

# **Year 1 Monitoring Report**

## **Hatchet's Grove Stream Restoration**



**April 2006**

**EEP Project No. 289**

Prepared for



NCEEP, 1652 Mail Service Center, Raleigh, NC 27699-1652

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### PLAN SHEETS

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## **I. Executive Summary / Project Abstract**

Due to historic channel modifications such as channelization and periodic dredging, Hatchet's Grove Tributary, which is located within the confines of the Prestonwood Country Club, was severely degraded. The project, located in Wake County, was designed by Soil and Environmental Consultants, PA (S&EC) using natural channel design methods and was restored in 2004. This report serves as the Year 1 Annual Monitoring report.

Monitoring of both the physical stream channel and the vegetated buffer was performed during the growing season of 2005. Within the established vegetation monitoring plots, live stem density was deemed successful. Visual channel monitoring identified several areas along the channel that have experienced localized erosion. These occurrences are typical of restoration projects within the first few years after restoration. Based on visual observation of the restored channel and in-channel structures, followed by a comparative analysis of the Year 1 and as-built data sets, the restored channels are relatively stable and exhibit very little departure (vertical or horizontal) from the as-built condition.

And while the channel is generally stable these areas of concern should be considered for repair or stabilization to ensure the future success of the project.

## **II. Project Background**

### **A. Location and Setting**

The project is located along a portion of managed golf course within the Prestonwood Country Club. The project site is specifically located approximately 2,600 feet southwest of the Morrisville-Carpenter Road (SR 3014)/Aviation Parkway (SR 3015) Intersection and approximately 3,000 feet east of Davis Drive (SR 1613), Morrisville, Wake county, North Carolina. See Sheet 1 for a vicinity map.

### **B. Structure and Objectives**

The site was chosen because of the degraded state of Hatchet's Grove Tributary. The degraded conditions were primarily the result of historical channel modifications such as channelization and periodic dredging, past vegetation maintenance practices, existing channel constraints (golf cart bridges), and the incremental increase of stormwater runoff onto the site from adjacent impervious sources.

Prior to completion on the restoration, the majority of the stream banks were nearly vertical and exposed, with minimal vegetative cover. As a result, the banks were actively eroding, subsequently slumping and promoting lateral channel migration and meander creation. The degraded channel was classified as an "F" type channel (with some sections minimally classifying as an E-type channel) under the Rosgen Stream Classification System. Some sections of channel had limited access to their historic flood plain (due to incision) during peak flood flows but not bankfull events that might typically occur as a result of the 1.5 to 2 year storm event.

The restoration plan proposed to construct a stream channel that is stable and self-maintaining that would not aggrade or degrade over time by utilizing Rosgen-based natural channel design procedures and techniques. This was accomplished by fulfilling the following objectives:

- 1) Develop a channel with the appropriate cross-sectional dimension, pattern, and longitudinal profile utilizing the existing channel condition survey, and collected reference reach data as a guide.
- 2) Improve and create bed form diversity (riffles, runs, pools, and glides).
- 3) Construct a flood plain (bankfull bench) that is accessible at the proposed bankfull channel elevation (Priority II restoration).
- 4) Insure channel and stream bank stabilization by integrating grade control structures, root wads, and native vegetation, in conjunction with the eradication or modification of current grounds maintenance practices.

- 5) Establish a native forested riparian plant community within a minimum of 30 feet, when possible, from the edge of the restored reach.
- 6) Integrate existing golf course uses with the proposed restoration plan providing aesthetic and educational values.

The project included 3,828 linear feet of stream restoration within the Hatchet's Grove Tributary while the restoration of Meadow Creek added an additional 295 linear feet of restoration. A total of 5.3 acres of buffer restoration was achieved. These figures are shown in Tables I and II.

**Table I: Project Structure Table  
Hatchet's Grove Stream and Buffer Restoration Site**

Segment/Reach ID	Linear Feet or Acreage
Restoration Reach - Hatchet's Grove	3,828 linear feet
Buffer Restoration	5.3 acres
Restoration Reach - Meadow Creek	295 linear feet

**Table II: Project Objectives Table  
Hatchet's Grove Stream and Buffer Restoration Site**

Segment/Reach ID	Objectives	Linear Feet or Acreage	Comment
Restoration Reach - Hatchet's Grove	Restoration	3828 lf	
Buffer	Restoration	5.3 ac	
Restoration Reach - Meadow Creek	Restoration	295 lf	

### **C. Project History and Background**

Construction of the Hatchet's Grove Stream Restoration was commenced in early 2004 with construction ending in May 2004. The As-built post-construction survey was completed in September 2004. 2005 served as Year 1 of the required 5-year monitoring period. Additional details regarding the timeline of the project are included as Table III.

**Table III: Project Activity and Reporting History  
Hatchet's Grove Stream and Buffer Restoration Site**

Activity or Report	Calendar Year of Completion or Planned Completion	Actual Completion Date
Restoration Plan		Oct-02
Construction		May-04
Temporary seed mix applied to entire project area		May-04
Planting		May-04
Mitigation Plan		Sep-04
As-Built report		Sep-04
Year 1 Vegetation monitoring	2005	Aug-05
Initial-Year 1 monitoring	2005	Oct-05
Year 2 monitoring	2006	
Year 3 monitoring	2007	
Year 4 monitoring	2008	
Year 5 monitoring	2009	

The project was designed by Soil and Environmental Consultants, PA (S&EC). Construction was performed by McQueen Construction Company and final planting was performed by Carolina Silvics, Inc. Monitoring activities for Year 1 were performed by S&EC. Additional information regarding contractors is shown in Table IV.

**Table IV: Project Contact Table  
Hatchet's Grove Stream and Buffer Restoration Site**

<b>Designer</b>	Soil & Environmental Consultants, PA 11010 Raven Ridge Road, Raleigh, NC 27614
<b>Construction Contractor</b>	McQueen Construction Co 619 Patrick Rd., Bahama, NC 27503
<b>Planting Contractor</b>	Carolina Silvics, Inc. 908 Indian Trail Rd, Edenton, NC 27932
<b>Seeding Contractor</b>	McQueen Construction Co 619 Patrick Rd., Bahama, NC 27503
<b>Monitoring Performers</b>	Soil & Environmental Consultants, PA 11010 Raven Ridge Road, Raleigh, NC 27614
Stream Monitoring POC	Rebecca Wargo, S&EC
Vegetation Monitoring POC	Jessica Regan, S&EC

The project is located within Wake County, portions of which are located within the Triassic Basin of the Piedmont of North Carolina. The site is located within a moderately high density residential area. Additional information regarding these streams is included as Table V.

**Table V: Project Background Table  
Hatchet's Grove Stream and Buffer Restoration Site**

<b>Project County</b>	Wake
<b>Drainage Area</b>	Hatchet's Grove - 3.7 miles
	Meadow Creek - 0.23 miles
<b>Drainage impervious cover estimate (%)</b>	30%
<b>Stream Order</b>	Hatchet's Grove - 3rd order
	Meadow Creek - 1st order
Physiographic Region	Piedmont
Ecoregion	Triassic Basin
<b>Rosgen Classification of As-Built</b>	E
Cowardin Classification	N/A
Dominant Soil Types	Chewacla, Wehadkee
Reference Site ID	N/A
USGS HUC for Project and Reference	3020201
NCDWQ Sub-basin for Project and Reference	30402
NCDWQ classification for Project	C NSW
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	N/A
% of project easement fenced	0

#### **D. Monitoring Plan View**

A series of monitoring devices have been installed on site. Permanent cross-section end points (left and right) were established utilizing sections of ½-inch rebar approximately 2 to 3 foot in length driven vertically into the ground. The pin locations are identified with painted 3-foot grade stakes labeled with the identity of the pin. A total of four (4) pairs of cross-sections were established or eight (8) individual cross-sections (6 on Hatchet's Grove and 2 on Meadow Creek). Each cross-section pair is made up of one riffle and one pool cross-section. Cross-sections were plotted from left to right facing downstream. Each cross-section is also a designated annual photo point. Each cross-section photograph is oriented facing downstream.

A total of six (6) vegetation plots were established along the length of the channel. Three are 10m x 10m square plots located within the riparian buffer with two (2) of these buffer monitoring plots consisting of bare root trees and one (1) was located in one of the shrub zones located within the play over areas. Three (3) additional plots have been established

to assess the success of species planted on the stream banks. These plots encompass both banks of the channel with corners at the top of both the left and right sides (approximately 25 feet) and are 50 feet long. All vegetation plots are marked at all corners with a 1.5" PVC stake.

The locations of all monitoring devices are shown on Sheets 3 through 6 – Monitoring Plan Views A through D.



### III. Project Condition and Monitoring Results

#### A. Vegetation Assessment

Stream restoration planting zones consisted of the riparian buffer zone and the active or bankfull channel area. The riparian buffer zone initiates at the top of the bank and continues outward perpendicular to the stream. The bankfull channel area initiates at the normal base flow elevation to the top of bank or interface with the floodplain.

The riparian buffer zone was planted with bare root trees and containerized shrubs. As described and depicted in the approved restoration plan, shrub species were planted in play over zones and the bare-root stock was planted on the remaining acreage where future tree height would not affect the field of vision for golfers.

Approximately 4,000 bare-root trees and 500 containerized shrubs consisting of 16 individual species were planted within the restored riparian zone. The riparian buffer consists of a total of 5.3 acres with an average planted density of approximately 750 trees or shrubs per acre. Bare-root trees were planted on an 8-foot by 8-foot spacing and containerized shrubs were planted at 6-foot by 6-foot spacing. Plant species are shown in the following tables:

<b>Tree Species Planted</b>	
<b>Common Name</b>	<b>Scientific Name</b>
Tulip Poplar	<i>Liriodendron tulipifera</i>
Swamp Chestnut Oak	<i>Quercus michauxii</i>
Willow Oak	<i>Quercus phellos</i>
Laurel Oak	<i>Quercus laurifolia</i>
Water Oak	<i>Quercus nigra</i>
Black Gum	<i>Nyssa sylvatica</i>
Persimmon	<i>Diospyros virginiana</i>
River Birch	<i>Betula nigra</i>

Shrub Species Planted	
Common Name	Scientific Name
Virginia Willow	<i>Itea virginica</i>
Witch-hazel	<i>Hamamelis virginiana</i>
Blueberry	<i>Vaccinium corymbosum</i>
Elderberry	<i>Sambucus canadensis</i>
Button-bush	<i>Cephalanthus occidentalis</i>
Red Chokeberry	<i>Aronia arbutifolia</i>
Yellow Root	<i>Xanthorhiza simplicissima</i>
Silky Dogwood	<i>Cornus amomum</i>

The bankfull channel area was live staked with black willow (*Salix nigra*), silky dogwood (*Cornus amomum*) and elderberry (*Sambucus canadensis*). Black willow composition was limited to approximately 25% of the total stakes installed.

Permanent seeding consisted of switch grass (*Panicum virgatum*), black-eyed Susan (*Rudbeckia hirta*), Virginia wild rye (*Elymus virginus*), and Arrow wood (*Viburnum dentatum*).

## 1. Soils Data

The project site is located in the Triassic Basin region of the North Carolina Piedmont physiographic province. Soils present in the riparian areas adjacent to Hatchet's Grove Tributary are characteristic of those found in alluvial landforms in the Triassic Basin. However, extensive grading and filling associated with the golf course has likely modified much of the naturally occurring soils on site.

Chewacla soils (*Aquic Fluventic Dystrochrepts*) are the prevalent map unit along the channel. Formed in fine loamy alluvial material, they are somewhat poorly drained with low natural fertility. Wehadkee soils (*Fluventic Haplaquepts*) are present along the channel to a lesser extent. These soils are also formed in fine loamy alluvial material, and are poorly drained with low fertility. As Hatchet's Grove Branch nears Crabtree Creek, it enters a large, contiguous area of Congaree (*Typic Udifluvents*) mapped immediately adjacent and parallel to Crabtree Creek. These are also alluvial soils with low fertility frequently found on floodplains.

Other soils in the project's vicinity include Augusta (*Aeric Ochraqults*) and Wahee (*Aeric Ochraqults*), which are often mapped on terraces. In the upland areas surrounding the project, Mayodan (*Typic Hapludults*) and Creedmoor (*Aquic Hapludults*) are the predominate soil series, which are both closely associated with the Triassic Basin landscape.

**Table VIII: Preliminary Soil Data  
Hatchet's Grove Stream and Buffer Restoration Site**

<b>Series</b>	<b>Max Depth (in.)</b>	<b>% Clay on Surface</b>	<b>K</b>	<b>T</b>	<b>OM %</b>
Chewacla (Cm)	60	10-35	0.28	5	1.0-4.0
Wehadkee (Wn)	84	5-20	0.24	5	2.0-5.0
Congaree (Cp)	70	10-25	0.37	5	1.0-4.0
Augusta (Au)	70	5-20	0.2	5	1.0-2.0
Wahee (Wh)	60	10-27	0.28	5	0.5-5.0
Mayodan (MyD)	79	4-20	0.43	3	0.5-2.0
Creedmor (CrB2)	99	7-20	0.28	3	0.5-2.0

## **2. Problem Areas Plan View (vegetation)**

Upon inspection on September 17, 2005, it was noted that several areas along the banks of Hatchet's Grove and its floodplain have suffered localized loss of vegetation. It is suspected that large overbank flows which occurred before the newly planted vegetation had sufficient time to establish roots strong enough to withstand flow. There are several areas with exposed soil as indicated on the problem area plan view as "Bare Bank."

**Table IX: Vegetative Problem Areas  
Hatchet's Grove Stream and Buffer Restoration Site - Hatchet's Grove**

<b>Feature Issues</b>	<b>Station numbers</b>	<b>Suspected Cause</b>	<b>Photo number</b>
Bare Bank	6+50 to 7+25	overbank flow	N/A
	23+50 to 24+00	overbank flow	

## **3. Vegetative Problem Areas Plan View**

Vegetative problem areas are shown on Sheets 7 through 10 – Problem Area Plan View E through H.

#### 4. Stem Counts

On August 4, 2005, S&EC conducted vegetation counts within each of the established plots as described above. The results of this survey are shown below in Table X.

**Table X: Stem Counts for Each Species Arranged by Plot  
Hatchet's Grove Stream and Buffer Restoration Site**

Species	Plots						Year 1 Totals
	Bank			Buffer			
	1	2	3	1	2	3	
<b>Swamp Chestnut Oak</b> <i>(Quercus michauxii)</i>		4			18	2	24
<b>Willow Oak</b> <i>(Quercus phellos)</i>	1					4	5
<b>Laurel Oak</b> <i>(Quercus laurifolia)</i>						1	1
<b>Black Willow</b> <i>(Salix Nigra)</i>	1	16	12	1			30
<b>Black Gum</b> <i>(Nyssa sylvatica)</i>						1	1
<b>Persimmon</b> <i>(Diospyros virginiana)</i>						7	7
<b>River Birch</b> <i>(Betula nigra)</i>		1				1	2
<b>Virginia Willow</b> <i>(Itea virginica)</i>				3		7	10
<b>Witch-hazel</b> <i>(Hamamelis virginiana)</i>		1	1	4			6
<b>Elderberry</b> <i>(Sambucus canadensis)</i>		8		2			10
<b>Red Chokeberry</b> <i>(Aronia arbutifolia)</i>						2	2
<b>Silky Dogwood</b> <i>(Cornus amomum)</i>	31		31	9			71
<b>Year 1 Totals</b>	<b>33</b>	<b>30</b>	<b>44</b>	<b>19</b>	<b>18</b>	<b>25</b>	<b>169</b>

Utilizing live stem densities from the buffer plots (which comprise an area of 3229.5 square feet) the 2005 vegetation monitoring of the site revealed an average tree density of approximately 836 stems per acre. While this density is greater than was recommended in the planting plan, it appears the original planting density was higher than originally prescribed.

## **5. Vegetation Photo Plots**

Photos taken during the August 4, 2005, vegetation sampling event are included in Appendix A.

