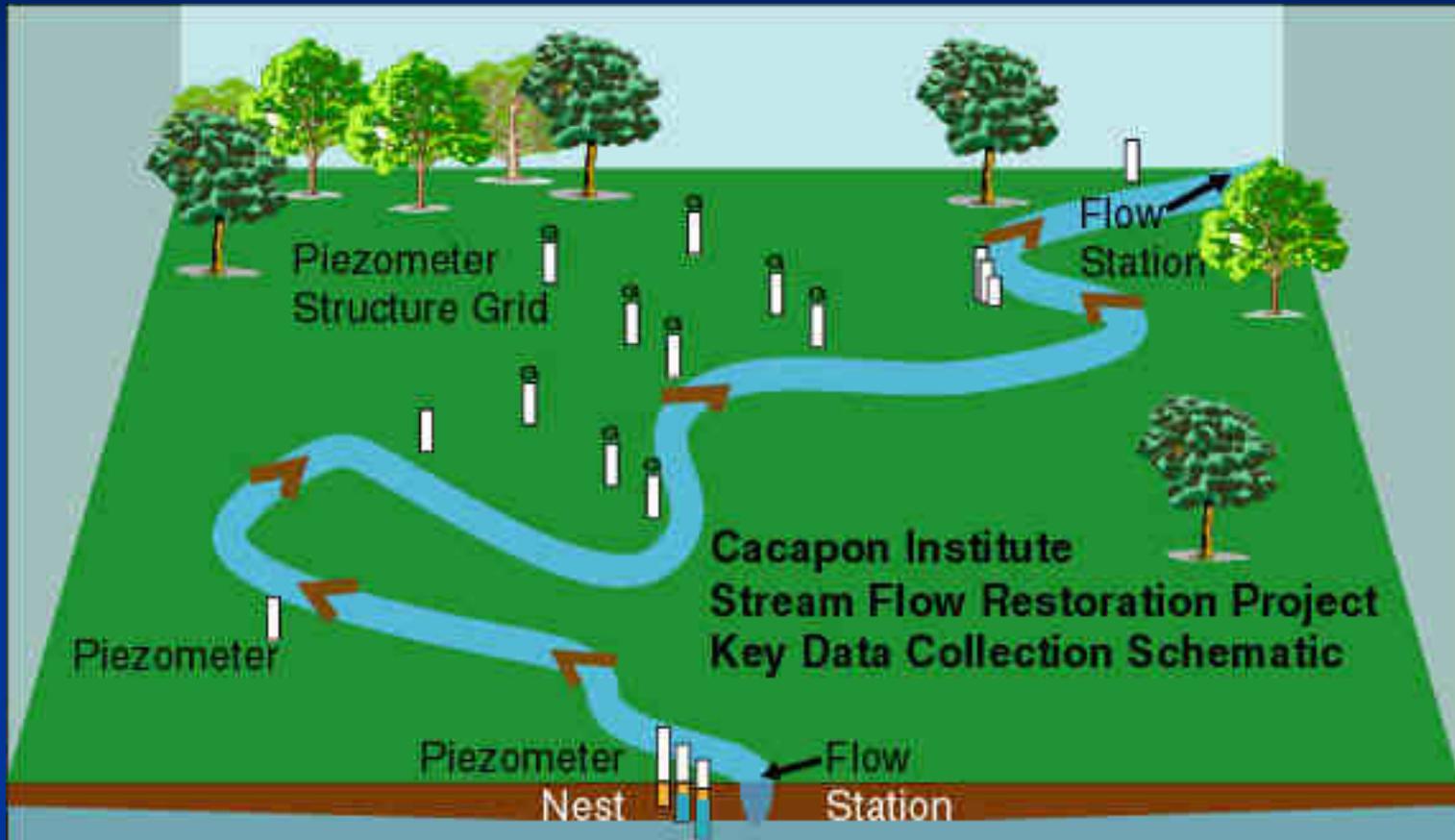
We hypothesized that **alluvial** water storage enhanced by upstream pools will extend periods of stream flow further downstream and create a **multiplier effect**, like batteries wired in series.

# Experimental Design

Changes in the system will be assessed based on **comparisons between control and experimental sites**, and **between upstream and downstream locations** within the experimental sites.

**Pre and Post structure** data collected for this project include **stream flow, groundwater "level", stream height, precipitation, and water temperature.**

# Data Collection Schematic



# Installing piezometers

Determine the depth



# Installing piezometers

Drill the hole



# Installing piezometers

Insert and seal



# Installing piezometers

The finished product



# Collecting piezometer data



## Collecting piezometer data



# Site Selection

The sites selected for this project needed to meet fairly rigid criteria:

**first or second order streams.**

2. These small streams needed to have **significant deposits of alluvial soils and shallow slopes.**
3. The selected sites **couldn't have active large animal agriculture**, the most common use for such lands.
4. The streams on the selected sites **couldn't run directly beside a road**, or weave repeatedly back and forth across a road. Roads are often built next to streams in these settings, further reducing the potential pool of sites.
5. Finally, sites with all of the above characteristics must also have **landowners willing to allow us permission** to conduct the experiments.

# Four suitable sites were found.

Skaggs Run Experimental



Skaggs Run Control



This presentation will focus on the Skaggs Run "meadow."

