

ENG Form  
4345

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DRAINAGE PERMITS

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18. Nature of Activity (Description of project, include all features)

The development of a 1025.6 acre surface mine operation. The project requires the impact to several intermittent and ephemeral streams, as well as wetlands and an open water areas (ponds). Mitigation is proposed on-site for all impacted resources..

19. Project Purpose (Describe the reason or purpose of the project, see instructions)

To develop a surface coal mine operation.

**USE BLOCKS 20-23 IF DREDGED AND/OR FILL MATERIAL IS TO BE DISCHARGED**

20. Reason(s) for Discharge

To necessitate the development of the mining site, intermittent and ephemeral streams, and wetlands are impacted. Avoidance and minimization measures were taken to reduce impacts at the site.

21. Type(s) of Material Being Discharged and the Amount of Each Type in Cubic Yards:

Type Amount in Cubic Yards	Type Amount in Cubic Yards	Type Amount in Cubic Yards
Approx. 349000 CY (common fill generated on site)		

22. Surface Area in Acres of Wetlands or Other Waters Filled (see instructions)

Acres 0.485 acres of perennial, 0.918 acres of intermittent, 2.562 acres of ephemeral, 9.941 acres of wetlands, and 37.115 acres of open waters.  
Or  
Liner Feet 2818' of perennial, 9627' of intermittent, and 38868' of ephemeral

23. Description of Avoidance, Minimization, and Compensation (see instructions)

See Section 2,B,(3) of the "Pre-construction Notification" document for a detailed discussion.

24. Is Any Portion of the Work Already Complete? Yes  No  IF YES, DESCRIBE THE COMPLETED WORK

25. Addresses of Adjoining Property Owners, Lessees, Etc., Whose Property Adjoins the Waterbody (if more than can be entered here, please attach a supplemental list).

Address - See attachment  
City - State - Zip -

26. List of Other Certifications or Approvals/Denials Received from other Federal, State, or Local Agencies for Work Described in This Application.

AGENCY	TYPE APPROVAL*	IDENTIFICATION NUMBER	DATE APPLIED	DATE APPROVED	DATE DENIED
EPPC- Div of Permits	WQC				

\* Would include but is not restricted to zoning, building, and flood plain permits

27. Application is hereby made for a permit or permits to authorize the work described in this application. I certify that the information in this application is complete and accurate. I further certify that I possess the authority to undertake the work described herein or am acting as the duly authorized agent of the applicant.

\_\_\_\_\_  
SIGNATURE OF APPLICANT

\_\_\_\_\_  
DATE

\_\_\_\_\_  
SIGNATURE OF AGENT

\_\_\_\_\_  
DATE

The application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in block 11 has been filled out and signed.

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals, or covers up any trick, scheme, or disguises a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statements or entry, shall be fined not more than \$10,000 or imprisoned not more than five years or both.

**ATTACHMENT  
BLOCK 25**

**Adjoining Property Owners**

Western Land Co., LLC  
407 Brown Road  
Madisonville, KY 42431

Lyman P. & Joyce Barnes  
State Route 69 South  
Centertown, KY 42328

Joseph L. & Roase Ralph  
110 Stony Point Lane  
Centertown, KY 42328

## MIDWAY SOUTH SITE

### SUMMARY OF IMPACTS (M=Mined through, B=Basin, S=Spoil material)

Site number	Latitude	Longitude	Cowardin Class or Flow Regime	Impact Type - Length or Acreage
P-1	37.389528	86.977194	Perennial	M=1115 linear feet
				B=1350 linear feet
P-2	37.372444	86.952500	Perennial	B=353 linear feet
I-1	37.389667	86.970889	Intermittent	M=302 linear feet
I-2	37.388667	86.975056	Intermittent	M=3971 linear feet
				B=200 linear feet
I-3	37.386472	86.973972	Intermittent	M=266 linear feet
I-4	37.385639	86.974306	Intermittent	M=565 linear feet
I-5	37.382778	86.967944	Intermittent	M=977 linear feet
I-6	37.381222	86.977694	Intermittent	M=626 linear feet
I-7	37.377722	86.973694	Intermittent	M=591 linear feet
I-8	37.383167	86.963111	Intermittent	M=627 linear feet
I-9	37.377389	86.955778	Intermittent	S=261 linear feet
I-10	37.376278	86.961944	Intermittent	M=278 linear feet
I-11	37.375111	86.956250	Intermittent	S=629 linear feet
I-12	37.378583	86.949833	Intermittent	S=334 linear feet
E-1	37.387972	86.978139	Ephemeral	M=402 linear feet
				B=200 linear feet
E-2	37.389889	86.975611	Ephemeral	M=354 linear feet
				B=150 linear feet
E-3	37.389500	86.971417	Ephemeral	M=144 linear feet
E-4	37.389250	86.971222	Ephemeral	M=709 linear feet
E-5	37.388278	86.970917	Ephemeral	M=224 linear feet

E-6	37.386611	86.971528	Ephemeral	M=657 linear feet
E-7	37.385667	86.970917	Ephemeral	M=1233 linear feet
E-8	37.383139	86.974472	Ephemeral	M=542 linear feet
E-9	37.383750	86.974111	Ephemeral	M=250 linear feet
E-10	37.384000	86.970944	Ephemeral	M=789 linear feet
E-11	37.383333	86.970278	Ephemeral	M=756 linear feet
E-12	37.382222	86.968639	Ephemeral	M=257 linear feet
E-13	37.383306	86.967861	Ephemeral	M=342 linear feet
E-14	37.383694	86.968194	Ephemeral	M=274 linear feet
E-15	37.383194	86.967139	Ephemeral	M=374 linear feet
E-16	37.383000	86.967306	Ephemeral	M=401 linear feet
E-17	37.385389	86.983250	Ephemeral	M=2901 linear feet
E-18	37.382611	86.977722	Ephemeral	M=565 linear feet
E-19	37.384083	86.982694	Ephemeral	M=227 linear feet
E-20	37.382028	86.974944	Ephemeral	M=903 linear feet
E-21	37.381611	86.975056	Ephemeral	M=306 linear feet
E-22	37.379250	86.976444	Ephemeral	M=210 linear feet
E-23	37.378806	86.975806	Ephemeral	M=298 linear feet
E-24	37.379417	86.972861	Ephemeral	M=997 linear feet
E-25	37.380833	86.973139	Ephemeral	M=297 linear feet
E-26	37.378333	86.972889	Ephemeral	M=1362 linear feet
E-27	37.379861	86.971333	Ephemeral	M=203 linear feet
E-28	37.377722	86.972889	Ephemeral	M=548 linear feet
E-29	37.374417	86.970222	Ephemeral	M=1500 linear feet

E-30	37.376101	86.969093	Ephemeral	M=478 linear feet
E-31	37.375521	86.970122	Ephemeral	M=680 linear feet
E-32	37.376139	86.968917	Ephemeral	M=998 linear feet
E-33	37.374556	86.959972	Ephemeral	M=302 linear feet
E-34	37.375333	86.960889	Ephemeral	M=190 linear feet
E-35	37.375722	86.961611	Ephemeral	M=334 linear feet
E-36	37.376389	86.962694	Ephemeral	M=451 linear feet
E-37	37.375944	86.963806	Ephemeral	M=895 linear feet
E-38	37.377194	86.964722	Ephemeral	M=311 linear feet
E-39	37.378306	86.964944	Ephemeral	M=1317 linear feet
E-40	37.378111	86.964556	Ephemeral	M=947 linear feet
E-41	37.377417	86.962583	Ephemeral	M=913 linear feet
E-42	37.376417	86.962056	Ephemeral	M=204 linear feet
E-43	37.376639	86.961000	Ephemeral	M=277 linear feet
E-44	37.379778	86.959333	Ephemeral	S=1401 linear feet
E-45	37.374944	86.955444	Ephemeral	S=235 linear feet
E-46	37.373389	86.955611	Ephemeral	S=143 linear feet
E-47	37.375417	86.954333	Ephemeral	S=355 linear feet
E-48	37.374194	86.953222	Ephemeral	B=380 linear feet
E-49	37.382889	86.963472	Ephemeral	M=500 linear feet
E-50	37.383972	86.963167	Ephemeral	M=407 linear feet
E-51	37.383611	86.962417	Ephemeral	M=390 linear feet
E-52	37.382889	86.961917	Ephemeral	M=220 linear feet
E-53	37.382944	86.960583	Ephemeral	M=266 linear feet

E-54	37.383444	86.960111	Ephemeral	M=342 linear feet
E-55	37.382250	86.957333	Ephemeral	S=218 linear feet
E-56	37.382917	86.958667	Ephemeral	S=657 linear feet
E-57	37.384944	86.961000	Ephemeral	M=258 linear feet
E-58	37.386611	86.961056	Ephemeral	M=251 linear feet
E-59	37.386861	86.960333	Ephemeral	M=448 linear feet
E-60	37.387167	86.958250	Ephemeral	M=512 linear feet
E-61	37.387278	86.957667	Ephemeral	M=343 linear feet
E-62	37.386861	86.957972	Ephemeral	M=294 linear feet
E-63	37.385944	86.957000	Ephemeral	M=578 linear feet
E-64	37.378944	86.955556	Ephemeral	S=1776 linear feet
E-65	37.386778	86.952833	Ephemeral	S=143 linear feet
E-66	37.386583	86.949861	Ephemeral	S=1007 linear feet
E-67	37.383583	86.952556	Ephemeral	M=100 linear feet S=270 linear feet
E-68	37.382389	86.950861	Ephemeral	S=198 linear feet
E-69	37.379583	86.951111	Ephemeral	S=504 linear feet
Wetland A	37.377028	86.953528	PEM1H	S=0.076 acres
Wetland B	37.375722	86.953083	PSS1H	S=0.048 acres
Wetland C	37.375139	86.953972	PEM1H	S=0.335 acres
Wetland D	37.374000	86.950389	PFO1B	B=0.093 acres
Wetland E	37.372778	86.951778	PEM1H	B=0.172 acres
Wetland F	37.376389	86.957472	PEM1H	S=1.442 acres
Wetland G	37.37806	86.955528	PEM1H	S=0.355 acres

Wetland H	37.372722	86.953139	PEM1H	S=0.606 acres
Wetland I	37.373222	86.955917	PEM1H	S=0.284 acres
Wetland J	37.385861	86.951389	PEM1H	S=0.136 acres
Wetland K	37.386306	86.952278	PEM1H	S=0.133 acres
Wetland L	37.386583	86.952222	PEM1H	S=0.469 acres
Wetland M	37.386806	86.953972	PEM1H	M=0.042 acres
Wetland N	37.386389	86.954694	PEM1H	M=0.093 acres
Wetland O	37.386972	86.958111	PEM1H	M=0.160 acres
Wetland P	37.384694	86.957333	PEM1H	S=1.037 acres
Wetland Q	37.398694	86.958083	PEM1H	S=0.028 acres
Wetland R	37.382056	86.958417	PEM1H	M=0.333 acres
				S=0.120 acres
Wetland S	37.383861	86.958083	PEM1H	M=0.141 acres
				S=0.300 acres
Wetland T	37.383639	86.951778	PEM1H	S=0.105 acres
Wetland U	37.375944	86.961611	PSS1H/PEM1H	M=0.620 acres
Wetland V	37.376639	86.962722	PFO1A	M=0.920 acres
Wetland W	37.385778	86.976361	PEM1H	M=0.015 acres
Wetland Y	37.385306	86.981722	PFO1A/PEM1A	M=0.237 acres
Wetland Z	37.386083	86.982417	PFO1A	M=0.107 acres
Wetland AA	37.383250	86.978194	PSS1A	M=0.022 acres
Wetland BB	37.377806	86.972889	PFO1A	M=0.273 acres
Wetland CC	37.390444	86.97817	PFO1A	B=0.419 acres
Wetland DD	37.389167	86.974472	PSS1A	B=0.263 acres
Wetland EE	37.386333	86.973583	PSS1B	M=0.022 acres
Wetland FF	37.384167	86.972750	PFO1B	M=0.190 acres
Wetland GG	37.381972	86.969722	PEM1B	M=0.177 acres

Wetland HH	37.382583	86.968417	PEM1B	M=0.102 acres
Wetland II	37.379944	86.968500	PEM1B	M=0.013 acres
Wetland JJ	37.379111	86.972361	PSS1B	M=0.053 acres
Pond 1	37.387018	86.953398	Open waters	M=2.576 acres
Pond 2	37.385342	86.950686	Open waters	S=0.685 acres
Pond 3	37.383208	86.950558	Open waters	S=3.380 acres
Pond 4	37.375779	86.951768	Open waters	B=8.096 acres
Pond 5	37.373115	86.951971	Open waters	B=1.297 acres
Pond 6	37.373354	86.954503	Open waters	S=5.782 acres
Pond 7	37.375625	86.959385	Open waters	M=5.649 acres
Pond 8	37.382040	86.960702	Open waters	M=4.184 acres
Pond 9	37.384887	86.959707	Open waters	M=4.404 acres
Pond 10	37.385842	86.957969	Open waters	M=0.919 acres
Pond 11	37.385839	86.976490	Open waters	M=0.143 acres

Totals: Perennial = 2818 ft.  
Intermittent = 9627 ft.  
Ephemeral = 38868 ft.  
Wetlands = 9.941 ac.  
Open waters = 37.115 ac.

*Final jurisdictional determinations will be made by US Army Corps of Engineers for all impacts.*

PCN

# **PRE-CONSTRUCTION NOTIFICATION**

## **SURFACE COAL MINE OPERATION In Ohio County, Kentucky**

### **MIDWAY SOUTH SITE**

Prepared for:

**Armstrong Coal Company**

407 Brown Road

Madisonville, KY 42431

Prepared by:

**T.H.E. *J-E* Engineers, Inc.**

2331 Fortune Drive, Suite #295

Lexington, Kentucky 40509

(859) 263-0009

November 21, 2012

(Revised January 11, 2013)

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# STANDARD OPERATING PROCEDURES

## **1. Pre-Application Meeting.**

An on-site meeting with representatives from the United States Army Corps of Engineers (USACE) was conducted at the site on January 8, 2013. It was determined that resources that appeared to be isolate, as indicated in the baseline report, were found to be jurisdictional waters.

## **2. Receipt of Application.**

Please refer to ENG Form 4345 and attachments for information related to applicant, authorized agent, project location, project description and purpose, adjoining property owners, summary of impacts and signature authorization. See Vicinity Map (Exhibit 1) for project location.

### **A. Detailed description of proposed activity:**

#### **(1) Impacts**

Under this application, Armstrong Coal Company is proposing the following impacts: 38868 feet of ephemeral stream (or 2.562 surface acres), 9627 feet of intermittent stream (or 0.918 surface acres), and 2818 feet of perennial stream (or 0.485 surface acres). There will be 35 wetlands filled with a total area of 9.941 acres (2.239 acres of palustrine forested (PFO) wetlands, 1.028 acres of palustrine scrub-shrub (PSS) wetlands, and 6.674 acres of palustrine emergent (PEM) wetlands). Additionally, eleven pond/pit open water areas, with a total area of 37.115 acres, will be filled.

##### **(a) Direct Impacts**

- The proposed activity will not involve hollow fills or permanent fills.
- Seven (7) temporary basins will be used for sediment control, impacting an estimated 2633 feet of total stream length.
- Mining will affect 2818 feet of perennial stream, 9627 feet of intermittent stream, and 38868 feet of ephemeral stream (totaling 51313 feet), 9.941 acres of wetlands, and 37.115 acres of ponds/open waters; required to access the coal reserves. Upon completion of mining, all impacted resources will be mitigated on-site. A mitigation plan will be submittal later.

(b) Indirect Impacts

- Water will be diverted within the project boundary. No diversions outside of the project boundary will be needed during the mining process.
- Site excavation will result in impacts to streams and wetlands and will indirectly impact aquatic life movement by creating temporary obstacles.

**(2) Drainage Acreage**

The total area within the project boundary is 1025.6 acres, located within one HUC-12 watershed; the Lewis Creek watershed (HUC 051100030502). There are two major watersheds where existing drainage leaves the project site; an overflow outlet for existing Pond 5 near the southeastern project limit and at the northwestern project limit for perennial stream P-1. The drainage areas for those watersheds are 411 acres and 593 acres respectively. Refer to the "Stream Habitat Assessment and Wetland Delineation Report" for drainage areas of each impact.

**(3) Purpose**

The purpose of the proposed activity is to establish a surface coal mine operation to extract coal from the WK #11, #13, and #13A seams in order to meet future energy demands of the United States. The operation is expected to last approximately 72 months. This project will retain employment for one hundred-twenty five jobs at the site, and extend employment for forty jobs at the plant/loading facility, as well as management and support jobs. There are a large number of indirect jobs supporting the facility. Business activities associated with the project are expected to boost local economy in a region that has suffered economically since the 1970's.

**(4) Schedule**

Work is expected to begin in summer of 2013, with expected completion in late 2019.

**(5) Dredged or Fill Material**

Material consisting of native rock and soil will be generated during project development. Streams, wetlands, and ponds will be impacted by excavation and/or fill during the mining process. The volume of streams, to ordinary high water mark, is approximately 4220 cubic yards. The volume of wetlands is approximately 16040 cubic yards, and the volume of ponds is estimated to be 329000 cubic yards.

## **B. Minimal Impact Determination**

### **(1) Loss of Aquatic Functions**

Loss of aquatic functions: The primary functions of streams within the project boundary are aquatic habitat and movement, water conveyance, sediment transport and a potential water source for terrestrial animals. In addition, smaller ephemeral streams and headwaters of the larger streams supply organic material to lower reaches and eventually to larger stream systems. The intermittent stream may be able to support aquatic insects and/or fish; however, streams located in previously mined areas may not have fully recovered from past disturbance. The primary functions of wetlands within the project boundary include: flood water storage, energy dissipation, nutrient retention, subsurface water storage and wildlife habitat. The wetlands will be mitigated on-site. A mitigation plan will be submitted later.

Stream and wetland functions will be temporarily lost during project development and will be replaced upon project completion. They will be affected over a period of 72 months. Proposed stream mitigation will include providing active floodplains and floodprone areas along low gradient streams. Wetland mitigation will provide creation of appropriate wetland types and functions, at approved ratios. Streams and wetlands will be restored beginning early in 2019 as mined areas are reclaimed.

### **(2) Gain of Aquatic Functions**

Aquatic functions gained with compensatory mitigation include:

- Replacing streams on site where practicable and feasible.
- Providing variable substrate material in the streams where appropriate.
- Providing variable flow regimes in the form of riffles, runs, pools and glides.
- Establishing wide riparian zones, using desirable native tree and shrub species.
- Utilizing in-stream structures such as J-hooks and vanes to create variable habitat.
- Creating stable stream systems based on natural channel design techniques and geomorphic principles.
- Wetland impacts will be mitigated by establishing wetlands of similar or higher quality than those being impacted.
- Providing permanent protection for both wetland and stream mitigation sites through a protective covenant.

### **(3) Avoidance and Minimization**

The project has been designed to avoid and minimize adverse impacts to waters of the U.S.

(a) Geologic exploration in the region indicates that the proposed surface mine area is the most appropriate based on the amount of coal reserves available and the inadequate overburden cover to recover the WK #11, #13, and #13A seams by other mining techniques; including underground mining.

(b) Use of this project site can be considered to some degree an avoidance and minimization effort, since a large portion of the area (approximately 32 percent) contains 251 acres of prior disturbed (past mining) area and approximately 77 acres currently affected by agricultural practices where impacts to waters have already taken place. The prior mining area contains nearly all the open waters, and the largest concentration of wetlands to be impacted. Considering the cumulative aquatic resources present on the entire proposed 1026 acre SMCRA site (9.941 acres of wetlands, 38868 linear feet of ephemeral stream, 9627 linear feet of intermittent stream, 2818 feet of perennial, and 37.115 acres of open waters), Armstrong Coal Company will avoid and minimize direct impacts to other resources in areas not prior disturbed by past mining activities. Armstrong proposes to mitigate the stream impacts at a ratio of 0.5:1 for ephemeral streams, providing at least 19434 total linear feet, and 1:1 for intermittent and perennial streams, providing at least 12445 total linear feet. In addition, existing excavated pond (pit) areas will be returned to their pre-disturbance state as stream channels. To compensate for the proposed wetland impacts, mitigation will be proposed on-site. The only alternative that would result in no impacts to waters of the U.S. is the no-build alternative, which would not meet the purpose and need of the proposed project. Completely avoiding impacts to all streams and wetlands within the project boundary was determined not to be practical.

Erosion control measures during project development will be employed to minimize the increase of suspended solids and turbidity. Erosion control structures will include a permanent silt basin located as close to impact areas as practicable, diversion ditches, rock check dams, temporary seeding and mulching and silt fence. Use of existing features on the site will avoid additional impacts to waters of the U.S. For example, the utilization of existing haul roads to transport coal to the prep plant instead of using public roadways. Additional measures include timely construction and maintenance of sediment control structures combined with concurrent reclamation and re-vegetation of disturbed areas.

(c) No information has been found that lists any of the aquatic sites as high quality waters. For example, there are no Outstanding Resource Waters, Division of Water Reference Reaches, Class 1-3 Undeveloped or Wild and Scenic Rivers or Cold Water Habitat located within the project boundary.

(d) Seven temporary sediment basins will be utilized for erosion controls. They will be located near the project limits and will serve to treat water before it leaves the site.

**(4) Cumulative Impacts Analysis:**

See Cumulative Impacts Analysis section of application.

**C. Compensatory Mitigation:**

See *Mitigation Plan for Stream and Wetland Impacts* section of application.

# Vicinity Map Midway South Site

**Permit Boundary**

SCALE 1"=4000'

**T.H.E.  
Engineers, Inc.**

PROJECT: MIDWAY SOUTH SITE

STREAMS: UT'S OF SOUTHWARDS CREEK & LEWIS CREEK

COUNTY: OHIO

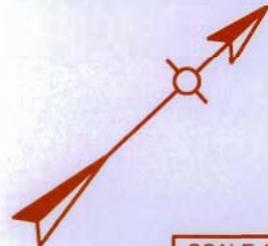
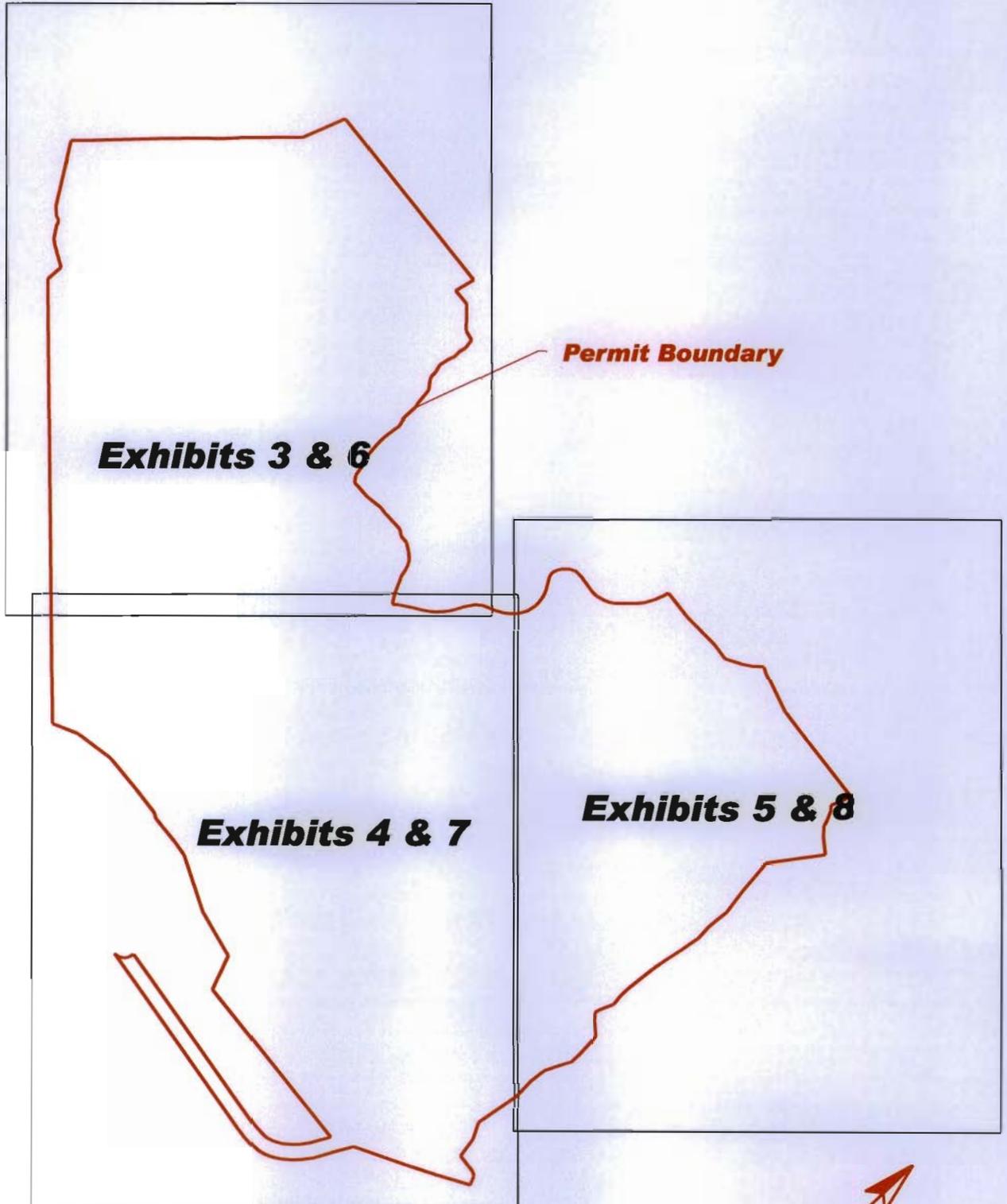
STATE: KY

NEAR: CENTERTOWN

ITEM: VICINITY MAP

EXHIBIT I

# Sheet Index



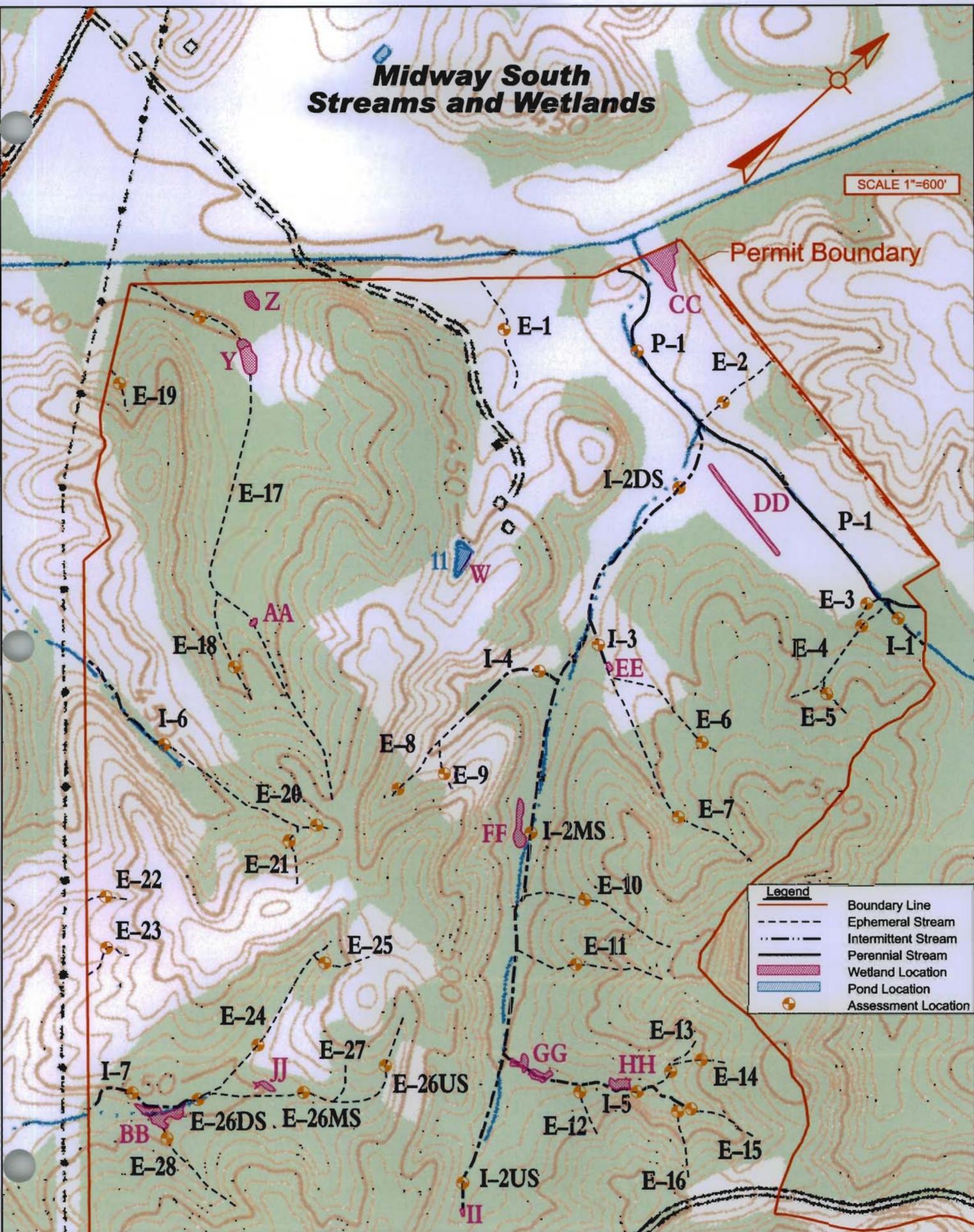
SCALE 1"=1500'

<b>T.H.E. Engineers, Inc.</b>	PROJECT: MIDWAY SOUTH SITE				
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: INDEX MAP	EXHIBIT 2

# Midway South Streams and Wetlands

SCALE 1"=600'

Permit Boundary



Legend	
	Boundary Line
	Ephemeral Stream
	Intermittent Stream
	Perennial Stream
	Wetland Location
	Pond Location
	Assessment Location

# Midway South Streams and Wetlands



Legend	
	Boundary Line
	Ephemeral Stream
	Intermittent Stream
	Perennial Stream
	Wetland Location
	Pond Location
	Assessment Location

**T.H.E.  
Engineers, Inc.**

PROJECT: MIDWAY SOUTH SITE - JURISDICTIONAL WATERS DELINEATION

STREAMS: UT'S OF SOUTHARDS CREEK & LEWIS CREEK

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

ITEM: QUAD

EXHIBIT 4

# Midway South Streams and Wetlands

Permit Boundary

SCALE 1"=600'



Legend	
	Boundary Line
	Ephemeral Stream
	Intermittent Stream
	Perennial Stream
	Wetland Location
	Pond Location
	Assessment Location

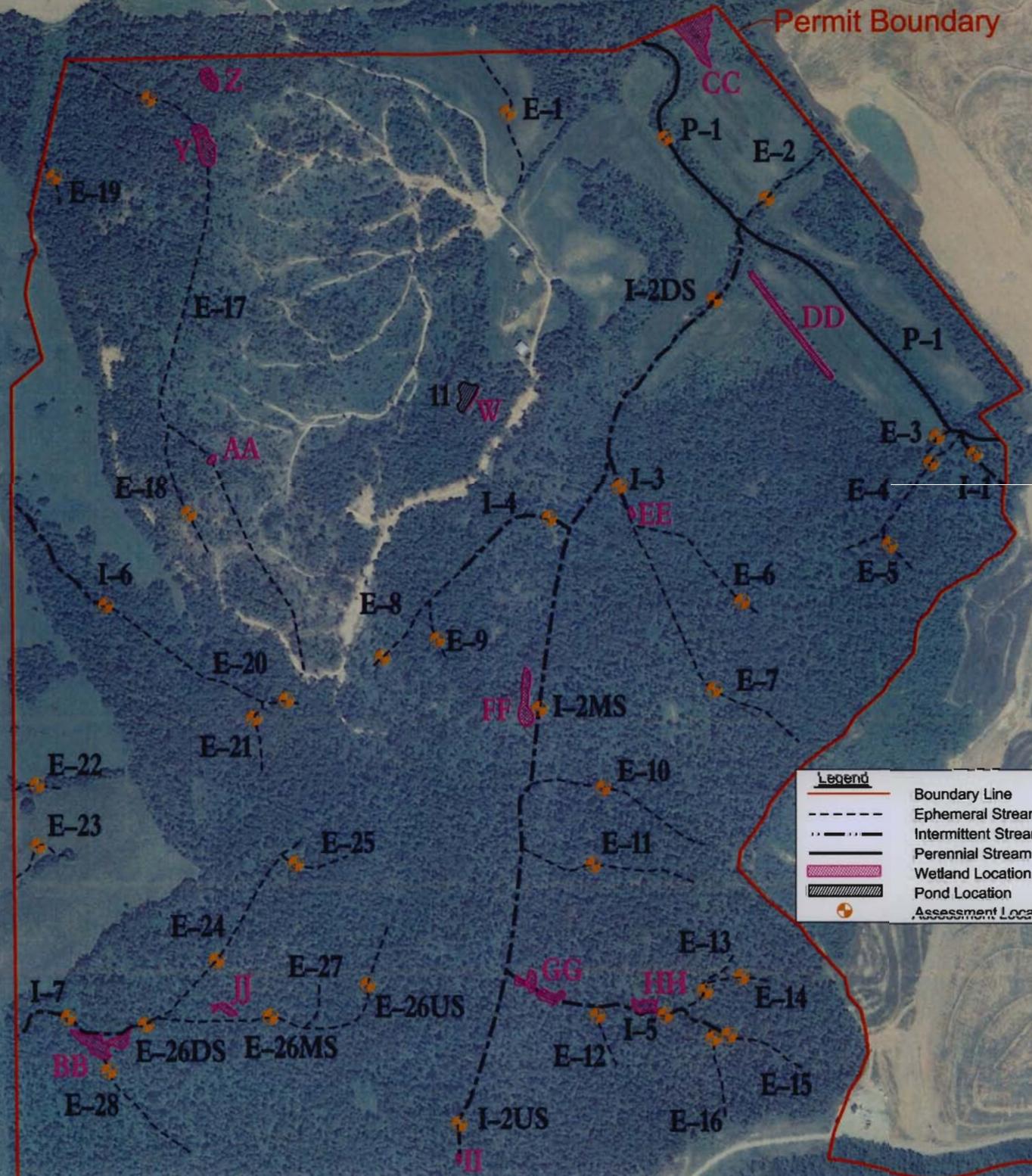
T.H.E. Engineers, Inc.	PROJECT: MIDWAY SOUTH SITE - JURISDICTIONAL WATERS DELINEATION			STREAMS: UT'S OF SOUTHARDS CREEK & LEWIS CREEK	
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: QUAD	EXHIBIT 5

# Midway South Streams and Wetlands

SCALE 1"=600'

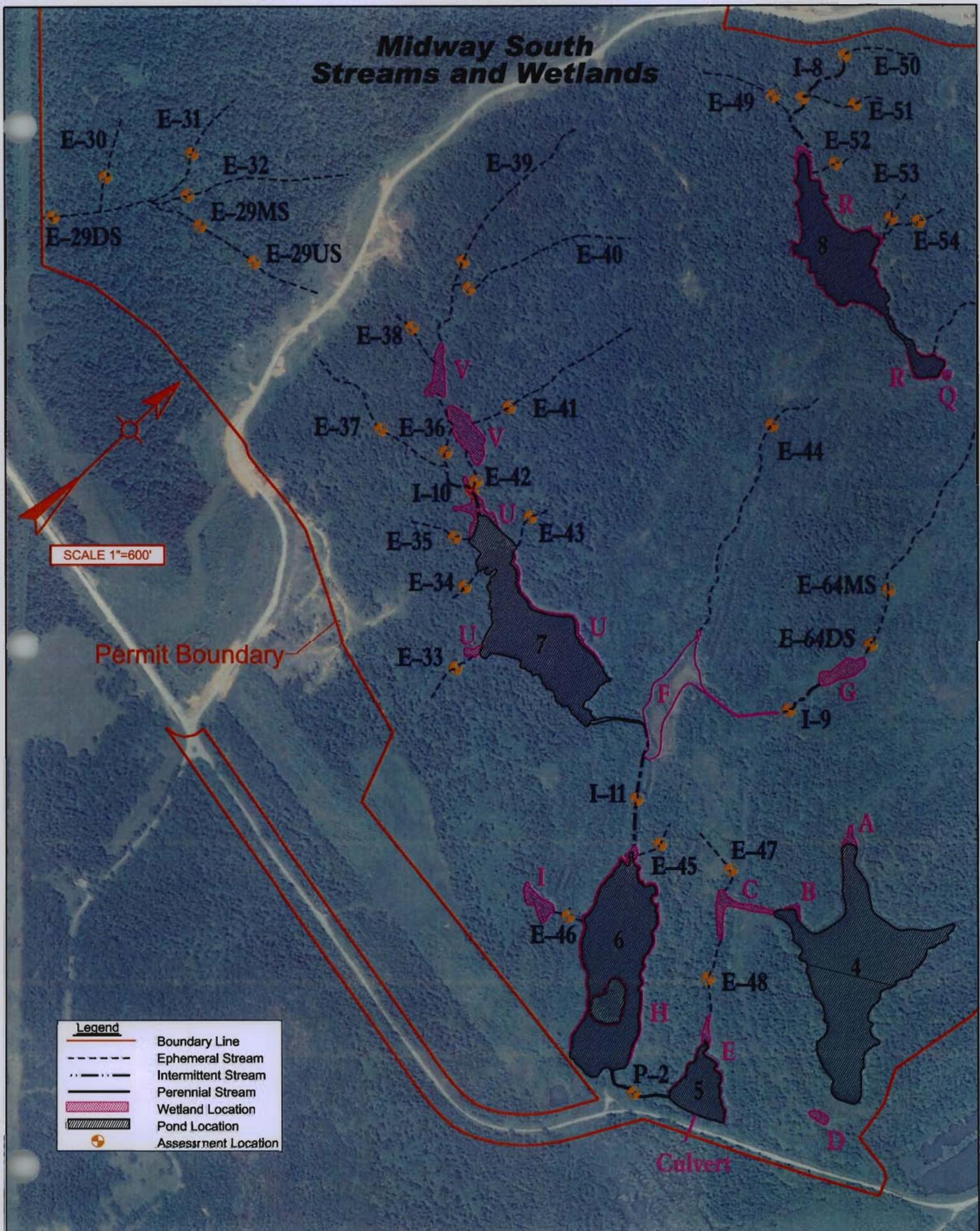


Permit Boundary



Legend	
	Boundary Line
	Ephemeral Stream
	Intermittent Stream
	Perennial Stream
	Wetland Location
	Pond Location
	Assessment Location

# Midway South Streams and Wetlands

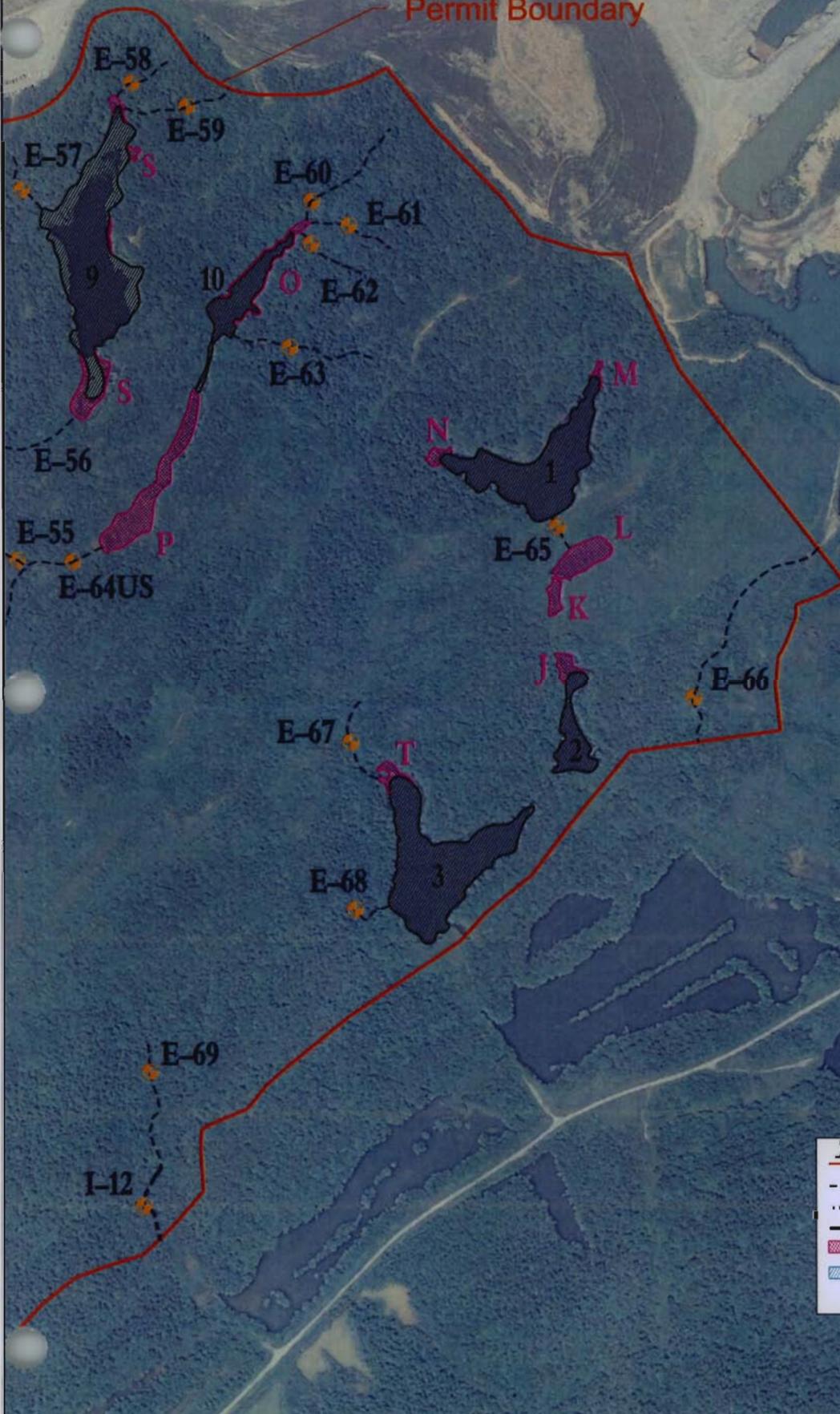


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	Boundary Line
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Cumulative  
Impacts  
Analysis

**CUMULATIVE IMPACTS ANALYSIS  
OHIO COUNTY, KENTUCKY  
Midway South Mine Site**

**Introduction**

This document will use terminology following current EIS guidance. An impact, or effect, means the change or modification to an environmental resource brought about by an outside action. Impacts can, and will, vary in significance, magnitude, and duration. Impacts may also be beneficial or adverse depending on the action and resource affected. For this analysis, short-term impacts are those with effects evident for a few years, generally less than the lifetime of the project (e.g. ground clearing activities). Long-term impacts generally would be those with effects extending beyond the lifetime of the project (i.e. beyond reclamation). Impact magnitude will be defined as follows: major impacts could cause significant change, stress, or depletion to an environmental resource, potentially resulting in irretrievable loss; moderate impacts could cause some change in a resource, generally with readily apparent effects; minor impacts are those that are detectable but slight; negligible impacts are those at the lower limit of detection causing insignificant change or stress to resources; and no impact applies to a level at which no discernable or measurable impacts are observed. In cases where quantitative resource evaluation was not possible, analyses were based on best available information and professional judgment. (Office of Surface Mining, 2006).

The proposed project area, also referred to as the Midway South Mine Site, has a footprint of approximately 1026 acres; but the cumulative impact analysis has been expanded to a 12-digit HUC watershed. The "Review Area" now refers to Lewis Creek, HUC 051100030504; an area of approximately 37.0 mi<sup>2</sup>. Little data, other than coal severance tax records, are available prior to the advent of SMCRA permitting in the late 1970's. As a result, much of the discussion of past impacts is qualitative. Current and future impacts are based upon the best available data for resources of concern, but still involve a degree of speculation. Cumulative impacts were considered based upon present-day baseline conditions defined. The future time boundary of the analysis is determined by the release of project areas from agency oversight. The estimated lifetime of the project is six years, and an additional five years for reclamation and bond release of the mine areas will be assessed. Therefore, the cumulative impacts analysis will focus on a period of earliest available data for each resource to eleven years after mining begins, and will refer to this timeframe as the "Review Period" for the remainder of the document.

***Baseline Conditions***

Landuse changes have impacted much of the landscape, but large forested areas remain. Forest still covers 58% of the Review Area (approximately 13,600 acres). Forests are concentrated in higher-relief areas and along the main stems and larger tributaries of local streams. Large blocks remain, and often are connected by forested riparian corridors. Cultivated agricultural land occupies 12% of the Review Area (approximately 2,800 acres), and is most common in the southern and western portions of the review area. Farm production is roughly evenly divided between soybean and corn (US Department of Agriculture, 2002). The remaining landuses reflect generally more recent land development. Developed areas occupy roughly 5% of the land surface (1,300 acres), and are concentrated around the cities of Centertown, and McHenry. Undeveloped grassland and pasture occupy 17% of the area (approximately 3,900 acres), and is a result of either agricultural development or mine

reclamation. Open water, scrub/shrub, and barren land represent other minor landcovers (2%), and often are the result of land manipulation related to surface mining and reclamation activities. Wetlands, both natural and manmade, represent the remaining 6% (or approximately 1,400 acres) of the Review Area (NLCD, 2001; SMIS, 2010).

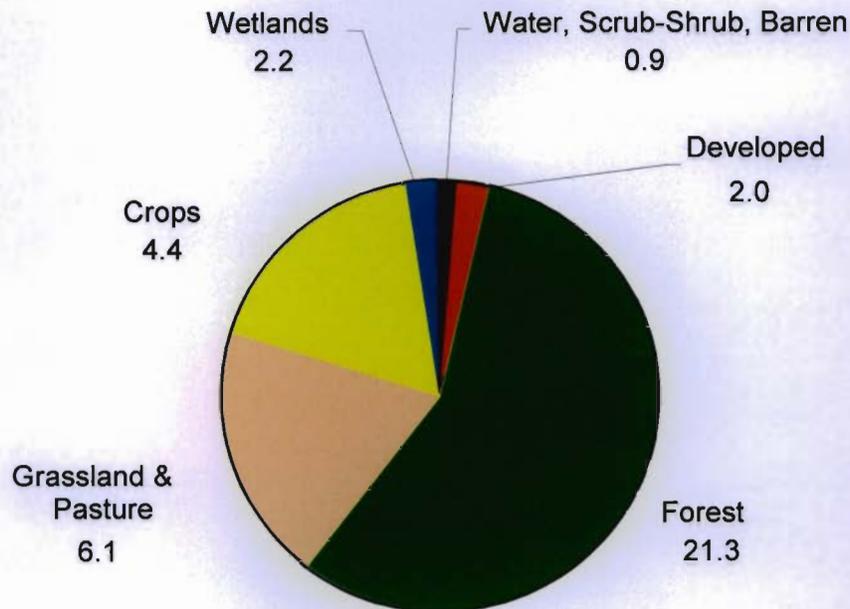


Figure 1. Review Area landcover totals in square miles. Data extracted from USGS NLCD 2001 dataset.

Agriculture has been extremely important to the economy of the region, and remains a significant source of employment and revenue, though to a lesser degree than historically. Still, the large areas cleared for pasture or row crops have converted much wetland and forest area into agricultural land. Wetland losses are difficult to quantify given sparse data for the area, but an estimate for the Review Area was made by comparing NWI wetland extent to hydric soil extent in a GIS. Results of this analysis suggest approximately 1,400 acres of wetland remain from a roughly estimated potential of 6,000 acres. While this represents a loss of approximately 69.8% of the Review Area's original wetlands, it is less than the estimates for the state as a whole, which range up to 85%. Most of the wetland loss occurred during agricultural development when the area was first settled, but losses continued even after passage of the Clean Water Act, declining by approximately 1.8% of the remaining area annually (Dahl and Johnson, 1991). From 1998 to 2006, declines have been approximately 0.5% for marshes (~0.08% annually), but increases of 1.1% (~0.2% annually) have been seen in forested wetlands as scrub-shrub areas mature. Relatively large overall wetland increases are inflated by construction of ponds, and may mask an overall loss of wetland function (Dahl, 2006).

Resource extraction is second only to agriculture as an agent of landuse change. Sixty-three permits have been issued in the Review Area; two are actively producing coal, one is in

reclamation, 11 are bond forfeitures, and the remaining 49 are reclaimed with full bond release. Two permits are pending (including Midway South), all submitted by Armstrong Coal. To date, mining has affected approximately 16,000 acres of the Review Area (approximately 9,500 acres of which are currently covered under the 64 previously issued and 2 pending permits). Despite this, most of the area has little disturbed ground. NLCD data shows approximately 31 acres as barren ground, and NAIP imagery show mines indicated as abandoned or bond forfeitures have groundcover established, and often are agricultural or forested areas.

### ***Future Actions***

Estimates and projections of future development follow methods discussed in the Final Programmatic Environmental Impact Statement on Mountaintop Mining/Valley Fills in Appalachia issued by EPA 28 October 2005. Even though this method of mining is not utilized in Western Kentucky, the projection method is still applicable. In this method, coal mine permit information for the previous ten years was used to determine a rate of impact for that time period. Assuming this rate will continue at this level in the future, cumulative impacts were then extrapolated from the data set. This method was used in the current cumulative impacts analysis and was further applied to other potentially significant agents of change in the Review Area.

Mining has occurred fairly continuously in the Review Area, with an upswing in activity over the previous five years. From 2000 to 2012, Armstrong Coal has had the only new permits; all others have been revisions, succession, or for minor changes. Armstrong Coal Company plans to mine an additional 1640 acres (which includes the Midway South area) with surface methods in the foreseeable future as well. Based on an average project time span of three years, future mining is expected to progress at approximately 300 acres of surface disturbance per year (or 0.1% annually). It should be noted that a significant portion of the Midway South site (approximately 251 acres) will be remaining areas previously impacted from mining activities.

The economic impact of agriculture has been declining in the Review Area; farmland in the region has declined since 1992 (USDA 1997 & 2002). As crop production is expected to remain relatively static, future projections therefore assume no net expansion of agricultural land over the review period (although use of existing agricultural land may become more intensive). Residential development will continue at a moderate pace in the review area. Construction of residences has increased in the previous ten years (Sperling, 2008; USCB, 1990) and likely will continue at similar rates in the future. Soil data for the Review Area indicate this development will be constrained to areas outside of much of the Impact Area, as most soils within are moderately, to very, limited for construction by flooding and shallow saturation zones (NRCS, 2010). It is expected that most development will occur around established communities, as supported by an analysis of population change projections for 2010 to 2020 (US Census data); which shows expected population growth in the Review Area near Centertown (6.4%) and McHenry (5.9%). Commercial development faces the same constraints due to flood-prone soils and shallow zones of saturation and is likely restricted to the same areas where residential development is expected to occur. Based on physical limitations and the lack of historical and current commercial development within the Review Area, future commercial development is likely negligible.

The current project will impact 9.941 acres of wetland, representing 0.6% of the total wetland area in the Review Area. The loss of wetland associated with the project plus current estimated background loss rates exceeds historic losses, but project impacts will be offset by significant restoration activities. Compensatory mitigation will establish at least 19.9 acres of wetlands on site. Cumulative impacts on wetlands therefore are expected to be minor, elevated above

negligible due to temporal loss of wetland function between project construction and mitigation activities, although it is likely that wetland mitigation will be conducted concurrently with mining activities.

