Mitigation Plan
for
Stream Impacts

Lewis Creek West 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

May 17, 2012

(Revised October 12, 2012)

Stream Mitigation Plan

Section C of PCN ..... Pages 1-9
Vicinity Map ..... Exhibit 1
Proposed Stream Locations ..... Exhibits 2-3
Plan Sheet Index ..... Exhibit 4
Stream Plan Views ..... Exhibits 5-9
Ephemeral Typical Plan / Cross Sections ..... Exhibits 10-49
Intermittent Typical Plan / Cross Sections ..... Exhibits 50-78
Rosgen Stream Type “C” and “E”- Typical Plan and Profile ..... Exhibit 79
Rosgen Stream Type “B” and “Ba” - Typical Plan and Profile ..... Exhibits 80-81
Stream Structures and Planting Details ..... Exhibits 82-86
Table of Existing and Proposed Stream Lengths ..... Exhibit 87

C. Compensatory Mitigation: Midway West 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 done on-site in conjunction with the mitigation of an intermittent stream (INT-1); refer to “Mitigation Plan for Wetland Impacts”.

(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. 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.

(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. Wetlands will be compensated for through the use of the in-lieu fee payment.

(b) It is proposed that a total of 25,796 feet of ephemeral and 21,306 feet of intermittent stream will be restored on-site.

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

(d) Please refer to the "Stream Habitat Assessment and Wetland Delineation Report" prepared for Armstrong Coal Company, dated February 1, 2012, for existing conditions of streams. The site is located within two twelve-digit Hydrologic Unit Codes (HUC’s); the Rough River (051100040505) and 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 barnyard 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.

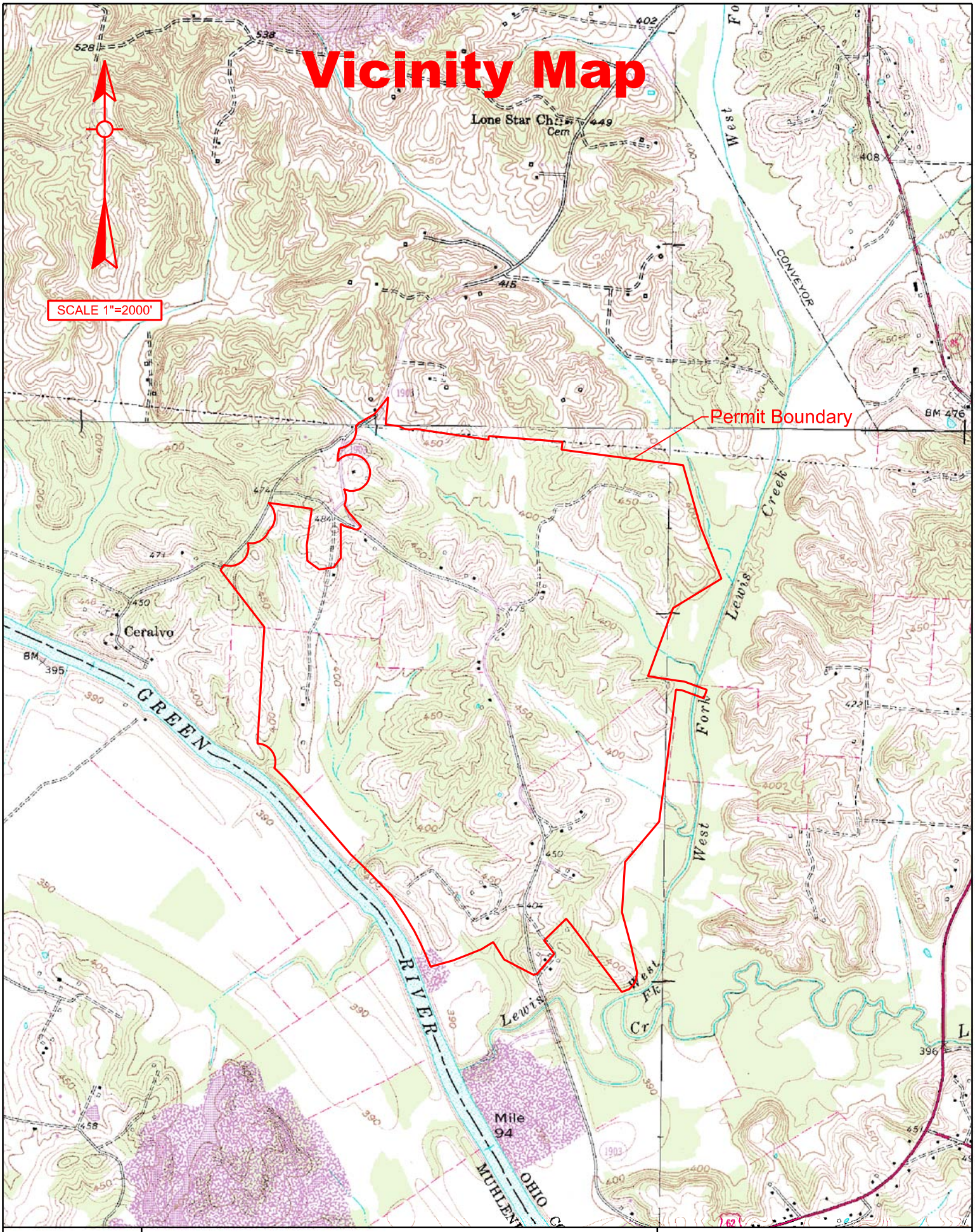
(9) Monitoring and Long-Term Management

(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.

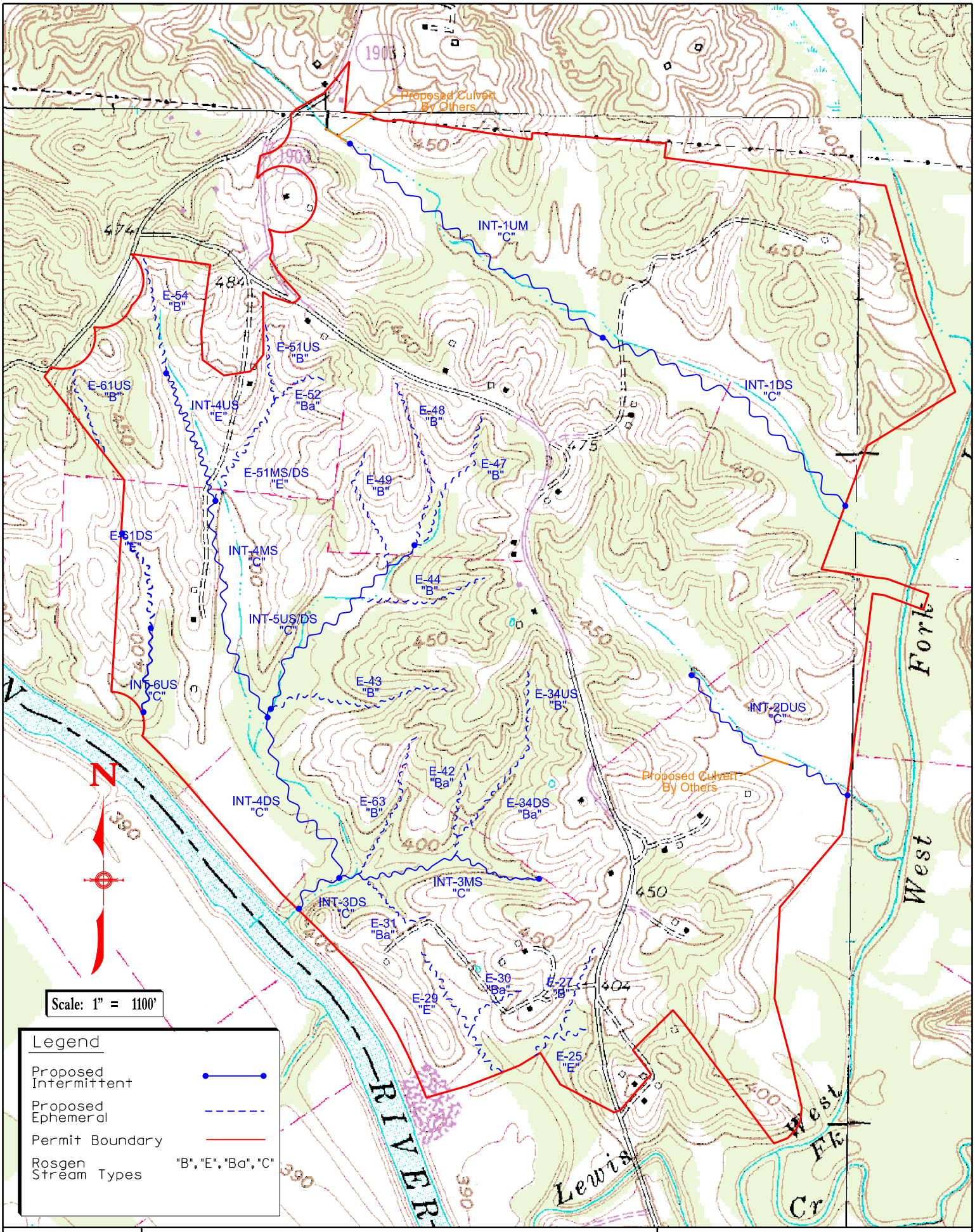
(10) Financial Assurances

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.



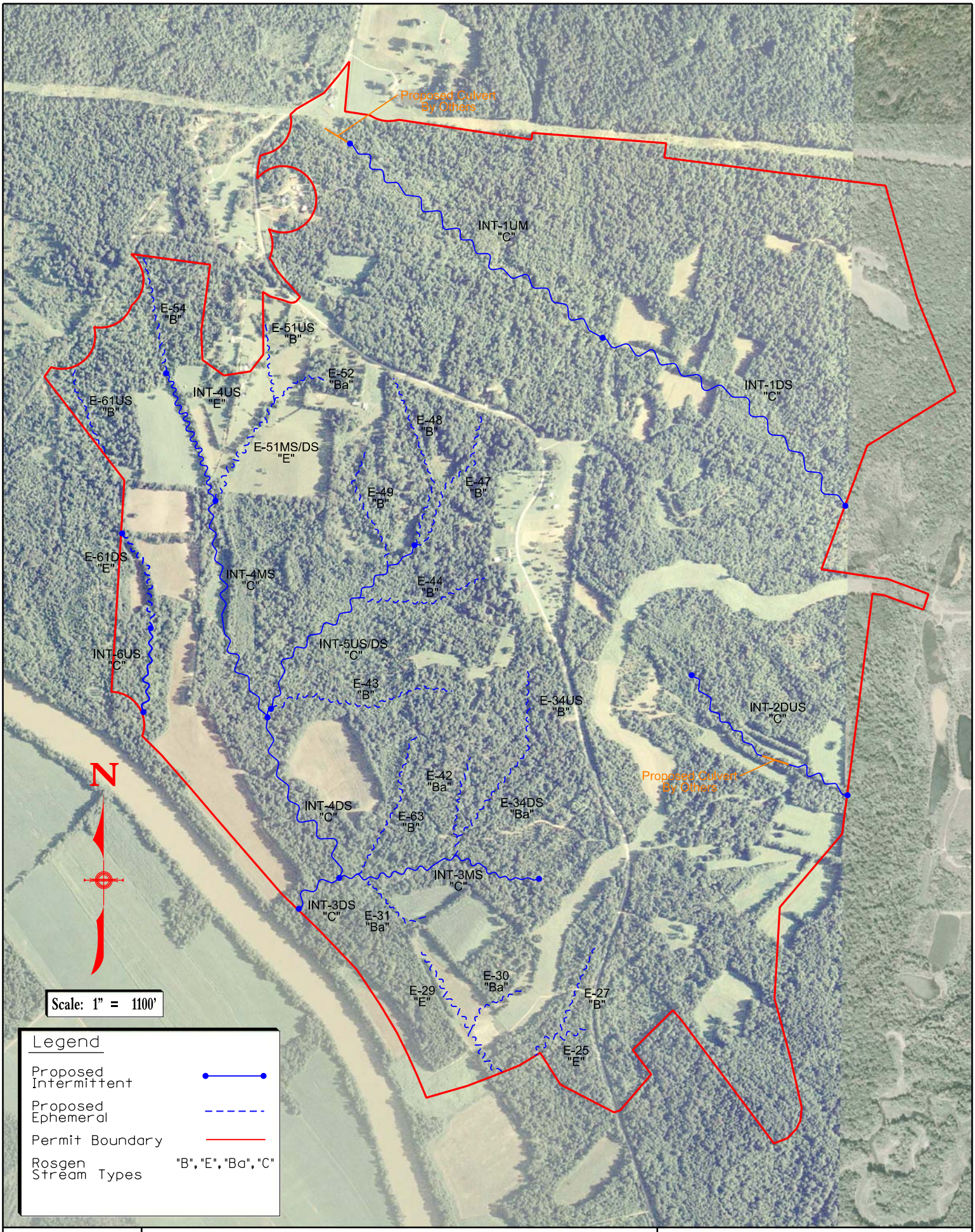
T.H.E. Engineers, Inc.	PROJECT: LEWIS CREEK WEST-SITE PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER	
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: VICINITY MAP	EXHIBIT 1

DATE:



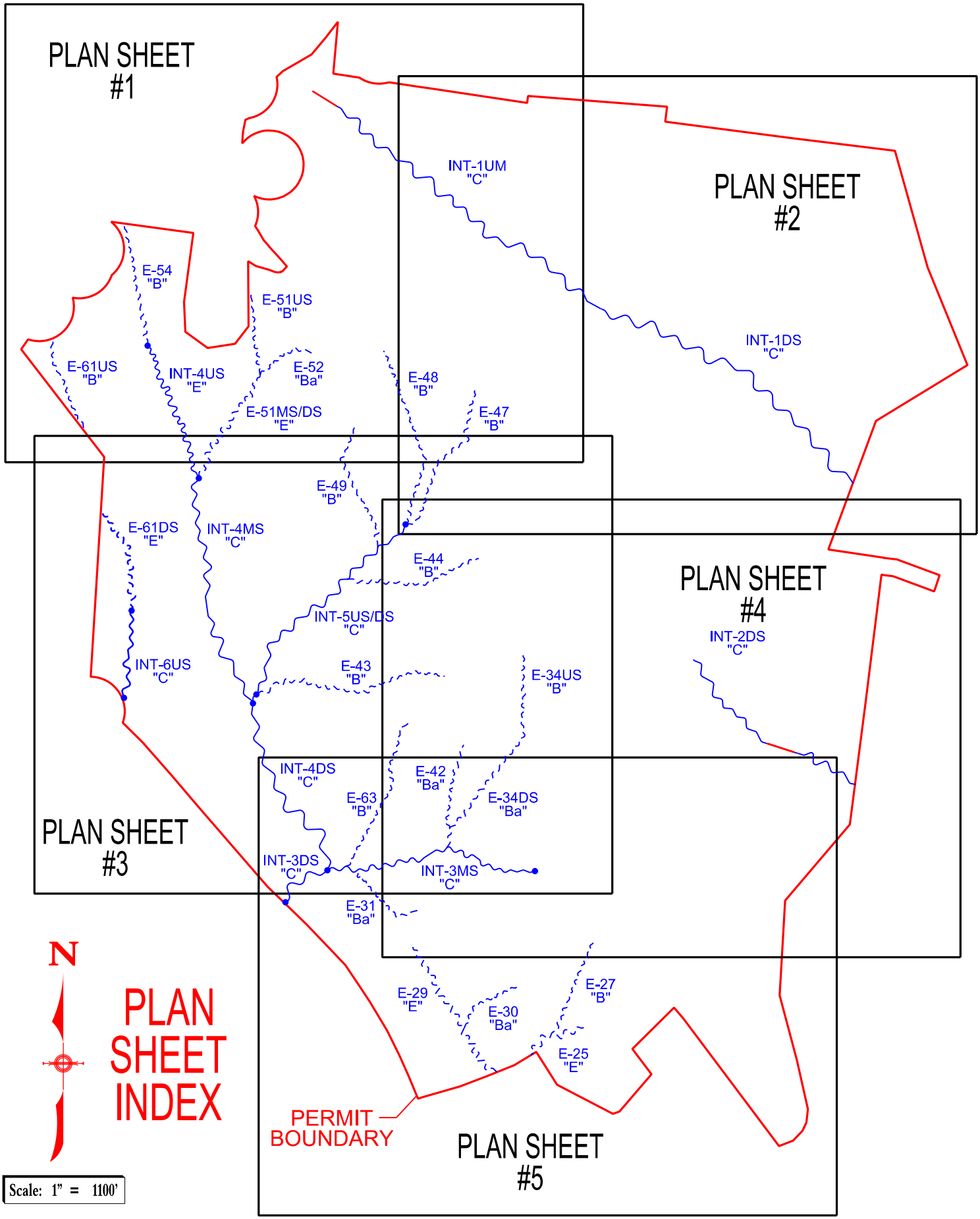
T.H.E. Engineers, Inc.	PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: AERIAL	EXHIBIT 2

DATE:



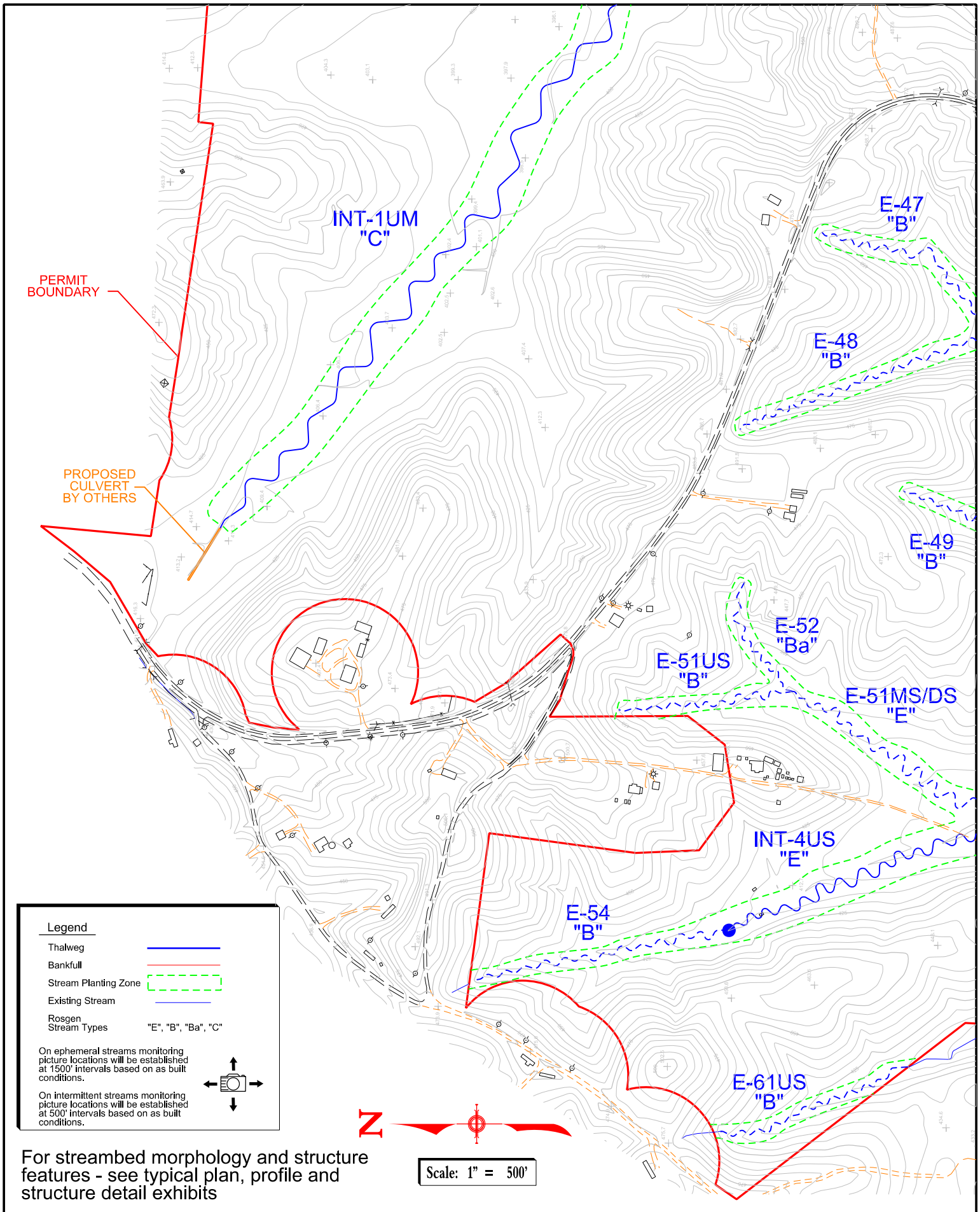
T.H.E. Engineers, Inc.	PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: AERIAL	EXHIBIT 3