Camp Branch Experimental



# Skaggs Run Experimental



● Piezometers

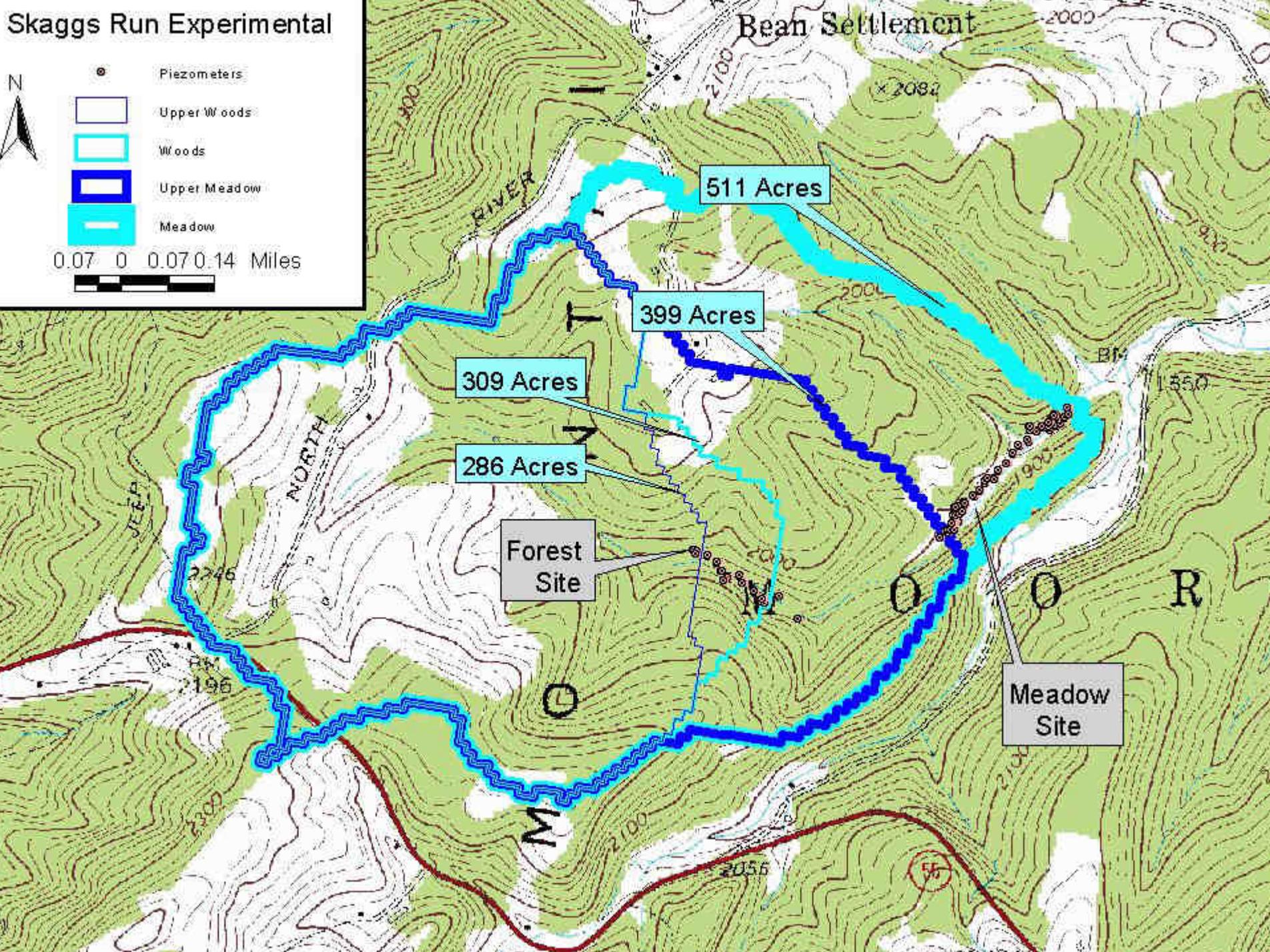
□ Upper Woods

□ Woods

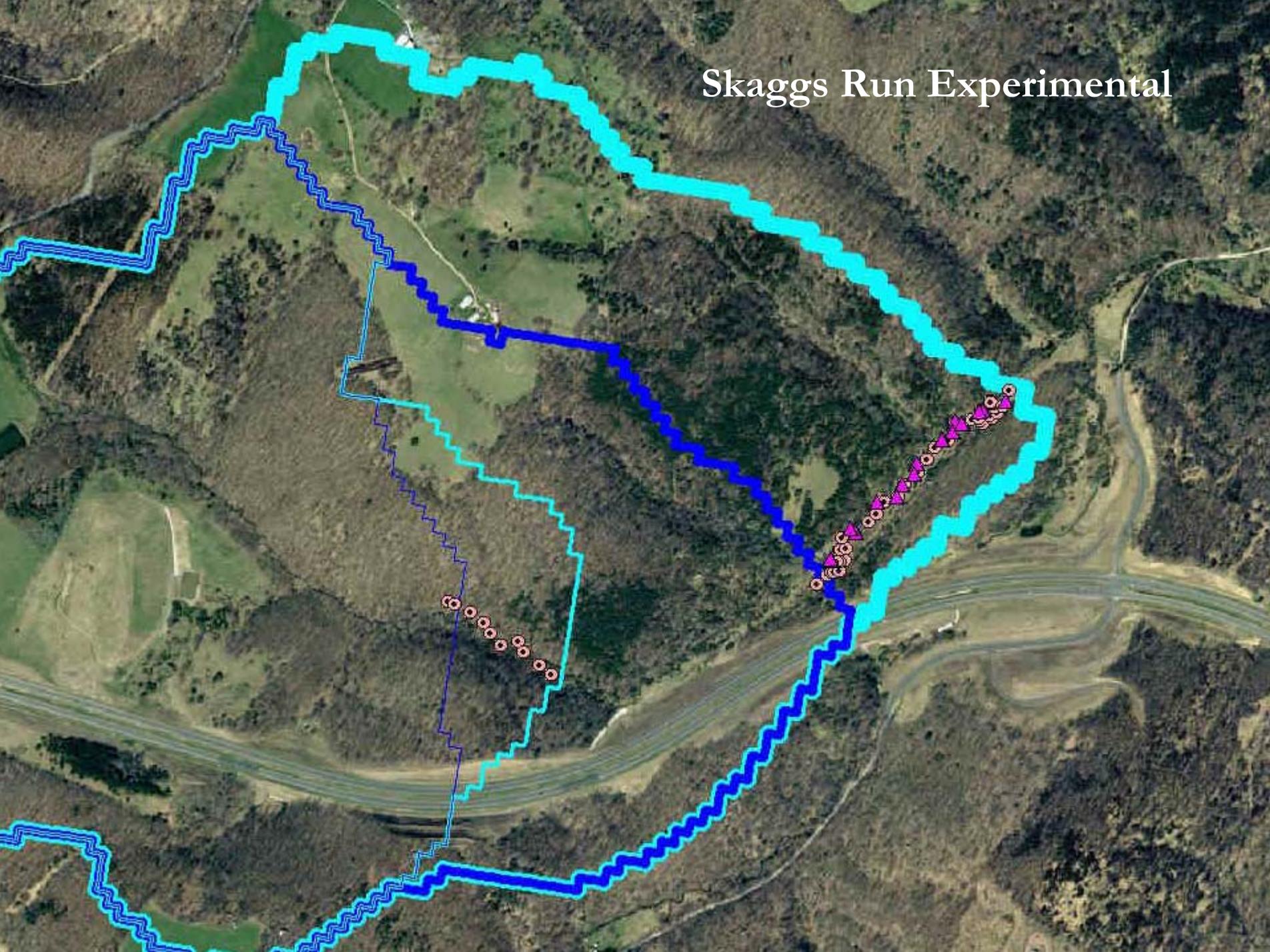
□ Upper Meadow

□ Meadow

0.07 0 0.07 0.14 Miles



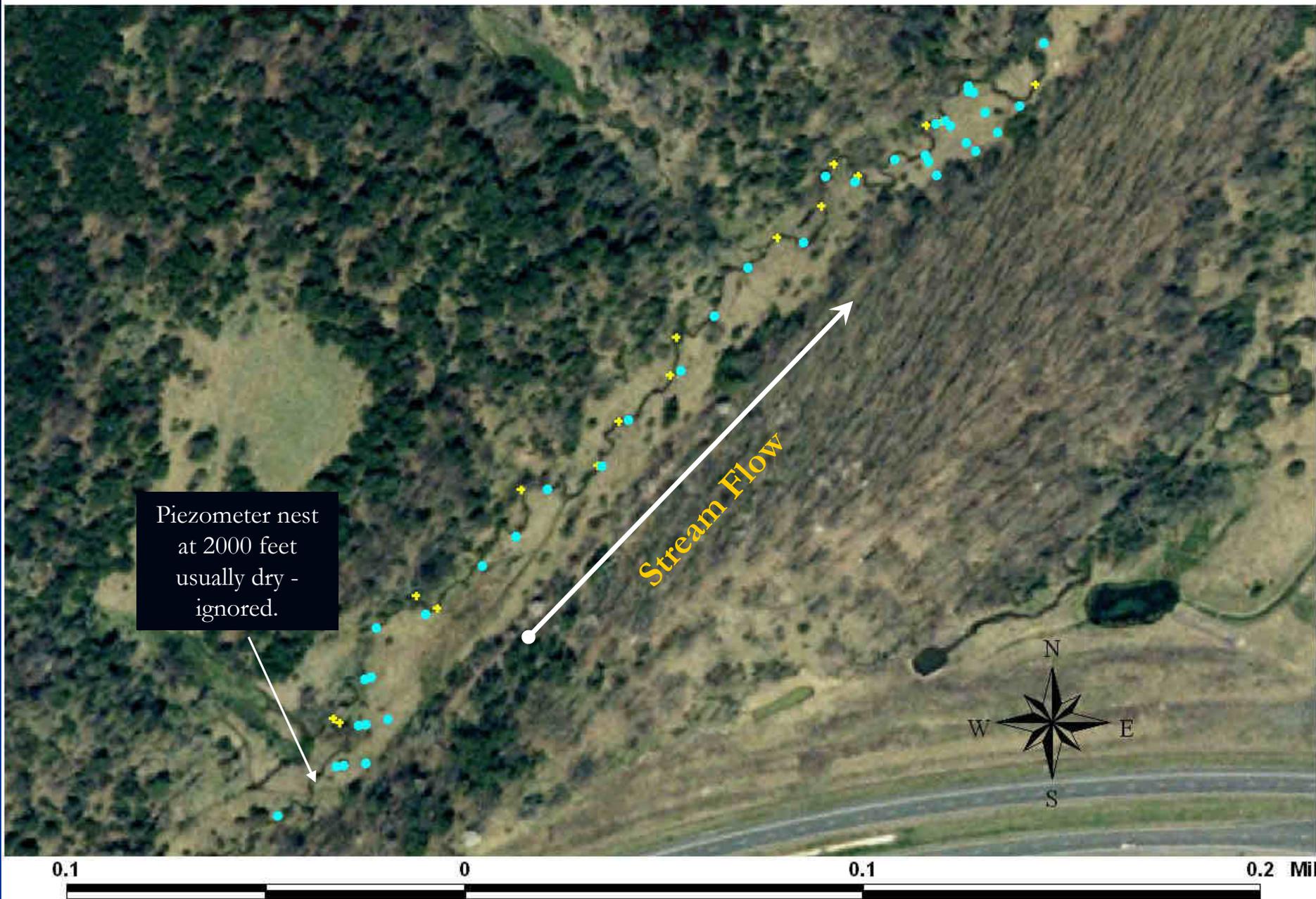
# Skaggs Run Experimental



## “The Meadow“ site

- Is in a broad valley with a sinuous stream and wetlands.
- Soils broadly classified as Potomac Series fine sandy loam, which is deep, well drained soil formed in coarse-textured alluvial material on flood plains.
- Has no roads or agriculture in the floodplain.
- The site's stream length is 2100 feet, with a slope of 1.7%.
- The watershed area at the base is 511 acres.
- Twenty-two "regular" piezometers were installed along the length of this stream, as well as six piezometer nests and two structure grids with a total of 20 piezometers.
- Fifteen structures were installed here.

# Site SREM Piezometers & Structures



The site has extensive wetlands.



and meanders . . .



. . . has undercut banks and abundant multiflora rose,



. . . has the occasional high water event,





. . . and occasionally dries up.



## How are structures doing:

- We installed 15 at the meadow site in October 2004.
- Three people would typically build a structure in 3-4 hours, using <\$100 in materials.