## B. Stream Assessment

### 1. Problem Areas Plan View (stream)

An assessment of the stability of the channel was performed on September 17, 2005, by S&EC. Several areas of concern were observed and documented including localized bank scour, overbank scour, and several failing structures. These problem areas are shown on Sheets 7 through 10 – Problem Area Plan Views E through H.

Several cross-sections display minor downcutting of the channel. It is our opinion that this downcutting is due to the placement of structures, and not to any instability within the channel.

On at least two occasions, evidence of overbank events onsite was observed. It is our opinion that at least two bankfull events have occurred, however, it is unknown how many, as no crest gauge is installed on-site.

### 2. Problem Areas Table Summary

**Table XIa: Stream Problem Areas  
Hatchet's Grove Stream and Buffer Restoration Site - Hatchet's Grove**

<b>Feature Issues</b>	<b>Station numbers</b>	<b>Suspected Cause</b>	<b>Photo number</b>
Bank Scour	0+50 to 1+00	high velocity/excess shear	Stream Problem Areas 1-2
	2+75	high velocity/excess shear	
	4+80 to 5+60	high velocity/excess shear	
	6+50 to 7+25	high velocity/excess shear	
	7+50	high velocity/excess shear	
	8+00 to 8+50	high velocity/excess shear	
	10+25 to 11+00	high velocity /excess shear	
	11+50 to 12+00	high velocity/excess shear	
	18+50 to 19+00	high velocity/excess shear	
	23+50 to 24+00	high velocity /excess shear	
	31+00 to 31+75	high velocity/excess shear	
Overbank Scour	3+25	floodplain drainage/stormwater outfall	N/A
	6+00	floodplain drainage/stormwater outfall	
	10+50	downstream of sewer pipe	
	25+00	floodplain drainage/stormwater outfall	

	28+50	floodplain drainage/stormwater outfall	
Failing Structures	3+25 to 3+50	rootwad scour	Stream Problem Areas 3-4
	5+25	rock shift on arm	
	6+50	collapsed sill	
	14+50	rootwad scour	
	18+50	scour at arm	
	22+75	arms of crossvane failed	
	25+25	rootwad scour	
	26+25	rootwad scour	
	31+25	rootwad scour	
	31+75	rock shift at apex of vane	
	32+50	footer rock shift (left arm)	
	14+50	rootwad scour	
	18+50	scour at arm	
	22+75	arms of crossvane failed	
	25+25	rootwad scour	
	26+25	rootwad scour	
	31+25	rootwad scour	
	31+75	rock shift at apex of vane	
	32+50	footer rock shift (left arm)	

**Table XIb: Stream Problem Areas  
Hatchet's Grove Stream and Buffer Restoration Site - Meadow Creek**

<b>Feature Issues</b>	<b>Station numbers</b>	<b>Suspected Cause</b>	<b>Photo number</b>
Bed Scour	2+75		
Failing Structures	1+00	Wood Sill Undermined	

### 3. Numbered Issues Photo Section

Representative photos of each category of stream problem area were taken and are shown in Appendix B.

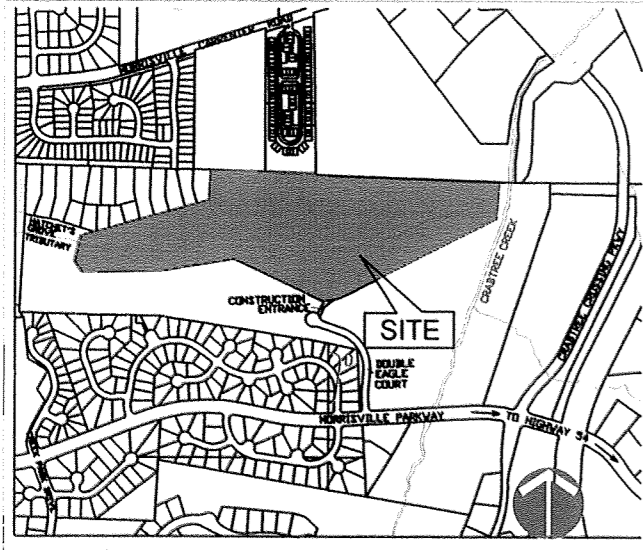
#### **4. Fixed Station Photos**

Photos from established photo stations were collected on October 14, 2005 during the stream survey. These photos are included in Appendix B along with the photos taken during the As-built post-construction survey.



**PLAN SHEETS**

# MONITORING YEAR I DRAWINGS FOR:



VICINITY MAP  
NOT TO SCALE

# HATCHET'S GROVE TRIBUTARY STREAM RESTORATION PROJECT PRESTONWOOD GOLF COURSE WAKE CO., NC

## CONTENTS:

1. COVER, CONTENTS, AND VICINITY MAP
2. RESTORATION SITE LAYOUT & KEYSHEET
3. MONITORING PLAN VIEW - A
4. MONITORING PLAN VIEW - B
5. MONITORING PLAN VIEW - C
6. MONITORING PLAN VIEW - D
7. PROBLEM AREA PLAN VIEW - E
8. PROBLEM AREA PLAN VIEW - F
9. PROBLEM AREA PLAN VIEW - G
10. PROBLEM AREA PLAN VIEW - H

## ENVIRONMENTAL DESIGN FIRM:

SOIL & ENVIRONMENTAL  
CONSULTANTS, PA  
11010 Raven Ridge Road  
Raleigh, NC 27614  
(919) 846-5900

## PREPARED FOR:

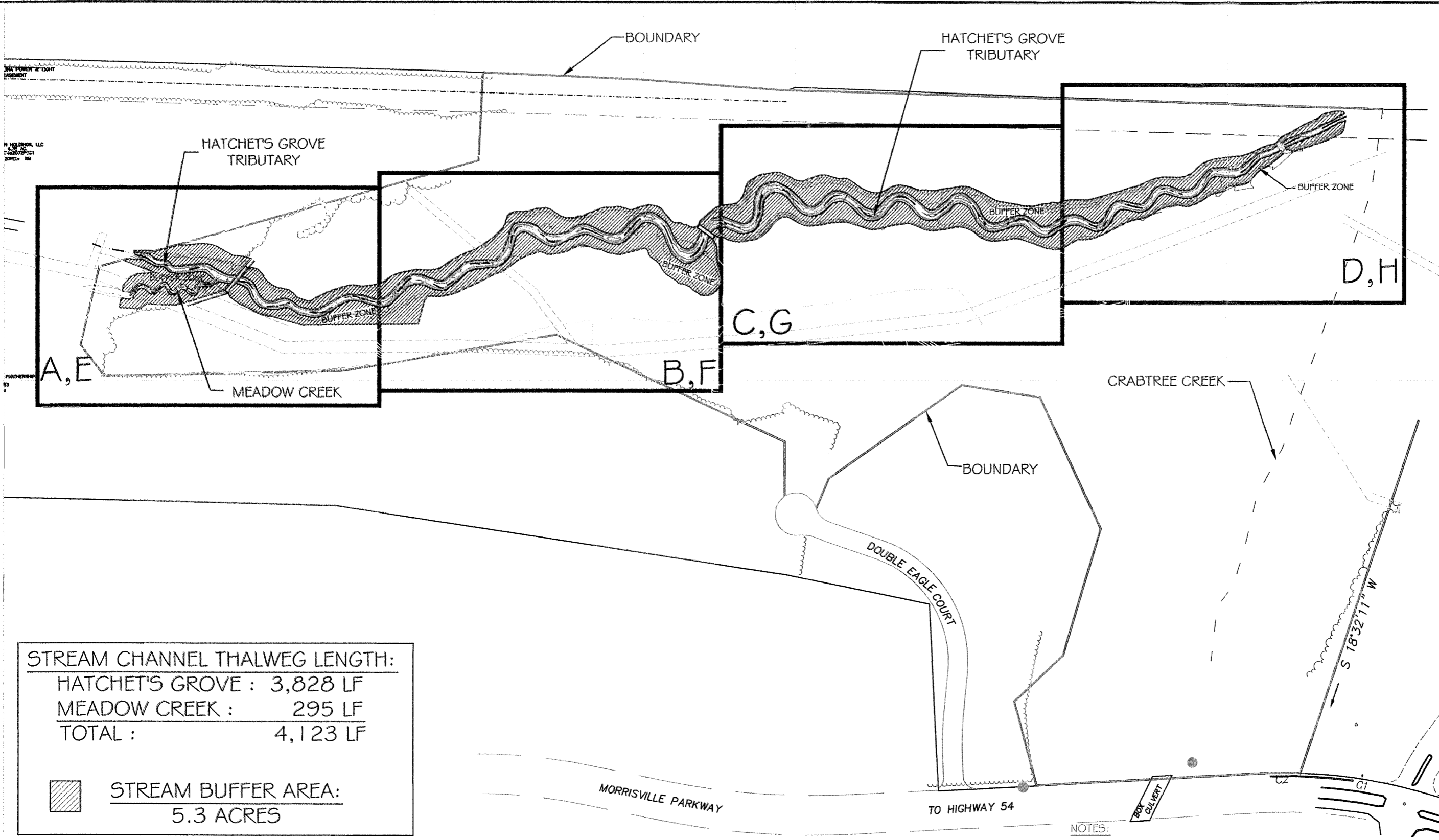
ECOSYSTEM ENHANCEMENT  
PROGRAM  
1652 Mail Service Center  
Raleigh, NC 27699-1652  
(919) 715-1828



Project No.: 6761	Drawn: EGT, MM
Designed: PAJ	Scale: NO SCALE
Client: ECOSYSTEM ENHANCEMENT PROGRAM	
Location: WAKE CO., NC	
Sheet Title: COVER, CONTENTS, & VICINITY MAP	
Sheet No.: 1 OF 10	


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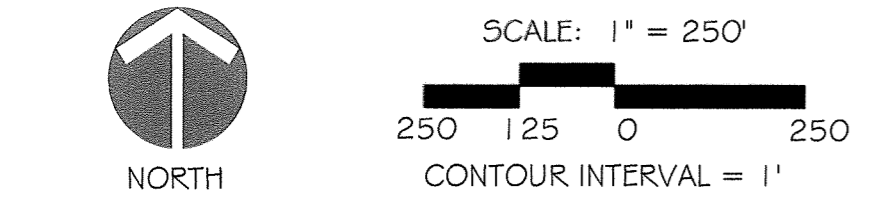




STREAM CHANNEL THALWEG LENGTH:	
HATCHET'S GROVE :	3,828 LF
MEADOW CREEK :	295 LF
TOTAL :	4,123 LF

	STREAM BUFFER AREA:
	5.3 ACRES



# RESTORATION SITE LAYOUT & KEYSHEET

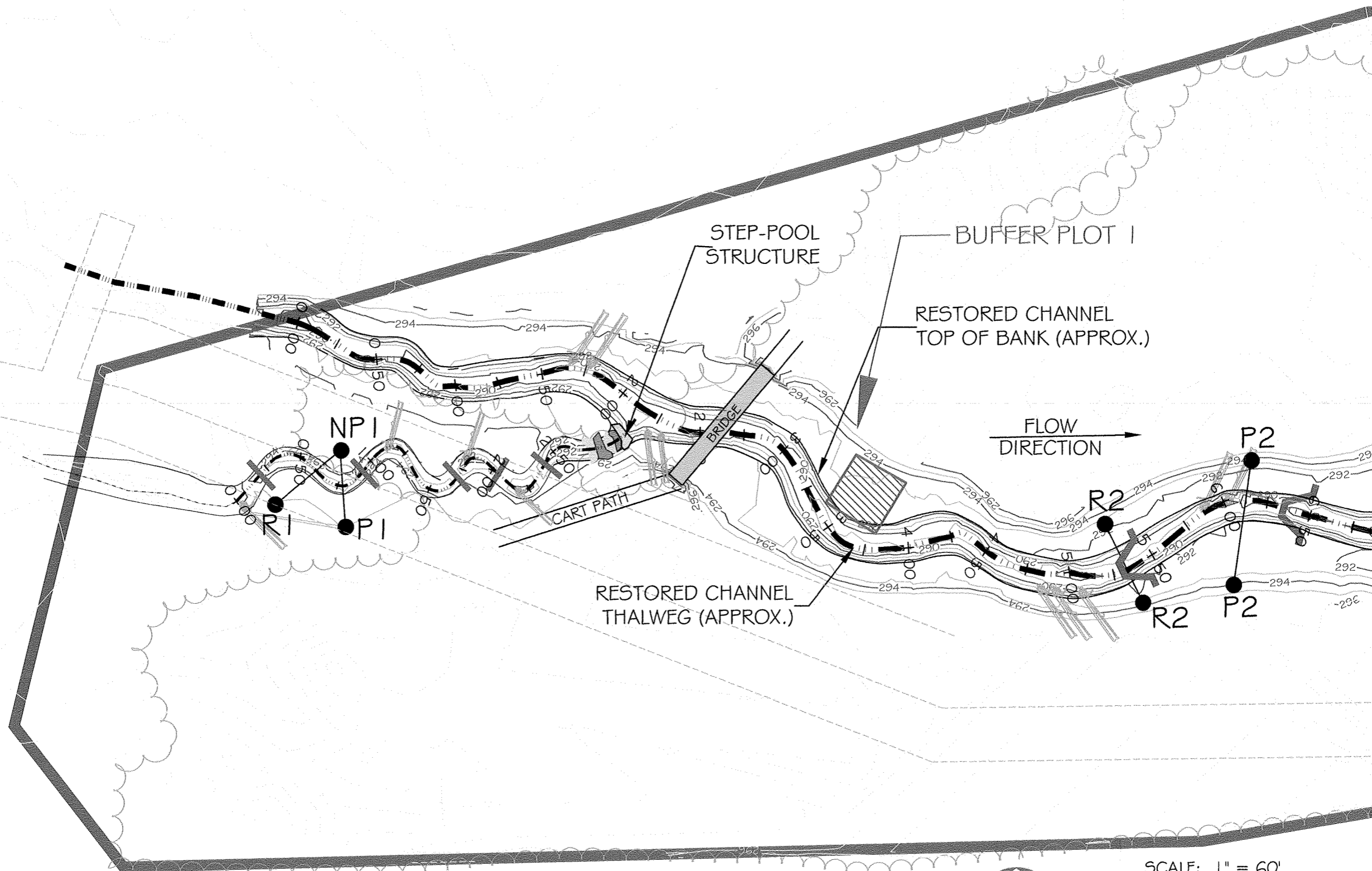
- NOTES:
- 1) THE PURPOSE OF THIS PLAT IS TO SHOW LOCATION OF RESTORED STREAM CHANNEL WITH CONTOURS AND ELEVATIONS. CONTOURS DO NOT REFLECT PRESTONWOOD GOLF COURSE TOPOGRAPHY. ALL CONTOURS ARE APPROXIMATE.
  - 2) ORIGINAL BOUNDARY AND TOPOGRAPHIC DATA PROVIDED BY WITHERS & RAVENEL, CARY, NC.
  - 3) AS-BUILT SURVEY DATA PROVIDED BY WITHERS & RAVENEL & INCORPORATED INTO SITE PLAT.
  - 4) SEE SHEETS 3-6 FOR CONSTRUCTED SITE FEATURES AND GRADING.
  - 5) FOR CHANNEL THALWEG ELEVATIONS, REFER TO LONGITUDINAL PROFILE.
  - 6) THIS IS NOT A BOUNDARY SURVEY AND IS NOT FOR RECORDATION, CONVEYANCE, OR SALES.