However, comparisons of forested areas indicated on USGS 7.5' topographic maps with the most recent (2004) FSA aerial photography suggest forests in the Review Area have expanded in the last few years (KY Environmental and Public Protection Cabinet, 2005; USGS 1953a, 1953b, 1964, 1971). The proposed project will remove approximately 918 acres of forest cover in the Review Area. However, much of this will be re-established on site during stream mitigation activities and reclamation. This low level of forest loss with concurrent gains, as well as low levels of projected development, suggests minor future forest conversion. Minimal loss of forest will occur as a result of the proposed project. In addition, the Review Area contains several relatively unfragmented forest blocks, most with corridors to adjacent stands. Forested wetlands that will be impacted by the project will be mitigated on-site, with an expected increase in function and value through the establishment of diverse species of high quality, hard mast trees. Overall forest acreage and ecological function is expected to remain near current levels during the review period; cumulative impacts on ecological systems of concern are therefore expected to be minor.

Historically, agricultural lands in the Review Area have been protected. Agriculture is not expected to expand significantly during the review period, but farmland may be converted to residential land near urban centers. As nearly all of the Review Area is rural, development of existing farmland is expected to be minor. Mining may impact areas currently in crop production, but stockpiling of prime farmland top-soils and restoration of these areas to pre-mining production levels are required by Kentucky reclamation regulations (405 KAR 16:020; 16:040; 16:200). The Midway South site has about 77 acres that appear to be currently used for agricultural purposes. Therefore, impacts to agricultural lands are insignificant due to temporal loss of function.

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Alternatives  
Analysis

Armstrong Coal Company  
Ohio County, Kentucky  
Midway South Mine  
KY DNR Permit 892-0117

## **ALTERNATIVES ANALYSIS**

### **I. INTRODUCTION**

The purpose of the proposed Midway South mine is to recover coal from properties owned and/or leased by Armstrong Coal Company (ACC) and sell this resource to local and regional utilities. The proposed action is needed to meet the energy demands of the United States, as well as to stimulate the local economy. ACC must do this in a manner that returns a reasonable profit on investments in land and mineral rights, site development, infrastructure, and equipment while being environmentally responsible and complying with regulatory requirements. Clean Water Act Section 404(b)(1) requires that all reasonable alternatives be considered for projects that impact Jurisdictional Waters of the United States. As discussed in federal guidelines established for this regulation (45 FR 85344), an alternative is considered practicable if it may be implemented considering environmental impact, cost, existing technology, and logistics as they relate to the project's purpose. An alternative is considered reasonable if it is practicable and feasible from a common sense technical or economic standpoint. The applicant first considered all alternatives, then eliminated those deemed non-practicable. Reasonable alternatives were then selected from the remaining practicable alternatives; the Preferred Alternate was then chosen from the practicable alternatives once baseline data for potential jurisdictional waters had been collected and reviewed. This document will demonstrate there are no practical offsite options for mine site development, the selected mining method is the only one practicable for the proposed mine site, and that the preferred mine configuration is the most reasonable choice.

### **II. NON-PRACTICABLE ALTERNATIVES**

#### **A. OFF-SITE**

##### **Alternate Sites**

Use of alternate mine sites was eliminated for several reasons, most significantly relating to environmental impact, public safety, and economics. Alternative sites would not allow the use of existing facilities present at the nearby Midway Mine site, specifically the rail loadout and coal

washing plant immediately to the north. Construction of these facilities (i.e. haul roads, buildings, parking areas) would fragment forested stands and farms in areas away from the current mine, impact prime farmland, and would also result in discharges into Waters of the U.S. Development of alternate mine sites would have similar impacts to those at the proposed site due to the similar environmental conditions and topography of properties in the area, while impacting additional watersheds. Additionally, 251 acres (~24%) of the Midway South site is previously mined; development of a similar facility elsewhere may affect previously unmined areas and would not provide the indirect benefit of reclaiming a pre-law site to current SMCRA standards.

Some alternate sites were excluded because of unfavorable geologic conditions resulting in low extraction ratios, placing an unreasonable economic burden on the project given current and projected future coal sales prices, and some were rejected due to the presence of high-sulfur coal. Surface and coal rights were not available at other alternate sites considered.

Most alternate sites would also require construction of new transportation facilities (which potentially could affect stream and wetland resources), or require trucking coal directly to consumers or to rail spurs or barge loading facilities on public roadways. The Midway South site will have access to existing haul roads; thus reducing potential environmental impacts from new road construction, and impacts to the public from long-distance truck transport.

#### **Alternate Spoil Disposal**

Development of a remote waste disposal site was considered, but eliminated due to potential environmental impacts and economic costs greater than those expected from on-site storage and disposal. Off-site spoil handling would require significant material trucking, requiring establishment of a transportation corridor between the mine facility and the waste area, and would leave several large borrow pits in the area. The action alternative will use spoil generated during mining to fill pits as they are created and to return the permit area to approximate original contour (AOC). An off-site waste area itself represents an impact in an additional watershed. In the proposed configuration, all surface disturbance is located in the same watershed and includes areas of previous mining disturbance

## **B. ON-SITE**

### **Alternate Mining Methods**

Mining method decisions were based on geologic conditions, economic feasibility, miner safety, and potential ecological impact. In this case, surface mining is the only practical option, maximizing coal recovery and safety while minimizing environmental impact. Surface methods will recover coal seams that cannot be mined by underground methods due to seam thicknesses and inadequate overburden cover (less than 120 feet), which potentially would lead to mine adit collapse and surface subsidence. In addition to miner safety, subsidence likely would have deleterious effects on streams and wetlands above the mine area; dewatering or significant disturbance of local hydrology could be seen as water left jurisdictional waters through fractures in the overburden and entered mine voids below.

Auger-highwall mining was considered but eliminated due to variations in coal thicknesses and non-uniform dipping and rolling of coal seam elevations. To utilize this method, deep box cuts would be required to access the coal seams, which then would be extracted by the auger. Supporting areas left between bore holes would reduce the extraction by 30%, while the amount of surface disturbance would be equivalent to that of surface mining.

### **Stream and Wetland Buffers**

Avoiding impacts to Jurisdictional Waters by establishing stream and wetland buffers is not feasible, given their locations onsite and the equipment involved. The 1,026 acre surface mining project includes approximately 51,313 linear feet of stream and 35 small wetland areas. Avoiding these jurisdictional waters would require mining along and between the jurisdictional waters; this would require approximately 236 acres of buffer zones, as well as construction of at least 52,000 linear feet of box cut pits. The additional average cost to develop box cut pits with the required depth of 90 feet and width of 120 feet would increase the total mining cost by more than 180% when compared to area surface mining, due to increased blasting, overburden handling, and use of additional equipment. The net increase is approximately \$84 per ton, which is more than double the current selling price for utility grade coal in the project's market.

The preceding cost analysis assumes that developing and implementing a mining plan to avoid jurisdictional waters is physically possible or practical. Due to the density and configuration of the jurisdictional waters, areas of mining would be very small and irregularly shaped, which would not allow for use of the existing dragline currently active at the nearby Midway West Mine.

Off-road trucks and excavators would be required for the tight quarters created, which Armstrong Coal would have to purchase specifically for the project. The equipment change would result in an additional mining cost increase of approximately 30%, making the project even more economically unviable. Even attempting to employ this methodology would not fully avoid impacts to Jurisdictional Waters. Constructing so many box cuts would greatly alter watershed hydrology. Stream flow regimes and drainage patterns would change significantly as flow and watershed runoff would be greatly reduced. Hydrological changes would result in indirect wetland impacts by changing hydric soil conditions and vegetation. Indirect impacts created by altered hydrology likely would decrease the functions and values of the aquatic resources that were buffered.

### III. PRACTICABLE ALTERNATIVES CONSIDERED

#### **No-Action Alternative**

The no-action alternative for the project was found to be unacceptable as it would not allow Armstrong Coal Company to recover coal at the Midway South mine and deliver it to the marketplace. The Midway South site is an expansion to the existing Midway Mine operation, which had an initial capital investment of \$60 million in obtaining property and mineral rights for the area; not allowing development of the mine would place an unreasonable financial burden on the company. The local economy also would be adversely impacted by the loss of coal production. The project would extend employment for 125 positions at the mine complex and 40 positions at the existing Midway prep plant and loading facility; each of these positions creates 6 to 7 additional support jobs in the region. Thus, 1.3% of the Ohio County workforce is directly employed by the mine and an additional 8.3% is supported by its operation. The Midway Mine is a substantial economic influence in a county with nearly 7% unemployment. The average wage of the mine (\$66,000 per year) more than doubles the median personal income in the county, and is 48% higher than the median household income. Not developing the mine would result in the loss of a total estimated \$18 million in coal severance taxes and \$1.5 million in property taxes, plus \$8.4 million in payroll taxes for the 6-year operating life of the mine to county and state collections. A final consideration is the existence of contracts with several energy partners. Eon (LG&E), Alcoa, East Kentucky Power Cooperative, Owensboro Municipal Utilities, and Tennessee Valley Authority are expecting deliveries of coal from the Midway South mine. In addition to loss of revenue to Armstrong Coal Co., electric power customers potentially face an increase in rates if these providers must find alternate sources of coal.

Impacts: None

Criteria for Exclusion: Does not meet project plan and purpose

### **General Mine Plan**

The general location of the site and mine method were selected based on the previously discussed rationale. Site investigations were then conducted to assess potential environmental impact at the site, which was used to determine the final mine configuration. A description of the general mining plan and comparison of two final alternatives follow.

The conventional variable cut area surface mining method consists of developing a series of open pits approximately 120 feet wide across the project area being mined. Prior to disturbing individual watersheds to be mined, sediment control structures and diversion ditches are constructed to control all surface water runoff from the area to be affected. A box cut open pit is initially excavated to allow mining equipment access to the coal to be recovered. Overburden material from subsequent open pits is placed directly into the previously developed adjacent open pit by cast blasting, dozing or hauling with mobile equipment, and direct casting with a dragline. The pits advance through the permitted project area until all recoverable coal has been uncovered and recovered. As mining progresses, the overburden material placed in open pits where coal has been removed is graded to approximate original pre-mining contour by dozers and other units of mobile equipment. Once final reclamation grade is established, topsoil is distributed over the area and liming, fertilizing, seeding, and mulching activities are completed. Once vegetation cover is established to stabilize the individual reclaimed watersheds, final stream channels, wetlands, hydraulic structures, and riparian zones are established.

Surface mining activities at the currently active Midway West Mine, located northwest of the proposed project area, are on scheduled for coal production to be completed by August 2013. Mine development would then shift to the Midway South area. In order for actual mining to begin, pre-mining development work consisting of sediment control structure construction, land clearing, and the removal of topsoil must begin 2 to 3 months prior to pit excavation. Mining would begin in the northeast portion of the proposed Midway South Mine permit area with open pits being developed generally in a north-south direction until mining reaches the western boundary of the proposed permit in 2019. A previously permitted area (Midway Mine), located just north of the proposed permit will be mined in conjunction with the proposed Midway South permit as shown on the Mine Schedule Map.

### **Mine Configuration 1**

Mine Configuration 1 is bounded by Southards Creek to the east, UT of West Fork Lewis Creek to the west, Midway Mine to the north, and Maddox Cemetery Mine to the South. The eastern portion has been heavily mined in the past. However, a number of large wetlands and open water bodies have been created by this activity, and tributaries to Southards Creek also are located in the area.

Impacts: Mining utilizing Configuration 1 would impact 1,170 acres of land surface. Within this area, 95 stream reaches would be impacted, totaling 58,726 linear feet. Forty wetlands of Cowardin PFO, PSS, PEM, including palustrine/lacustrine fringe types would be directly impacted, totaling 26.541 acres. Please refer to Tables 1 and 2 for more detailed information.

Table 1. Impacts to Streams from Mine Configuration 1

Stream Type	Number Affected	Length Affected (feet)
Ephemeral	77	42,514
Intermittent	15	10,296
Perennial	3	5,916
Total:		58,726

Note some stream extent in eastern permit area estimated during initial project scoping

Table 2. Impacts to Wetlands from Mine Configuration 1

Wetland Type	Number Affected	Acreage Affected
Forested	7	2.239
Scrub/Shrub	6	1.028
Emergent (includes open water fringe)	27	23.274
Total:		26.541

Benefits: Meets project plan and purpose, allowing extraction of 11.9 million tons of coal, which will produce approximately 26.9 billion kWh of energy for the regional power grid. Operation of facility will maintain 165 high-paying jobs.

Criteria for Exclusion: Significant disturbance of land surface and impacts to aquatic resources.

### **Mine Configuration 2**

Although adjacent areas contain minable coal reserves and the applicant has mineral rights to these reserves, the permit boundary was revised to reduce stream, wetland and open water impacts in these areas. Boundary revisions included removing a 98.6 acre tract to the east, a 33.9 acre tract to the south, and 12 acres to the northeast (Exhibit 1). These adjustments

eliminated many aquatic resources from the permit, including over 2,600 feet of a perennial UT of West Fork Lewis Creek to the northwest. Otherwise, mining would proceed in the same manner as described in the General Mine Plan and shown in Exhibit 2. Revision of the boundary in other areas is not practical. Expansion into other areas would increase surface disturbance. Further reduction of the permit area would reduce the amount of recoverable coal and not meet the project purpose and need. Thus, the current boundary represents the largest available adjacent minable area with the least environmental impact, while remaining economically viable.

Table 3. Impacts to Streams from Mine Configuration 2

Stream Type	Number Affected	Length Affected (feet)
Ephemeral	69	38,868
Intermittent	12	9,627
Perennial	2	2,818
Total:		51,313

Table 4. Impacts to Wetlands from Mine Configuration 2

Wetland Type	Number Affected	Acreage Affected
Forested	7	2.239
Scrub/Shrub	6	1.028
Emergent	22	6.674
Total:		9.941

Table 5. Aquatic Resources Not Impacted by Mine Configuration 2

Resource	Number	Amount
Ephemeral Streams	8	3,646 ft
Intermittent Streams	3	669 ft
Perennial Streams	3	3,098 ft
Wetlands	5	16.600 ac
Open Water	5	24.3 ac

Benefits: Economic benefits largely the same as Mine Configuration 1, but impacts 12% less area (145 acres less) with less stream and wetland impacts. Meets project plan and purpose, allowing extraction of 9.8 million tons of coal. Mine will produce 22.2 billion kWh of energy for the regional power grid.

Criteria for Exclusion: 19% decrease in coal extraction, disturbance of streams and wetlands.

#### IV. PREFERRED ALTERNATIVE AND CONCLUSION

The Midway South mine facility was selected and configured to maximize coal extraction efficiency while minimizing impacts to jurisdictional Waters of the U.S. Underlying geology makes it economically viable to construct the mining facility at the proposed location. In addition to geological advantages, the land and mineral rights were available for purchase, making the proposed site most viable of the locations considered. Impacts were generally similar for alternate facility locations examined, however, the proposed site was most advantageous because it would be adjacent to existing mining operations and utilize the existing infrastructure. Streams and wetland impacts were removed by altering the permit boundary so water bodies lie outside of the mine area. Streams that cannot be avoided will potentially receive significant ecological "lift" over existing conditions by reclamation to current regulatory standards and mitigation and restoration efforts within the project area. Most project area streams exhibit significant manipulation from previous land uses (*e.g.* agriculture, mining, and logging); restored channels will reflect stable, geomorphically correct streams for the proposed post-mining landforms and hydrologic conditions. Wetlands on-site are smaller, geographically (not hydrologically) isolated features, often by-products of human activities (*i.e.* remnant mine pits, stock ponds). A more diverse, cohesive wetland block will be created during the reclamation phase of the mining operation to offset the impacts to wetlands within the permit boundary. This area will provide a larger wetland area and will provide higher ecological function and value than what is currently present on-site.

Seven temporary in-stream sediment ponds are proposed to be used to treat runoff from the proposed mine area, which will limit downstream water quality impacts to those authorized under Clean Water Act Section 401. In all cases, water quality exiting the site will meet all applicable state standards, as required by KDOW and DNR. All runoff will be treated within the permit boundaries. Spoil will be disposed of on-site to return the area to AOC; no permanent in-stream fills are proposed and streams re-routed during mining will be restored to their original locations during reclamation activities.

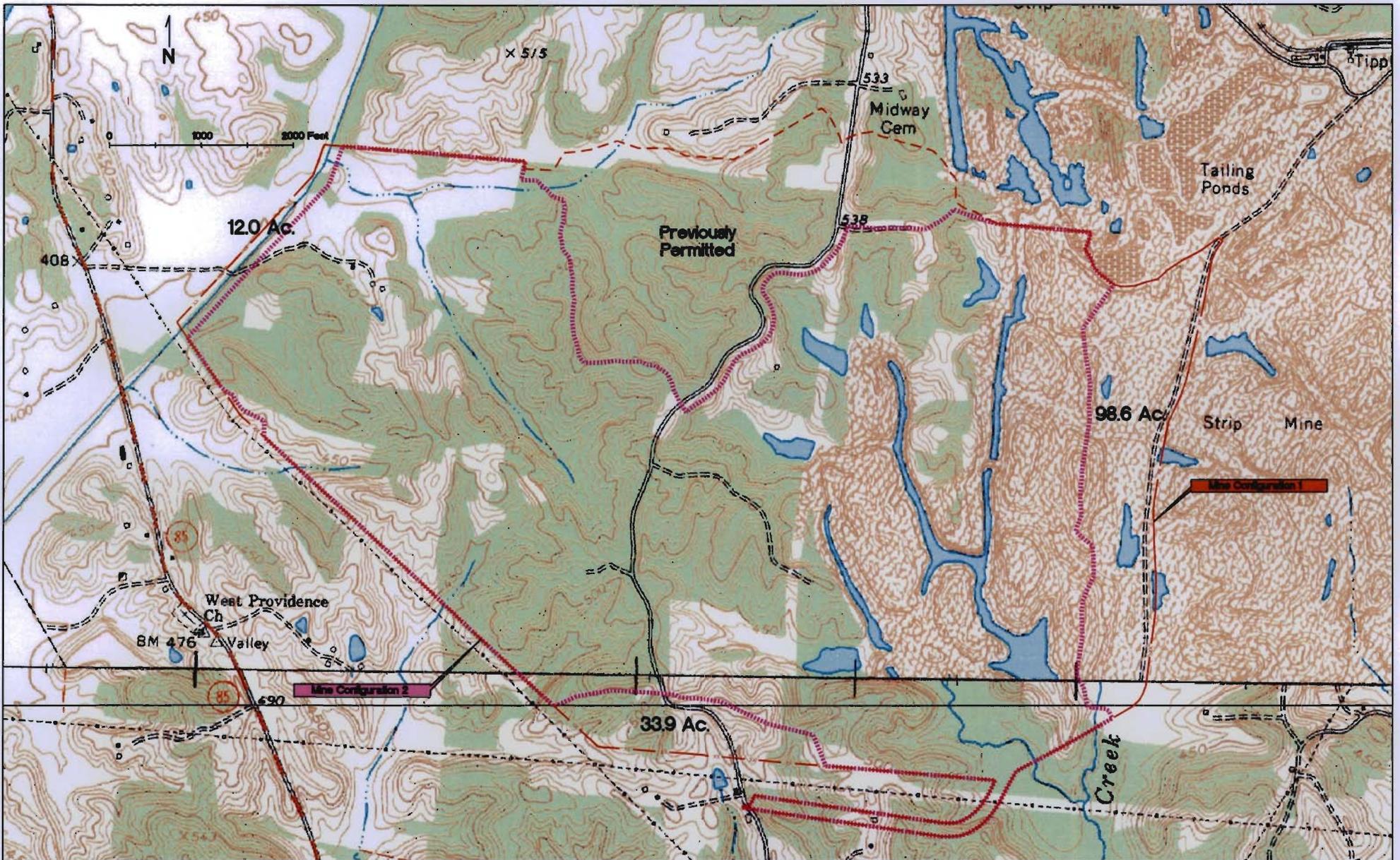
The Midway South site is able to transport coal in the most environmentally, socially, and economically responsible manner. An existing haul road will be utilized to transport coal to a washing plant. Public safety will be protected by eliminating heavy vehicle traffic on county roads, thereby limiting automobile encounters with coal trucks. In addition, fugitive dust, noise

and exhaust emissions associated with coal truck traffic will be reduced below *de minimis* levels in areas used by the general public. The use of existing haul roads also avoids the introduction of these potential pollutants to new geographic areas.

Coal recovery at the Midway South mine and its delivery it to the marketplace has significant economic benefits. The local economy would maintain high-quality employment for 6 years with this operation of this mine; it is anticipated that around 125 persons currently working at the active Midway West mine will be retained with an average salary of \$66,000. The mine operation will also ensure the continued employment of 40 people at the Midway wash plant/rail loading facility, as well as an estimated 6 regional support positions for every direct mine employee. The Midway South mine would continue to significantly raise the per capita and household income. The state and county stand to gain \$18 million in coal severance taxes over the lifetime of the project, as well as \$1.5 million in property taxes and \$1.4 million in payroll taxes per year. Also, the applicant has existing contracts with Eon, Alcoa, East Kentucky Power, Owensboro Municipal Utilities and TVA. Electric power customers potentially face an increase in rates if these providers must find alternate sources of coal.

Nationally, coal represents 21% of the energy supply and is used to produce 50% of our electricity. Approximately 93% of the Kentucky's electricity comes from coal fired plants, and over 50% of the coal comes from western Kentucky. Given a yield of 2,260 kWh per ton for coal, the Midway South Mine will produce approximately 22 billion kWh of electric power over its lifespan. Kentucky's demand of coal for electricity generation is approximately 42 million tons per year; therefore, the Midway South Mine will satisfy approximately 4% of the annual demand.

Overall, the proposed facility location and configuration is believed to be the least environmentally invasive option resulting in the most cost-effective recovery of the natural resource. The facility will accomplish this while maximizing public safety and minimizing its environmental footprint.



PROJECT: Midway South Mine  
 COUNTY: Ohio

STATE: Kentucky

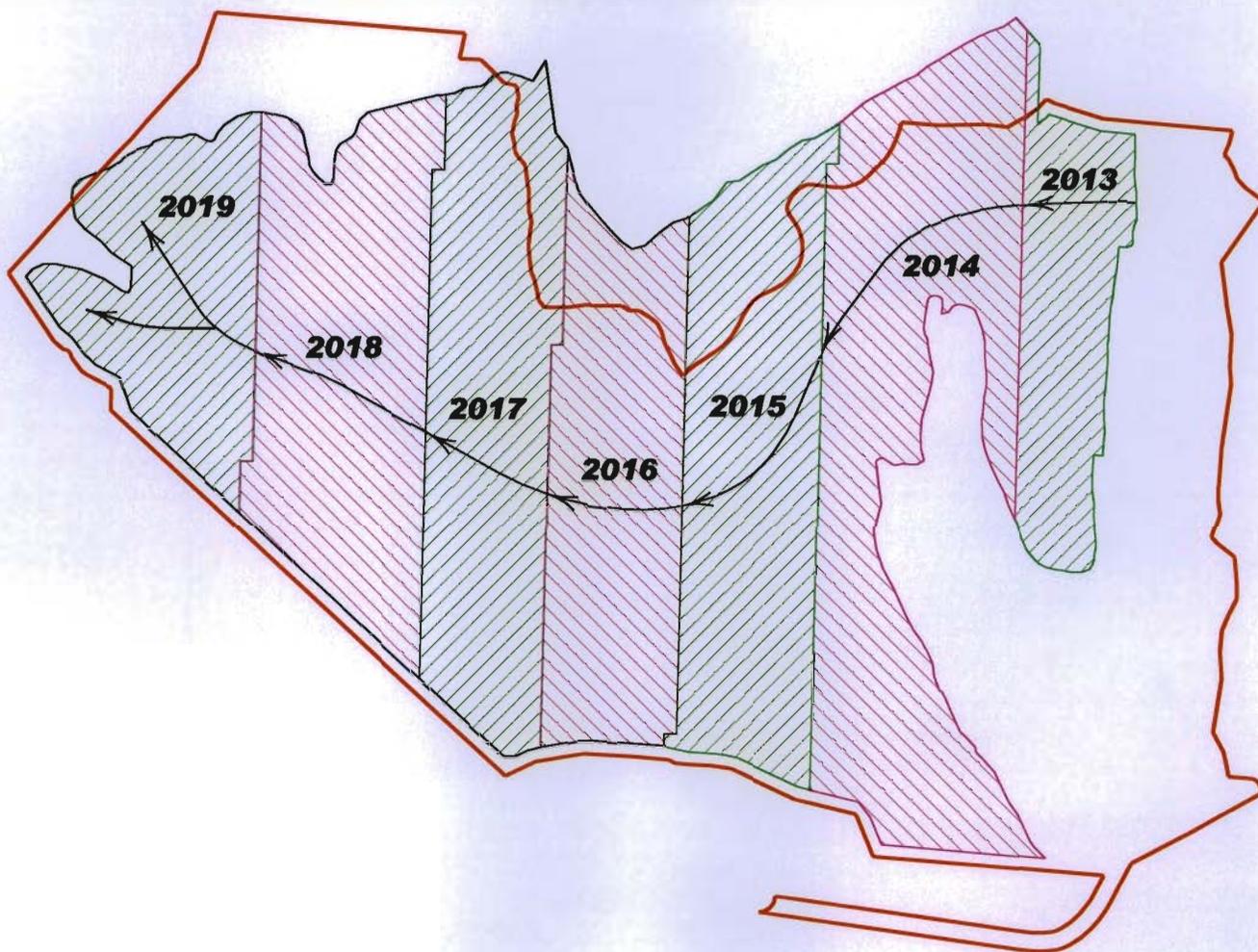
Comparison of Practicable Alternate Extents  
 NEAR: Centertown

EXHIBIT 1

# Midway South Mining Schedule Map



SCALE 1"=1500'



Legend	
	Permit Boundary
	Recovery Extent
	Mining Progression

Mitigation

**Mitigation Plan  
for  
Stream Impacts**

**Midway South Mine Site  
Ohio County, Kentucky**

**Prepared for:**

**Armstrong Coal Company  
407 Brown Road  
Madisonville, KY 42431**

**Prepared by:**

**T.H.E.  Engineers, Inc.**

**2331 Fortune Drive, Suite 295  
Lexington, Kentucky 40509  
(859) 263-0009**

**March 8, 2013**

**(Revised April 3, 2013)**

## Stream Mitigation Plan

Section C of PCN .....	Pages 1-9
Vicinity Map .....	Exhibit 1
Plan Sheet Index .....	Exhibit 2
Stream Plan Views .....	Exhibits 3-8
Perennial Typical Plan / Cross Sections .....	Exhibits 9-14
Intermittent Typical Plan / Cross Sections.....	Exhibits 15-36
Ephemeral Typical Plan / Cross Sections .....	Exhibits 37-66
Rosgen Stream Type "C" - Typical Plan and Profile.....	Exhibit 67
Rosgen Stream Type "E" - Typical Plan and Profile.....	Exhibit 68
Rosgen Stream Type "B" - Typical Plan and Profile.....	Exhibits 69-70
Stream Structures and Planting Details .....	Exhibits 71-75
Table of Proposed Stream Lengths .....	Exhibit 76

## **C. Compensatory Mitigation: Midway South Mine Site**

### **(1) Goals and Objectives**

Streams will be replaced on site and will perform the same functions as the existing streams as described in the baseline report. The goal of stream mitigation will be to provide in-stream habitat and to construct stable stream systems that convey the bankfull discharge and sediment supplied by the watershed. Stream dimensions, patterns, and profiles will be constructed so as to create stream types that would naturally occur within the proposed valleys and hydrologic conditions. Mitigation for wetlands will be performed in conjunction with the stream mitigation (see separate wetland mitigation report).

### **(2) Site Selection**

Site selection for those streams to be mitigated was based on the principal of replacing the aquatic resource impacted on-site and in-kind. Mitigation will also replace stream length lost when the existing pits/ponds were left un-reclaimed from prior mining activities. The most practical way to replace the existing stream functions and contribute to the aquatic resource needs of the watershed is to create stream systems and drainage networks that are similar to, or better than, the existing conditions. Where prior mining activities have altered drainage patterns, pre-mining information was utilized for proposed channel alignments and locations.

### **(3) Baseline Information**

(a) Stream mitigation will be performed on-site. On-site will consist of trying to restore entire reaches of intermittent streams and ephemeral tributaries; focusing on streams that have the larger watersheds.

(b) It is proposed that a total of 28,793 feet of ephemeral, 10,320 feet of intermittent, and 3,109 feet of perennial stream will be restored on-site. This provides a final ratio greater than 1:1 for perennial and intermittent streams, 1:1 for ephemeral stream length associated with existing pond areas, and 0.5:1 for ephemeral streams not associated with existing pond areas.

(c) The aquatic resource type includes ephemeral, intermittent, and perennial streams.

(d) Please refer to the "Stream Habitat Assessment and Wetland Delineation Report" prepared for Armstrong Coal Company, dated November 16, 2012, for existing conditions of streams. The site is located within one twelve-digit Hydrologic Unit Codes (HUC); the Lewis Creek (051100030502). According to NRCS climate data, the region receives approximately 48 inches of rainfall per year

#### (4) Mitigation Work Plan

(a) Boundaries of the proposed mitigation sites are provided in the exhibits.

(b) Stream construction will be conducted concurrently with the reclamation phase of the project. Stream construction will be integrated within valleys having characteristics corresponding to appropriate stream types. Valley morphology will consist of landform features that will correspond to proposed stream system morphology including meander planform (radius of curvature, wavelength, belt width and sinuosity), channel profile morphology (riffle/pool or step/pool bed features) and cross section dimensions (low flow, bankfull and flood prone).

Stream construction sequence will be as follows:

1. Locate and flag proposed thalweg.
2. Excavate corresponding bankfull width to bankfull elevation as indicated on plans.
3. Excavate bankfull channel to dimensions indicated on profile and cross sections.
4. Grade side slopes to obtain appropriate flood prone width.
5. Grade side slopes to tie into existing ground.
6. Install in-stream structures.
7. Add substrate in riffle and run sections if necessary to provide armoring and riffle habitat.
8. Prepare streambanks and riparian area for seeding.
9. Seed area with native seed mixture as indicated on planting detail sheet.
10. Install erosion control blanket as needed.
11. Plant USACE approved trees and shrubs.

(c) Proposed streams will have similar drainage patterns and connectivity as existing conditions.

(d) Native vegetation to be planted along stream banks and riparian zones include the following species or species available at the time of ordering and approved by USACE:

Grasses - Virginia wild rye (*Elymus virginicus*), Switchgrass (*Panicum virgatum*), Rough banyard grass (*Echinochloa muricata*), Big bluestem (*Andropogon gerardii*), Forking panic grass/smooth panic grass (*Dichanthelium dichotomum/dichotomiflorum*) and Annual rye (*Lolium perenne*).

Shrubs – Rough-leaf dogwood (*Cornus drummondii*), Strawberry bush (*Euonymus americanus*), and Indigo-bush (*Amorpha fruticosa*). Shrubs will be 3-gallon container grown, planted on a four foot spacing along the streambanks at the bankfull elevation.

Trees – For intermittent streams: Shellbark hickory (*Carya laciniosa*), Willow oak (*Quercus phellos*), Cherrybark oak (*Quercus pagoda*), Water oak (*Quercus nigra*), and White oak (*Quercus alba*). For ephemeral streams: Shagbark hickory (*Carya glabra*), American beech

(*Fagus grandifolia*), Shingle oak (*Quercus imbricaria*), Post oak (*Quercus stellata*), and Shumard oak (*Quercus shumardii*). Trees will be either 3-gallon container grown RPM planted at a rate of 60 trees per acre, or 3-gallon non-RPM planted at a rate of 120 trees per acre, or non-RPM bare root seedlings (minimum of 30 inches in height) planted at a rate of 450 stems per acre. The option utilized will be dependent on plant availability at the time of mitigation planting (if plant availability is not an issue, more than one option may be utilized to compare survival rates for future mitigation projects). In addition, a single row of shrubs will be planted along edge of stream just above bankfull elevation. Shrub spacing will be approximately 4 feet on average with higher densities at high shear locations (ex. outside bends).

Per Kentucky Division of Mine Permits (KDMP) requirements: planting of woody species will occur during first dormant season following stream restoration.

(e) Any vegetation that would hinder planting or provide excessive competition to natural regeneration of planted species will be removed with appropriate treatment and documented in each annual monitoring report.

(f) Exotic vegetation control: The following efforts will be made to reduce introduction and dispersal of invasive species: removal of exotic species before mitigation begins, cleaning equipment before it reaches the site, inspecting labels on seed mixtures and mulch for composition and vegetative monitoring during the required monitoring period. Volunteers, invasives, and/or exotic vegetation along riparian zones will be removed by mowing, digging, spraying, burning or a combination of these during annual maintenance; and documented in each annual monitoring report.

(g) The proposed mitigation plan sheets provide elevation and slope details for the stream designs.

(h) Erosion control methods will consist of the following: constructing stream channels during low or no flow periods, allowing vegetation to become established before flow is allowed into the channels, applying seed and installing erosion control blanket immediately after final grading, planting trees and shrubs and installing silt fence as needed. Stream restoration will proceed in a downstream direction to avoid re-suspension of sediment.

(i) The proposed stream design is based on geomorphic and hydrologic principles incorporated with natural channel design techniques utilizing in-stream structures for habitat diversity and stream bank protection.

(j) Proposed Stream Plans indicate stream type, pattern, profile and dimensions for each stream. Stream morphology was determined by using regional curve data, collecting and

studying data from the existing streams, sediment transport and hydrologic calculations, and experience designing and constructing streams.

(k) Natural channel design methods, in-stream structures and habitat enhancement features have been incorporated into the mitigation plan. The "C" Stream Types are typically low relief channels found in well-developed floodplains, and have been designed to be more sinuous, with J-hooks, cross-vanes and/or pools placed at high shear stress locations along outside bends. The "E" Stream Types have been designed to maintain a high resistance to bank erosion and downcutting. The relatively narrow and deep channel (low width/depth ratio) will help maintain transport capacity and the wide active floodplain will reduce shear stresses during high flow events. Habitat enhancement features will consist of root wads, log overhangs and submerged logs. These features will also provide bank stability while vegetation becomes established. Step-pool structures will be installed on "B" Stream Types. Through a series of rapids and scour pools, stream energy is dissipated and channel stability maintained. Pool to pool spacing will be based on bankfull width and stream gradient. In general, the steeper the slope the closer the pool to pool spacing will be. Ephemeral in-stream structures will include log or rock weirs and log overhangs for habitat and stability. Proposed stream substrate will consist of soils used during reclamation. Particle size will range from silt/clay to small cobble. If it is determined during stream construction that adequate riffle material is not present, then appropriately sized material will be supplied to riffle and run sections.

(l) Mitigation sites will be permanently protected and maintenance will be provided as needed, throughout the monitoring period. Site protection will be provided through use of a restrictive covenant. Maintenance will include elimination of volunteer species by use of general or spot applications of herbicides, hand picking and mowing, where appropriate.

(m) A representative from the design team will be on site during critical phases of the construction process. The representative will make periodic site visits and will familiarize construction personnel with design plans and restoration methods.

#### **(5) Performance Standards/Success Criteria**

(a) Standards for assessing stream mitigation goals include:

1. Streams must be constructed to meet the dimension, pattern and profile of the indicated Rosgen Stream Type.
2. There should be no signs of excessive stream bank erosion or severe headcutting.
3. At the end of the monitoring period, the streams shall have average riffle cross section dimensions reflective of the indicated Rosgen Stream Type.

4. At the end of the monitoring period, the streams shall have minimum EPA Rapid Bioassessment Protocol scores in the sub-optimal range, with intermittent equal to or greater than 110, and ephemeral equal to or greater than 101.
5. Root Production Method (RPM) trees will be planted at a rate of 60 trees per acre, or non-RPM 3-gallon container grown will be planted at a rate of 120 trees per acre, or bare root seedlings (minimum height of 30 inches) will be planted at a rate of 450 trees per acre. The option utilized will be dependent on plant availability at the time of mitigation planting (if plant availability is not an issue, more than one option may be utilized to compare survival rates for future mitigation projects).
6. Riparian vegetation shall have at least an 80% survival rate of the initial planting of 450 stems per acre, with no single planted tree species constituting more than 25 percent of the surviving species. The survival rate for RPM plantings is 90 percent. No one species shall comprise more than 25 percent of the surviving RPM plantings.
7. Riparian vegetation will consist of no volunteer tree species at the end of the monitoring period.
8. Per Kentucky Division of Mine Permits (KDMP) requirements: one measure of project success will be final stream assessment scores that equal or exceed pre-project scores.
9. In the riparian areas, herbaceous plantings must provide a minimum of 70 percent ground cover; with no one species accounting for more than 40 percent ground cover.
10. Linear footage and flow regimes will match the USACE approved mitigation plan.
11. Streams will have a definable bed and bank, with an Ordinary High Water Mark.
12. Stream channel and in-stream structures must be stable and functioning as designed.
13. Stream morphology must meet the proposed Rogsen classification (i.e., stream slope, sinuosity, belt width, meanders, bankfull cross-sectional area, width/depth ratios).
14. Annual monitoring should indicate that mitigation is progressing toward meeting success criteria.

(b) Adaptive Management

If success criteria are not met during the monitoring period, an analysis of the contributing conditions will be conducted and documented. Remedial action, if required by USACE, will be performed and documented by the applicant. Remedial actions may include replanting trees and shrubs, reseeding grasses, adjusting in-stream structures and repairing eroded banks. These actions will be performed at least twice, depending on the nature of the problem. Should these efforts not resolve the problem, another site will be found to replace failed sections of the mitigation site. The contingency plan for proposed intermittent streams will be payment of in-

lieu fees. Contingency payment will be based on the length of stream that does not support intermittent hydrology during the monitoring period.

(c) Project Performance Evaluations

All stream sites will be monitored in accordance with the Mitigation Final Rule, 2008. In general, the following guidelines will be used:

1. The monitoring period must be sufficient to demonstrate that the compensatory mitigation has met performance standards. The monitoring period length shall be a minimum of five years unless performance standards are met in less than five years. In this case, the monitoring period length can be reduced if there are at least two consecutive monitoring reports that demonstrate that performance standards have been met. Longer monitoring timeframes are necessary for compensatory mitigation projects that take longer to develop.
2. Biannual inspections will be conducted each year during the first and last month of the growing season.
3. The first monitoring report will be due after the first full growing season following the initial planting.
4. Monitoring reports are due to USACE by January 31 for the previous year, and to the Kentucky Division of Mine Permits (KDMP) by December 31 for the same monitoring year.
5. Photo stations and monitoring stations will be at the same location.
6. Permanent photo/monitoring stations will be set at a minimum of 1 per 1500 feet of ephemeral stream, and 1 per 500 feet of intermittent stream.
7. The same monitoring stations shall be used every year.
8. Personnel familiar with natural stream design principles will perform monitoring tasks.
9. Stream monitoring will consist of assessing stream parameters and documenting vegetation survival.
10. Stream channel form and in-stream structure stability will be monitored to ensure stream functionality. Maintenance will be performed if the following conditions develop: excessive bank erosion occurs (RBP scores in the marginal range for bank stability), erosion around or under structures that would render them ineffective or cause structure collapse, excessive siltation of pools reducing their effectiveness in reducing energy and/or adversely affecting pool habitat, and upstream directed vertical bed erosion (headcut) that would jeopardize structure stability and lead to unstable channel conditions (RBP scores in marginal range for epifaunal/substrate cover or sediment deposition). Stream conditions will be inspected frequently by design and/or stream construction team. Stream channel maintenance will be performed as needed to ensure stream stability, function and value.

11. Water quality monitoring will be conducted in accordance with the approved SMCRA/KPDES permit, which states:

Beginning at the time of initial disturbance within the respective watershed, grab samples will be collected from the KPDES point twice each month during the active permit operation phase and reclamation phase and will continue until Phase I bond release. After Phase I bond release, monitoring at the discharge point will be on a once per month basis for six months followed by quarterly sampling thereafter (unless specifically disallowed by the regulatory authorities) continuing until final bond release or when KPDES monitoring is otherwise no longer required by the regulatory authorities.

Prior to Phase I bond release the parameters to be monitored at the discharge point will be, when appropriate: flow (estimated), acidity, alkalinity, total iron, total manganese, pH, total suspended solids and settleable solids. After Phase I bond release the parameters to be monitored will be: flow (estimated), pH, acidity, alkalinity, and settleable solids (when acceptable and appropriate total suspended solids may be analyzed instead of settleable solids). Discharge limitations for these parameters will be as specified in the KPDES permit issued for the discharge.

Monitoring results obtained during the previous three months will be summarized for each discharge for each month and reported on a Discharge Monitoring Report Form, as required. Signed forms as well as all other reports required will be submitted to the appropriate DMRE regional office within 30 days following the end of each quarter. If the results of any KPDES discharge monitoring data collection indicate noncompliance with a permit condition, then the permittee shall promptly notify the cabinet and shall take immediate corrective actions to return the operations to compliance with all permit conditions. Specialized requirements for compliance with KPDES regulations (e.g. alternate rainfall sampling requirements and limitations, special noncompliance notifications, signatories requirements, testing procedures, recording of results, records of retention, management requirements, other responsibilities, etc.) will be as specified in the KPDES permit issued for the discharge.

Water quality monitoring locations will be at basin outfalls. Results will be submitted to USACE as part of stream monitoring reports.

12. Monitoring reports will include a discussion of inspection findings. Conditions such as bank erosion, streambed characteristics and vegetation survival will be documented. Stream assessments will be conducted and RBP scores will be compared to pre-disturbance scores and previous monitoring scores to determine if mitigation is progressing towards meeting goals. Any problems will be identified and remedial action taken.

13. Parties responsible for monitoring will be Armstrong personnel familiar with the project and natural channel design, or USACE-approved consultants.

14. RBP assessments will be used to assess physical quality of stream and will include conductivity, pH and temperature readings. Monitoring reports will include photographic documentation of streams and riparian vegetation. In addition, riparian vegetation will be inspected and density, survivorship, composition, percent cover and any non-native species will be documented. Macroinvertebrate and fish surveys will be conducted, as required. The Kentucky Division of Water's "Methods for Sampling Benthic Macroinvertebrates Communities in Wadeable Waters" will be followed.

15. When petitioning the Corps for release of mitigation requirements, a full stream delineation for the mitigation site will be provided (e.g. linear footage, Rosgen, RBP, flow regimes, riffle/pool count, riparian vegetation survivability).

16. With the first annual report, as-built drawings for the constructed stream mitigation, watershed drainage area, and reclaimed geomorphological landscape will be provided.

17. Data collected at the permanent monitoring stations shall, at a minimum, include Rosgen analysis and RBP characterization/habitat measurements. Data will be recorded on appropriate documents.

18. Annual macroinvertebrate and fish sampling will commence the first full year after construction.

#### **(6) Project Success**

The applicant will be responsible for all mitigation including construction oversight, monitoring and reports, corrective measures, site access control and protection. The surface mining operation will obtain and submit to KDMP a certification from a registered professional engineer that all mitigation work has been completed in accordance with the conditions of the Water Quality Certification.

### **(7) Site Protection**

Site protection will be provided through use of a restrictive covenant. The restrictive covenant will be executed after completion of the mitigation construction. It will be recorded within 60 days after mitigation construction completion, with USACE notification of recording at the time of execution. Durable signs will be placed identifying all mitigation sites as areas not to be disturbed. They will be placed on approximately 500 foot intervals along streams. The mitigation sites will be integrated into the reclamation plan, with limited site access.

### **(8) Contingency Plan**

If success criteria are not met for any portion of the monitoring year and/or final success criteria are not satisfied, an analysis of the contributing conditions will be conducted and documented. Remedial action, if required by USACE, will be performed and documented by the applicant. Should these efforts not resolve the problem, the contingency plan for proposed intermittent streams will be payment of in-lieu fees. Contingency payment will be based on the length of stream that does not support intermittent hydrology during the monitoring period.

### **(9) Monitoring and Long-Term Management**

(a) The applicant will be responsible for accomplishing, maintaining, and monitoring all mitigation sites. Long-term management will include a protective covenant.

(b) Monitoring plans will be provided as discussed under Performance Standards.

### **(10) Financial Assurances**

The applicant will be responsible for managing any financial assurances and contingency funds set-aside for remedial measures. The USACE, Louisville District, currently does not have the means to handle financial assurances; therefore, no USACE-managed financial assurances are proposed for this project.

# Vicinity Map Midway South Site



Boundary

SCALE 1"=4000'

T.H.E.  
Engineers, Inc.

PROJECT: MIDWAY SOUTH SITE - PROPOSED MITIGATION

STREAMS: UT'S OF SOUTHARDS CREEK & LEWIS CREEK

COUNTY: OHIO

STATE: KY

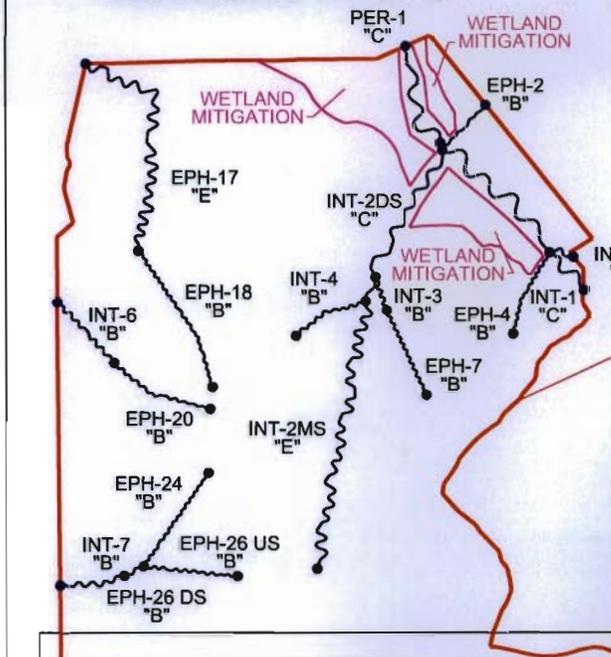
NEAR: CENTERTOWN

ITEM: VICINITY MAP

EXHIBIT I

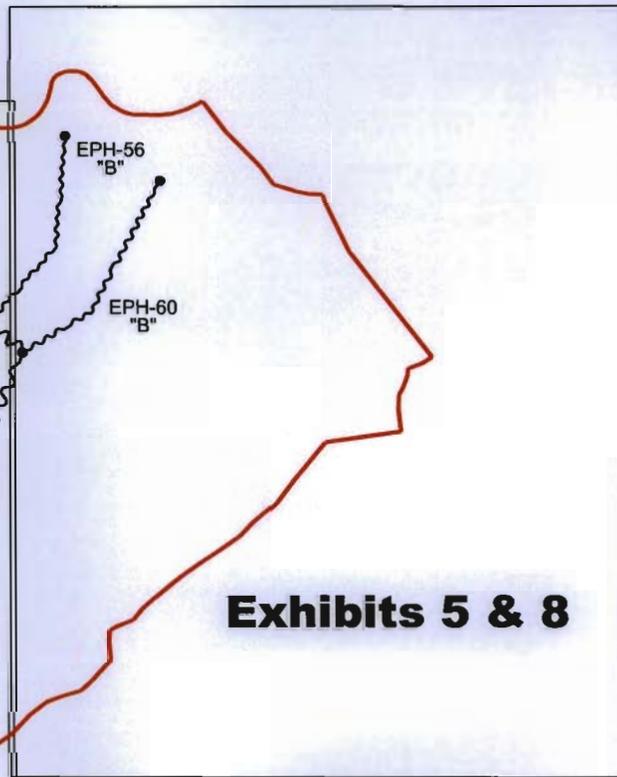
# Sheet Index

## Exhibits 3 & 6

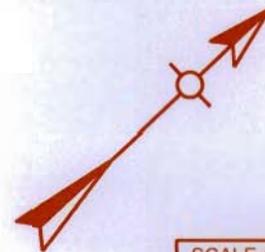
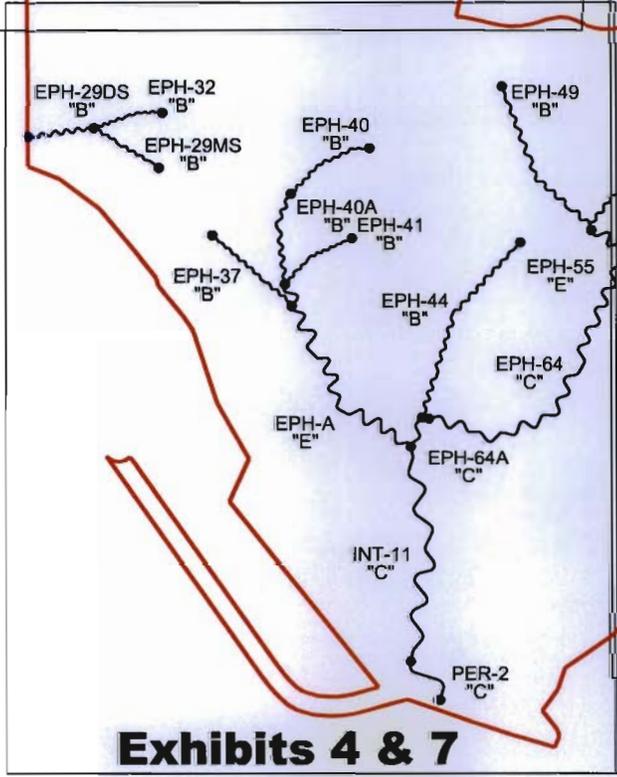


Boundary

## Exhibits 5 & 8



## Exhibits 4 & 7

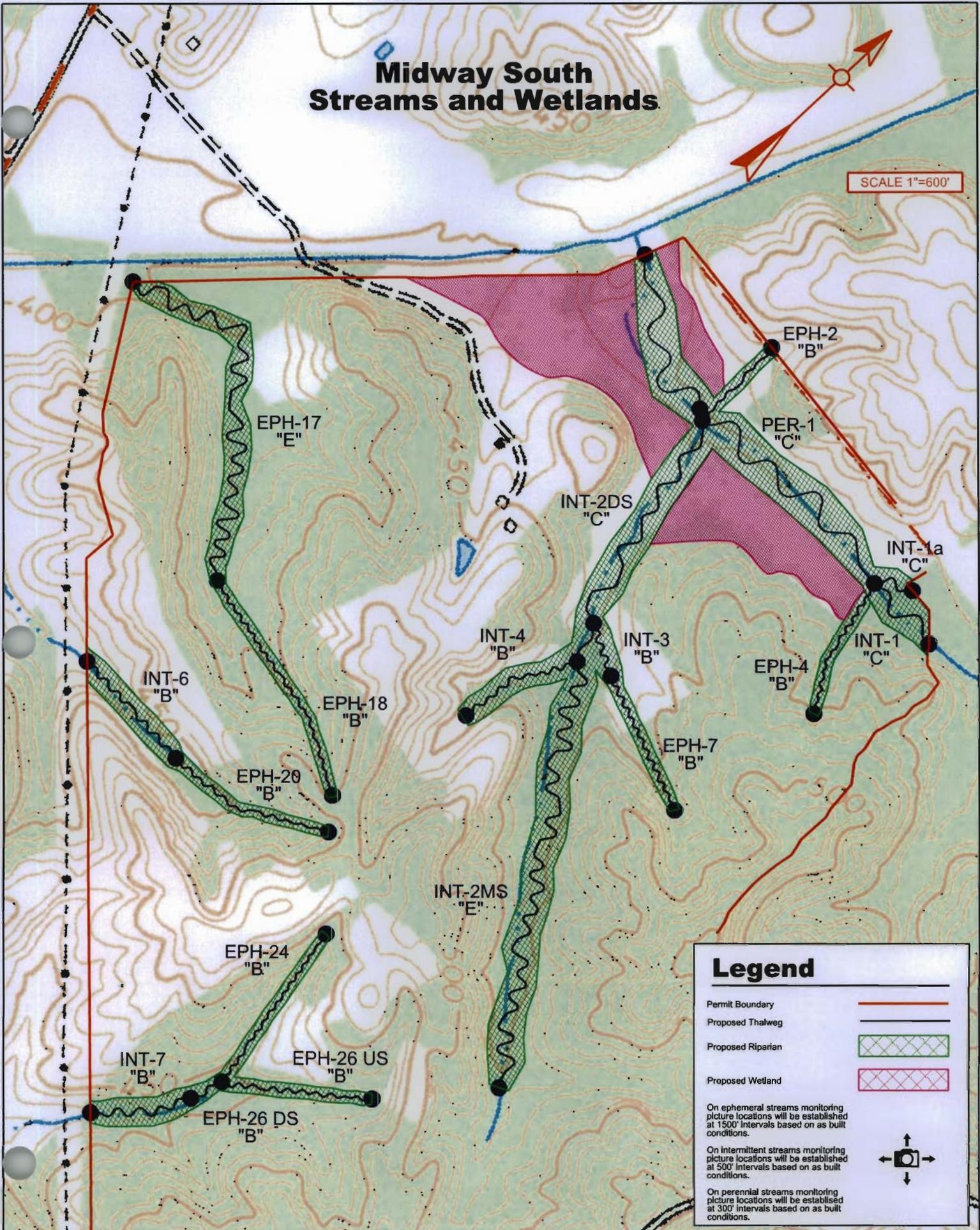


SCALE 1"=1500'

T.H.E. Engineers, Inc.	PROJECT: MIDWAY SOUTH SITE - PROPOSED MITIGATION				
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: INDEX MAP	EXHIBIT 2

# Midway South Streams and Wetlands

SCALE 1"=600'



# Midway South Streams and Wetlands



## Legend

- Permit Boundary 
- Proposed Thalweg 
- Proposed Riparian 

On ephemeral streams monitoring picture locations will be established at 1500' intervals based on as built conditions.

