

Purdue's Two-Stage Ditch:

What we've learned so far about what to plant and impacts on nutrients

- **Ditch Design and Construction**

Jane Frankenberger, Agricultural Engineer

- **Water Quality Impacts**

Laura Bowling, Watershed Hydrologist

- **Vegetation Establishment**

Andi Hodaj, Graduate Research Assistant



Why establish and monitor a two-stage ditch?

Research, Education, and Extension





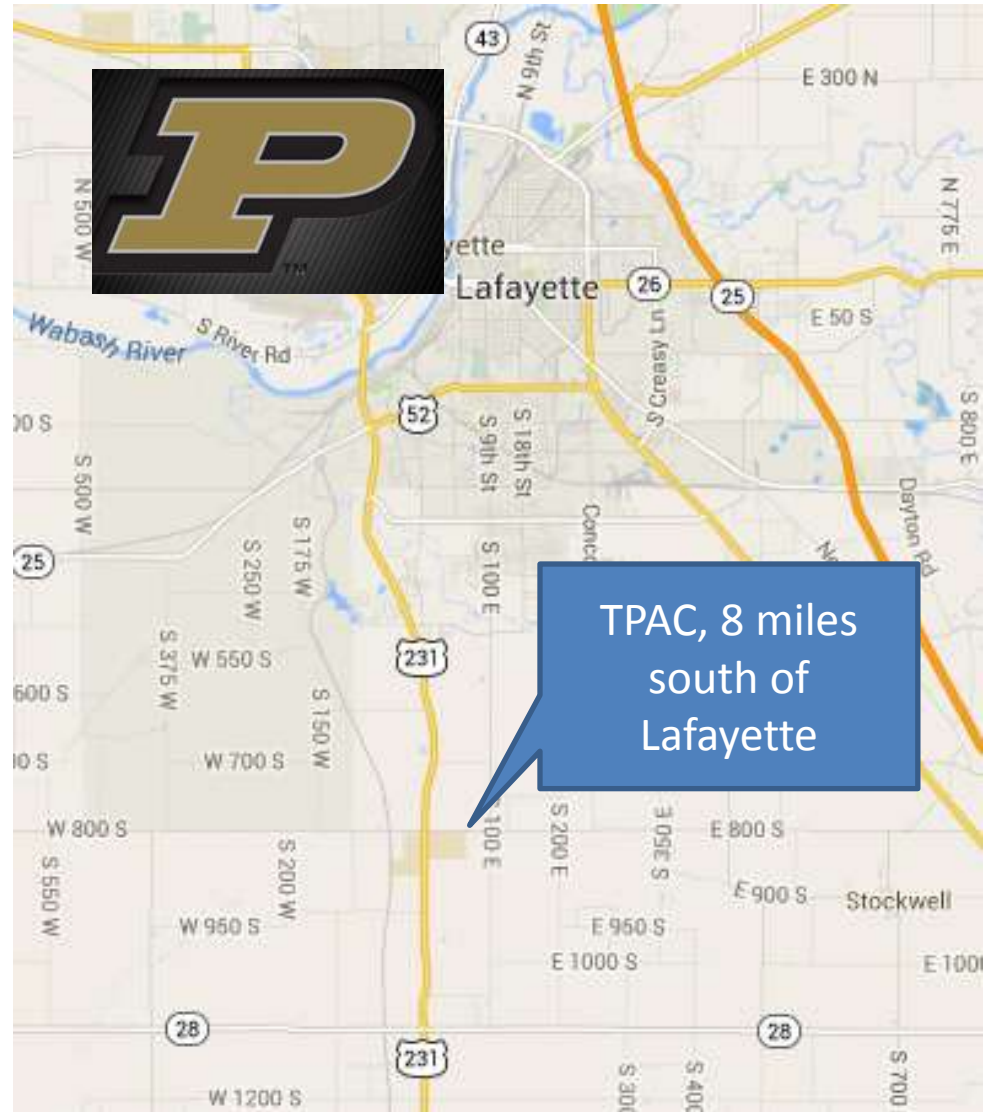
Our site includes a denitrifying bioreactor upstream, and a two-stage ditch downstream, so we can examine the effects of these practices as a system



The Purdue Two-Stage Ditch Site

Throckmorton Purdue Agricultural Center

- The ditch was unstable
- downstream neighbors had complained about flooding
- access is good for research, education and extension.



The first step: Assessment

- Done by two seniors in Agricultural and Biological Engineering as their Senior Design project.
- Ten cross sections were surveyed



Hard work assessing the ditch



Soils cores were taken to assess the potential for spoil to be used



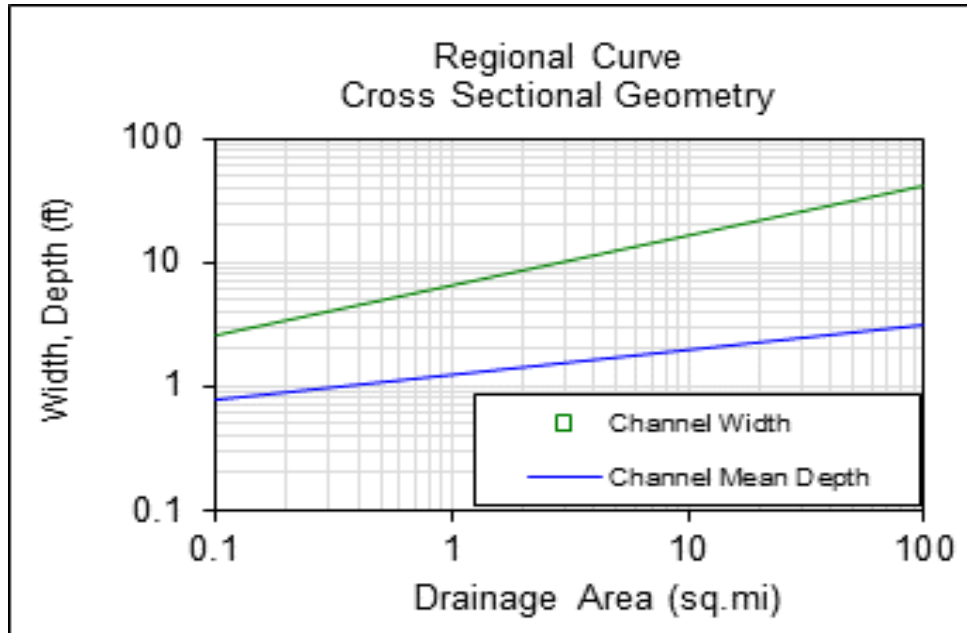
Soils Site #1

Horizon	Depth	Texture
<u>Ap</u>	0-9 in	<u>SiCL</u>
<u>A</u>	9-28 in	<u>SiCL</u>
<u>Bg1</u>	28-41 in	<u>SiCL</u>
<u>Bg2</u>	41-51 in	<u>SiCL</u>
<u>2Cg</u>	> 51 in	<u>SiL</u>