Project No: G7G1  
 Drawn: PAJ  
 EGT, MM  
 Scale: 1" = 250'  
 Sheet No: 2 OF 10

HATCHET'S GROVE at PRESTONWOOD  
 MONITORING YEAR 1 DRAWINGS  
 WAKE CO., NC  
 ECOSYSTEM ENHANCEMENT PROGRAM  
 RESTORATION SITE LAYOUT & KEYSHEET

**Soil & Environmental Consultants, PA**  
 11010 Raven Ridge Road • Raleigh, North Carolina 27614 • Phone: (919) 846-5900 • Fax: (919) 846-9467  
 www.StandEC.com





LEGEND	
	CHANNEL SILL
	ROCK J-HOOK
	ROCK CROSS-VANE
	ROOT WAD
	PERMANENT CROSS-SECTION LOCATION

# MONITORING PLAN VIEW - A



SCALE: 1" = 60'  
  
 CONTOUR INTERVAL = 1'

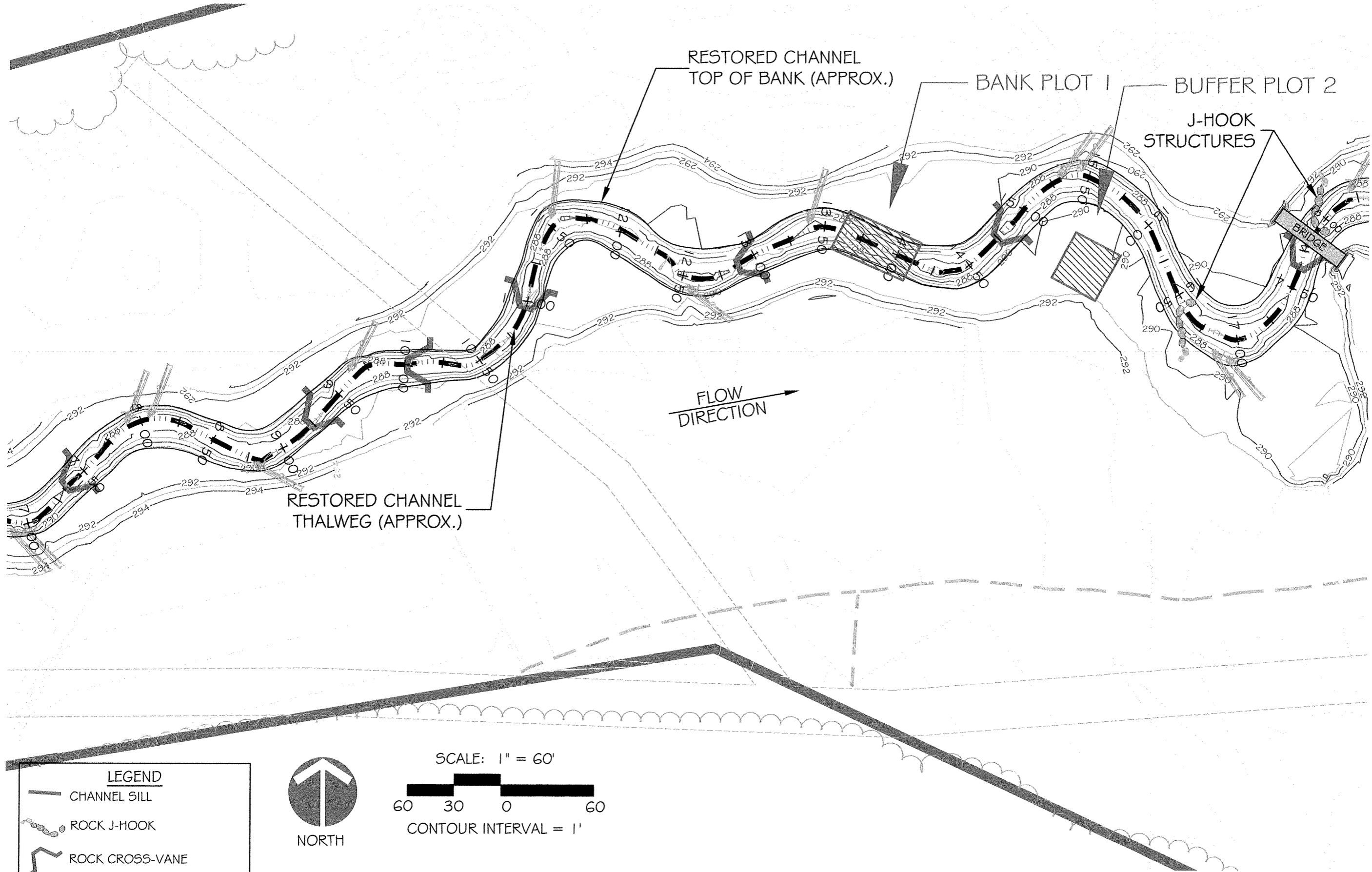
- NOTES:
- 1) ALL CONTOURS ARE APPROXIMATE.
  - 2) FOR CHANNEL THALWEG ELEVATIONS, PLEASE REFER TO LONGITUDINAL PROFILE ON SHEET 7.
  - 3) STATIONS DENOTE LENGTH ALONG THALWEG.
  - 4) LOCATIONS OF CROSS-VANES AND ROOT WADS ARE APPROXIMATE.

Project No.: 6761	Drawn: EGT, MM
Designed: PAJ	Scale: 1" = 60'
Client: WAKE CO., NC	Sheet No.: 3 OF 10
Project: HATCHET'S GROVE at PRESTONWOOD	
Monitoring Year 1 Drawings	
Client: ECOSYSTEM ENHANCEMENT PROGRAM	
Location: WAKE CO., NC	
Sheet Title: MONITORING PLAN VIEW - A	

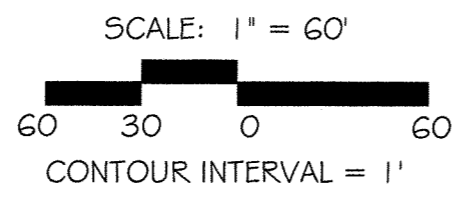
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File: \\s22\user4-61676\1\Year 1\Monitoring\Drawings\mon plan view.dwg



LEGEND	
	CHANNEL SILL
	ROCK J-HOOK
	ROCK CROSS-VANE
	ROOT WAD
	PERMANENT CROSS-SECTION LOCATION



# MONITORING PLAN VIEW - B

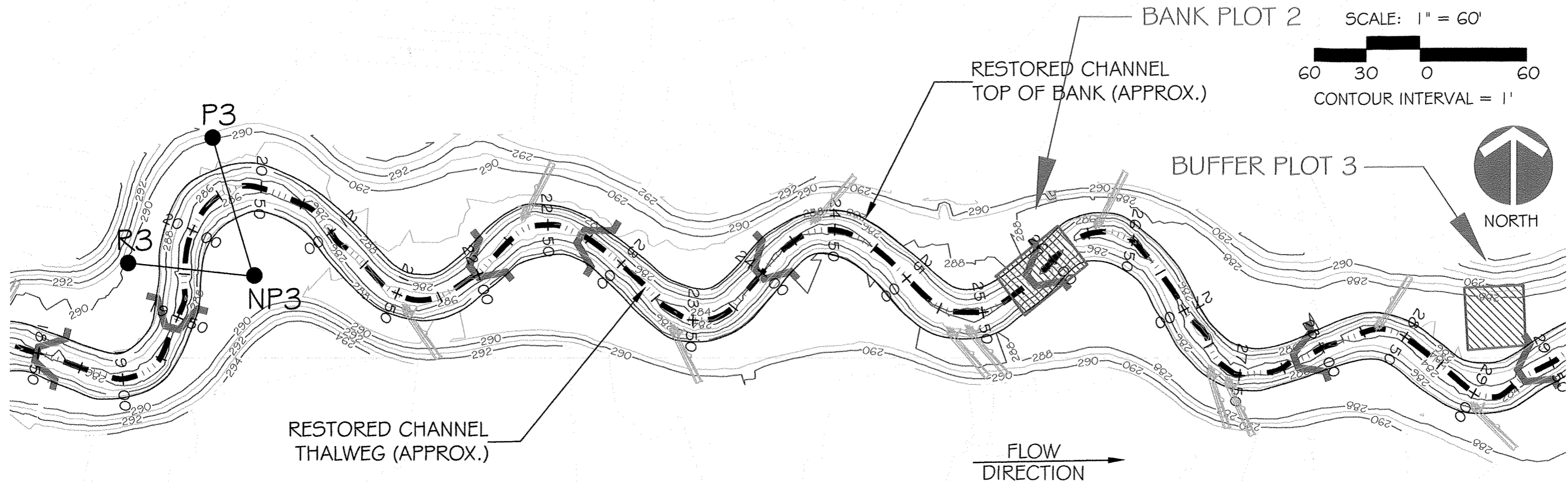
- NOTES:
- 1) ALL CONTOURS ARE APPROXIMATE.
  - 2) FOR CHANNEL THALWEG ELEVATIONS, PLEASE REFER TO LONGITUDINAL PROFILE ON SHEET 7.
  - 3) STATIONS DENOTE LENGTH ALONG THALWEG.
  - 4) LOCATIONS OF CROSS-VANES AND ROOT WADS ARE APPROXIMATE.

Project No.: 6761	Drawn: EGT, MM
Designed: PAJ	Scale: 1" = 60'
Client: ECOSYSTEM ENHANCEMENT PROGRAM	
Sheet No.: 4 OF 10	

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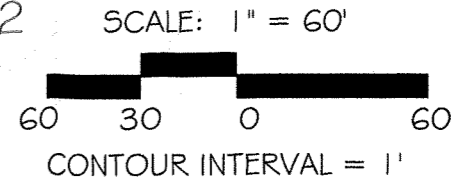


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RESTORED CHANNEL  
THALWEG (APPROX.)

FLOW  
DIRECTION



Vegetation Monitoring Plot Coordinates					
	Easting	Northing		Easting	Northing
Bank 1	2049351	751752.1	Buffer 1	2048517	751600.6
Bank 2	2050271	751803.9	Buffer 2	2049495	751739.8
Bank 3	2050832	751859.6	Buffer 3	2050518	751786.8

Permanent Cross-Section Coordinates			
		Easting	Northing
Cross-section 1 (Meadow Creek)	Base Point	2048244	751630
	Riffle Endpoint	2048207	751599
	Pool Endpoint	2048247	751587
Cross-section 2	Riffle Endpoint 1	2048673	751589
	Riffle Endpoint 2	2048696	751544
	Pool Endpoint 1	2048756	751624
	Pool Endpoint 2	2048746	751554
Cross-section 3	Base Point	2049836	751829
	Riffle Endpoint	2049763	751836
	Pool Endpoint	2049813	751906
Cross-section 4	Base Point	2050653	751819
	Riffle Endpoint	2050616	751753
	Pool Endpoint	2050680	751763

LEGEND	
	CHANNEL SILL
	ROCK J-HOOK
	ROCK CROSS-VANE
	ROOT WAD
	PERMANENT CROSS-SECTION LOCATION

# MONITORING PLAN VIEW - C

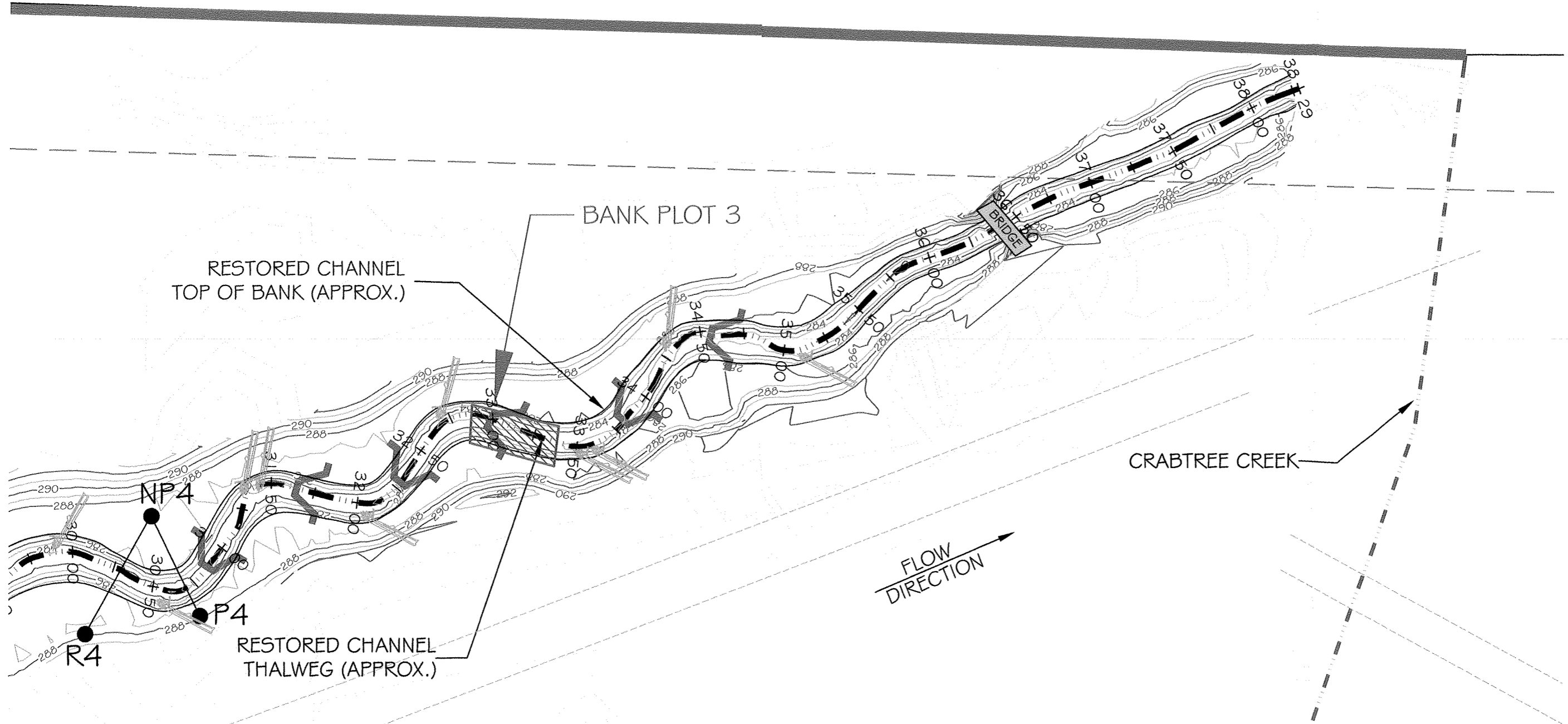
- NOTES:
- 1) ALL CONTOURS ARE APPROXIMATE.
  - 2) FOR CHANNEL THALWEG ELEVATIONS, PLEASE REFER TO LONGITUDINAL PROFILE ON SHEET 7.
  - 3) STATIONS DENOTE LENGTH ALONG THALWEG.
  - 4) LOCATIONS OF CROSS-VANES AND ROOT WADS ARE APPROXIMATE.