- The structures have been severely tested . . .

By moderately high water





# Freezing



# High water



**Really high water!**



Still there after the flood.



More typical conditions.



And some days like this.



## Overall the structures have performed well:



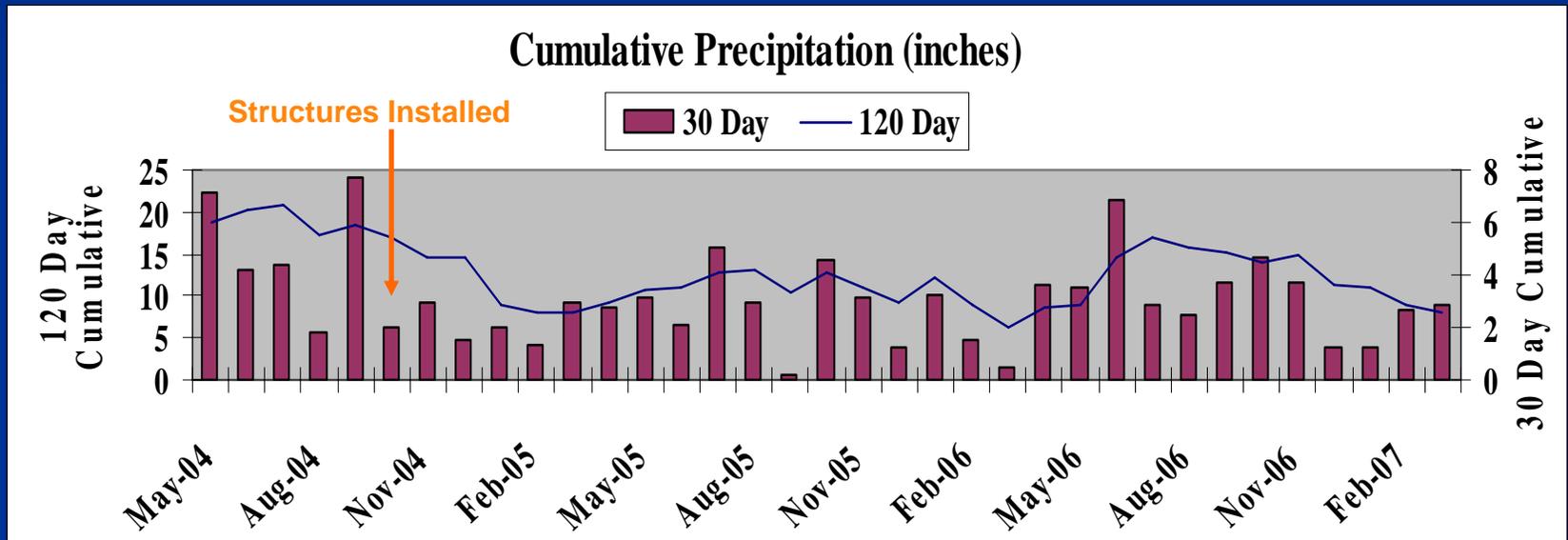
- None have failed.
- All direct the water to the center of the channel as intended.
- All raise the water level behind the structure from 0.3 to 0.6 feet.
  - Trickle charge
- Many have had problems with lateral bypass through undercut banks on the outside of the bend. This has created the primary repair issue.
- But are they changing the water levels in the ground and in the stream?

Determining hydrologic changes is based on **Before** and **After** comparisons between control and experimental sites, and upstream and downstream sites.

It would have been helpful if the precipitation patterns before and after structure installation had been similar.

# But they weren't.

Cumulative precipitation data provides a measure of antecedent moisture conditions throughout the study period.

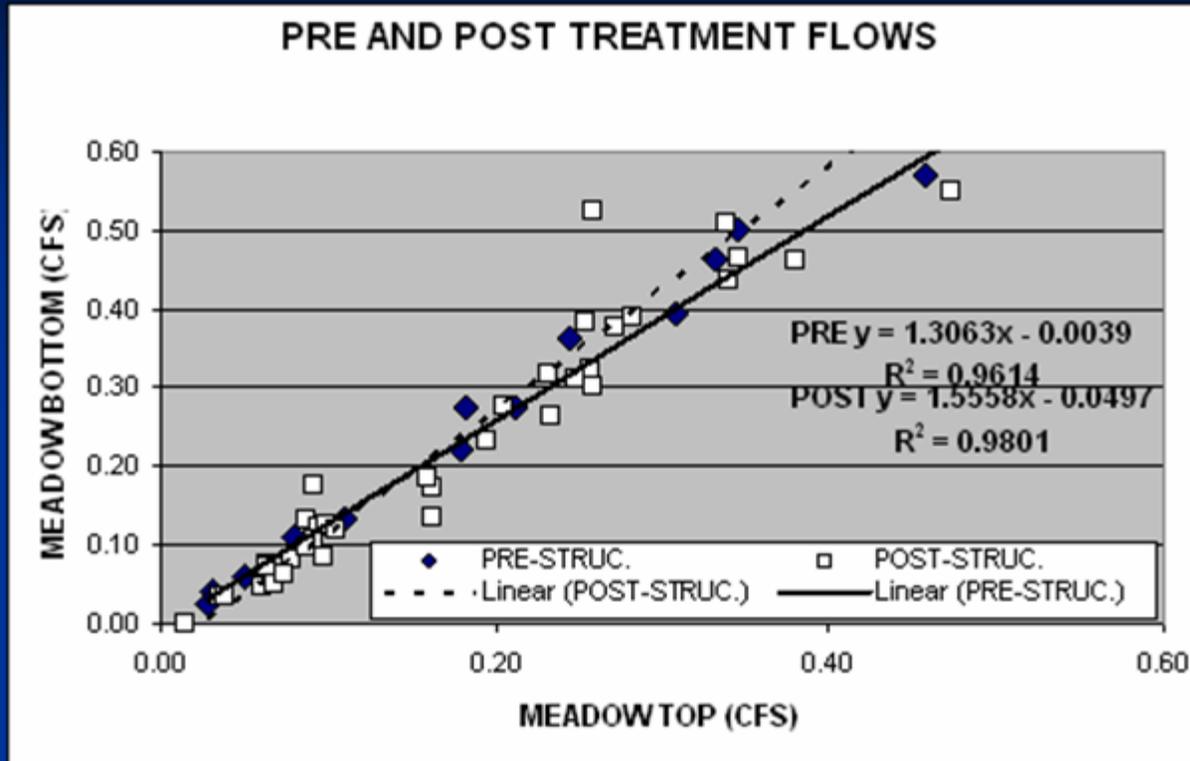


The pretreatment period through September 2004 was very wet in comparison to most of the post treatment period. This unfortunate fact had important ramifications on the data analysis.