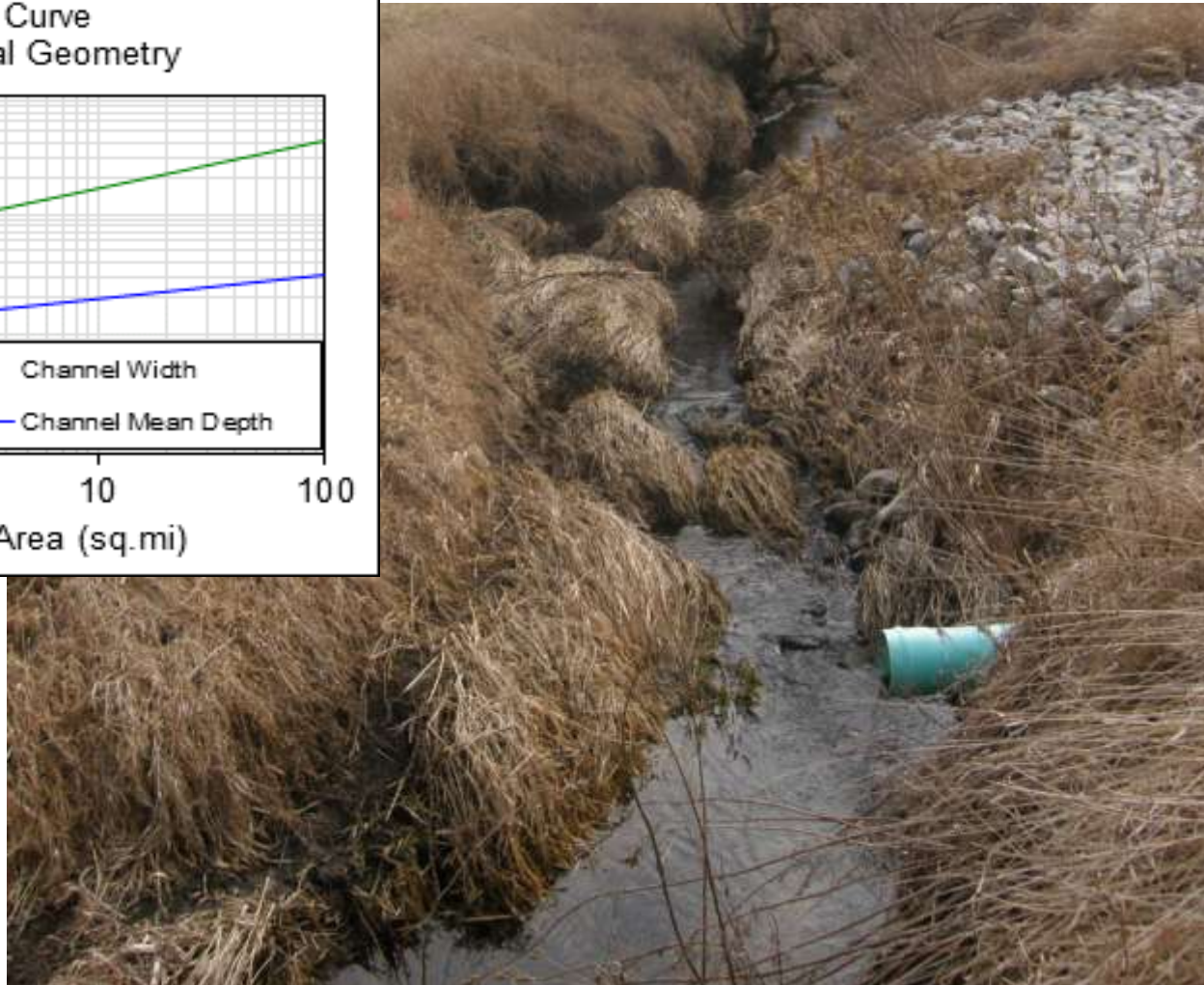
Soils Site #2

Horizon	Depth	Texture
<u>Ap</u>	0-6 in	<u>SiCL</u>
<u>A</u>	6-16 in	<u>SiCL</u>
<u>Bg1</u>	16-24 in	CL
<u>Bg2</u>	24-35 in	<u>SiCL</u>
<u>Bg3</u>	35-51	CL
<u>2Cg</u>	> 51 in	<u>SiL</u>

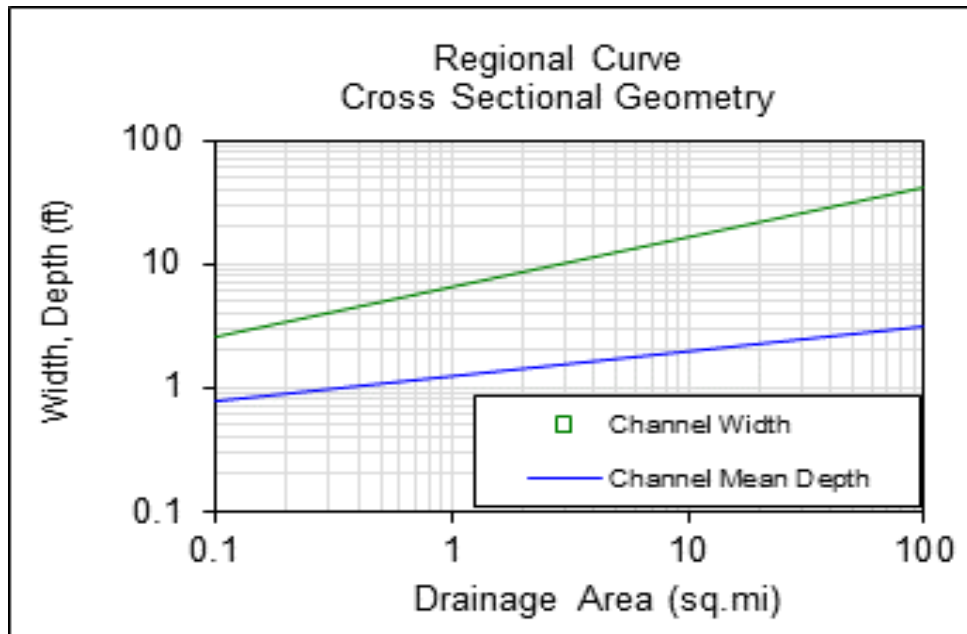
Bench **height** was selected based on
(1) existing bench height, and
(2) regional curves developed in Ohio



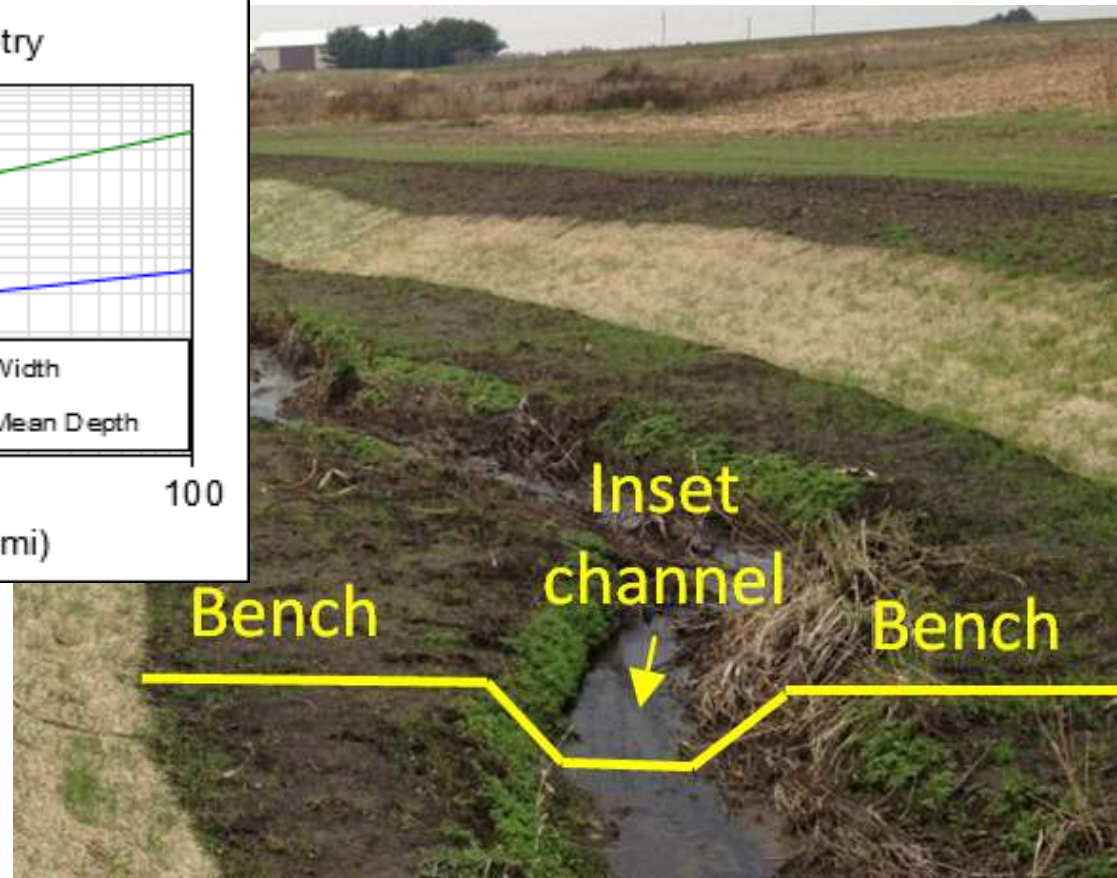
Result was
consistent between
methods, 1.6 feet