Project No.: 6761  
 Designed: PAJ  
 Drawn: EGT, MM  
 Scale: 1" = 60'  
 Sheet No.: 5 OF 10

HATCHET'S GROVE AT PRESTONWOOD  
 MONITORING YEAR 1 DRAWINGS  
 WAKE CO., NC  
 ECOSYSTEM  
 ENHANCEMENT PROGRAM  
 MONITORING PLAN  
 VIEW - C

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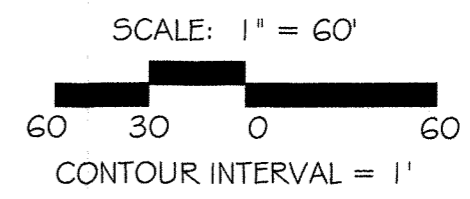




LEGEND	
	CHANNEL SILL
	ROCK J-HOOK
	ROCK CROSS-VANE
	ROOT WAD
	PERMANENT CROSS-SECTION LOCATION

- NOTES:
- 1) ALL CONTOURS ARE APPROXIMATE.
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# MONITORING PLAN VIEW - D



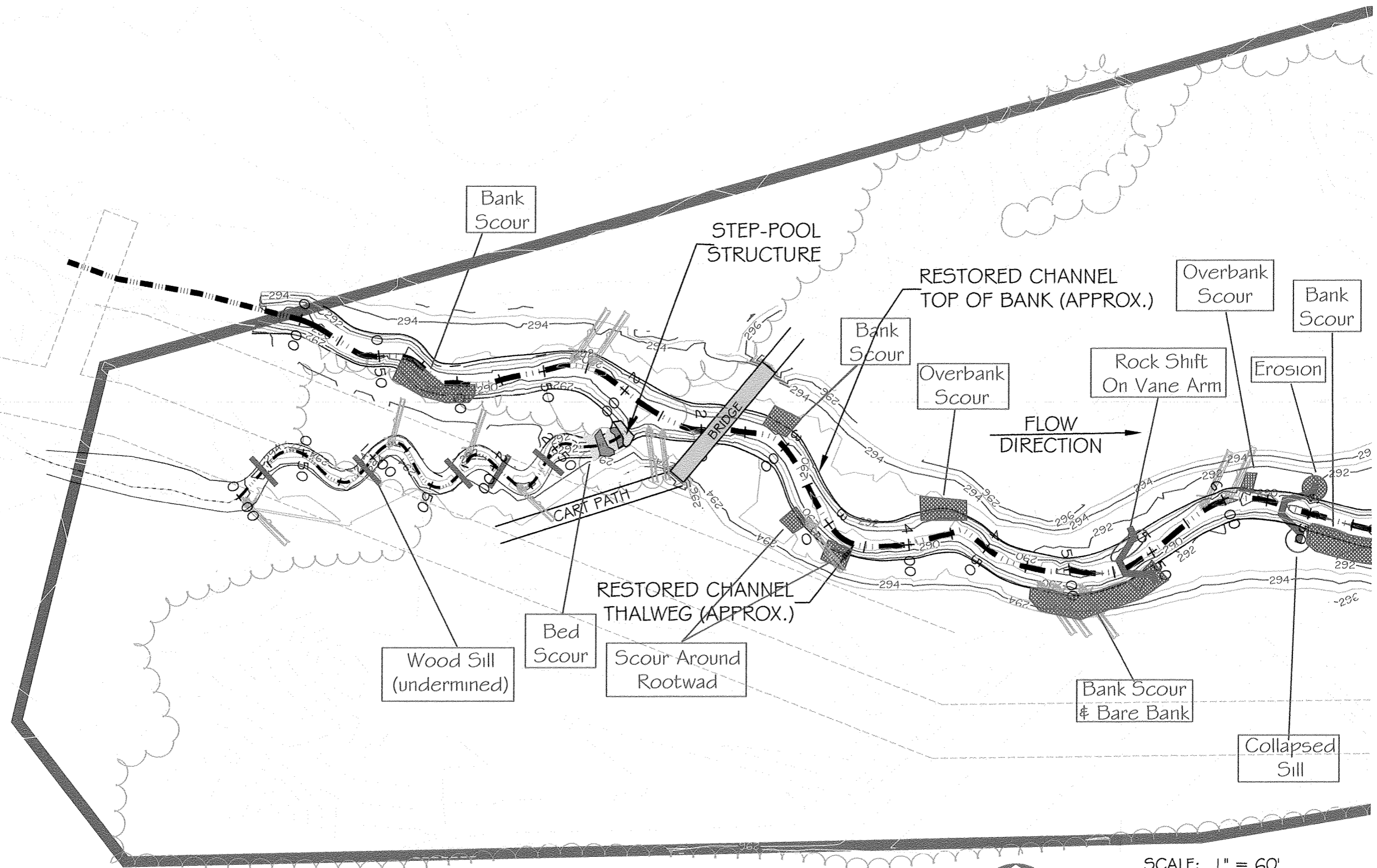
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HATCHET'S GROVE at PRESTONWOOD MONITORING YEAR 1 DRAWINGS		Client: ECOSYSTEM ENHANCEMENT PROGRAM	
WAKE CO., NC		MONITORING PLAN VIEW - D	

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LEGEND	
	CHANNEL SILL
	ROCK CROSS-VANE
	ROOT WAD
	ROCK J-HOOK

BOUNDARY

# PROBLEM AREA PLAN VIEW - E



SCALE: 1" = 60'

CONTOUR INTERVAL = 1'

- NOTES:
- 1) ALL CONTOURS ARE APPROXIMATE.
  - 2) FOR CHANNEL THALWEG ELEVATIONS, PLEASE REFER TO LONGITUDINAL PROFILE ON SHEET 7.
  - 3) STATIONS DENOTE LENGTH ALONG THALWEG.
  - 4) LOCATIONS OF CROSS-VANES AND ROOT WADS ARE APPROXIMATE.

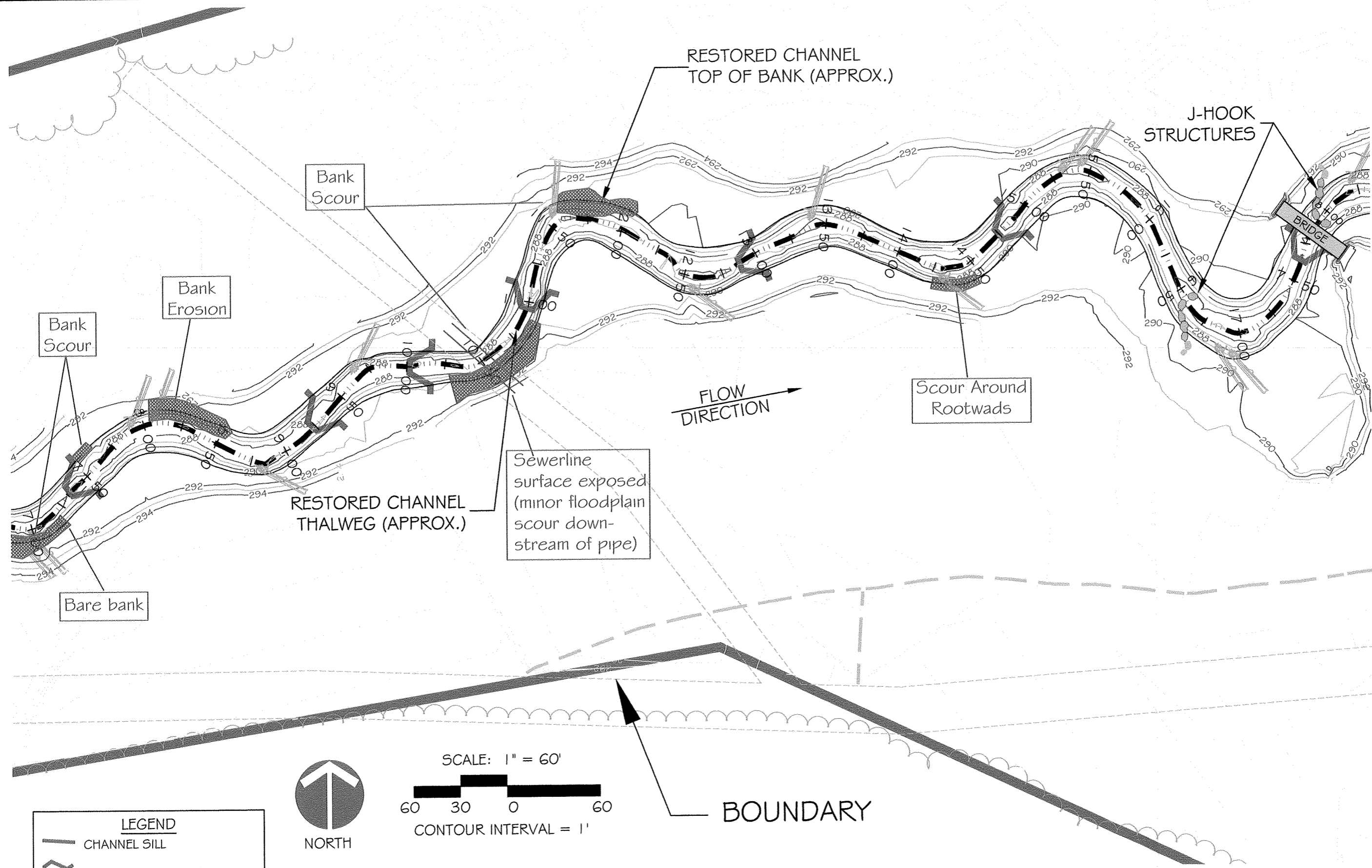
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 Drawn: EGT, MM  
 Checked: PAJ  
 Scale: 1" = 60'  
 Sheet No.: 7 OF 10

HATCHETS GROVE at PRESTONWOOD  
 MONITORING YEAR 1 DRAWINGS  
 CLIENT: ECOSYSTEM ENHANCEMENT PROGRAM  
 LOCATION: WAKE CO., NC  
 SHEET TITLE: PROBLEM AREA PLAN VIEW - E

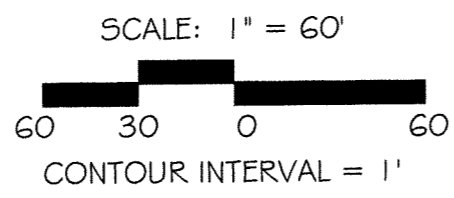
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LEGEND	
	CHANNEL SILL
	ROCK CROSS-VANE
	ROOT WAD
	ROCK J-HOOK



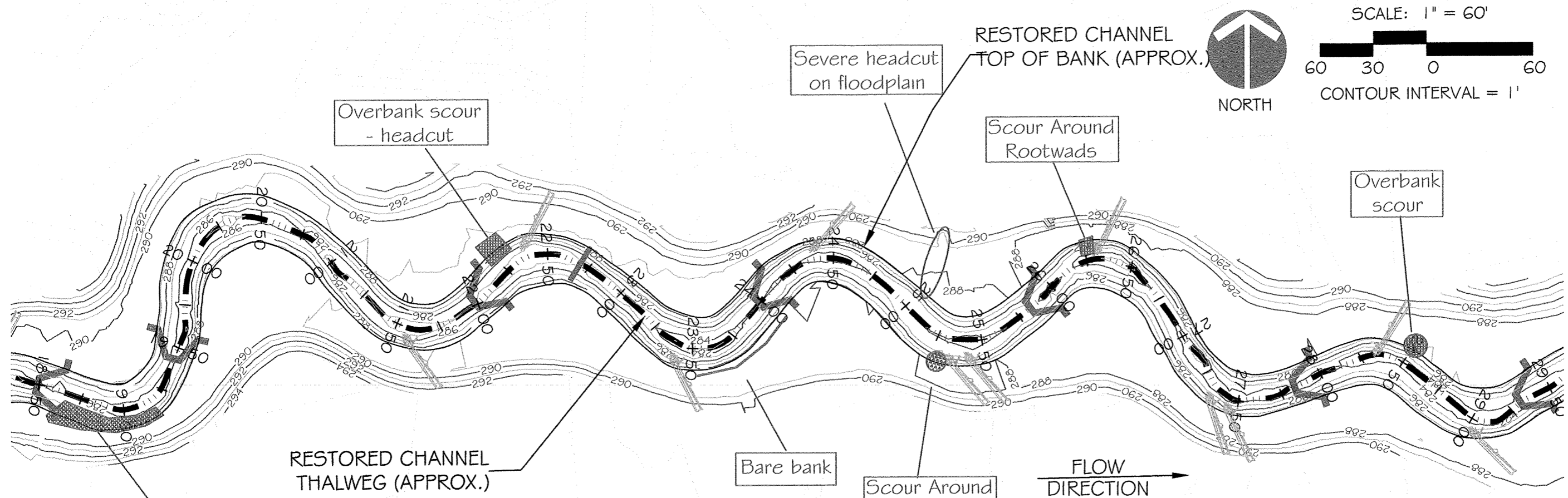
# PROBLEM AREA PLAN VIEW - F

- NOTES:
- 1) ALL CONTOURS ARE APPROXIMATE.
  - 2) FOR CHANNEL THALWEG ELEVATIONS, PLEASE REFER TO LONGITUDINAL PROFILE ON SHEET 7.
  - 3) STATIONS DENOTE LENGTH ALONG THALWEG.
  - 4) LOCATIONS OF CROSS-VANES AND ROOT WADS ARE APPROXIMATE.

Project No.: 6761	Drawn: EGT, MM	Scale: 1" = 60'	Sheet No.: 8 OF 10
Designed: PAJ	Client: ECOSYSTEM ENHANCEMENT PROGRAM	PROBLEM AREA PLAN VIEW - F	
Project: HATCHETS GROVE at PRESTONWOOD MONITORING YEAR 1 DRAWINGS			
Location: WAKE CO., NC			

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Project No.: 6761  
 Drawn: FAJ  
 EGT, MM  
 Scale: 1" = 60'  
 Sheet No.: 9 OF 10

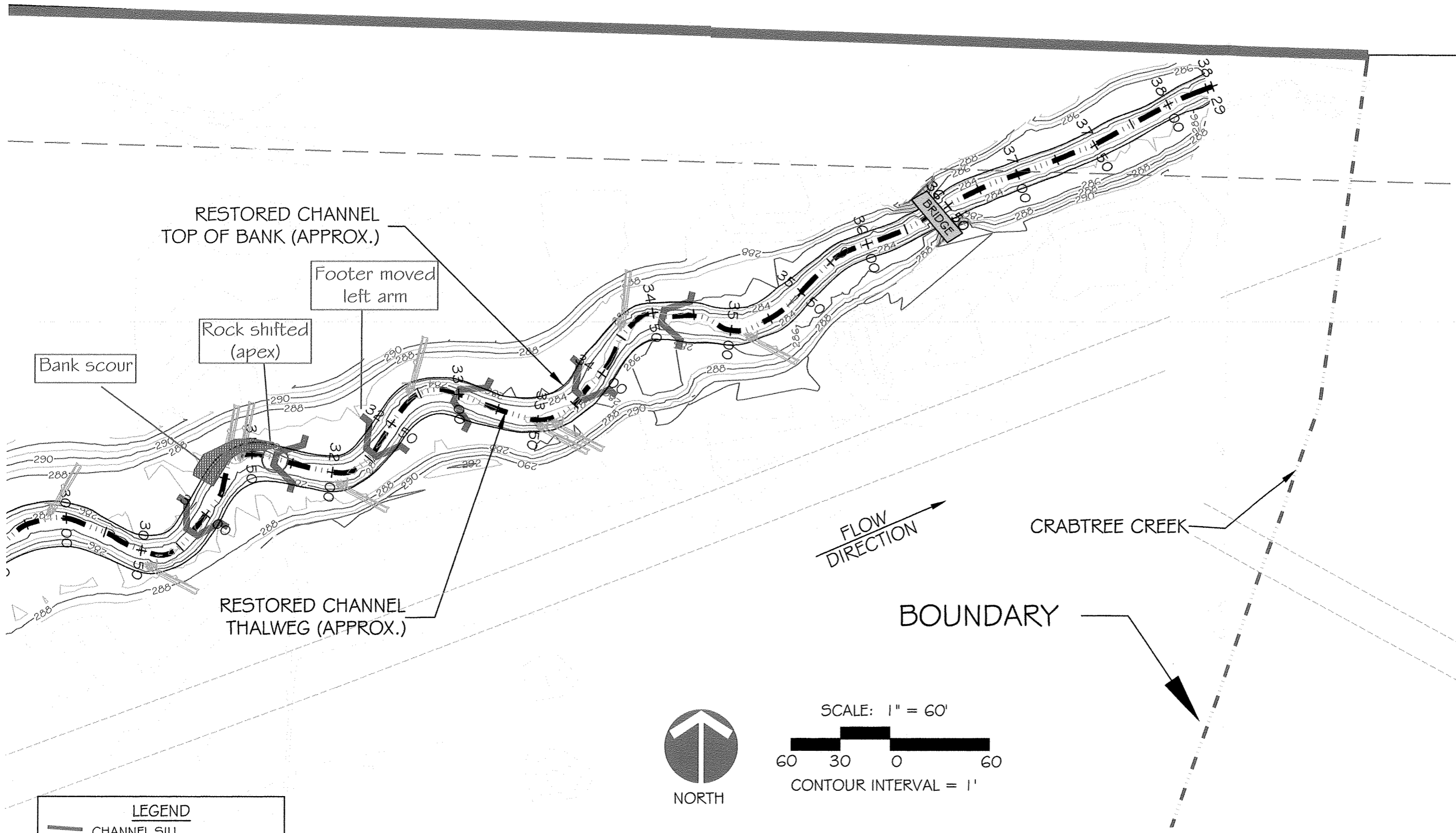
HATCHET'S GROVE at PRESTONWOOD  
 MONITORING YEAR 1 DRAWINGS  
 ECOSYSTEM  
 ENHANCEMENT PROGRAM  
 WAKE CO., NC  
 PROBLEM AREA  
 PLAN VIEW - G

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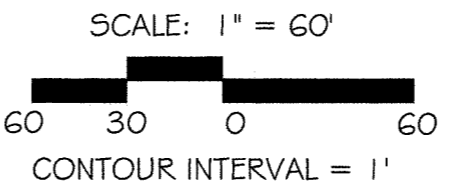
LEGEND	
	CHANNEL SILL
	ROCK CROSS-VANE
	ROOT WAD
	ROCK J-HOOK

## PROBLEM AREA PLAN VIEW - G

- NOTES:
- 1) ALL CONTOURS ARE APPROXIMATE.
  - 2) FOR CHANNEL THALWEG ELEVATIONS, PLEASE REFER TO LONGITUDINAL PROFILE ON SHEET 7.
  - 3) STATIONS DENOTE LENGTH ALONG THALWEG.
  - 4) LOCATIONS OF CROSS-VANES AND ROOT WADS ARE APPROXIMATE.