One of the testable hypotheses of this project was that the anticipated increase in alluvial groundwater due the structure effects would in turn augment flows during low flow periods.

Comparisons of pretreatment and post treatment flow data were required to determine if this occurred.

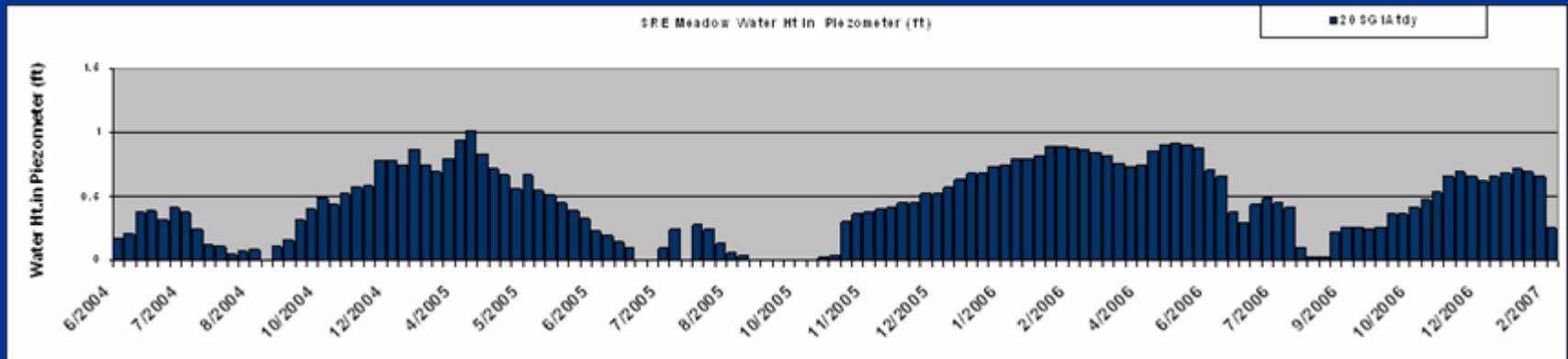
However, because the pre treatment period was very wet, there were few opportunities to collect low water stream flows.



Regardless, correlations between the various flow sites were quite strong. The data, so far, broadly indicate no discernable effect on stream flow due to structure installation within the study area.

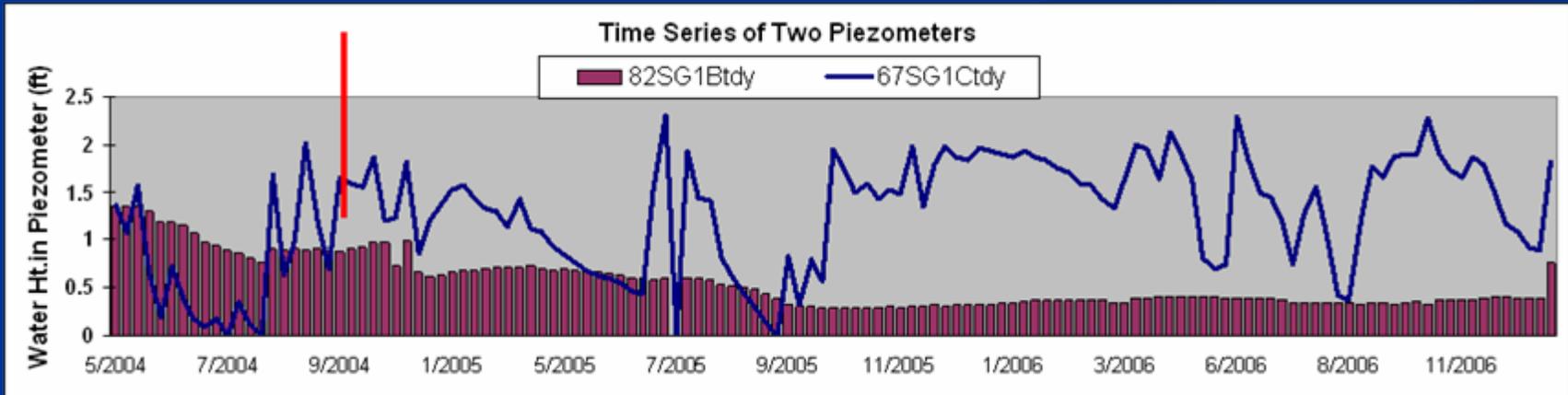
Piezometer data was far less predictable than the flow data, and impossible to generalize.

The one pattern that was reasonably consistent was that most piezometers had significantly higher water levels during the dormant season (October through April) than the growing season (May through September).