DATE:



T.H.E. Engineers, Inc.	PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: PLAN SHEET INDEX	EXHIBIT 4

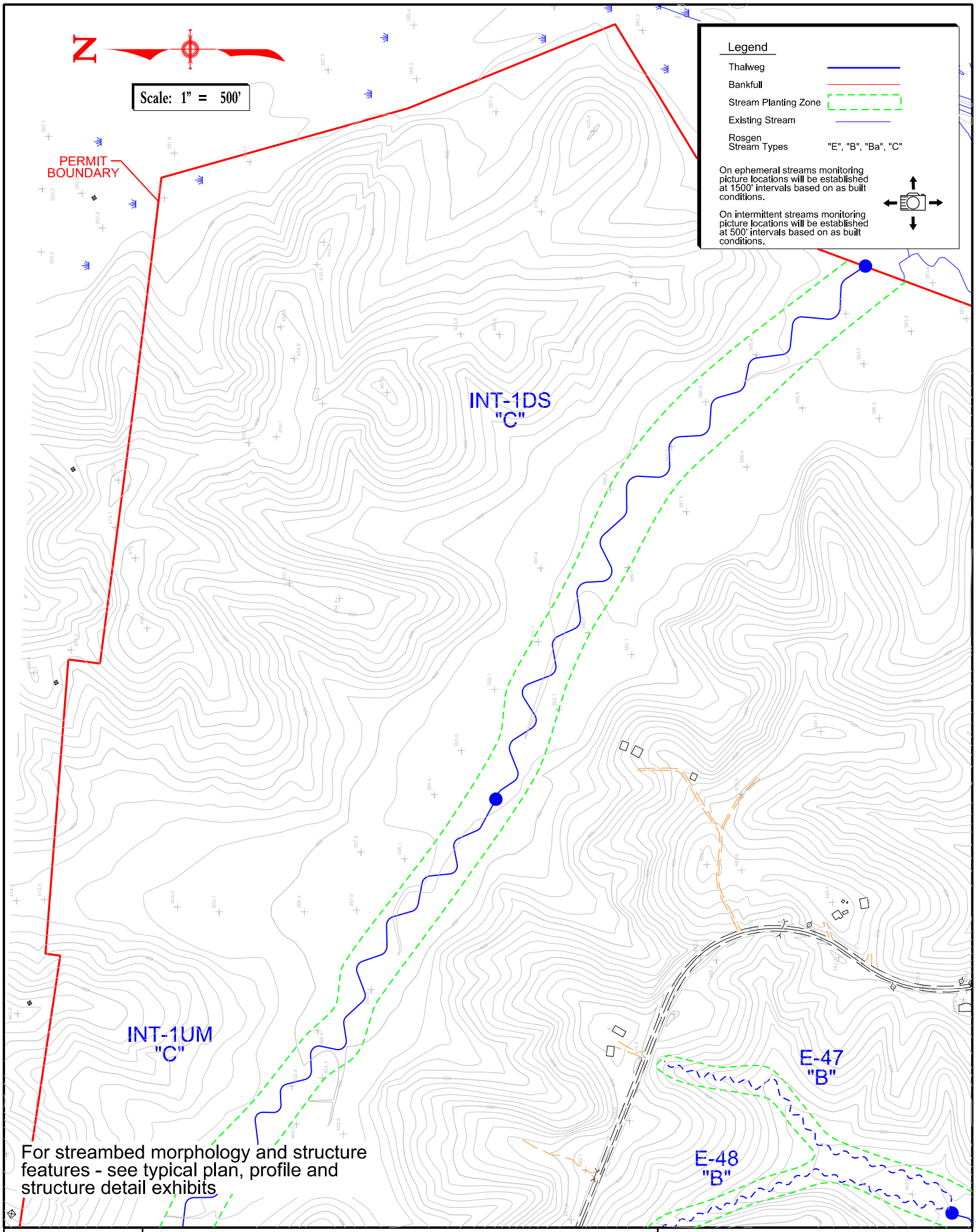
DATE:



For streambed morphology and structure features - see typical plan, profile and structure detail exhibits

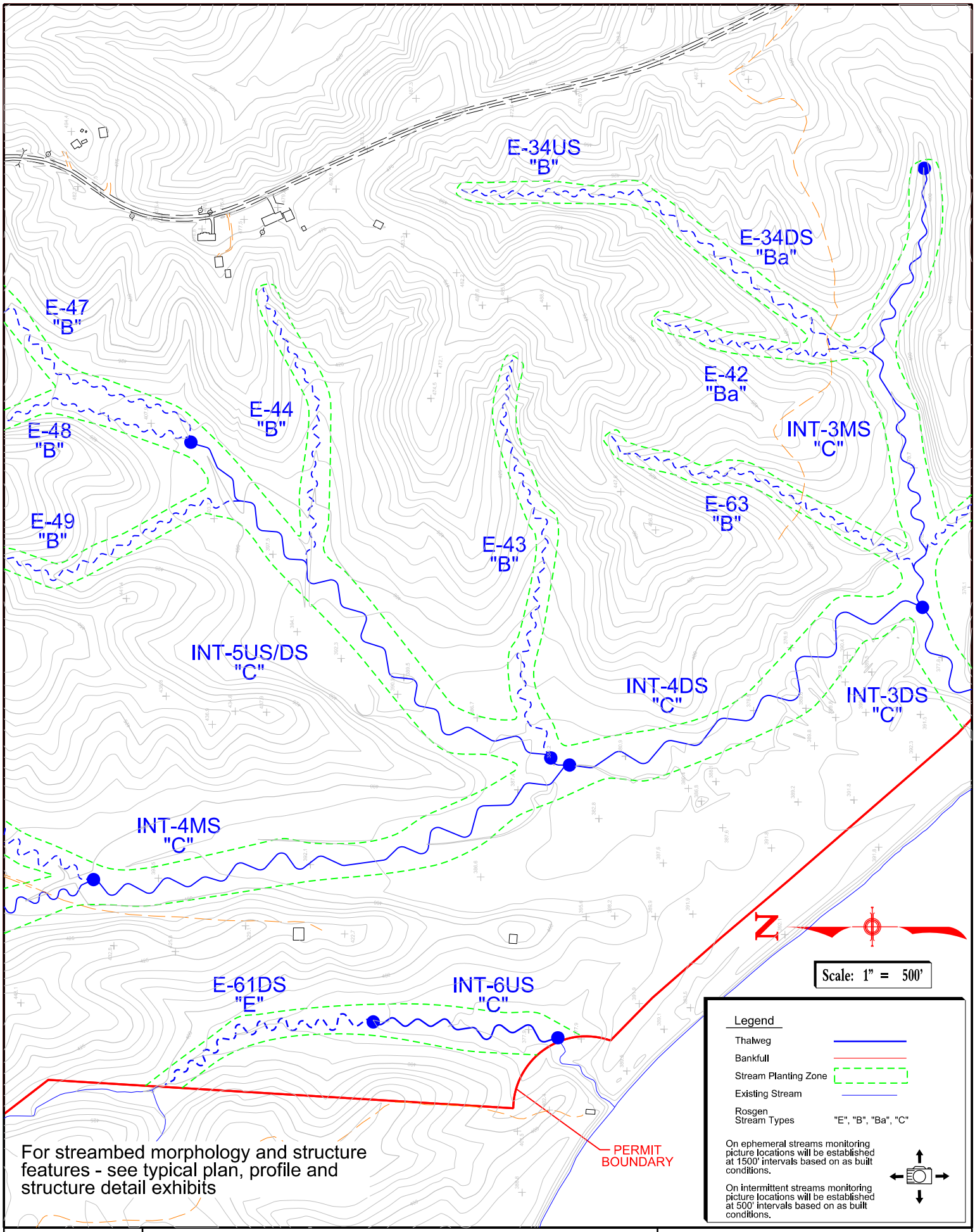
T.H.E. Engineers, Inc.	PROJECT: HICKORY RIDGE SITE-PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER	
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: PLAN SHEET 1	EXHIBIT 5

DATE:



T.H.E. Engineers, Inc.	PROJECT: HICKORY RIDGE SITE-PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: PLAN SHEET 2	EXHIBIT 6

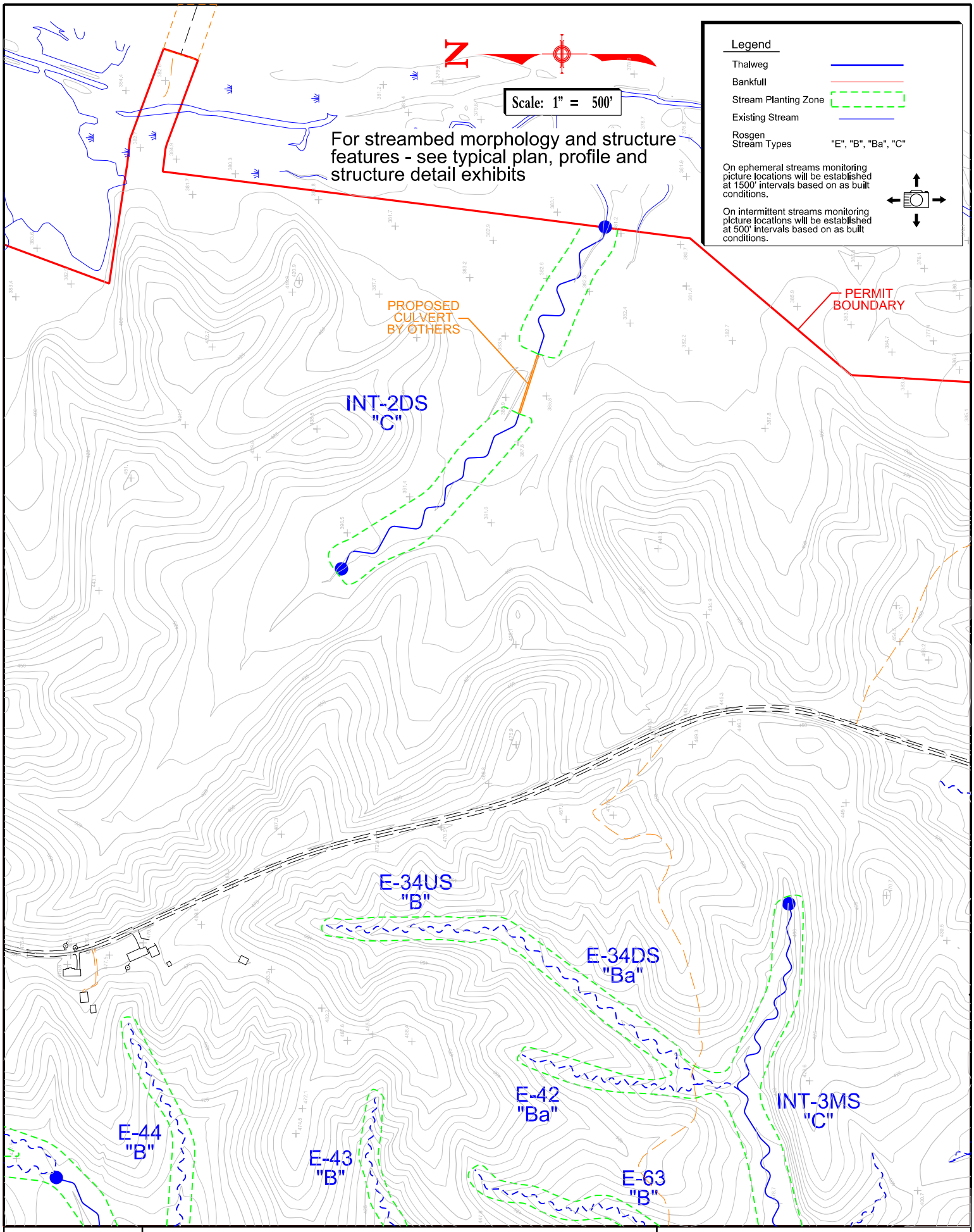
DATE:



For streambed morphology and structure features - see typical plan, profile and structure detail exhibits

T.H.E. Engineers, Inc.	PROJECT: HICKORY RIDGE SITE-PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: PLAN SHEET 3	EXHIBIT 7

DATE:



T.H.E. Engineers, Inc.	PROJECT: HICKORY RIDGE SITE-PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER	
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: PLAN SHEET 4	EXHIBIT 8

DATE:

For streambed morphology and structure features - see typical plan, profile and structure detail exhibits

E-25
"E"

E-27
"B"

E-30
"Ba"

E-34DS
"Ba"

PERMIT
BOUNDARY

E-29
"E"

INT-3MS
"C"

E-42
"Ba"

E-63
"B"

E-31
"Ba"

INT-4DS
"C"

INT-3DS
"C"

Z

Scale: 1" = 500'

Legend

Thalweg	
Bankfull	
Stream Planting Zone	
Existing Stream	
Rosgen Stream Types	"E", "B", "Ba", "C"

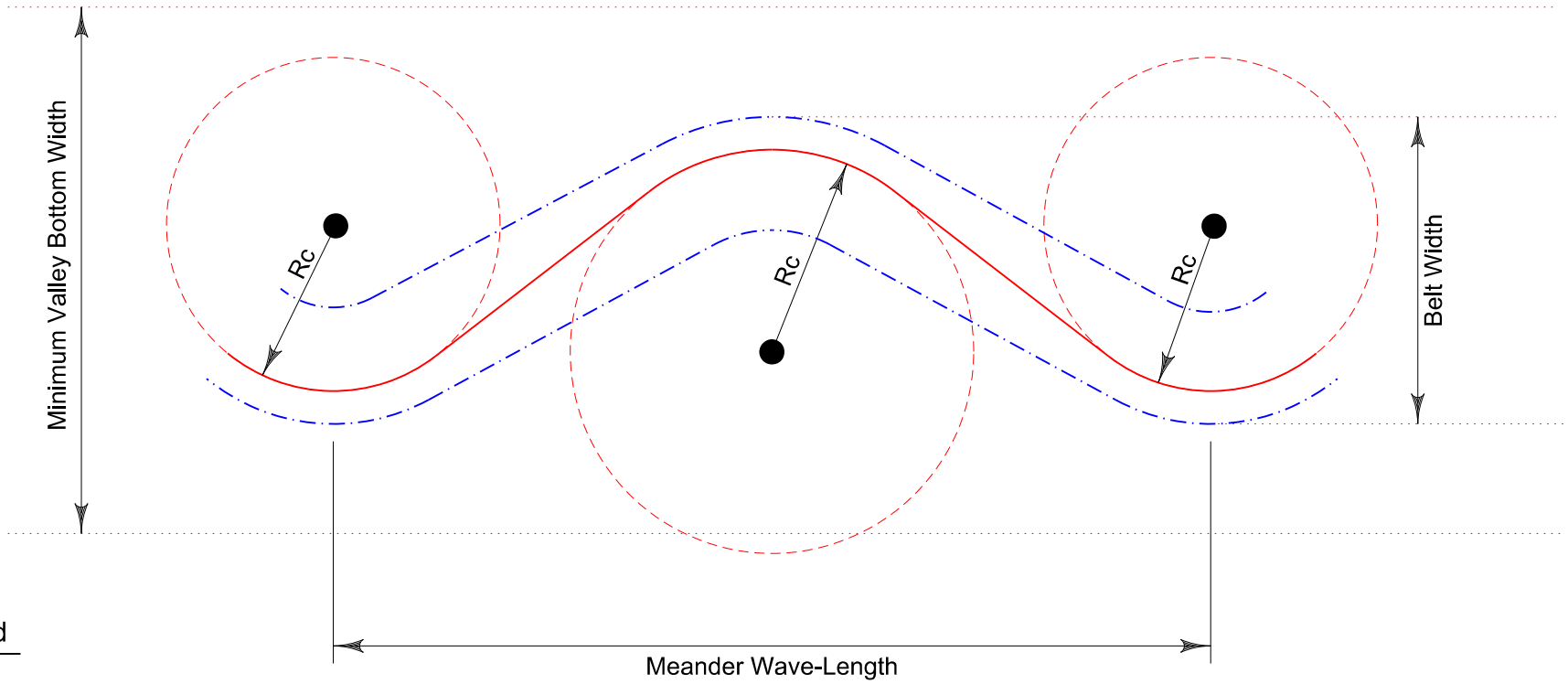
On ephemeral streams monitoring picture locations will be established at 1500' intervals based on as built conditions.

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

T.H.E. Engineers, Inc.	PROJECT: HICKORY RIDGE SITE-PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER	
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: PLAN SHEET 5	EXHIBIT 9

DATE:

Typical Meander Pattern for Rosgen Stream Type "E"
Stream E25



Legend

Bankfull

Thalweg

Bankfull Width=5.6'
Radius of Curvature (Rc) Ranges from 14' to 19'
Belt Width Ranges from 56' to 85'
Meander Wave-Length Ranges from 56' to 79'
Approximate Proposed Reach Length = 836'
Proposed Sinuosity is Approximately 1.5 (1.5 or greater)
Proposed Stream Gradient Ranges from 1% to 1.5%
Proposed Valley Slope Ranges from 1.5% to 2.2%
Minimum Valley Bottom Width = 90'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-25 | EXHIBIT 10

DATE:

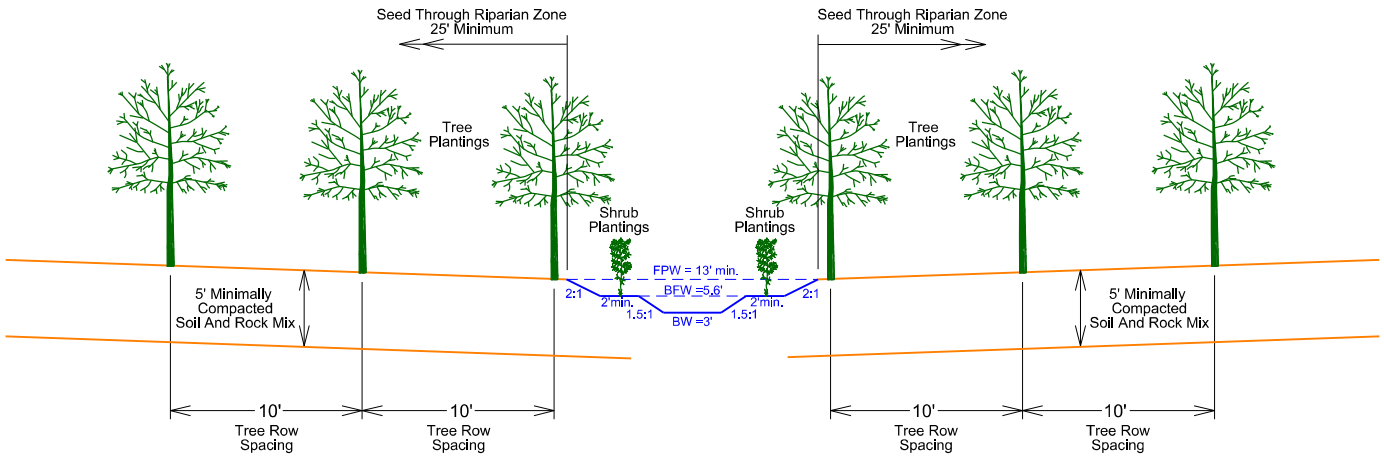
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 5.6'
* Bankfull Max. Depth = 0.87'
* Bankfull Area = 3.75SF
* Bankfull Mean Depth = 0.67'
* Flood-Prone Width (FPW) = 13.0' min
* W/D Ratio = 8.37
* Entrenchment Ratio = 2.31
* 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 E25
Rosgen Stream Type "E"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