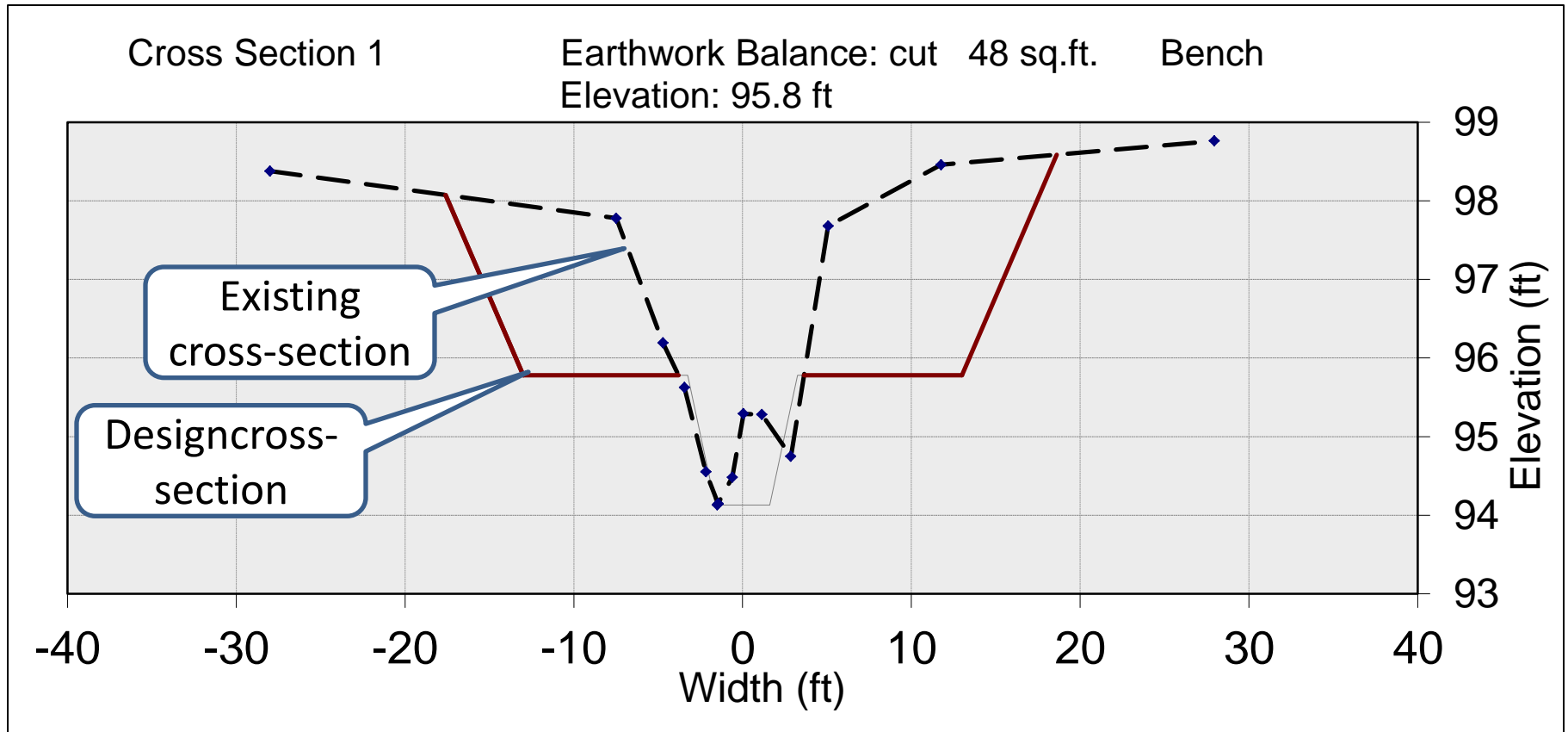
Bench **width** was selected based on
(1) regional curves developed in Ohio, and
(2) a “rule of thumb” that bench width is 3 to 5
times the width of the channel at bench height.