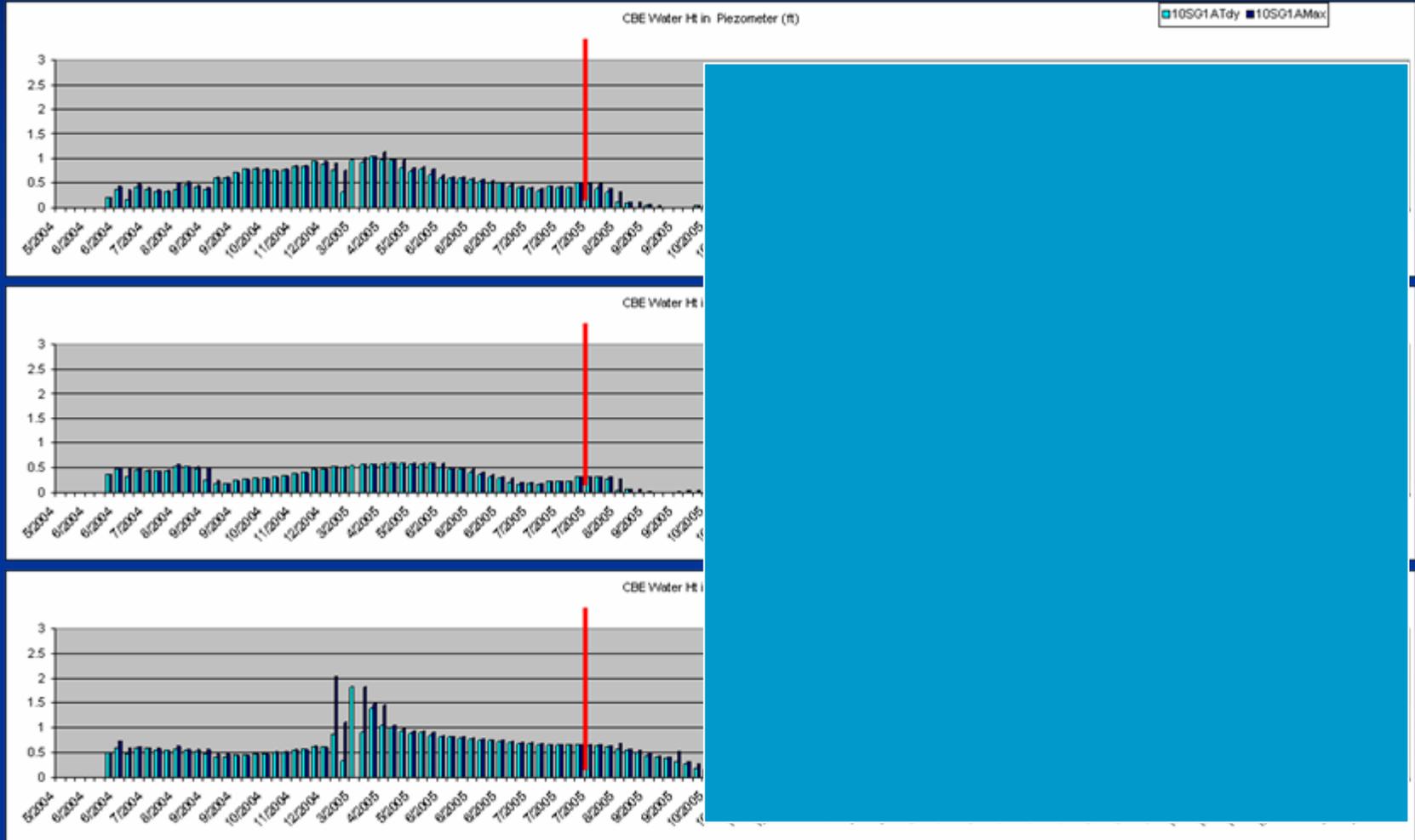


Piezometers in proximity to one another often "behaved" quite differently.

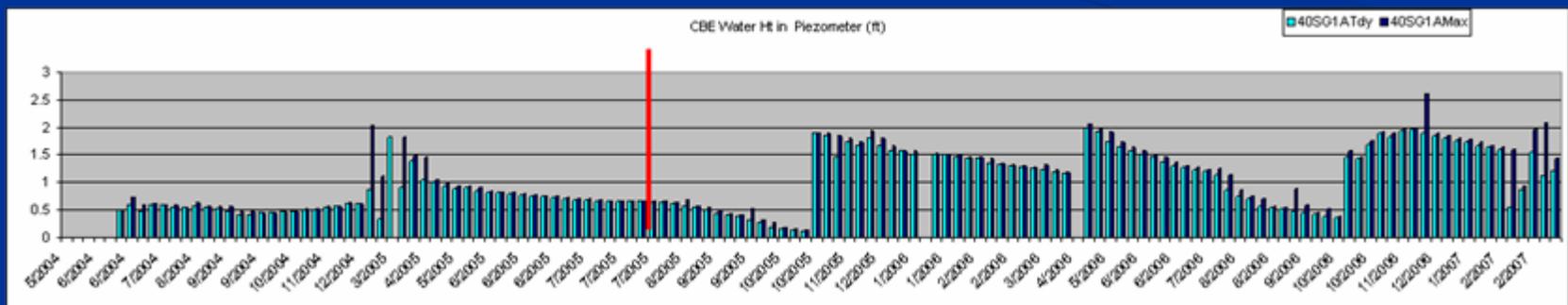
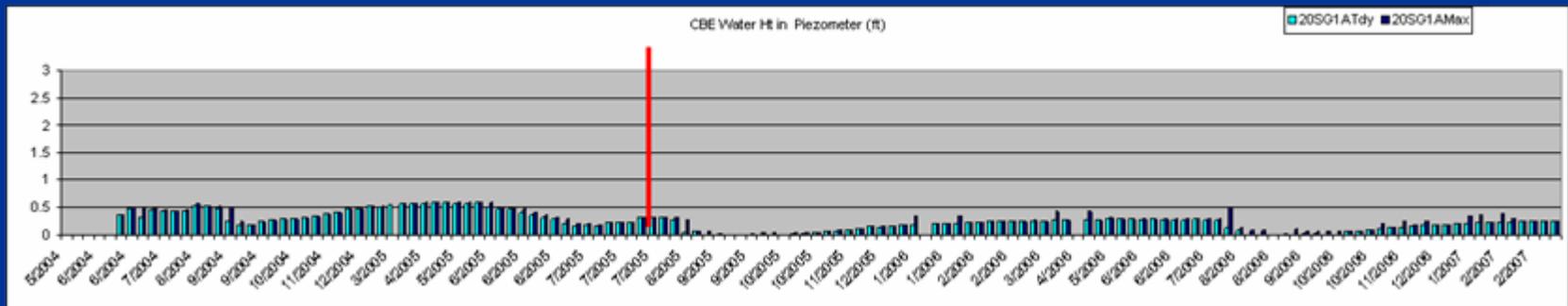
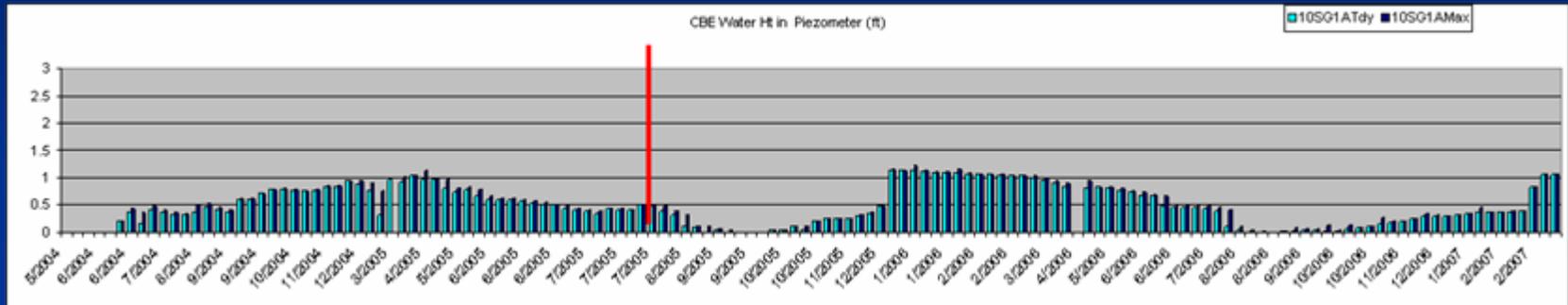
For example, below is a time series graph of water level in two piezometers located fifty feet apart. Both are at the tow of the slope at the edge of the floodplain farthest from the stream.



These three piezometers are 30 feet apart. The top is 10' from the stream, the second is 20' from the stream, the third is 40' from the stream. X-axis is time scale, common to all three graphs. Y-axis is height of water in piezometer.



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As we do not have pretreatment dormant season groundwater data, the following piezometer data will focus on the growing season.

## Seeking order in the chaos

Correlations were used to find similar patterns of behavior among piezometers.

Cluster analysis (hierarchical, average linkage) was then used on the correlation matrices to detect piezometer groupings.

The following maps show the results.

# Site SREM Grow Season 2004 Clusters

## Pretreatment

Blue dot indicates  
site did not form  
cluster.