On intermittent streams monitoring picture locations will be established at 500' intervals based on as built conditions.

On perennial streams monitoring picture locations will be established at 300' intervals based on as built conditions.



T.H.E.  
Engineers, Inc.

PROJECT: MIDWAY SOUTH SITE - PROPOSED MITIGATION

STREAMS: UT'S OF SOUTHWARDS CREEK & LEWIS CREEK

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

ITEM: QUAD

EXHIBIT 4

# Midway South Streams and Wetlands

SCALE 1"=600'

EPH-56  
"B"

EPH-60  
"B"

## Legend

- Permit Boundary 
- Proposed Thalweg 
- Proposed Riparian 

On ephemeral streams monitoring picture locations will be established at 1500' intervals based on as built conditions.

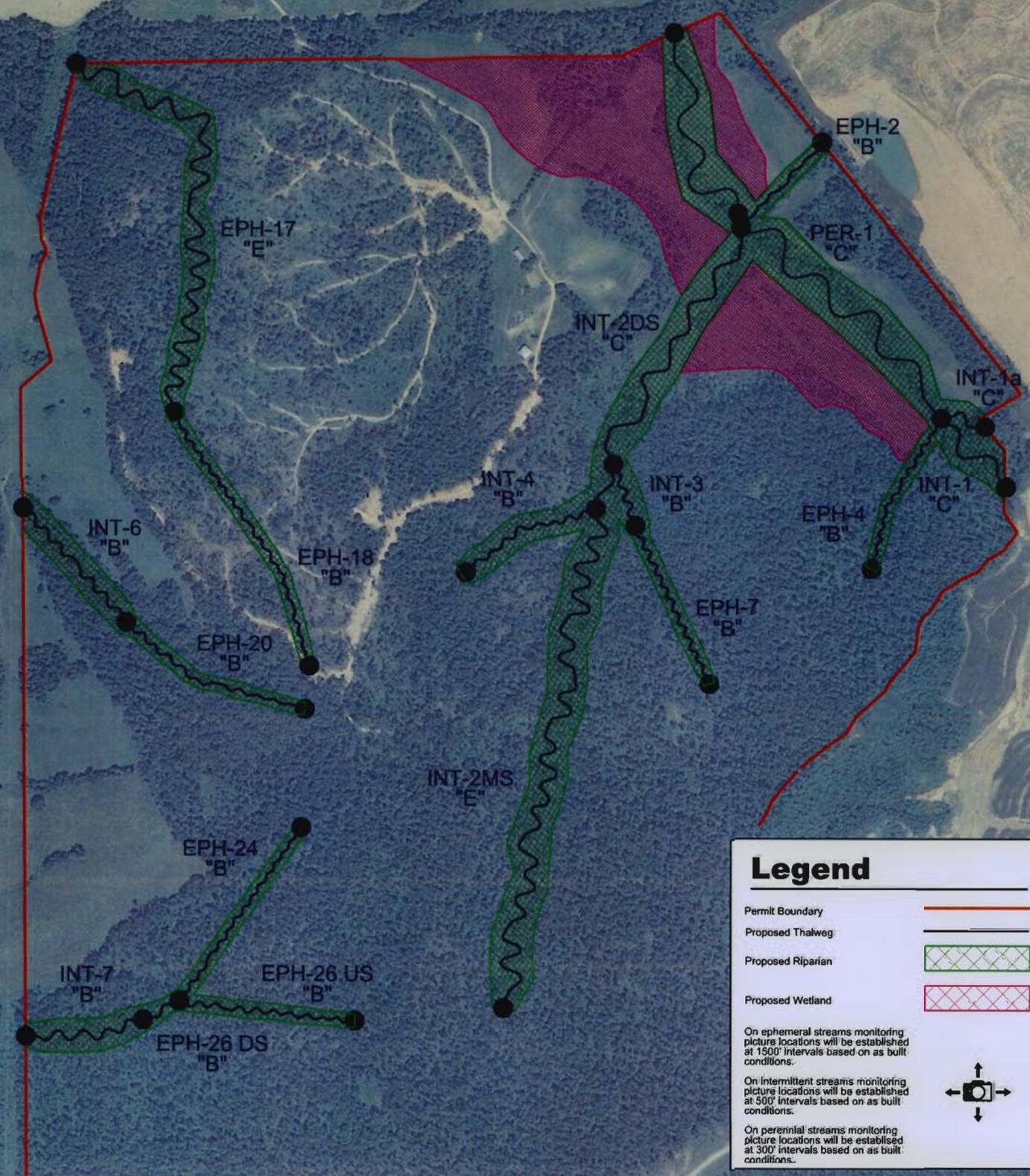
On intermittent streams monitoring picture locations will be established at 500' intervals based on as built conditions.

On perennial streams monitoring picture locations will be established at 300' intervals based on as built conditions.



# Midway South Streams and Wetlands

SCALE 1"=600'



## Legend

- Permit Boundary
- Proposed Thalweg
- Proposed Riparian
- Proposed Wetland

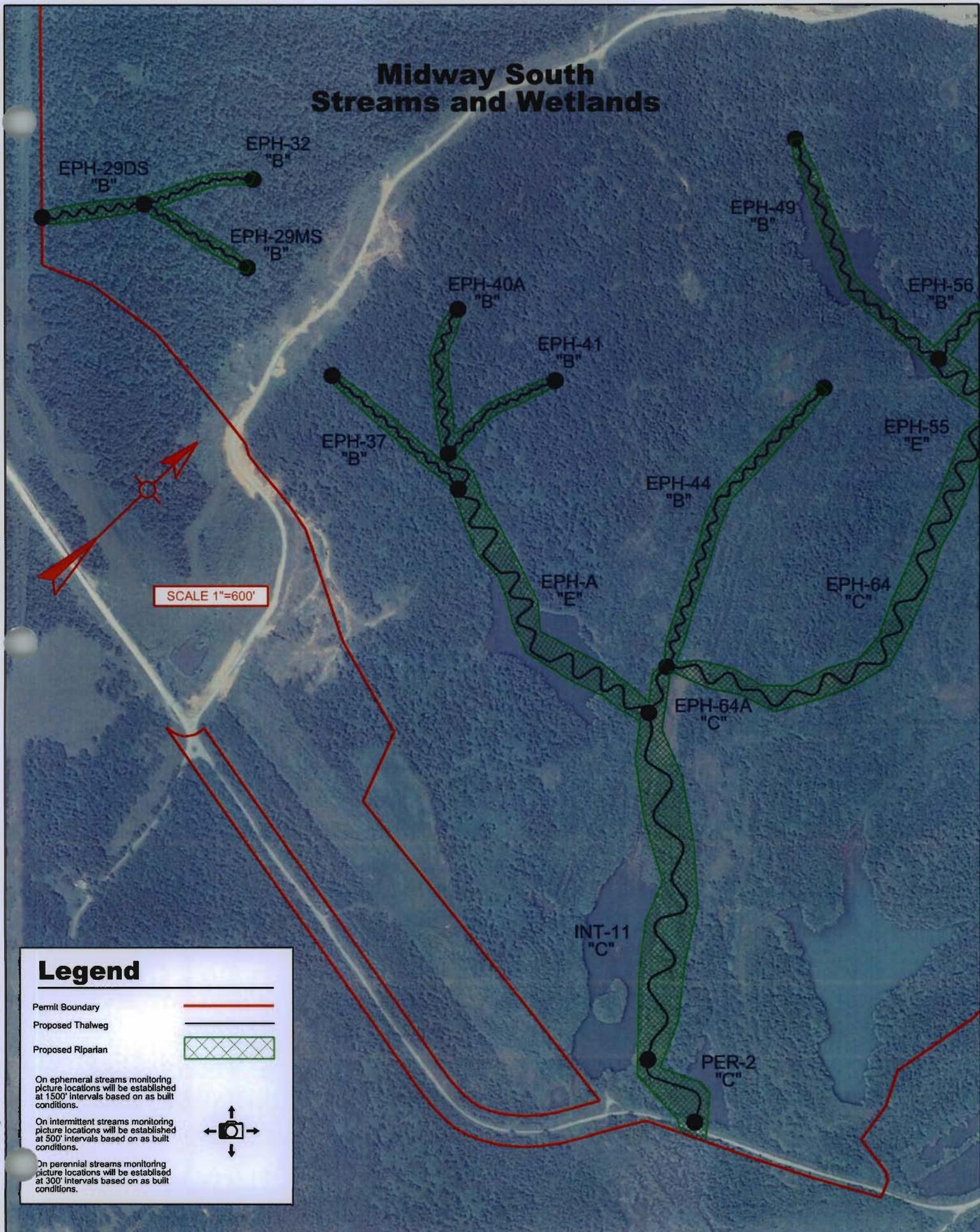
On ephemeral streams monitoring picture locations will be established at 1500' intervals based on as built conditions.

On intermittent streams monitoring picture locations will be established at 500' intervals based on as built conditions.

On perennial streams monitoring picture locations will be established at 300' intervals based on as built conditions.



# Midway South Streams and Wetlands



SCALE 1"=600'

## Legend

- Permit Boundary 
- Proposed Thalweg 
- Proposed Riparian 

On ephemeral streams monitoring picture locations will be established at 1500' intervals based on as built conditions.

On intermittent streams monitoring picture locations will be established at 500' intervals based on as built conditions.

On perennial streams monitoring picture locations will be established at 300' intervals based on as built conditions.



# Midway South Streams and Wetlands

SCALE 1"=600'

EPH-56  
"B"

EPH-60  
"B"

## Legend

- Permit Boundary 
- Proposed Thalweg 
- Proposed Riparian 

On ephemeral streams monitoring picture locations will be established at 1500' intervals based on as built conditions.

On intermittent streams monitoring picture locations will be established at 500' intervals based on as built conditions.

On perennial streams monitoring picture locations will be established at 300' intervals based on as built conditions.



**T.H.E.**  
**Engineers, Inc.**

PROJECT: MIDWAY SOUTH SITE - PROPOSED MITIGATION

STREAMS: UT'S OF SOUTHARDS CREEK & LEWIS CREEK

COUNTY: OHIO

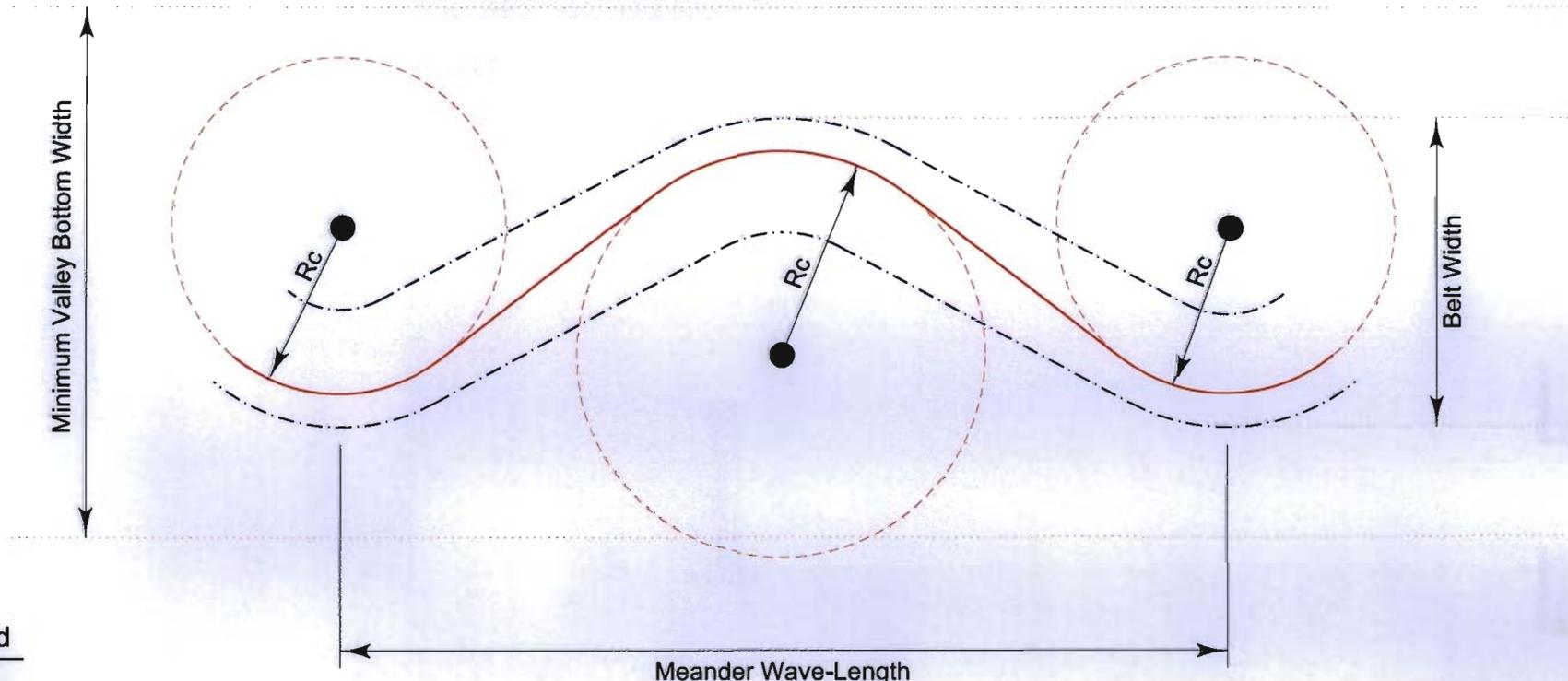
STATE: KY

NEAR: CENTERTOWN

ITEM: AERIAL

EXHIBIT 8

# Typical Meander Pattern for Rosgen Stream Type "C" Stream Per-1



**Legend**

- Bankfull    - - - - -
- Thalweg    —————

- Bankfull Width=18.7'
- Radius of Curvature (Rc) Ranges from 46' to 56.5'
- Belt Width Ranges from 150' to 206'
- Meander Wave-Length Ranges from 168' to 262'
- Approximate Proposed Reach Length = 2634'
- Proposed Stream Sinuosity is Approximately 1.2 or Greater
- Proposed Stream Gradient Ranges from 0.25% to 0.75%
- Proposed Valley Slope Ranges from 0.3% to 0.9%
- Minimum Valley Bottom Width = 220'

**T.H.E. Engineers, Inc.**  
 PROJECT: MIDWAY SOUTH MINE SITE - PROPOSED MITIGATION  
 COUNTY: OHIO    STATE: KY  
 NEAR: CENTERTOWN  
 ITEM: PROPOSED TYPICAL MEANDOR PATTERN  
 STREAM: PERENNIAL I  
 EXHIBIT 9

**EROSION CONTROL BLANKET (may be used as needed)**

- E.C.B. 1 shall meet the following specifications:
- \* Netting: Biodegradable, natural fiber.
  - \* Matrix Material: 100% coconut fiber.
  - \* Stitching: Biodegradable thread on 1.5 inch centers.
  - \* Shear stress: 2.35 lbs / SQ. FT.
  - \* Velocity: 10 feet per second.
  - \* Longevity: up to 24 months.
  - \* North American Green C125 BN or equivalent shall be used.

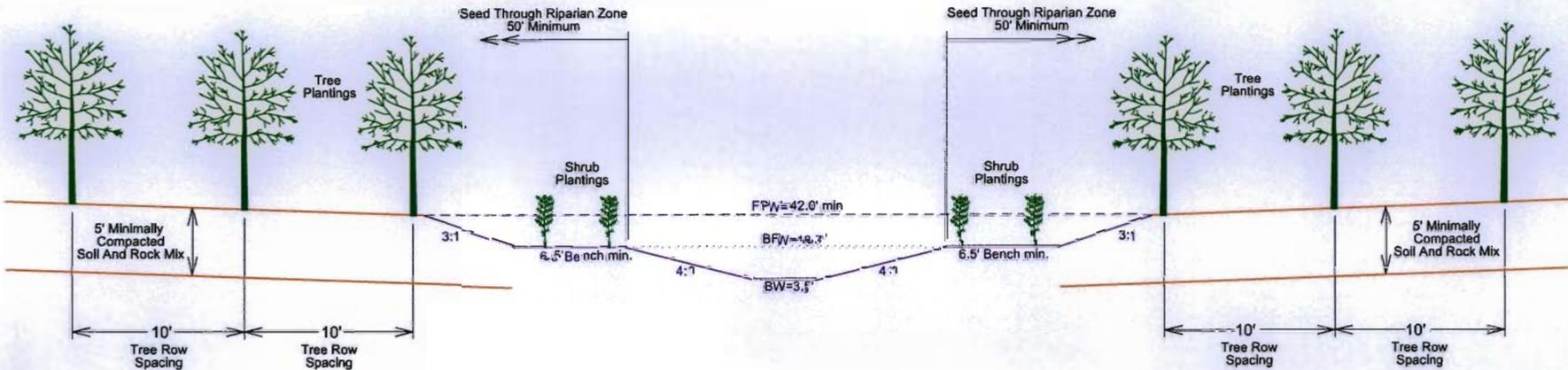
- E.C.B. 2 shall meet the following specifications:
- \* Netting: 100% Biodegradable, natural fiber.
  - \* Matrix Material: 100% straw.
  - \* Stitching: Biodegradable thread on 1.5 inch centers.
  - \* Shear stress: 1.855 lbs. / SQ. FT.
  - \* Velocity: 6 feet per second.
  - \* Longevity: up to 12 months.
  - \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 18.7'
- Bankfull Max. Depth = 1.9'
- Bankfull Area = 21.1 sq. ft.
- Bankfull Mean Depth = 1.13'
- Flood-Prone Width (FPW) = 42.0' (Minimum)
- W/D Ratio = 16.6
- Entrenchment Ratio = 2.24 (Minimum)
- Bench Width = 6.5' (Minimum)



**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.
- \* Typical cross section where stream not adjacent to wetlands

**Typical Riffle Cross Section Stream Per-1**  
**Rosgen Stream Type "C"**  
**Scale: 1"=10'**

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

In bend sections, the outside bend may be stabilized with a combination of Erosion Control Blanket Type 1 (E.C.B. 1) and shrub plantings. E.C.B. 1 shall be anchored in at residual pool elevation and extend to Flood Prone Elevation. Beyond this elevation E.C.B. 2 may be placed throughout the riparian zone. In bend sections where structures (J-Hooks, Cross Vanes, etc.) are specified, E.C.B. 1 installation shall begin just above the structure location.

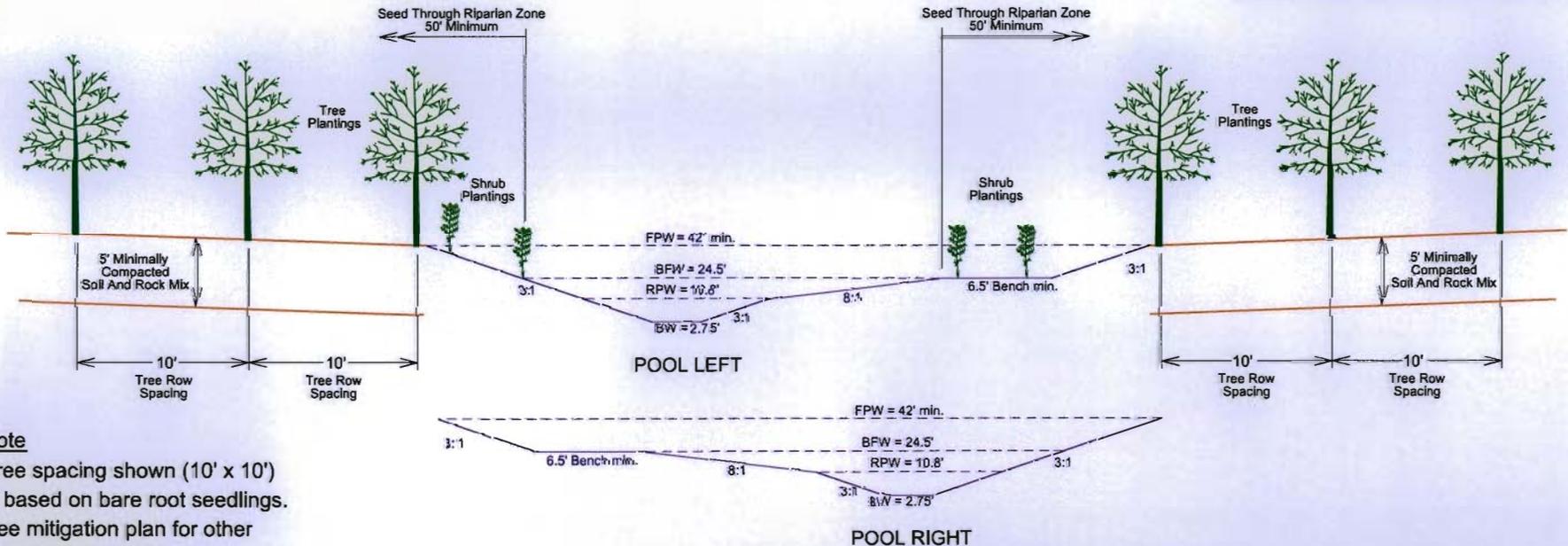
In bend sections, E.C.B. 1 may be placed along the inside bend (Point Bar). Blanket installation shall begin at the bottom of the point bar slope (just above Residual Pool Elevation) and extend to Flood Prone Elevation. E.C.B. 2 may be placed beyond this location as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 24.5'
- Bankfull Max. Depth = 2.55'
- Bankfull Area = 30.3 sq. ft.
- Bankfull Mean Depth = 1.23'
- Flood-Prone Width (FPW) = 42.0' (Minimum)
- W/D Ratio = 19.81
- Residual Pool (RP) Max. Depth = 1.34'
- Residual Pool (RP) Width = 10.8'

**Note**

- \* Durable rock may be used instead of ECB 1 along outside bends. The rock shall be placed at bottom of pool and extend to bankfull elevation. ECB 1 may be used above this elevation, rock size shall be a minimum of 1' diameter and shall be keyed into bank and bottom of channel.

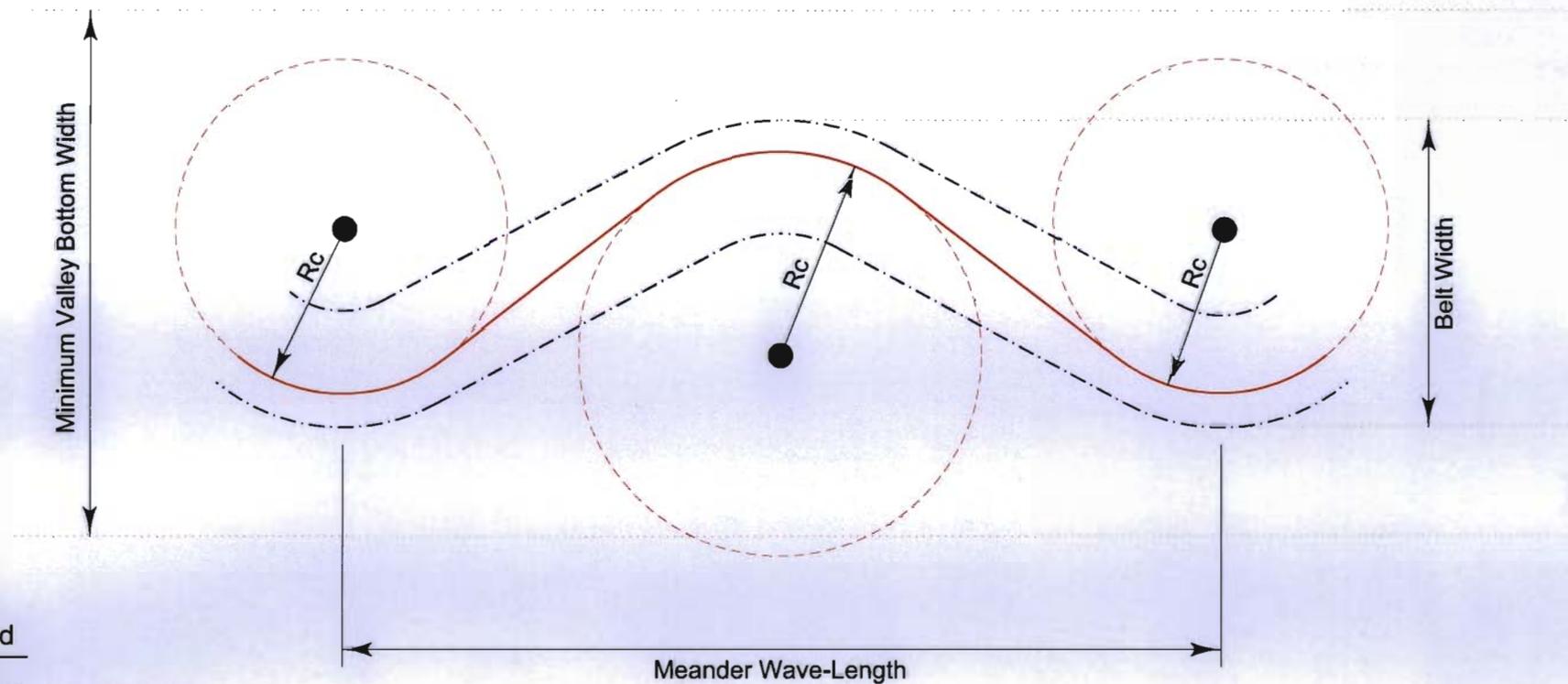


**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.
- \* Typical cross section where stream not adjacent to wetlands

**Typical Pool Cross Section Stream Per-1  
Rosgen Stream Type "C"  
Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "C" Stream Per-2



**Legend**

- Bankfull
- Thalweg

- Bankfull Width=18.7'
- Radius of Curvature (Rc) Ranges from 46' to 56.5'
- Belt Width Ranges from 150' to 206'
- Meander Wave-Length Ranges from 168' to 262'
- Approximate Proposed Reach Length = 475'
- Proposed Stream Sinuosity is Approximately 1.2 or Greater
- Proposed Stream Gradient Ranges from 0.17% to 0.67%
- Proposed Valley Slope Ranges from 0.2% to 0.8%
- Minimum Valley Bottom Width = 220'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

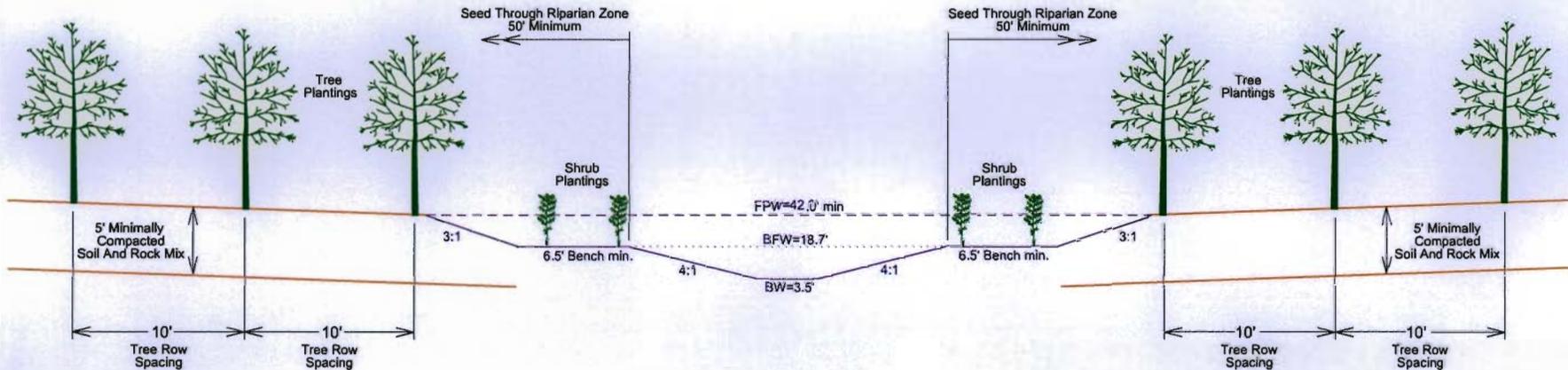
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 18.7'
- Bankfull Max. Depth = 1.9'
- Bankfull Area = 21.1 sq. ft.
- Bankfull Mean Depth = 1.13'
- Flood-Prone Width (FPW) = 42.0' (Minimum)
- W/D Ratio = 16.6
- Entrenchment Ratio = 2.24 (Minimum)
- Bench Width = 6.5' (Minimum)



**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Per-2  
 Rosgen Stream Type "C"  
 Scale: 1"=10'**

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

In bend sections, the outside bend may be stabilized with a combination of Erosion Control Blanket Type 1 (E.C.B. 1) and shrub plantings. E.C.B. 1 shall be anchored in at residual pool elevation and extend to Flood Prone Elevation. Beyond this elevation E.C.B. 2 may be placed throughout the riparian zone. In bend sections where structures (J-Hooks, Cross Vanes, etc.) are specified, E.C.B. 1 installation shall begin just above the structure location.

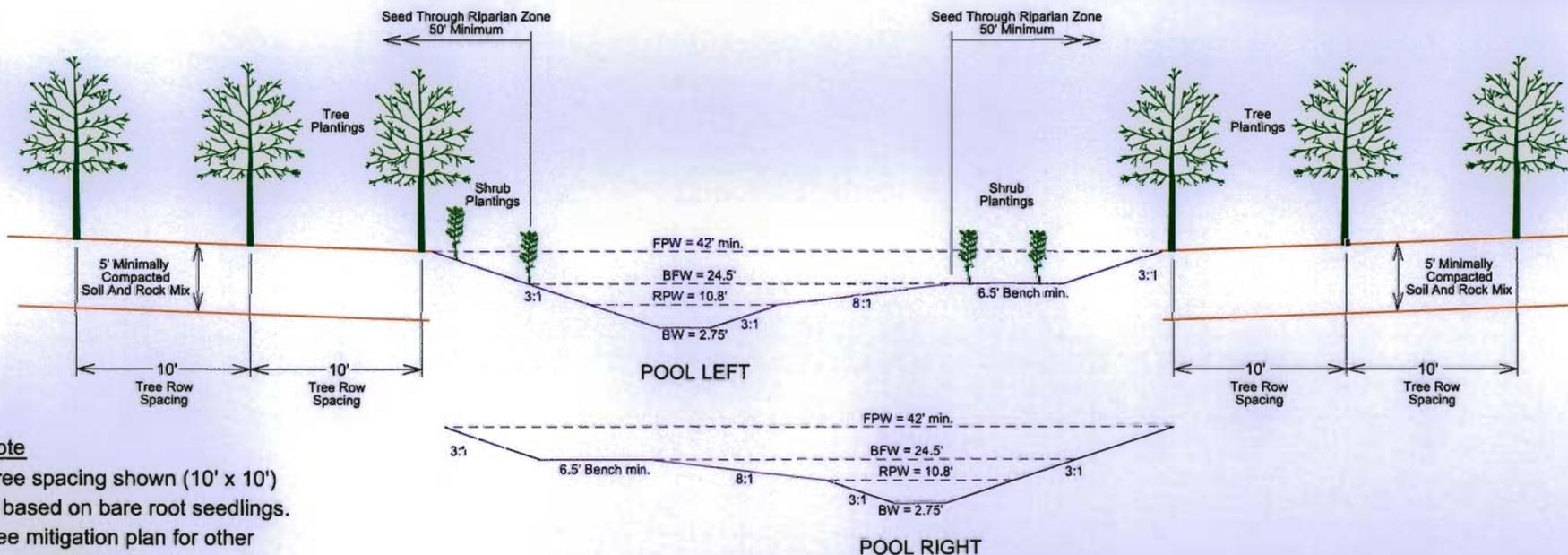
In bend sections, E.C.B. 1 may be placed along the inside bend (Point Bar). Blanket installation shall begin at the bottom of the point bar slope (just above Residual Pool Elevation) and extend to Flood Prone Elevation. E.C.B. 2 may be placed beyond this location as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 24.5'
- Bankfull Max. Depth = 2.55'
- Bankfull Area = 30.3 sq. ft.
- Bankfull Mean Depth = 1.23'
- Flood-Prone Width (FPW) = 42.0' (Minimum)
- W/D Ratio = 19.81
- Residual Pool (RP) Max. Depth = 1.34'
- Residual Pool (RP) Width = 10.8'

**Note**

- \* Durable rock may be used instead of ECB 1 along outside bends. The rock shall be placed at bottom of pool and extend to bankfull elevation. ECB 1 may be used above this elevation, rock size shall be a minimum of 1' diameter and shall be keyed into bank and bottom of channel.

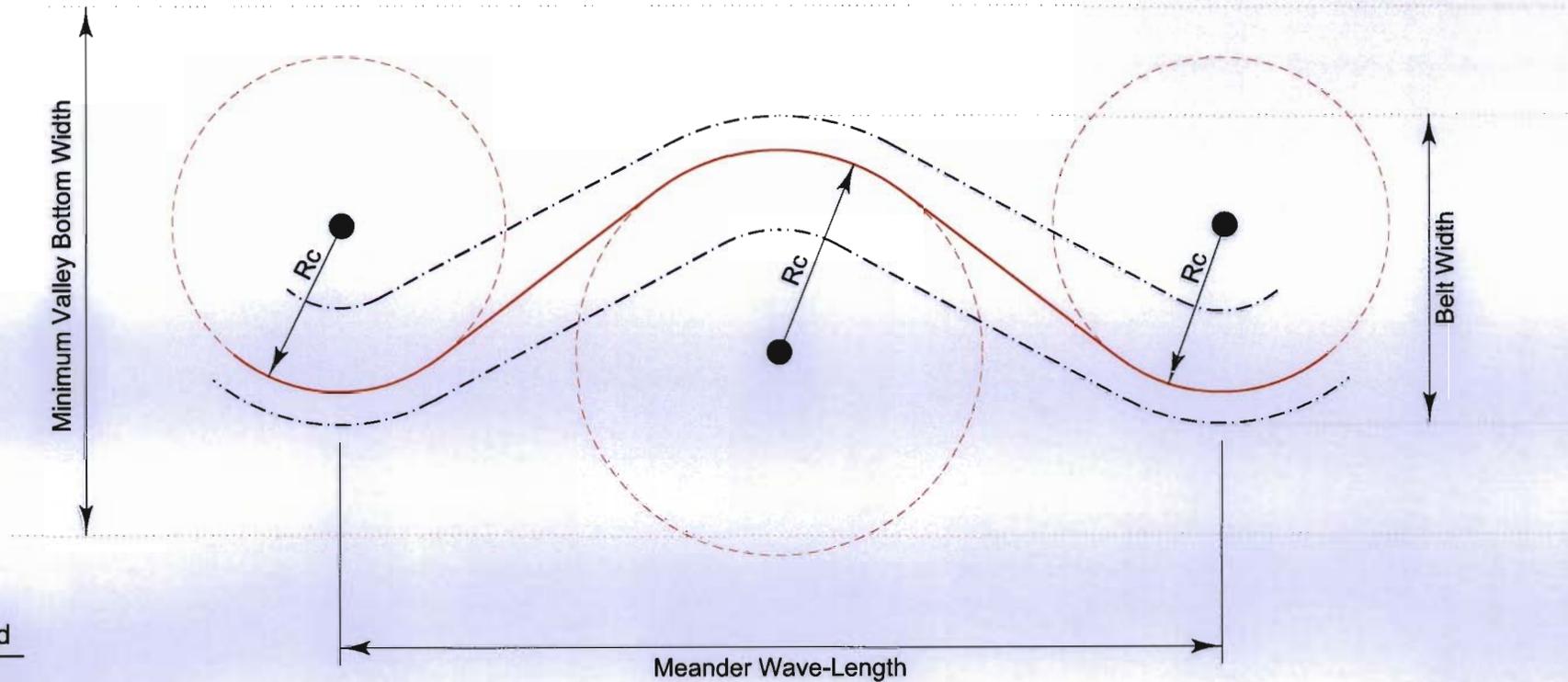


**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Pool Cross Section Stream Per-2  
Rosgen Stream Type "C"  
Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "C" Stream Int-1



**Legend**

- Bankfull
- Thalweg

- Bankfull Width= 13.7'
- Radius of Curvature (Rc) Ranges from 34' to 42'
- Belt Width Ranges from 110' to 150' (Some Deviation Allowable)
- Meander Wave-Length Ranges from 123' to 192' (Some Deviation Allowable)
- Approximate Proposed Reach Length = 503'
- Proposed Sinuosity is Approximately 1.2 or Greater
- Proposed Stream Gradient Ranges from 0.33% to 1.25%
- Proposed Valley Slope Ranges from 0.4% to 1.5%
- Minimum Valley Bottom Width = 165'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

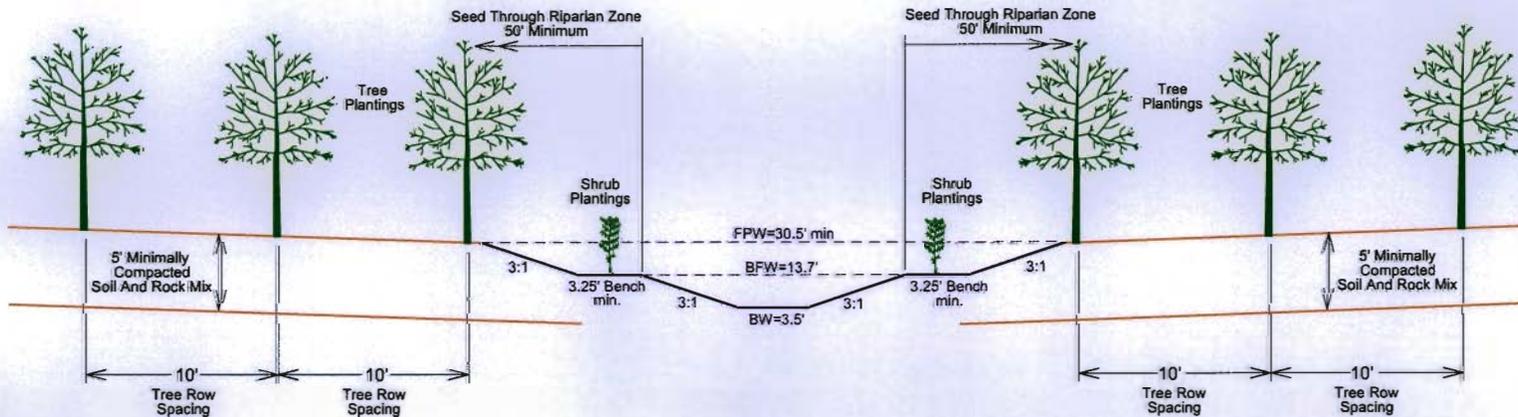
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 13.7'
- Bankfull Max. Depth = 1.7'
- Bankfull Area = 14.6 sq. ft.
- Bankfull Mean Depth = 1.07'
- Flood-Prone Width (FPW) = 30.5' (Minimum)
- W/D Ratio = 12.84
- Entrenchment Ratio = 2.22 (Minimum)
- Bench Width = 3.25' (Minimum)



**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Int-1  
Rosgen Stream Type "C"  
Scale: 1"=10'**

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

In bend sections, the outside bend may be stabilized with a combination of Erosion Control Blanket Type 1 (E.C.B. 1) and shrub plantings. E.C.B. 1 shall be anchored in at residual pool elevation and extend to Flood Prone Elevation. Beyond this elevation E.C.B. 2 may be placed throughout the riparian zone. In bend sections where structures (J-Hooks, Cross Vanes, etc.) are specified, E.C.B. 1 installation shall begin just above the structure location.

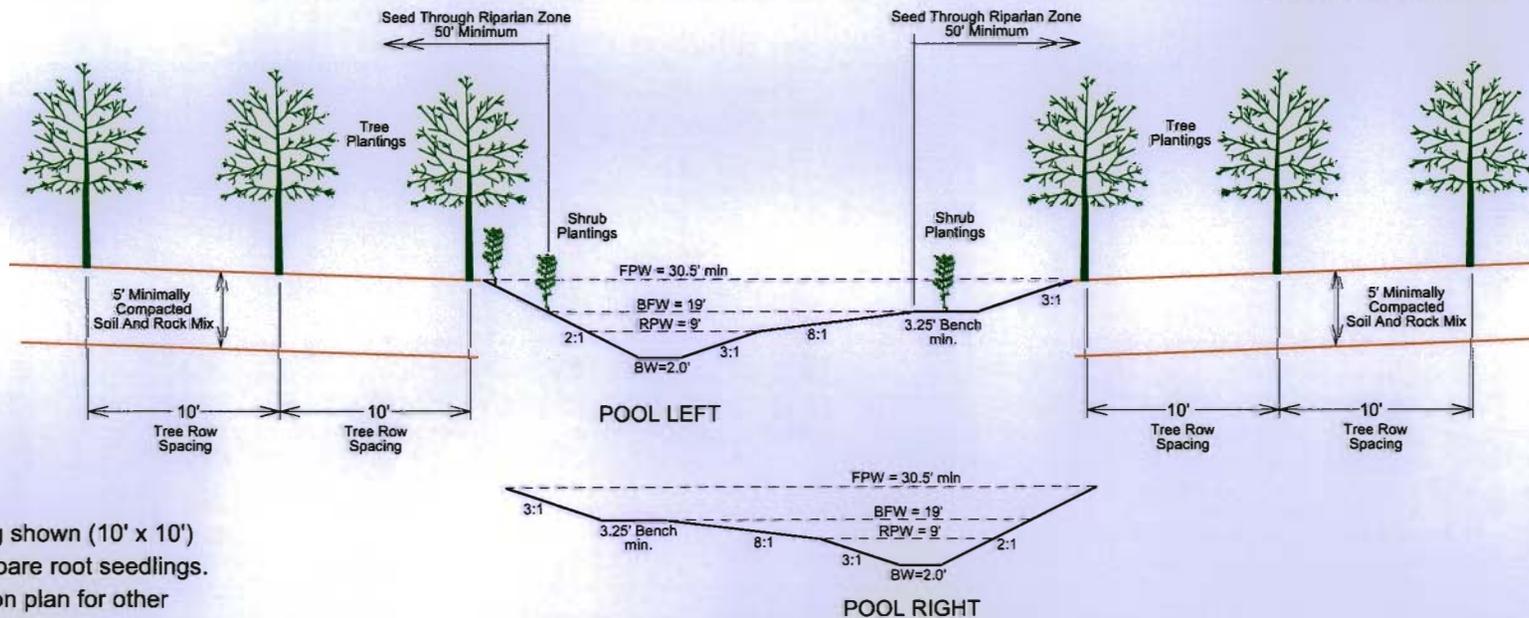
In bend sections, E.C.B. 1 may be placed along the inside bend (Point Bar). Blanket installation shall begin at the bottom of the point bar slope (just above Residual Pool Elevation) and extend to Flood Prone Elevation. E.C.B. 2 may be placed beyond this location as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 19'
- Bankfull Max. Depth = 2.4'
- Bankfull Area = 21.7 sq. ft.
- Bankfull Mean Depth = 1.14'
- Flood-Prone Width (FPW) = 30.5' (Minimum)
- W/D Ratio = 16.7
- Residual Pool (RP) Max. Depth = 1.39'
- Residual Pool (RP) Width = 9.0'

**Note**

- \* Durable rock may be used instead of ECB 1 along outside bends. The rock shall be placed at bottom of pool and extend to bankfull elevation. ECB 1 may be used above this elevation, rock size shall be a minimum of 1' diameter and shall be keyed into bank and bottom of channel.

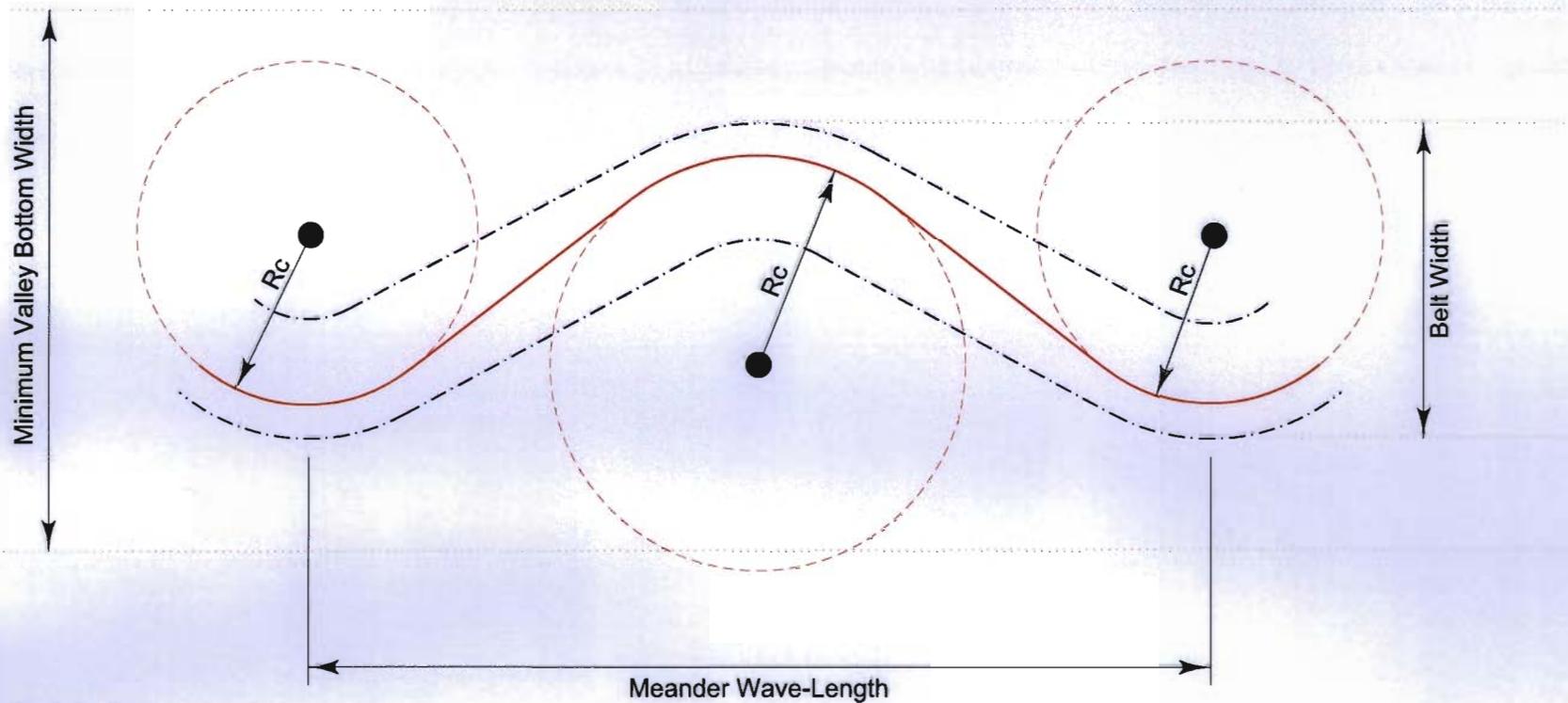


**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Pool Cross Section Stream Int-1  
 Rosgen Stream Type "C"  
 Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "C" Stream Int-1A



### Legend

Bankfull     - - - - -  
Thalweg     —————

- Bankfull Width=7.6'
- Radius of Curvature (Rc) Ranges from 19' to 23'
- Belt Width Ranges from 60' to 84'
- Meander Wave-Length Ranges from 68' to 106'
- Approximate Proposed Reach Length = 239'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 0.42% to 1.25%
- Proposed Valley Slope Ranges from 0.5% to 1.5%
- Minimum Valley Bottom Width = 95'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

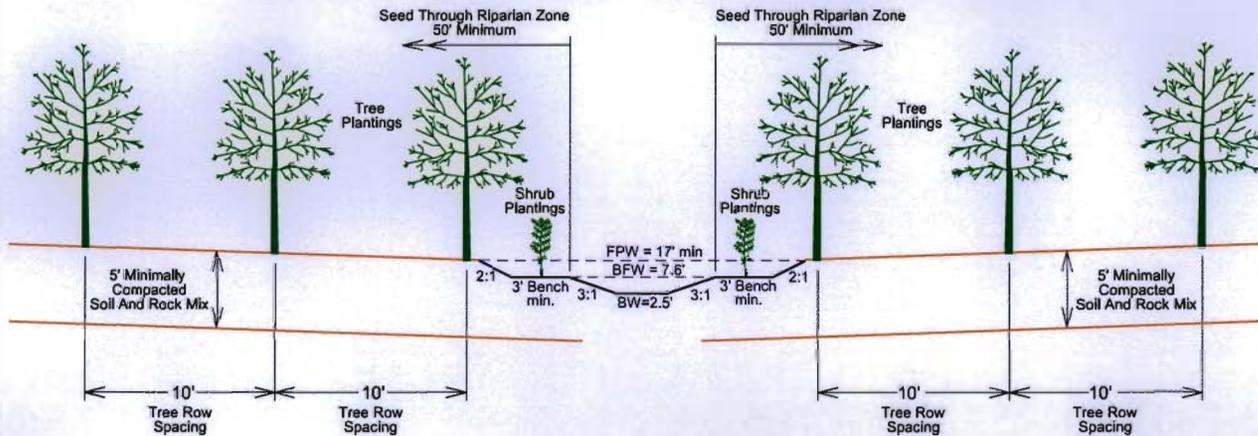
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 7.6'
- Bankfull Max. Depth = 0.85'
- Bankfull Area = 4.27SF
- Bankfull Mean Depth = 0.56'
- Flood-Prone Width (FPW) = 17' Min
- W/D Ratio = 13.5
- Entrenchment Ratio = 2.24 Min
- Bench Width = 3.0' Min



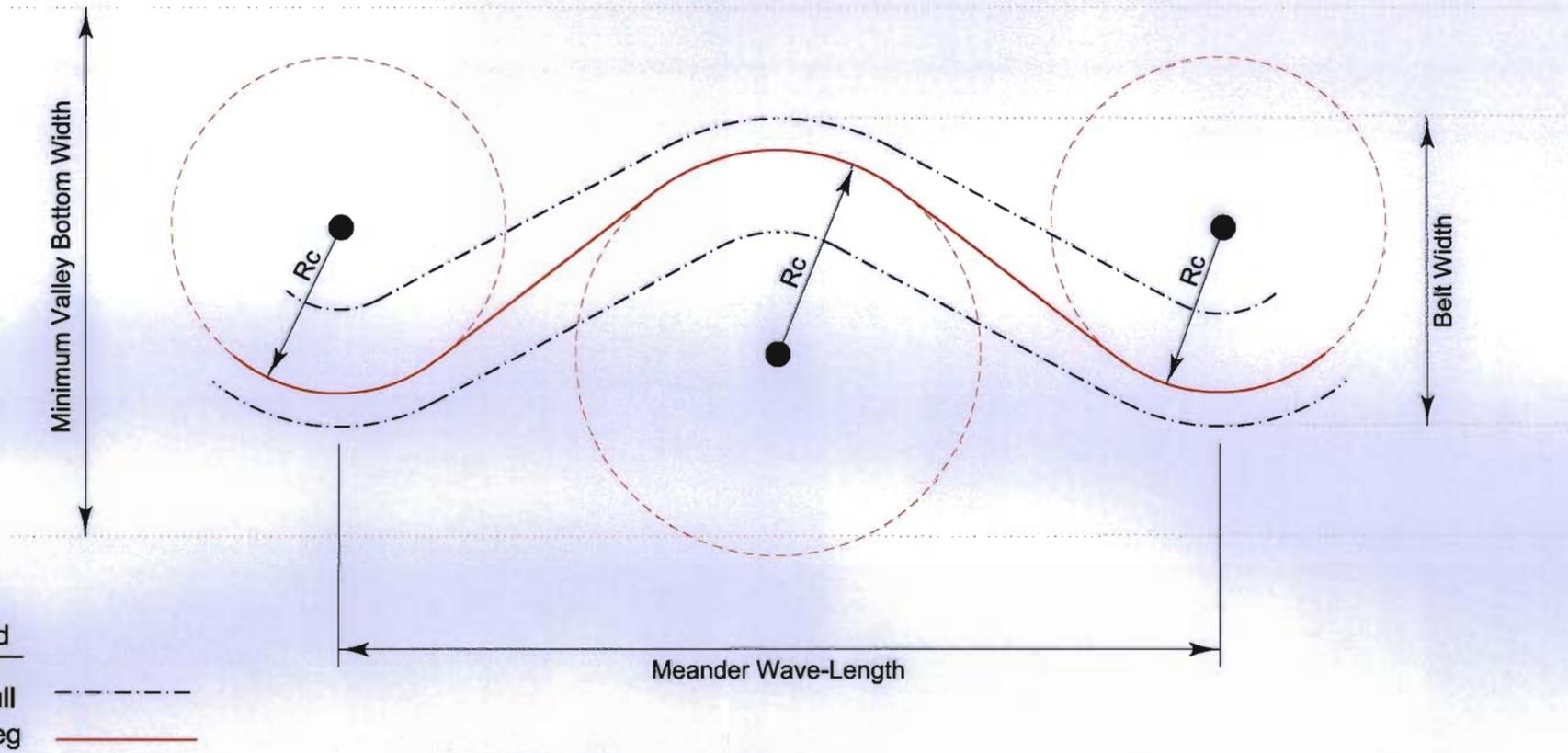
**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Int-1A**  
**Rosgen Stream Type "C"**  
**Scale: 1"=10'**



## Typical Meander Pattern for Rosgen Stream Type "C" Stream Int-2 DS



**Legend**

- Bankfull
- Thalweg

- Bankfull Width=10.7'
- Radius of Curvature (Rc) Ranges from 26.5' to 32'
- Belt Width Ranges from 85' to 118'
- Meander Wave-Length Ranges from 96' to 150'
- Approximate Proposed Reach Length = 1593'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 0.42% to 1.25%
- Proposed Valley Slope Ranges from 0.5% to 1.5%
- Minimum Valley Bottom Width = 130'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

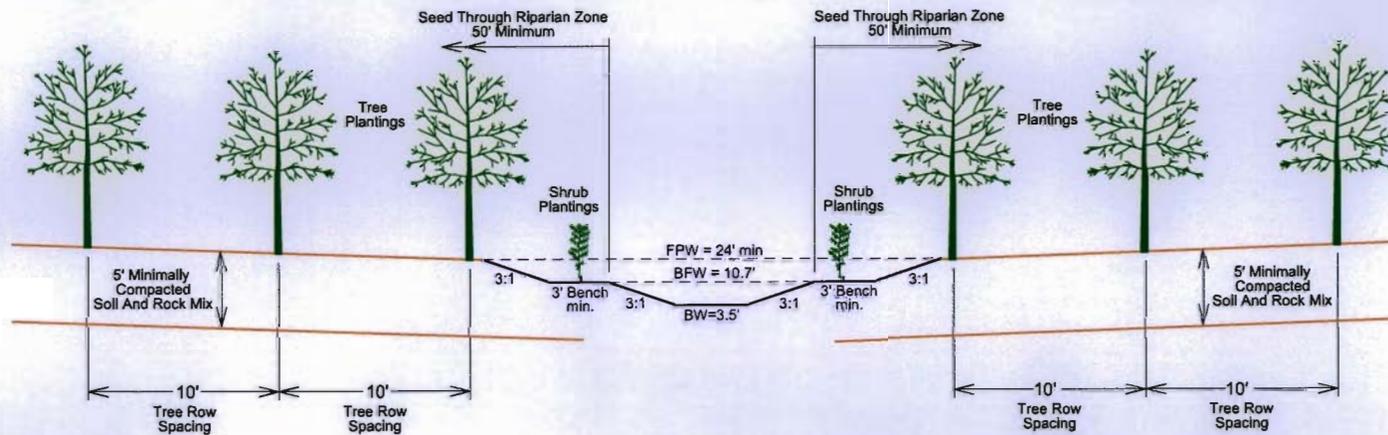
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 10.7'
- Bankfull Max. Depth = 1.2'
- Bankfull Area = 8.52 SF
- Bankfull Mean Depth = 0.8'
- Flood-Prone Width (FPW) = 24' Min
- W/D Ratio = 13.44
- Entrenchment Ratio = 2.24 Min
- Bench Width = 3' Min



**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.
- \* Typical cross section where stream not adjacent to wetlands

**Typical Riffle Cross Section Stream Int-2 DS  
Rosgen Stream Type "C"  
Scale: 1"=10'**

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

In bend sections, the outside bend may be stabilized with a combination of Erosion Control Blanket Type 1 (E.C.B. 1) and shrub plantings. E.C.B. 1 shall be anchored in at residual pool elevation and extend to Flood Prone Elevation. Beyond this elevation E.C.B. 2 may be placed throughout the riparian zone. In bend sections where structures (J-Hooks, Cross Vanes, etc.) are specified, E.C.B. 1 installation shall begin just above the structure location.