Result was
9.75 feet



Resulting cross-sections were calculated using the Ohio DNR Spreadsheet

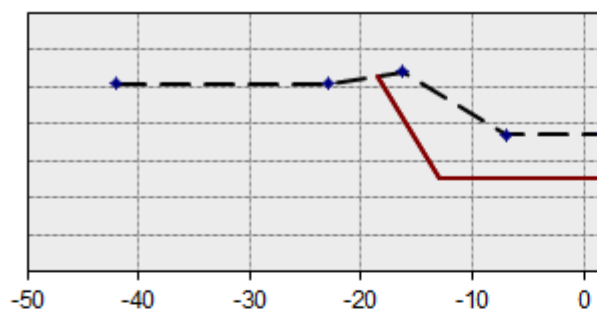


Additional Cross Sections

Part Area

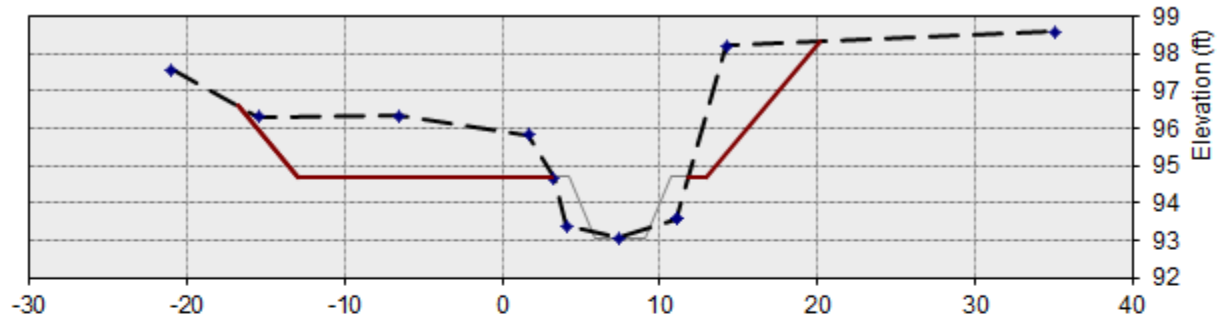
Cross Section 2

Earthwork Balance: cut 40 sq.ft. Bench Elevation: 95.5 ft



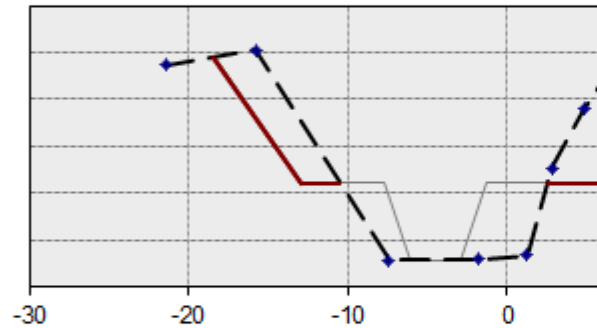
Cross Section 5

Earthwork Balance: cut 38 sq.ft. Bench Elevation: 94.7 ft



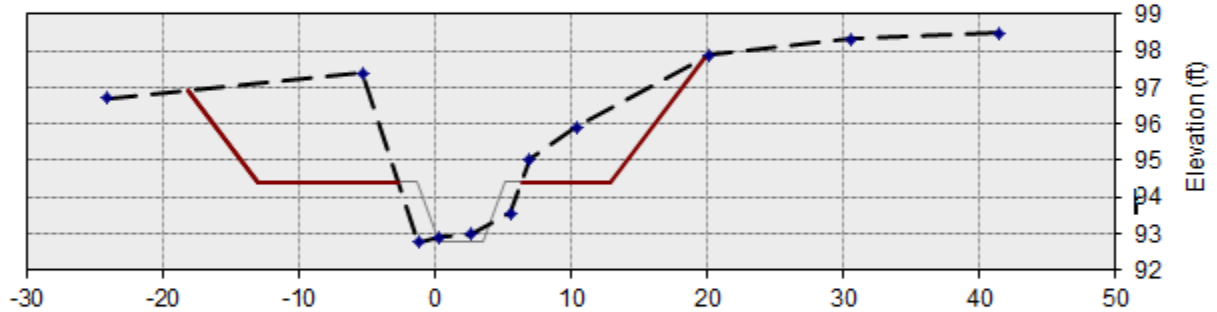
Cross Section 3

Earthwork Bala



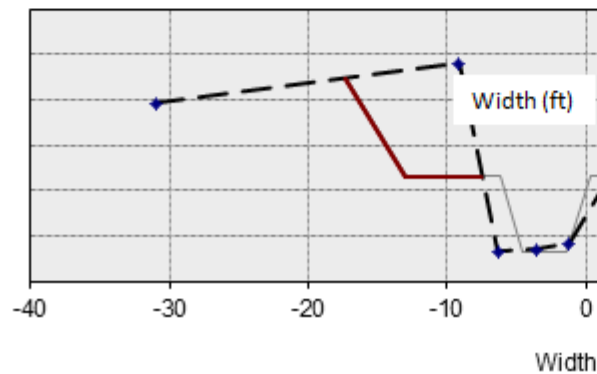
Cross Section 6