0.1

0

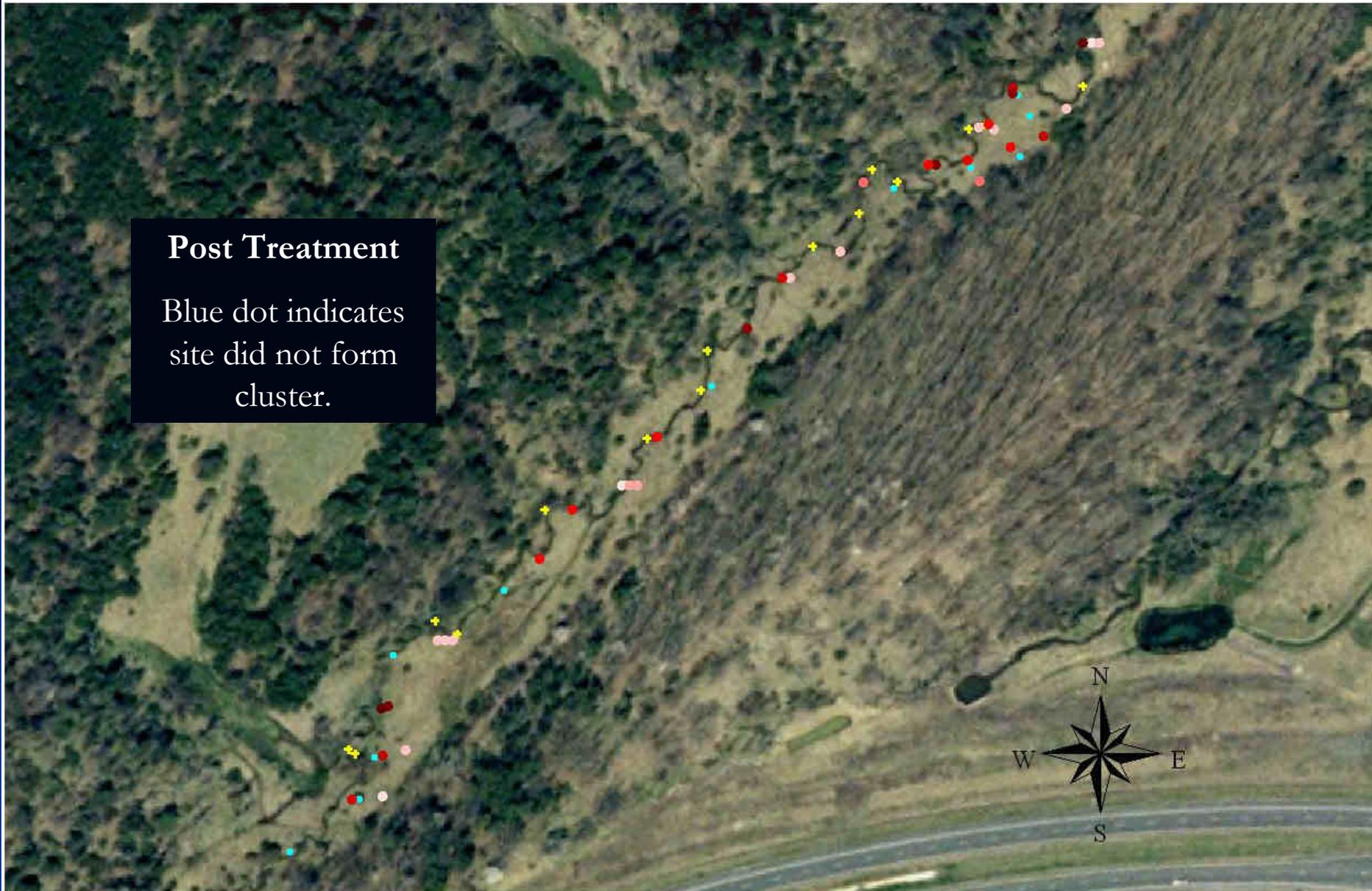
0.1

0.2 Miles

# Site SREM Grow Season 2005 Clusters

## Post Treatment

Blue dot indicates site did not form cluster.



0.1

0

0.1

0.2 Miles



# Site SREM Grow Season 2006 Clusters

Blue dot indicates site did not form cluster.

	1200LOW	1300SB	1400SB	1600SB	20SG1C	20SG2C	300SB
1200LOW	1	0.96	0.98	0.94	0.95	0.92	0.939
1300SB		1	0.98	0.985	0.97	0.96	0.96
1400SB			1	0.98	0.97	0.96	0.95
1600SB				1	0.96	0.98	0.94
20SG1C					1	0.96	0.9885
20SG2C						1	0.95
300SB							1

0.1

0

0.1

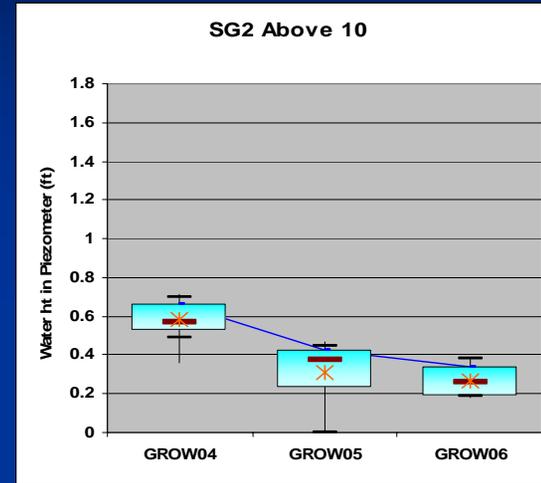
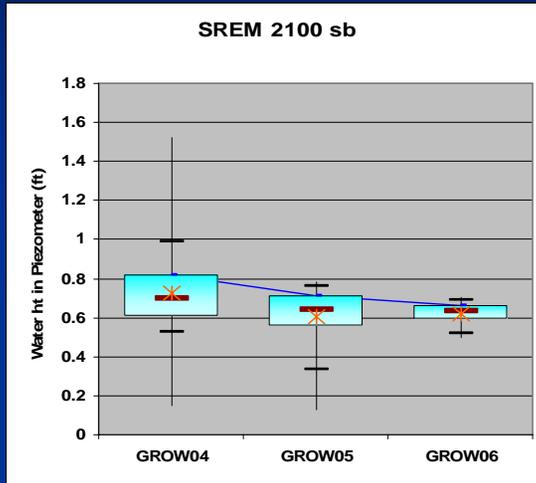
0.2 Miles



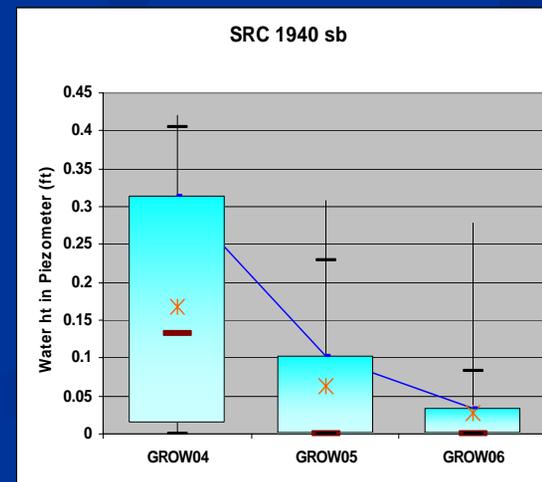
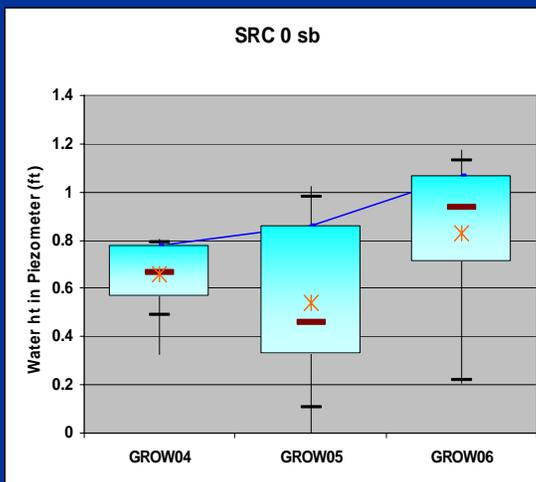
Were there any consistent patterns in the control piezometers when comparing pre-treatment to post treatment periods?