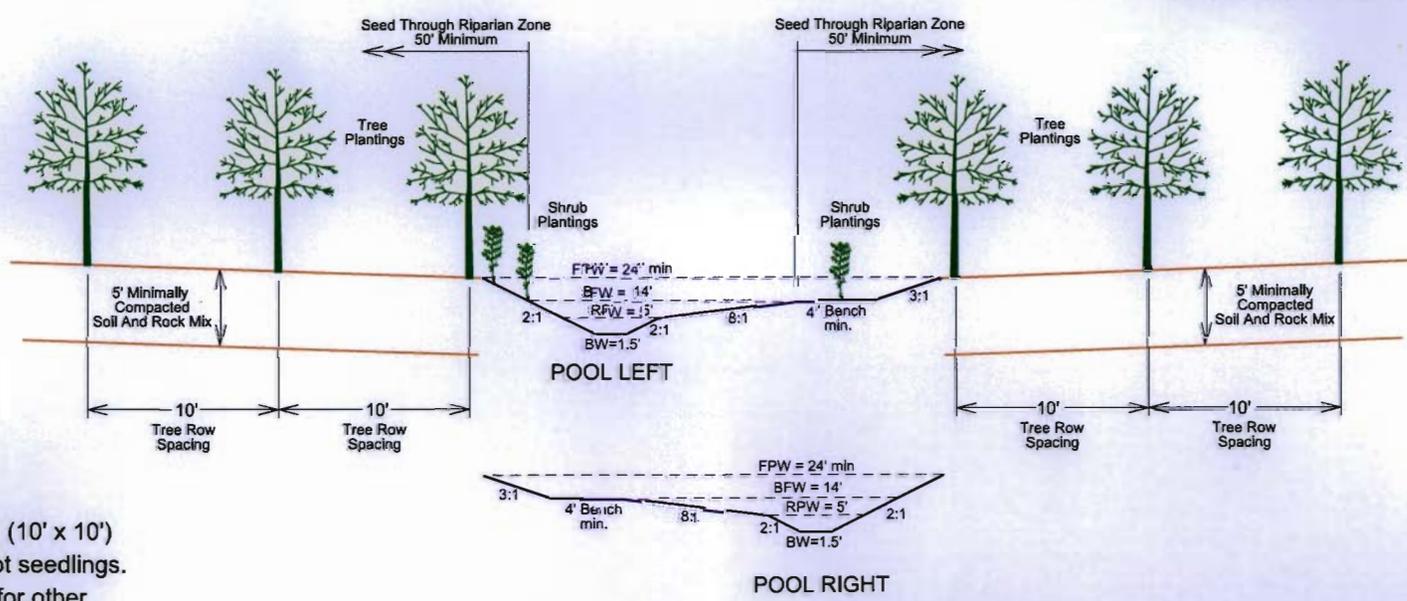
In bend sections, E.C.B. 1 may be placed along the inside bend (Point Bar). Blanket installation shall begin at the bottom of the point bar slope (just above Residual Pool Elevation) and extend to Flood Prone Elevation. E.C.B. 2 may be placed beyond this location as needed.

Proposed Channel Dimensions

- Bankfull Width (BFW) = 14.0'
- Bankfull Max. Depth = 1.76'
- Bankfull Area = 11.4 sq. ft.
- Bankfull Mean Depth = 0.81'
- Flood-Prone Width (FPW) = 24' Min
- W/D Ratio = 17.25
- Residual Pool Max. Depth = 0.85'
- Residual Pool (RPW) Width = 5'

Note

- \* Durable rock may be used instead of ECB 1 along outside bends. The rock shall be placed at bottom of pool and extend to bankfull elevation. ECB 1 may be used above this elevation, rock size shall be a minimum of 1' diameter and shall be keyed into bank and bottom of channel.

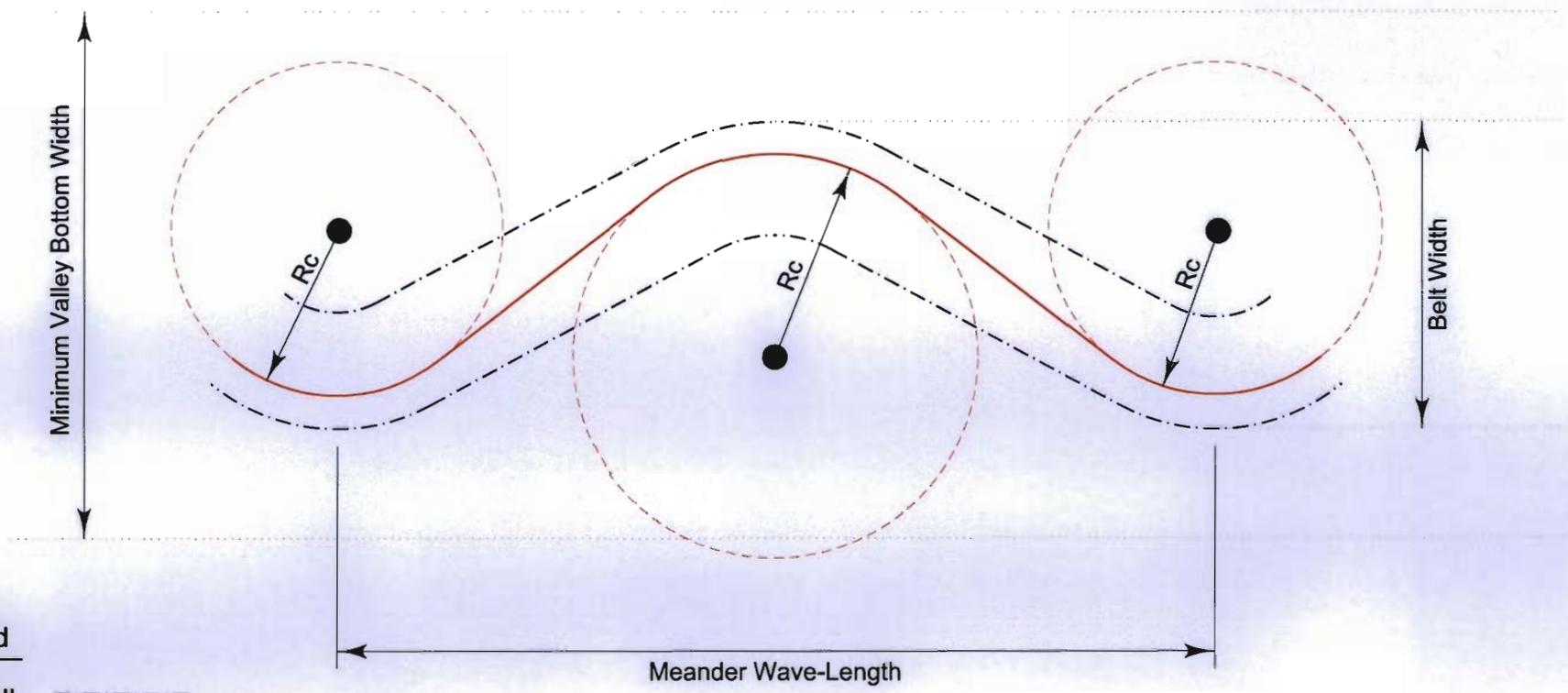


Note

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.
- \* Typical cross section where stream not adjacent to wetlands

**Typical Pool Cross Section Stream Int-2 DS  
 Rosgen Stream Type "C"  
 Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "E" Stream Int-2 MS



**Legend**

- Bankfull      - - - - -
- Thalweg        —————

- Bankfull Width=7.8'
- Radius of Curvature (Rc) Ranges from 19' to 24'
- Belt Width Ranges from 78' to 140'
- Meander Wave-Length Ranges from 78' to 109'
- Approximate Proposed Reach Length = 3334'
- Proposed Sinuosity is Approximately 1.5 or greater
- Proposed Stream Gradient Ranges from 0.67% to 1.3%
- Proposed Valley Slope Ranges from 1.0% to 2.0%
- Minimum Valley Bottom Width = 155'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

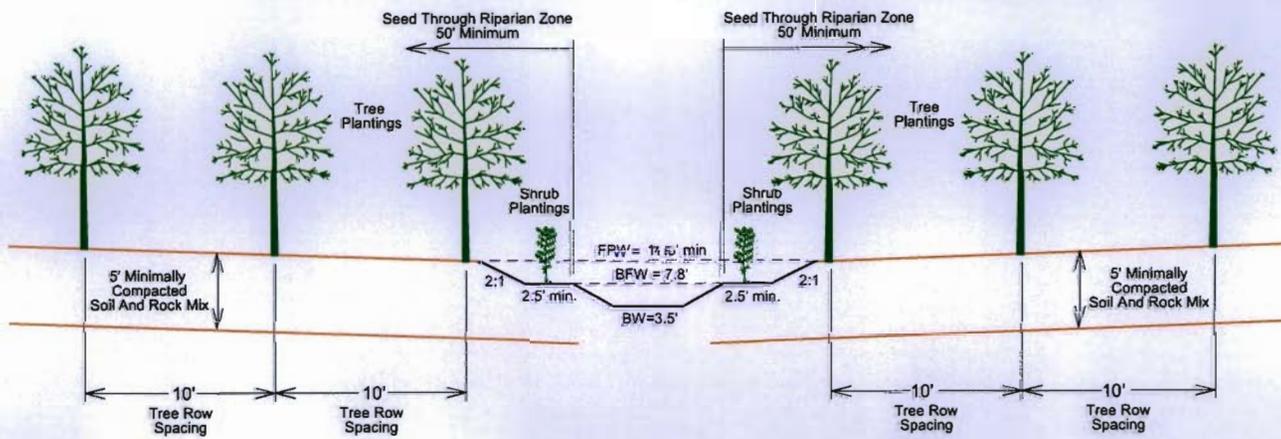
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 7.8'
- Bankfull Max. Depth = 1.2'
- Bankfull Area = 6.8 SF
- Bankfull Mean Depth = 0.87'
- Flood-Prone Width (FPW) = 17.5' min
- W/D Ratio = 8.99
- Entrenchment Ratio = 2.24 min
- Bench Width = 2.5' min

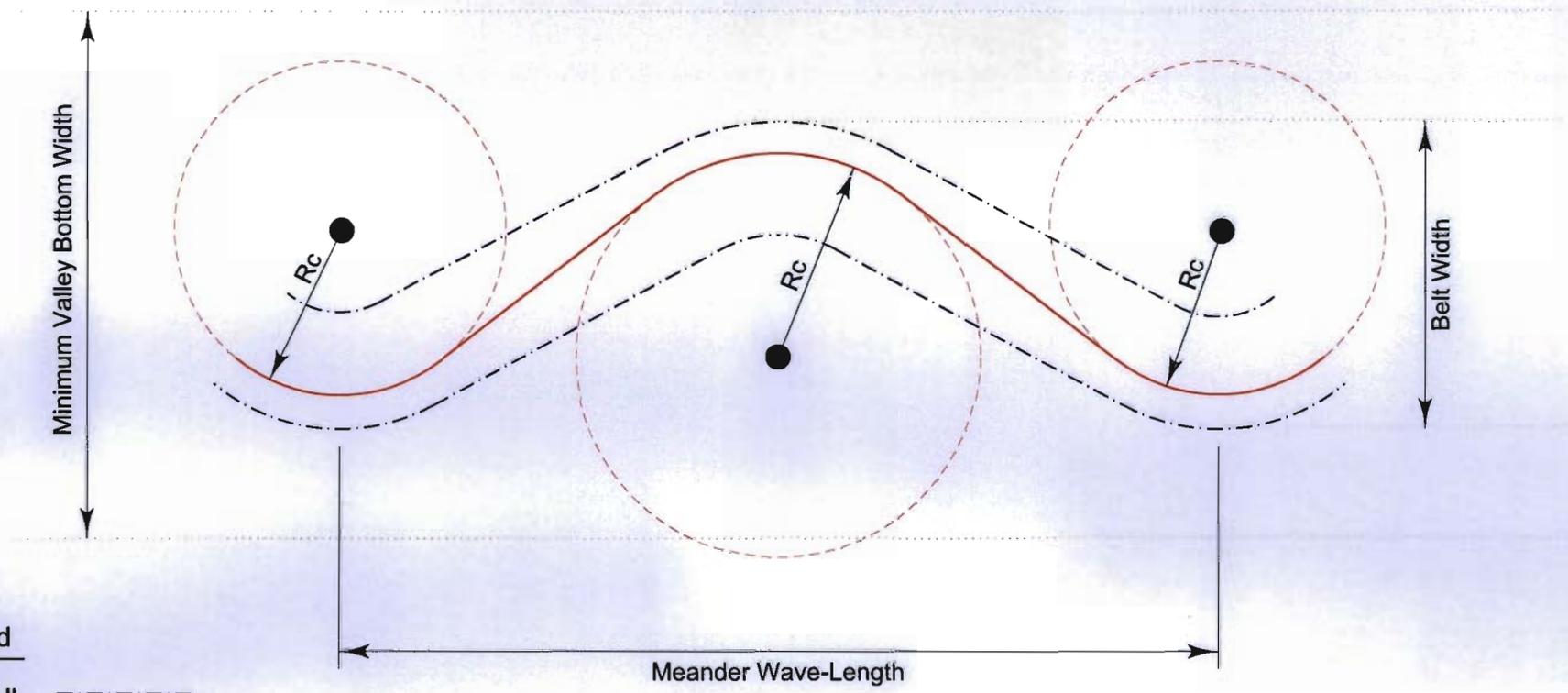


**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Int-2 MS**  
**Rosgen Stream Type "E"**  
**Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "B" Stream Int-3



**Legend**

- Bankfull     - - - - -
- Thalweg     —————

- Bankfull Width=5.5'
- Radius of Curvature (Rc) Ranges from 13.5' to 16.5'
- Belt Width= 22' to 28'
- Meander Wavelength= NA
- Approximate Proposed Reach Length = 359'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 2.5% to 3.3%
- Proposed Valley Slope Ranges from 3.0% to 4.0%
- Minimum Valley Bottom Width = 40'

T.H.E. Engineers, Inc.  
 PROJECT: MIDWAY SOUTH MINE SITE - PROPOSED MITIGATION  
 COUNTY: OHIO  
 STATE: KY  
 NEAR: CENTERTOWN  
 ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION  
 STREAM: INTERMITTENT 3  
 EXHIBIT 27

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

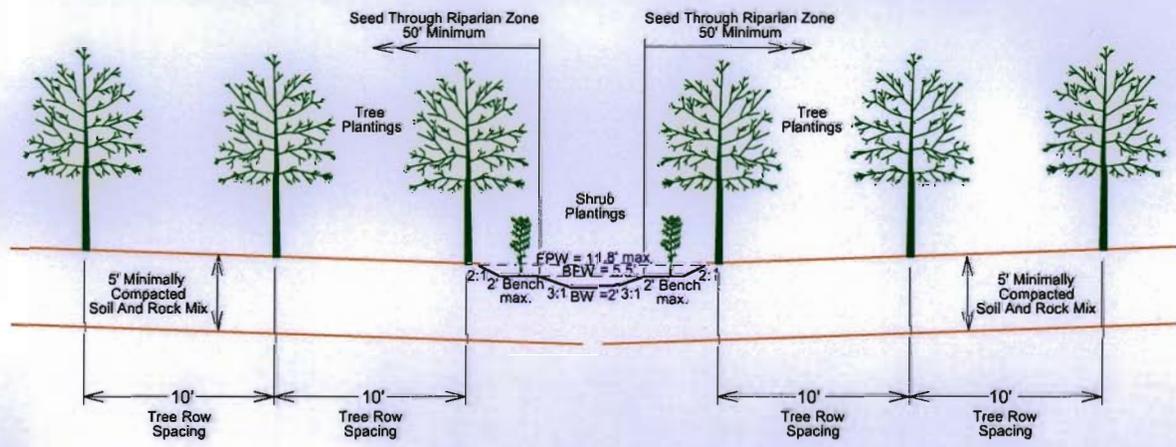
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 5.5'
- Bankfull Max. Depth = 0.58'
- Bankfull Area = 2.17SF
- Bankfull Mean Depth = 0.4'
- Flood-Prone Width (FPW) = 11.8' max
- W/D Ratio = 13.84
- Entrenchment Ratio = 2.15 (1.4-2.2)
- Bench Width = 2.0' max

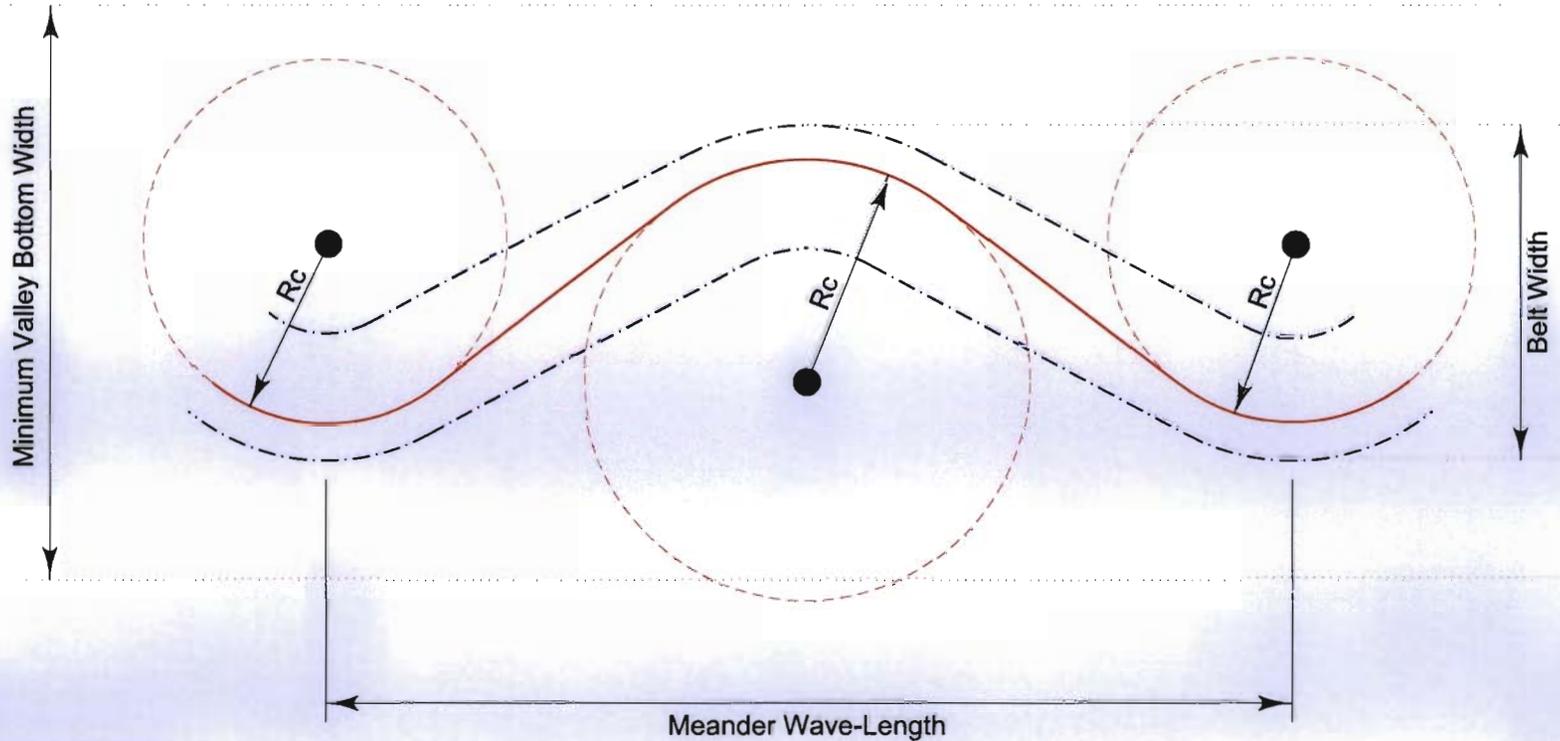


**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Int-3**  
**Rosgen Stream Type "B"**  
**Scale: 1"=10'**

# Typical Meander Pattern for Rosgen Stream Type "B" Stream Int-4



**Legend**

- Bankfull
- Thalweg

- Bankfull Width=5.5'
- Radius of Curvature ( $R_c$ ) Ranges from 13.5' to 16.5'
- Belt Width= 22' to 28'
- Meander Wavelength= NA
- Approximate Proposed Reach Length = 739'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 2.5% to 3.3%
- Proposed Valley Slope Ranges from 3.0% to 4.0%
- Minimum Valley Bottom Width = 40'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

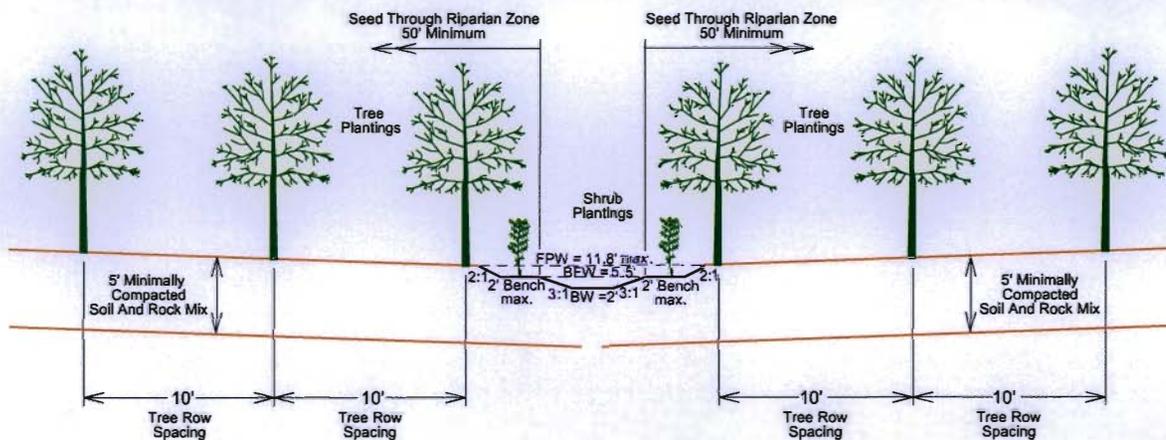
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 5.5'
- Bankfull Max. Depth = 0.58'
- Bankfull Area = 2.17SF
- Bankfull Mean Depth = 0.4'
- Flood-Prone Width (FPW) = 11.8' max
- W/D Ratio = 13.84
- Entrenchment Ratio = 2.15 (1.4-2.2)
- Bench Width = 2.0' max

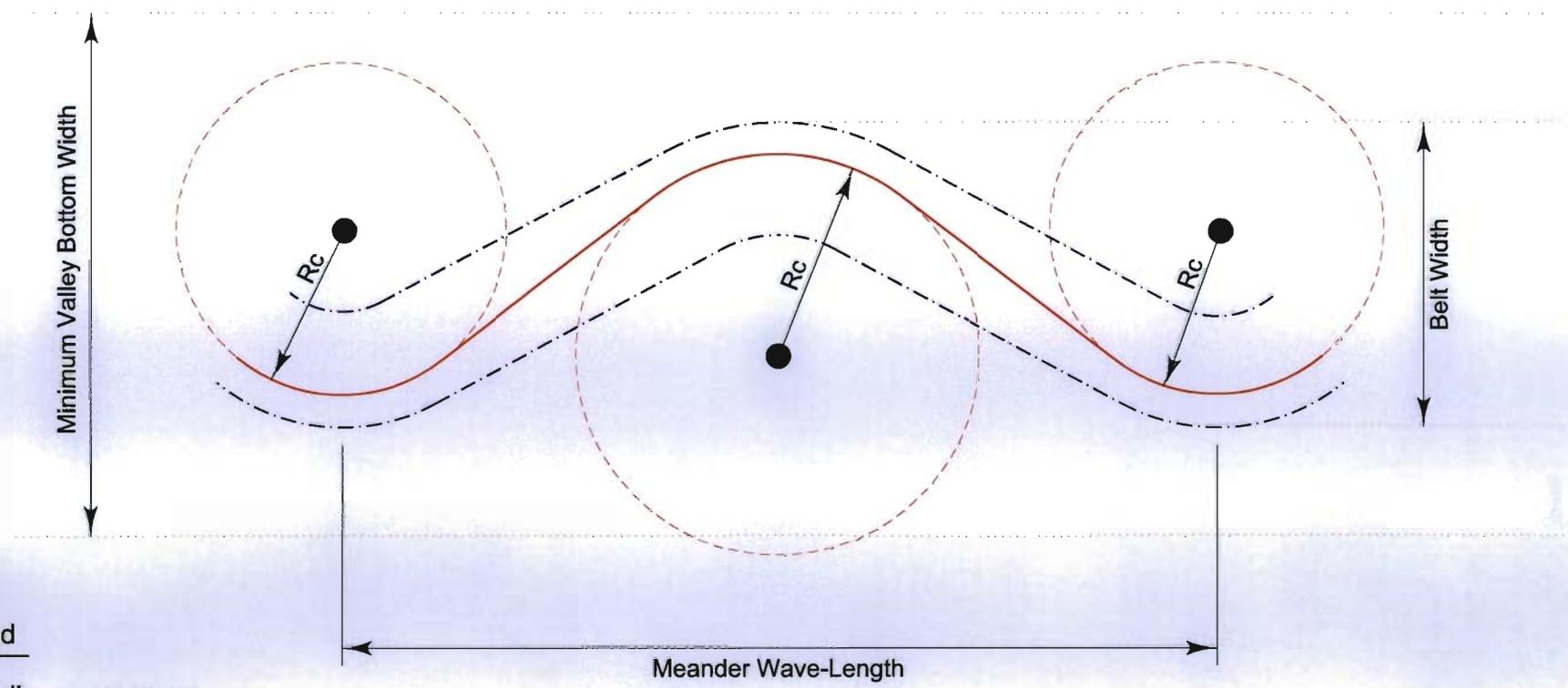


**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Int-4  
 Rosgen Stream Type "B"  
 Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "B" Stream Int-6



**Legend**

- Bankfull    - - - - -
- Thalweg    —————

- Bankfull Width= 5.9'
- Radius of Curvature (Rc) Ranges from 14.5' to 18'
- Belt Width= 23.5' to 30'
- Meander Wavelength= NA
- Approximate Proposed Reach Length = 781'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 2.1% to 2.9%
- Proposed Valley Slope Ranges from 2.5% to 3.5%
- Minimum Valley Bottom Width = 45'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

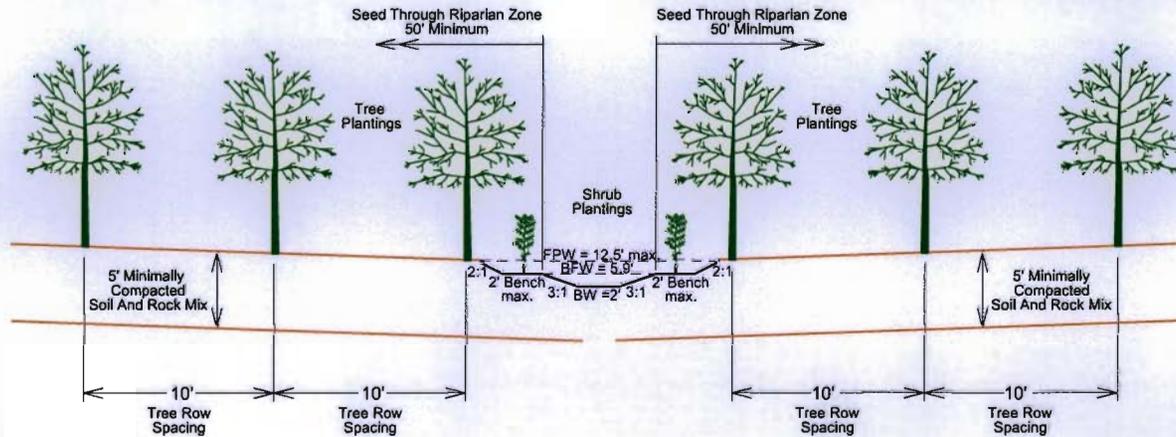
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

Note

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

Proposed Channel Dimensions

- Bankfull Width (BFW) = 5.9'
- Bankfull Max. Depth = 0.65'
- Bankfull Area = 2.57SF
- Bankfull Mean Depth = 0.43'
- Flood-Prone Width (FPW) = 12.5' max
- W/D Ratio = 13.54
- Entrenchment Ratio = 2.12 (1.4-2.2)
- Bench Width = 2.0' max

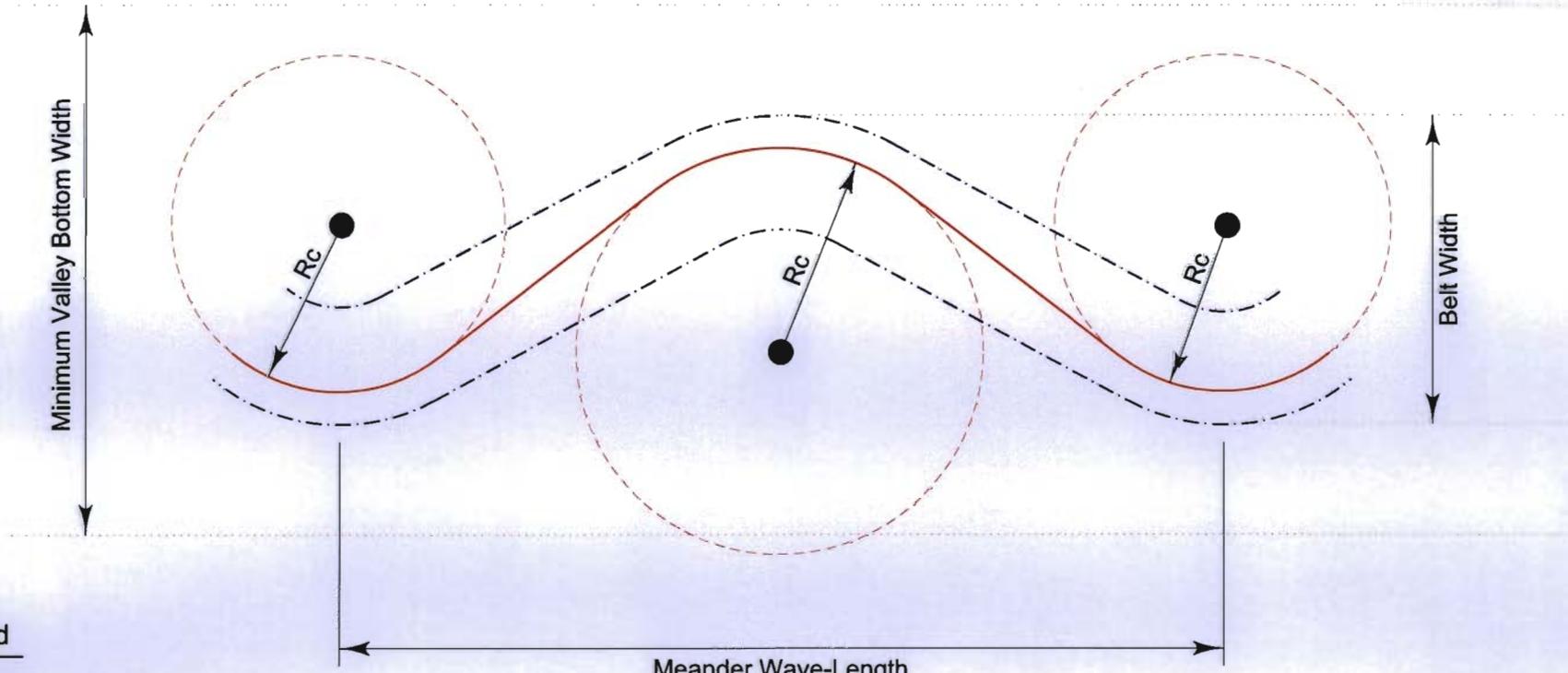


Note

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Int-6**  
**Rosgen Stream Type "B"**  
**Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "B" Stream Int-7



**Legend**

- Bankfull     - - - - -
- Thalweg     —————

- Bankfull Width=7.8'
- Radius of Curvature (Rc) Ranges from 19.5' to 23.5'
- Belt Width= 31' to 39'
- Meander Wavelength= NA
- Approximate Proposed Reach Length = 619'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 1.25% to 2.5%
- Proposed Valley Slope Ranges from 1.5% to 3.0%
- Minimum Valley Bottom Width = 50'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

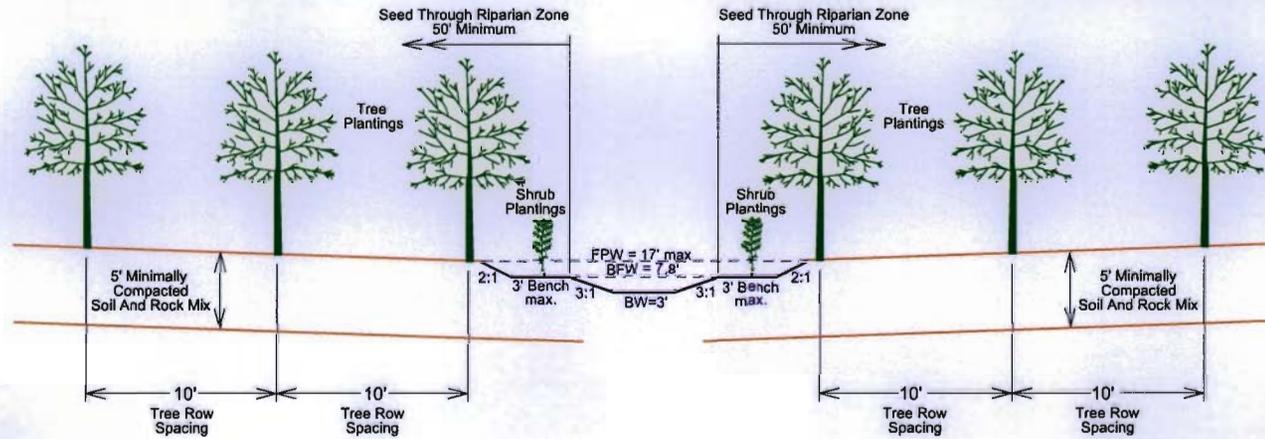
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 7.8'
- Bankfull Max. Depth = 0.8'
- Bankfull Area = 4.28 SF
- Bankfull Mean Depth = 0.55'
- Flood-Prone Width (FPW) = 17' max
- W/D Ratio = 14.1
- Entrenchment Ratio = 2.18 (1.4-2.2)
- Bench Width = 3.0' max

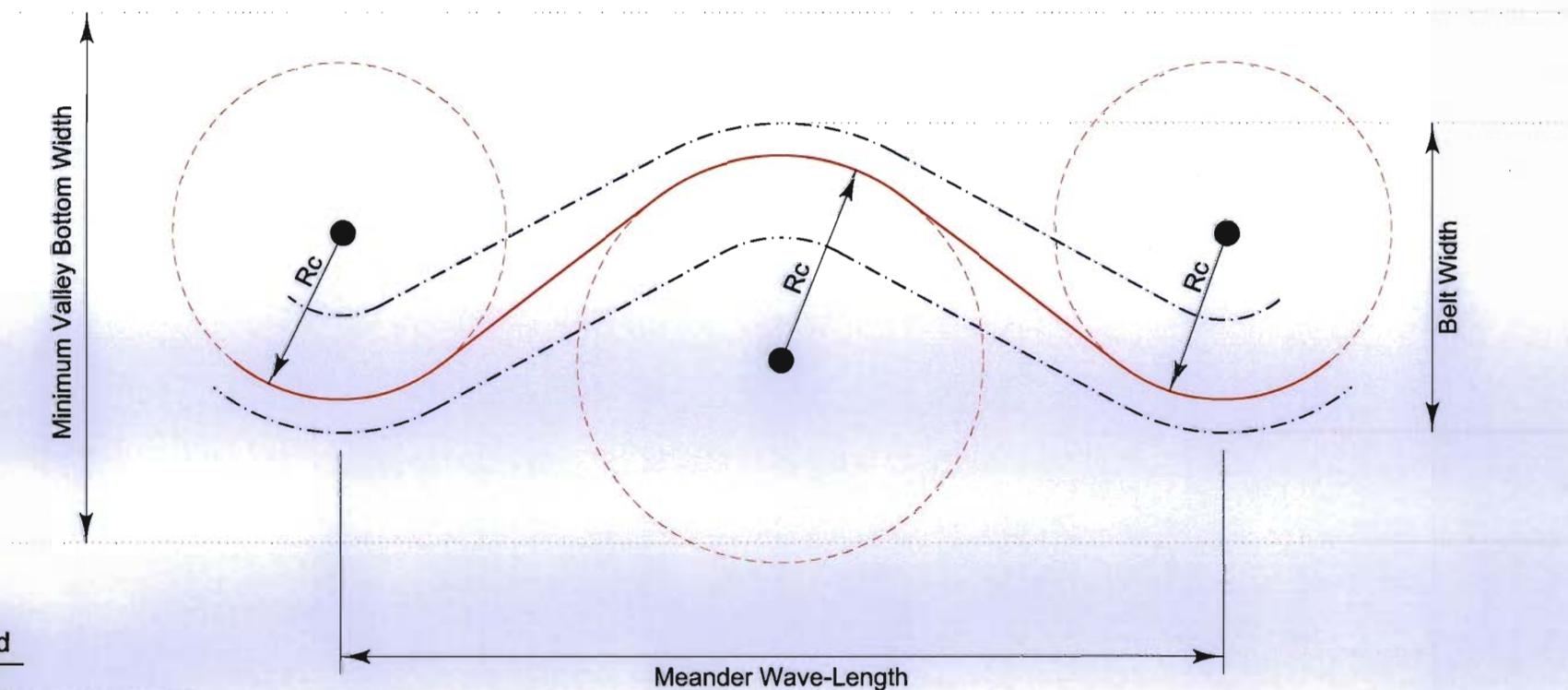


**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Int-7**  
**Rosgen Stream Type "B"**  
**Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "C" Stream Int-11



**Legend**

- Bankfull     - - - - -
- Thalweg     —————

- Bankfull Width=18.5'
- Radius of Curvature (Rc) Ranges from 46' to 56'
- Belt Width Ranges from 148' to 204'
- Meander Wave-Length Ranges from 166' to 259'
- Approximate Proposed Reach Length = 2153'
- Proposed Stream Sinuosity is Approximately 1.2 or Greater
- Proposed Stream Gradient Ranges from 0.17% to 0.67%
- Proposed Valley Slope Ranges from 0.2% to 0.8%
- Minimum Valley Bottom Width = 220'

PROJECT: MIDWAY SOUTH MINE SITE - PROPOSED MITIGATION

STREAM: INTERMITTENT II

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

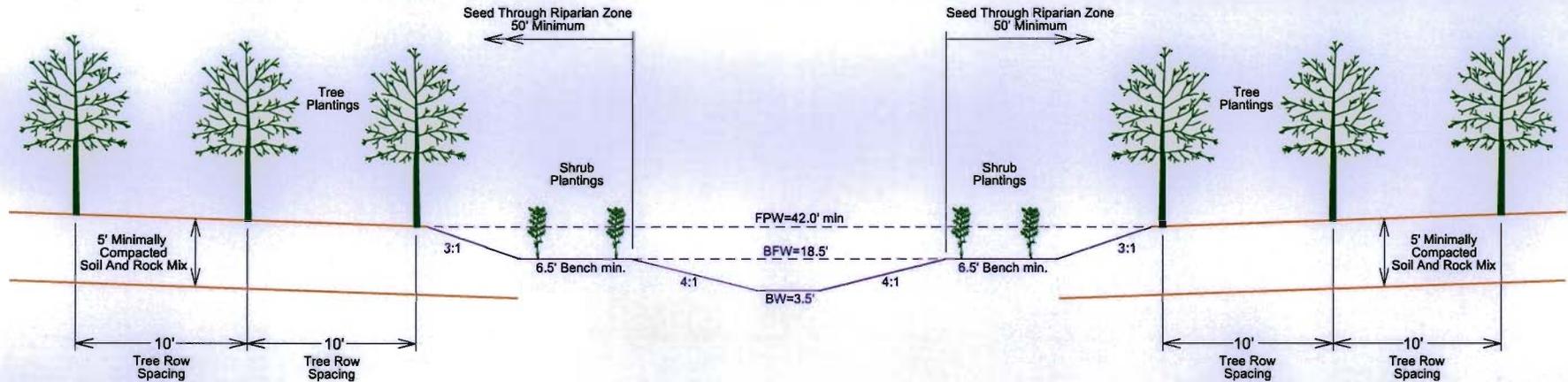
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 18.5'
- Bankfull Max. Depth = 1.87'
- Bankfull Area = 20.6 SF
- Bankfull Mean Depth = 1.11'
- Flood-Prone Width (FPW) = 42' Min
- W/D Ratio = 16.6
- Entrenchment Ratio = 2.27 Min
- Bench Width = 6.5' Min



**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Int-11**  
**Rosgen Stream Type "C"**  
**Scale: 1"=10'**

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

In bend sections, the outside bend may be stabilized with a combination of Erosion Control Blanket Type 1 (E.C.B. 1) and shrub plantings. E.C.B. 1 shall be anchored in at residual pool elevation and extend to Flood Prone Elevation. Beyond this elevation E.C.B. 2 may be placed throughout the riparian zone. In bend sections where structures (J-Hooks, Cross Vanes, etc.) are specified, E.C.B. 1 installation shall begin just above the structure location.

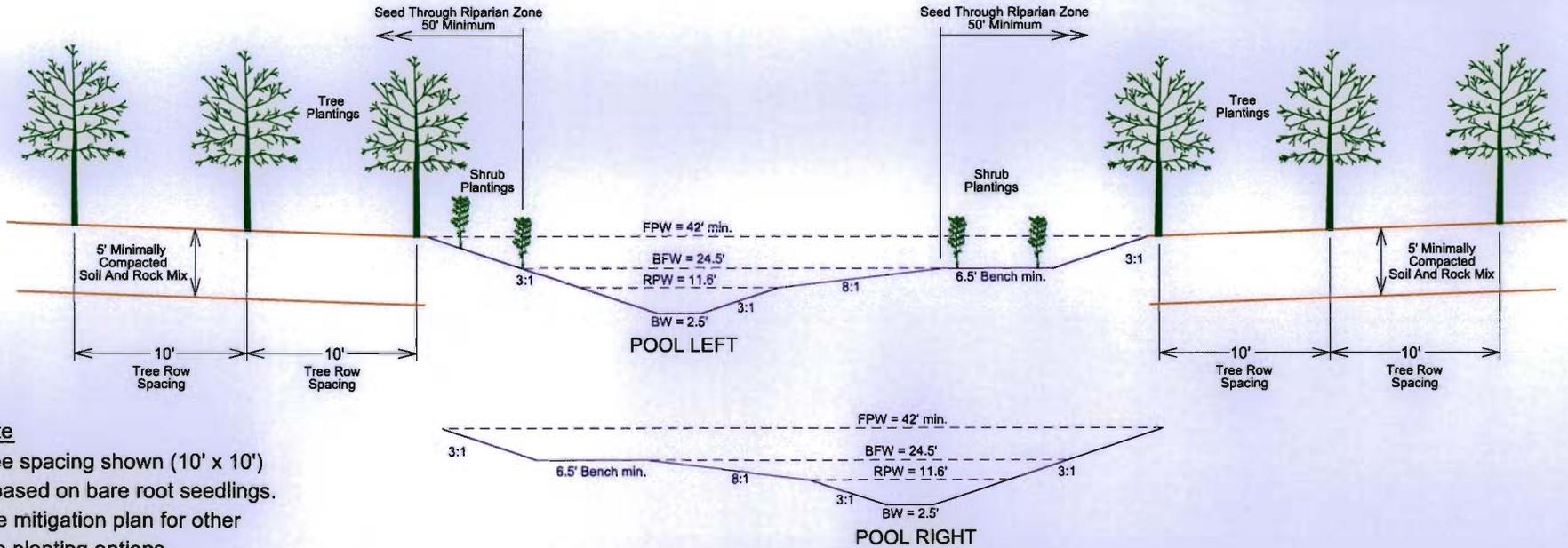
In bend sections, E.C.B. 1 may be placed along the inside bend (Point Bar). Blanket installation shall begin at the bottom of the point bar slope (just above Residual Pool Elevation) and extend to Flood Prone Elevation. E.C.B. 2 may be placed beyond this location as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 24.5'
- Bankfull Max. Depth = 2.65'
- Bankfull Area = 31.1 sq. ft.
- Bankfull Mean Depth = 1.27'
- Flood-Prone Width (FPW) = 42' Min
- W/D Ratio = 19.29
- Residual Pool Max. Depth = 1.5'
- Residual Pool (RPW) Width = 11.6'

**Note**

- \* Durable rock may be used instead of ECB 1 along outside bends. The rock shall be placed at bottom of pool and extend to bankfull elevation. ECB 1 may be used above this elevation, rock size shall be a minimum of 1' diameter and shall be keyed into bank and bottom of channel.