LEGEND	
	CHANNEL SILL
	ROCK CROSS-VANE
	ROOT WAD
	ROCK J-HOOK



# PROBLEM AREA PLAN VIEW - H

- NOTES:
- 1) ALL CONTOURS ARE APPROXIMATE.
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  - 3) STATIONS DENOTE LENGTH ALONG THALWEG.
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Project No.: 6761	Drawn: EGT, MM
Designed: PAJ	Client: ECOSYSTEM ENHANCEMENT PROGRAM
Scale: 1" = 60'	Location: WAKE CO., NC
Sheet No.: 10 OF 10	Sheet Title: PROBLEM AREA PLAN VIEW - H

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## **APPENDIX A**

**Table VIII: Stem Counts for Each Species Arranged by Plot  
Hatchet's Grove Stream and Buffer Restoration Site**

Species	Plots						Year 1 Totals
	Bank			Buffer			
	1	2	3	1	2	3	
<i>Swamp Chestnut Oak</i> ( <i>Quercus michauxii</i> )		4			18	2	24
<i>Willow Oak</i> ( <i>Quercus phellos</i> )	1					4	5
<i>Laurel Oak</i> ( <i>Quercus laurifolia</i> )						1	1
<i>Black Willow</i> ( <i>Salix Nigra</i> )	1	16	12	1			30
<i>Black Gum</i> ( <i>Nyssa sylvatica</i> )						1	1
<i>Persimmon</i> ( <i>Diospyros virginiana</i> )						7	7
<i>River Birch</i> ( <i>Betula nigra</i> )		1				1	2
<i>Virginia Willow</i> ( <i>Itea virginica</i> )				3		7	10
<i>Witch-hazel</i> ( <i>Hamamelis virginiana</i> )		1	1	4			6
<i>Elderberry</i> ( <i>Sambucus canadensis</i> )		8		2			10
<i>Red Chokeberry</i> ( <i>Aronia arbutifolia</i> )						2	2
<i>Silky Dogwood</i> ( <i>Cornus amomum</i> )	31		31	9			71
<b>Year 1 Totals</b>	<b>33</b>	<b>30</b>	<b>44</b>	<b>19</b>	<b>18</b>	<b>25</b>	<b>169</b>