All but one of the relevant control sites had lower water levels in the first post treatment growing season than pretreatment. For example:

### Meadow – Upstream Sites

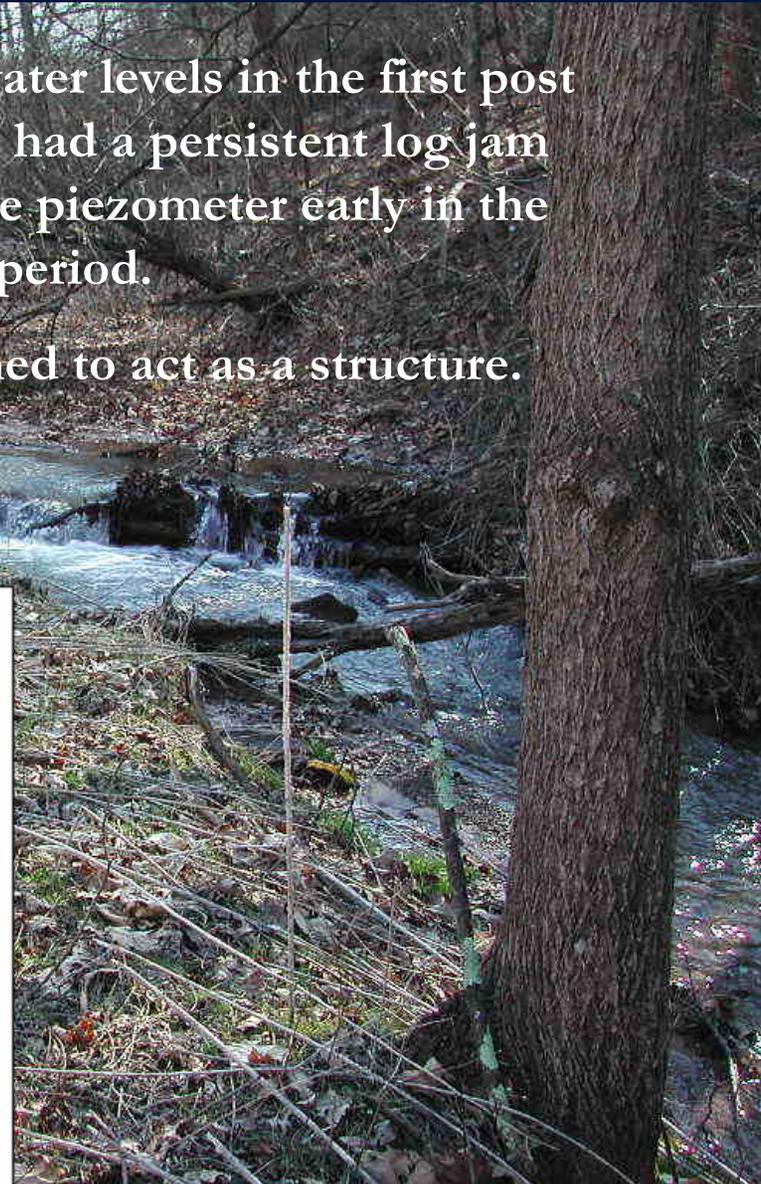
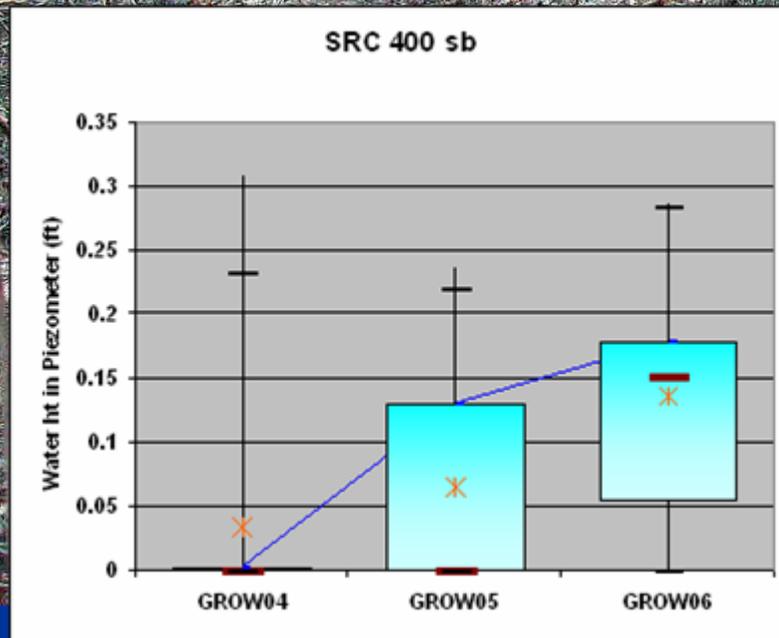


### Control Stream



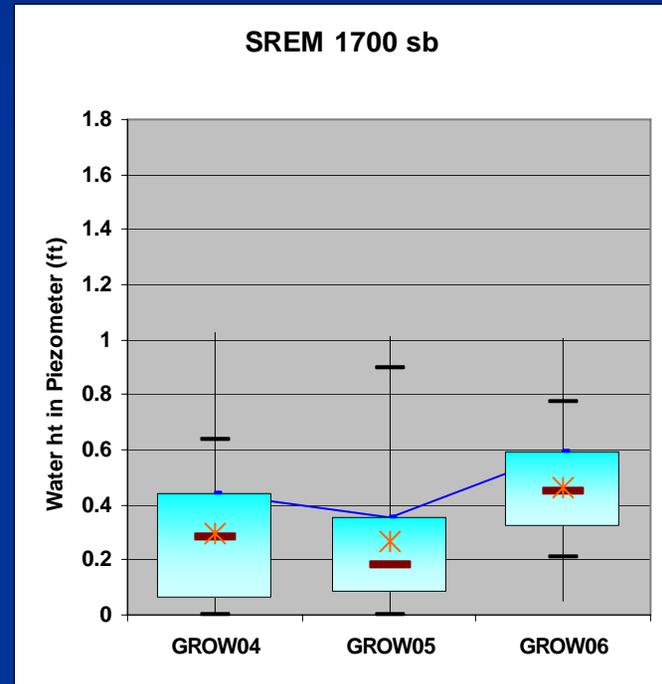
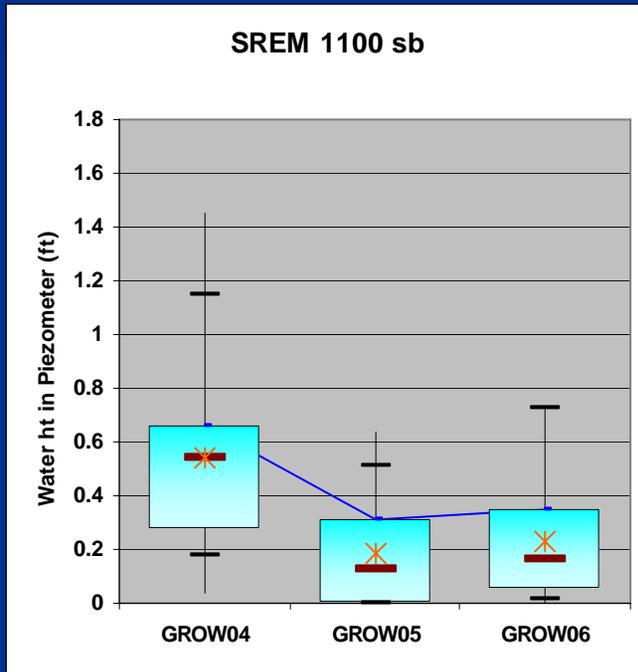
The one control site with higher water levels in the first post treatment year than pretreatment had a persistent log jam immediately upstream of the piezometer early in the post treatment period.

This could reasonably be assumed to act as a structure.