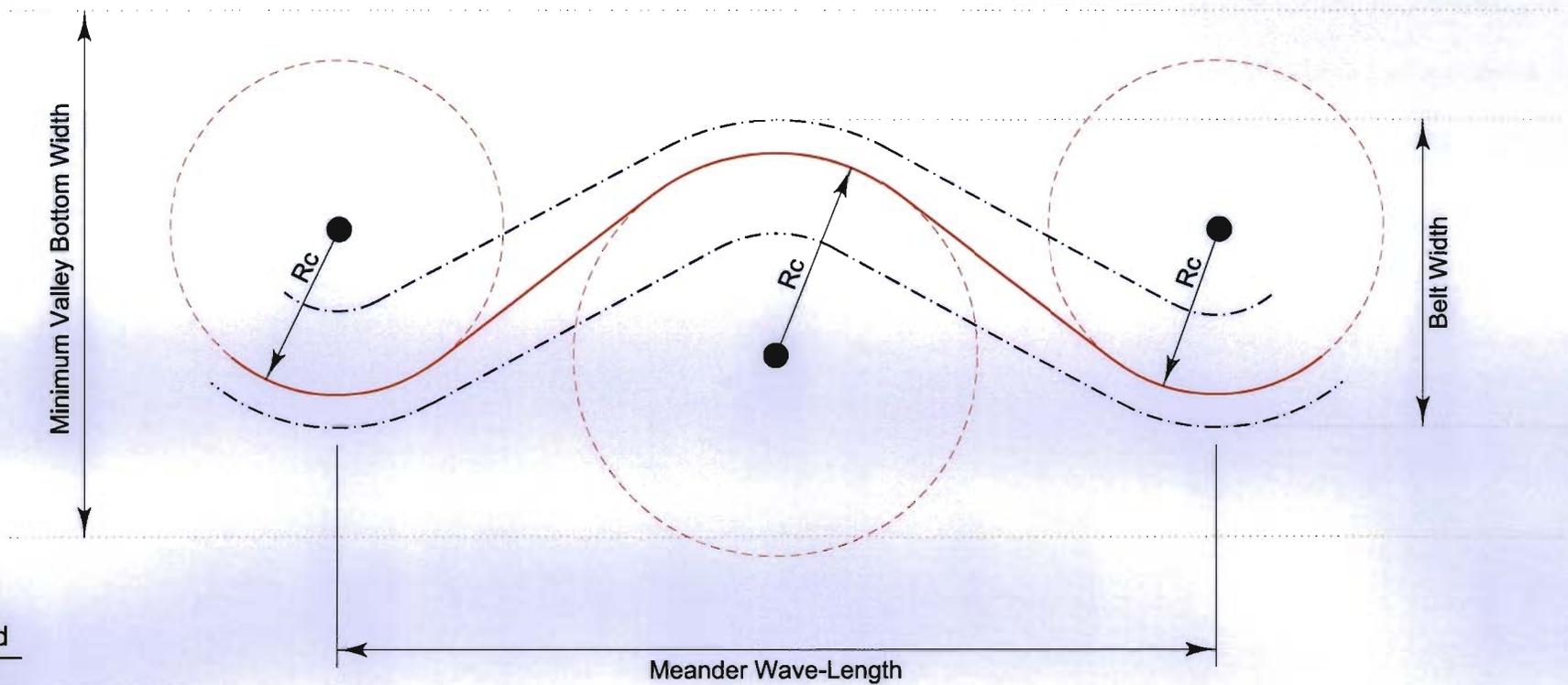


**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Pool Cross Section Stream Int-11  
Rosgen Stream Type "C"  
Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "E" Stream Eph-17



**Legend**

- Bankfull      - - - - -
- Thalweg        —————

- Bankfull Width=6.6'
- Radius of Curvature (Rc) Ranges from 16.5' to 20'
- Belt Width= 66' to 120' (Some Deviation Allowable)
- Meander Wave-Length Ranges from 66' to 92.5'
- Approximate Proposed Reach Length = 2888'
- Proposed Sinuosity is Approximately 1.5 or greater
- Proposed Stream Gradient Ranges from 0.67% to 1.33%
- Proposed Valley Slope Ranges from 1.0% to 2.0%
- Minimum Valley Bottom Width = 130'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

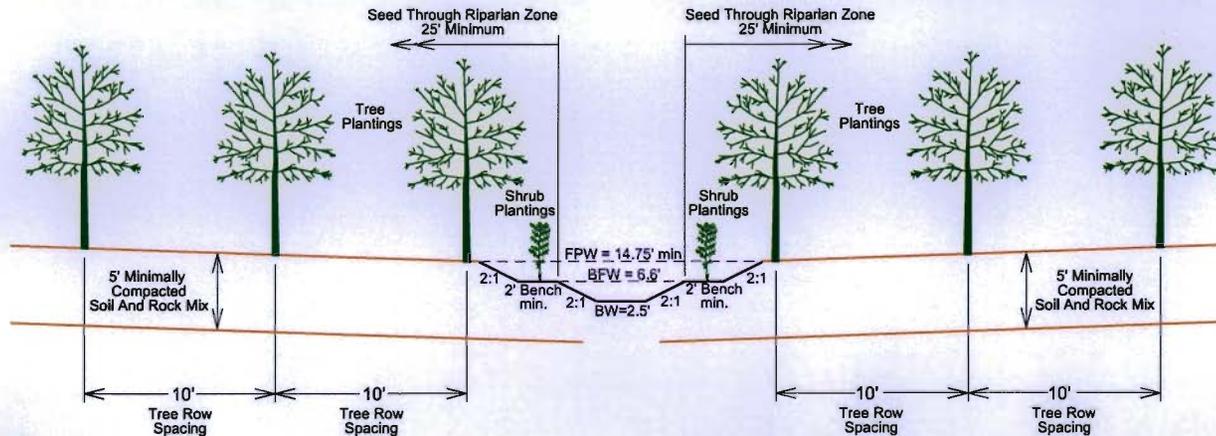
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 6.6'
- Bankfull Max. Depth = 1.03'
- Bankfull Area = 4.7 SF
- Bankfull Mean Depth = 0.71'
- Flood-Prone Width (FPW) = 14.75' min
- W/D Ratio = 9.32
- Entrenchment Ratio = 2.23
- Bench Width = 2.0' min

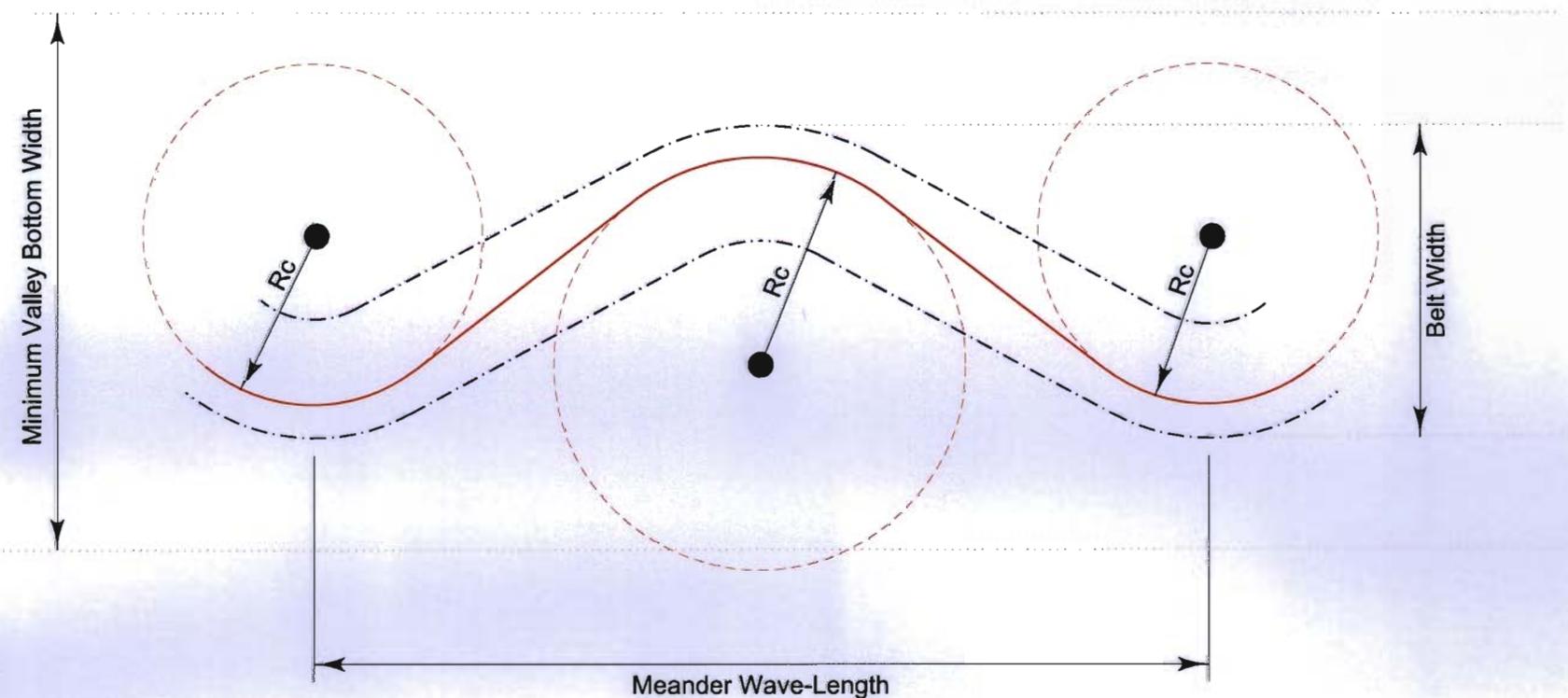


**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Eph-17**  
**Rosgen Stream Type "E"**  
**Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "B" Stream Eph-26 DS



**Legend**

- Bankfull     - - - - -
- Thalweg     —————

- Bankfull Width=7.0'
- Radius of Curvature (Rc) Ranges from 17.5' to 21.0'
- Belt Width= 28' to 35'
- Meander Wavelength= NA
- Approximate Proposed Reach Length = 189'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 1.67% to 2.5%
- Proposed Valley Slope Ranges from 2.0% to 3.0%
- Minimum Valley Bottom Width = 45'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

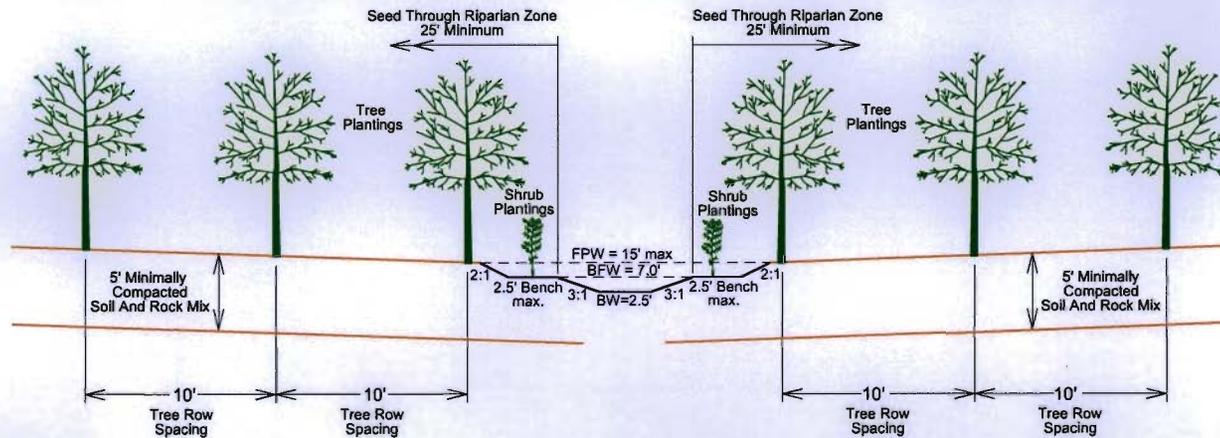
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 7.0'
- Bankfull Max. Depth = 0.76'
- Bankfull Area = 3.59 SF
- Bankfull Mean Depth = 0.51'
- Flood-Prone Width (FPW) = 15' max
- W/D Ratio = 13.77
- Entrenchment Ratio = 2.13 (1.4-2.2)
- Bench Width = 2.5' max

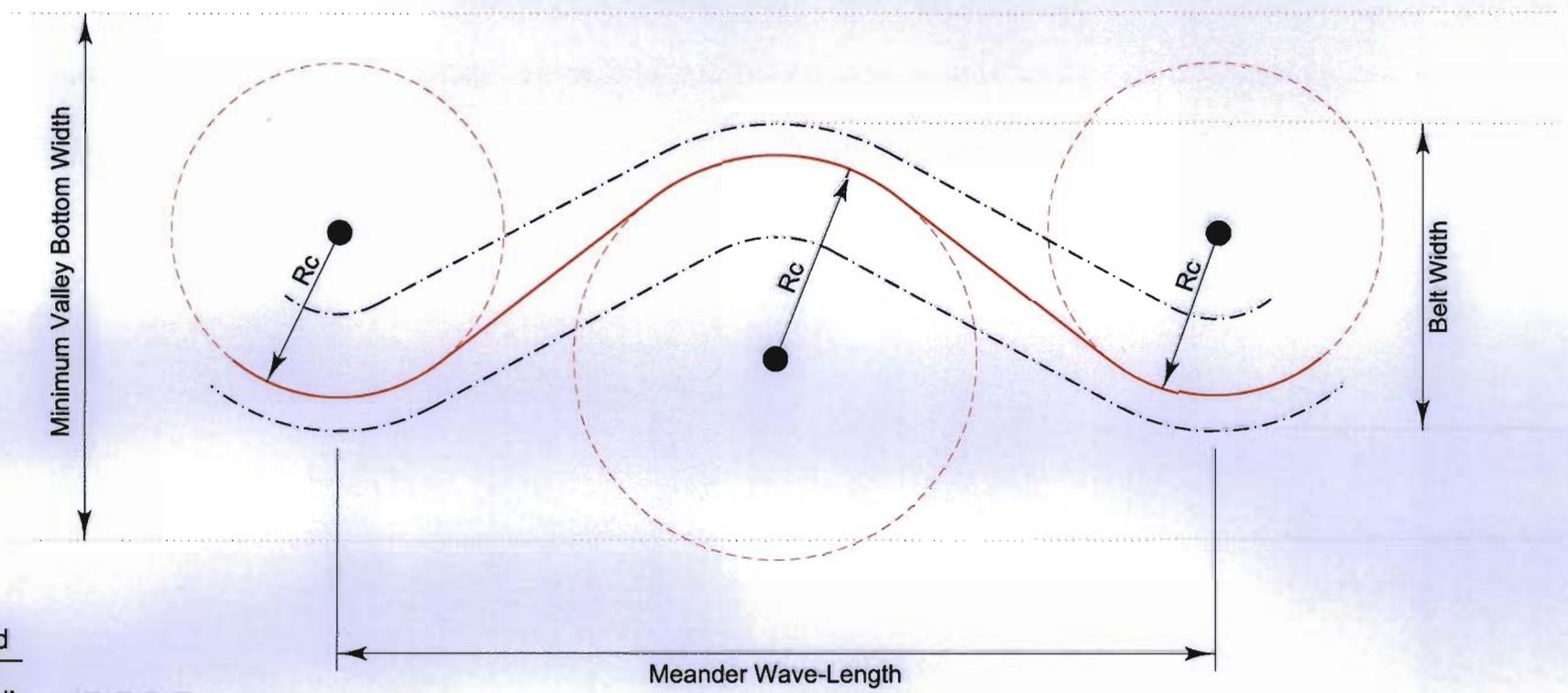


**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Eph-26 DS**  
**Rosgen Stream Type "B"**  
**Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "B" Stream Eph-29 DS



**Legend**

- Bankfull     - - - - -
- Thalweg     —————

- Bankfull Width=7.0'
- Radius of Curvature (Rc) Ranges from 17.5' to 21.0'
- Belt Width= 28' to 35'
- Meander Wavelength= NA
- Approximate Proposed Reach Length = 613'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 1.67% to 2.5%
- Proposed Valley Slope Ranges from 2.0% to 3.0%
- Minimum Valley Bottom Width = 45'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

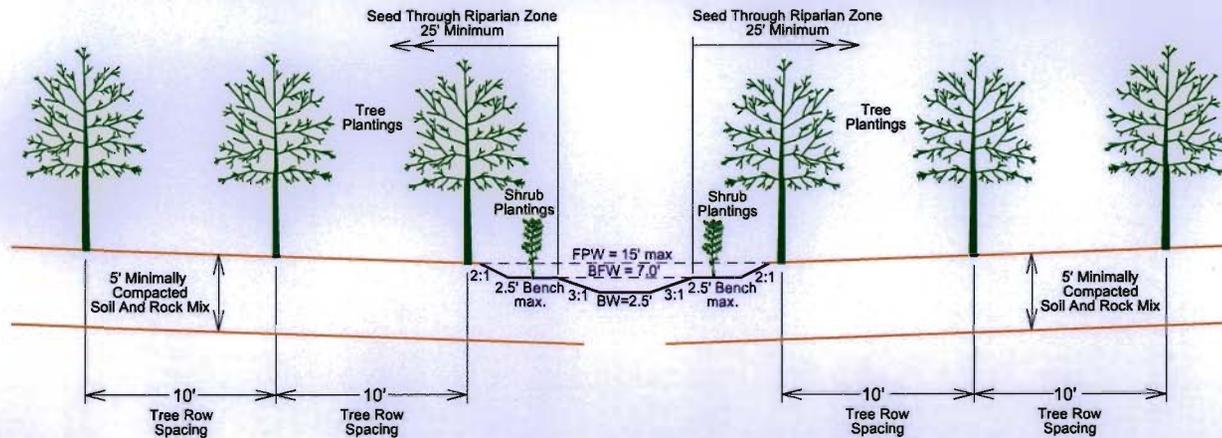
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

Note

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

Proposed Channel Dimensions

- Bankfull Width (BFW) = 7.0'
- Bankfull Max. Depth = 0.76'
- Bankfull Area = 3.59 SF
- Bankfull Mean Depth = 0.51'
- Flood-Prone Width (FPW) = 15' max
- W/D Ratio = 13.77
- Entrenchment Ratio = 2.13 (1.4-2.2)
- Bench Width = 2.5' max

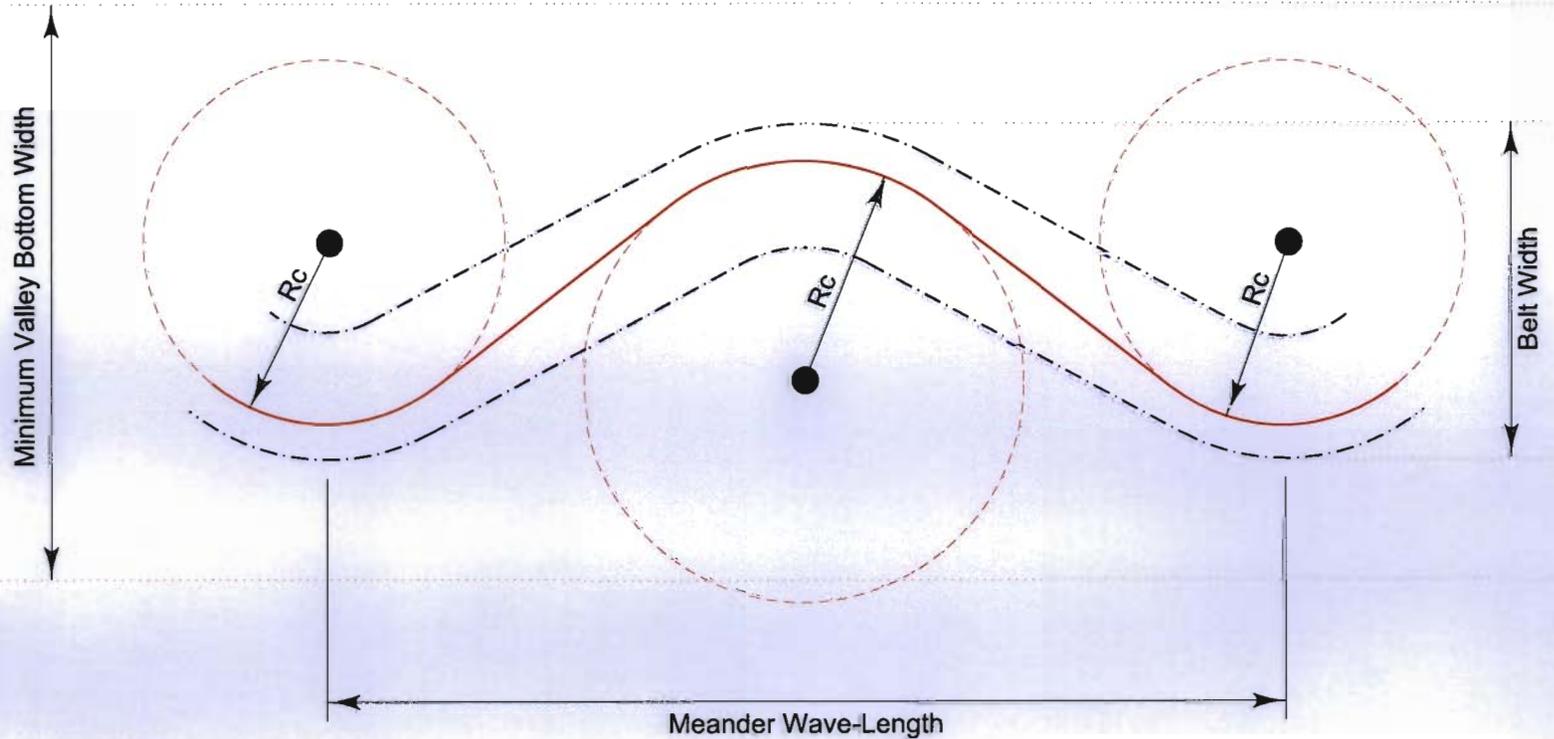


Note

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Eph-29 DS**  
**Rosgen Stream Type "B"**  
**Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "B" Stream Eph-40A



**Legend**

- Bankfull     - - - - -
- Thalweg     —————

- Bankfull Width=7.0'
- Radius of Curvature (Rc) Ranges from 17.5' to 21.0'
- Belt Width= 28' to 35'
- Meander Wavelength= NA
- Approximate Proposed Reach Length = 885'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 2.1% to 3.3%
- Proposed Valley Slope Ranges from 2.5% to 4.0%
- Minimum Valley Bottom Width = 45'

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

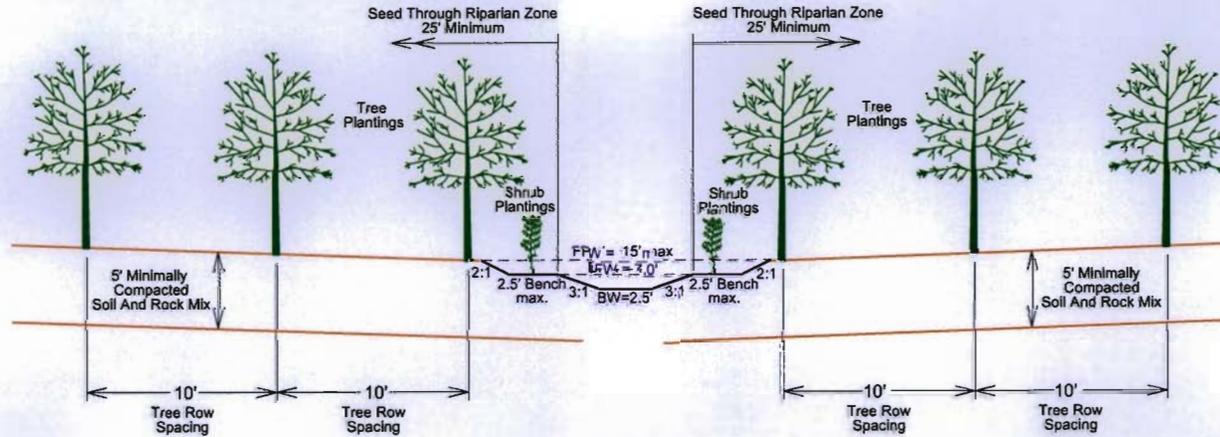
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

Note

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

Proposed Channel Dimensions

- Bankfull Width (BFW) = 7.0'
- Bankfull Max. Depth = 0.76'
- Bankfull Area = 3.59 SF
- Bankfull Mean Depth = 0.51'
- Flood-Prone Width (FPW) = 15' max
- W/D Ratio = 13.77
- Entrenchment Ratio = 2.13 (1.4-2.2)
- Bench Width = 2.5' max

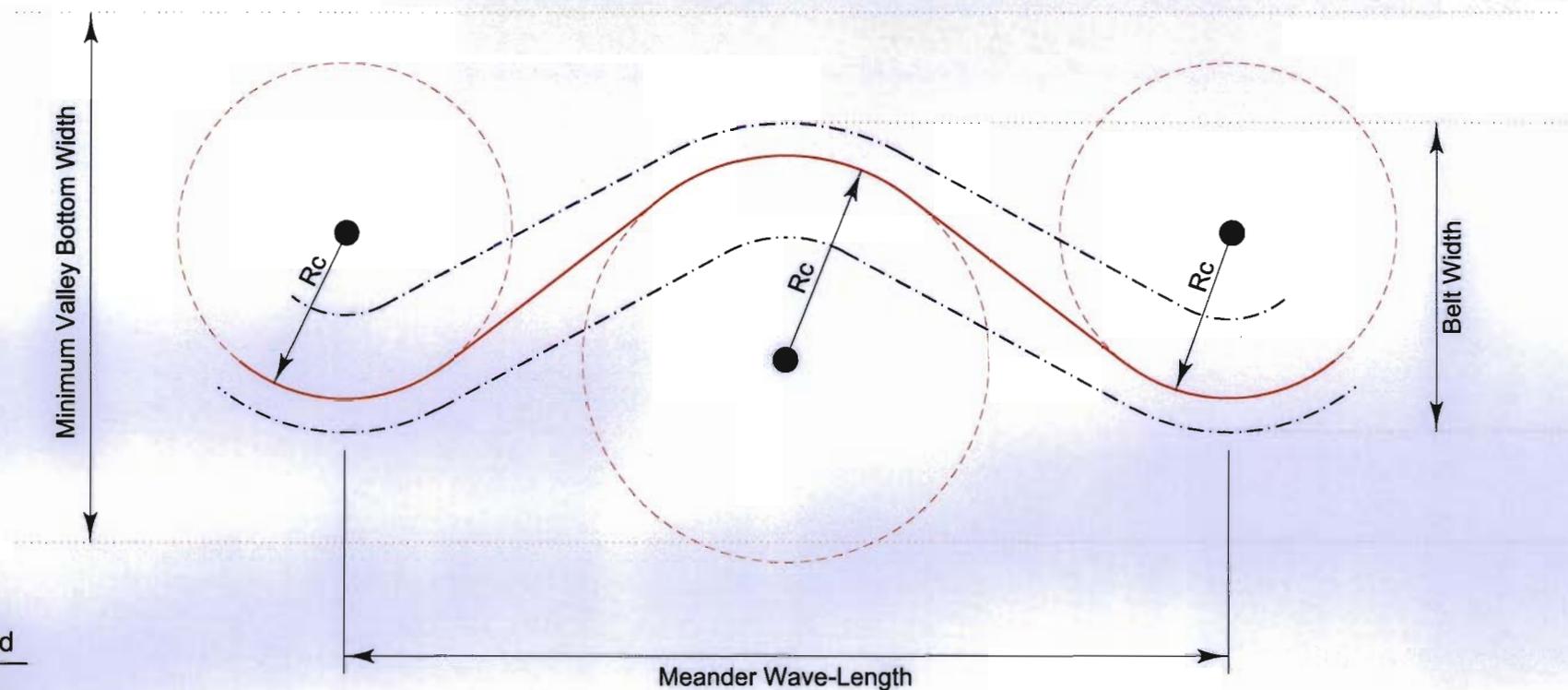


Note

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

Typical Riffle Cross Section Stream Eph-40A  
Rosgen Stream Type "B"  
Scale: 1"=10'

## Typical Meander Pattern for Rosgen Stream Type "B" Stream Eph-44



**Legend**

- Bankfull
- Thalweg

- Bankfull Width=7.0'
- Radius of Curvature (Rc) Ranges from 17.5' to 21.0'
- Belt Width= 28' to 35'
- Meander Wavelength= NA
- Approximate Proposed Reach Length = 1922'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 2.1% to 3.3%
- Proposed Valley Slope Ranges from 2.5% to 4.0%
- Minimum Valley Bottom Width = 45'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

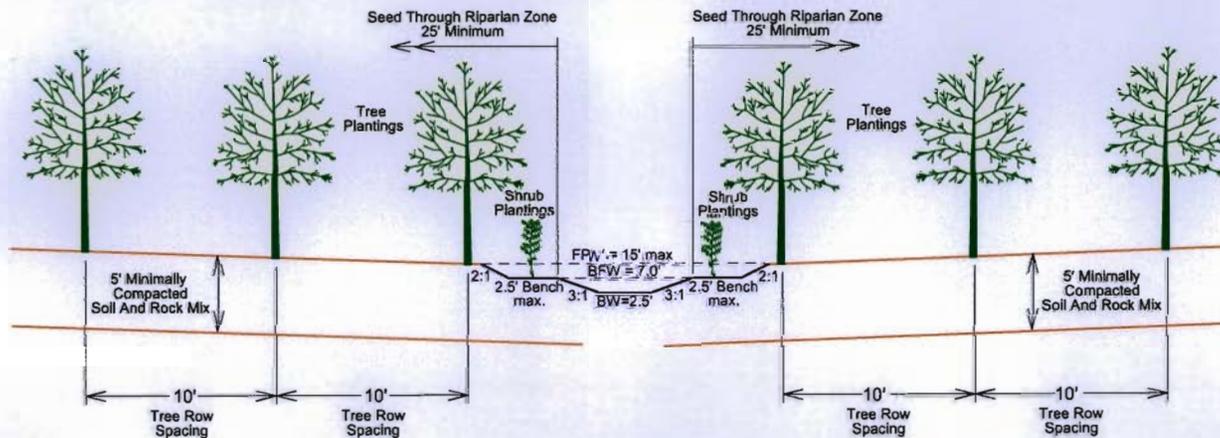
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 7.0'
- Bankfull Max. Depth = 0.76'
- Bankfull Area = 3.59 SF
- Bankfull Mean Depth = 0.51'
- Flood-Prone Width (FPW) = 15' max
- W/D Ratio = 13.77
- Entrenchment Ratio = 2.13 (1.4-2.2)
- Bench Width = 2.5' max

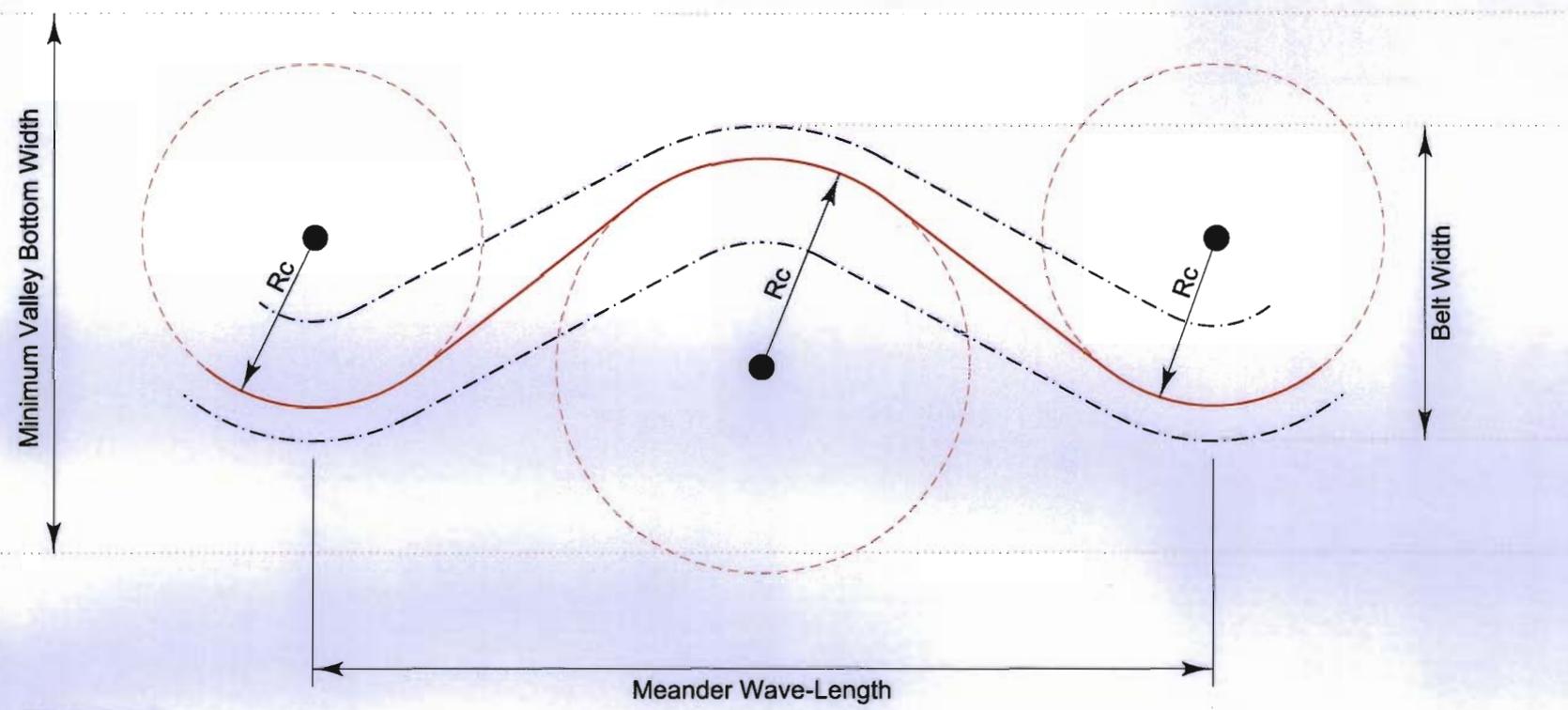


**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Eph-44**  
**Rosgen Stream Type "B"**  
**Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "B" Stream Eph-49



**Legend**

- Bankfull
- Thalweg

- Bankfull Width=7.8'
- Radius of Curvature (Rc) Ranges from 19.5' to 23.5'
- Belt Width= 31' to 39'
- Meander Wavelength= NA
- Approximate Proposed Reach Length = 1579'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 0.83% to 1.67%
- Proposed Valley Slope Ranges from 1.0% to 2.0%
- Minimum Valley Bottom Width = 50'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

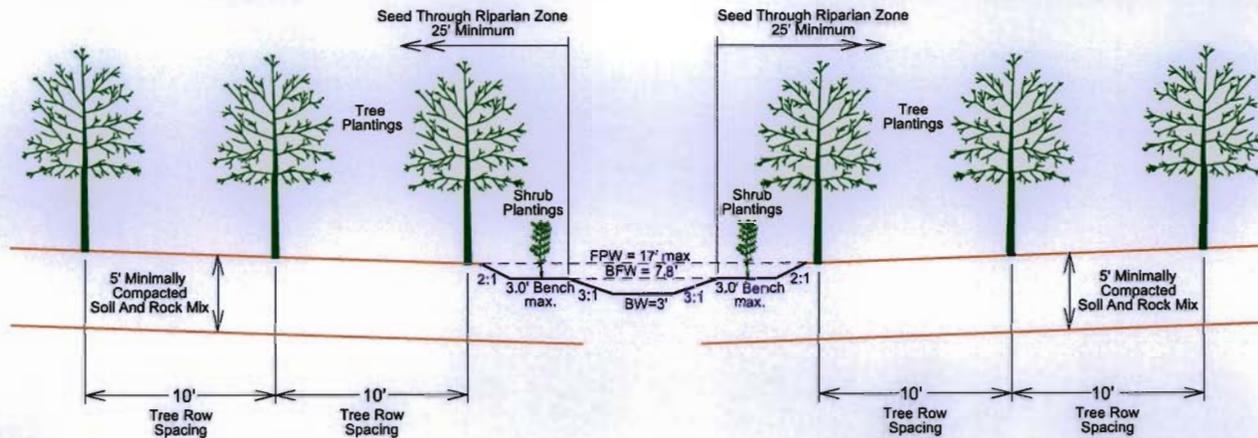
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 7.8'
- Bankfull Max. Depth = 0.8'
- Bankfull Area = 4.28 SF
- Bankfull Mean Depth = 0.55'
- Flood-Prone Width (FPW) = 17' max
- W/D Ratio = 14.1
- Entrenchment Ratio = 2.18 (1.4-2.2)
- Bench Width = 3.0' max

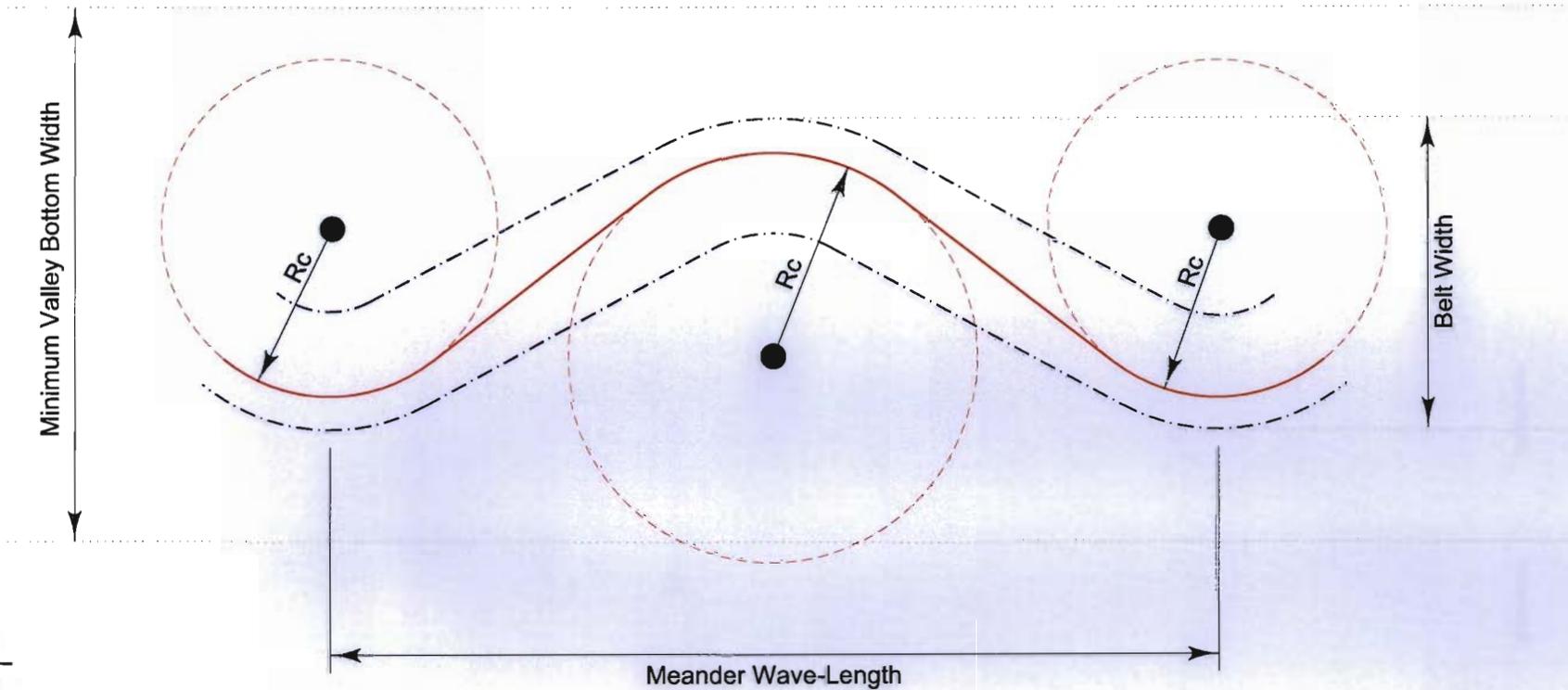


**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Eph-49**  
**Rosgen Stream Type "B"**  
**Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "E" Stream Eph-55



**Legend**

Bankfull    - - - - -  
Thalweg     —————

- Bankfull Width=7.4'
- Radius of Curvature (Rc) Ranges from 18.5' to 22.5'
- Belt Width= 74' to 133'
- Meander Wave-Length Ranges from 74' to 104'
- Approximate Proposed Reach Length = 528'
- Proposed Sinuosity is Approximately 1.5 or greater
- Proposed Stream Gradient Ranges from 0.67% to 1.33%
- Proposed Valley Slope Ranges from 1.0% to 2.0%
- Minimum Valley Bottom Width = 145'

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

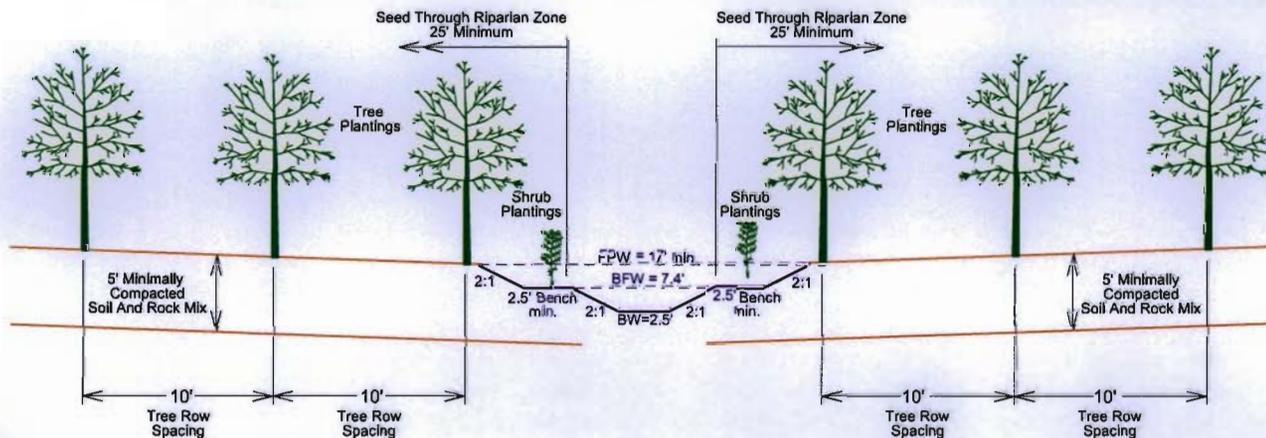
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

Note

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

Proposed Channel Dimensions

- Bankfull Width (BFW) = 7.4'
- Bankfull Max. Depth = 1.22'
- Bankfull Area = 6.0 SF
- Bankfull Mean Depth = 0.82'
- Flood-Prone Width (FPW) = 17' min
- W/D Ratio = 9.03
- Entrenchment Ratio = 2.3
- Bench Width = 2.5' min

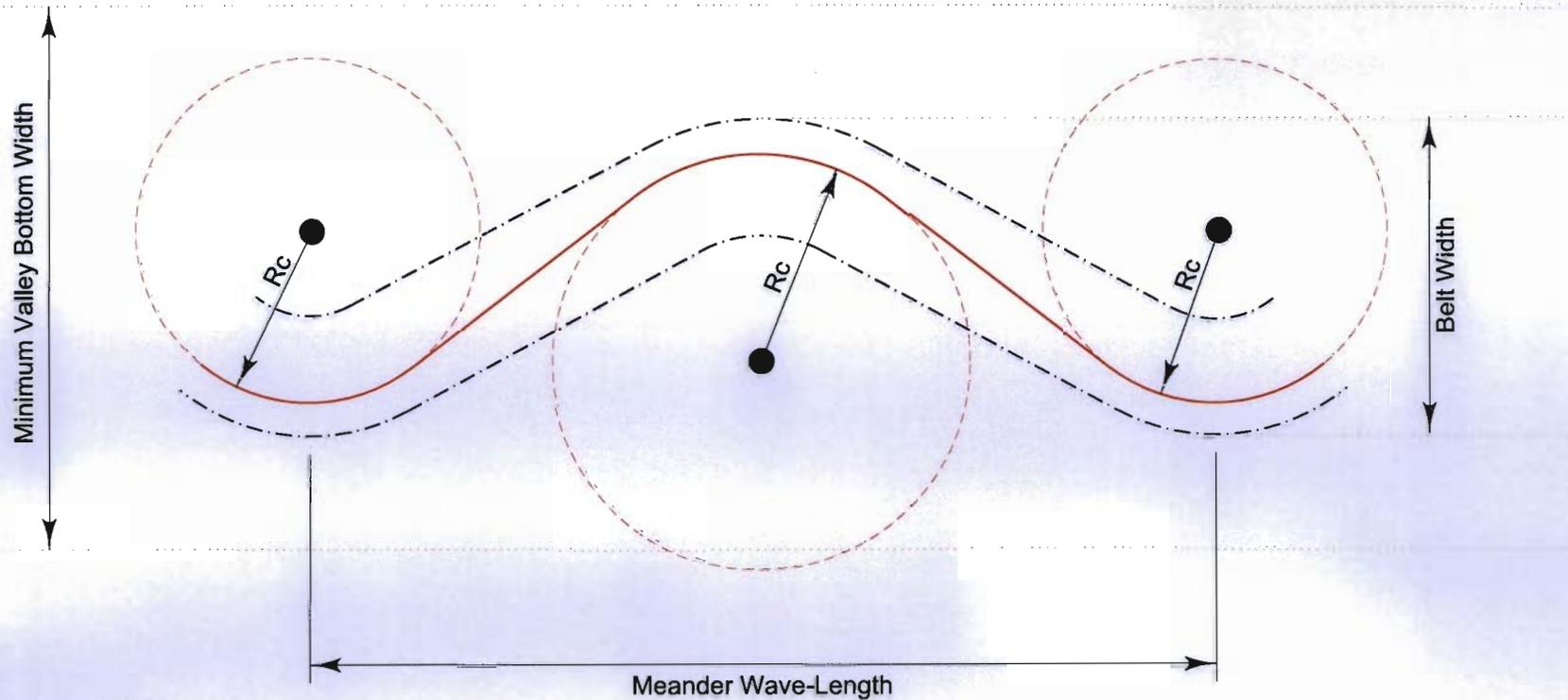


Note

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

Typical Riffle Cross Section Stream Eph-55  
Rosgen Stream Type "E"  
Scale: 1"=10'

## Typical Meander Pattern for Rosgen Stream Type "B" Stream Eph-56



**Legend**

- Bankfull    - - - - -
- Thalweg    —————

- Bankfull Width=7.0'
- Radius of Curvature (Rc) Ranges from 17.5' to 21.0'
- Belt Width= 28' to 35'
- Meander Wavelength= NA
- Approximate Proposed Reach Length = 1898'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 1.67% to 2.92%
- Proposed Valley Slope Ranges from 2.0% to 3.5%
- Minimum Valley Bottom Width = 45'

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

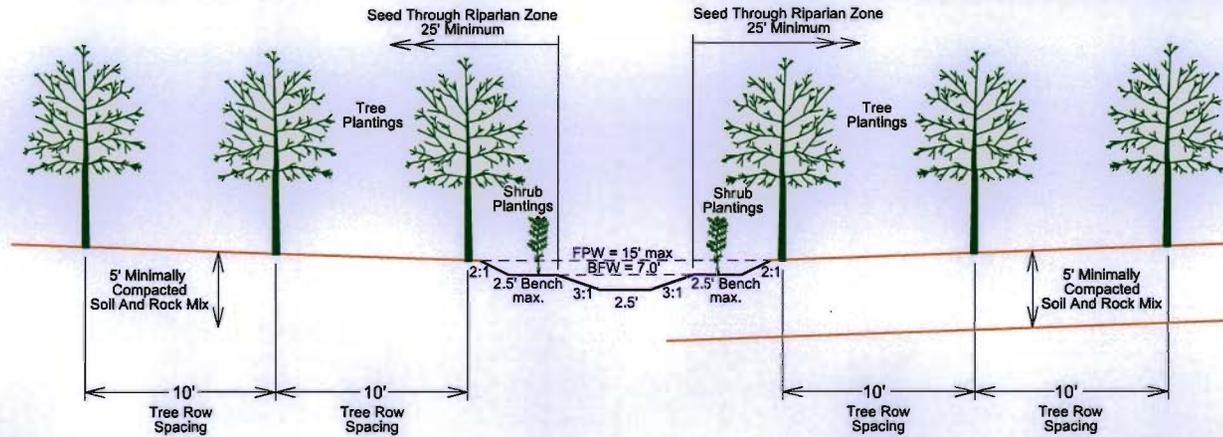
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

Note

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

Proposed Channel Dimensions

- Bankfull Width (BFW) = 7.0'
- Bankfull Max. Depth = 0.76'
- Bankfull Area = 3.59 SF
- Bankfull Mean Depth = 0.51'
- Flood-Prone Width (FPW) = 15' max
- W/D Ratio = 13.77
- Entrenchment Ratio = 2.13 (1.4-2.2)
- Bench Width = 2.5' max

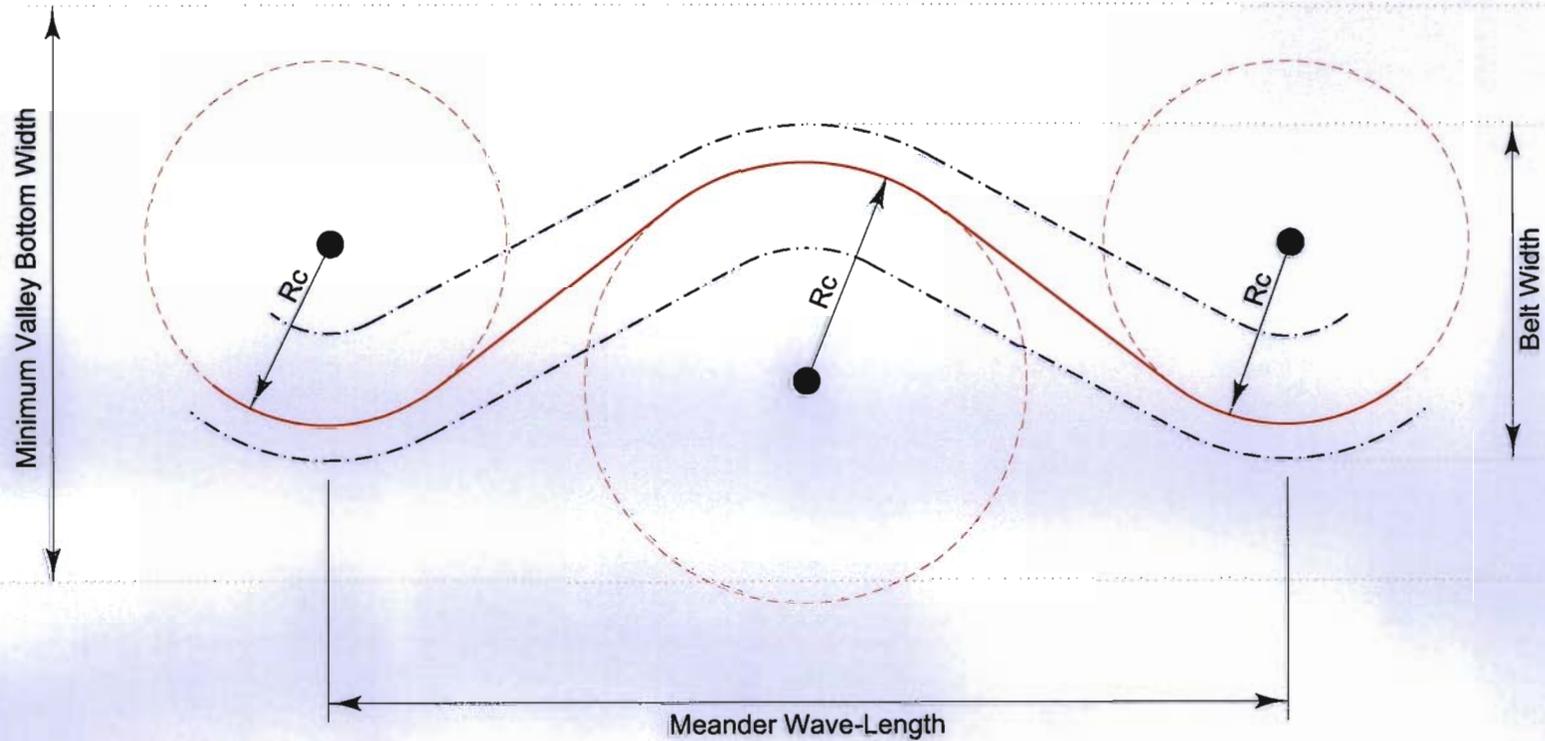


Note

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

Typical Riffle Cross Section Stream Eph-56  
Rosgen Stream Type "B"  
Scale: 1"=10'