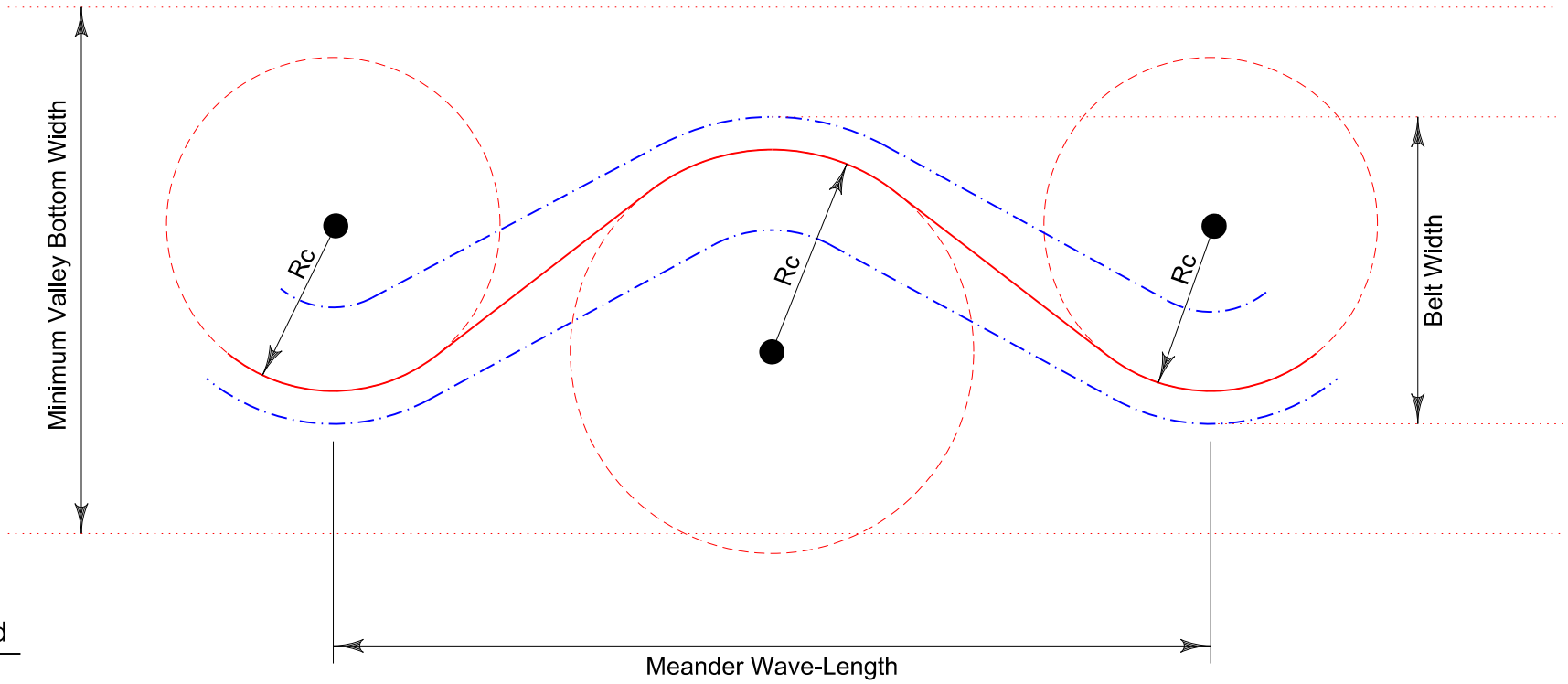
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-25

EXHIBIT 11

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E27



Legend

Bankfull

Thalweg

Bankfull Width=4.7'
Radius of Curvature (Rc) Ranges from 11' to 16'
Belt Width Ranges from 18' to 25' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 1028'
Proposed Sinuosity is Approximately 1.2 (1.2 or greater)
Proposed Stream Gradient Ranges from 1.5% to 2.3%
Proposed Valley Slope Ranges from 1.8% to 2.8%
Minimum Valley Bottom Width = 35'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-27 | EXHIBIT 12

DATE:

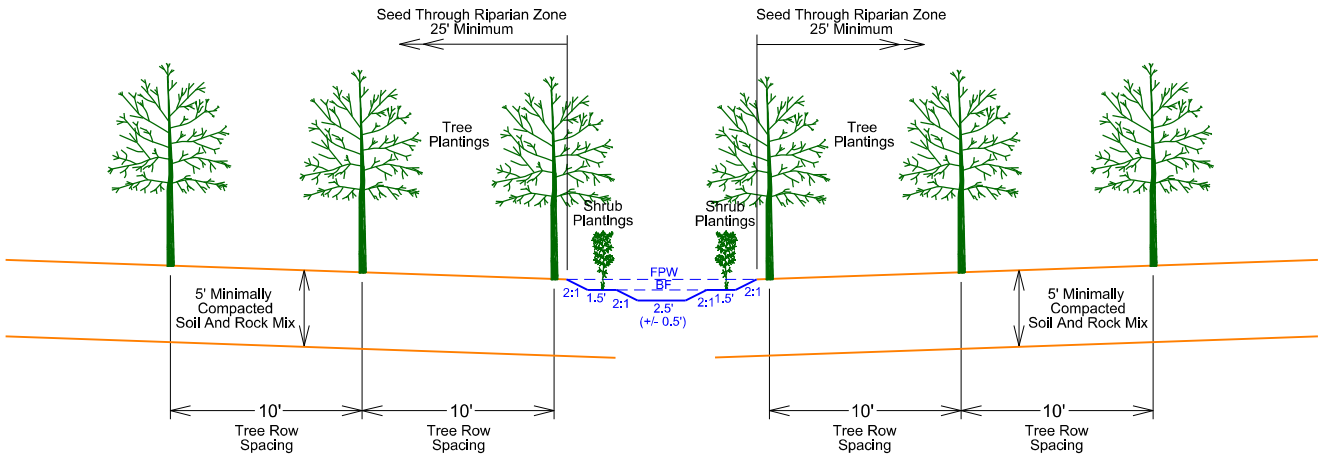
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 4.7'
* Bankfull Max. Depth = 0.55'
* Bankfull Area = 1.98 sq. ft.
* Bankfull Mean Depth = 0.42'
* Flood-Prone Width (FPW) = 10.0' (Maximum)
* W/D Ratio = 12
* Entrenchment Ratio = 2.1
* Bench Width = 1.5'



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 E27
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

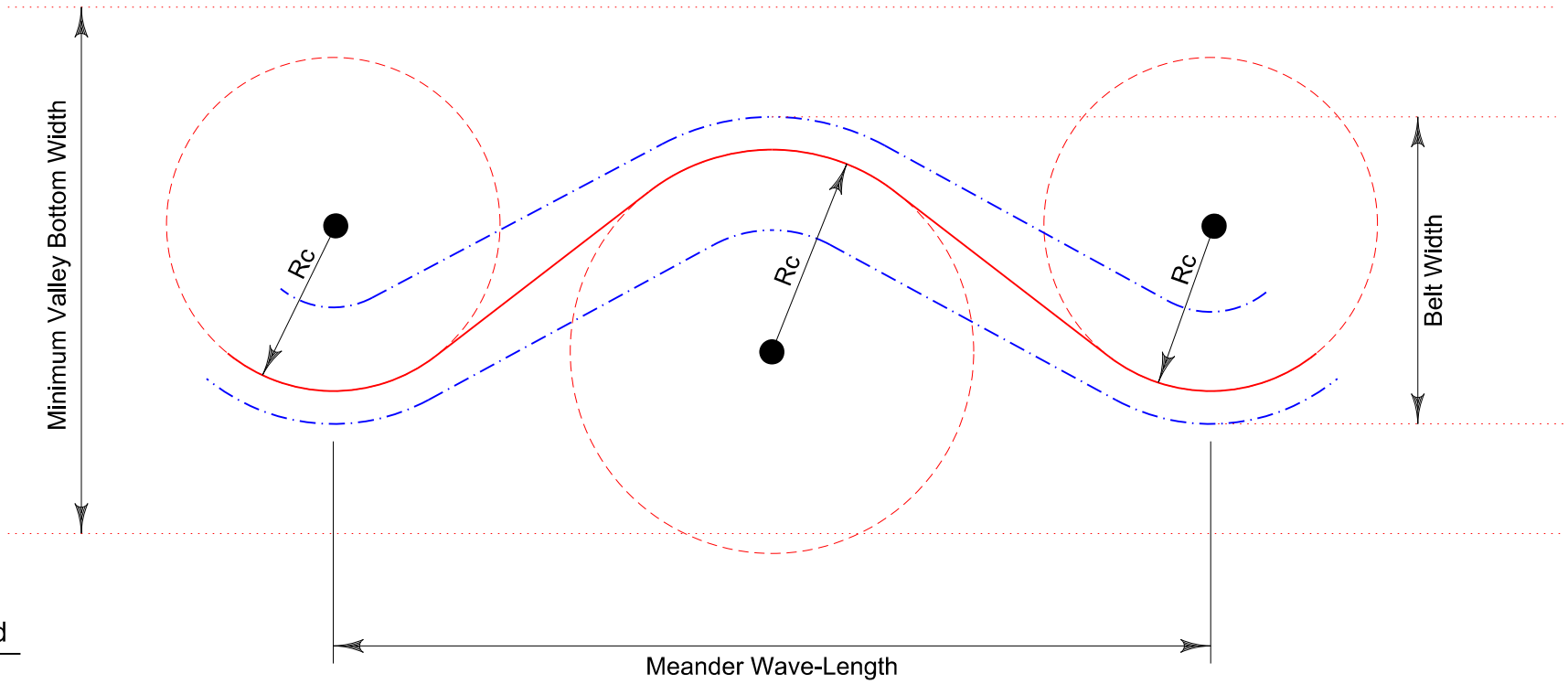
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-27

EXHIBIT 13

DATE:

Typical Meander Pattern for Rosgen Stream Type "E"
Stream E29



Legend

Bankfull

Thalweg

Bankfull Width=5.05'
Radius of Curvature (Rc) Ranges from 12' to 18'
Belt Width Ranges from 50' to 85'
Meander Wave-Length Ranges from 50' to 70'
Approximate Proposed Reach Length = 1976'
Proposed Sinuosity is Approximately 1.5 (1.5 or greater)
Proposed Stream Gradient Ranges from 1% to 1.8%
Proposed Valley Slope Ranges from 0.7% to 1.2%
Minimum Valley Bottom Width = 92'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-29 | EXHIBIT 14

DATE:

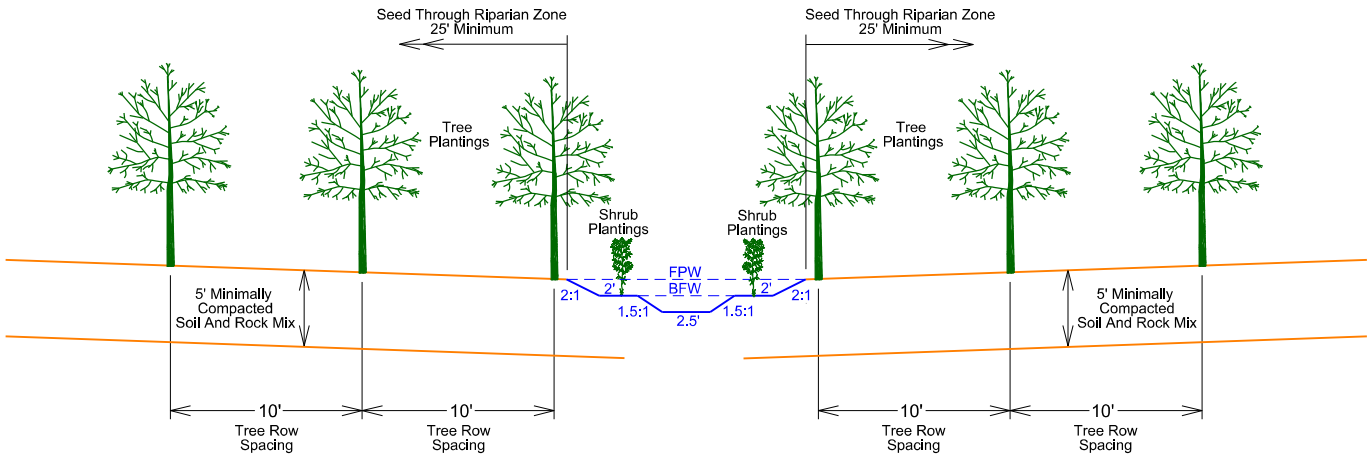
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 5.05'
* Bankfull Max. Depth = 0.85'
* Bankfull Area = 3.2SF
* Bankfull Mean Depth = 0.63'
* Flood-Prone Width (FPW) = 12.5' Min
* W/D Ratio = 8
* Entrenchment Ratio = 2.47 Min
* Bench Width = 2' 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 E29
Rosgen Stream Type "E"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

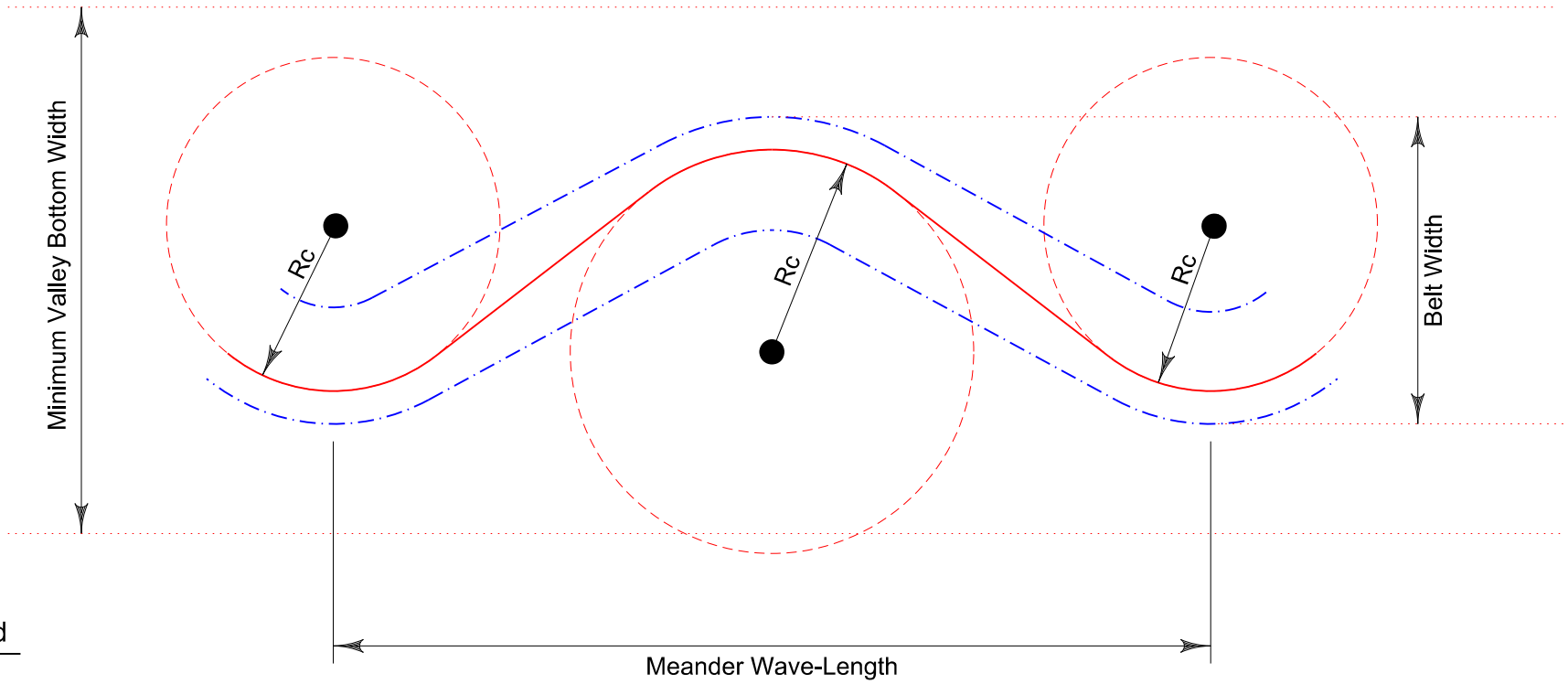
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-29

EXHIBIT 15

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E30



Legend

Bankfull

Thalweg

Bankfull Width=4.3'
Radius of Curvature (Rc) Ranges from 10' to 14'
Belt Width Ranges from 18' to 24' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 772'
Proposed Sinuosity is Approximately 1.25 (1.2 or greater)
Proposed Stream Gradient Ranges from 2.5% to 5%
Proposed Valley Slope Ranges from 3% to 6%
Minimum Valley Bottom Width = 40'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-30 | EXHIBIT 16

DATE:

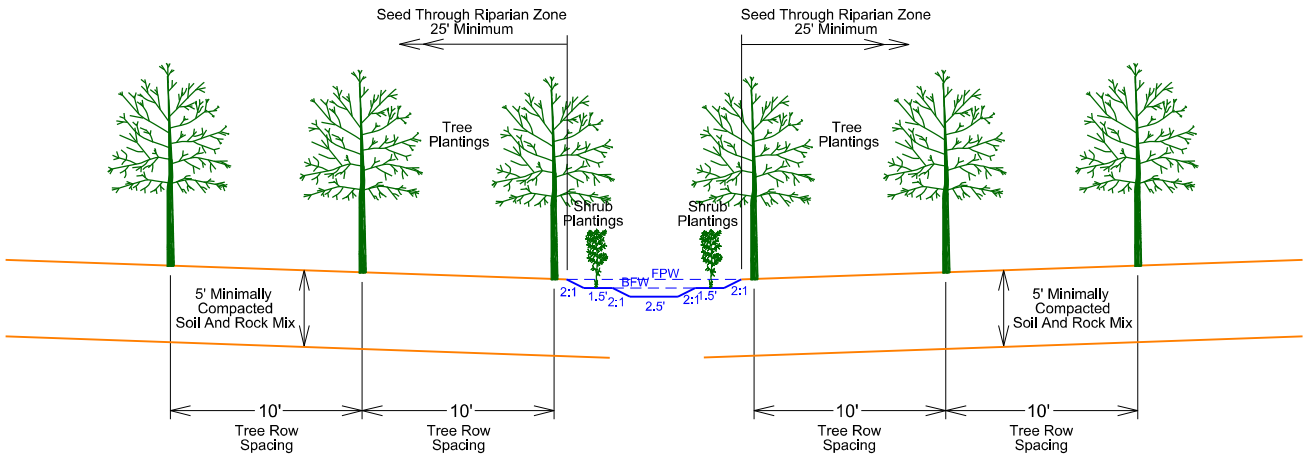
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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 = 1.53SF
* Bankfull Mean Depth = 0.36'
* Flood-Prone Width (FPW) = 9.1' Max
* W/D Ratio = 12.1
* Entrenchment Ratio = 2.1 Max
* 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 E30
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