Vegetative Problem Area—Bare Bank



Buffer Vegetation Plot 1— Year 1



Bank Vegetation Plot 1— Year 1



Buffer Vegetation Plot 2—Year 1



Bank Vegetation Plot 2—Year 1



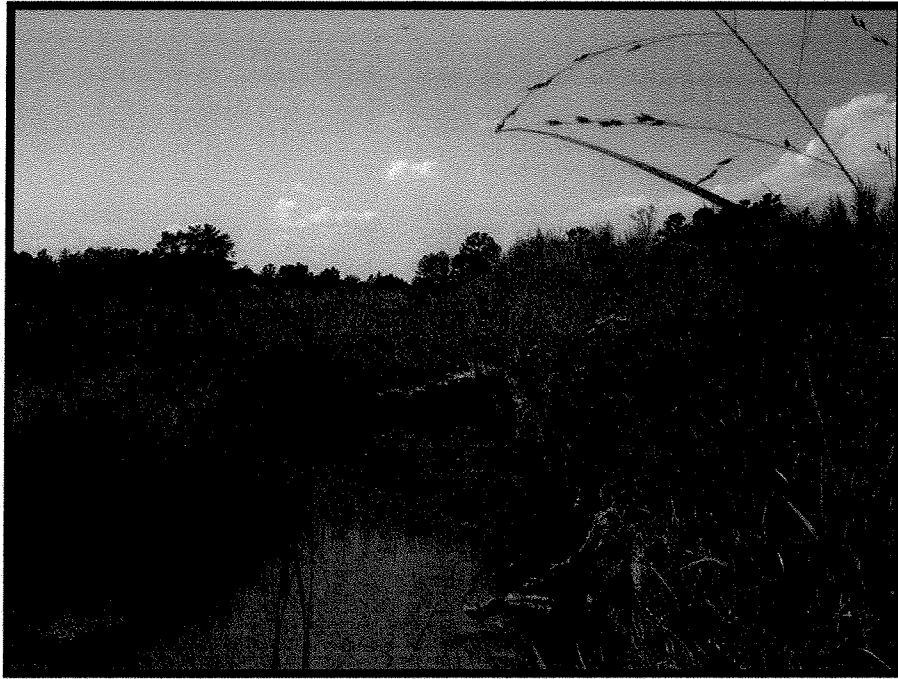


Buffer Vegetation Plot 3—Year 1



Bank Vegetation Plot 3—Year 1

## **APPENDIX B**



Stream Problem Area 1—Bank Erosion



Stream Problem Area 2—Bank Erosion



Stream Problem Area 3—Failing Structure



Stream Problem Area 4—Failing Structure



Riffle 1—As-Built



Riffle 1— Year 1



Pool 1— As-Built



Pool 1— Year 1



Riffle 2—As-built



Riffle 2—Year 1



Pool 2—As-built



Pool 2—Year 1

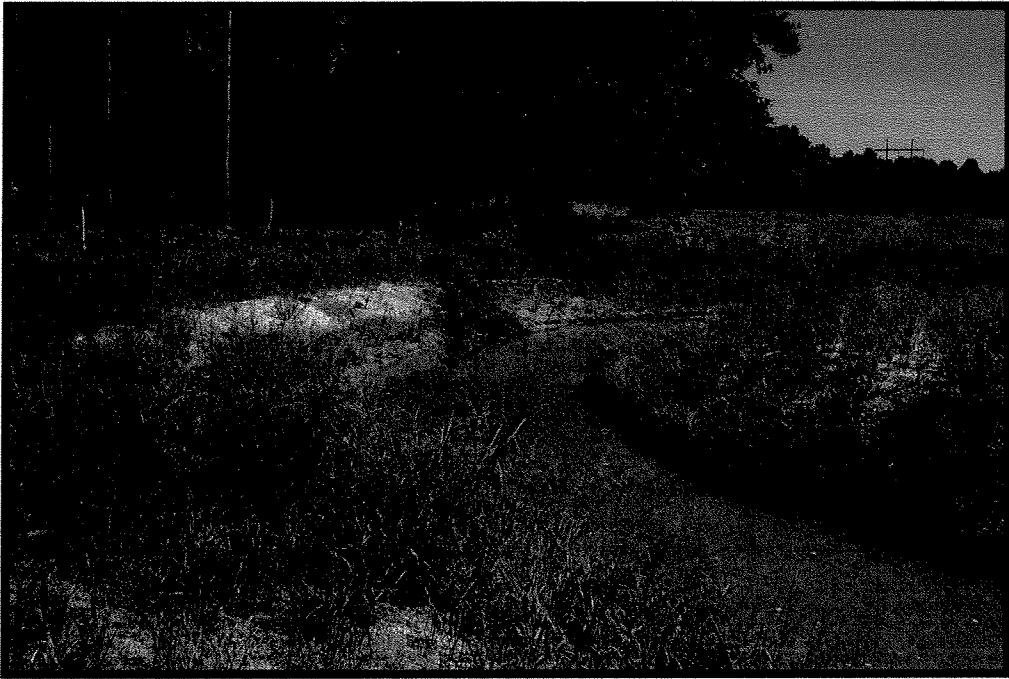




Riffle 3 — As-built



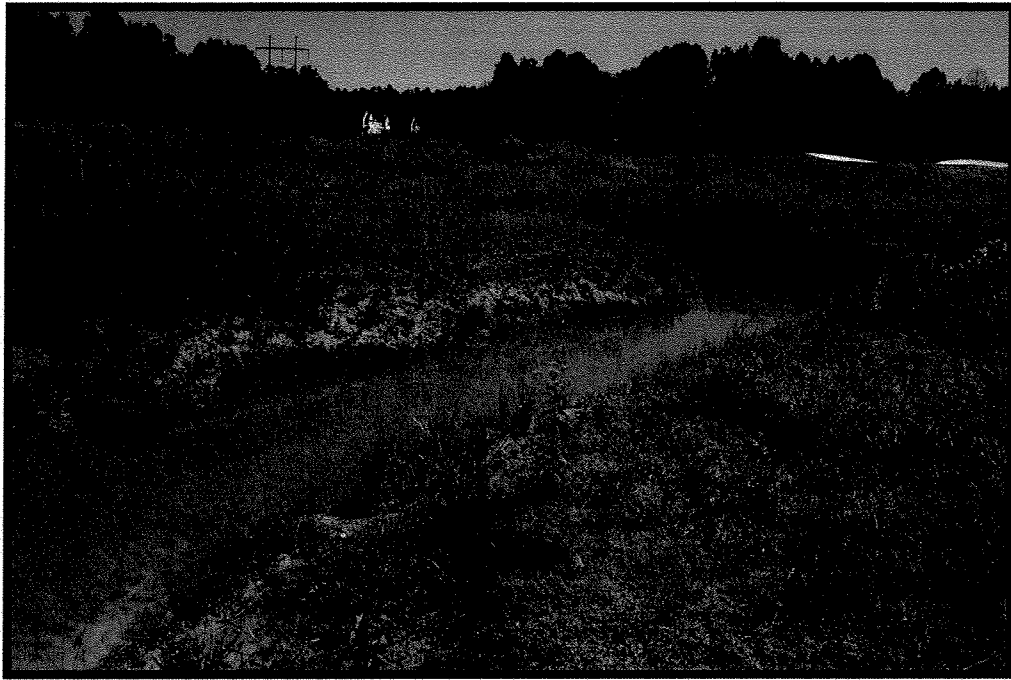
Riffle 3 — Year 1



Pool 3 — As-built



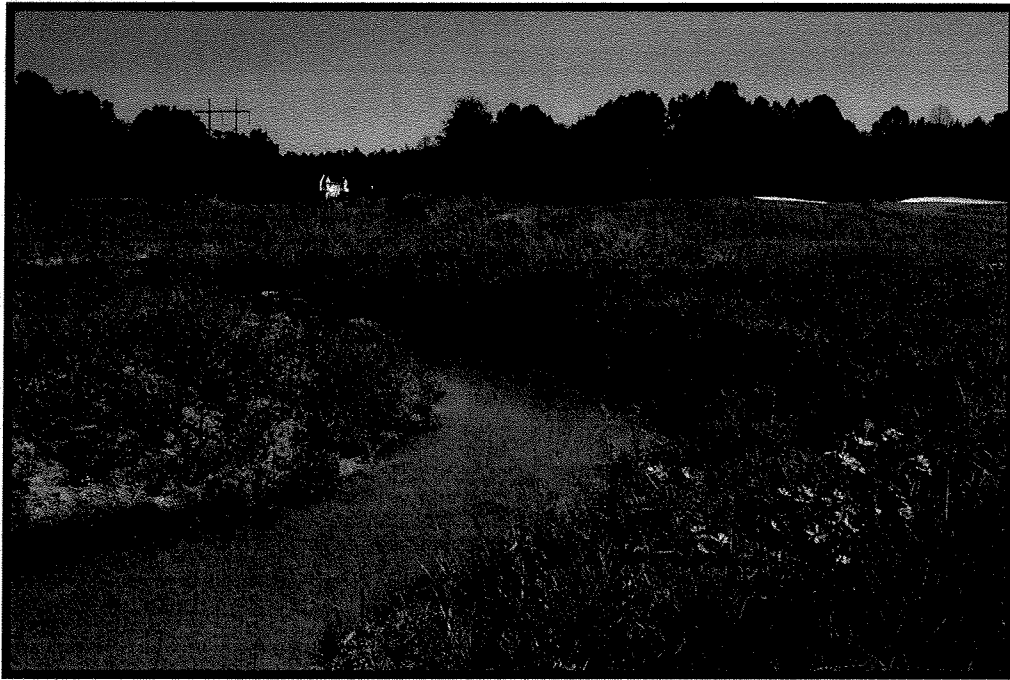
Pool 3 — Year 1



Riffle 4— As-built