## Typical Meander Pattern for Rosgen Stream Type "B" Stream Eph-60



**Legend**

- Bankfull
- Thalweg

- Bankfull Width=7.8'
- Radius of Curvature (Rc) Ranges from 19.5' to 23.5'
- Belt Width= 31' to 39'
- Meander Wavelength= NA
- Approximate Proposed Reach Length = 2144'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 0.83% to 1.67%
- Proposed Valley Slope Ranges from 1.0% to 2.0%
- Minimum Valley Bottom Width = 50'

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

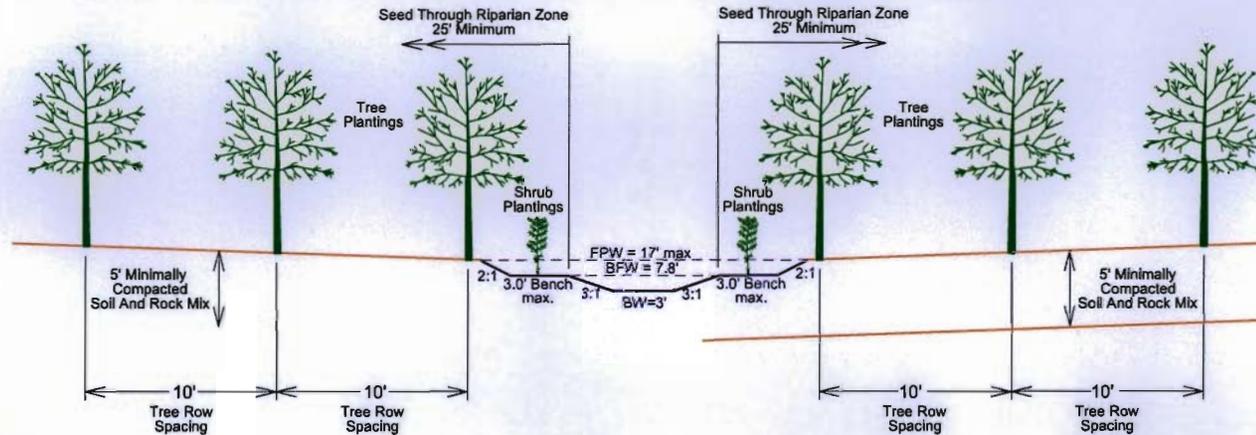
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

Note

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

Proposed Channel Dimensions

- Bankfull Width (BFW) = 7.8'
- Bankfull Max. Depth = 0.8'
- Bankfull Area = 4.28 SF
- Bankfull Mean Depth = 0.55'
- Flood-Prone Width (FPW) = 17' max
- W/D Ratio = 14.1
- Entrenchment Ratio = 2.18 (1.4-2.2)
- Bench Width = 3.0' max

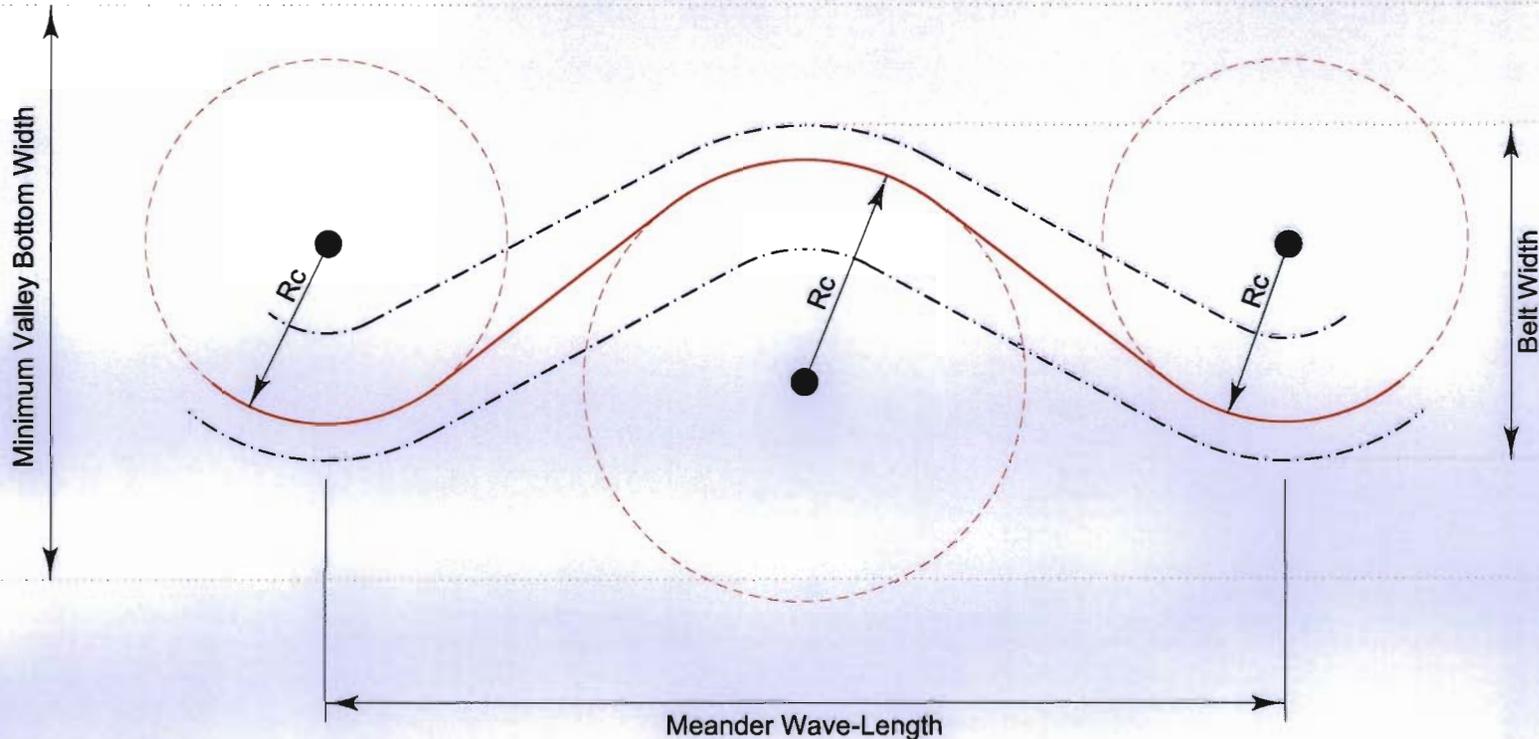


Note

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

Typical Riffle Cross Section Stream Eph-60  
Rosgen Stream Type "B"  
Scale: 1"=10'

## Typical Meander Pattern for Rosgen Stream Type "C" Stream Eph-64



**Legend**

- Bankfull    - - - - -
- Thalweg    —————

- Bankfull Width=11.77'
- Radius of Curvature (Rc) Ranges from 29' to 35.5'
- Belt Width Ranges from 94 to 129'
- Meander Wave-Length Ranges from 106' to 165'
- Approximate Proposed Reach Length = 3150'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 0.42% to 1.25%
- Proposed Valley Slope Ranges from 0.5% to 1.5%
- Minimum Valley Bottom Width = 140'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

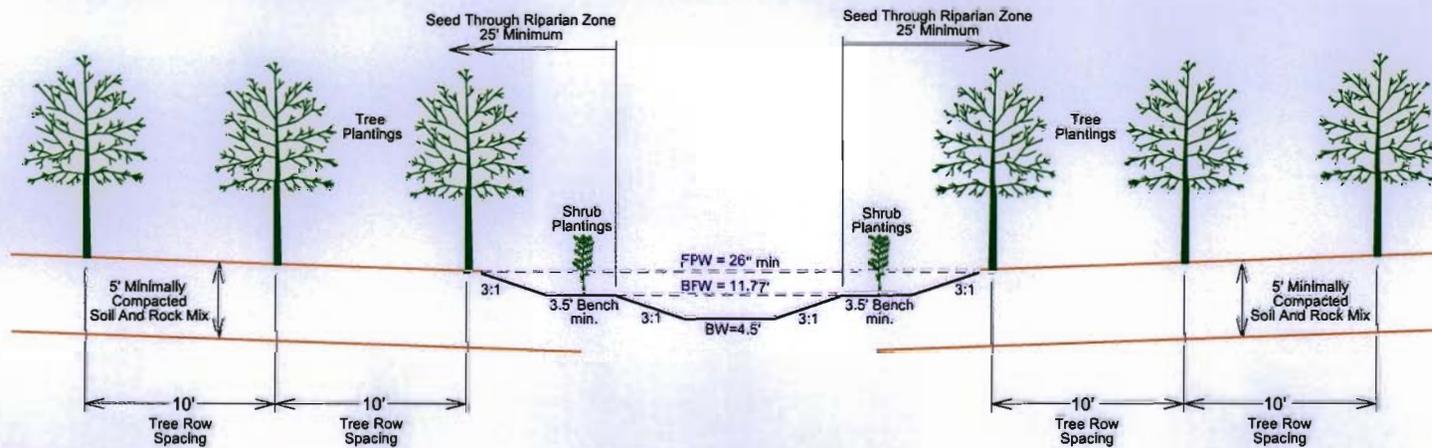
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 11.77'
- Bankfull Max. Depth = 1.21'
- Bankfull Area = 9.86 sq. ft.
- Bankfull Mean Depth = 0.84'
- Flood-Prone Width (FPW) = 26' Min
- W/D Ratio = 14.05
- Entrenchment Ratio = 2.21 Min
- Bench Width = 3.5' Min



**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Eph-64  
Rosgen Stream Type "C"  
Scale: 1"=10'**

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

In bend sections, the outside bend may be stabilized with a combination of Erosion Control Blanket Type 1 (E.C.B. 1) and shrub plantings. E.C.B. 1 shall be anchored in at residual pool elevation and extend to Flood Prone Elevation. Beyond this elevation E.C.B. 2 may be placed throughout the riparian zone. In bend sections where structures (J-Hooks, Cross Vanes, etc.) are specified, E.C.B. 1 installation shall begin just above the structure location.

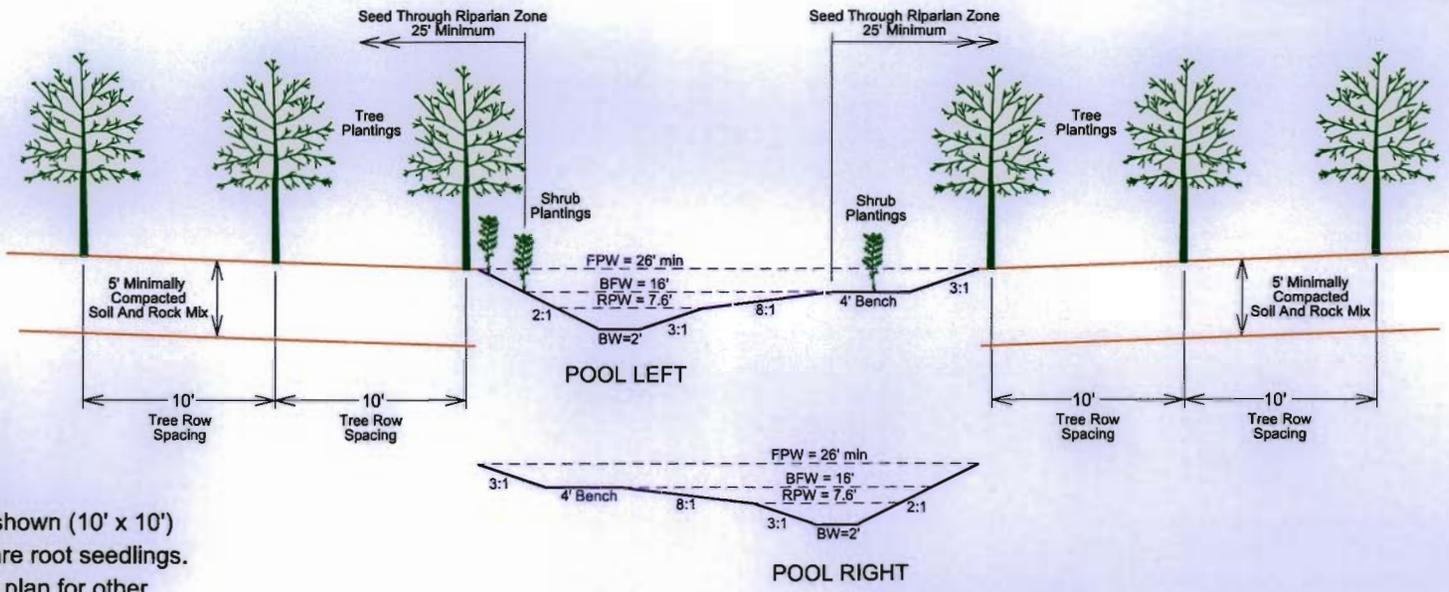
In bend sections, E.C.B. 1 may be placed along the inside bend (Point Bar). Blanket installation shall begin at the bottom of the point bar slope (just above Residual Pool Elevation) and extend to Flood Prone Elevation. E.C.B. 2 may be placed beyond this location as needed.

Proposed Channel Dimensions

- Bankfull Width (BFW) = 16.0'
- Bankfull Max. Depth = 1.96'
- Bankfull Area = 15.3 sq. ft.
- Bankfull Mean Depth = 0.96'
- Flood-Prone Width (FPW) = 26' Min
- W/D Ratio = 16.73
- Residual Pool (RP) Max. Depth = 1.12'
- Residual Pool (RP) Width = 7.6'

Note

- \* Durable rock may be used instead of ECB 1 along outside bends. The rock shall be placed at bottom of pool and extend to bankfull elevation. ECB 1 may be used above this elevation, rock size shall be a minimum of 1' diameter and shall be keyed into bank and bottom of channel.

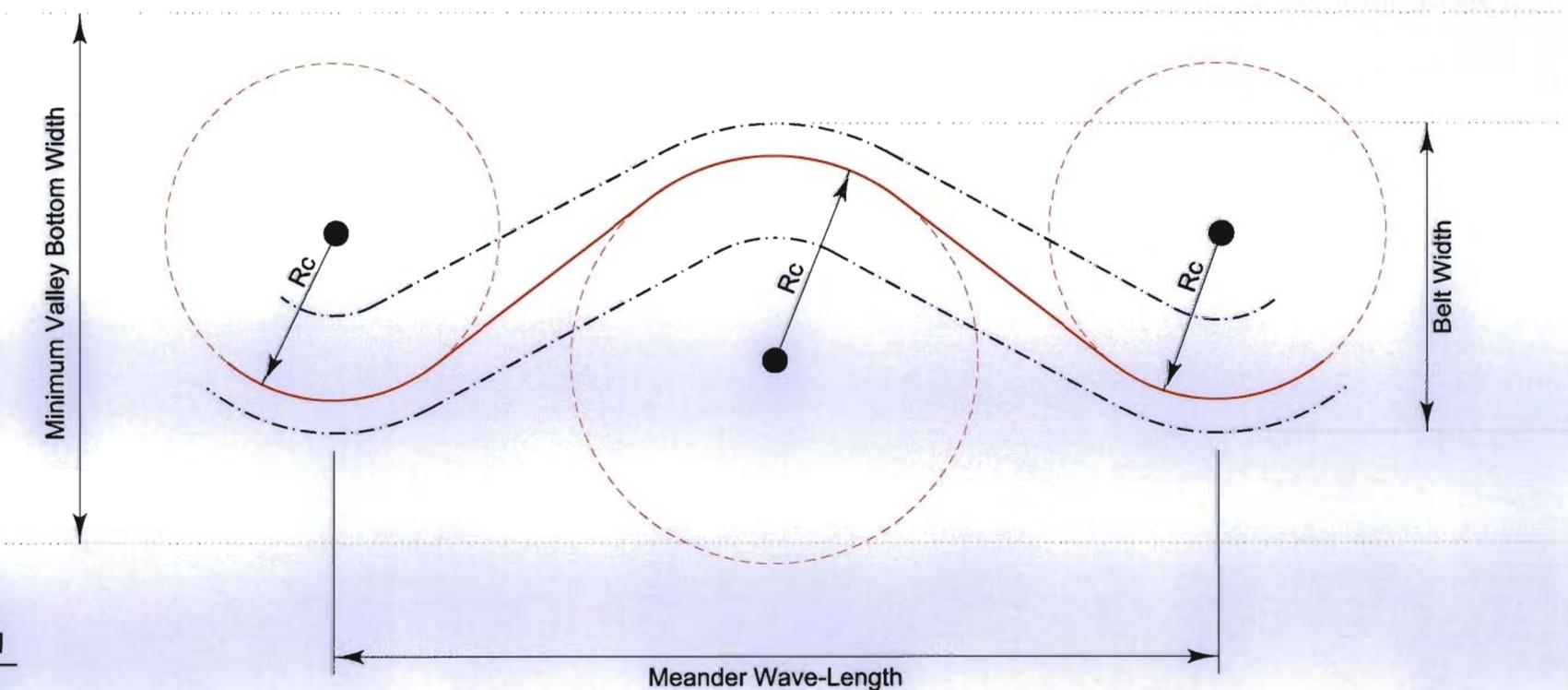


Note

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Pool Cross Section Stream Eph-64**  
**Rosgen Stream Type "C"**  
**Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "C" Stream Eph-64A



**Legend**

- Bankfull    - - - - -
- Thalweg    —————

- Bankfull Width=12.55'
- Radius of Curvature (Rc) Ranges from 31' to 38'
- Belt Width Ranges from 100 to 138'
- Meander Wave-Length Ranges from 113' to 176'
- Approximate Proposed Reach Length = 311'
- Proposed Sinuosity is Approximately 1.2 or greater
- Proposed Stream Gradient Ranges from 0.42% to 1.25%
- Proposed Valley Slope Ranges from 0.5% to 1.5%
- Minimum Valley Bottom Width = 150'

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

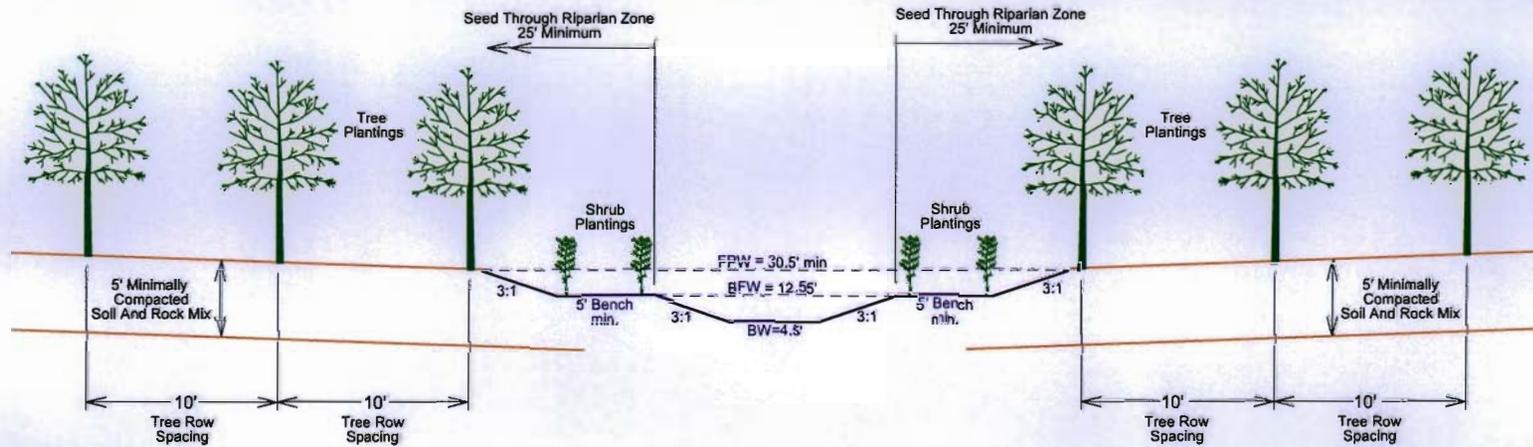
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

**Note**

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 12.55'
- Bankfull Max. Depth = 1.34'
- Bankfull Area = 11.44 sq. ft.
- Bankfull Mean Depth = 0.91'
- Flood-Prone Width (FPW) = 30.5' Min
- W/D Ratio = 13.77
- Entrenchment Ratio = 2.43 Min
- Bench Width = 5.0' Min



**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Riffle Cross Section Stream Eph-64A**  
**Rosgen Stream Type "C"**  
**Scale: 1"=10'**

**EROSION CONTROL BLANKET (may be used as needed)**

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

In bend sections, outside bend may be stabilized with a combination of Erosion Control Blanket Type 1 (E.C.B. 1) and shrub plantings. E.C.B. 1 shall be anchored in at residual pool elevation and extend to Flood Prone Elevation. Beyond this elevation E.C.B. 2 may be placed throughout the riparian zone. In bend sections where structures (J-Hooks, Cross Vanes, etc.) are specified, E.C.B. 1 installation shall begin just above the structure location.

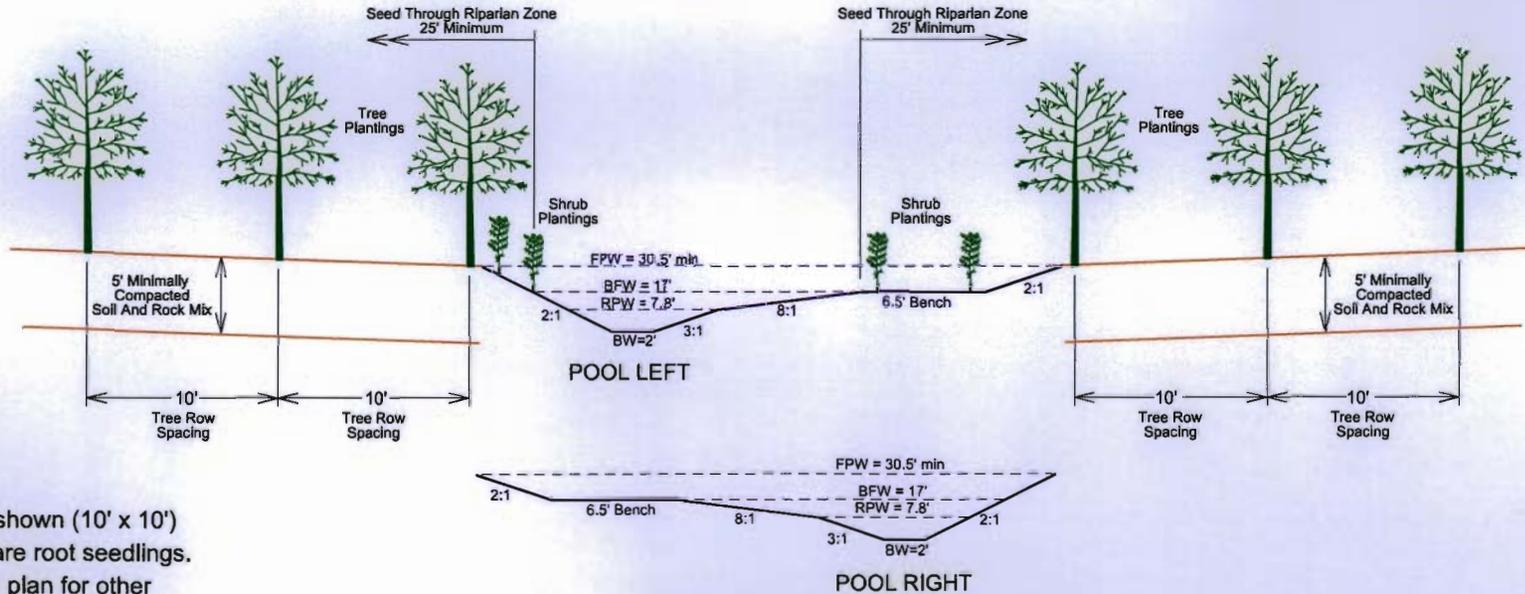
In bend sections, E.C.B. 1 may be placed along the inside bend (Point Bar). Blanket installation shall begin at the bottom of the point bar slope (just above Residual Pool Elevation) and extend to Flood Prone Elevation. E.C.B. 2 may be placed beyond this location as needed.

**Proposed Channel Dimensions**

- Bankfull Width (BFW) = 17.0'
- Bankfull Max. Depth = 2.08'
- Bankfull Area = 17.1 sq. ft.
- Bankfull Mean Depth = 1.01'
- Flood-Prone Width (FPW) = 30.5' Min
- W/D Ratio = 16.91
- Residual Pool (RP) Max. Depth = 1.16'
- Residual Pool (RP) Width = 7.8'

**Note**

- \* Durable rock may be used instead of ECB 1 along outside bends. The rock shall be placed at bottom of pool and extend to bankfull elevation. ECB 1 may be used above this elevation, rock size shall be a minimum of 1' diameter and shall be keyed into bank and bottom of channel.

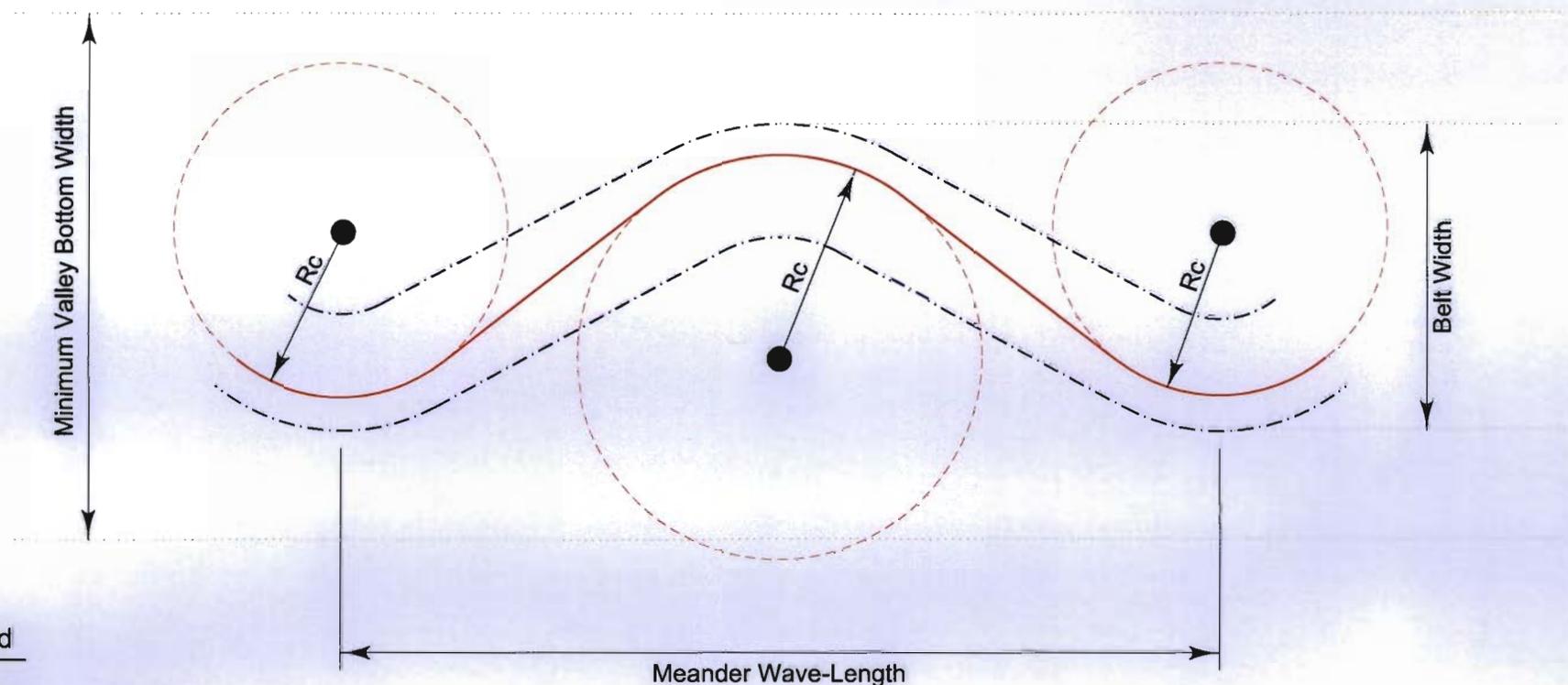


**Note**

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

**Typical Pool Cross Section Stream Eph-64A  
Rosgen Stream Type "C"  
Scale: 1"=10'**

## Typical Meander Pattern for Rosgen Stream Type "E" Stream Eph-A



**Legend**

- Bankfull    - - - - -
- Thalweg    —————

- Bankfull Width=8.5'
- Radius of Curvature (Rc) Ranges from 21' to 26'
- Belt Width= 85' to 153'
- Meander Wave-Length Ranges from 85' to 119'
- Approximate Proposed Reach Length = 2523'
- Proposed Sinuosity is Approximately 1.5 or greater
- Proposed Stream Gradient Ranges from 0.33% to 1.0%
- Proposed Valley Slope Ranges from 0.5% to 1.0%
- Minimum Valley Bottom Width = 165'

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

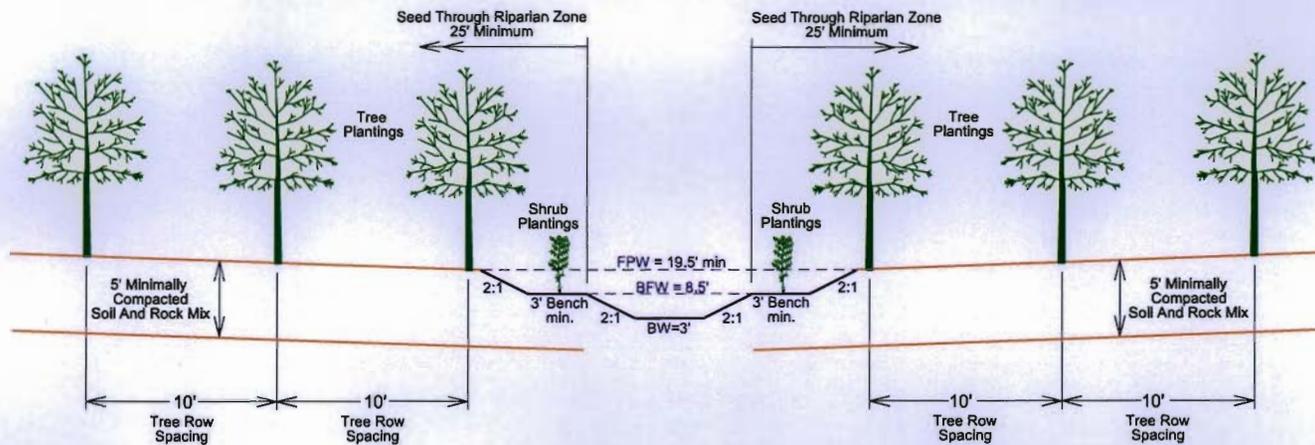
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

Note

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

Proposed Channel Dimensions

- Bankfull Width (BFW) = 8.5'
- Bankfull Max. Depth = 1.26'
- Bankfull Area = 7.59 SF
- Bankfull Mean Depth = 0.89'
- Flood-Prone Width (FPW) = 19.5' min
- W/D Ratio = 8.54
- Entrenchment Ratio = 2.29
- Bench Width = 3.0' min

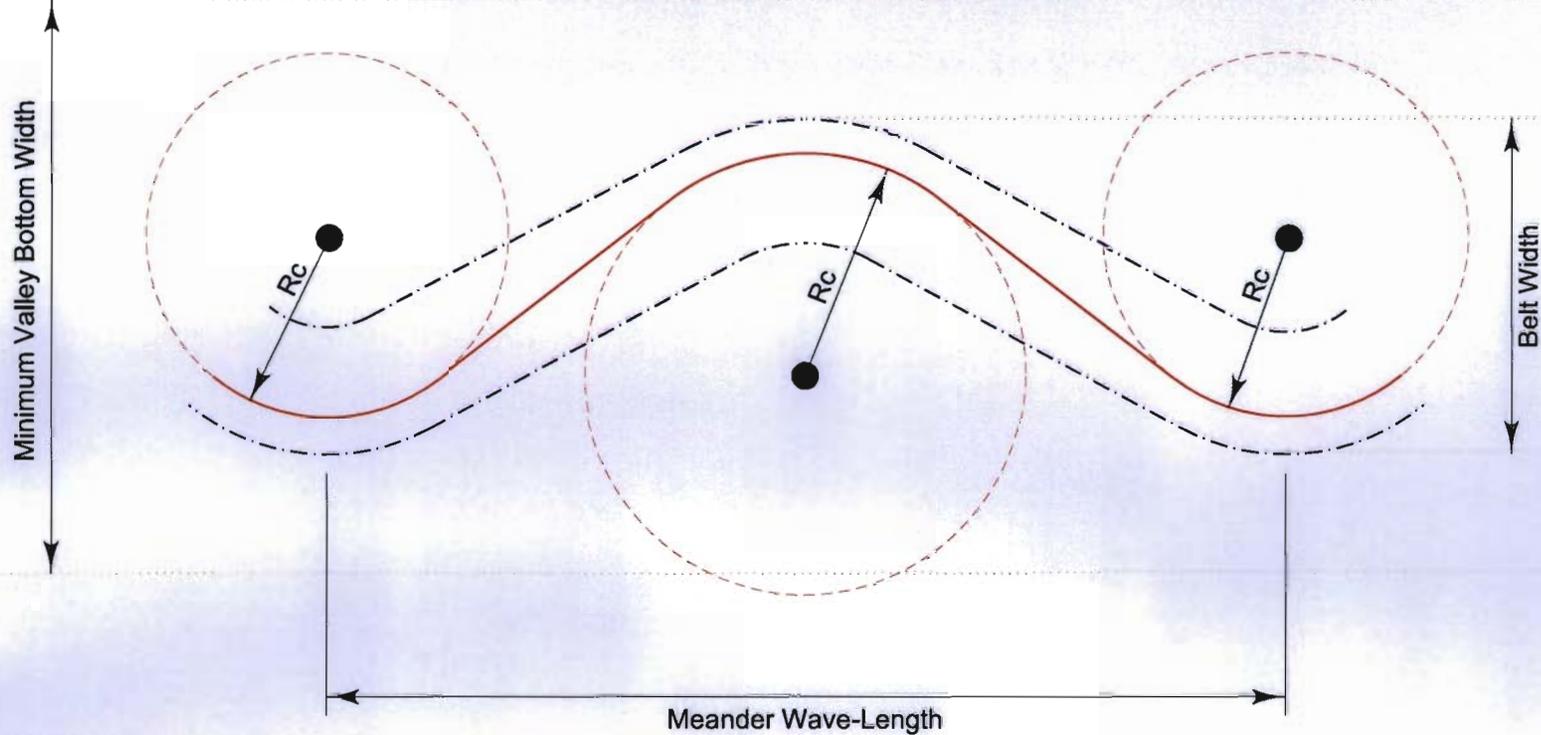


Note

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

Typical Riffle Cross Section Stream Eph-A  
Rosgen Stream Type "E"  
Scale: 1"=10'

## Typical Meander Pattern for Rosgen Stream Type "B" Stream E 2, 4, 7, 18, 24, 32, 41



**Legend**

- Bankfull    - - - - -
- Thalweg    —————

- Bankfull Width=4.3'
- Radius of Curvature (Rc) Ranges from 10.5' to 13'
- Belt Width Ranges from 17' to 21.5'
- Meander Wave-Length Ranges from 34' to 43'
- Approximate Proposed Reach Length = See Proposed Mitigation Length Table
- Proposed Stream Gradient Ranges from 2.0% to 3.0%
- Minimum Valley Bottom Width = 31'

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

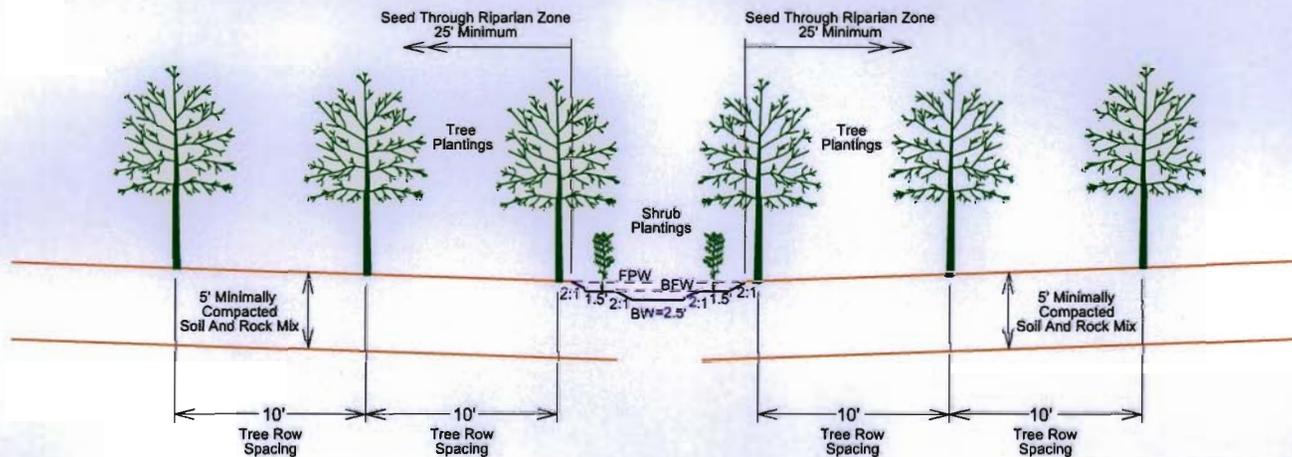
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

Note

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

Proposed Channel Dimensions

- Bankfull Width (BFW) = 4.3'
- Bankfull Max. Depth = 0.45'
- Bankfull Area = 1.53 SF
- Bankfull Mean Depth = 0.36'
- Flood-Prone Width (FPW) = 9.1' max
- W/D Ratio = 12.1
- Entrenchment Ratio = 2.1 (1.4-2.2)
- Bench Width = 1.5' max

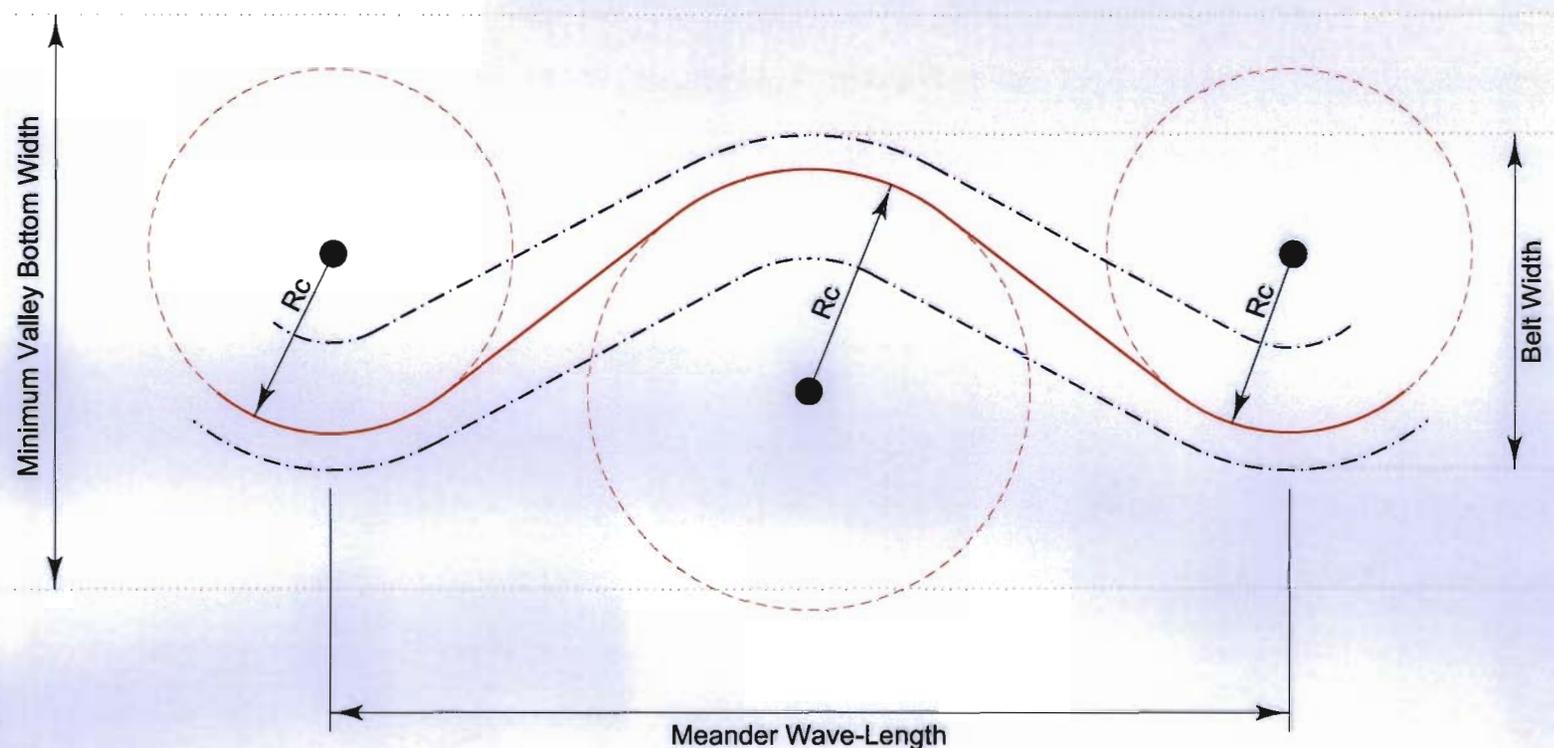


Note

- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

Typical Riffle Cross Section Stream E 2, 4, 7, 18, 24, 32, 41  
Rosgen Stream Type "B"  
Scale: 1"=10'

## Typical Meander Pattern for Rosgen Stream Type "B" Stream E 20, 26 US, 29 MS, 37, 40



**Legend**

- Bankfull    - - - - -
- Thalweg    —————

- Bankfull Width=5.3'
- Radius of Curvature (Rc) Ranges from 13' to 16'
- Belt Width Ranges from 21' to 27'
- Meander Wave-Length Ranges from 42' to 53'
- Approximate Proposed Reach Length = See Proposed Mitigation Length Table
- Proposed Stream Gradient Ranges from 2.0% to 3.0%
- Minimum Valley Bottom Width = 38'

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. 1 shall meet the following specifications:

- \* Netting: Biodegradable, natural fiber.
- \* Matrix Material: 100% coconut fiber.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 2.35 lbs / SQ. FT.
- \* Velocity: 10 feet per second.
- \* Longevity: up to 24 months.
- \* North American Green C125 BN or equivalent shall be used.

E.C.B. 2 shall meet the following specifications:

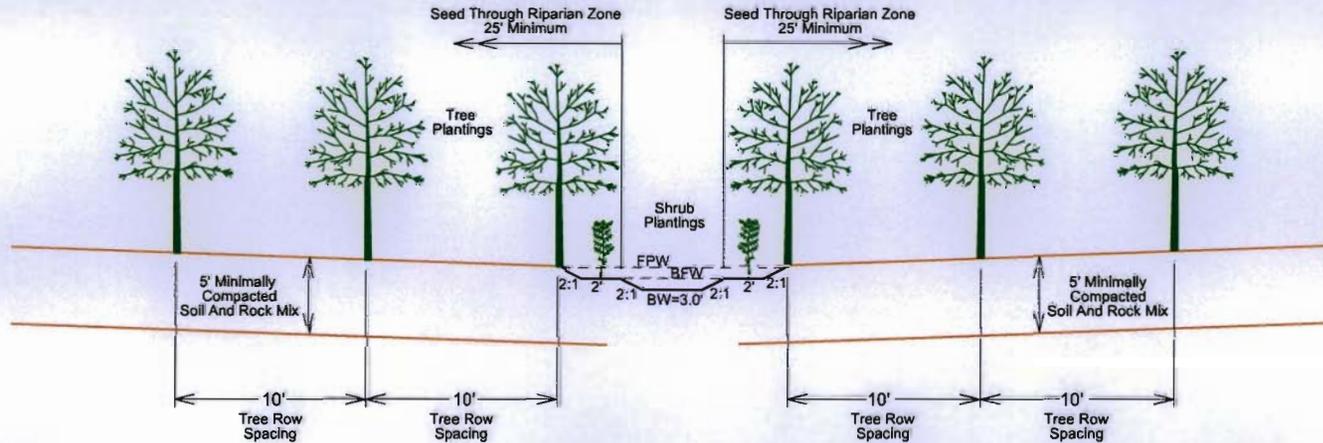
- \* Netting: 100% Biodegradable, natural fiber.
- \* Matrix Material: 100% straw.
- \* Stitching: Biodegradable thread on 1.5 inch centers.
- \* Shear stress: 1.855 lbs. / SQ. FT.
- \* Velocity: 6 feet per second.
- \* Longevity: up to 12 months.
- \* North American Green S150 BN or equivalent shall be used.

Note

- \* E.C.B. 1, E.C.B. 2, straw mulch or a combination of each will be used to prevent erosion and assist vegetation establishment along stream banks and throughout the riparian zone. Straw mulch will be crimped, tacked, or held in place with a biodegradable net, as needed.

Proposed Channel Dimensions

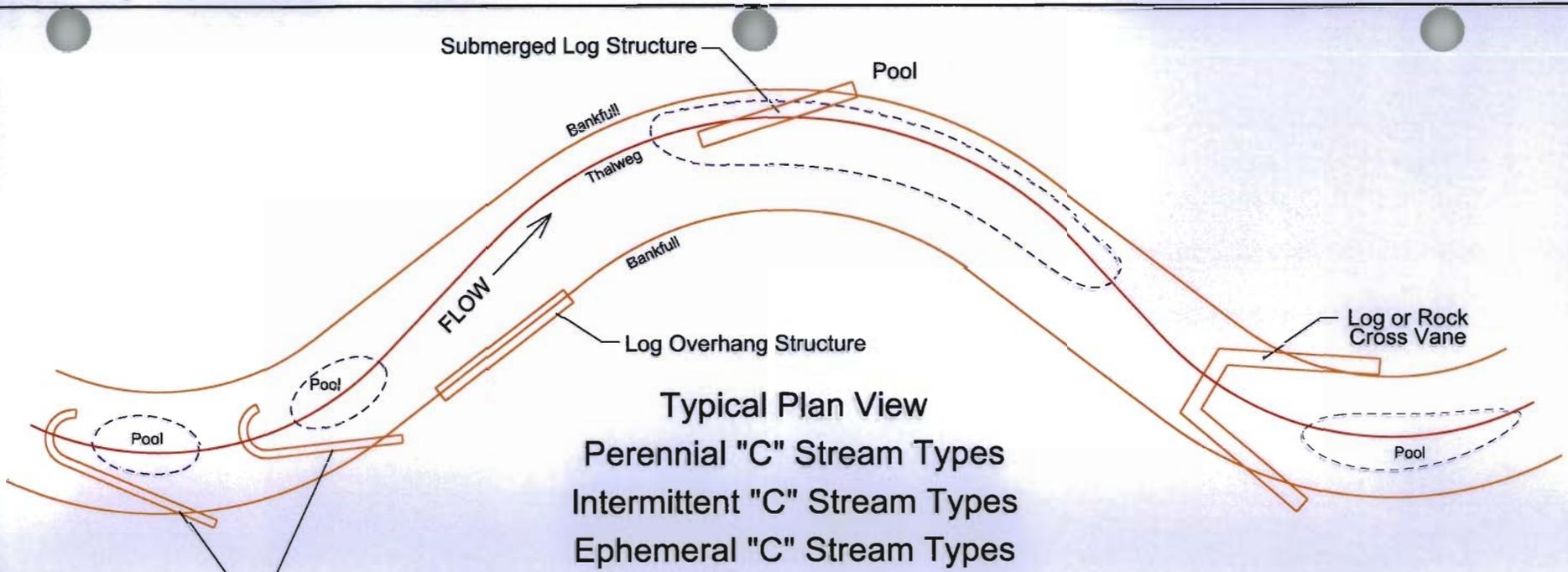
- Bankfull Width (BFW) = 5.3'
- Bankfull Max. Depth = 0.58'
- Bankfull Area = 2.39 SF
- Bankfull Mean Depth = 0.45'
- Flood-Prone Width (FPW) = 11.5' max
- W/D Ratio = 12
- Entrenchment Ratio = 2.19 (1.4-2.2)
- Bench Width = 2.0' max



Note

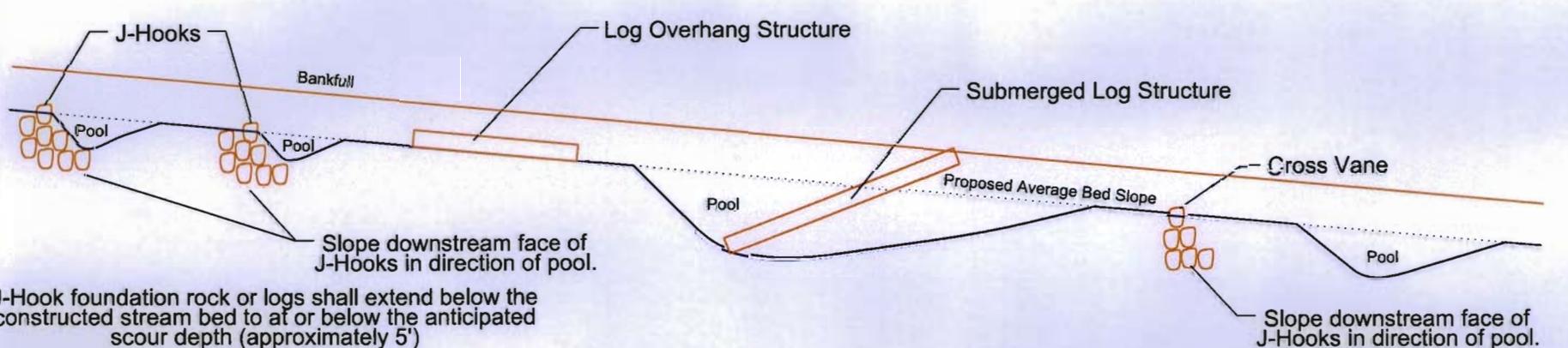
- \* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

Typical Riffle Cross Section Stream E 20, 26 US, 29 MS, 37, 40  
Rosgen Stream Type "B"  
Scale: 1"=10'



**Typical Plan View**  
Perennial "C" Stream Types  
Intermittent "C" Stream Types  
Ephemeral "C" Stream Types

J-Hooks will be made of logs, rock or a combination of rock and logs

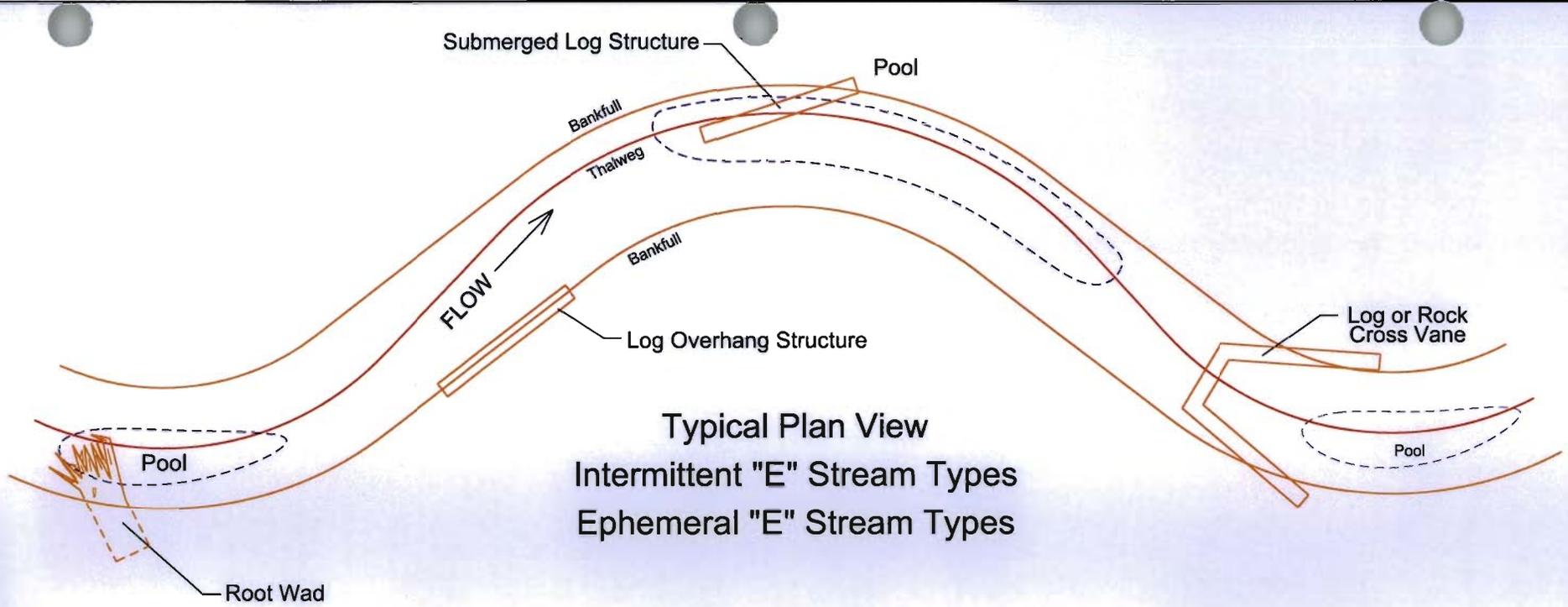


J-Hook foundation rock or logs shall extend below the constructed stream bed to at or below the anticipated scour depth (approximately 5')

Cross Vane foundation rock or logs shall extend below the constructed stream bed to at or below the anticipated scour depth (approximately 5')

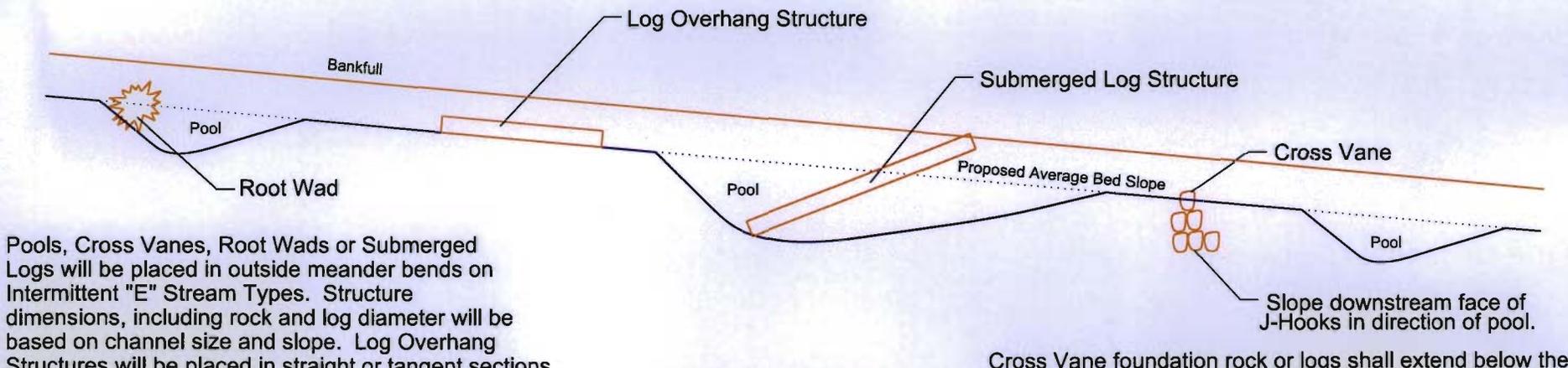
**Typical Profile View**  
Perennial "C" Stream Types  
Intermittent "C" Stream Types  
Ephemeral "C" Stream Types

Pools, J-Hooks, Cross Vanes or submerged logs will be placed in outside meander bends on Perennial, Intermittent and Ephemeral "C" Stream Types. Structure dimensions, including rock and log diameter will be based on channel size and slope. Log Overhang Structures will be placed in straight or tangent sections of the stream. The frequency and randomness of structure placement will be determined as the stream is constructed.