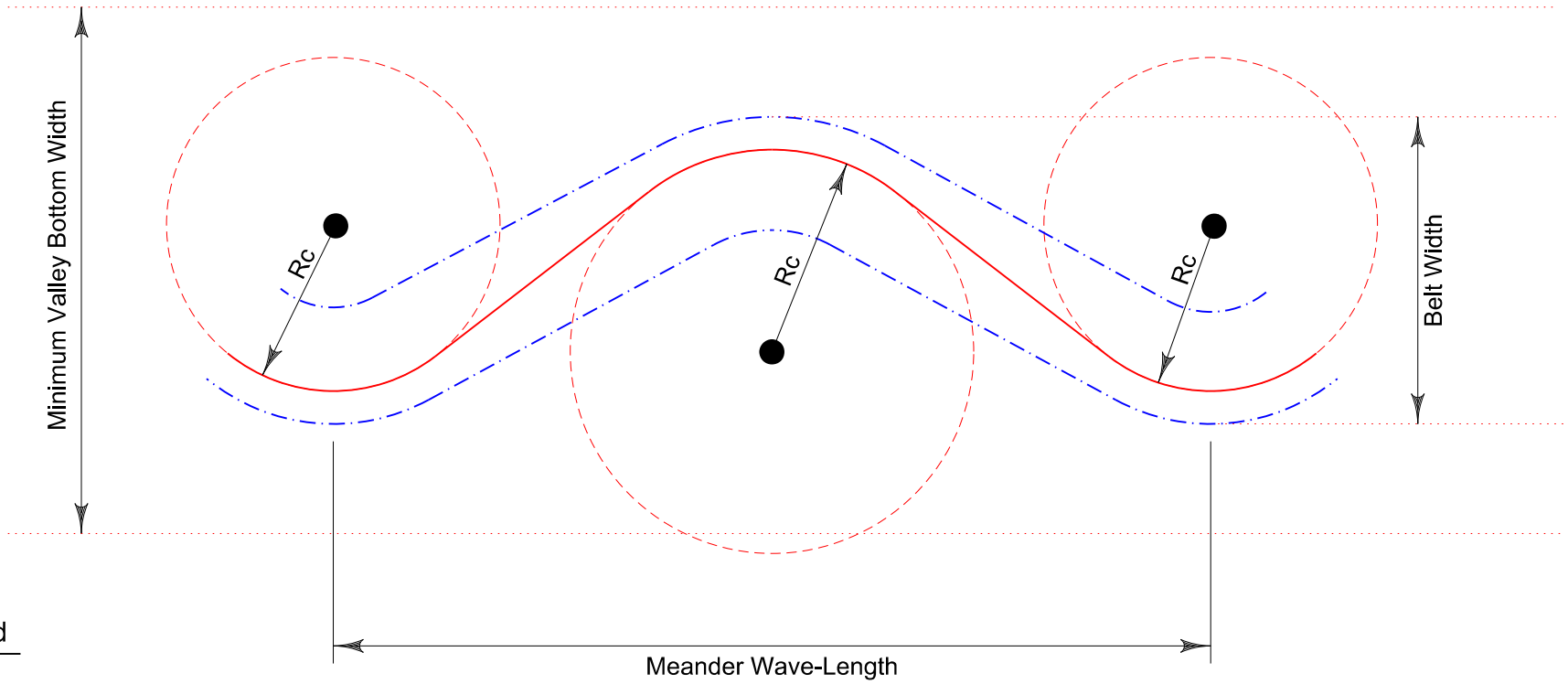
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-30

EXHIBIT 17

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E31



Legend

Bankfull

Thalweg

Bankfull Width=4.3'
Radius of Curvature (Rc) Ranges from 10' to 14'
Belt Width Ranges from 18' to 24' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 907'
Proposed Sinuosity is Approximately 1.24 (1.2 or greater)
Proposed Stream Gradient Ranges from 2.5% to 5%
Proposed Valley Slope Ranges from 3% to 6%
Minimum Valley Bottom Width = 40'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-31 | EXHIBIT 18

DATE:

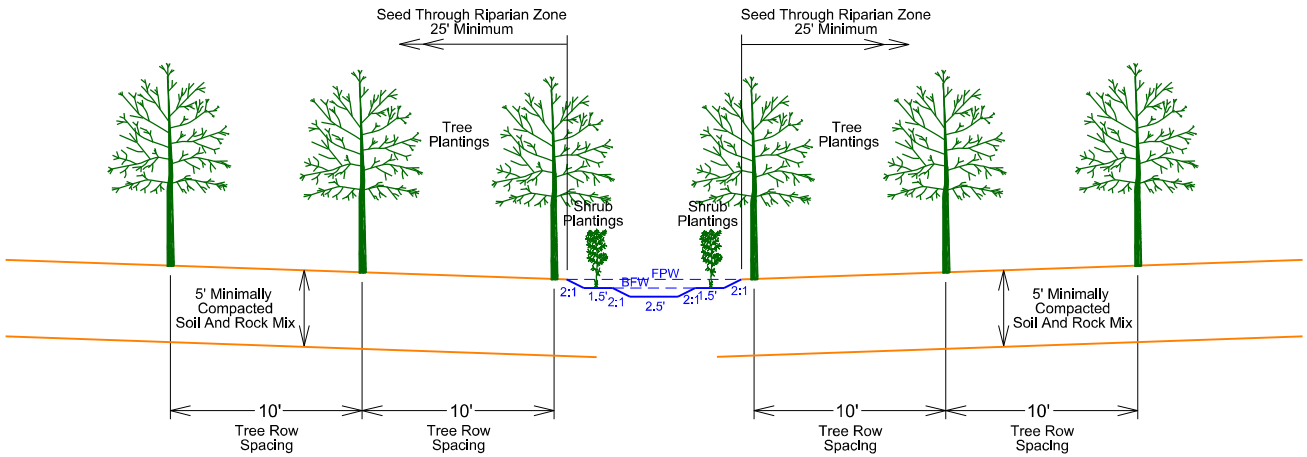
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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 = 1.53SF
* Bankfull Mean Depth = 0.36'
* Flood-Prone Width (FPW) = 9.1' Max
* W/D Ratio = 12.1
* Entrenchment Ratio = 2.1 Max
* 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 E31
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

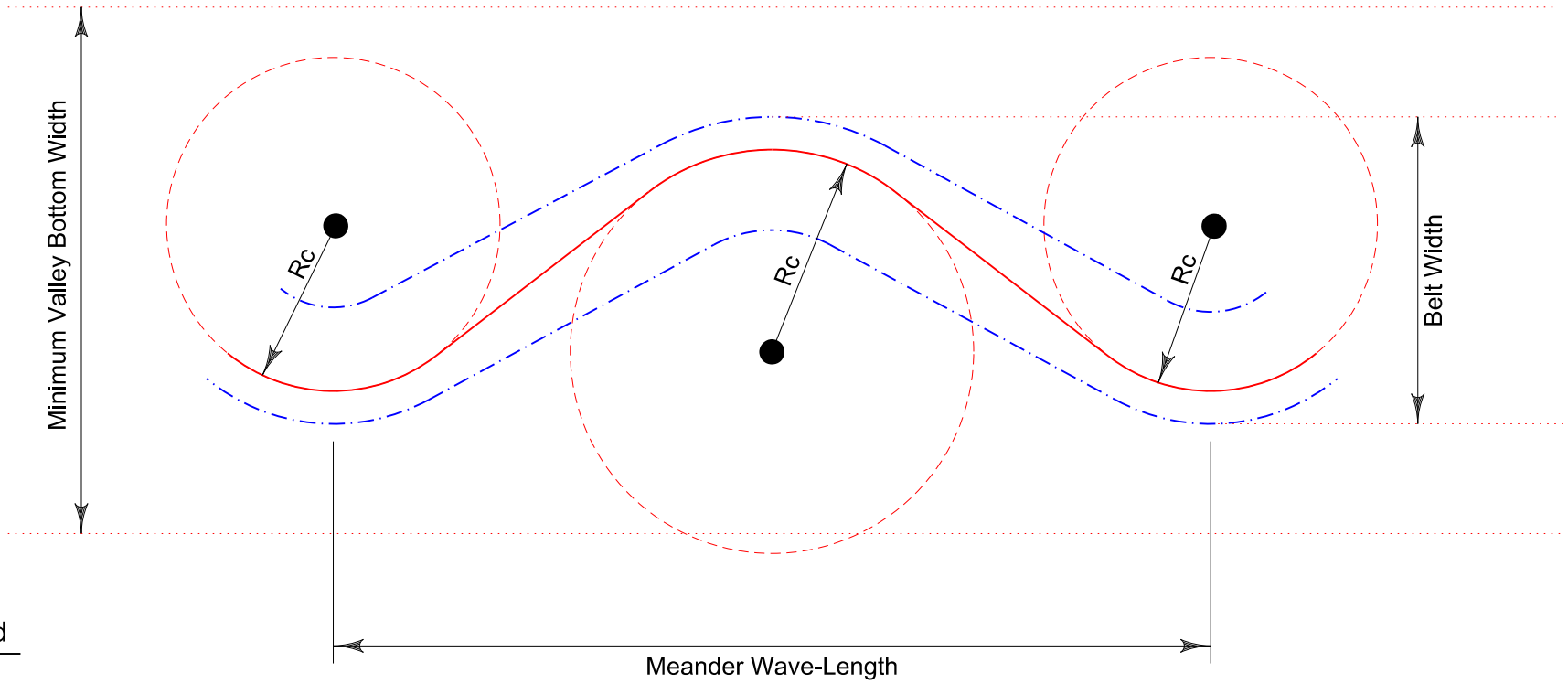
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-31

EXHIBIT 19

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E34US



Legend

Bankfull

Thalweg

Bankfull Width=4.7'
Radius of Curvature (Rc) Ranges from 11' to 16'
Belt Width Ranges from 18' to 25' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 903'
Proposed Sinuosity is Approximately 1.21 (1.2 or greater)
Proposed Stream Gradient Ranges from 2.5% to 3.3%
Proposed Valley Slope Ranges from 3% to 4%
Minimum Valley Bottom Width = 35'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-34US | EXHIBIT 20

DATE:

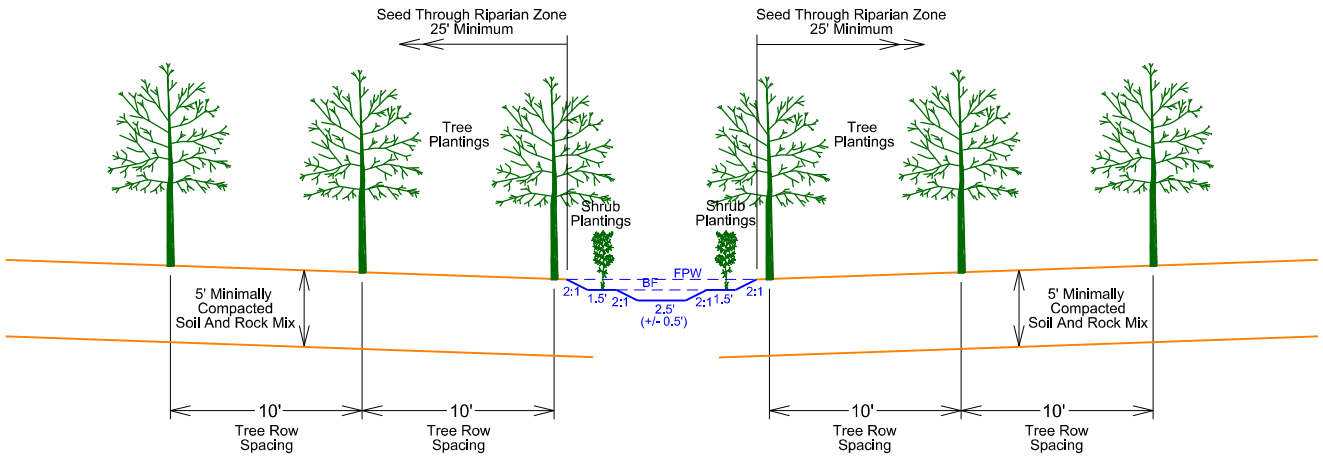
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 4.7'
* Bankfull Max. Depth = 0.55'
* Bankfull Area = 1.98 sq. ft.
* Bankfull Mean Depth = 0.42'
* Flood-Prone Width (FPW) = 10.0' Max
* W/D Ratio = 12
* Entrenchment Ratio = 2.1
* Bench Width = 1.5'



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 E34US
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

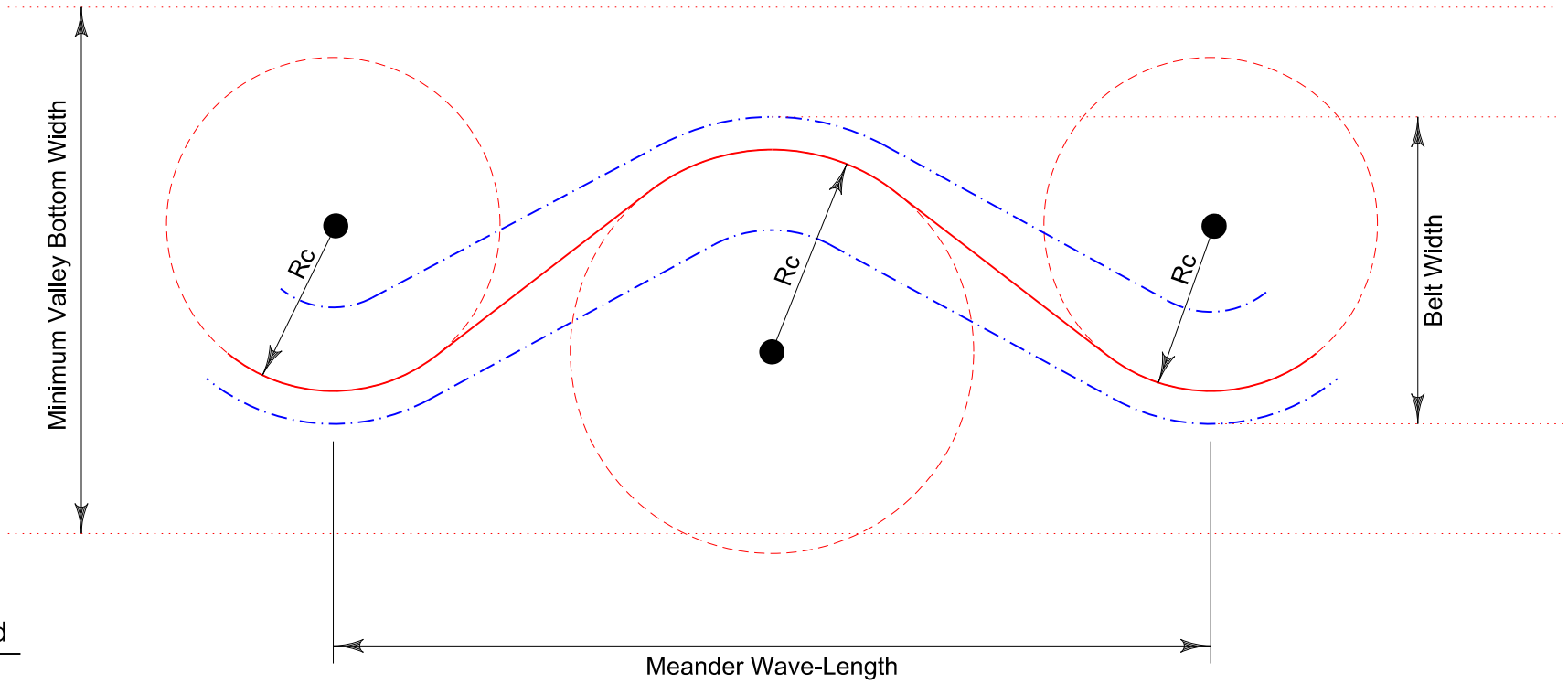
STREAM: E-34US

ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

EXHIBIT 21

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E34DS



Legend

Bankfull

Thalweg

Bankfull Width=7.0'
Radius of Curvature (Rc) Ranges from 17' to 24'
Belt Width Ranges from 28' to 35' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 1424'
Proposed Sinuosity is Approximately 1.22 (1.2 or greater)
Proposed Stream Gradient Ranges from 2% to 2.5%
Proposed Valley Slope Ranges from 2.4% to 3%
Minimum Valley Bottom Width = 50'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-34DS | EXHIBIT 22

DATE:

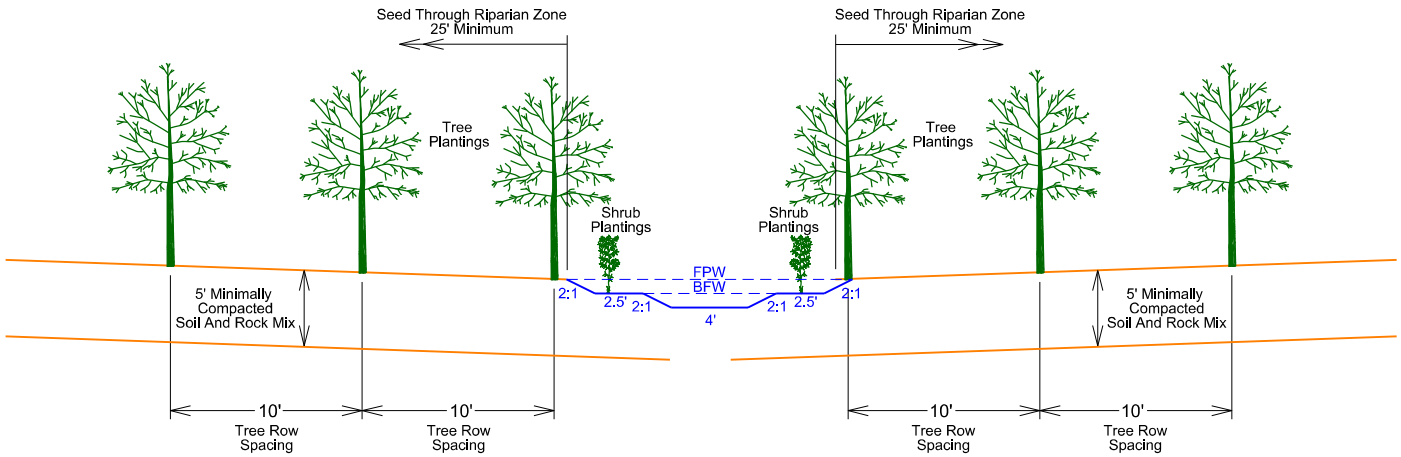
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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 = 0.74'
* Bankfull Area = 4.02SF
* Bankfull Mean Depth = 0.58'
* Flood-Prone Width (FPW) = 15.0' Max
* W/D Ratio = 12.0
* Entrenchment Ratio = 2.2 Max
* Bench Width = 2.5'



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 E34DS
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

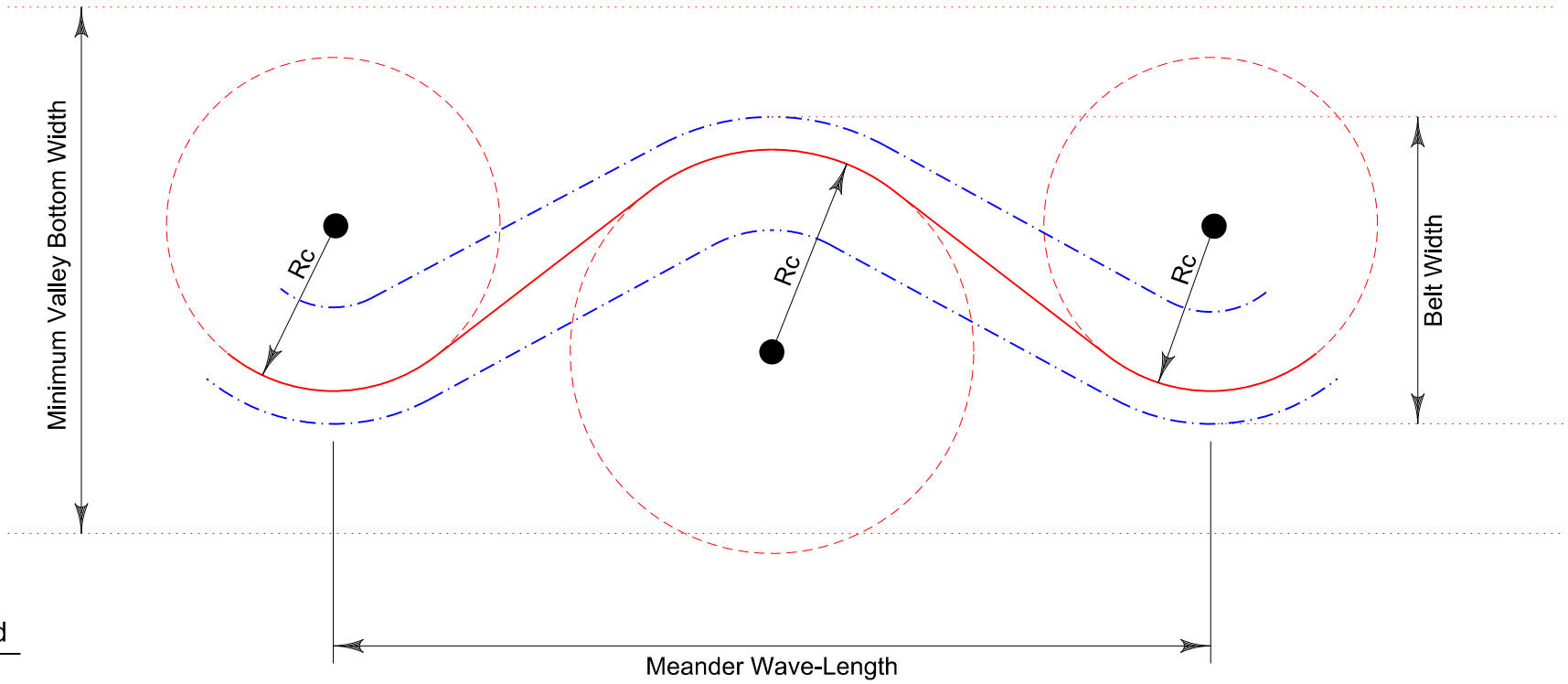
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-34DS