Earthwork Balance: cut 48 sq.ft. Bench Elevation: 94.4 ft



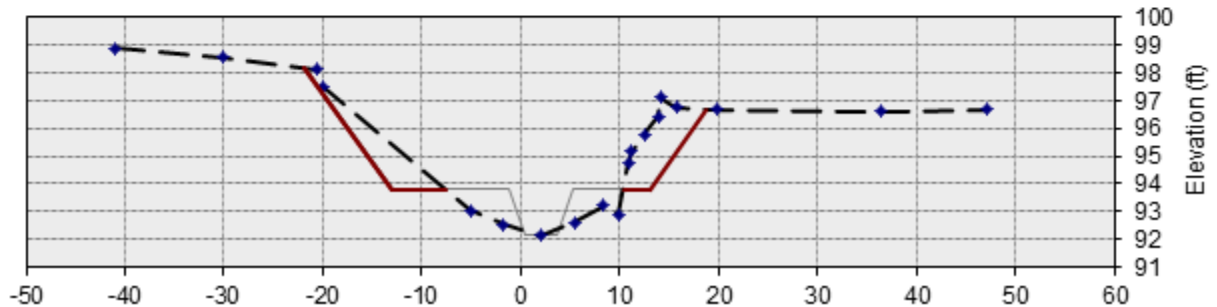
Cross Section 4

Earthwork Balan

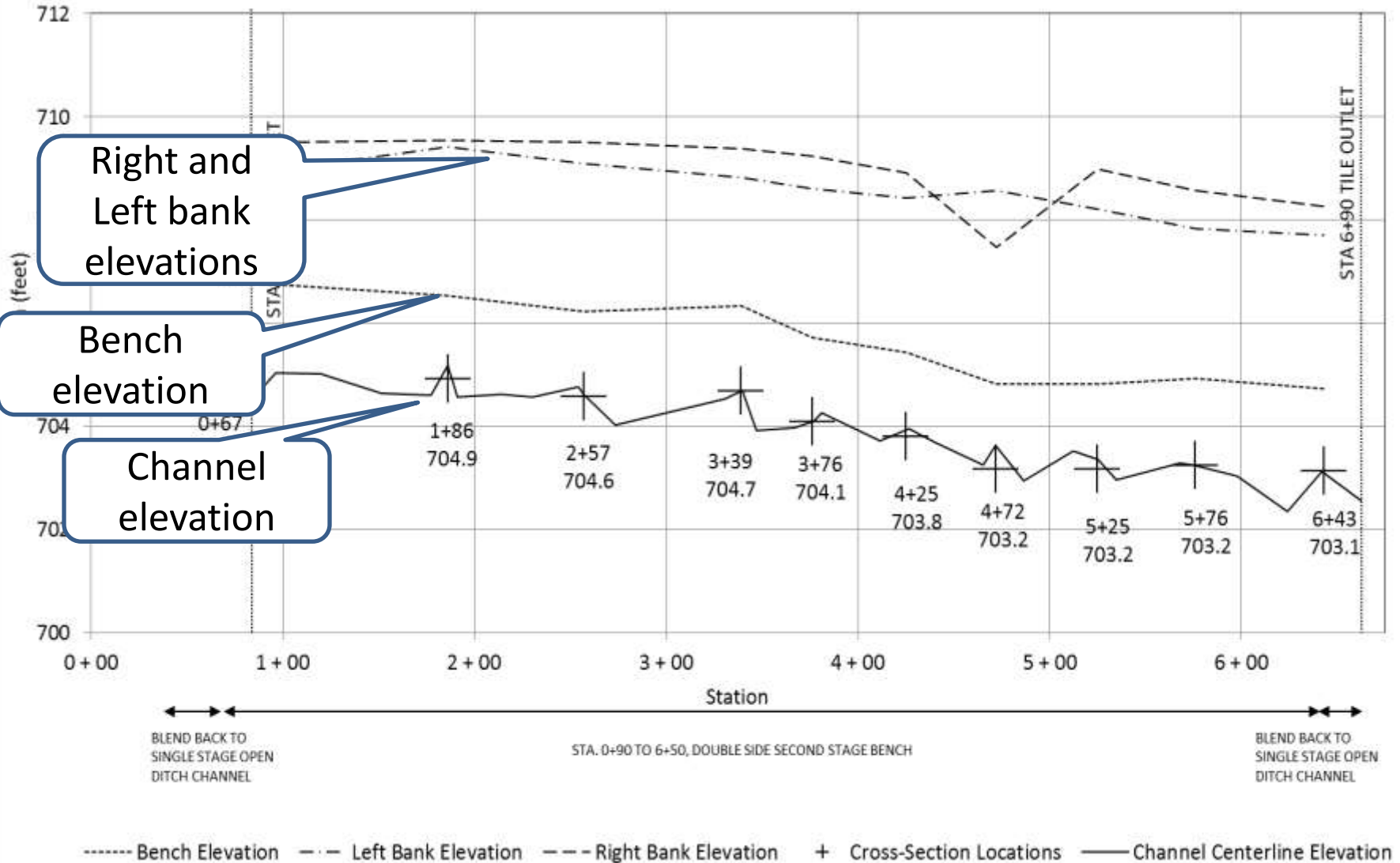


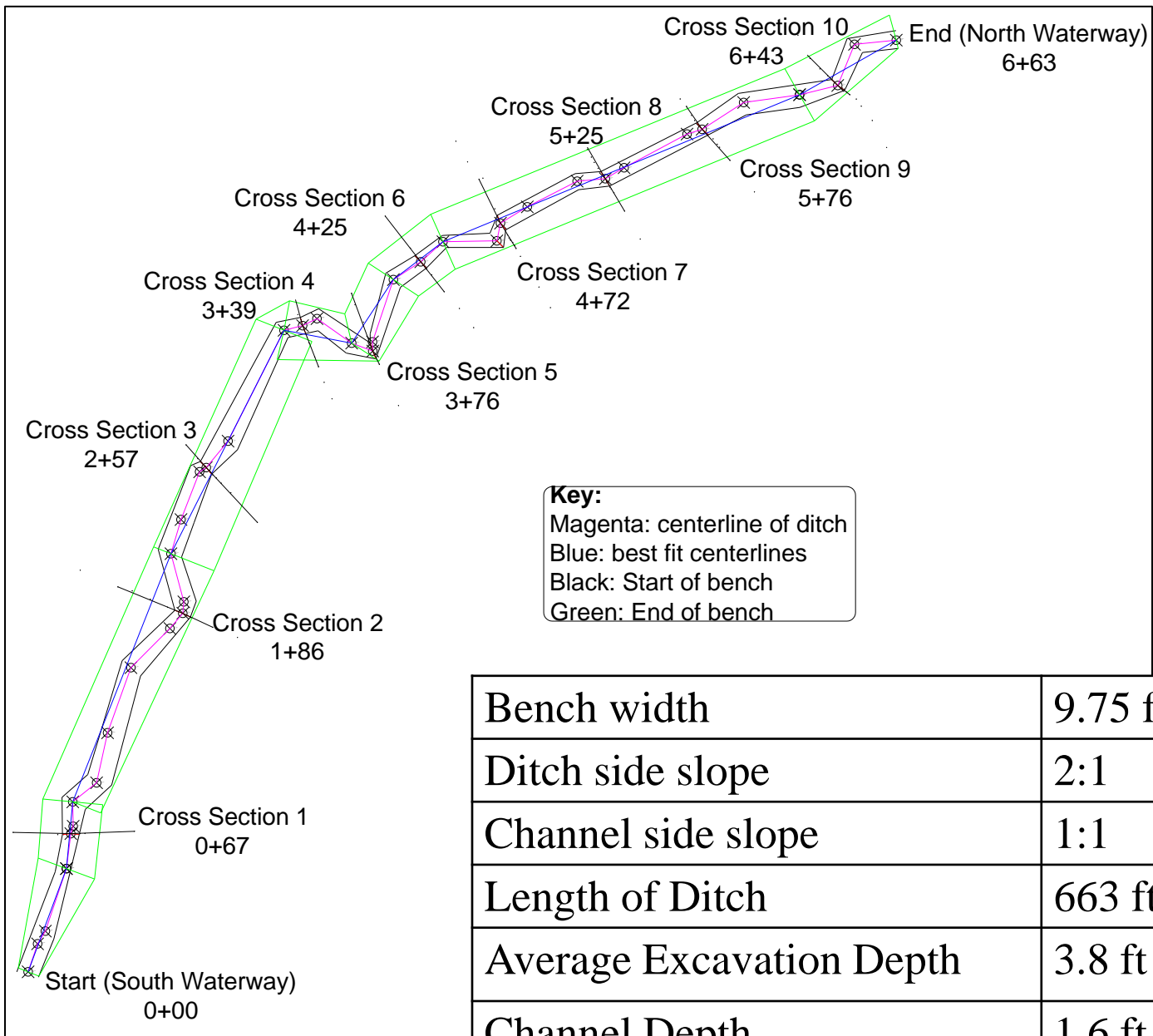
Cross Section 7

Earthwork Balance: cut 24 sq.ft. Bench Elevation: 93.8 ft

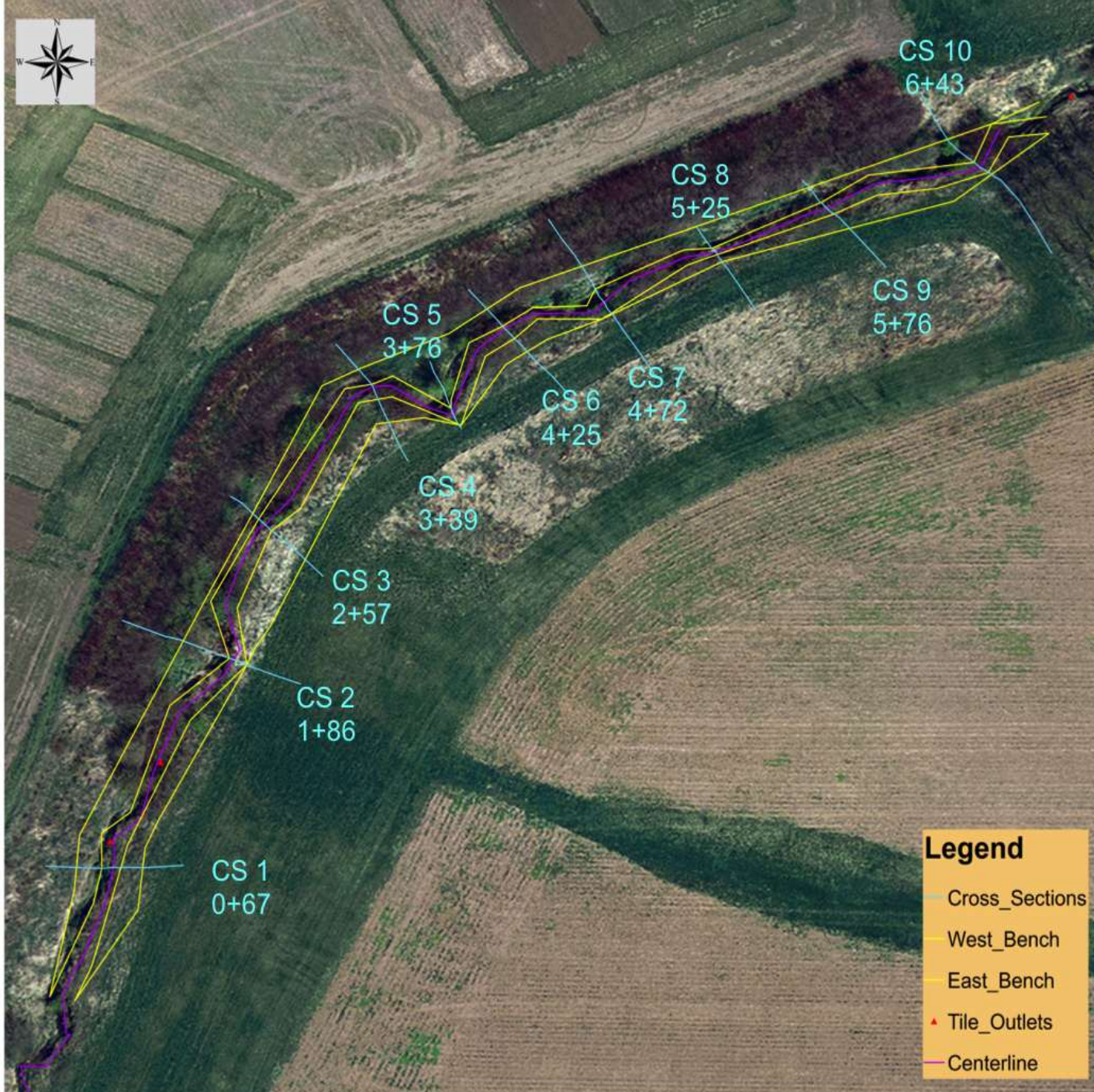


These were combined into a ditch profile diagram used in construction





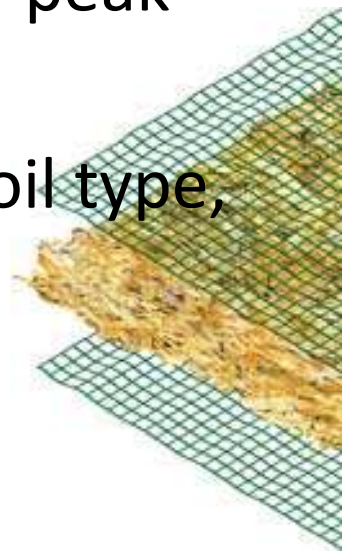
Bench width	9.75 ft
Ditch side slope	2:1
Channel side slope	1:1
Length of Ditch	663 ft
Average Excavation Depth	3.8 ft
Channel Depth	1.6 ft