Riffle 4— Year 1



Pool 4— As-built



Pool 4— Year 1



Lower 300 feet of restoration—As-built



Lower 300 feet of restoration—Year 1

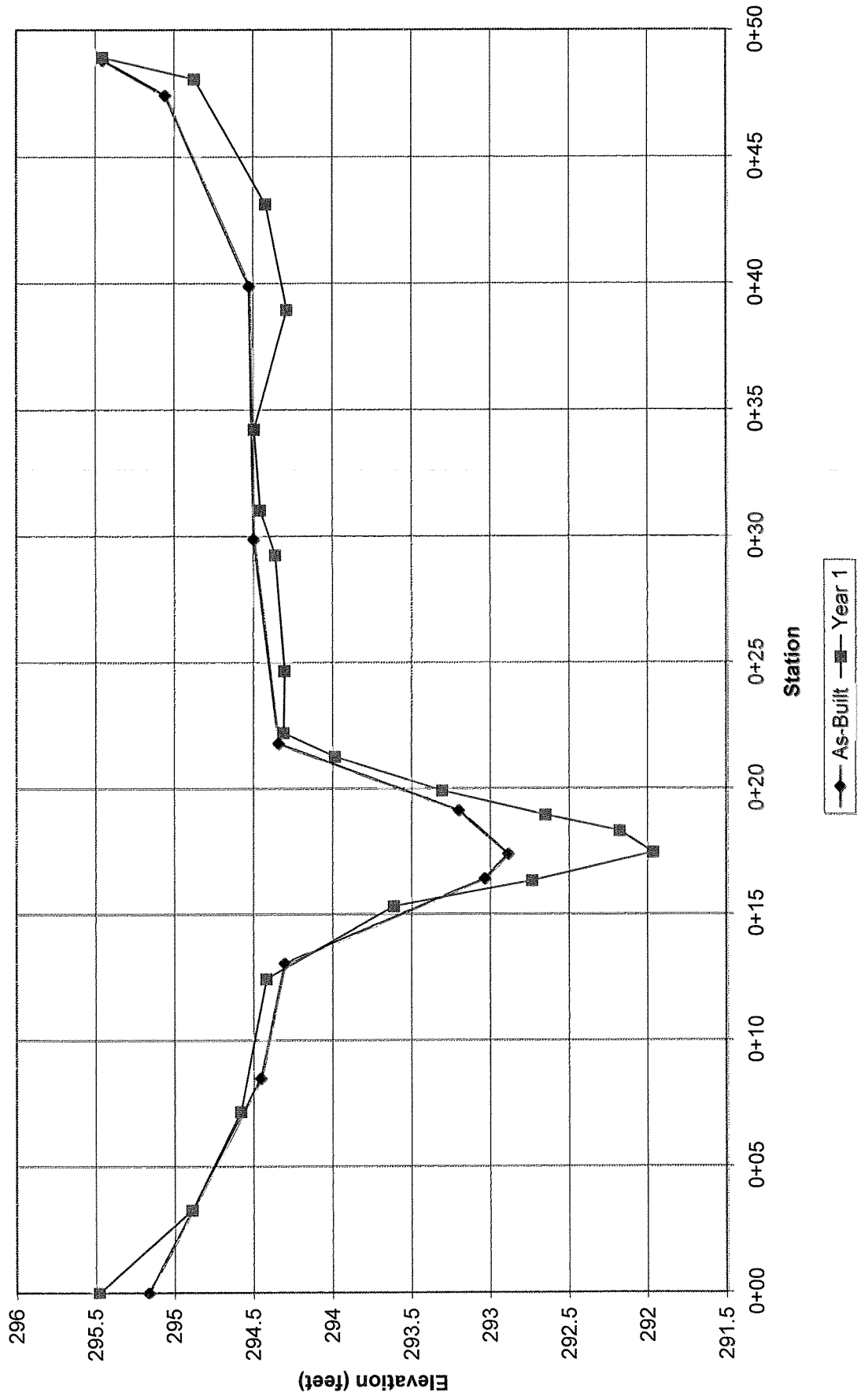


Upper 300 feet of restoration and confluence with Meadow Creek—As-built

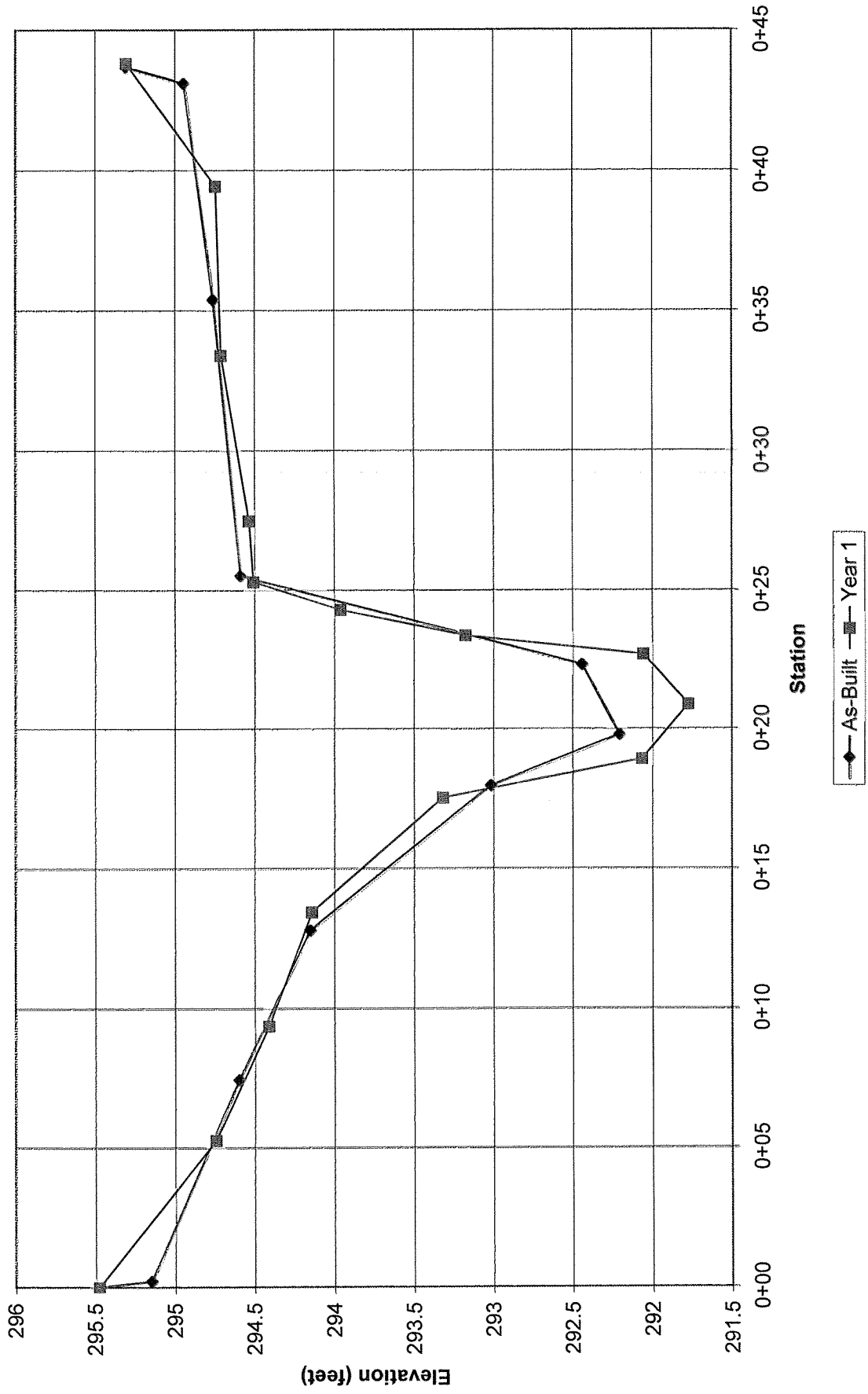


Upper 300 feet of restoration and confluence with Meadow Creek—Year 1

# UT of Hatchet's Grove-Riffle 1

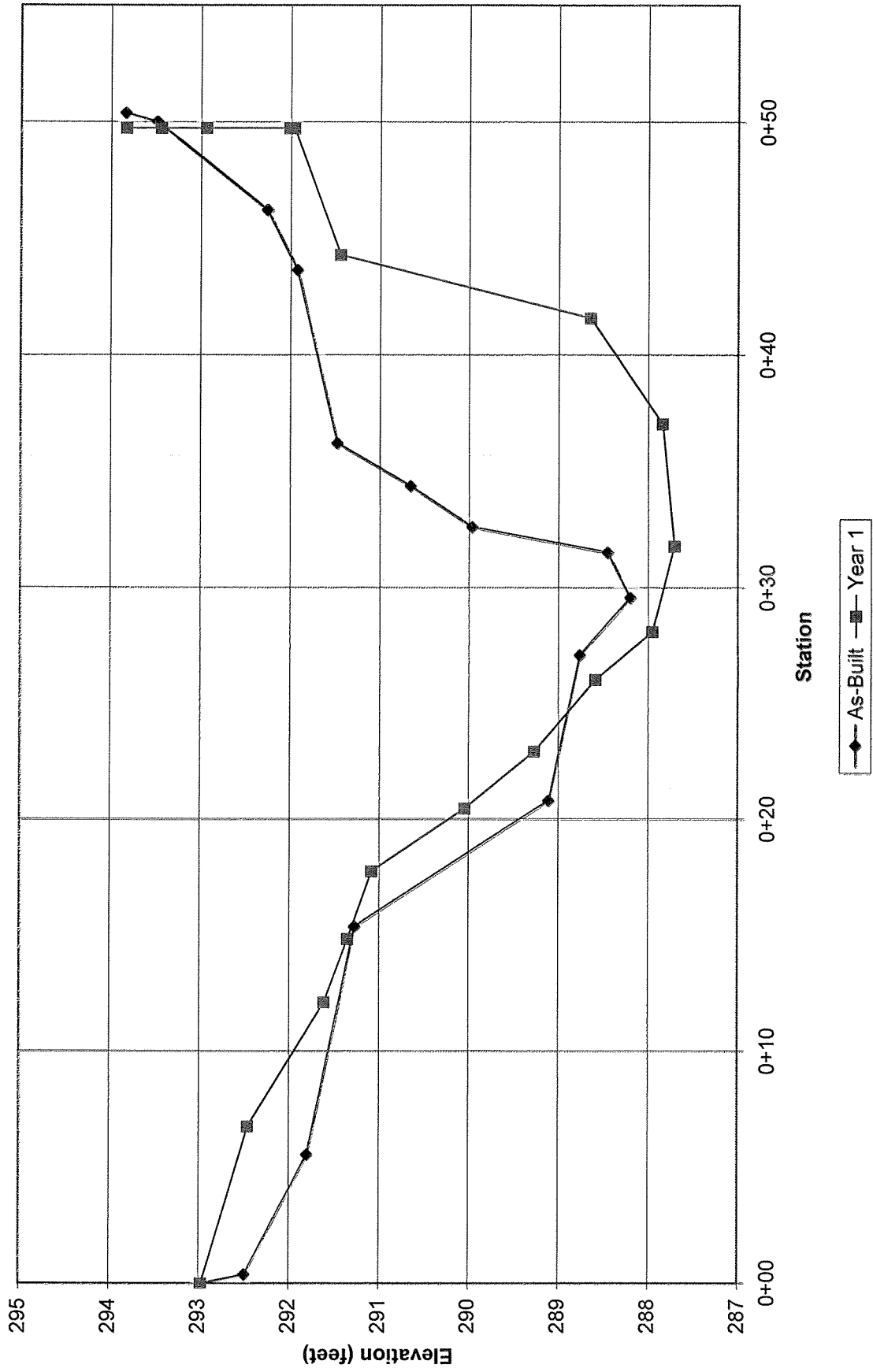


UT of Hatchet's Grove-Pool 1

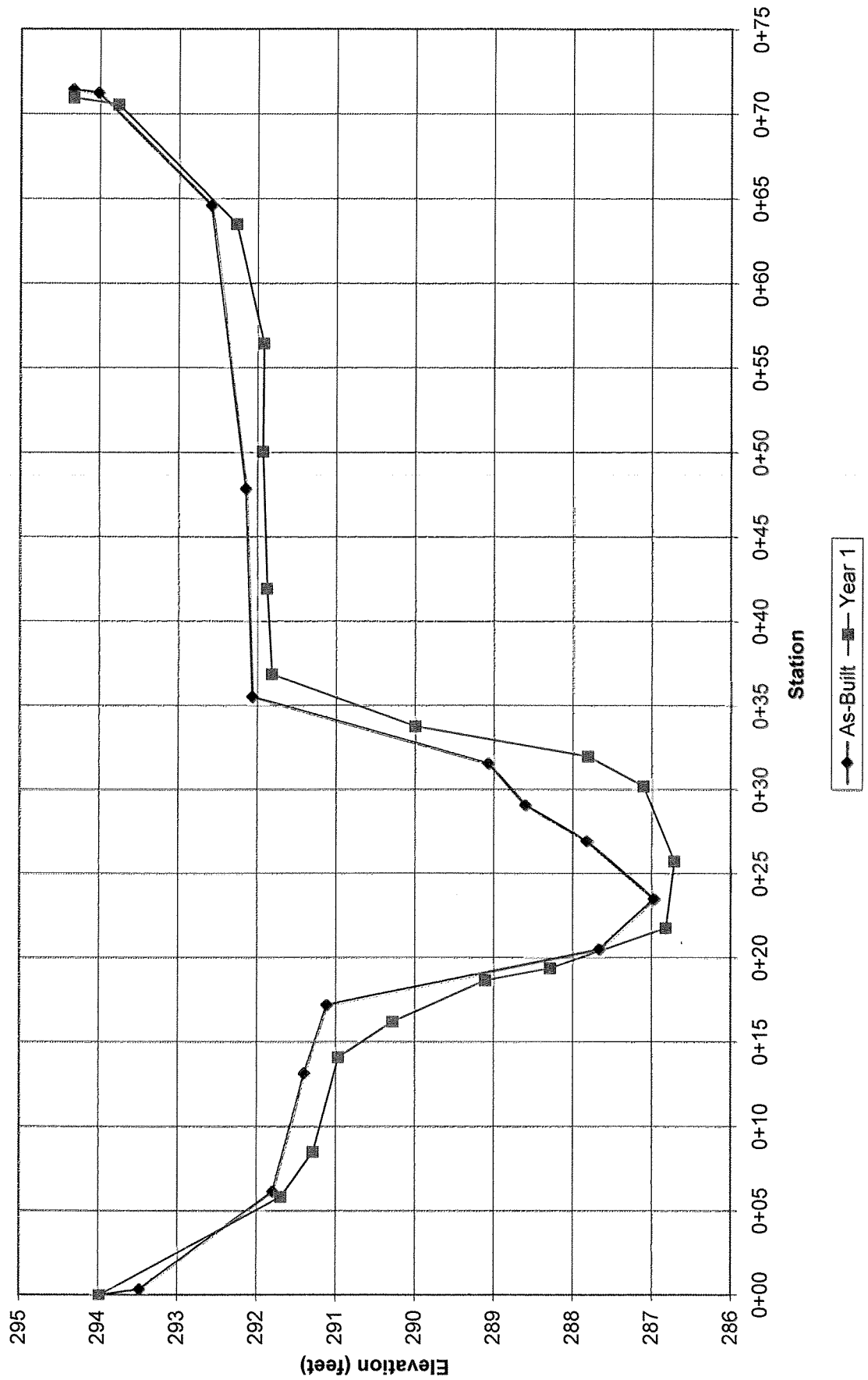




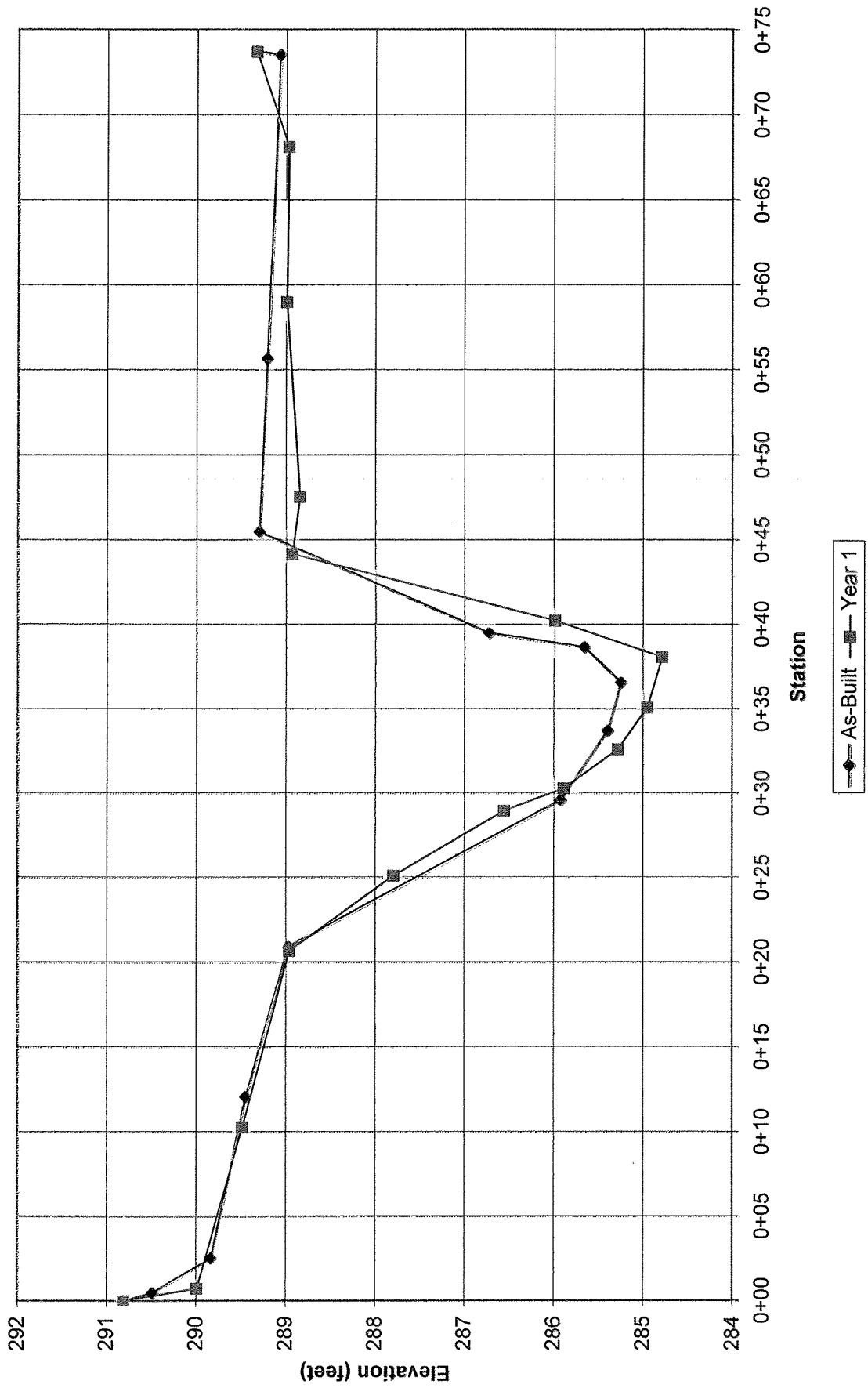
Hatchet's Grove Tributary - Riffle 2



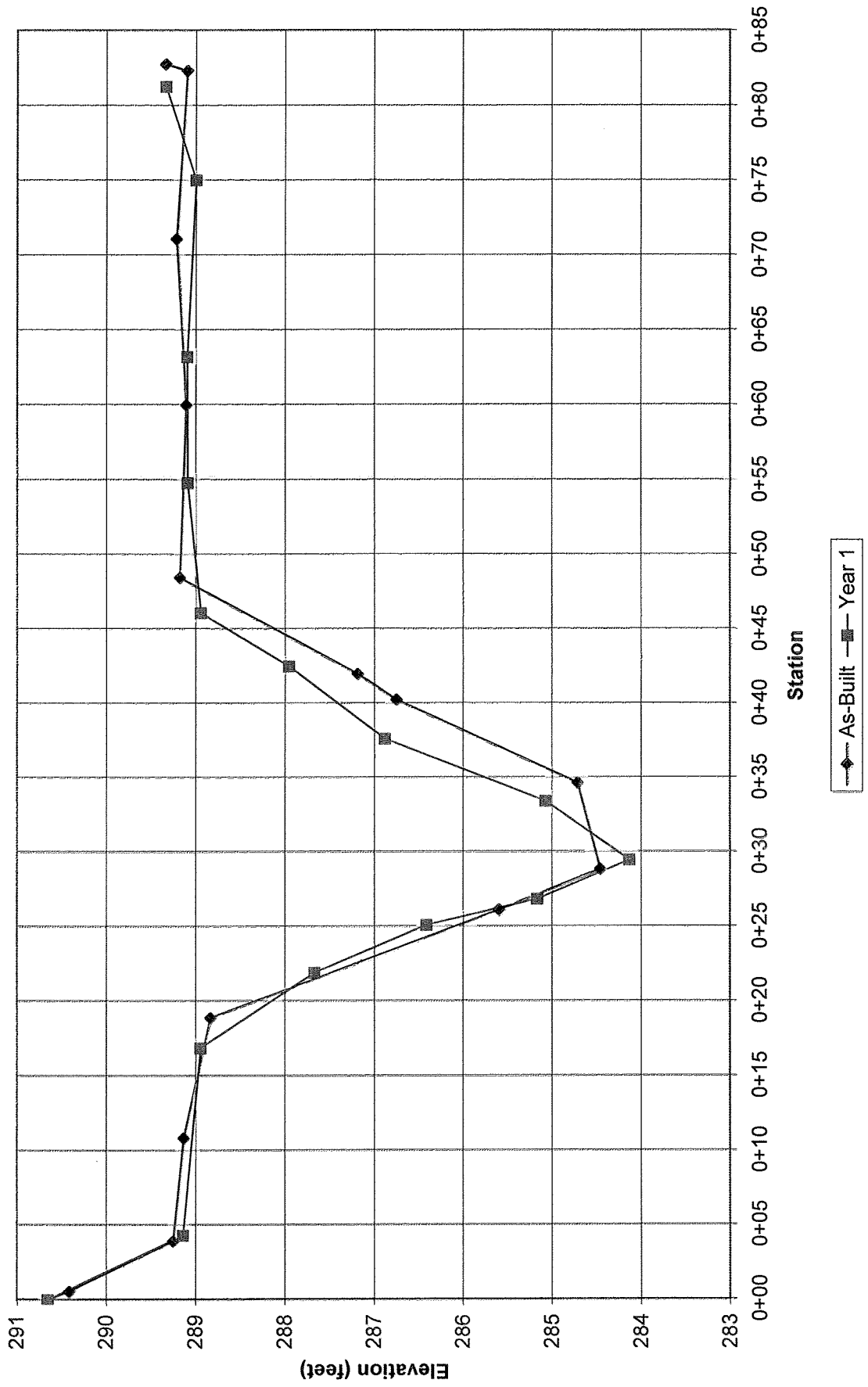
Hatchet's Grove Tributary - Pool 2



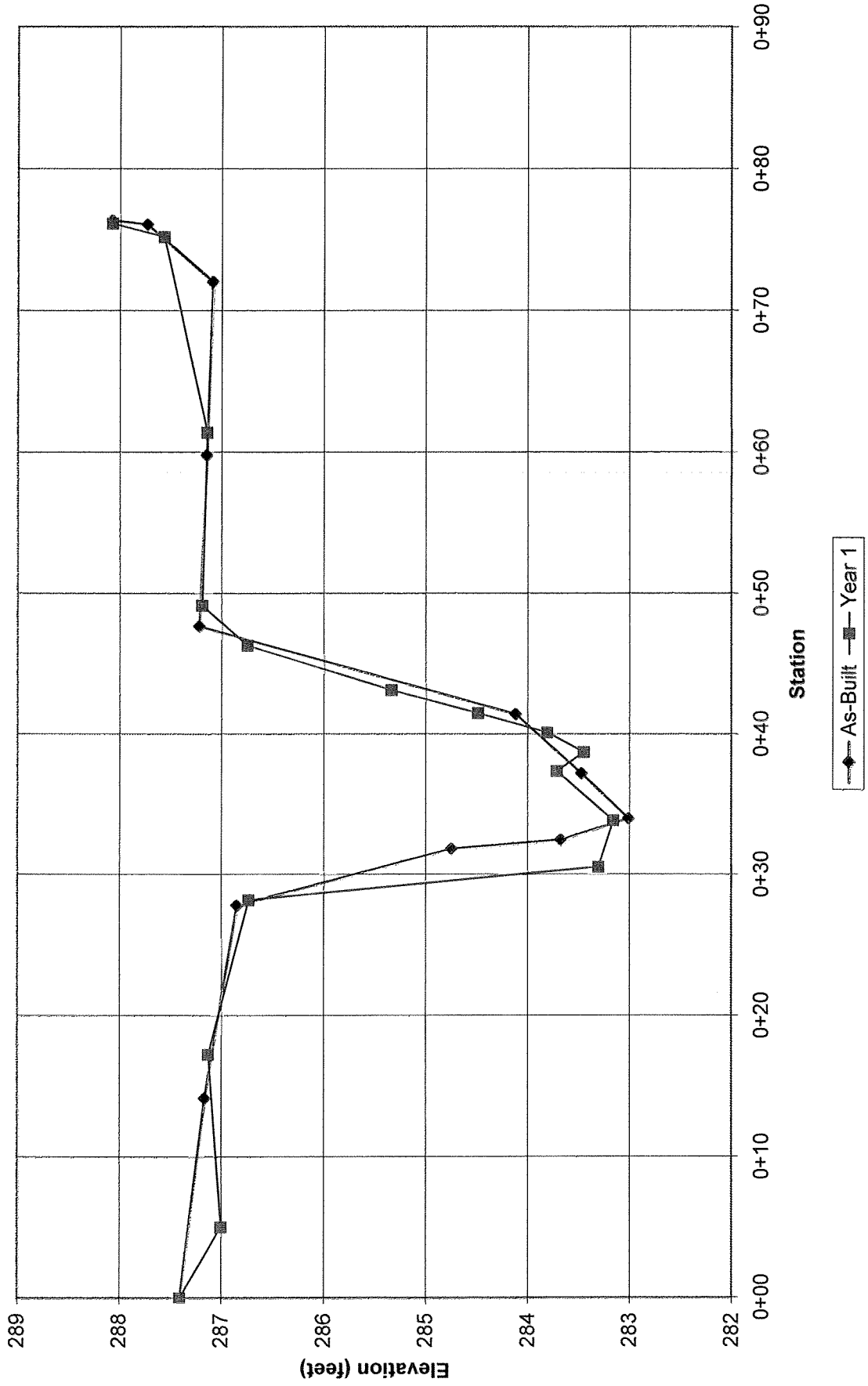
Hatchet's Grove Tributary - Riffle 3



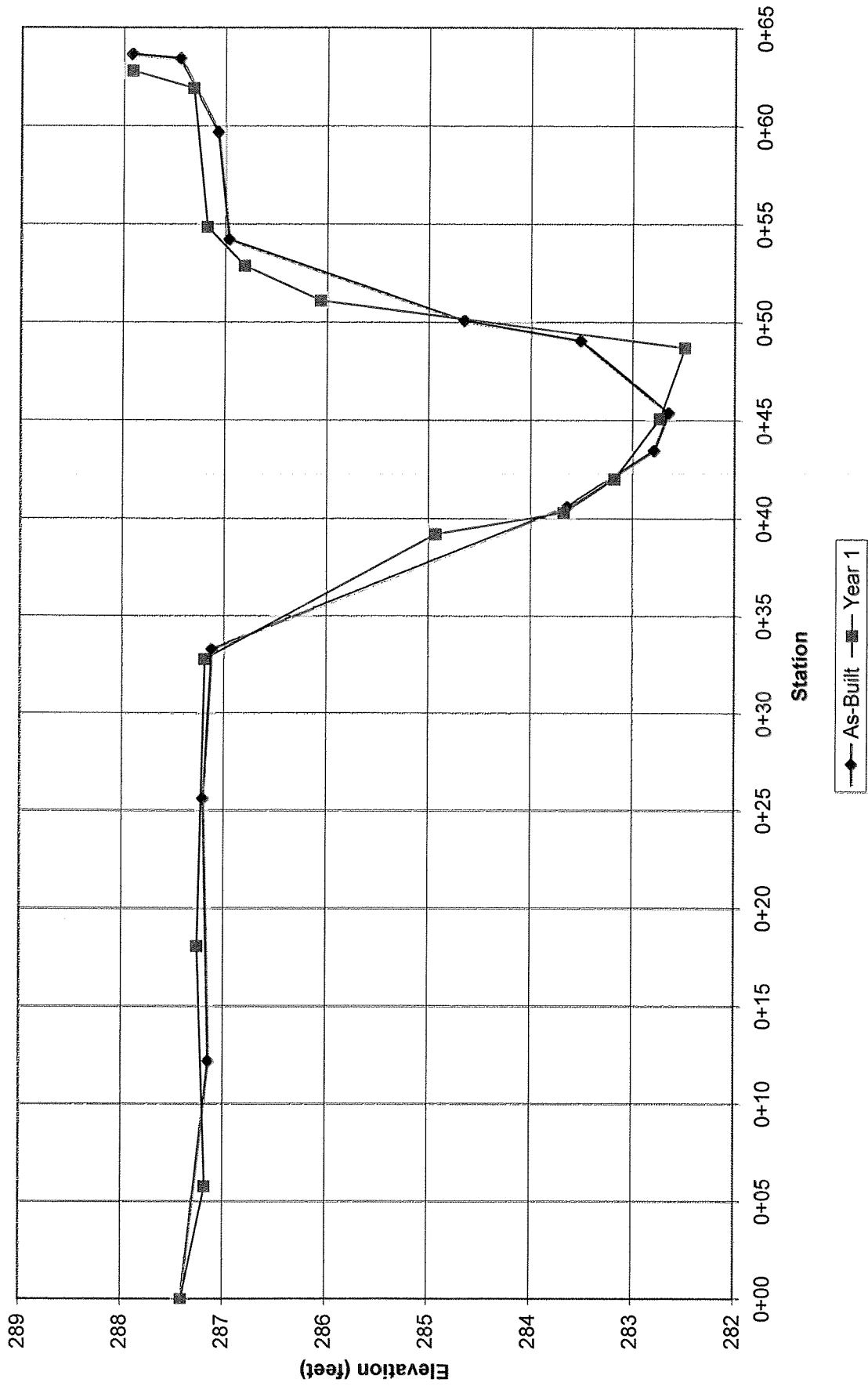
Hatchet's Grove Tributary - Pool 3