EXHIBIT 23

DATE:

Typical Meander Pattern for Rosgen Stream Type "Ba"
Stream E42



Legend

Bankfull

Thalweg

Bankfull Width=4.3'
Radius of Curvature (Rc) Ranges from 10' to 14'
Belt Width Ranges from 18' to 24' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 934'
Proposed Sinuosity is Approximately 1.23 (1.2 or greater)
Proposed Stream Gradient Ranges from 2.5% to 5%
Proposed Valley Slope Ranges from 3% to 6%
Minimum Valley Bottom Width = 40'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-42 | EXHIBIT 24

DATE:

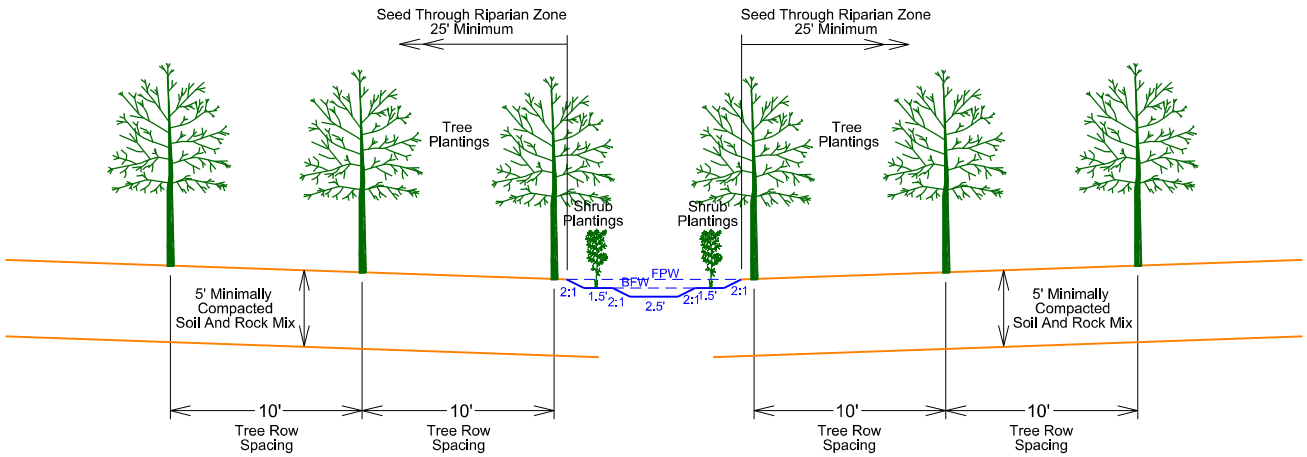
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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 = 1.53SF
* Bankfull Mean Depth = 0.36'
* Flood-Prone Width (FPW) = 9.1' Max
* W/D Ratio = 12.1
* Entrenchment Ratio = 2.1 Max
* 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 E42
Rosgen Stream Type "Ba"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

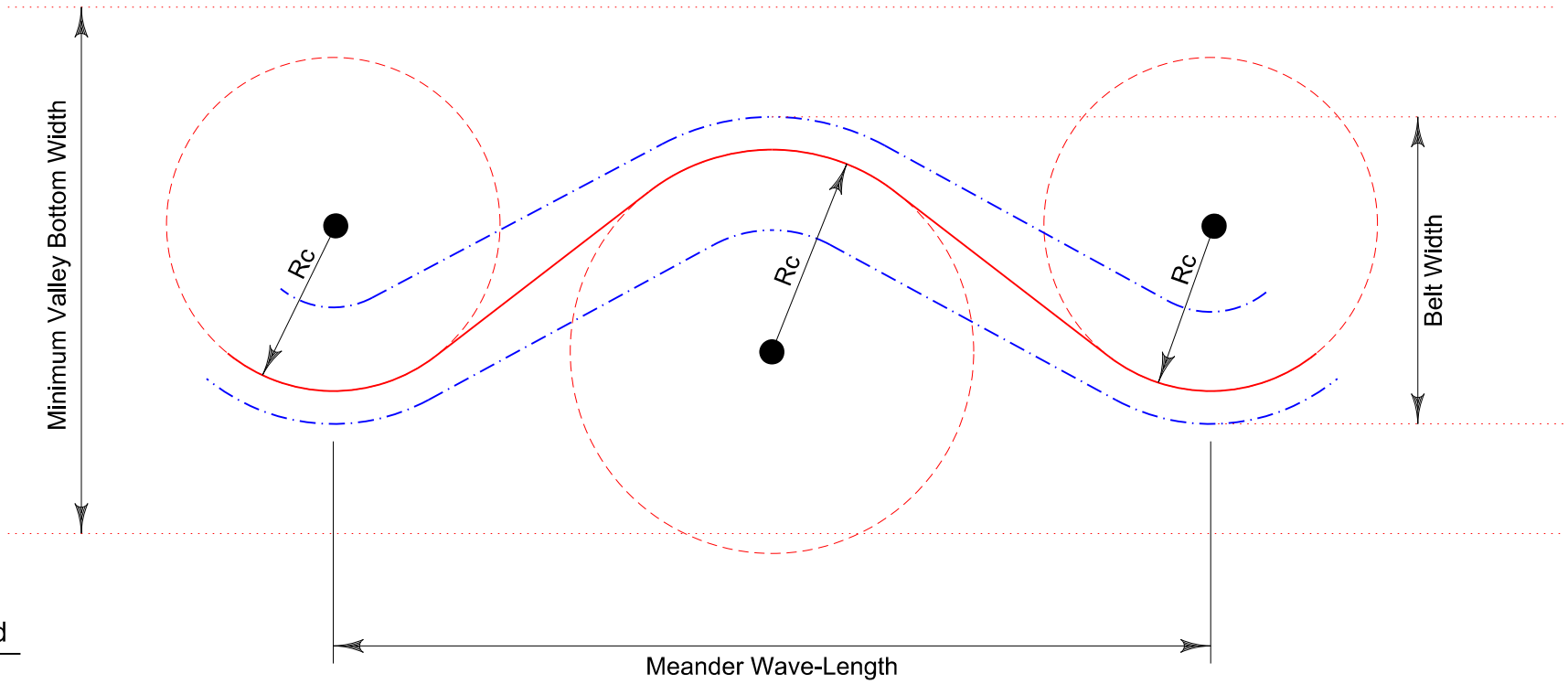
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-42

EXHIBIT 25

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E43



Legend

Bankfull

Thalweg

Bankfull Width=5.3'
Radius of Curvature (Rc) Ranges from 13' to 18'
Belt Width Ranges from 21' to 28' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 2123'
Proposed Sinuosity is Approximately 1.24 (1.2 or greater)
Proposed Stream Gradient Ranges from 3.3% to 4%
Proposed Valley Slope Ranges from 4% to 4.8%
Minimum Valley Bottom Width = 45'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-43 | EXHIBIT 26

DATE:

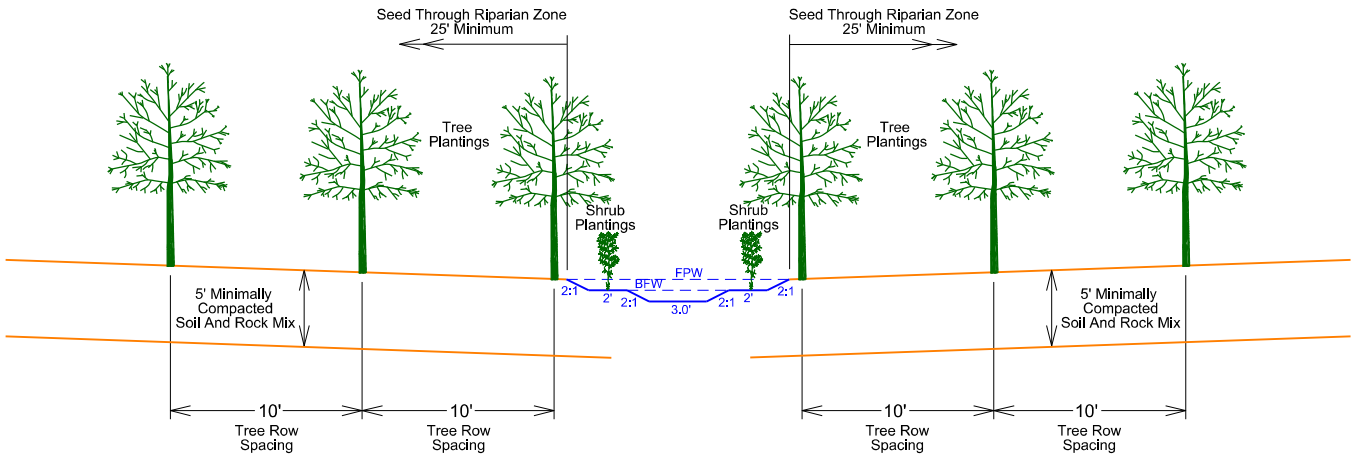
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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 = 2.39SF
* Bankfull Mean Depth = 0.45'
* Flood-Prone Width (FPW) = 11.6'
* W/D Ratio = 12
* Entrenchment Ratio = 2.19 Max
* 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 E43
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

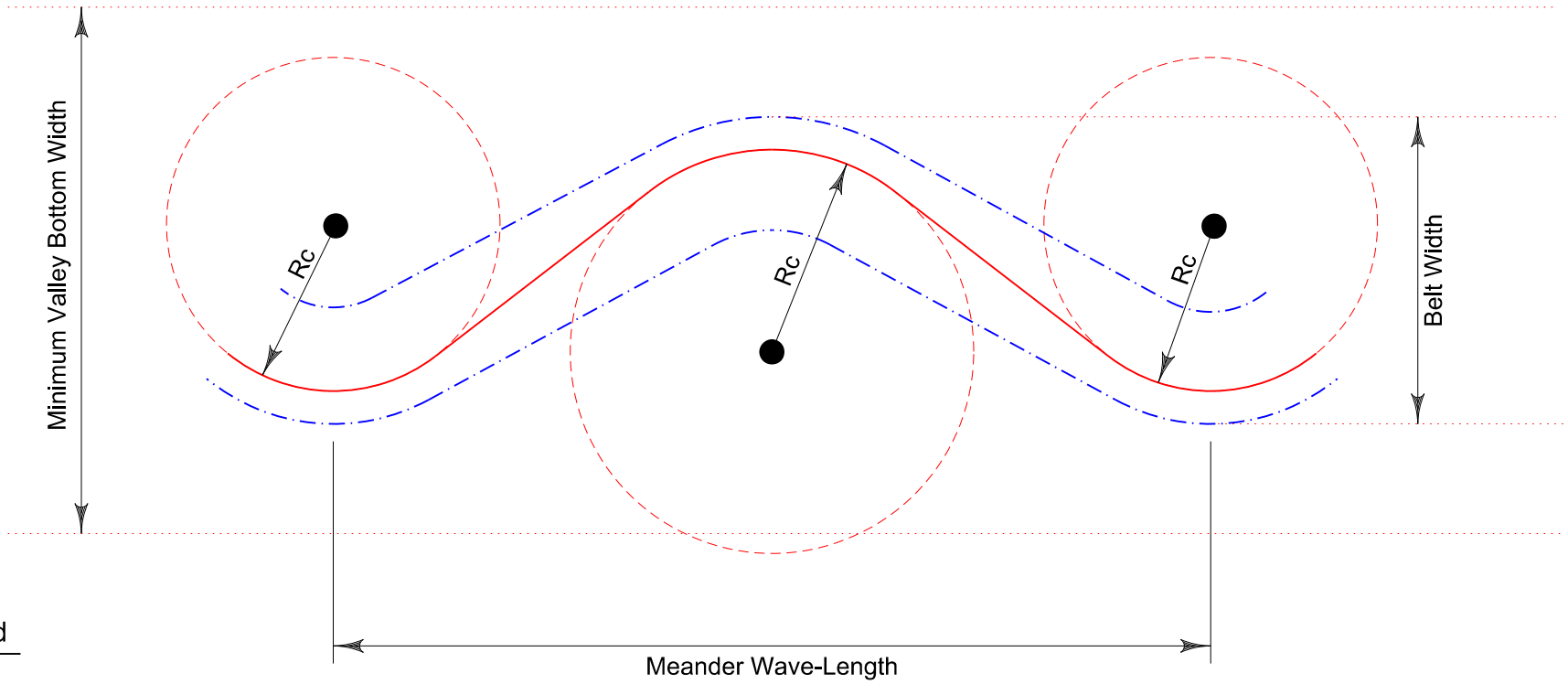
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-43

EXHIBIT 27

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E44



Legend

Bankfull

Thalweg

Bankfull Width=5.3'
Radius of Curvature (Rc) Ranges from 13' to 18'
Belt Width Ranges from 21' to 28' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 1442'
Proposed Sinuosity is Approximately 1.21 (1.2 or greater)
Proposed Stream Gradient Ranges from 3.3% to 4%
Proposed Valley Slope Ranges from 4% to 4.8%
Minimum Valley Bottom Width = 45'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-44 | EXHIBIT 28

DATE:

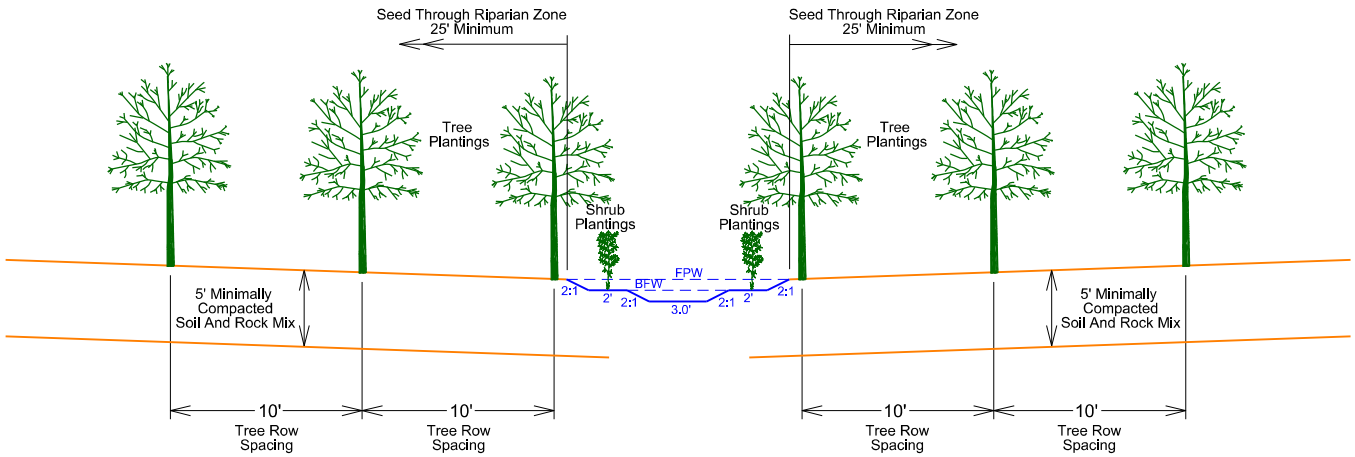
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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 = 2.39SF
* Bankfull Mean Depth = 0.45'
* Flood-Prone Width (FPW) = 11.6'
* W/D Ratio = 12
* Entrenchment Ratio = 2.19 Max
* 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 E44
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

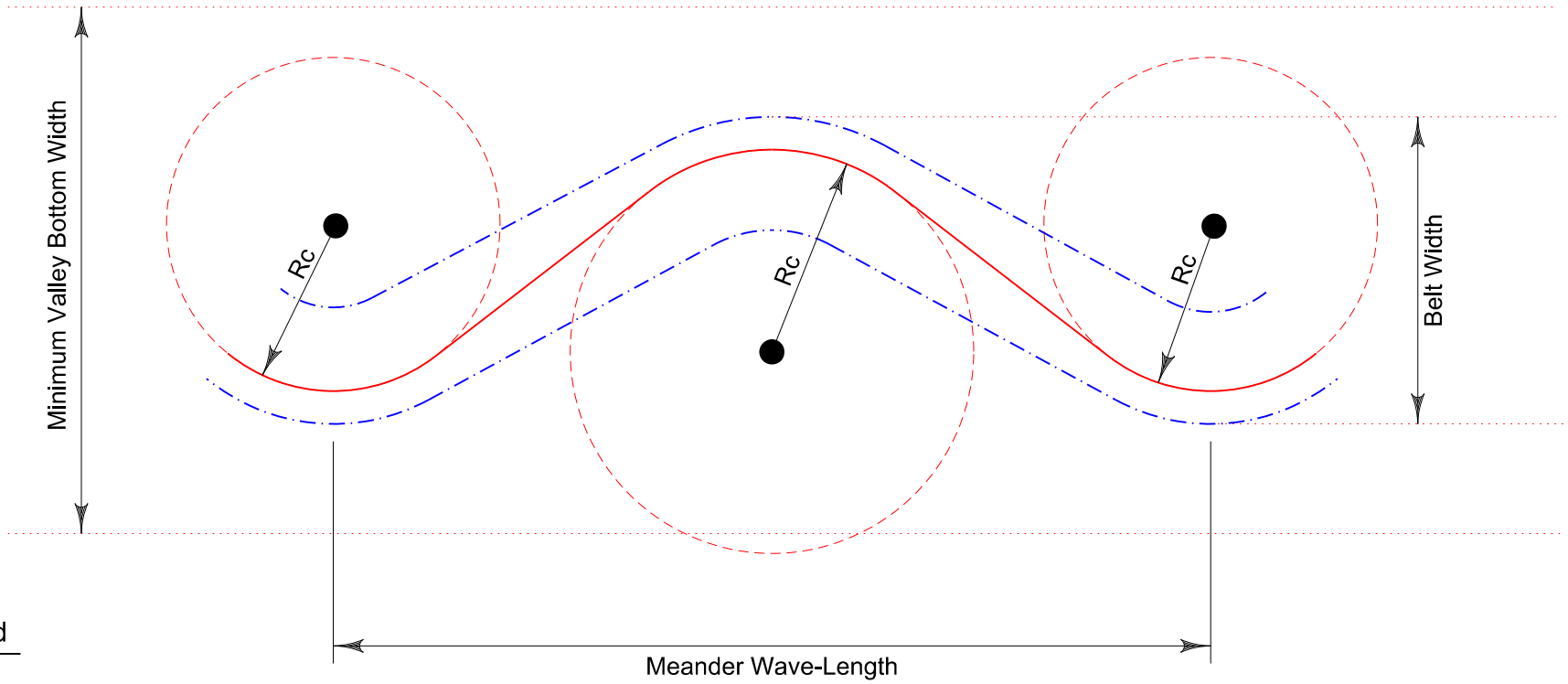
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-44

EXHIBIT 29

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E47



Legend

Bankfull

Thalweg

Bankfull Width=6.0'
Radius of Curvature (Rc) Ranges from 15' to 20'
Belt Width Ranges from 24' to 30' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 1702'
Proposed Sinuosity is Approximately 1.20 (1.2 or greater)
Proposed Stream Gradient Ranges from 2.8% to 3.3%
Proposed Valley Slope Ranges from 3.3% to 4%
Minimum Valley Bottom Width = 40'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-47 | EXHIBIT 30