**Typical Plan View**  
Intermittent "E" Stream Types  
Ephemeral "E" Stream Types

Maximum pool depth to be 1' to 2'.

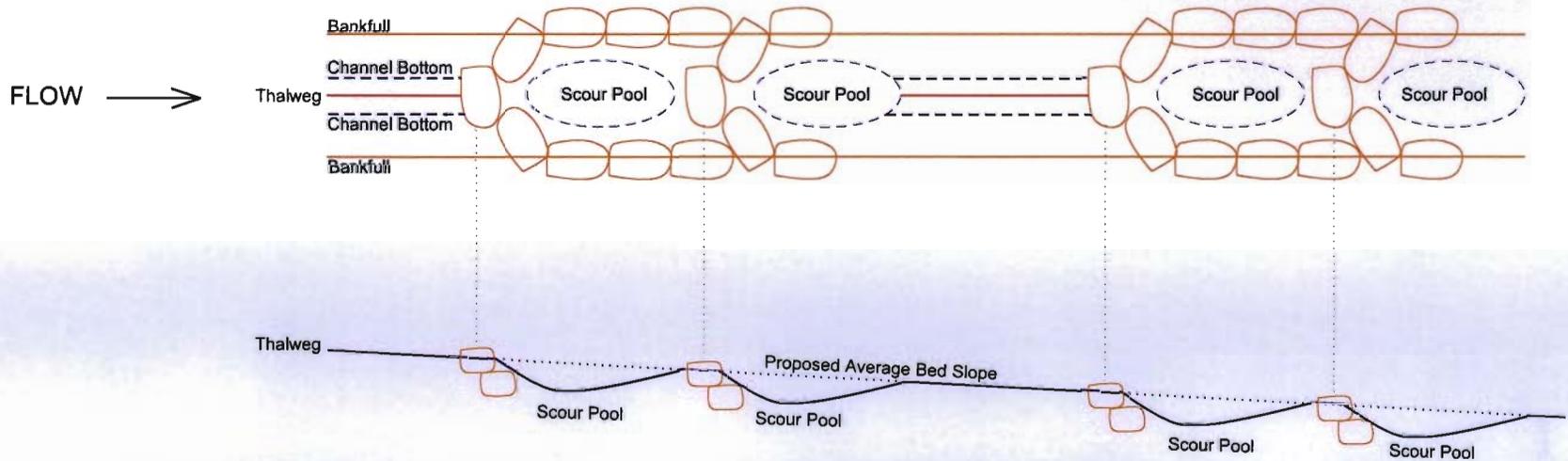


Cross Vane foundation rock or logs shall extend below the constructed stream bed to at or below the anticipated scour depth (approximately 5')

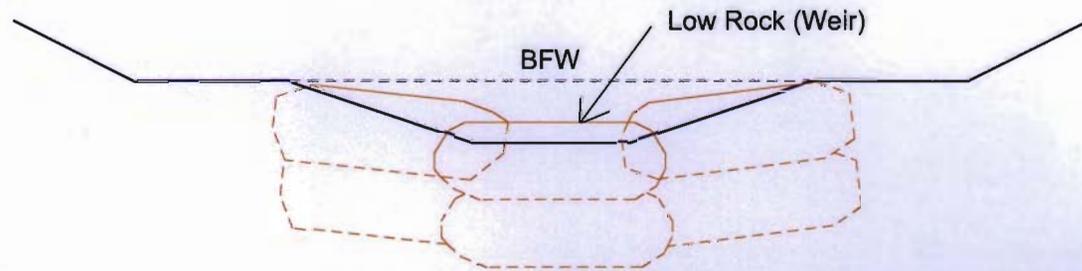
**Typical Profile View**  
Intermittent "E" Stream Types  
Ephemeral "E" Stream Types

Pools, Cross Vanes, Root Wads or Submerged Logs will be placed in outside meander bends on Intermittent "E" Stream Types. Structure dimensions, including rock and log diameter will be based on channel size and slope. Log Overhang Structures will be placed in straight or tangent sections of the stream. The frequency and randomness of structure placement will be determined as the stream is constructed.

## Typical Plan View Rock Step Structure Intermittent "B" Stream Types Alternate Ephemeral "B" Stream Types



## Typical Profile View Step-Pool Channel Intermittent "B" Stream Types Alternate Ephemeral "B" Stream Types



Typical Section of Rock Step Structure

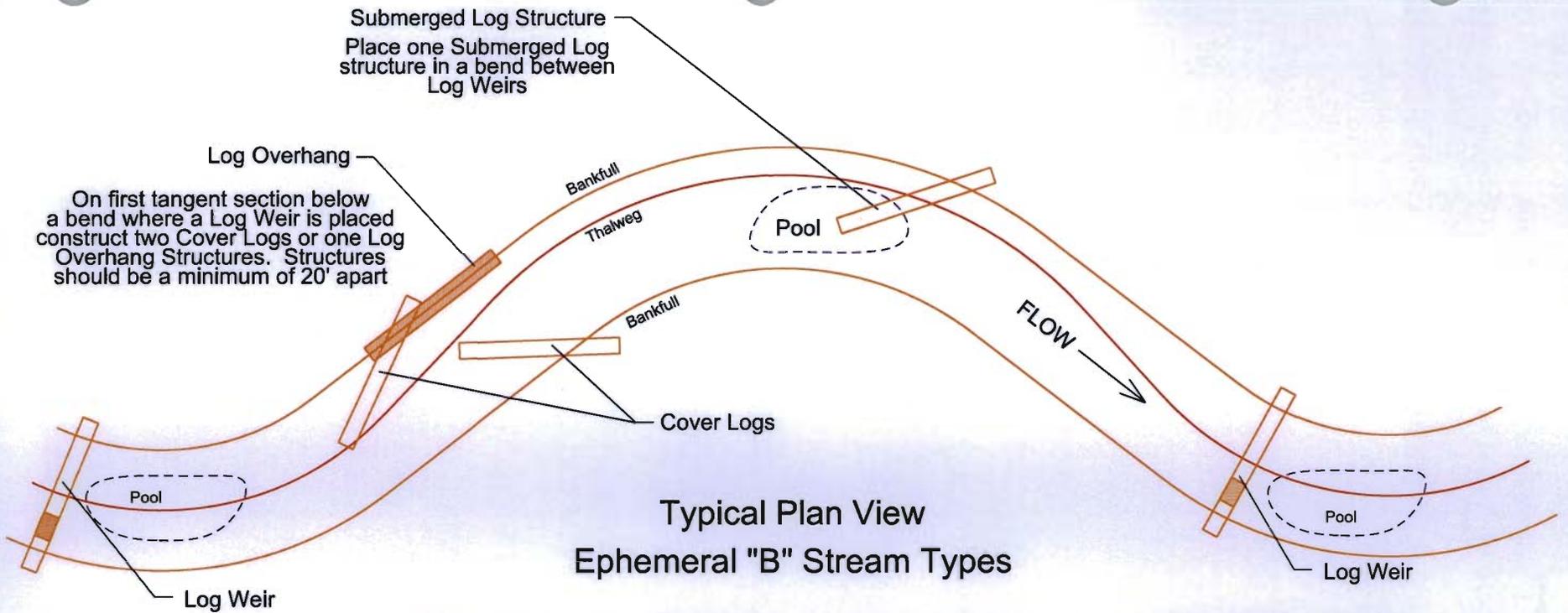
Spacing of Rock Step Structures and size of rock used will be based on channel size and channel slope. These structures will be used on Ephemeral "B" Stream Types as alternatives.

Pools are to be excavated just downstream of low rock (weir). Pool depths will vary from 0.5 foot to 1.0 foot.

When rock is not available, logs spanning the stream bottom and buried into the banks at least  $\frac{1}{2}$  the bankfull stream width can be substituted. Top of the logs need to be placed so that they are level with the bankfull elevation and a notch cut out to form a weir at least  $\frac{1}{2}$  the bank full depth and running  $\frac{1}{3}$  of the length of the bankfull width. Logs should be buried below the stream bottom to prevent scour.

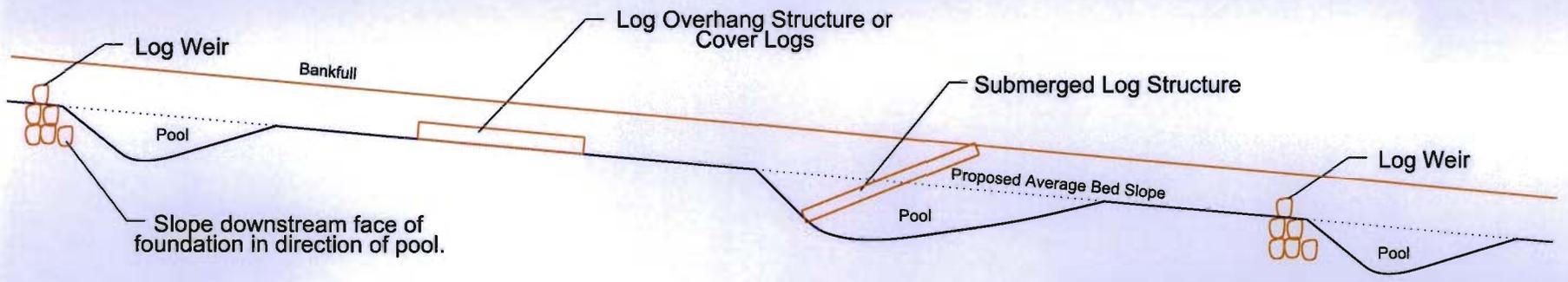
Submerged Log Structure  
Place one Submerged Log structure in a bend between Log Weirs

Log Overhang  
On first tangent section below a bend where a Log Weir is placed construct two Cover Logs or one Log Overhang Structures. Structures should be a minimum of 20' apart



Typical Plan View  
Ephemeral "B" Stream Types

Max pool depths to be 1' to 2'.



Typical Profile View  
Ephemeral "B" Stream Types

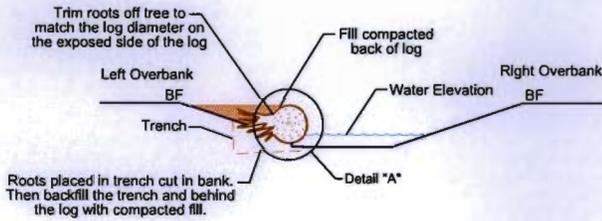
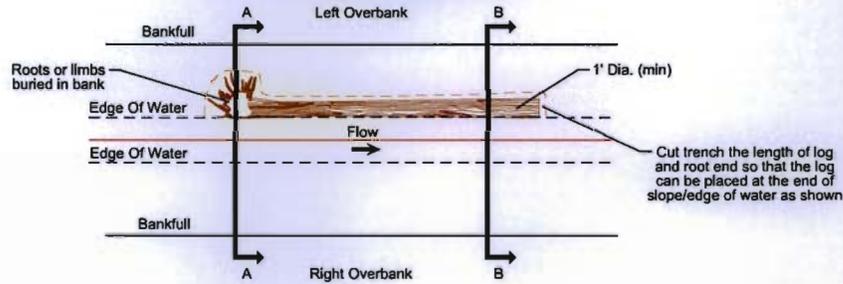
Foundation logs below the exposed weir log shall extend below the constructed stream bed to at or below the anticipated scour depth (approximately 5').

Note: Meander Length may vary.  
Generally place a Log Weir every 150'-250' along the stream reach at the beginning of a bend in the stream.

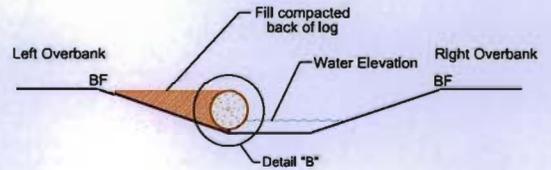
# Habitat Structure Details

Perennial "C" Type Streams  
 Intermittent "E" & "C" Type Streams  
 Ephemeral "E" & "C" Type Streams

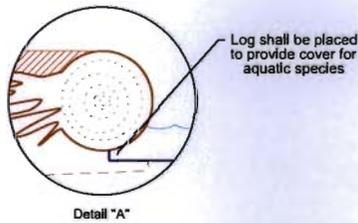
## Log Overhang Structure



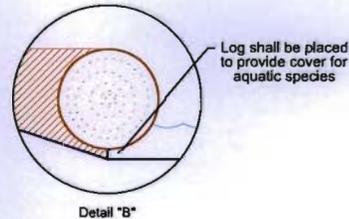
Section A-A



Section B-B

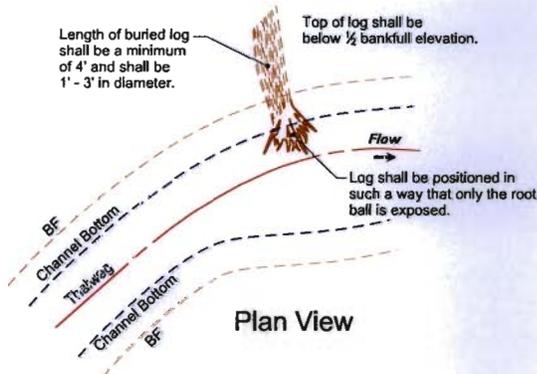


Detail "A"



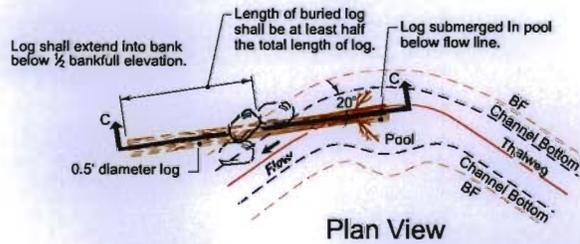
Detail "B"

## Root Wad



Plan View

## Submerged Log Structure



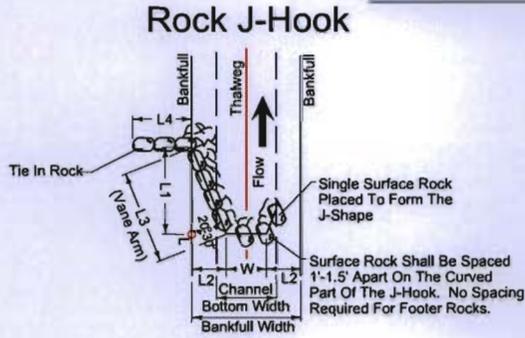
Plan View



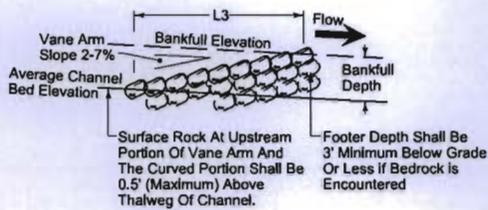
Section C-C

# Stability And Habitat Structure Details

Perennial "C" Type Streams  
 Intermittent "E" & "C" Type Streams  
 Ephemeral "E" & "C" Type Streams

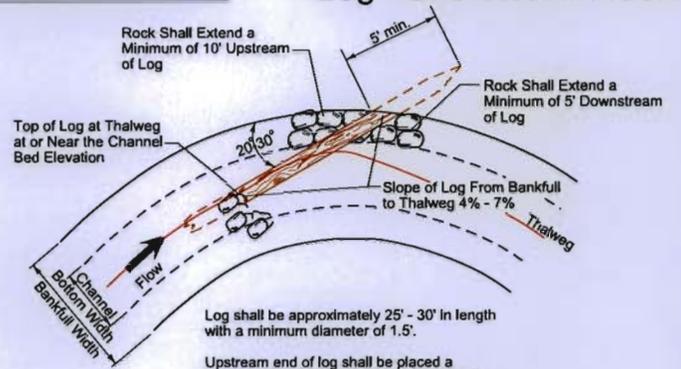


(Plan View)



(Profile Along Vane Arm)

## Log Vane With J-Hook



Log shall be approximately 25' - 30' in length with a minimum diameter of 1.5'.

Upstream end of log shall be placed a minimum of 5' into bank at bankfull elevation. The log can be sawed at a sharp angle and driven into bank or placed in trench and backfilled.

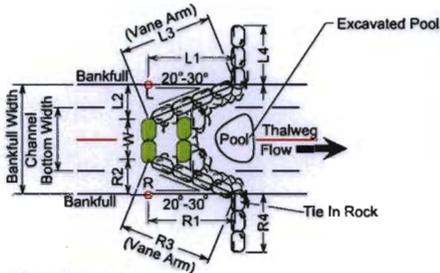
Downstream end of log shall be placed in the channel bottom at center of thalweg.

Rock protection shall be placed along the bank upstream and downstream of the log. Rock placement shall begin at channel bottom toe of slope and extend to bankfull elevation. Rock shall be a minimum of 1.5' diameter and keyed into channel bank.

Rock that is to be placed in the channel to form the J shape shall meet same specifications as those required on Rock J-Hook Structures.

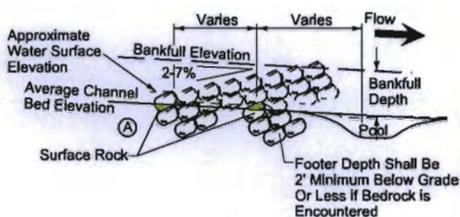
The log at bankfull shall be buried into the channel bank a minimum of 5'.

## Double Invert Cross Vane



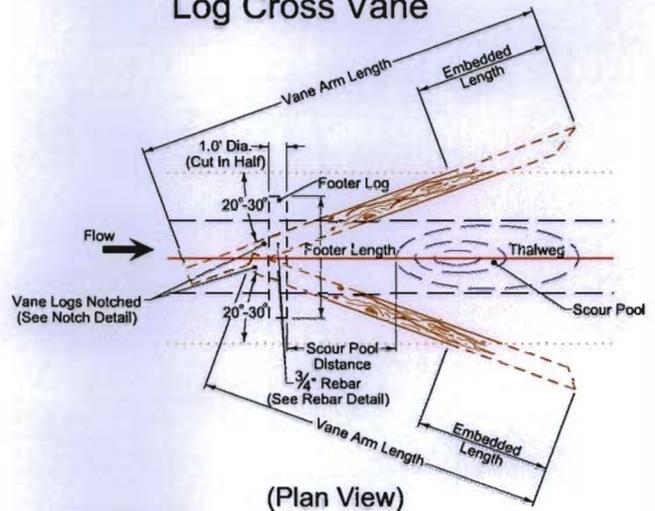
Top Of Cross-Vane Across Width (W) Is Level. Surface Rock In This Level (Upstream) Portion Is 0.5' (Maximum) Above Thalweg Of Channel.

(Plan View)

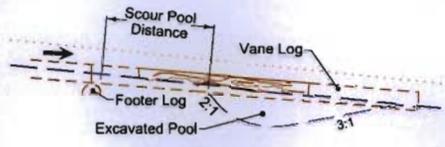


(Profile)

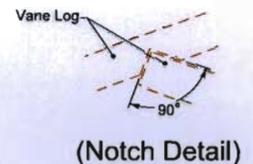
## Log Cross Vane



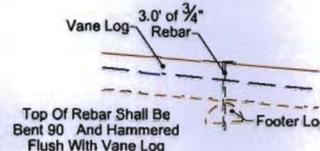
(Plan View)



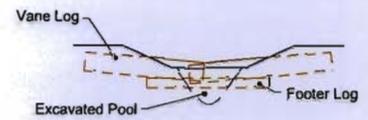
(Profile)



(Notch Detail)



(Rebar Detail)

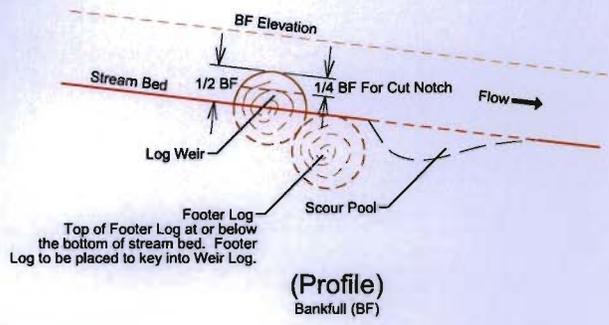
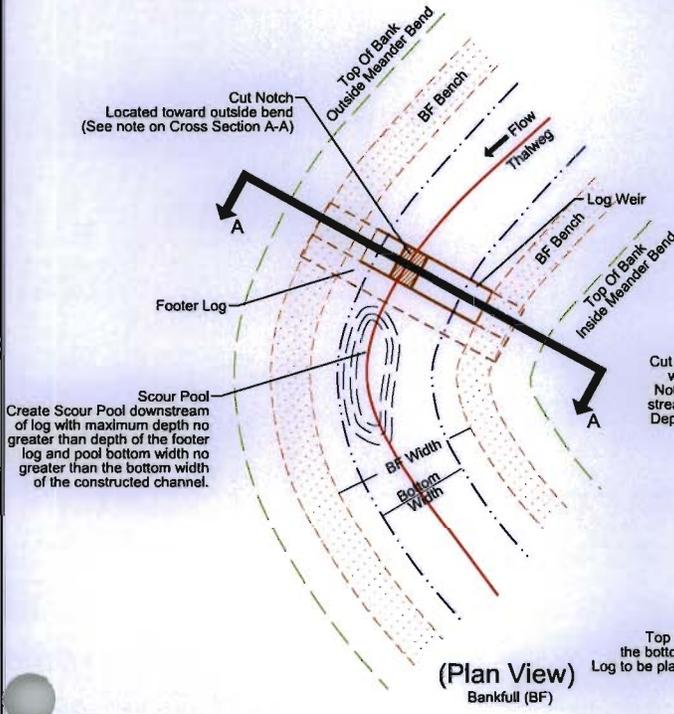


(Cross Section View)

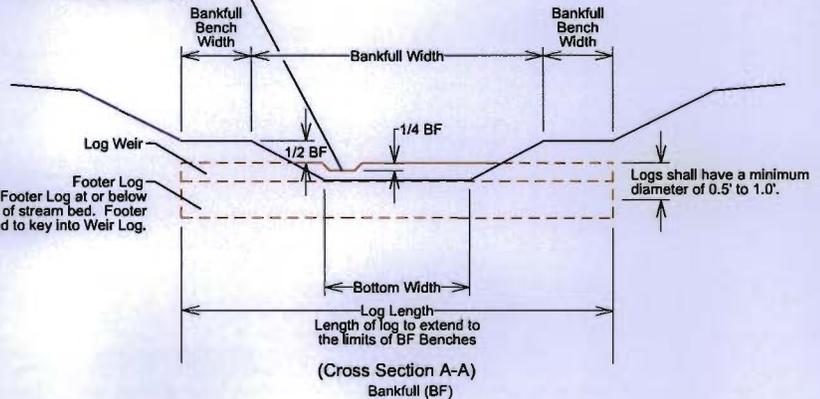
# Habitat Structure Details

## Ephemeral "B" Type Streams

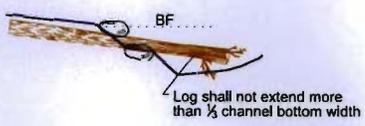
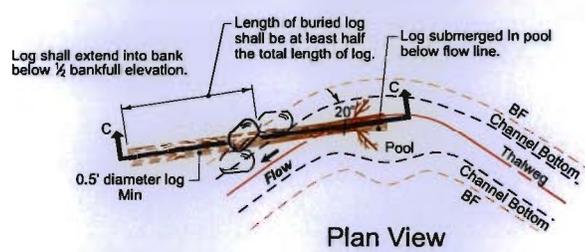
### Log Weir



Cut Notch in log to create a weir with width 1/3 to 1/2 the Bottom Width. Notch to be offset from the center of stream channel toward outside bend. Depth of Notch to be no greater than 1/4 BF Max. Depth.



### Submerged Log Structure



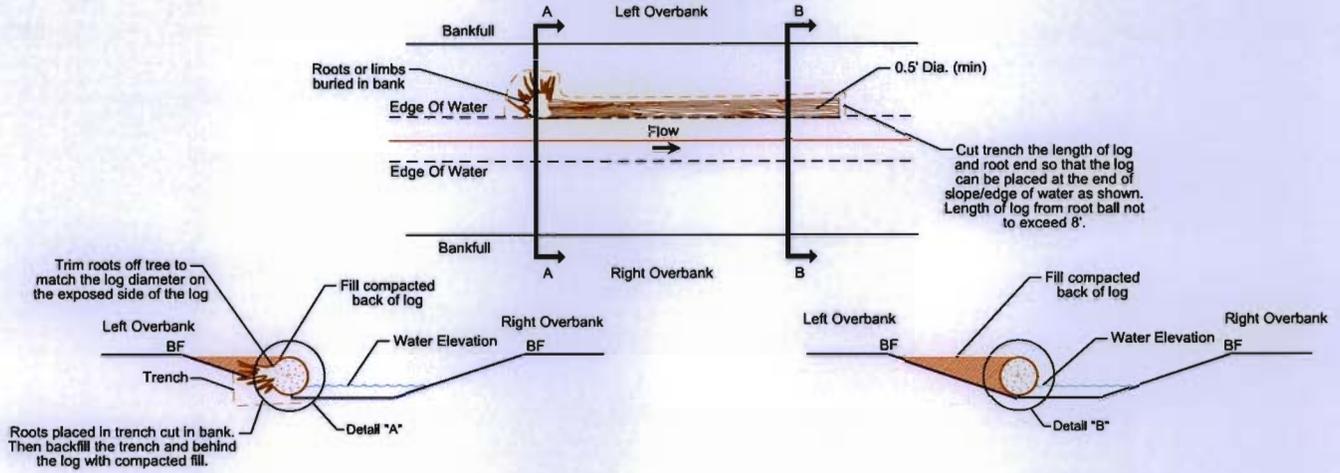
**Note:** Placement and need of habitat structures to be determined by engineer at time of construction.

T.H.E. Engineers, Inc.	PROJECT: MIDWAY SOUTH MINE SITE				
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: HABITAT STRUCTURE DETAILS	EXHIBIT 73

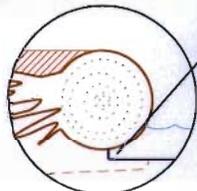
# Habitat Structure Details

## Ephemeral "B" Type Streams

### Log Overhang Structure



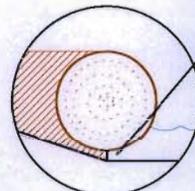
Section A-A



Detail "A"

Log shall be placed to provide cover for aquatic species

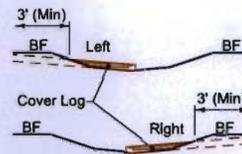
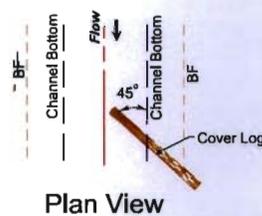
Section B-B



Detail "B"

Log shall be placed to provide cover for aquatic species

### Cover Log



Cover log shall consist of a 0.5' to 1.0' diameter log placed flush on channel bottom. One end of log will extend a minimum of 3.0' into channel bank and other end will extend to 1/4 to 1/2 channel bottom width. The log shall be angled in upstream direction.

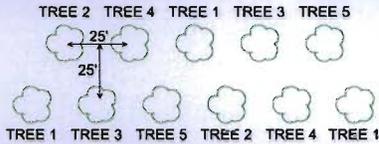
Log will alternate sides. (See Plan Sheets)

Note: Placement and need of habitat structures to be determined by engineer at time of construction.

# RIPARIAN ZONE PLANTING NOTES

(USE OPTION ONE OR OPTION TWO FOR TREE PLANTINGS)

## PLAN VIEW: PLANTING DETAIL RPM Riparian Trees (Option One)



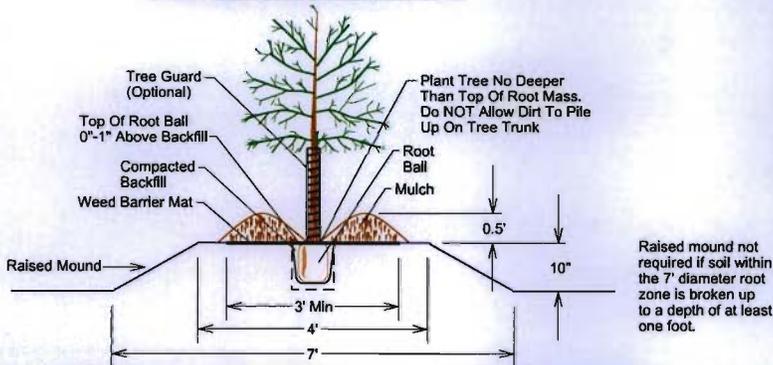
### RPM RIPARIAN TREE PLANTINGS (OPTION ONE)

- Only trees that have been produced by the Root Production Method (RPM) shall be planted in the Riparian zone.
- The trees shall be three gallon container grown.
- The trees shall be planted between the dates of October 1 and December 15.
- Trees in the same row shall be planted on 25 foot spacing.
- The first row of trees nearest the channel shall be planted approximately 8 feet beyond the shrub plantings.
- The second row shall be planted 25 feet behind the first row. The subsequent rows will also be on 25 foot spacing.
- The trees shall be planted in a staggered pattern, not one directly behind the other.
- The trees shall be planted with alternating species.

### RECOMMENDED PROCEDURES FOR PLANTING RPM TREES

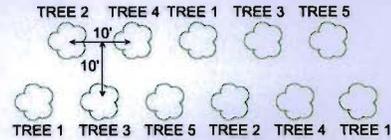
- Site preparation - trees are to be planted on a raised mound of existing soil. The mound shall be 8-10 inches high after mild compaction. The base of the mound shall have a minimum width of seven feet with a flat crown (top) at approximately four feet.
- The hole shall be approximately the same size as the container (10 inch diameter-8 inch depth).
- After unloading trees, they shall be watered thoroughly and protected from excessive heat or cold. Do not allow rootball to freeze or dry out.
- If the trees are not to be planted for several days or weeks, they should be watered every 3-4 days and again immediately before planting.
- Remove the plastic container in which the trees have been growing prior to planting. Do not disturb rootball after container has been removed.
- Do not plant trees any deeper than the level at which they were growing in the container. It is acceptable to plant the trees 1 inch above the level they were growing in the container.
- Trees planted between October 1 and December 15, will require the application of a slow release fertilizer after planting. 1-1 1/2 tablespoons around drip zone is recommended. An analysis of 27-3-7 with I.B.D.U. or similar is recommended.

## RPM TREE PLANTING DETAIL



Round hardwood mulch chips around base of each tree. Diameter of mulch placed around tree trunk can vary from 3' to 4'. Maximum depth of mulch to be 0.5' one foot from center of tree trunk. Lessen depth of mulch closer to the trunk to provide a minimal layer of mulch over the top of the root ball. Mounding should form a cone area near the trees trunk that will trap water around the tree. During the first growing season, trees should be watered thoroughly at least once a week.

## PLAN VIEW: PLANTING DETAIL NON - RPM Riparian Trees (Option Two)



### TREE PLANTING (OPTION TWO)

- Trees shall be container grown or bare root.
- Bare root stock must be a minimum 30" (inches) in height and planted on 10' x 10' spacing in a staggered pattern.
- Three-gallon trees shall be planted on 19' x 19' spacing in a staggered pattern.
- NOTE: Option One notes with \* also apply to Option Two

### THE FOLLOWING TREES WILL BE USED FOR BOTH OPTIONS

An equal amount of the following trees are to be planted throughout the riparian zone.

#### PERENNIAL TREE LIST

- Tree 1: Shellbark hickory (*Carya laciniosa*)
- Tree 2: Willow oak (*Quercus phellos*)
- Tree 3: Cherrybark oak (*Quercus pagoda*)
- Tree 4: Swamp white oak (*Quercus bicolor*)
- Tree 5: Pin oak (*Quercus palustris*)
- Tree 6: Baldcypress (*Taxodium distichum*)

#### INTERMITTENT TREE LIST

- Tree 1: Shellbark hickory (*Carya laciniosa*)
- Tree 2: Willow oak (*Quercus phellos*)
- Tree 3: Cherrybark oak (*Quercus pagoda*)
- Tree 4: Water oak (*Quercus nigra*)
- Tree 5: White oak (*Quercus alba*)

#### EPHEMERAL STREAM TREE LIST

- Tree 1: Shagbark hickory (*Carya glabra*)
- Tree 2: American Beech (*Fagus grandifolia*)
- Tree 3: Shingle oak (*Quercus imbricaria*)
- Tree 4: Post Oak (*Quercus stellata*)
- Tree 5: Shumard Oak (*Quercus shumardii*)

## SHRUB PLANTINGS (These will not be RPM Plantings)

### PLAN VIEW: SHRUB PLANTING DETAIL



The following shrubs are to be planted near bankfull elevation. See typical cross sections for number of rows and placement.

- Shrub 1: Rough-leaf Dogwood (*Cornus drummondii*)
- Shrub 2: Strawberry Bush (*Euonymus americanus*)
- Shrub 3: Indigo Bush (*Amorpha fruticosa*)

Three gallon container shrubs shall be planted on approximate 4' spacing with an equal amount of each species planted in random sequence.

### SEEDING:

The following native grasses will be sown along both stream banks and throughout the riparian zone:

Annual Rye ( <i>Lolium perenne</i> )	20%
Orchard Grass ( <i>Dactylis glomerata</i> )	10%
Red Top ( <i>Argrostis gigantea</i> )	20%
KY Bluegrass ( <i>Poa pratensis</i> )	20%
Wheat Grass ( <i>Triticum aestivum</i> )	30%

Apply seed at a rate of 20 pounds/acre or as recommended by seed supplier.

Straw mulch or erosion control blanket shall be placed immediately following seeding.

Additional native species may be substituted based on approval of Army Corps of Engineers

Riparian Zone Width will be a minimum of 100' for intermittent streams

Shrub plantings and seeding will be the same for each option.

Streams To Be Mitigated On Site  
Midway South Mine

Stream	Proposed Stream Stream Length (ft)	Stream	Proposed Stream Stream Length (ft)
PER-1	2634	EPH-26DS	189
PER-2	475	EPH-26US	847
INT-1	503	EPH-29DS	613
INT-1A	239	EPH-29MS	665
INT-2DS	1593	EPH-32	617
INT-2MS	3334	EPH-37	933
INT-3	359	EPH-40	834
INT-4	739	EPH-40A	885
INT-6	781	EPH-41	713
INT-7	619	EPH-44	1922
INT-11	2153	EPH-49	1579
EPH-2	532	EPH-55	528
EPH-4	816	EPH-56	1898
EPH-7	890	EPH-60	2144
EPH-17	2888	EPH-64	3150
EPH-18	1372	EPH-64A	311
EPH-20	947	EPH-A	2523
EPH-24	997		

**For Stream Impact Lengths  
See Baseline/PCN**

TOTAL IMPACTS IN BASELINE  
 Total Perennial (PER)= 2818'  
 Total Intermittent (INT)= 9627'  
 Total Ephemeral (EPH)= 38868'

TOTAL PROPOSED MITIGATION

Total Perennial (PER)= 3109'  
 Total Intermittent (INT)= 10320'  
 Total Ephemeral (EPH)= 28793'

**Mitigation Plan  
for  
Wetland Impacts**

**Midway South Mine Site  
Ohio County, Kentucky**

Prepared for:

**Armstrong Coal Company**  
407 Brown Road  
Madisonville, KY 42431

Prepared by:

**T.H.E.  Engineers, Inc.**

2331 Fortune Drive, Suite #295  
Lexington, Kentucky 40509  
(859) 263-0009

**March 8, 2013**

## Wetland Mitigation Plan

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## Introduction

The following report describes the wetland mitigation plan for the Midway South Mine Site in Ohio County, Kentucky. This mitigation plan is to be utilized in conjunction with the Stream Habitat Assessment and Wetland Delineation Report for the Midway South Mine Site, as well as the Individual 404 Permit Application. Onsite wetland mitigation is proposed to mitigate for the mine site's total of 9.914 acres (ac) of jurisdictional wetland impacts (2.239 ac forested wetland, 1.028 acres scrub-shrub wetland, and 6.674 ac emergent wetland). Based on ratios provided in the table below, 19.882 acres of wetland mitigation are required.

Wetland Impact	Mitigation Ratio	Mitigation Required
2.239 ac Forested Wetland	2:1	4.478 ac
1.028 ac Scrub-Shrub Wetland	2:1	2.056 ac
6.674 ac Emergent Wetland	2:1	13.348 ac
	<b>Total</b>	<b>19.882 ac</b>

The goal of the mitigation is to establish a minimum of 19.882 acres of palustrine forested wetlands (PFO), based on the Cowardin Classification. There is one proposed forested wetland which will account for each type of wetland impact, including scrub-shrub and emergent wetland impacts. The wetlands to be constructed is expected to be of higher quality and value than the wetlands to be replaced, by providing more hard mast trees for habitat and food sources in a single large tract that consolidates numerous small existing wetland areas. The proposed wetland will provide a buffer and flood storage for adjacent streams being restored in original locations.

## Location

The proposed wetland site is located on-site at the Midway South Mine Site, which is located along both sides of Midway Road that runs through the property. Midway Road intersects with KY69 east of the community of Centertown, Kentucky. The mine site is located approximately 3 miles southeast of Centertown, in Ohio County (Hartford and Paradise USGS 7.5 minute topographic quadrangles), at Latitude: 37° 22' 49" N, Longitude: 86° 58' 00" W.

## Wetland Plan

The wetland established will be forested wetlands (PFO). It will be created/restored in a long flat valley during the mine reclamation (see Exhibit 1 for the location).

The wetland lies in the floodplain of proposed mitigation stream PER-1, which has the largest watershed available for maintenance of flow (a 563-acre drainage area, including the watershed for proposed mitigation stream INT-2). The existing valley gradient for PER-1 is 0.6% or less. Such a gradient along the valley lends the valley to develop wetland areas along the stream and in the adjacent floodplain areas due to sluggish stream flows and the inability of the floodplain to completely dewater after storm events. Evidence of this is the presence of several existing wetlands (Wetlands CC and DD) within the PER-1 floodplain valley. Both of these wetlands will lie within the proposed wetland boundary. Bank overflow from PER-1 (as well as the downstream portion of INT-2) currently does not access the overbank areas as frequently as it could since the channel is incised below the bankfull elevation. The proposed wetland will continue to be fed by the 593-ac watershed mentioned, but the restored PER-1 and INT-2 are designed to allow for flows above bankfull to more frequently access the floodplain and proposed wetland, receiving the benefit of additional hydrologic input. In addition to headwater flows, the downstream area of wetland should receive some backwater flooding of PER-1 from a tributary of the Left Fork Lewis Creek (according to existing FEMA flood mapping). The downslope gradient of the wetland will be held near the existing valley slope of 0.6%, which will make flows in and through the wetland sluggish, promoting the formation of hydric conditions. The floodplain access will be improved from the 593-ac watershed flowing into PER-1, and running parallel with the wetland, by constructing an adverse slope from the floodprone bench running along the banks (one or both banks where proposed) of PER-1 down to half the maximum bankfull depth in the proposed wetland. The proposed wetland bottom will generally be at half the maximum bankfull depth for its entire length and width with no outlet below the bankfull elevation to PER-1 or its tributaries provided. Therefore, flow into the wetland will stay until it evaporates, drains into the groundwater, or overflows into PER-1 when the bankfull elevation is reached in the wetland. Refer to Exhibits 2 and 3 for proposed construction details and profiles and cross-sections.

The existing soil mapping unit on the proposed wetland site is Steff silt loam, occasionally flooded (Sf), a map unit known to have inclusions of hydric soils such as Stendal. The silt loam soil is described as nearly level, deep, and moderately well drained, occurring on floodplains. Runoff is slow, and the soil has a seasonal high water table<sup>1</sup>. Clay-textured soils, as well as the top 12 inches of existing wetland soils, will be stockpiled during topsoil management, for use in

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<sup>1</sup> United States Department of Agriculture. 1987. Soil Survey of Ohio County, Kentucky.

mitigation. A layer of topsoil will be loosely placed over the proposed wetland area to allow for root development.

Monitoring wells will be installed per TN WRAP 05-02 (USACE 2005)<sup>2</sup> to establish flooding frequency and wetland boundaries. Monitoring wells will be installed at six locations in the wetland. Guidelines for well installation and interpretation as detailed in the USACE technical document will be followed. See Exhibit 2 for approximate locations of monitoring wells.

### **Planting Plan**

It is the intention of the design to create a wetland that will be forested at maturity. A successful implementation of the plan should exhibit a trend toward a forested classification by the end of the monitoring period. See Exhibit 4 for the planting plan.

Trees will be planted in the wetland at a rate of 60 Root Production Method (RPM) trees per acre, or 120 non-RPM 3-gallon container trees (minimum height - 30 inches) per acre, or bare root seedlings with a minimum height of 30 inches planted at a rate of 450 trees per acre. If RPM trees are purchased, trees should be planted in mounds of soil to increase survivability (see detail on Exhibit 4). RPM or non-RPM 3-gallon container trees will have a 25 X 25-foot or 19 X 19-foot spacing, respectively. Bare-root seedlings will be planted on 10 X 10-foot spacing. At least five of the six tree species listed below shall be planted.

The forested planting zone covers at least 19.882 acres and will be planted in trees and a herbaceous mix. The wetland is anticipated to be seasonally flooded. Selected trees must tolerate inundated conditions for part of the year. Due to cost and availability constraints, any tree or shrub species may be substituted with a USACE-approved appropriate species, provided that overall species diversity is maintained.

### Trees

Shellbark hickory (*Carya laciniosa*)  
Cherrybark oak (*Quercus pagoda*)  
Pin oak (*Quercus palustris*)  
Swamp white oak (*Quercus bicolor*)  
Willow oak (*Quercus phellos*)  
Baldcypress (*Taxodium distichum*)

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<sup>2</sup> U.S. Army Corps of Engineers. 2005. "Technical Standard for Water-Table Monitoring of Potential Wetland Sites," *WRAP Technical Notes Collection* (ERDC TN-WRAP-05-2), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

A seed mix, such as Cardno JFNew's "Wooded Wetland Establishment" is suggested. As an alternative, the following species lists shall be followed to provide sufficient diversity and ground cover. A minimum of six species shall be used to provide sufficient diversity and ground cover throughout the entire growing season. Other appropriate species may be substituted as cost and availability allows, provided similar diversity is maintained and approved by the USACE. No single species shall constitute more than twenty-five percent of the entire mix; an even distribution and diversity of genera is advised.

#### Herbaceous seed mix

Green bulrush (*Scirpus atrovirens*)  
Virginia wild rye (*Elymus virginicus*)  
Fox sedge (*Carex vulpinoidea*)  
Soft rush (*Juncus effusus*)  
Woolgrass (*Scirpus cyperinus*)  
Common sneezeweed (*Helenium autumnale*)

#### **Maintenance Plan**

Invasive, exotic, or undesirable volunteer species will be removed from the mitigation site during annual maintenance.

#### **Performance standards**

Standards for assessing wetland mitigation goals include:

- Success will be based on the USACE 2009 Draft Interim Regional Supplement to the Corps of Engineers' Wetland Delineation Manual: Eastern Mountains and Piedmont Region.
- If bare root seedlings are planted, no single species may comprise more than twenty-five percent of the surviving plantings, not including volunteers. Eighty percent of bare root seedlings must survive. If RPM or container trees are used, no one species may comprise more than 25 percent of surviving plantings. Ninety percent of the planted RPM trees must survive. Herbaceous plantings must provide a minimum of 70 percent ground cover with no one species accounting for more than 40 percent of ground cover.
- The wetlands will meet the proposed Cowardin Classification (PFO) at the end of the monitoring period.
- At least 19.882 acres of wetland will develop in order to fully meet mitigation requirements.
- Wetland hydrology will be achieved through the measurement of 14 or more consecutive days of flooding or ponding, or a water table 12 inches or less below the soil surface, during

the growing season at a minimum frequency of 5 years in 10, as stated in the USACE Regional Supplement<sup>3</sup>. Monitoring wells will be installed at locations near the perimeter of the wetland to measure the level of saturation. Six will be installed.

- Three hydrogeomorphic (HGM) variables will be measured during biannual monitoring to assess the restoration of wetland functions. Water table fluctuation, redoximorphic features, and ground vegetation biomass will be measured per the regional HGM guidebook<sup>4</sup>. These variables will determine the wetland's ability to maintain a characteristic plant community, remove and sequester elements and compounds, and cycle nutrients.

### **Monitoring Requirements**

The wetland mitigation site will be monitored in accordance with the Mitigation Final Rule, 2008.

In general, the following guidelines will be used:

- The monitoring period must be sufficient to demonstrate that the compensatory mitigation has met success criteria. The monitoring period length shall be 10 years; however, the applicant can petition for early release after 5 years if success is assured.
- Biannual inspections will be conducted each year during the first and last two months of the growing season.
- The first monitoring report will be due after the first full growing season following the initial planting.
- Monitoring reports are due to USACE by January 31 for the previous year.
- One permanent monitoring and photo station will be required for every three acres of each wetland type, for a total of six stations each. A Regional Supplement wetland delineation form will be filled out at each station.
- Monitoring wells will be installed, per TN WRAP 05-02 to measure saturation. Monitoring wells will be installed at six locations.

### **Long-Term Management Plan**

The applicant will be responsible for accomplishing, maintaining, and monitoring the mitigation site. The mitigation site will be integrated into the reclamation plan, with site access limited. Site protection will be provided through the use of a restrictive covenant to be recorded with

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<sup>3</sup> U.S. Army Corps of Engineers. 2010. Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region, ed. J.S. Wakeley, R.W. Lichvar, and C.V. Noble. ERDC/EL TR-10-XX. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

<sup>4</sup> Ainslie, W. B., Smith, R. D., Pruitt, B. A., Roberts, T. H., Sparks, E. J., West, L., Godshalk, G. L., and Miller, M. V. (1999). "A regional guidebook for assessing the functions of low gradient, riverine wetlands in western Kentucky," Technical Report WRP-DE-17, U. S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

property deeds. The restrictive covenant for the wetland mitigation area shall be recorded within 60 days after mitigation construction is complete, with proof of recording submitted to USACE at the time of execution.