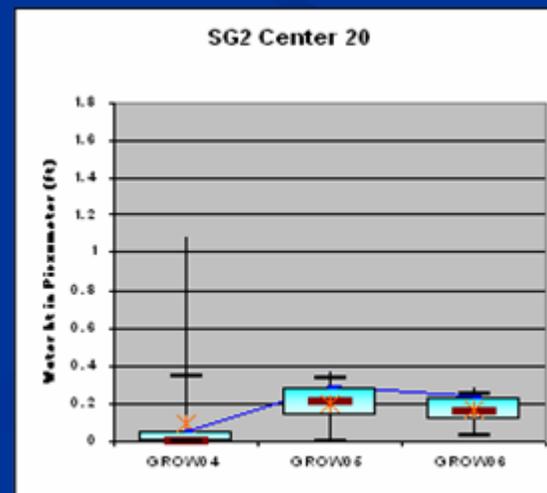
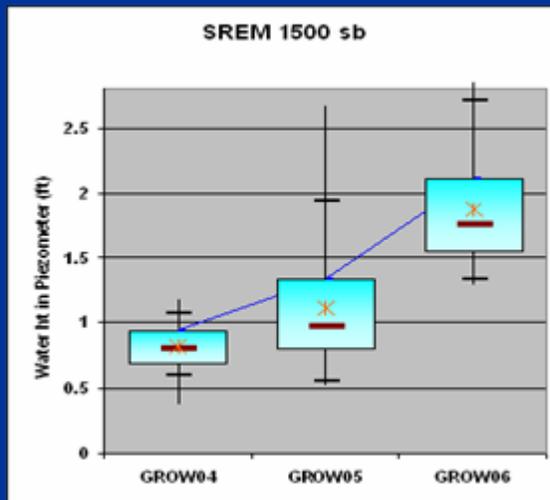
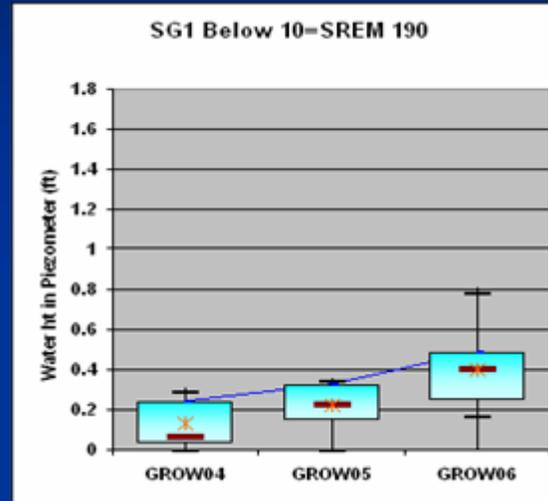
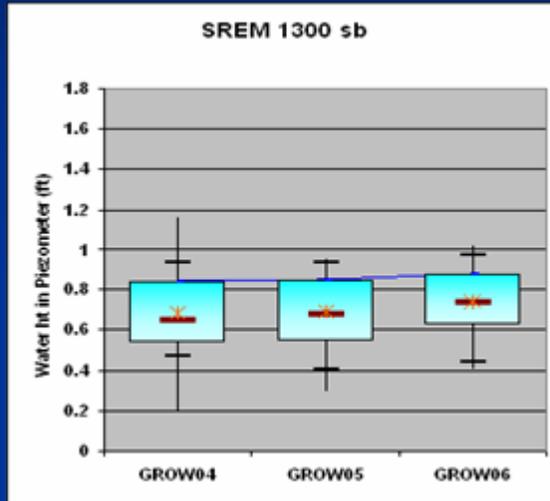
How did the groundwater levels in the treatment piezometer sites compare in the first post treatment year than the pretreatment period?

Many were lower, similar to the control sites.

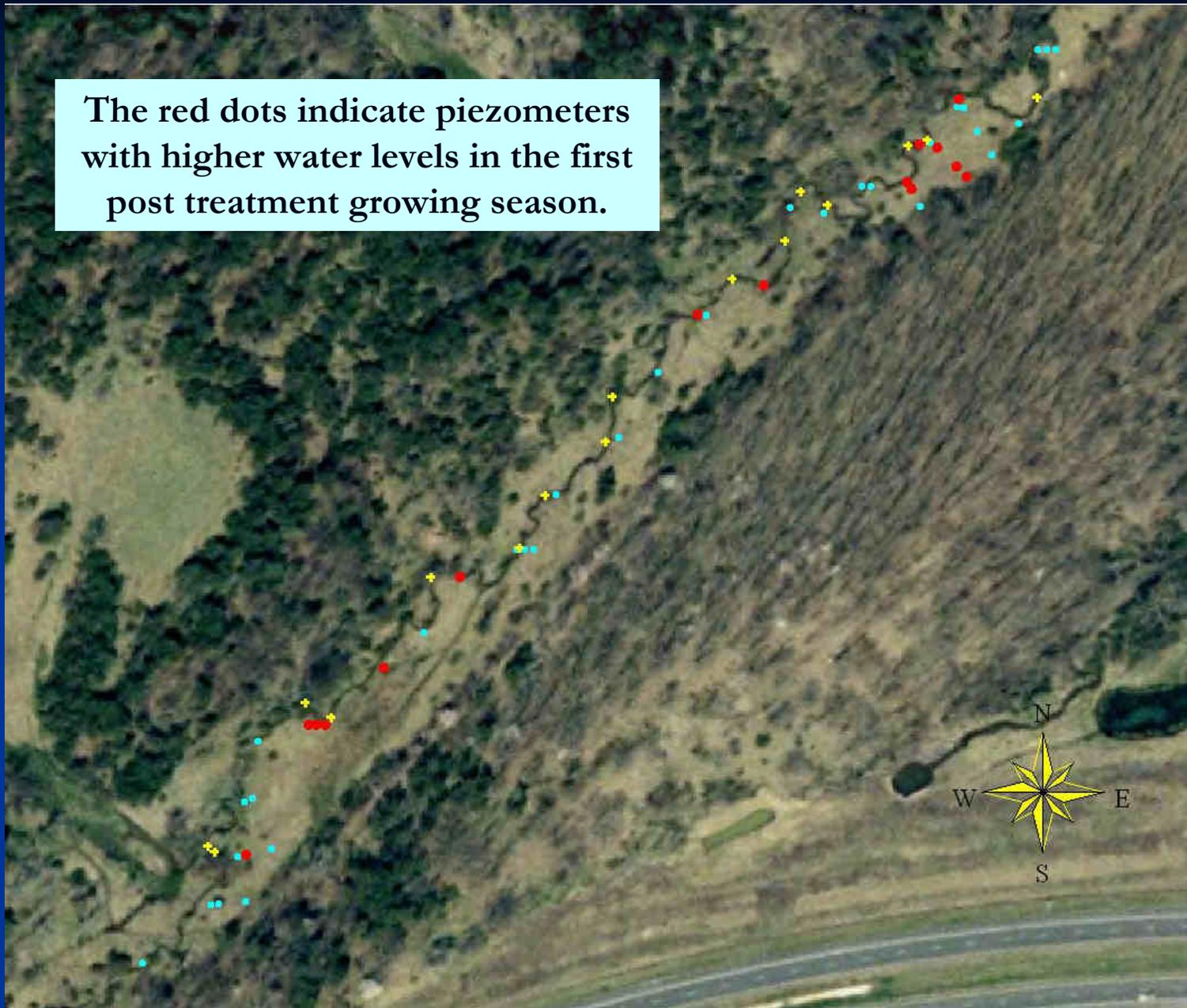


How did the groundwater levels in the treatment piezometer sites compare in the first post treatment year than the pretreatment period?

Some increased.



The red dots indicate piezometers with higher water levels in the first post treatment growing season.



# Summary

This is a continuing project. Data collection will continue through this summer, including some targeted field experiments. As of this point, this is the status of the three hypotheses:

1. **We can build low cost structures that raise the water level in sections of a stream, require little maintenance, and do not destabilize the stream.** This appears to be true, but some ongoing maintenance is required.
2. **The structures will elevate the local alluvial water table.** This may be correct, but probably in a very localized way that will defy generalizations such as “we created XX acre feet of water storage.” Our primary challenge at this point is to develop filters that will isolate the effects of our manipulations from the world’s variability.
3. **The structures will increase surface flow in local streams during base flow periods.** Not observed. Conceivably, there could be an effect “elsewhere” but we would have no way to know.

In the meantime . . .



Beavers moved into the stream upstream of the meadow site in autumn 2006. And now they are gone again.

We collect flow and piezometer data upstream and downstream of these dams, and are looking for changes to the system that relate to these structures.