DATE:

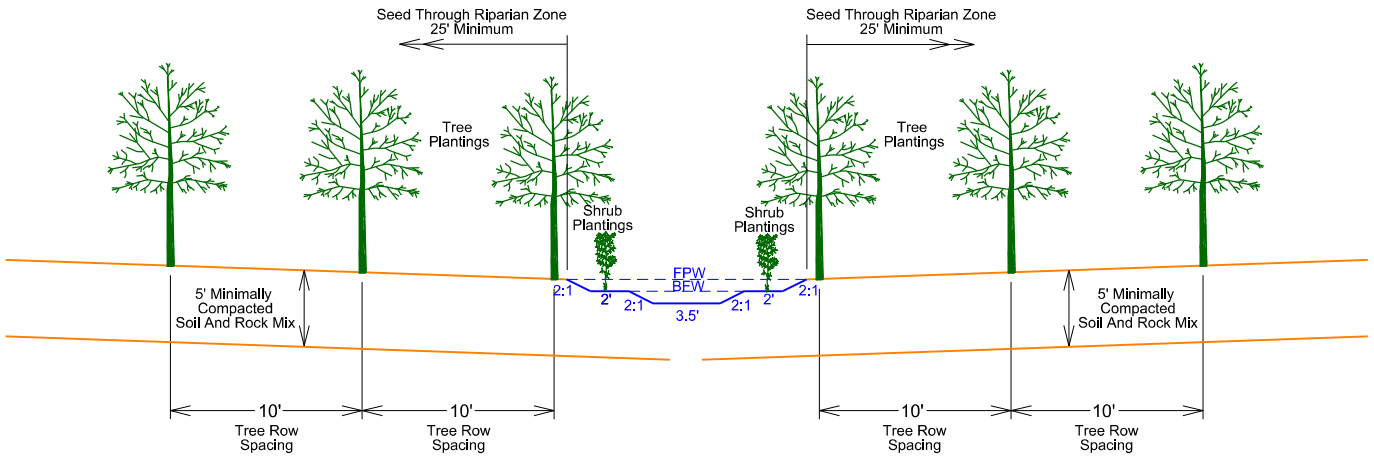
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 6.0'
* Bankfull Max. Depth = 0.63'
* Bankfull Area = 3.0 SF
* Bankfull Mean Depth = 0.5'
* Flood-Prone Width (FPW) = 13.2' Max
* W/D Ratio = 12.1
* Entrenchment Ratio = 2.2 Max
* 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 E47
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

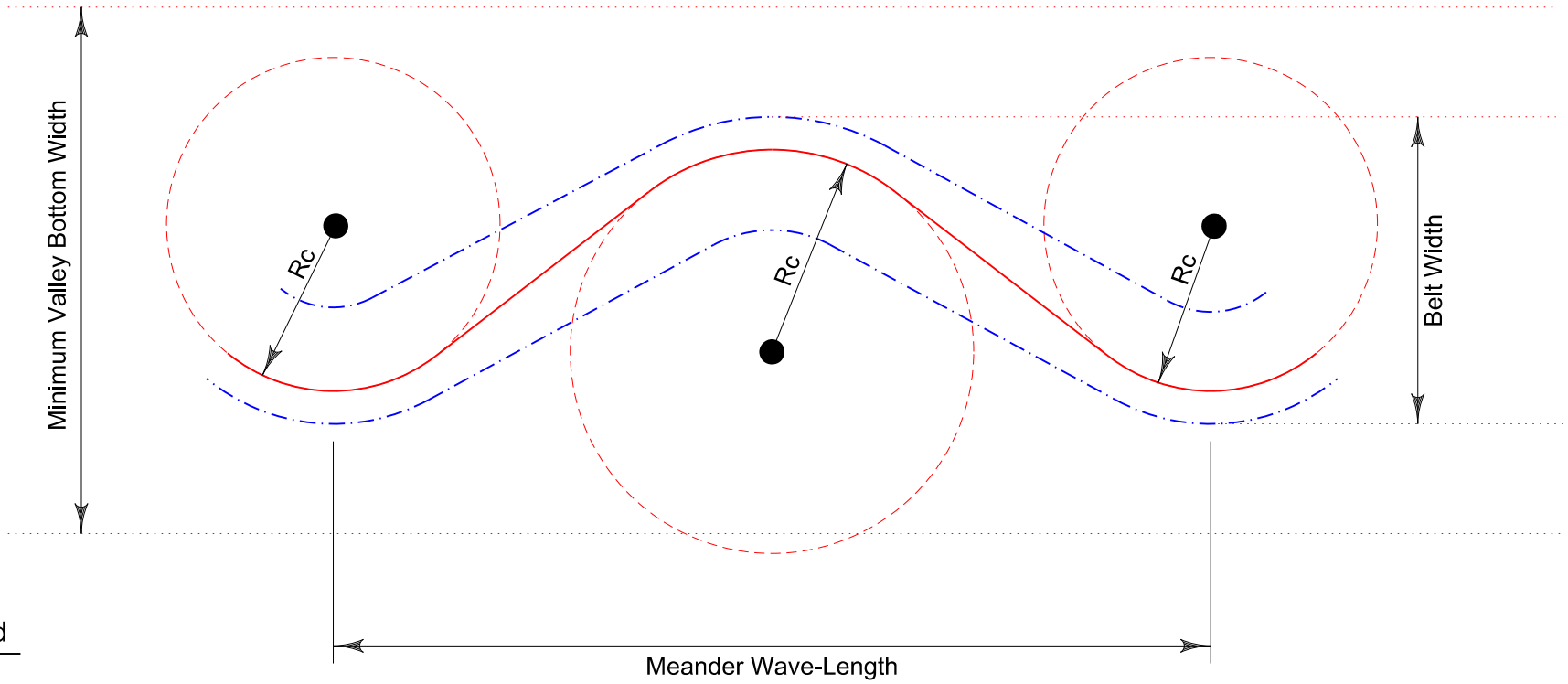
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-47

EXHIBIT 31

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E48



Legend

Bankfull

Thalweg

Bankfull Width=4.7'
Radius of Curvature (Rc) Ranges from 11' to 16'
Belt Width Ranges from 18' to 25' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 1924'
Proposed Sinuosity is Approximately 1.20 (1.2 or greater)
Proposed Stream Gradient Ranges from 2.9% to 3.6%
Proposed Valley Slope Ranges from 3.5% to 4.3%
Minimum Valley Bottom Width = 35'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-48 | EXHIBIT 32

DATE:

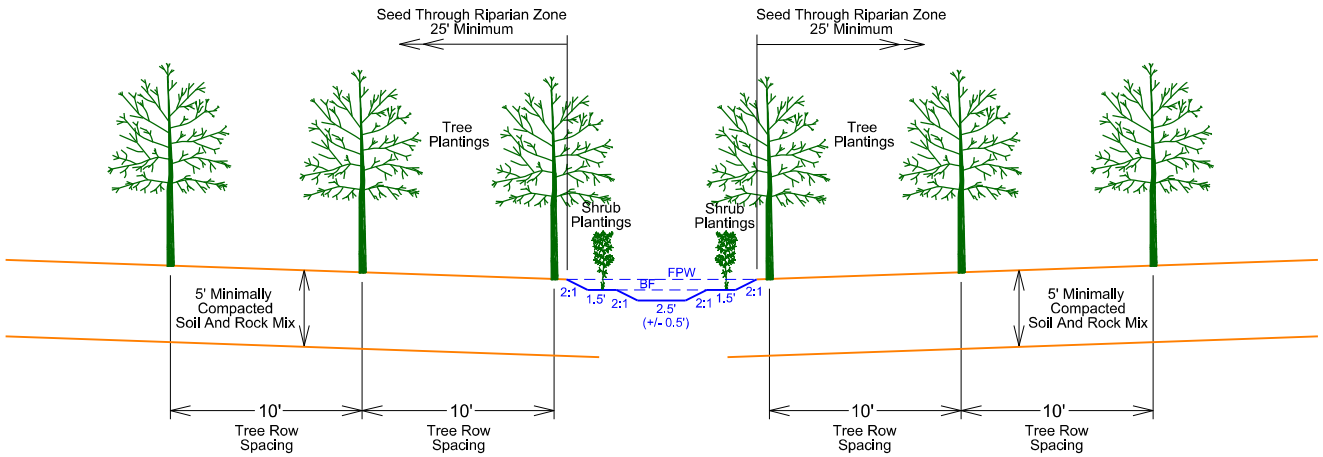
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 4.7'
* Bankfull Max. Depth = 0.55'
* Bankfull Area = 1.98 sq. ft.
* Bankfull Mean Depth = 0.42'
* Flood-Prone Width (FPW) = 10.0' (Maximum)
* W/D Ratio = 12
* Entrenchment Ratio = 2.1
* Bench Width = 1.5'



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 E48
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

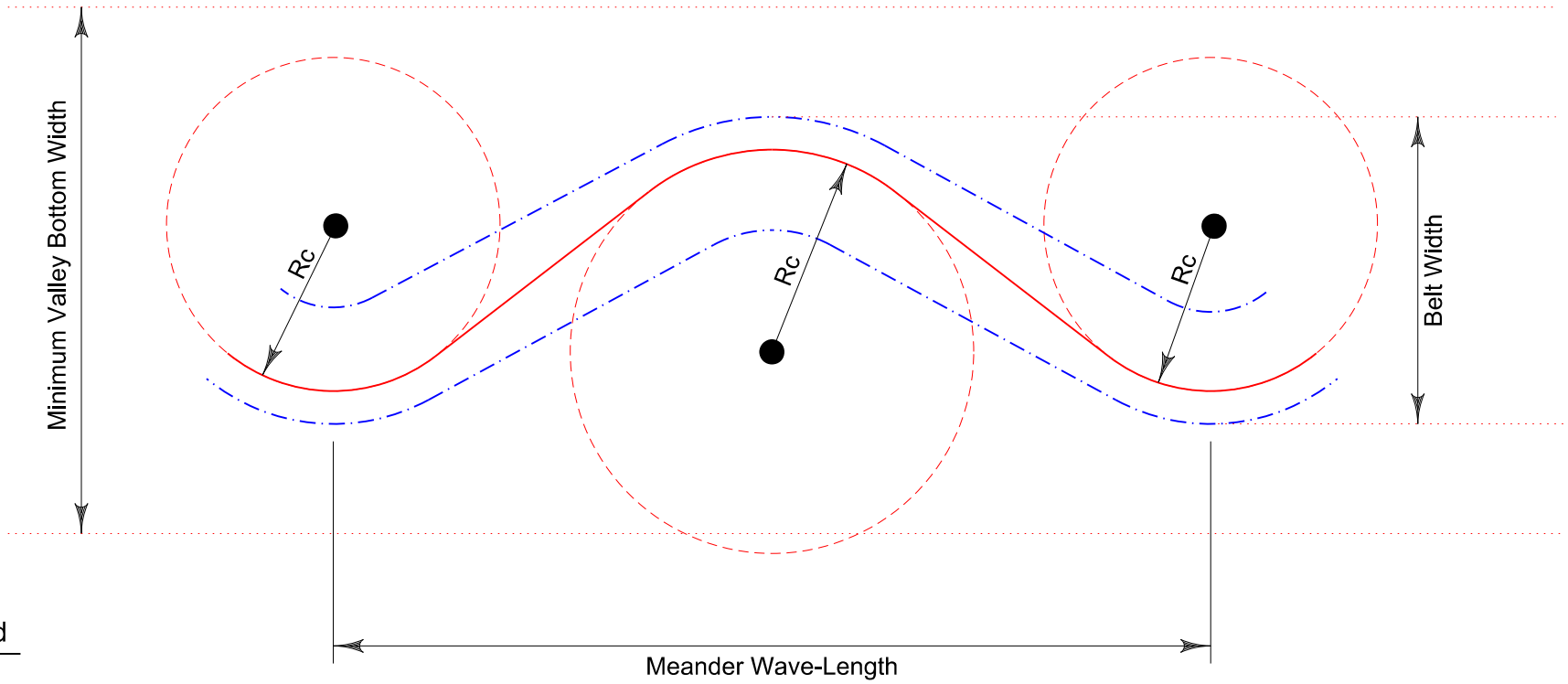
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-48

EXHIBIT 33

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E49



Legend

Bankfull

Thalweg

Bankfull Width=4.7'
Radius of Curvature (Rc) Ranges from 11' to 16'
Belt Width Ranges from 18' to 25' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 1366'
Proposed Sinuosity is Approximately 1.20 (1.2 or greater)
Proposed Stream Gradient Ranges from 2.9% to 3.6%
Proposed Valley Slope Ranges from 3.5% to 4.3%
Minimum Valley Bottom Width = 35'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-49 | EXHIBIT 34

DATE:

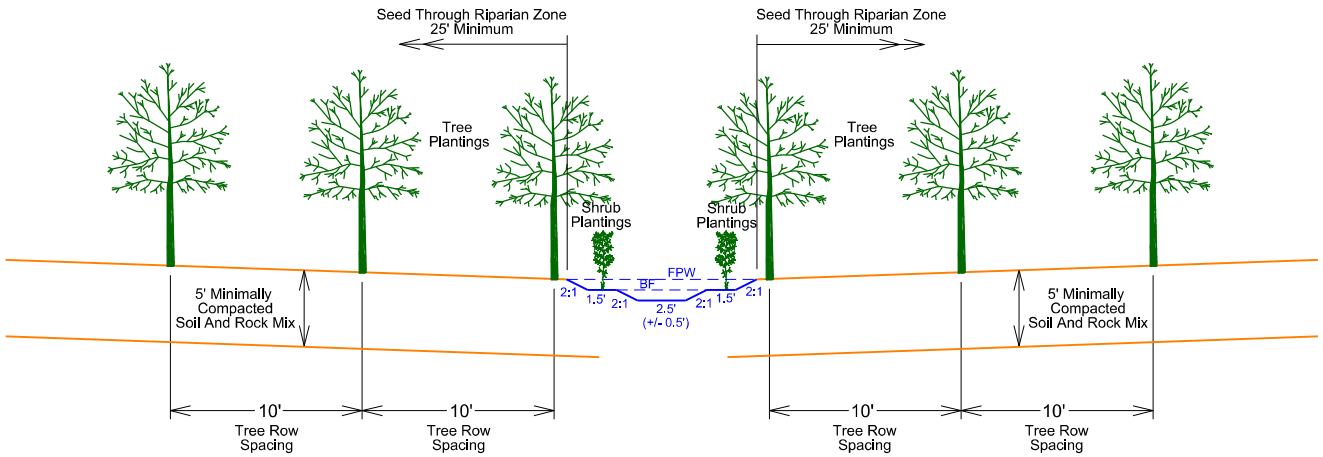
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 4.7'
* Bankfull Max. Depth = 0.55'
* Bankfull Area = 1.98 sq. ft.
* Bankfull Mean Depth = 0.42'
* Flood-Prone Width (FPW) = 10.0' (Maximum)
* W/D Ratio = 12
* Entrenchment Ratio = 2.1
* Bench Width = 1.5'



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 E49
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

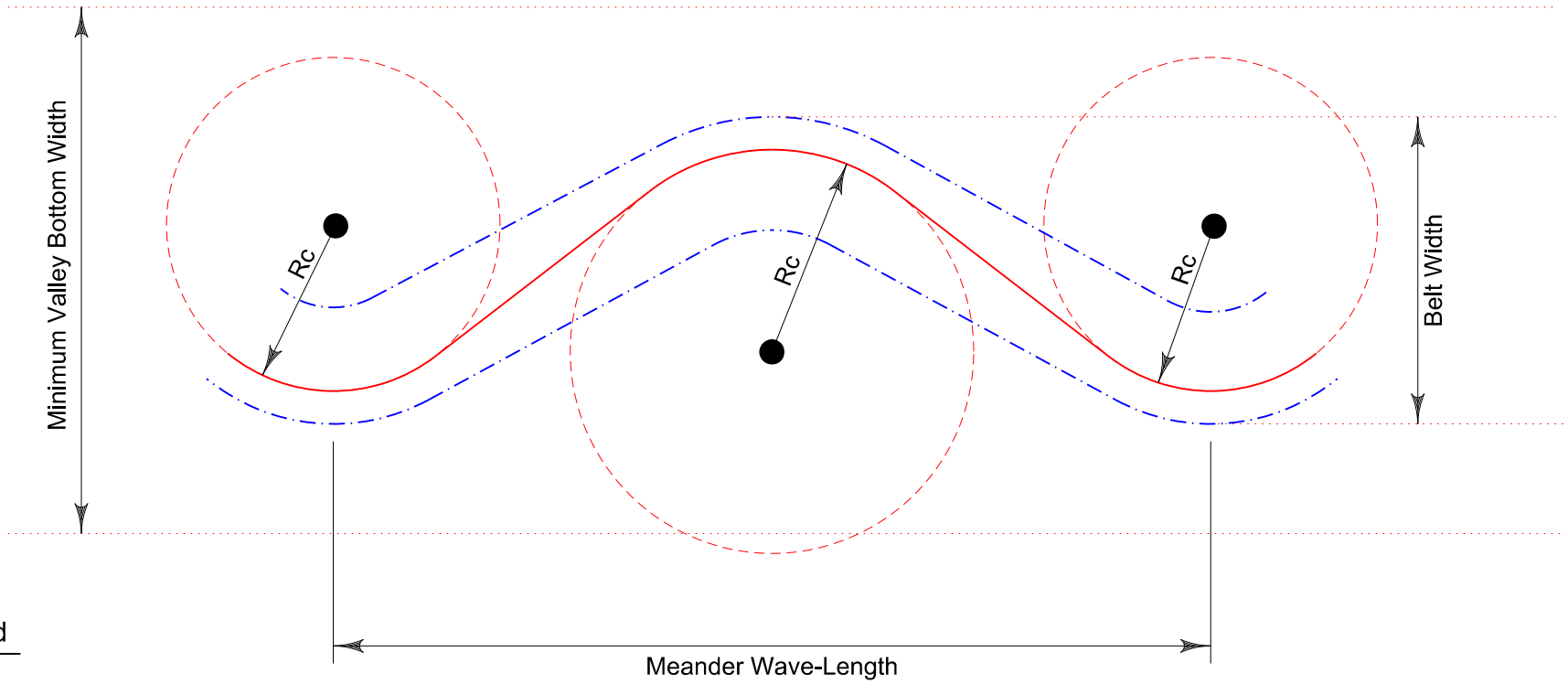
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-49

EXHIBIT 35

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E51US



Legend

Bankfull

Thalweg

Bankfull Width=4.7'
Radius of Curvature (Rc) Ranges from 11' to 16'
Belt Width Ranges from 18' to 25' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 878'
Proposed Sinuosity is Approximately 1.22 (1.2 or greater)
Proposed Stream Gradient Ranges from 2.9% to 3.7%
Proposed Valley Slope Ranges from 3.5% to 4.4%
Minimum Valley Bottom Width = 35'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-5IUS | EXHIBIT 36

DATE:

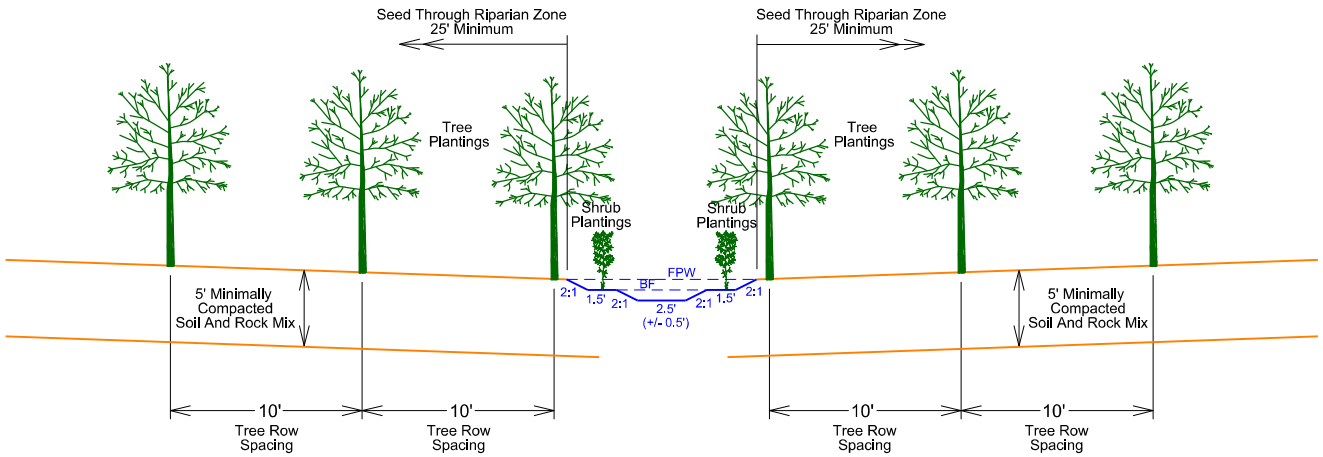
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 4.7'
* Bankfull Max. Depth = 0.55'
* Bankfull Area = 1.98 sq. ft.
* Bankfull Mean Depth = 0.42'
* Flood-Prone Width (FPW) = 10.0' Max
* W/D Ratio = 12
* Entrenchment Ratio = 2.1
* Bench Width = 1.5'



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 E51US
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

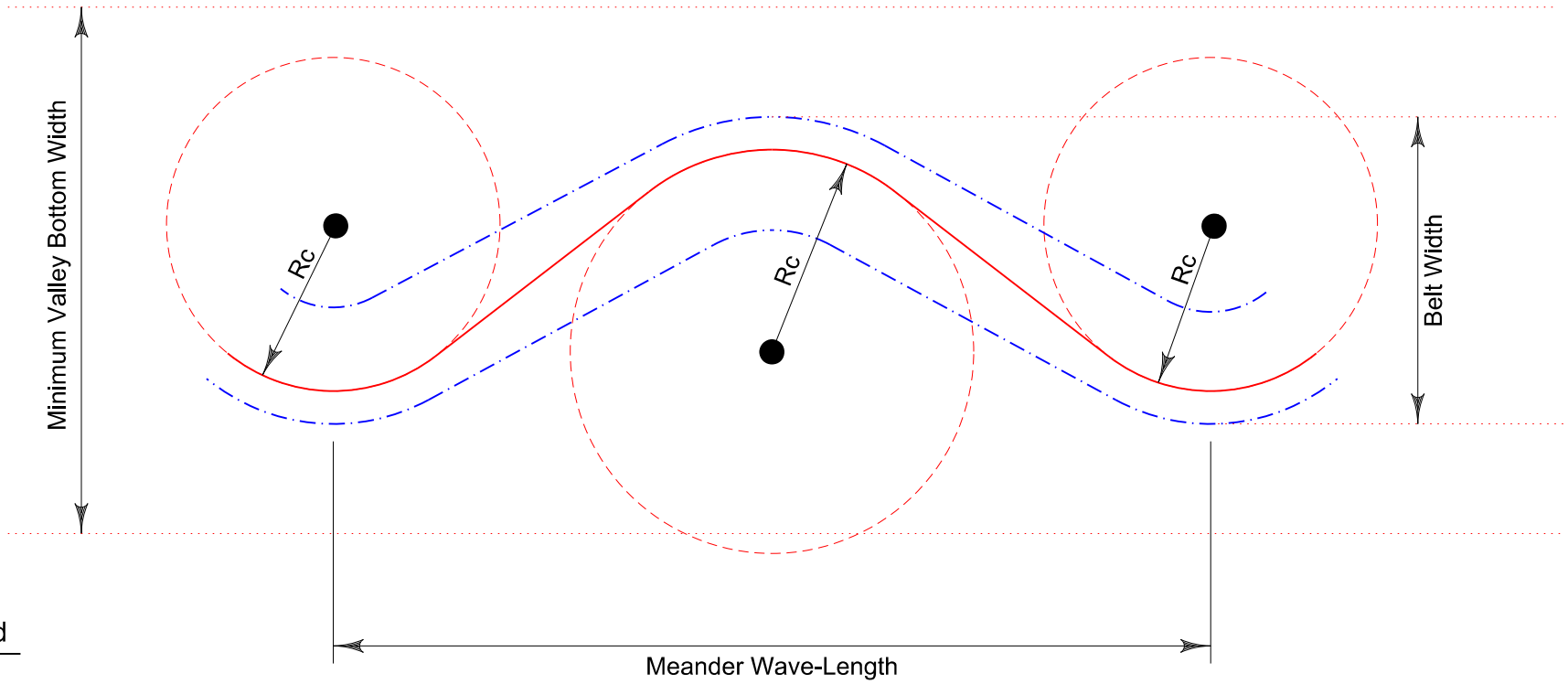
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-5US

EXHIBIT 37

DATE:

Typical Meander Pattern for Rosgen Stream Type "E"
Stream E51MS/DS



Legend

Bankfull

Thalweg

Bankfull Width=6.0'
Radius of Curvature (Rc) Ranges from 15' to 20'
Belt Width Ranges from 60' to 90' (Some Deviation Allowable)
Meander Wave-Length Ranges from 60' to 85'
Approximate Proposed Reach Length = 1570'
Proposed Sinuosity is Approximately 1.51 (1.5 or greater)
Proposed Stream Gradient Ranges from 0.8% to 1.2%
Proposed Valley Slope Ranges from 1.2% to 1.8%
Minimum Valley Bottom Width = 98'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-5IMS/DS | EXHIBIT 38

DATE:

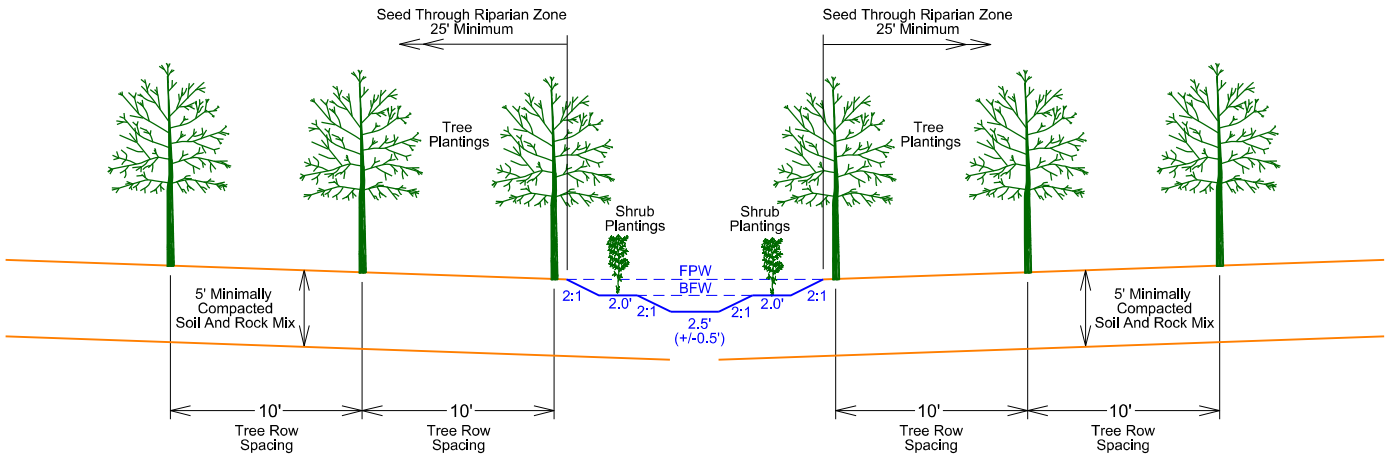
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 6.0'
* Bankfull Max. Depth = 0.84'
* Bankfull Area = 3.57 sq. ft.
* Bankfull Mean Depth = 0.60'
* Flood-Prone Width (FPW) = 13.36' Min
* W/D Ratio = 10
* Entrenchment Ratio = 2.23 Min
* 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 E51MS/DS
Rosgen Stream Type "E"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

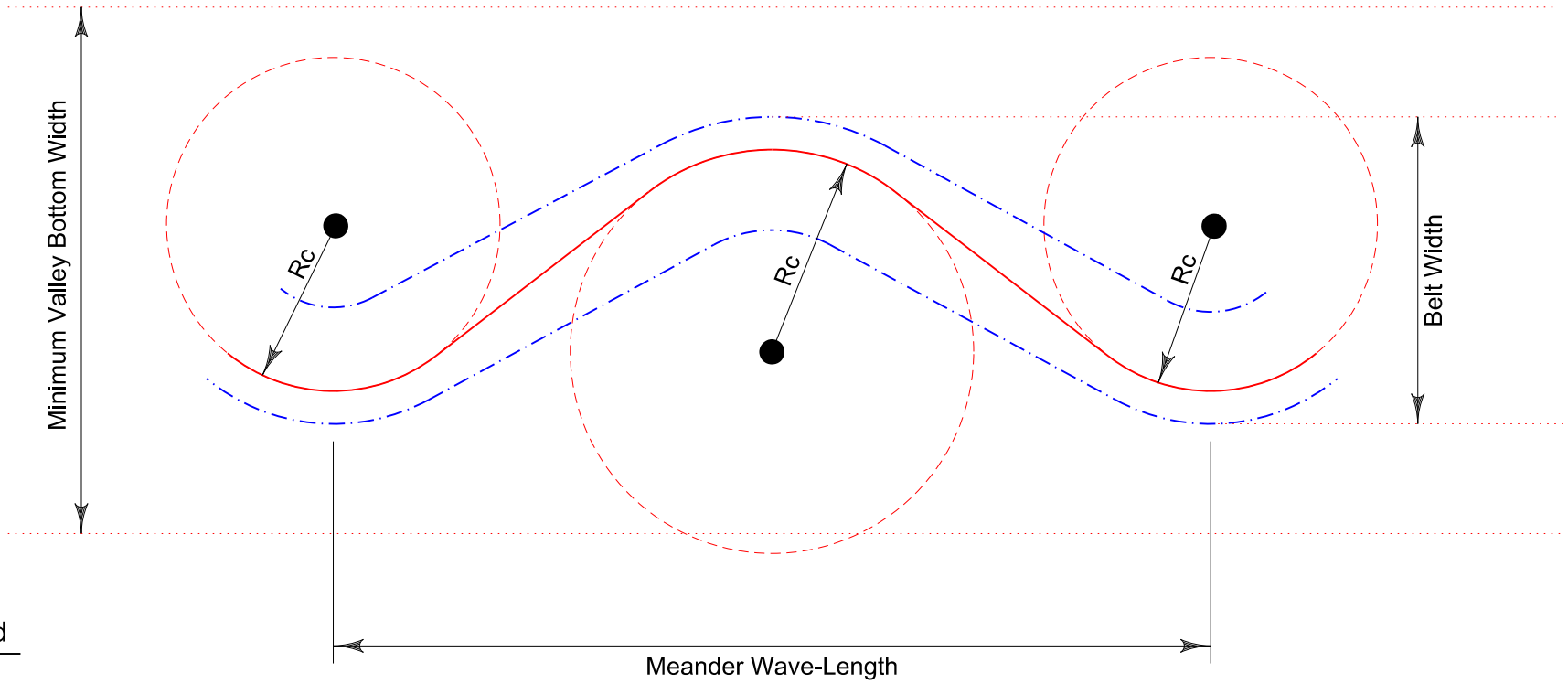
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-5MS/DS

EXHIBIT 39

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E52



Legend

Bankfull

Thalweg

Bankfull Width=4.3'
Radius of Curvature (Rc) Ranges from 10' to 14'
Belt Width Ranges from 18' to 24' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 676'
Proposed Sinuosity is Approximately 1.26 (1.2 or greater)
Proposed Stream Gradient Ranges from 2.5% to 5%
Proposed Valley Slope Ranges from 3% to 6%
Minimum Valley Bottom Width = 40'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-52 | EXHIBIT 40

DATE:

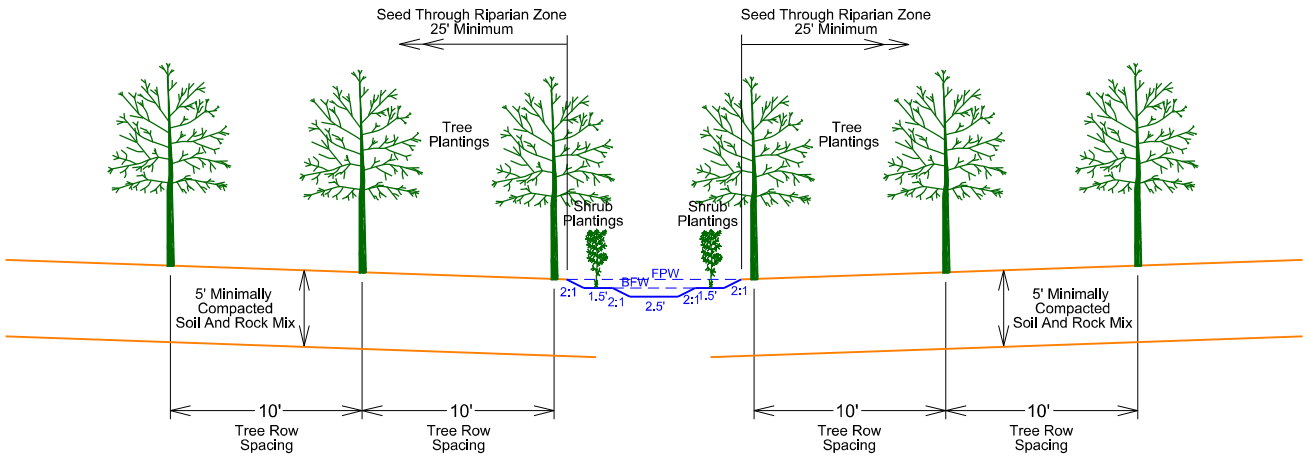
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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 = 1.53SF
* Bankfull Mean Depth = 0.36'
* Flood-Prone Width (FPW) = 9.1' Max
* W/D Ratio = 12.1
* Entrenchment Ratio = 2.1 Max
* 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 E52
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

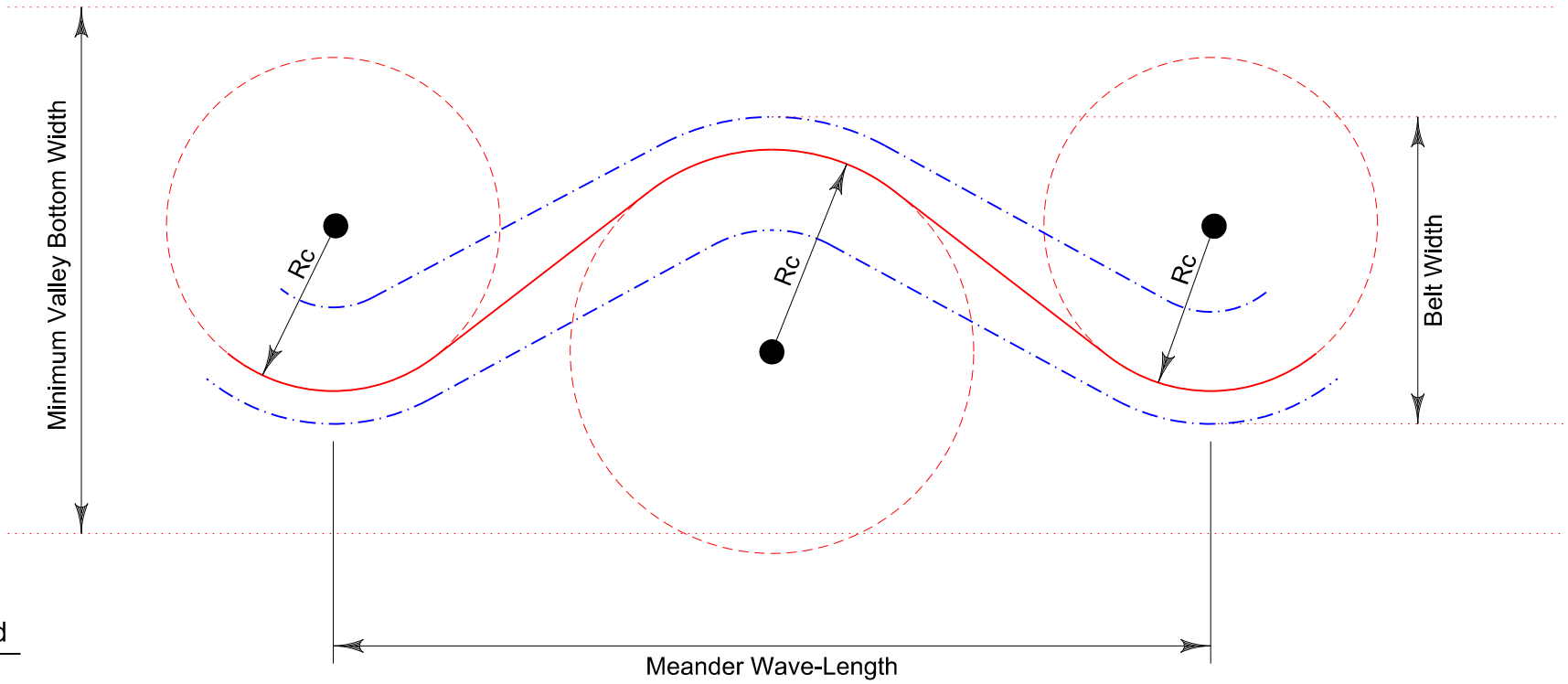
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-52

EXHIBIT 41

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E54



Legend

Bankfull

Thalweg

Bankfull Width=6.0'
Radius of Curvature (Rc) Ranges from 15' to 20'
Belt Width Ranges from 24' to 30' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 1277'
Proposed Sinuosity is Approximately 1.21 (1.2 or greater)
Proposed Stream Gradient Ranges from 2.5% to 3.3%
Proposed Valley Slope Ranges from 3% to 4%
Minimum Valley Bottom Width = 40'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-54 | EXHIBIT 42

DATE:

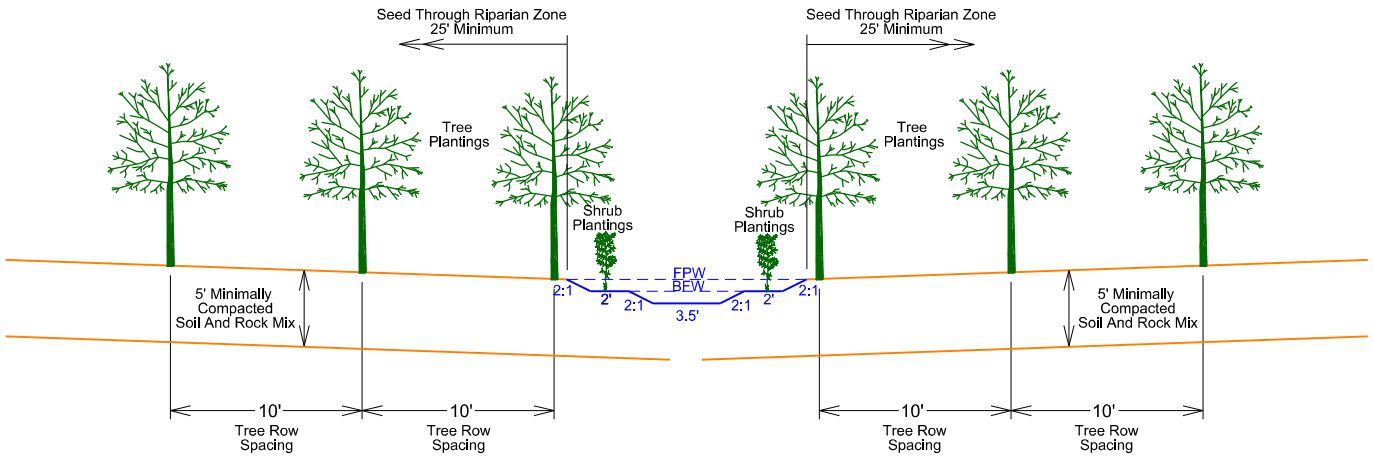
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 6.0'
* Bankfull Max. Depth = 0.63'
* Bankfull Area = 3.0 SF
* Bankfull Mean Depth = 0.5'
* Flood-Prone Width (FPW) = 13.2' Max
* W/D Ratio = 12.1
* Entrenchment Ratio = 2.2 Max
* 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 E54
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