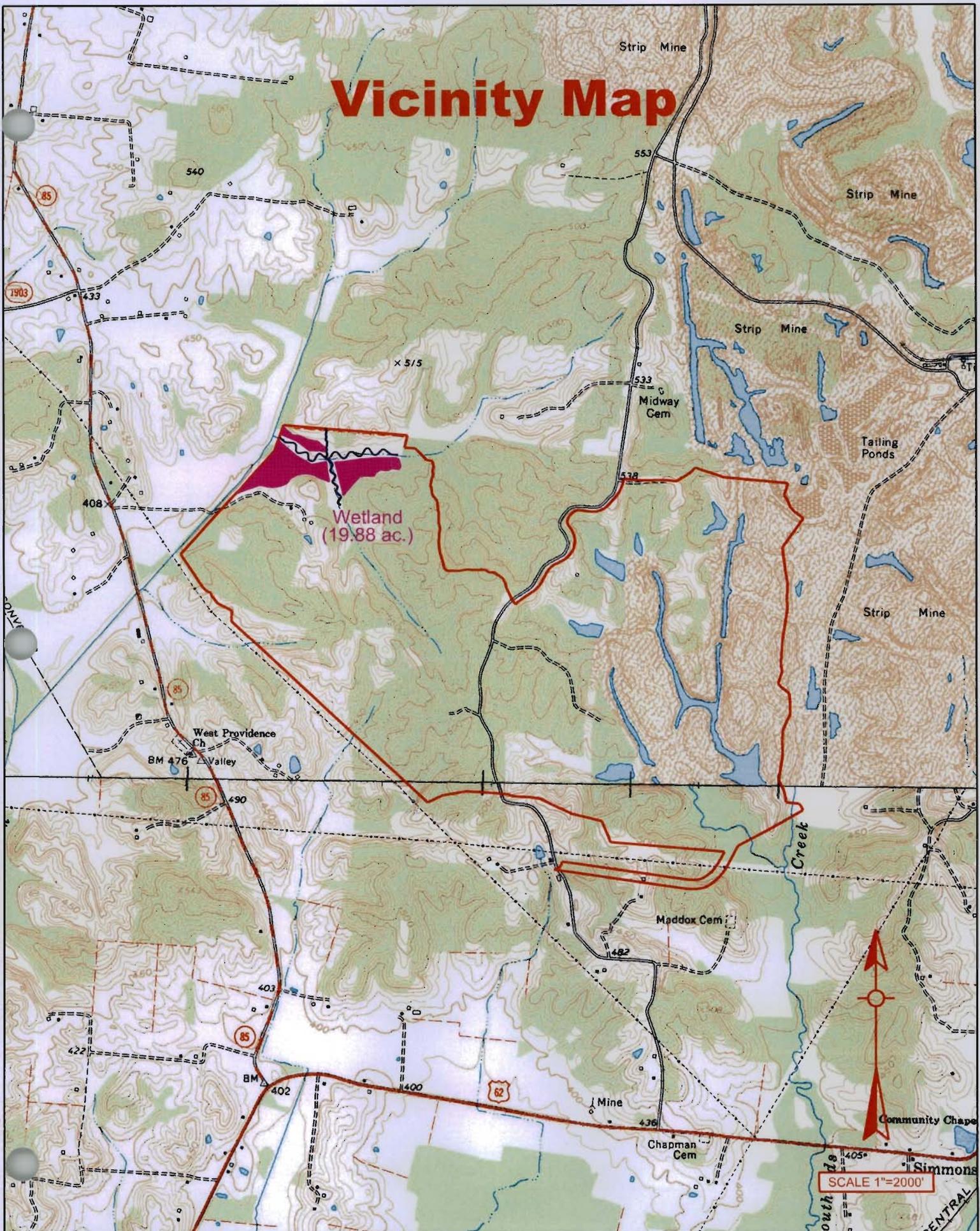
#### **Adaptive Management Plan**

If success criteria are not met for any portion of the monitoring year and / or final success criteria are not satisfied, an analysis of the contributing conditions will be conducted and documented. Remedial action, if required by USACE, will be performed and documented by the applicant. Remedial actions may include replanting trees, reseeding vegetation, restoring hydrology, and repairing constructed features. These actions will be performed at least twice, depending on the nature of the problem. Should these efforts not resolve the problem, another site will be found to off-set failed sections of the mitigation sites. The payment of an in-lieu fee is another option to compensate for sections of wetlands that do not meet performance standards.

#### **Financial Assurances**

The applicant will be responsible for managing any financial assurances and contingency funds set-aside for remedial measures. The USACE, Louisville District, currently does not have the means to handle financial assurances; therefore, no USACE-managed financial assurances are proposed for this project.

# Vicinity Map



**T.H.E.  
Engineers, Inc.**

PROJECT: MIDWAY SOUTH SITE - PROPOSED WETLAND MITIGATION

PROPOSED WETLAND LOCATION

COUNTY: OHIO

STATE: KY

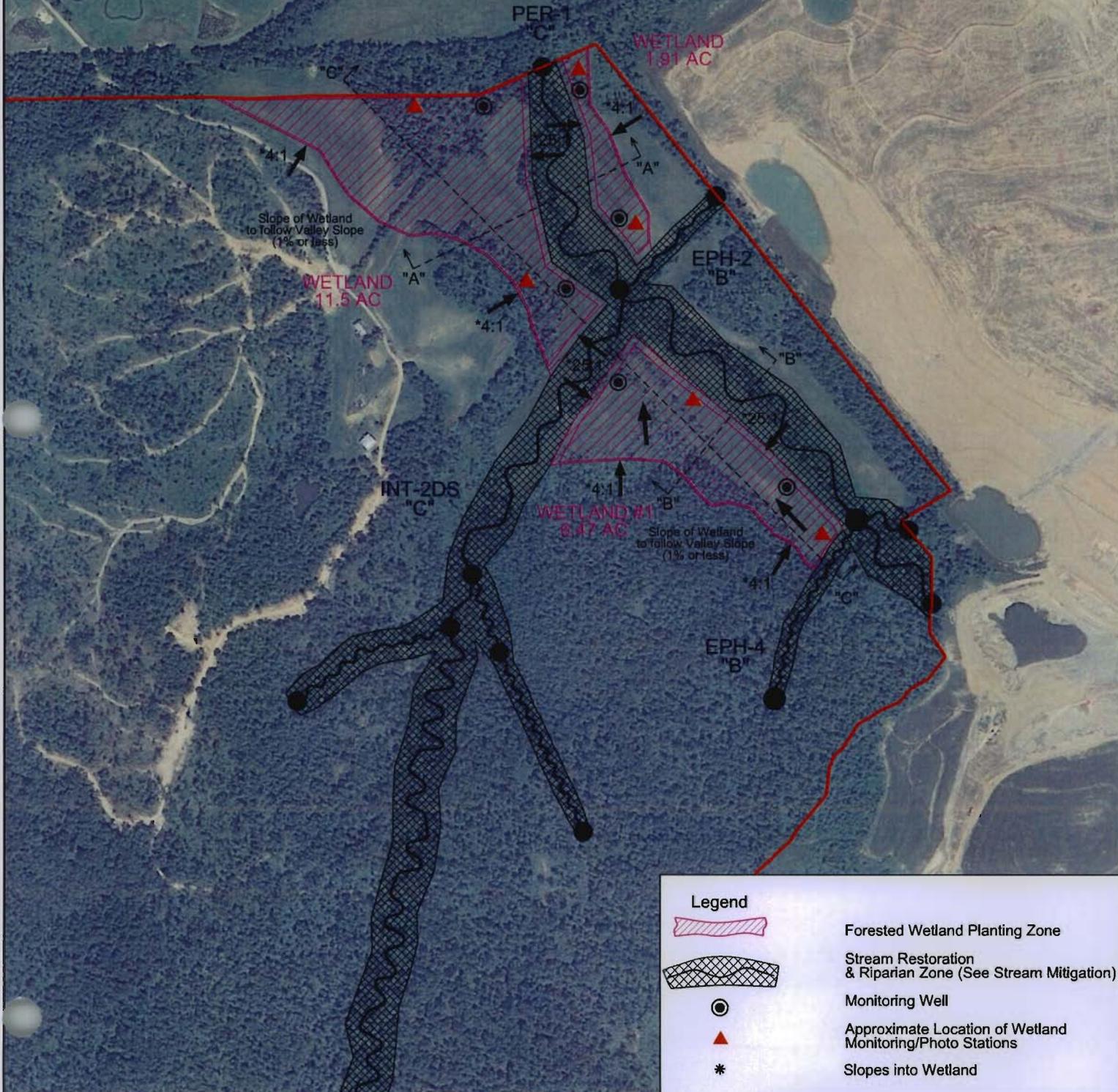
NEAR: CENTERTOWN

ITEM: VICINITY MAP

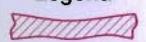
EXHIBIT I

# Midway South Streams and Wetlands

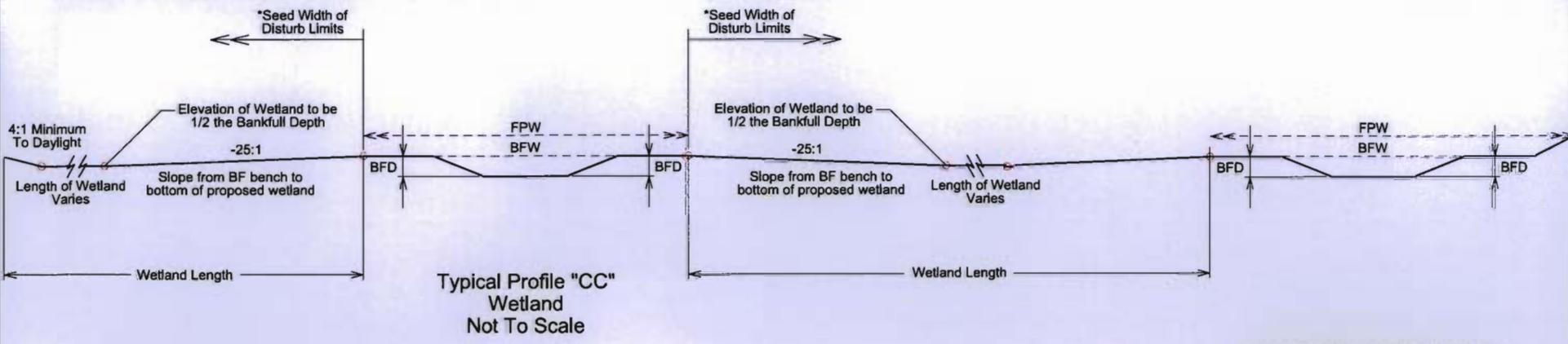
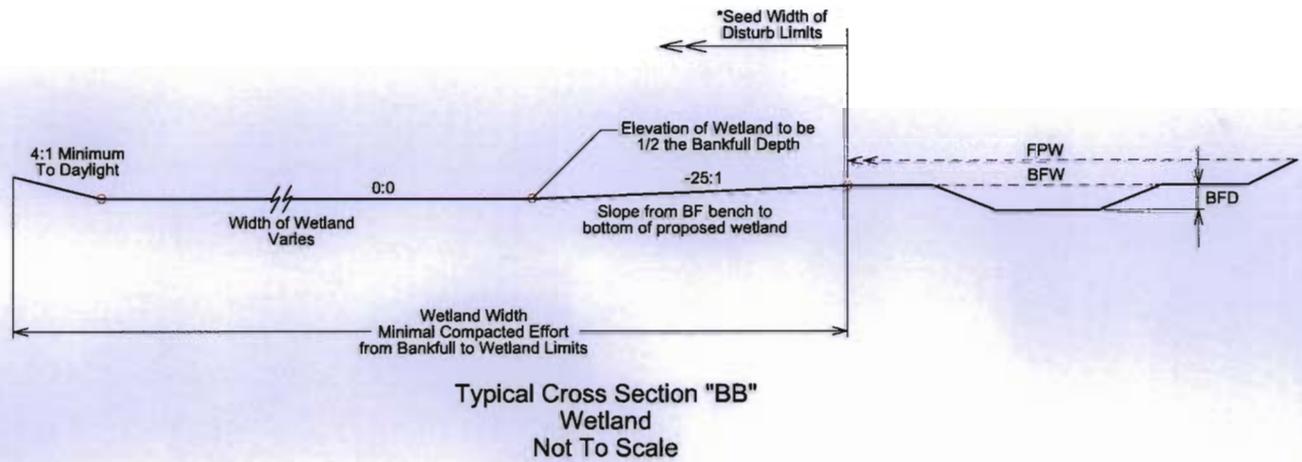
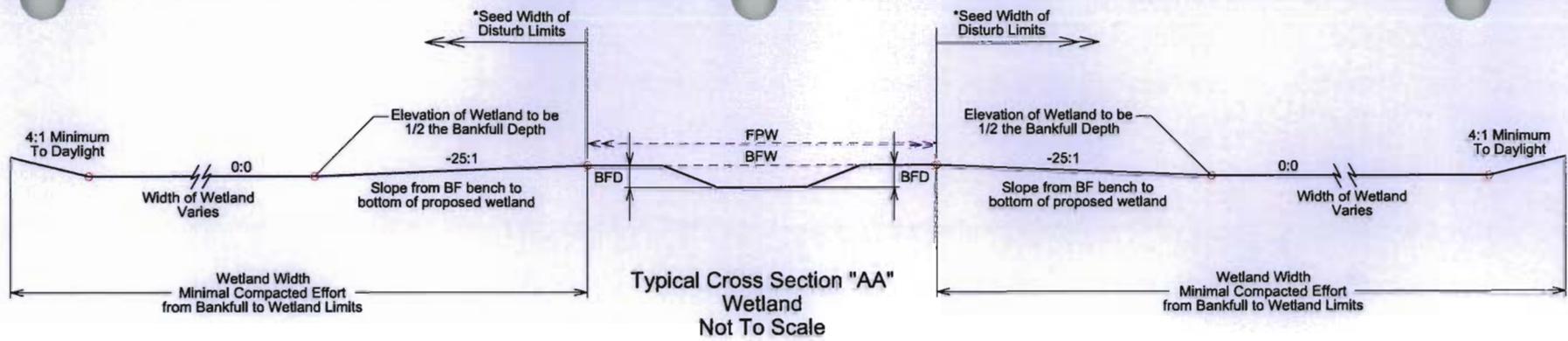
SCALE 1"=500'



**Legend**

-  Forested Wetland Planting Zone
-  Stream Restoration & Riparian Zone (See Stream Mitigation)
-  Monitoring Well
-  Approximate Location of Wetland Monitoring/Photo Stations
-  Slopes into Wetland

T.H.E. Engineers, Inc.	PROJECT: MIDWAY SOUTH SITE - WETLAND MITIGATION PLAN			PROPOSED WETLAND	
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: AERIAL	EXHIBIT 2



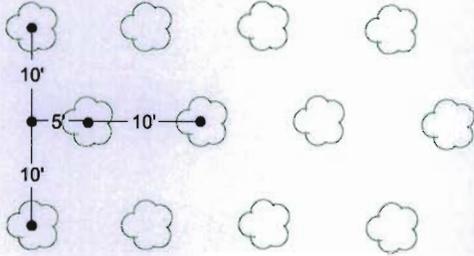
\* Typical stream cross section where adjacent to wetlands.

See Plan Sheets for limits of Proposed Wetlands.

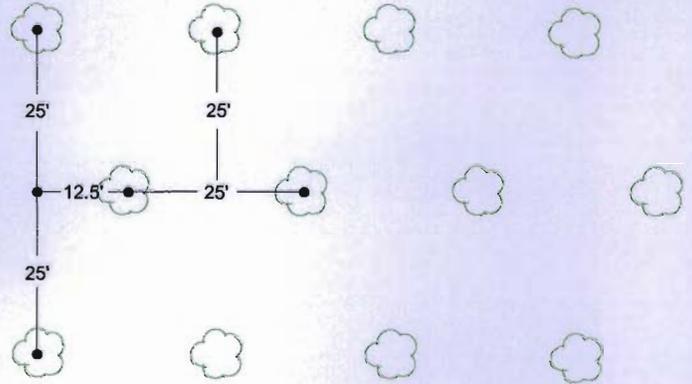
\*See Wetland Planting Details for seeding mixes.

# WETLAND PLANTING DETAILS

If using tree seedlings, use 10 foot spacing.



If using RPM trees, use 25 foot spacing.  
(non-RPM 3-gal. trees, use 19 foot spacing)



Planting Quantities Shall Meet Densities Stated In The Wetland Mitigation Planting Plan. Plant Locations Shall Be Irregularly Spaced And Distributed Such That No Area Is Dominated By Any Single Species

## WETLAND PLANTING SPECIES LIST

### TREES

- Shellbark hickory (*Carva laciniosa*)
- Cherrybark oak (*Quercus pagoda*)
- Pin oak (*Quercus palustris*)
- Swamp white oak (*Quercus bicolor*)
- Willow oak (*Quercus phellos*)
- Baldcypress (*Taxodium distichum*)

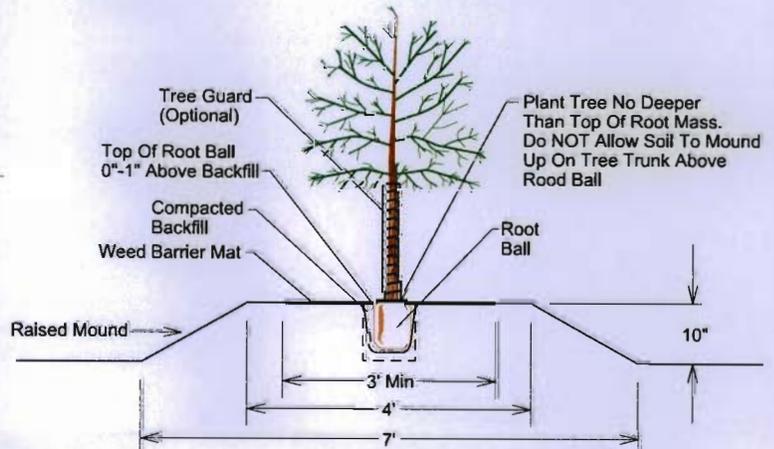
### HERBACEOUS SEED MIX

- Cardno JFNew's "Wooded Wetland Establishment" seed mix  
OR
- Green bulrush (*Scirpus atrovirens*)
  - Virginia wild rye (*Elymus virginicus*)
  - Fox sedge (*Carex vulpinoidea*)
  - Soft rush (*Juncus effusus*)
  - Woolgrass (*Scirpus cyperinus*)
  - Common sneezeweed (*Helenium autumnale*)

## RECOMMENDED PROCEDURES FOR PLANTING RPM TREES

1. Site preparation - trees are to be planted on a raised mound of existing soil. The mound shall be 8-10 inches high after mild compaction. The base of the mound shall have a minimum width of seven feet with a flat crown (top) approximately three to four feet in width.
2. The hole shall be approximately the same size as the container (10 inch diameter-8 inch depth) or slightly larger.
3. After unloading trees, they shall be watered thoroughly and protected from excessive heat or cold. Do not allow rootball to freeze or dry out.
4. If the trees are not to be planted for several days or weeks, they should be watered every 3-4 days and again immediately before planting.
5. Remove the plastic container in which the trees have been growing prior to planting. Rough up the sides and bottom of planting hole so roots can penetrate the soil. Position tree in hole with top of root mass level with top of mound. Backfill hole with loose soil.
6. Trees planted between October 1 and December 10, will require the application of a slow release fertilizer after trees are dormant in late fall or winter. 1 tablespoon of Scottfield fertilizer 27-3-6 with IBDU or equal applied to the soil around the base of the trees is recommended.
7. Install 4'x4' weed mat, if desired.
8. Install 24" tree guard around tree, if desired.
9. Planted trees should be watered daily for 7 to 10 days, then watered every other day for the next 2 weeks (or the equivalent in rainfall).

## RPM TREE PLANTING DETAIL



JD Forms

**PRELIMINARY JURISDICTIONAL DETERMINATION FORM**

**BACKGROUND INFORMATION** For Midway South Area

**A. REPORT COMPLETION DATE FOR PRELIMINARY JURISDICTIONAL DETERMINATION (JD):**

**B. NAME AND ADDRESS OF PERSON REQUESTING PRELIMINARY JD:** David Cobb, P.E.; Armstrong Coal Co., 407 Brown Rd., Madisonville, KY 42431

**C. DISTRICT OFFICE, FILE NAME, AND NUMBER:**

**D. PROJECT LOCATION(S) AND BACKGROUND INFORMATION:  
(USE THE ATTACHED TABLE TO DOCUMENT MULTIPLE WATERBODIES AT DIFFERENT SITES)**

State: Kentucky County/parish/borough: Ohio City: Centertown (nearest)  
Center coordinates of site (lat/long in degree decimal format): Lat. 37.380229°N,  
Long. 86.966625°W.

Universal Transverse Mercator: 16S 4137054N 502954E

Name of nearest waterbody: UT to Southards Creek & W.F. Lewis Creek.

Identify (estimate) amount of waters in the review area:

Non-wetland waters: 51313 linear feet: width (ft) and/or 37.115 acres (open waters).

Cowardin Class: N/A

Stream Flow: Ephemeral= 38868', Intermittent= 9627', Perennial= 2818'

Wetlands: 9.941 acres

Cowardin Class: PEM1A, PEM1B, PEM1H, PFO1A, PFO1B, PSS1A, PSS1B, PSS1H

Name of any water bodies on the site that have been identified as Section 10 waters:

Tidal: N/A

Non-Tidal: N/A

**E. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):**

Office (Desk) Determination. Date:

Field Determination. Date(s):

1. The Corps of Engineers believes that there may be jurisdictional waters of the United States on the subject site, and the permit applicant or other affected party who requested this preliminary JD is hereby advised of his or her option to request and obtain an approved jurisdictional determination (JD) for that site. Nevertheless, the permit applicant or other person who requested this preliminary JD has declined to exercise the option to obtain an approved JD in this instance and at this time.

2. In any circumstance where a permit applicant obtains an individual permit, or a Nationwide General Permit (NWP) or other general permit verification requiring "pre-construction notification" (PCN), or requests verification for a non-reporting NWP or other

general permit, and the permit applicant has not requested an approved JD for the activity, the permit applicant is hereby made aware of the following: (1) the permit applicant has elected to seek a permit authorization based on a preliminary JD, which does not make an official determination of jurisdictional waters; (2) that the applicant has the option to request an approved JD before accepting the terms and conditions of the permit authorization, and that basing a permit authorization on an approved JD could possibly result in less compensatory mitigation being required or different special conditions; (3) that the applicant has the right to request an individual permit rather than accepting the terms and conditions of the NWP or other general permit authorization; (4) that the applicant can accept a permit authorization and thereby agree to comply with all the terms and conditions of that permit, including whatever mitigation requirements the Corps has determined to be necessary; (5) that undertaking any activity in reliance upon the subject permit authorization without requesting an approved JD constitutes the applicant's acceptance of the use of the preliminary JD, but that either form of JD will be processed as soon as is practicable; (6) accepting a permit authorization (e.g., signing a proffered individual permit) or undertaking any activity in reliance on any form of Corps permit authorization based on a preliminary JD constitutes agreement that all wetlands and other water bodies on the site affected in any way by that activity are jurisdictional waters of the United States, and precludes any challenge to such jurisdiction in any administrative or judicial compliance or enforcement action, or in any administrative appeal or in any Federal court; and (7) whether the applicant elects to use either an approved JD or a preliminary JD, that JD will be processed as soon as is practicable. Further, an approved JD, a proffered individual permit (and all terms and conditions contained therein), or individual permit denial can be administratively appealed pursuant to 33 C.F.R. Part 331, and that in any administrative appeal, jurisdictional issues can be raised (see 33 C.F.R. 331.5(a)(2)). If, during that administrative appeal, it becomes necessary to make an official determination whether CWA jurisdiction exists over a site, or to provide an official delineation of jurisdictional waters on the site, the Corps will provide an approved JD to accomplish that result, as soon as is practicable. This preliminary JD finds that there "may be" waters of the United States on the subject project site, and identifies all aquatic features on the site that could be affected by the proposed activity, based on the following information:

**SUPPORTING DATA. Data reviewed for preliminary JD (check all that apply - checked items should be included in case file and, where checked and requested, appropriately reference sources below):**

- Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant: .
- Data sheets prepared/submitted by or on behalf of the applicant/consultant.
  - Office concurs with data sheets/delineation report.
  - Office does not concur with data sheets/delineation report.
- Data sheets prepared by the Corps:
- Corps navigable waters' study:
- U.S. Geological Survey Hydrologic Atlas:
  - USGS NHD data.
  - USGS 8 and 12 digit HUC maps.
- U.S. Geological Survey map(s). Cite scale & quad name: Hartford, Paradise, KY 1:24000.
- USDA Natural Resources Conservation Service Soil Survey. Citation: Ohio County, 1987.

- National wetlands inventory map(s). Cite name: Hartford, Paradise NWI.
- State/Local wetland inventory map(s):
- FEMA/FIRM maps: Ohio County FIRM, 1989.
- 100-year Floodplain Elevation is: \_\_\_\_\_ (National Geodectic Vertical Datum of 1929)
- Photographs:  Aerial (Name & Date): Unknown date.  
or  Other (Name & Date): Taken during assessments.
- Previous determination(s). File no. and date of response letter:
- Other information (please specify):

**IMPORTANT NOTE: The information recorded on this form has not necessarily been verified by the Corps and should not be relied upon for later jurisdictional determinations.**

\_\_\_\_\_  
Signature and date of  
Regulatory Project Manager  
(REQUIRED)

*David Platt* 1-15-13  
Signature and date of  
person requesting preliminary JD  
(REQUIRED, unless obtaining the  
signature is impracticable)

MIDWAY SOUTH SITE

Site number	Latitude	Longitude	Cowardin Class/Flow Regime	Estimated amount of resource in permit area	Class of aquatic resource
P-1	37.389528	86.977194	Perennial	2465 linear feet	non-section 10 – non-wetland
P-2	37.372444	86.952500	Perennial	353 linear feet	non-section 10 – non-wetland
I-1	37.389667	86.970889	Intermittent	302 linear feet	non-section 10 – non-wetland
I-2	37.388667	86.975056	Intermittent	4171 linear feet	non-section 10 – non-wetland
I-3	37.386472	86.973972	Intermittent	266 linear feet	non-section 10 – non-wetland
I-4	37.385639	86.974306	Intermittent	565 linear feet	non-section 10 – non-wetland
I-5	37.382778	86.967944	Intermittent	977 linear feet	non-section 10 – non-wetland
I-6	37.381222	86.977694	Intermittent	626 linear feet	non-section 10 – non-wetland
I-7	37.377722	86.973694	Intermittent	591 linear feet	non-section 10 – non-wetland
I-8	37.383167	86.963111	Intermittent	627 linear feet	non-section 10 – non-wetland
I-9	37.377389	86.955778	Intermittent	261 linear feet	non-section 10 – non-wetland
I-10	37.376278	86.961944	Intermittent	278 linear feet	non-section 10 – non-wetland
I-11	37.375111	86.956250	Intermittent	629 linear feet	non-section 10 – non-wetland
I-12	37.378583	86.949833	Intermittent	334 linear feet	non-section 10 – non-wetland
E-1	37.387972	86.978139	Ephemeral	602 linear feet	non-section 10 – non-wetland
E-2	37.389889	86.975611	Ephemeral	504 linear feet	non-section 10 – non-wetland
E-3	37.389500	86.971417	Ephemeral	144 linear feet	non-section 10 – non-wetland
E-4	37.389250	86.971222	Ephemeral	709 linear feet	non-section 10 – non-wetland
E-5	37.388278	86.970917	Ephemeral	224 linear feet	non-section 10 – non-wetland
E-6	37.386611	86.971528	Ephemeral	657 linear feet	non-section 10 – non-wetland

E-7	37.385667	86.970917	Ephemeral	1233 linear feet	non-section 10 – non-wetland
E-8	37.383139	86.974472	Ephemeral	542 linear feet	non-section 10 – non-wetland
E-9	37.383750	86.974111	Ephemeral	250 linear feet	non-section 10 – non-wetland
E10	37.384000	86.970944	Ephemeral	789 linear feet	non-section 10 – non-wetland
E-11	37.383333	86.970278	Ephemeral	756 linear feet	non-section 10 – non-wetland
E-12	37.382222	86.968639	Ephemeral	257 linear feet	non-section 10 – non-wetland
E-13	37.383306	86.967861	Ephemeral	342 linear feet	non-section 10 – non-wetland
E-14	37.383694	86.968194	Ephemeral	274 linear feet	non-section 10 – non-wetland
E-15	37.383194	86.967139	Ephemeral	374 linear feet	non-section 10 – non-wetland
E-16	37.383000	86.967306	Ephemeral	401 linear feet	non-section 10 – non-wetland
E-17	37.385389	86.983250	Ephemeral	2901 linear feet	non-section 10 – non-wetland
E-18	37.382611	86.977722	Ephemeral	565 linear feet	non-section 10 – non-wetland
E-19	37.384083	86.982694	Ephemeral	227 linear feet	non-section 10 – non-wetland
E-20	37.382028	86.974944	Ephemeral	903 linear feet	non-section 10 – non-wetland
E-21	37.381611	86.975056	Ephemeral	306 linear feet	non-section 10 – non-wetland
E-22	37.379250	86.976444	Ephemeral	210 linear feet	non-section 10 – non-wetland
E-23	37.378806	86.975806	Ephemeral	298 linear feet	non-section 10 – non-wetland
E-24	37.379417	86.972861	Ephemeral	997 linear feet	non-section 10 – non-wetland
E-25	37.380833	86.973139	Ephemeral	297 linear feet	non-section 10 – non-wetland
E-26	37.378333	86.972889	Ephemeral	1362 linear feet	non-section 10 – non-wetland
E-27	37.379861	86.971333	Ephemeral	203 linear feet	non-section 10 – non-wetland
E-28	37.377722	86.972889	Ephemeral	548 linear feet	non-section 10 – non-wetland
E-29	37.374417	86.970222	Ephemeral	1500 linear feet	non-section 10 – non-wetland

E-30	37.376101	86.969093	Ephemeral	478 linear feet	non-section 10 – non-wetland
E-31	37.375521	86.970122	Ephemeral	680 linear feet	non-section 10 – non-wetland
E-32	37.376139	86.968917	Ephemeral	998 linear feet	non-section 10 – non-wetland
E-33	37.374556	86.959972	Ephemeral	302 linear feet	non-section 10 – non-wetland
E-34	37.375333	86.960889	Ephemeral	190 linear feet	non-section 10 – non-wetland
E-35	37.375722	86.961611	Ephemeral	334 linear feet	non-section 10 – non-wetland
E-36	37.376389	86.962694	Ephemeral	451 linear feet	non-section 10 – non-wetland
E-37	37.375944	86.963806	Ephemeral	895 linear feet	non-section 10 – non-wetland
E-38	37.377194	86.964722	Ephemeral	311 linear feet	non-section 10 – non-wetland
E-39	37.378306	86.964944	Ephemeral	1317 linear feet	non-section 10 – non-wetland
E-40	37.378111	86.964556	Ephemeral	947 linear feet	non-section 10 – non-wetland
E-41	37.377417	86.962583	Ephemeral	913 linear feet	non-section 10 – non-wetland
E-42	37.376417	86.962056	Ephemeral	204 linear feet	non-section 10 – non-wetland
E-43	37.376639	86.961000	Ephemeral	277 linear feet	non-section 10 – non-wetland
E-44	37.379778	86.959333	Ephemeral	1401 linear feet	non-section 10 – non-wetland
E-45	37.374944	86.955444	Ephemeral	235 linear feet	non-section 10 – non-wetland
E-46	37.373389	86.955611	Ephemeral	143 linear feet	non-section 10 – non-wetland
E-47	37.375417	86.954333	Ephemeral	355 linear feet	non-section 10 – non-wetland
E-48	37.374194	86.953222	Ephemeral	380 linear feet	non-section 10 – non-wetland
E-49	37.382889	86.963472	Ephemeral	500 linear feet	non-section 10 – non-wetland
E-50	37.383972	86.963167	Ephemeral	407 linear feet	non-section 10 – non-wetland
E-51	37.383611	86.962417	Ephemeral	390 linear feet	non-section 10 – non-wetland
E-52	37.382889	86.961917	Ephemeral	220 linear feet	non-section 10 – non-wetland

E-53	37.382944	86.960583	Ephemeral	266 linear feet	non-section 10 – non-wetland
E-54	37.383444	86.960111	Ephemeral	342 linear feet	non-section 10 – non-wetland
E-55	37.382250	86.957333	Ephemeral	218 linear feet	non-section 10 – non-wetland
E-56	37.382917	86.958667	Ephemeral	657 linear feet	non-section 10 – non-wetland
E-57	37.384944	86.961000	Ephemeral	258 linear feet	non-section 10 – non-wetland
E-58	37.386611	86.961056	Ephemeral	251 linear feet	non-section 10 – non-wetland
E-59	37.386861	86.960333	Ephemeral	448 linear feet	non-section 10 – non-wetland
E-60	37.387167	86.958250	Ephemeral	512 linear feet	non-section 10 – non-wetland
E-61	37.387278	86.957667	Ephemeral	343 linear feet	non-section 10 – non-wetland
E-62	37.386861	86.957972	Ephemeral	294 linear feet	non-section 10 – non-wetland
E-63	37.385944	86.957000	Ephemeral	578 linear feet	non-section 10 – non-wetland
E-64	37.378944	86.955556	Ephemeral	1776 linear feet	non-section 10 – non-wetland
E-65	37.386778	86.952833	Ephemeral	143 linear feet	non-section 10 – non-wetland
E-66	37.386583	86.949861	Ephemeral	1007 linear feet	non-section 10 – non-wetland
E-67	37.383583	86.952556	Ephemeral	370 linear feet	non-section 10 – non-wetland
E-68	37.382389	86.950861	Ephemeral	198 linear feet	non-section 10 – non-wetland
E-69	37.379583	86.951111	Ephemeral	504 linear feet	non-section 10 – non-wetland
Wetland A	37.377028	86.953528	PEM1H	0.076 acres	non-section 10 – wetland
Wetland B	37.375722	86.953083	PSS1H	0.048 acres	non-section 10 – wetland
Wetland C	37.375139	86.953972	PEM1H	0.335 acres	non-section 10 – wetland
Wetland D	37.374000	86.950389	PFO1B	0.093 acres	non-section 10 – wetland
Wetland E	37.372778	86.951778	PEM1H	0.172 acres	non-section 10 – wetland
Wetland F	37.376389	86.957472	PEM1H	1.442 acres	non-section 10 – wetland

Wetland G	37.37806	86.955528	PEM1H	0.355 acres	non-section 10 – wetland
Wetland H	37.372722	86.953139	PEM1H	0.606 acres	non-section 10 – wetland
Wetland I	37.373222	86.955917	PEM1H	0.284 acres	non-section 10 – wetland
Wetland J	37.385861	86.951389	PEM1H	0.136 acres	non-section 10 – wetland
Wetland K	37.386306	86.952278	PEM1H	0.133 acres	non-section 10 – wetland
Wetland L	37.386583	86.952222	PEM1H	0.469 acres	non-section 10 – wetland
Wetland M	37.386806	86.953972	PEM1H	0.042 acres	non-section 10 – wetland
Wetland N	37.386389	86.954694	PEM1H	0.093 acres	non-section 10 – wetland
Wetland O	37.386972	86.958111	PEM1H	0.160 acres	non-section 10 – wetland
Wetland P	37.384694	86.957333	PEM1H	1.037 acres	non-section 10 – wetland
Wetland Q	37.398694	86.958083	PEM1H	0.028 acres	non-section 10 – wetland
Wetland R	37.382056	86.958417	PEM1H	0.453 acres	non-section 10 – wetland
Wetland S	37.383861	86.958083	PEM1H	0.441 acres	non-section 10 – wetland
Wetland T	37.383639	86.951778	PEM1H	0.105 acres	non-section 10 – wetland
Wetland U	37.375944	86.961611	PSS1H/PEM1H	0.620 acres	non-section 10 – wetland
Wetland V	37.376639	86.962722	PFO1A	0.920 acres	non-section 10 – wetland
Wetland W	37.385778	86.976361	PEM1H	0.015 acres	non-section 10 – wetland
Wetland Y	37.385306	86.981722	PEM1A/PFO1A	0.237 acres	non-section 10 – wetland
Wetland Z	37.386083	86.982417	PFO1A	0.107 acres	non-section 10 – wetland
Wetland AA	37.383250	86.978194	PSS1A	0.022 acres	non-section 10 – wetland
Wetland BB	37.377806	86.972889	PFO1A	0.273 acres	non-section 10 – wetland
Wetland CC	37.390444	86.97817	PFO1A	0.419 acres	non-section 10 – wetland
Wetland DD	37.389167	86.974472	PSS1A	0.263 acres	non-section 10 – wetland
Wetland EE	37.386333	86.973583	PSS1B	0.022 acres	non-section 10 – wetland

Wetland FF	37.384167	86.972750	PFO1B	0.190 acres	non-section 10 – wetland
Wetland GG	37.381972	86.969722	PEM1B	0.177 acres	non-section 10 – wetland
Wetland HH	37.382583	86.968417	PEM1B	0.102 acres	non-section 10 – wetland
Wetland II	37.379944	86.968500	PEM1B	0.013 acres	non-section 10 – wetland
Wetland JJ	37.379111	86.972361	PSS1B	0.053 acres	non-section 10 – wetland
Pond 1	37.387018	86.953398	Open water	2.576 acres	non-section 10 – wetland
Pond 2	37.385342	86.950686	Open water	0.685 acres	non-section 10 – wetland
Pond 3	37.383208	86.950558	Open water	3.380 acres	non-section 10 – non-wetland
Pond 4	37.375779	86.951768	Open water	8.096 acres	non-section 10 – non-wetland
Pond 5	37.373115	86.951971	Open water	1.297 acres	non-section 10 – non-wetland
Pond 6	37.373354	86.954503	Open water	5.782 acres	non-section 10 – non-wetland
Pond 7	37.375625	86.959385	Open water	5.649 acres	non-section 10 – non-wetland
Pond 8	37.382040	86.960702	Open water	4.184 acres	non-section 10 – non-wetland
Pond 9	37.384887	86.959707	Open water	4.404 acres	non-section 10 – non-wetland
Pond 10	37.385842	86.957969	Open water	0.919 acres	non-section 10 – non-wetland
Pond 11	37.385839	86.976490	Open water	0.143 acres	non-section 10 – non-wetland

*Final jurisdictional determinations will be made by US Army Corps of Engineers for all impacts.*

Threatened &  
Endangered  
Species Habitat

## THREATENED AND ENDANGERED SPECIES

The federally endangered Indiana bat (*Myotis sodalis*) has the potential to occur in Ohio County, Kentucky (USFWS 2008). The Kentucky Fish and Wildlife Information System does not have any recorded Indiana bat observations for Ohio County (KDFWR 2010), and there are no Priority 1-4 caves listed in the Indiana bat's Recovery Plan for the county (USFWS 2007). Based on the available information, no "known habitat" occurs in the study area or within a 10-mile radius.

Potential summer roosting and foraging habitats exist on the proposed Midway South mine site. The site is composed of approximately 615 acres of second-growth or younger forest. Land use in the project area includes forest, wetlands and ponds, and roads. A summer survey for Indiana bat presence has not been conducted.



Photo of typical forested landscape of project area. Dominant tree species on site consist of sugar and red maple, tulip-poplar, oak spp., beech, shagbark hickory, ash, sycamore, elm, and flowering dogwood.

Due to the potential for caves, rockshelters, and abandoned underground mines to be present onsite, site visits by T.H.E. Engineers, Inc. during August, September, and October 2012 evaluated the site for potential Indiana bat habitat.

Hibernation site requirements for the Indiana bat include caves and mines with large volumes, extensive passages, and stable temperatures below 10 degrees Celsius (USFWS 2007). The Hartford and Paradise USGS topographic quadrangles do not show any cave or mine adit symbols within the project boundary. The Hartford and Paradise Geologic Quadrangles show past strip mining on parts of the site. The geology is composed of alluvium

and the Sturgis Formation, which consists of sandstone, siltstone, shale, coal, and underclay (Kehn 1974). The Kentucky Surface Mining Viewer (2010) and Available Mine Maps from the Kentucky Mine Mapping Initiative (2010) were accessed for locations of mine shafts and active and closed permits. The Available Mine Maps show abandoned strip mining in the project area. No caves, underground mines, or potential winter habitat for the Indiana bat were found on the project site.

The USFWS species database (2008) lists several federally endangered mussel species as being known from Ohio County: purple catspaw pearlymussel (*Epioblasma obliquata obliquata*), fanshell (*Cyprogenia stegaria*), and orangefoot pimpleback (*Plethobasus cooperianus*). The database also lists several mussel species as having the potential to occur in Ohio County: pink mucket (*Lampsilis abrupta*), ring pink (*Obovaria retusa*), clubshell (*Pleurobema clava*), rough pigtoe (*Pleurobema plenum*), and fat pocketbook (*Potamilus capax*). Kentucky's Comprehensive Wildlife Conservation Strategy describes the preferred habitat for each of these mussel species. Most of the species prefer medium-sized to large rivers with sand and gravel substrates, and specifically the Green River provides or has historically provided habitat to many of these mussels (KDFWR 2005). No suitable habitat for any of these mussels is located within the project area.

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Stream  
Biological Status

## **Biological Status of Streams – Midway South Site**

This discussion will focus on an assessment of each perennial and intermittent stream in regards to the habitat provided or available for aquatic colonization. The ephemeral streams will be discussed as a group.

### **Perennial Stream 1 (P-1)**

This stream has a riffle/pool complex, and some variability in its substrate material, which should provide more variability in available habitat. With its large watershed, it should be prone to have drift and/or debris, and have larger size substrate material moved into and through its system. This is evidenced by the stream bottom in riffles and runs being predominantly gravel, with smaller amounts of sand size material found. It is rated as suboptimal for epifaunal substrate/available cover, indicating that there is enough stable habitat that is suitable for a full colonization potential. Additionally, even though there has been mining upstream of the study boundary, the stream did not appear to be subject to undue sediment deposition, again indicating that the substrate is stable. The tree canopy is poor, due to agricultural practices (cropped fields) along both sides of the stream. This condition allows for only some shading and aid in regulating/cooling the water temperature.

### **Perennial Stream 2 (P-2)**

This stream also has a riffle/pool complex, with good variability in its substrate material that should provide variability in available habitat. It is rated as optimal for epifaunal substrate/available cover, indicating that there is enough stable habitat to allow for a full colonization potential. Its large watershed should also provide drift and/or debris. Some larger size substrate material may move into and through its system. This is evidenced by the stream bottom throughout the system of riffles, runs, and pools maintaining a good mix of material sizes. The stream did not appear to be subject to undue sediment deposition, again indicating that the substrate is stable. The tree canopy is sufficient to provide shading and aid in regulating/cooling the water temperature.

### **Intermittent Stream 1 (I-1)**

This stream lacks riffles and pools that would provide habitat. In addition, the substrate is silt/clay material only. The epifaunal substrate/available cover scored as only marginal, another indication that it is lacking stable substrate and habitat availability. Sediment deposition was moderate. There was little to no flow in the stream at the time of assessment. The reach had adequate canopy cover to provide some regulation of water temperatures. No macroinvertebrates or fishes were observed during the time of assessment, or expected to be found, due to the lack of flow in the stream.

#### Intermittent Stream 2 (I-2)

This stream morphology is essentially all runs and pools, void of riffles except in its lower reach. Flow was present, and appeared normal at the time of assessment. The substrate was predominantly a mix of silt/clay and sand, with the lower reach being predominantly gravel size material. The epifaunal substrate/available cover scored suboptimal, which would indicate there is adequate stable habitat or desirable conditions for colonization (mainly debris and detritus). The upper reaches showed some deposition of new fine material, while the lower reach showed moderate deposition, which may be an indication of some instability of the substrate. No macroinvertebrates or fishes were observed during the time of assessment.

#### Intermittent Stream 3 (I-3)

This stream consists of only runs, and the substrate is all silt/clay material. This substrate would not typically provide for stable habitat needed for colonization, however there was little evidence of new deposition of fine material which may indicate the bottom is relatively stable. For this reason, the epifaunal substrate/available cover scored suboptimal. The stream is partially exposed, lacking the shade that would provide regulation of water temperature. Flow was present at the time of assessment, but the small watershed may not provide for sustained flows. No macroinvertebrates or fishes were observed during the time of assessment.

#### Intermittent Stream 4 (I-4)

This stream also consists of runs only. The substrate material is a mix of silt/clay and sand sizes. Moderate deposition of new fine material was found, indicating the channel bottom is unstable and not desirable for colonization. The stream was flowing during the time of the assessment. The watershed size would indicate that there is likely a lack of continued flow needed for the development of a sustainable aquatic habitat. The riparian zone was low marginal, with most of the stream length fully exposed. Little shading for water temperature regulation is available. No macroinvertebrates or fishes were observed during the time of assessment.

#### Intermittent Stream 5 (I-5)

This stream consists of runs only. The substrate is predominantly sand, with lesser amounts of silt/clay sizes. There was moderate deposition of new material occurring, which limits the amount of stable habitat available for colonization. However, there was drift and detritus found that could provide for habitat. Flow was present during the time of assessment, but again, the watershed size does not appear adequate to provide for sustained flow. Adequate tree canopy to aid in water temperature regulation was found. No macroinvertebrates or fishes were observed during the time of assessment.

#### Intermittent 6 (I-6)

I-6 consisted of long runs and very short pool sections. The substrate consists of only silt/clay material with little evidence of new deposition in the channel found. This indicates that the substrate is somewhat stable. Some flow was observed, and pooled at the time of assessment. Once again, the watershed size is small, and it appears that sustaining flows in this stream maybe problematic and hindering colonization. The tree canopy was adequate for shading and regulation of water temperatures. No macroinvertebrates or fishes were observed during the time of assessment.

#### Intermittent 7 (I-7)

This stream also consisted of long runs and short pools. The substrate was an equal mix of silt/clay and sand size material. Some deposition of new material was found, which would indicate that stable habitat is somewhat limited, but suitable for colonization. The exposed root systems and availability of debris and detritus could aid in providing some habitat in the channel. There was flow and pooling during the time of the assessment. The stream is fully shaded, allowing for water temperature regulation. No macroinvertebrates or fishes were observed during the time of assessment.

#### Intermittent 8 (I-8)

This stream consisted of short riffles, long runs and short pools. The substrate was a mix of silt/clay, sand, and gravel size materials. Moderate deposition of new material was found, indicating that stable habitat is limited. But again, exposed root systems and debris and detritus could aid in providing some habitat. There was flow and pooling during the time of the assessment, but sustained flows may be problematic due to the small watershed size. The stream is fully shaded, allowing for water temperature regulation. No macroinvertebrates or fishes were observed during the time of assessment.

#### Intermittent 9 (I-9)

This stream consisted of equal length runs and pools. The substrate was silt/clay size material only. There was little evidence of deposition of new material found, indicating that there was stable habitat available. There was flow and pooling during the time of the assessment. The stream is partially shaded, allowing for some water temperature regulation. No macroinvertebrates or fishes were observed during the time of assessment.

#### Intermittent 10 (I-10)

This stream consisted of very short riffles, long runs and short pools. The substrate was predominantly silt/clay size material, with some sand present. There was evidence of moderate deposition of new material found, indicating that there was unstable habitat. There was flow and pooling during the time of the assessment. The stream is partially shaded, allowing for some water temperature regulation. No macroinvertebrates or fishes were observed during the time of assessment.

#### Intermittent 11 (I-11)

This stream consisted of only a long deep pool. The substrate was predominantly silt/clay size material, but with a mix of materials up to boulder size present. Although there was evidence of some deposition of new material found, the substrate appears stable and suitable for colonization. There was flow and the pool occupied most of the channel bottom during the time of the assessment. The stream is partially shaded, allowing for some water temperature regulation. No macroinvertebrates or fishes were observed during the time of assessment.

#### Intermittent 12 (I-12)

This stream consisted of long runs and shorter pools. The substrate was predominantly silt/clay size material, but with sand sizes present. There was evidence of moderate deposition of new material found, making the substrate less than desirable for colonization. There was flow during the time of the assessment, although the small watershed would not allow for sustained flows for adequate colonization to take place. The stream is partially exposed, not allowing for much water temperature regulation. No macroinvertebrates or fishes were observed during the time of assessment.

In general, for many of these intermittent streams it appears that conditions for development of biological communities would be abated by the lack of adequate, and sustainable, flow and/or the instability of the predominantly silt/clay nature of the substrate.

#### EPHEMERAL STREAMS

By their very nature, these streams are typically dry for majority of the year. The lack of flow does not encourage the development of aquatic colonization. These streams usually consist of long runs only, with an occasional short shallow pool section. The streambed material is typically silt/clay with some deposition of new material found, indicating a limited stable substrate. It is expected that these streams would have difficulty in developing and maintaining habitat suitable for colonization due to the lack of flow in the streams. No macroinvertebrates or fish were observed during the time of assessment.

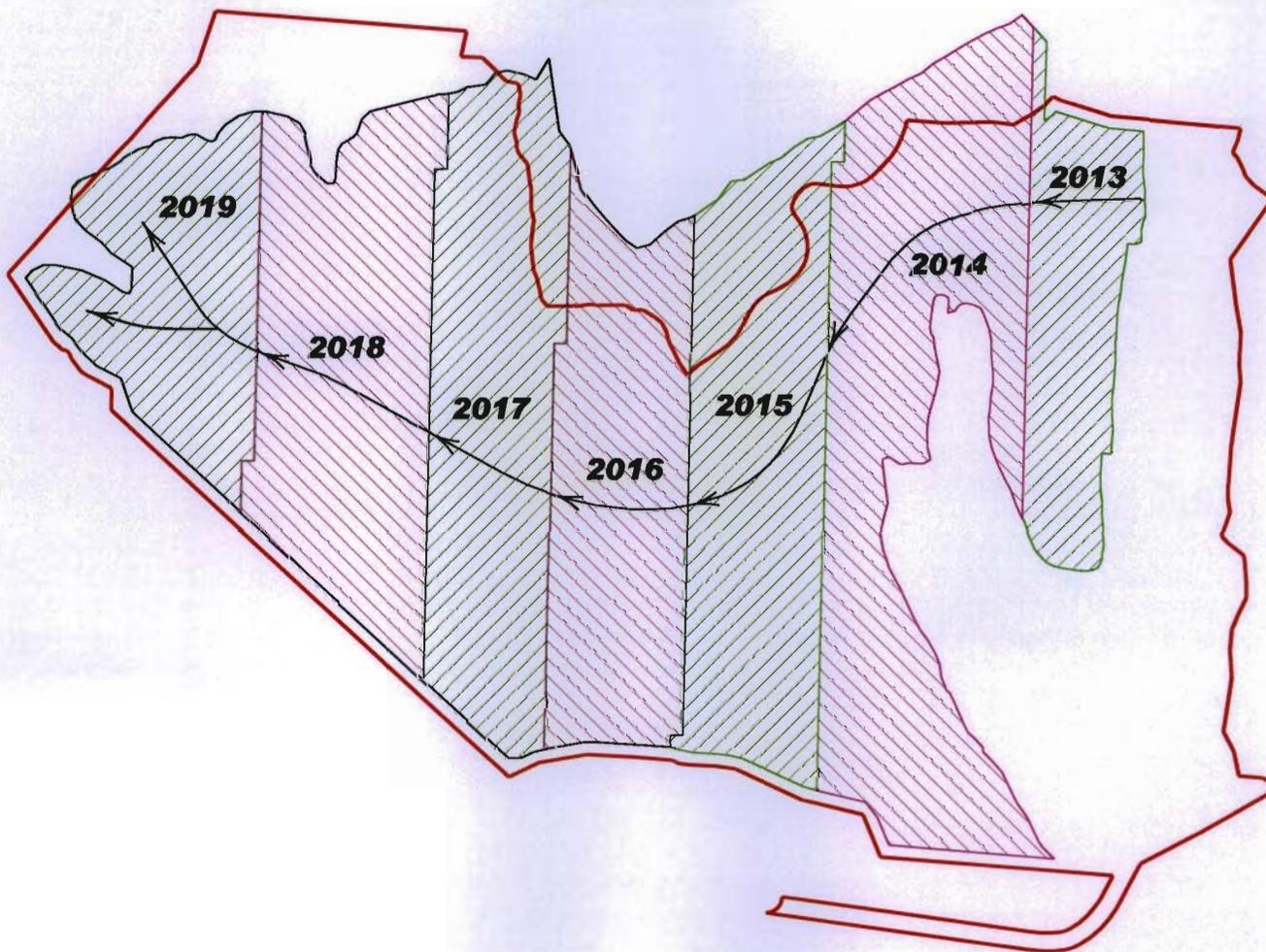
Mining  
Maps



# Midway South Mining Schedule Map



SCALE 1"=1500'



Legend	
	Permit Boundary
	Recovery Extent
	Mining Progression