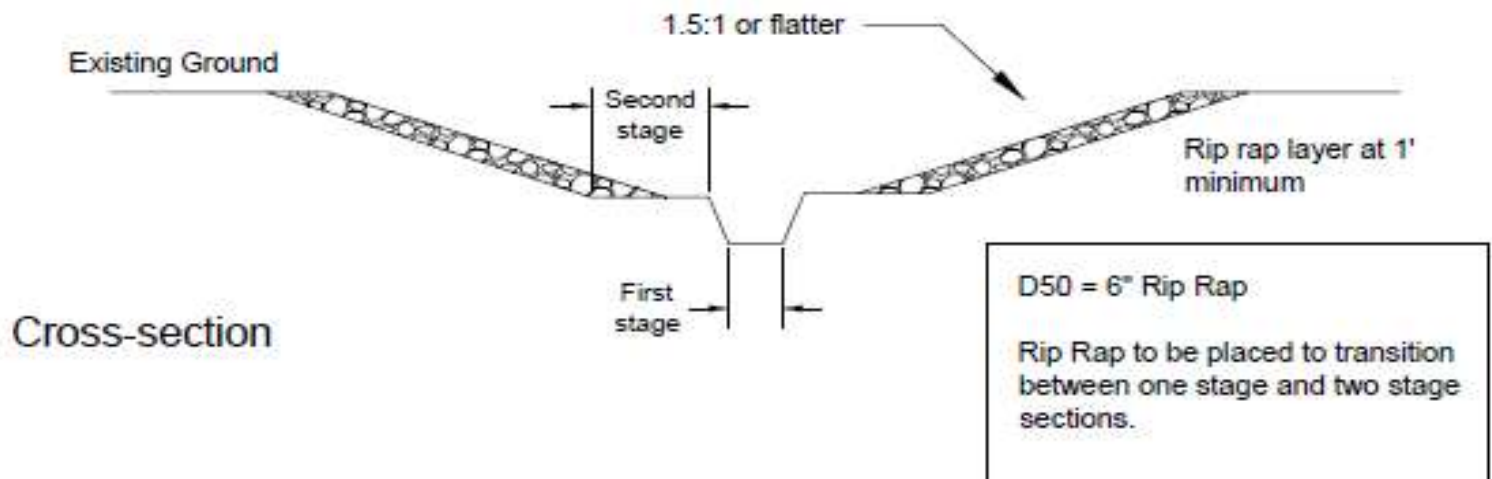
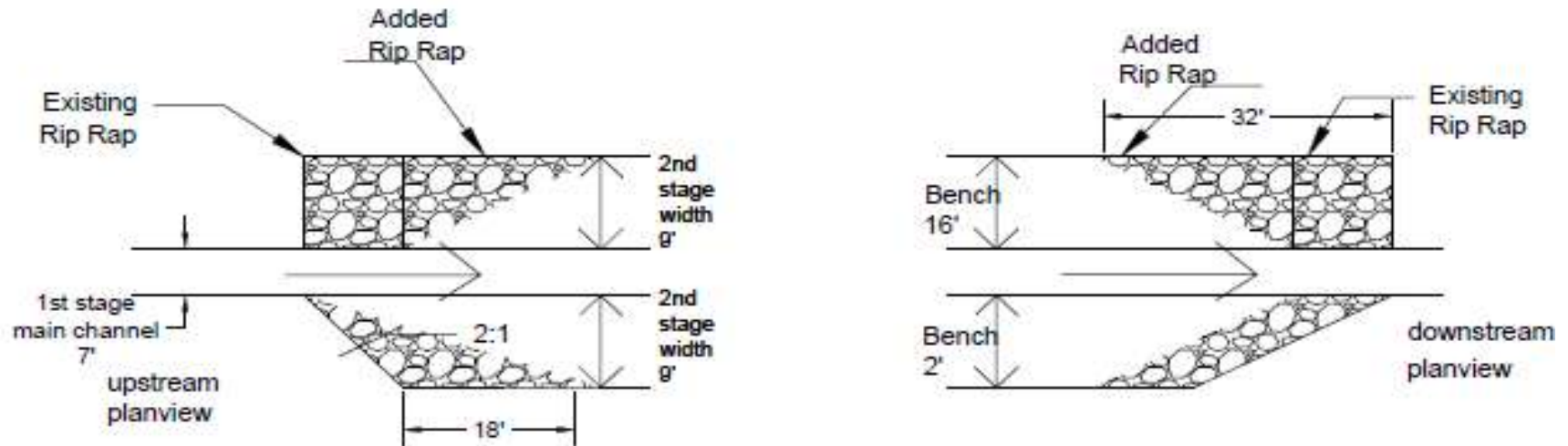
Ditch stability analysis:

Would channel stabilization measures be necessary?

- Used the NRCS Engineering Field Handbook 2 (EFH2) method to estimate 10-year peak flow, found 355 cfs.
- Calculated average channel profile for two sections (0.3% and 0.5%).
- Used Manning's Equation (for the complex geometry) to estimate that velocity of 10-year peak discharge would be 5.0 ft/s and 6.1 ft/s.
- Since this exceeds allowable velocity for the soil type, added erosion blankets to the design.