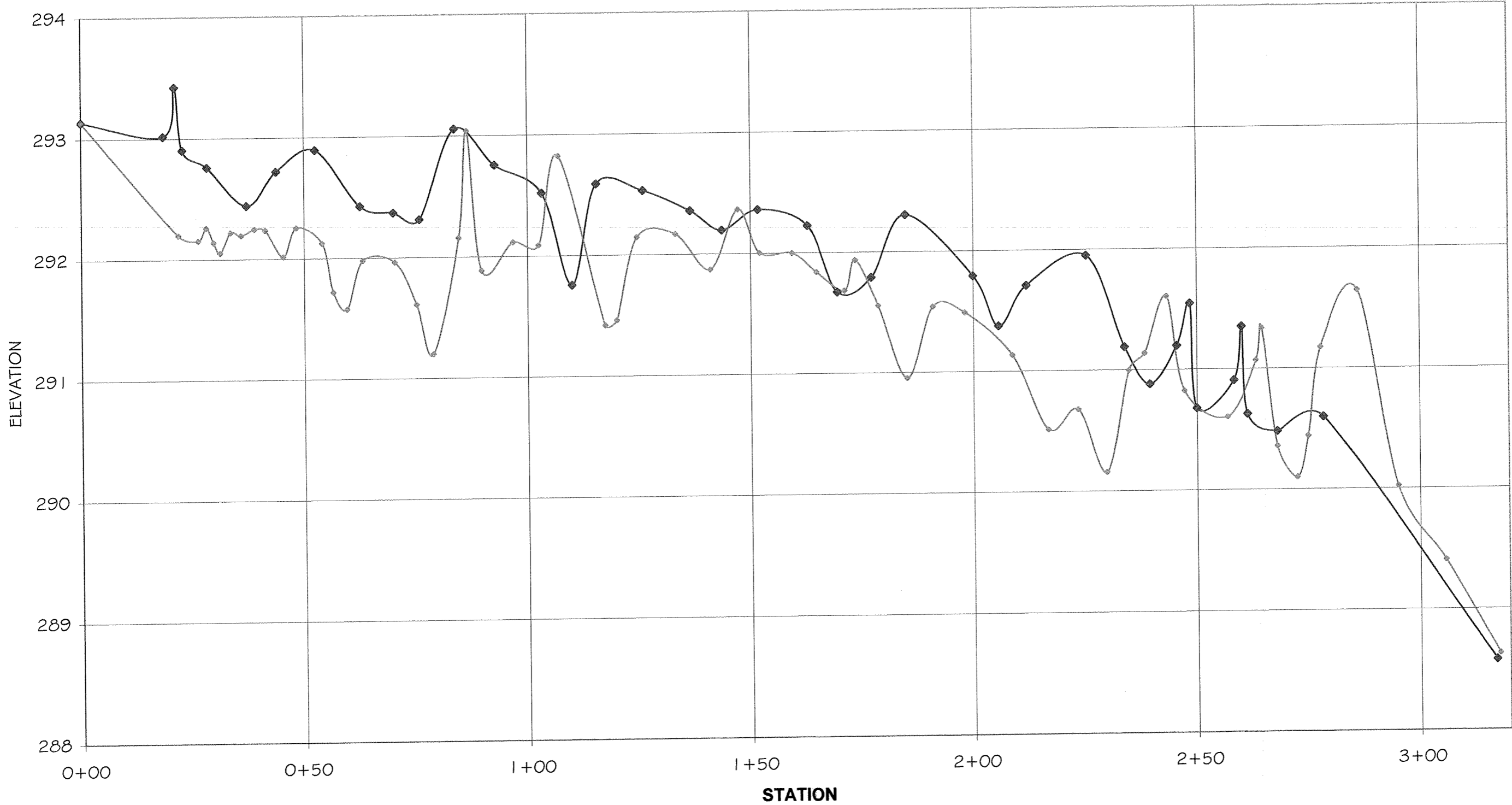
Hatchet's Grove Tributary - Riffle 4



Hatchet's Grove Tributary - Pool 4

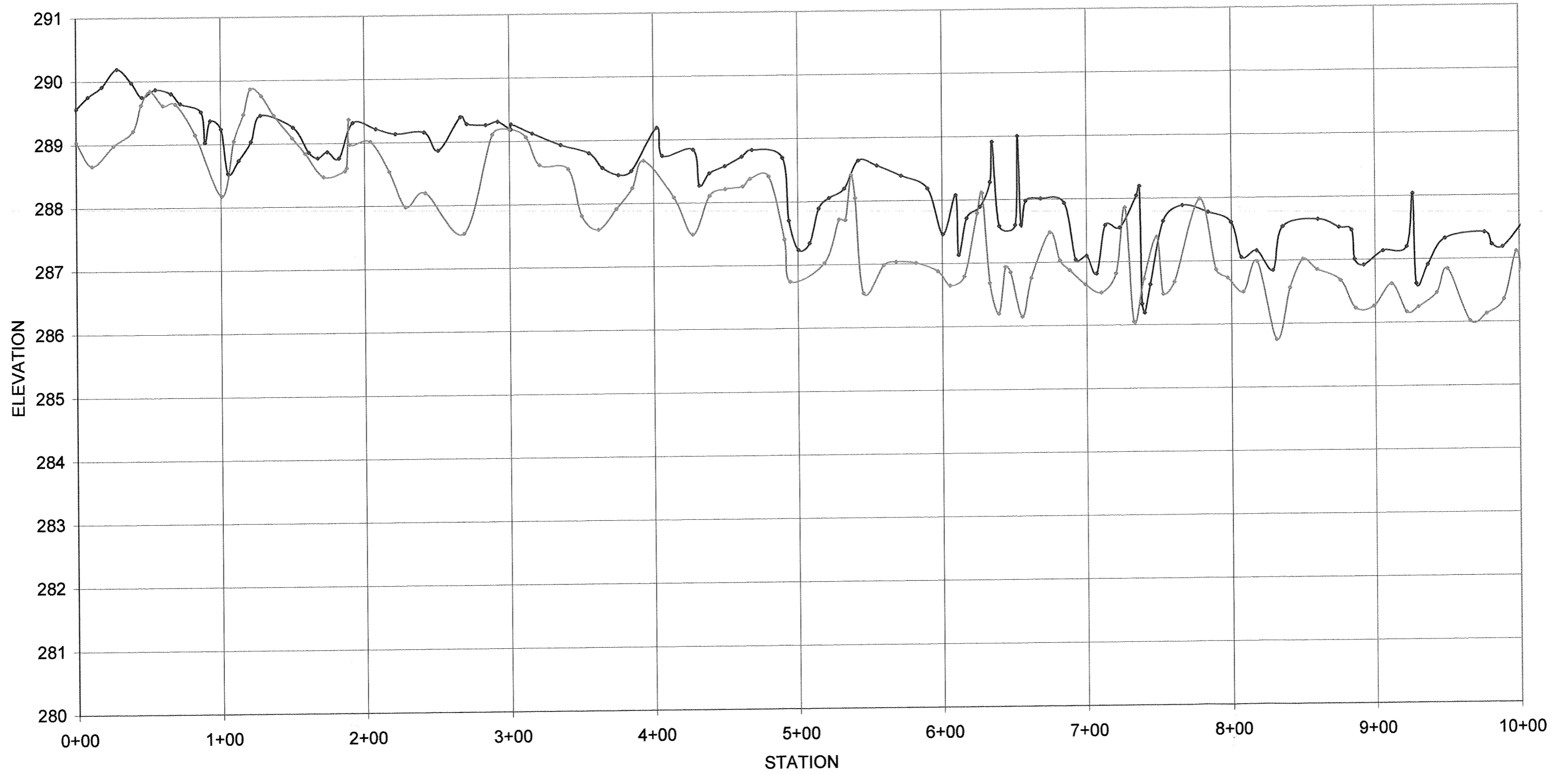


Longitudinal Profile  
UT of Hatchet's Grove



◆ Longitudinal Profile - As Built      ◆ Longitudinal Profile - Year 1

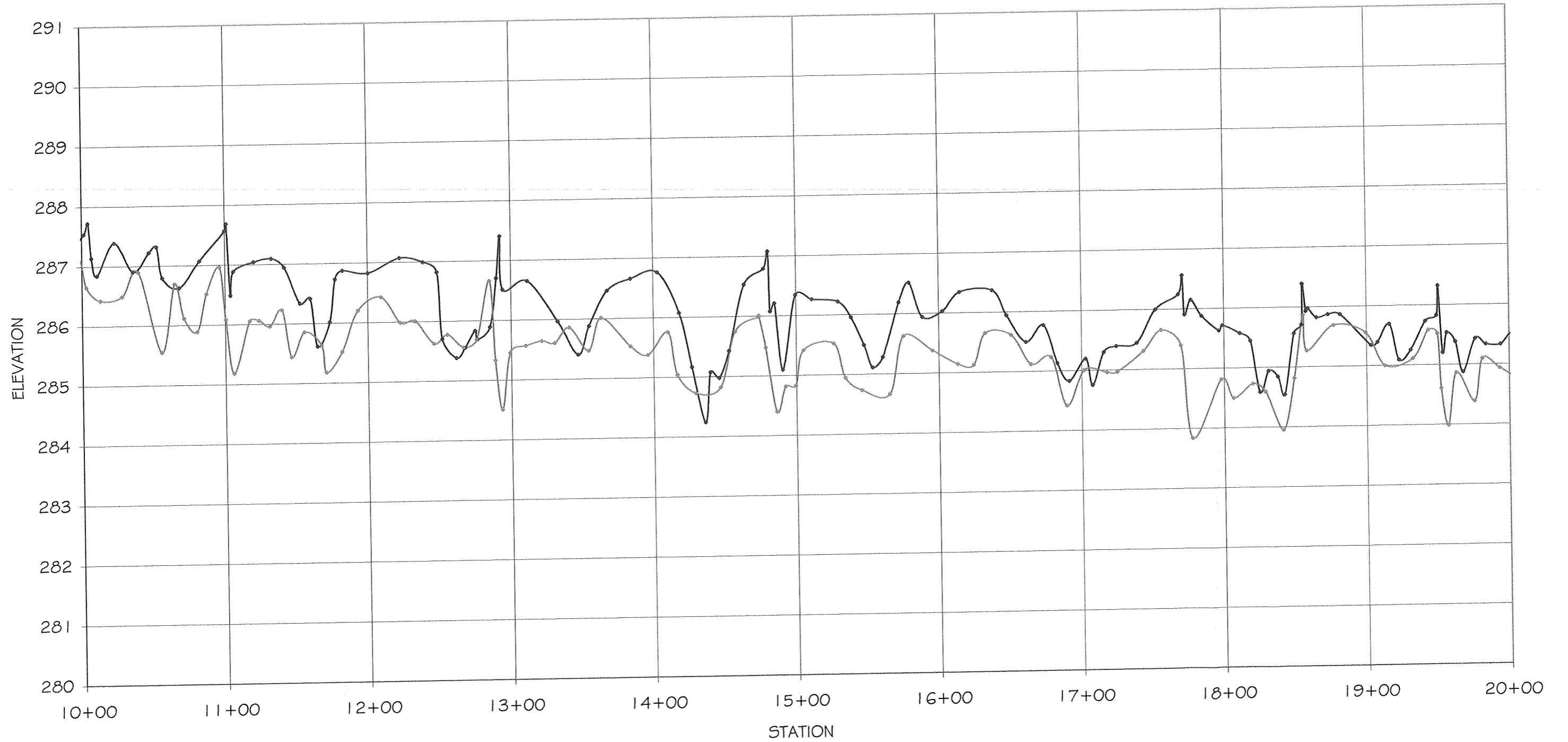
Longitudinal Profile  
Hatchet's Grove



—●— Longitudinal Profile As-Built —●— Longitudinal Profile - Year 1

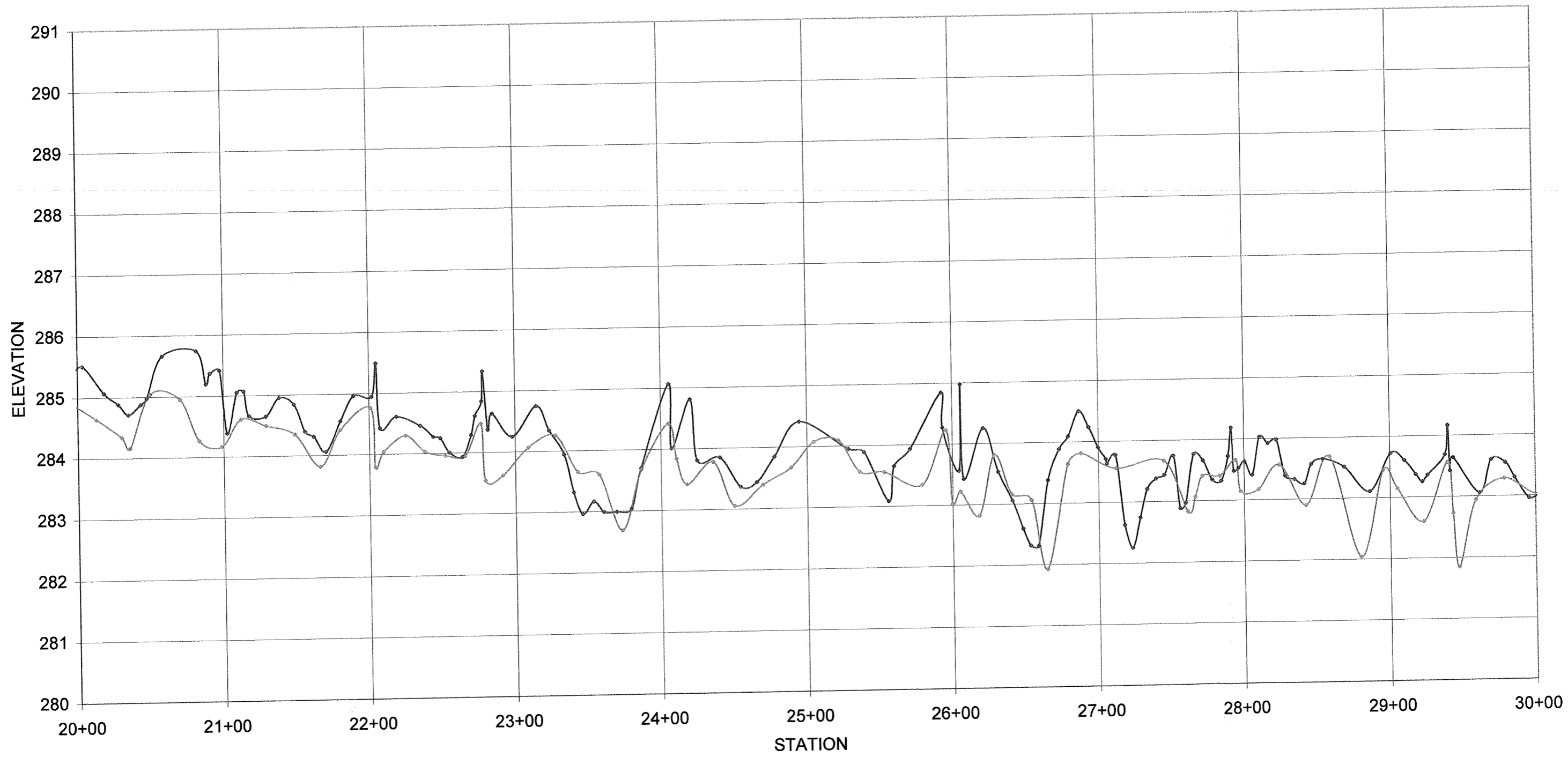


Longitudinal Profile  
Hatchet's Grove



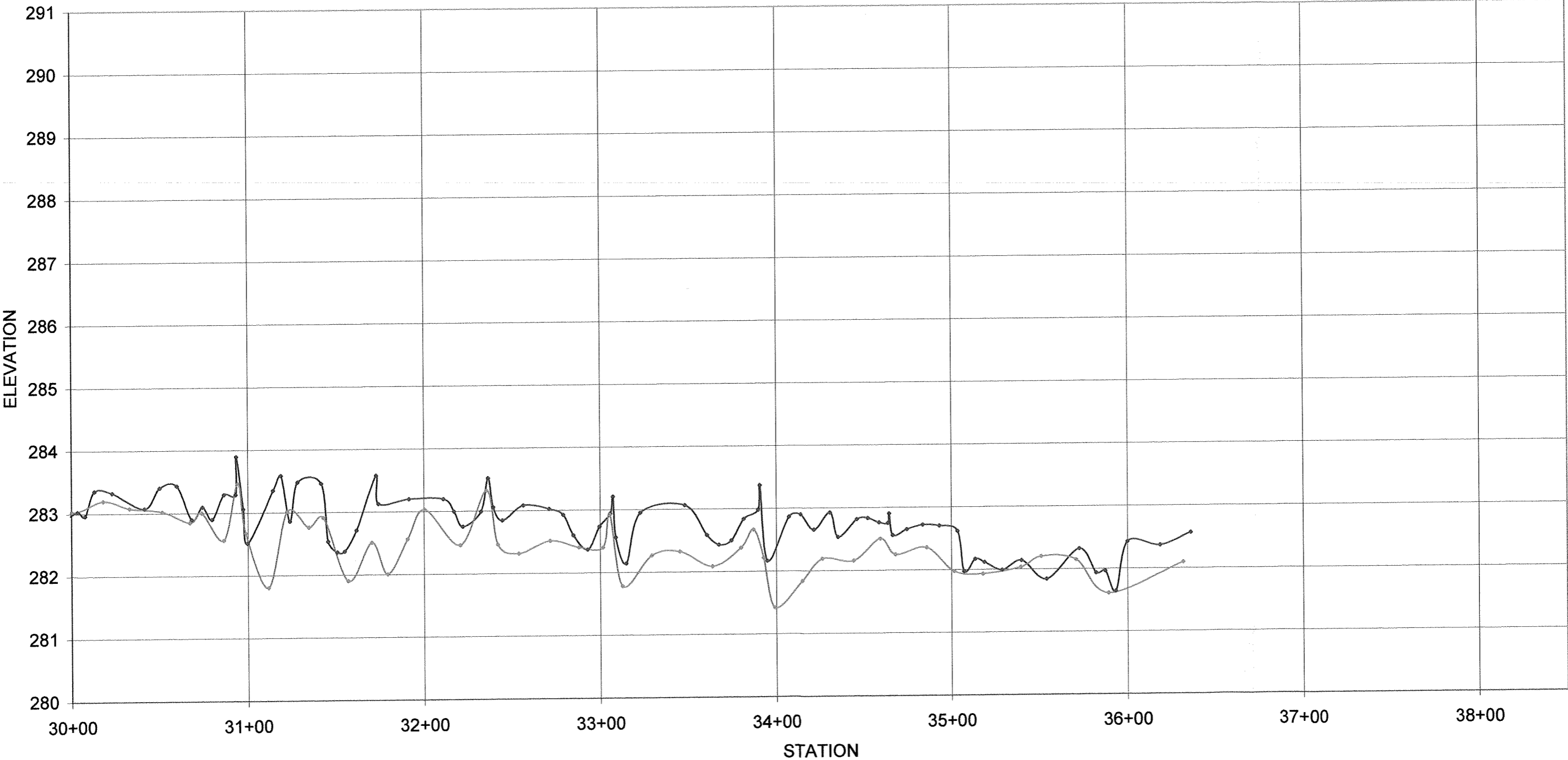
—●— Longitudinal Profile - As-Built —●— Longitudinal Profile - Year 1

Longitudinal Profile  
Hatchet's Grove



— Longitudinal Profile - As-Built — Longitudinal Profile - Year 1

Longitudinal Profile  
Hatchet's Grove



—•— Longitudinal Profile - As-Built —•— Longitudinal Profile - Year 1