Designed transition from and to the two-stage reach for stability

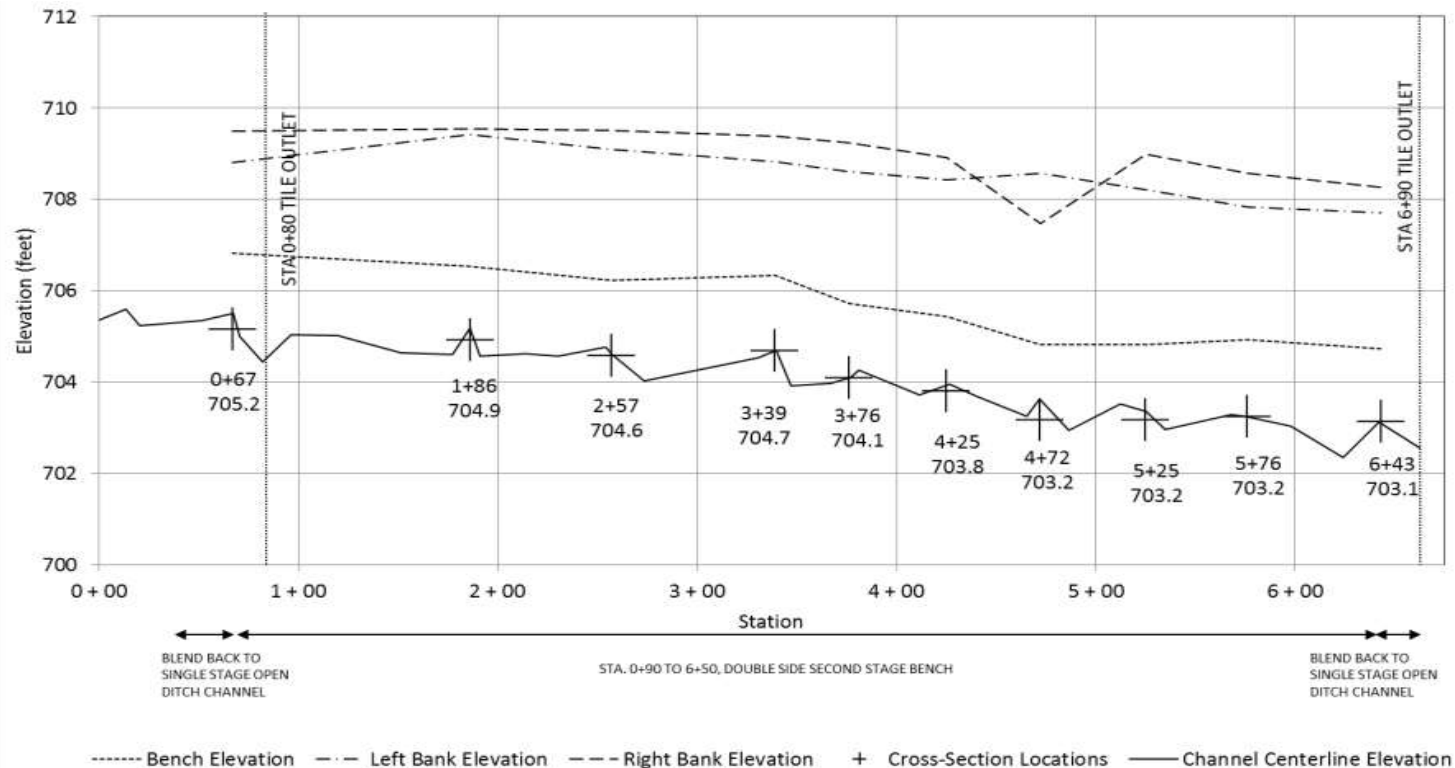


Final estimate of work to be done

Description	No	Size	Quantity	units
Excavation				
Ditch benches	2	9.75' x 3.8' x 663''	1400	cu yd
Spoil management				
Transport 0.4 mile to gully	1	626 cu yd	16	hr
Dozer work to <u>regrade</u> gully	1	626 cu yd	626	cu yd
Dozer work to backfill benches	1	4" depth	162	cu yd
Dozer work to backfill bioreactor	1	1' depth	74	cu yd
Dozer work to feather spoil on east side	1	0 to 8" depth	636	cu yd
Dozer work to feather spoil on west side	1	0 to 8" depth	252	cu yd
Slope Stability				
Installation of erosion control blanket	1	350'	362	sq yd
Installation of erosion control blanket	1	313'	354	sq yd
Installation of rip rap at new tile outlet and transition zones	4	Bench transitions	40	cu yd
Seeding				
Seeding, fertilizing and mulching spoil areas	1	Side-slopes & spoil	2	ac
Seeding & fertilizing benches	1	2 x 10' x 663'	0.3	ac

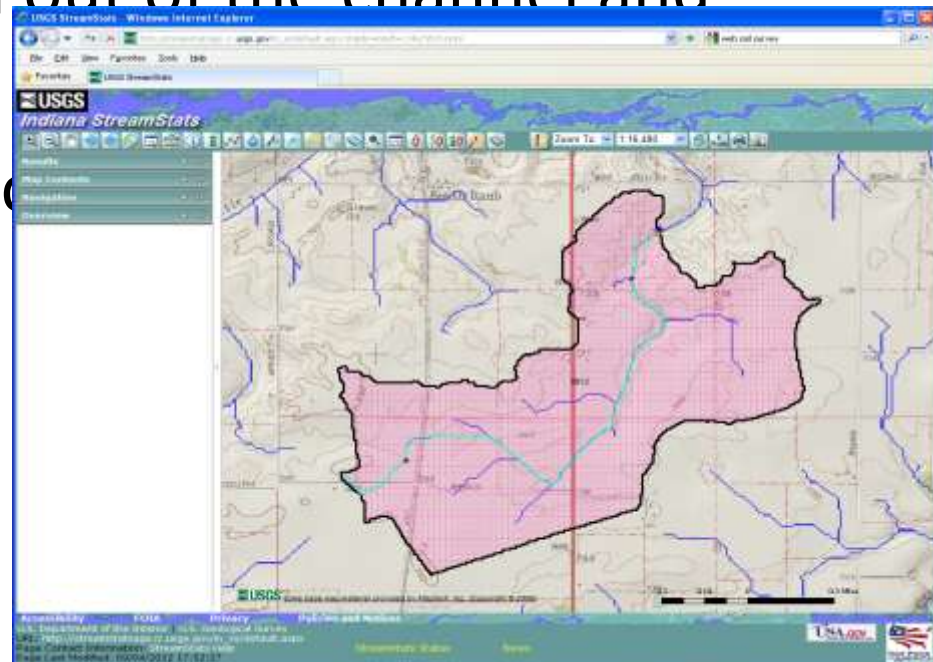
We appreciate the support we received in designing the ditch

- Dr. Jon Witter and the team at The Ohio State University
- NRCS Area Engineer Jeff Cannaday
- Dr. Bernie Engel, PE
- Steve Hawkins, Purdue Agricultural Research Program



Investigating and Obtaining Appropriate Permits

- Ditch was not a county regulated drain. But we checked with County Surveyor to discuss any requirements.
- Clean Water Act Section 404 permit not needed, because excavation stayed out of the channel and sediment was not allowed
- IDNR Construction in a Flood





PERMIT APPLICATION FOR CONSTRUCTION

State Form 42946 (R6 / 2-05)

Approved by the State Board of Accounts, 2005

Mail To: Department of Natural Resources Division of Water
 402 West Washington Street, Room W264
 Indianapolis, Indiana 46204-2641
 Telephone Number: (317) 232-4160
 Toll Free: 1-877-928-3755
 Fax Number: (317) 233-4579
www.IN.gov/dnr/water

Based on the "Permit Application Assistance Manual", I am submitting this application to perform work under:

Permit Type	Application Fee	Permit Type	Application Fee
<input type="checkbox"/> IC 14-26-2 Lake Preservation Act	\$ 100.00	<input type="checkbox"/> IC 14-29-3 Sand and Gravel Permits Act	\$ 50.00
<input type="checkbox"/> IC 14-26-5 Lowering of the Ten Acre Lake Act	\$ 25.00	<input type="checkbox"/> IC 14-29-4 Construction of Channels Act	\$ 100.00
<input type="checkbox"/> IC 14-29-1 Navigable Waterways Act	No Fee		
<input type="checkbox"/> IC 14-28-1 Flood Control Act, (select one of the following:)			
<input type="checkbox"/> Excavation, fill, or non-residential construction in a floodway			\$ 200.00
<input type="checkbox"/> Residential reconstruction in a floodway, other than the Ohio River floodway			\$ 50.00
<input type="checkbox"/> Residential construction, or reconstruction, in the Ohio River floodway			\$ 10.00

PLEASE TYPE OR PRINT

1. APPLICANT INFORMATION

Name of Applicant _____ Name of Contact Person _____

Applicant Mailing Address _____
 Street, P.O. Box or Rural Route City State ZIP Code

Contact Information: Daytime Tele. # () _____ Fax # () _____ E-mail Address _____

We appreciate the advice of

- Kent Wamsley, The Nature Conservancy,
- Staff at IDNR Division of Water

All neighboring landowners had to be notified in person or by certified mail.

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Total Postage & Fees	\$	\$3.40

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Restricted Delivery Fee (Endorsement Required)		\$0.00
Total Postage & Fees	\$	\$3.40

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Mitigation Plan for Construction in a floodway of an unnamed tributary of Wea Creek

1) Disturbed Area

Woody vegetation was removed from this site in winter 2012 prior to design of the proposed channel construction. The vegetation largely consisted of curly willow and yellow twig dogwood planted as research plots. The plots were no longer maintained, and the roots were impeding field drainage.

Permanent removal of woody vegetation will occur in those areas that previously supported woody vegetation that lie within the excavation limits of the two-stage ditch. The proposed bioreactor will not be constructed in an area of woody vegetation. The excavation limits are shown in Figure 1. The total enclosed area is 0.25 acres (0.10 ha) of sparsely populated woodland.



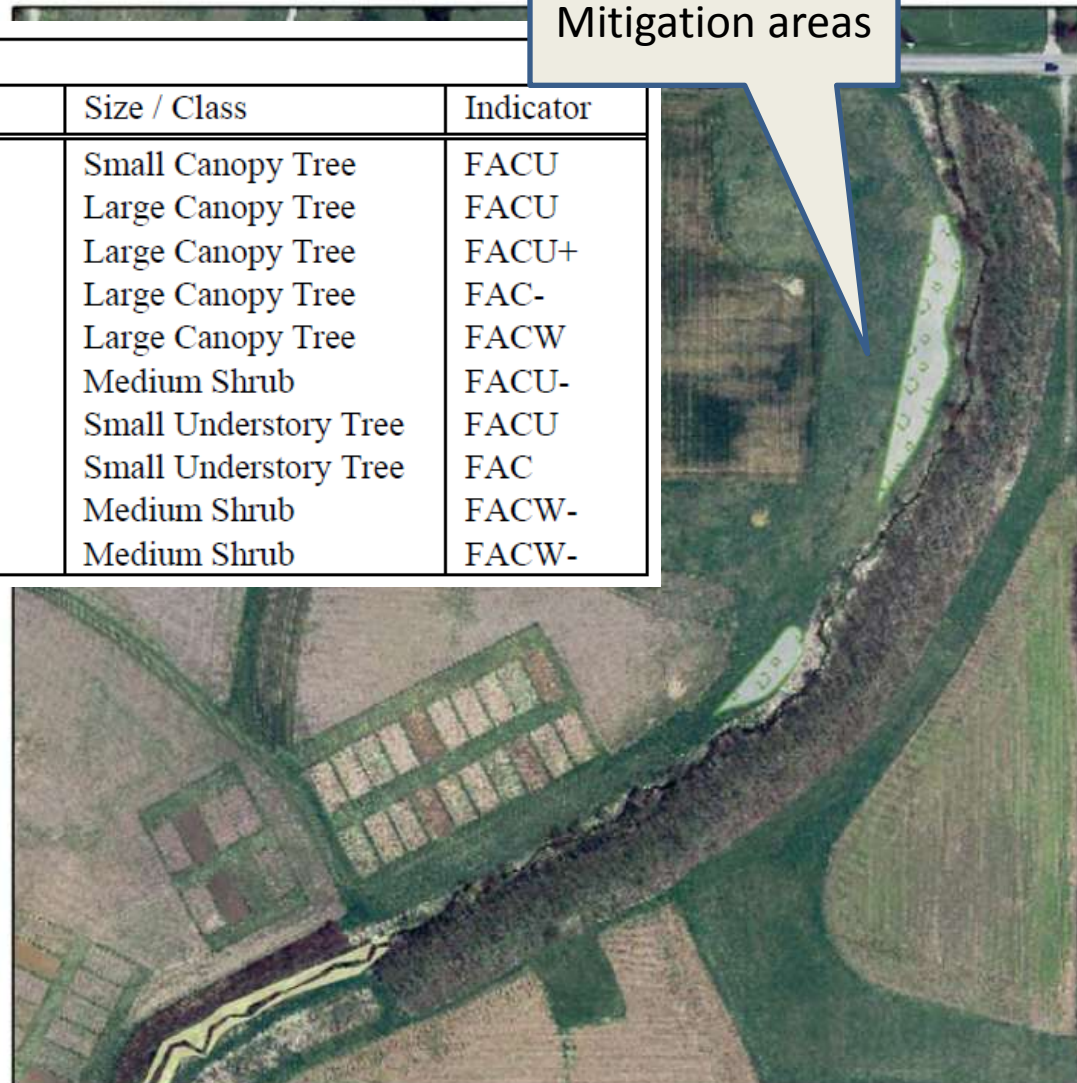
Because there were stumps in the floodway from an earlier research project, mitigation was required.

We planted native trees in neighboring areas of the farm

Mitigation areas

Table 1: Woody Riparian Vegetation Planting List

Common Name	Scientific Name	Size / Class	Indicator
Black Cherry	<i>Prunus serotina</i>	Small Canopy Tree	FACU
White Oak	<i>Quercus alba</i>	Large Canopy Tree	FACU
Tuliptree	<i>Liriodendron tulipifera</i>	Large Canopy Tree	FACU+
Bur Oak	<i>Quercus macrocarpa</i>	Large Canopy Tree	FAC-
Silver Maple	<i>Acer saccharinum</i>	Large Canopy Tree	FACW
Gray Dogwood	<i>Cornus racemosa</i>	Medium Shrub	FACU-
Redbud	<i>Cercis canadensis</i>	Small Understory Tree	FACU
Common Paw Paw	<i>Asimina triloba</i>	Small Understory Tree	FAC
Spicebush	<i>Lindera benzoin</i>	Medium Shrub	FACW-
Elderberry	<i>Sambucus canadensis</i>	Medium Shrub	FACW-





STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES



CERTIFICATE OF APPROVAL
CONSTRUCTION IN A FLOODWAY

Success!

APPLICATION # : FW-26844
STREAM : Unnamed Tributary Wea Creek
APPLICANT : Purdue University
Jane R Frankenberger
Office of Physical and Capital Planning
401 South Grant Street
West Lafayette, IN 47907-2024

AUTHORITY : IC 14-28-1 with 312 IAC 10

DESCRIPTION : Approximately 1,733 cubic yards of soil will be excavated from both banks for approximately 663' to construct a two-stage ditch. The banks will be excavated an average of 3.8' in depth to create two, 10' wide benches. The original channel width will be maintained and will have a depth of approximately 1.6'. The upper stage banks will have 2:1 sideslopes and will transition to match banks at the project limits. The excavated material will be side-cast and graded on the adjacent lands to a maximum depth of 8". An existing 12" drainage tile will be reconstructed to outfall at the two-stage bench. Approximately 0.46 acre of native tree mitigation will be planted up stream of the project site. Details of the project are contained in information received electronically at the Division of Water on August 7, 2012 and in plans and information received at the Division of Water on August 6, 2012, August 9, 2012, August 31, 2012 and September 11, 2012.

LOCATION : Beginning approximately 1,600' upstream of County Road West 800 South, continuing approximately 663' upstream near Lafayette, Randolph Township, Tippecanoe County

Constructing the Ditch

- Educational Field Day with the Indiana Land Improvement Contractors Association
 - About 20 contractors worked on the site
 - About 80 people viewed the construction.
- Funding for constructing and monitoring the two-stage ditch provided by
 - Wabash River Enhancement Corporation, through an IDEM 319 grant
 - Purdue Research Foundation and the Estate of Mary Rice
 - NRCS Conservation Innovation Grant



Seeding the banks and applying erosion blankets