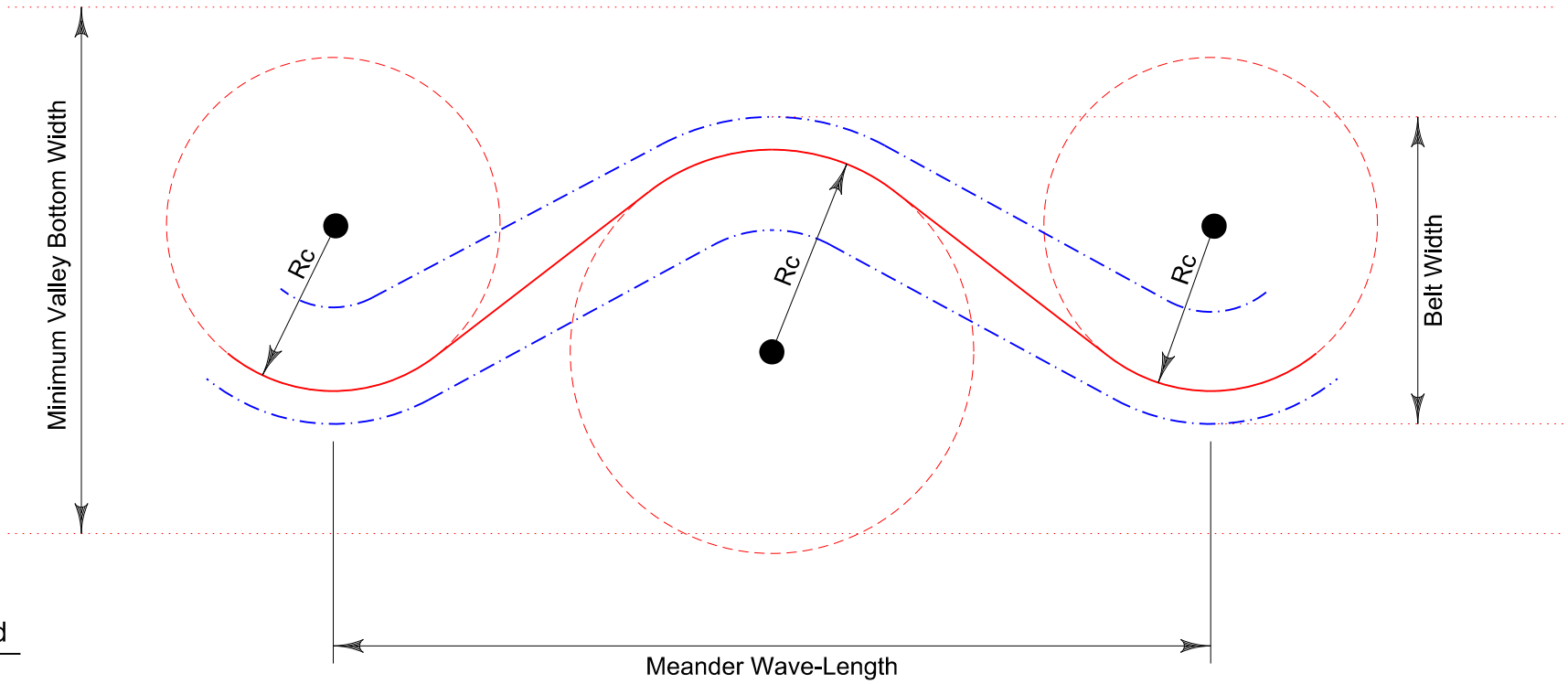
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-54

EXHIBIT 43

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E61US



Legend

Bankfull

Thalweg

Bankfull Width=4.7'
Radius of Curvature (Rc) Ranges from 11' to 16'
Belt Width Ranges from 18' to 25'
Meander Wave-Length NA
Approximate Proposed Reach Length = 984'
Proposed Sinuosity is Approximately 1.20 (1.2 or greater)
Proposed Stream Gradient Ranges from 2.9% to 3.6%
Proposed Valley Slope Ranges from 3.5% to 4.3%
Minimum Valley Bottom Width = 35'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-6US | EXHIBIT 44

DATE:

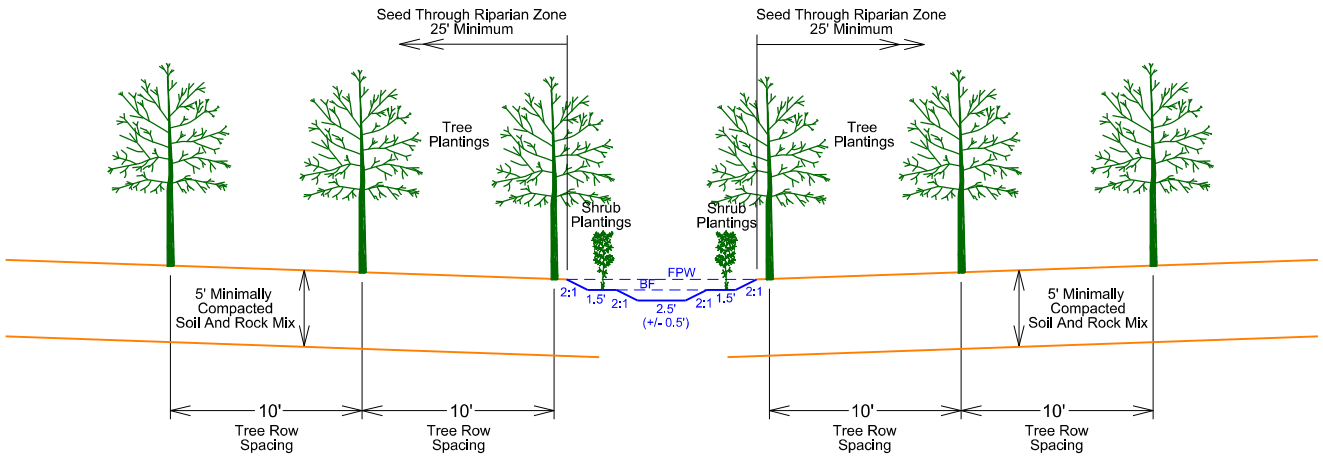
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 4.7'
* Bankfull Max. Depth = 0.55'
* Bankfull Area = 1.98 sq. ft.
* Bankfull Mean Depth = 0.42'
* Flood-Prone Width (FPW) = 10.0' Max
* W/D Ratio = 12
* Entrenchment Ratio = 2.1
* Bench Width = 1.5'



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 E61US
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

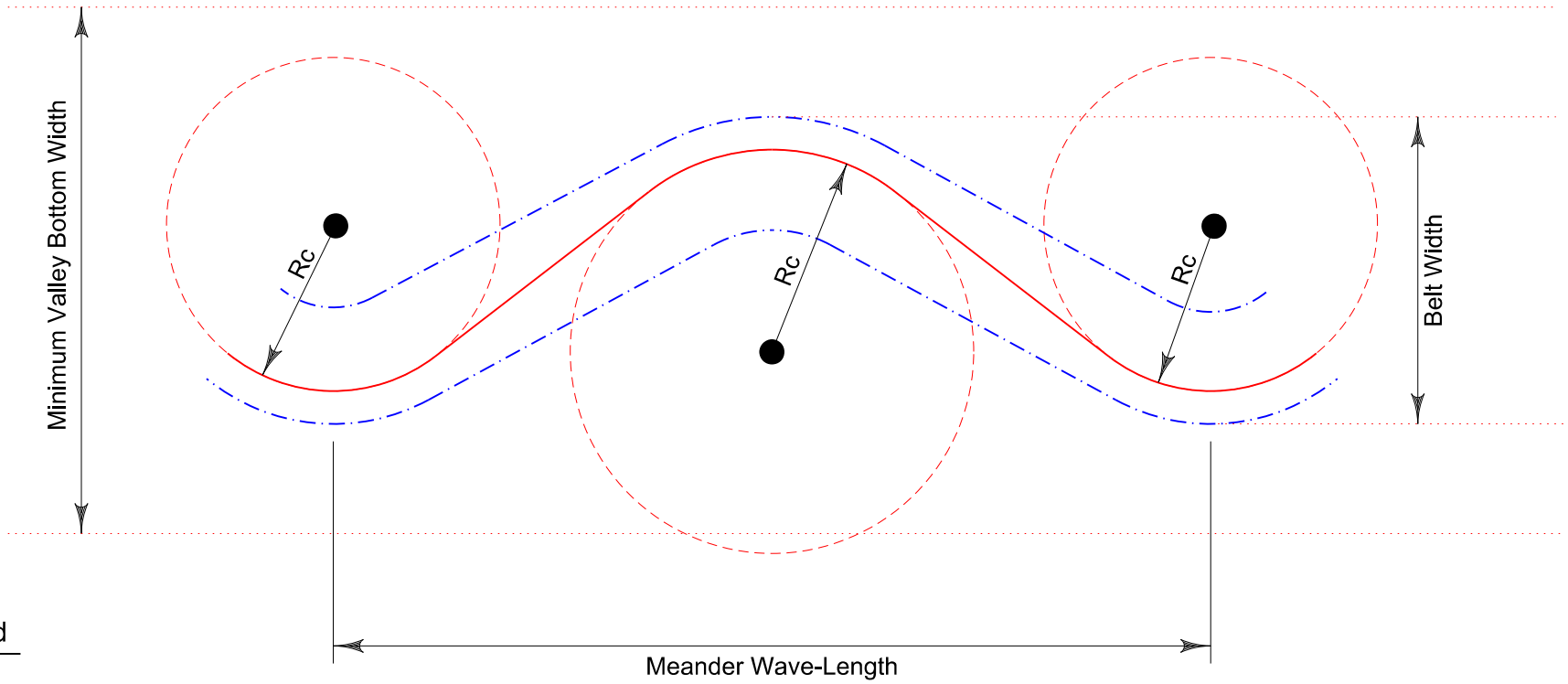
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-6US

EXHIBIT 45

DATE:

Typical Meander Pattern for Rosgen Stream Type "E"
Stream E61DS



Legend

Bankfull

Thalweg

Bankfull Width=6.0'
Radius of Curvature (Rc) Ranges from 15' to 20'
Belt Width Ranges from 60' to 90' (Some Deviation Allowable)
Meander Wave-Length Ranges from 60' to 85' (Some Deviation Allowable)
Approximate Proposed Reach Length = 1386'
Proposed Sinuosity is Approximately 1.51 (1.5 or greater)
Proposed Stream Gradient Ranges from 0.67% to 1.3%
Proposed Valley Slope Ranges from 1% to 2%
Minimum Valley Bottom Width = 135'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

STREAM: E-6DS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

ITEM: PROPOSED TYPICAL MEANDOR PATTERN

EXHIBIT 46

DATE:

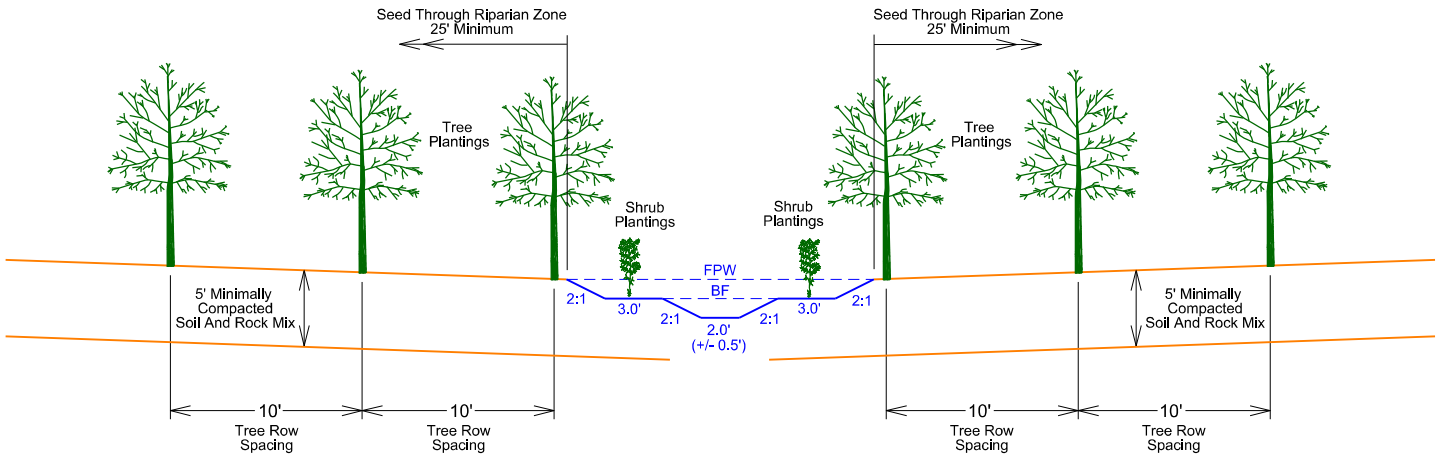
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 6.0'
* Bankfull Max. Depth = 1.0'
* Bankfull Area = 4.0 sq. ft.
* Bankfull Mean Depth = 0.66'
* Flood-Prone Width (FPW) = 16.0' Min
* W/D Ratio = 9.1
* Entrenchment Ratio = 2.6 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 E61DS
Rosgen Stream Type "E"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

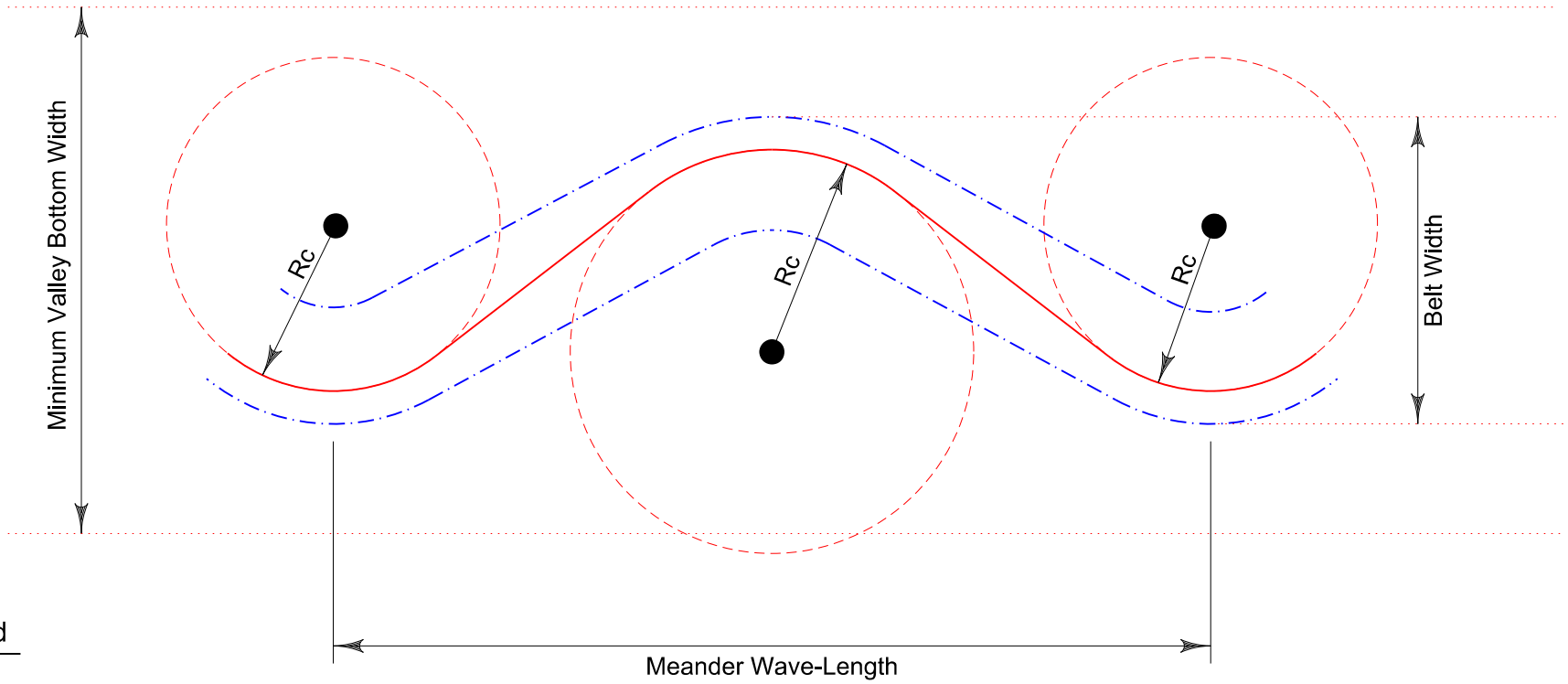
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-6IDS

EXHIBIT 47

DATE:

Typical Meander Pattern for Rosgen Stream Type "B"
Stream E63



Legend

Bankfull

Thalweg

Bankfull Width=4.7'
Radius of Curvature (Rc) Ranges from 11' to 16'
Belt Width Ranges from 18' to 25' (Some Deviation Allowable)
Meander Wave-Length NA
Approximate Proposed Reach Length = 1688'
Proposed Sinuosity is Approximately 1.21 (1.2 or greater)
Proposed Stream Gradient Ranges from 2.9% to 3.8%
Proposed Valley Slope Ranges from 3.5% to 4.6%
Minimum Valley Bottom Width = 35'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: E-63 | EXHIBIT 48

DATE:

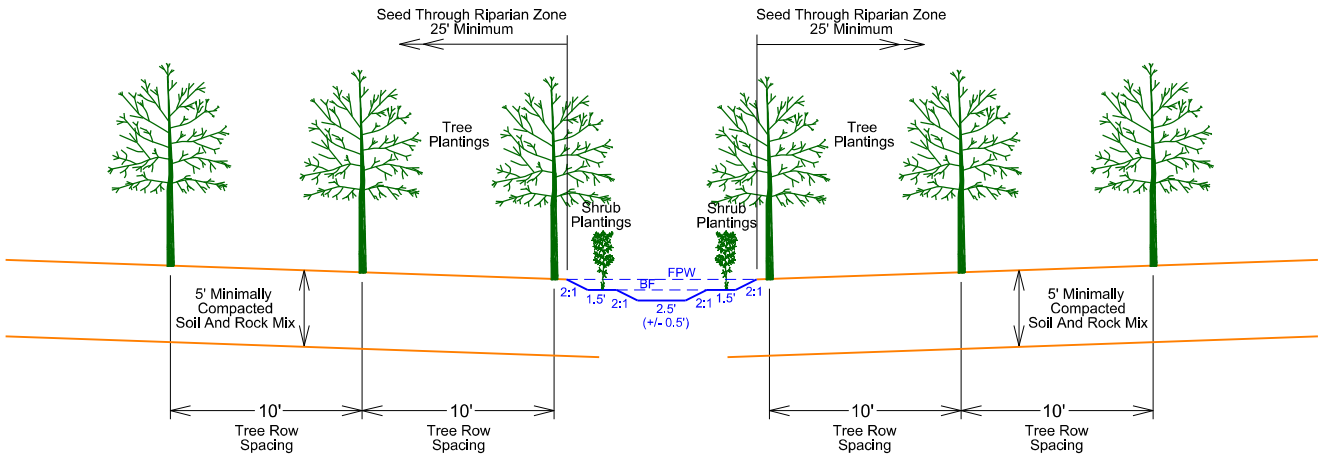
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 4.7'
* Bankfull Max. Depth = 0.55'
* Bankfull Area = 1.98 sq. ft.
* Bankfull Mean Depth = 0.42'
* Flood-Prone Width (FPW) = 10.0' Max
* W/D Ratio = 12
* Entrenchment Ratio = 2.1
* Bench Width = 1.5'



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 E63
Rosgen Stream Type "B"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

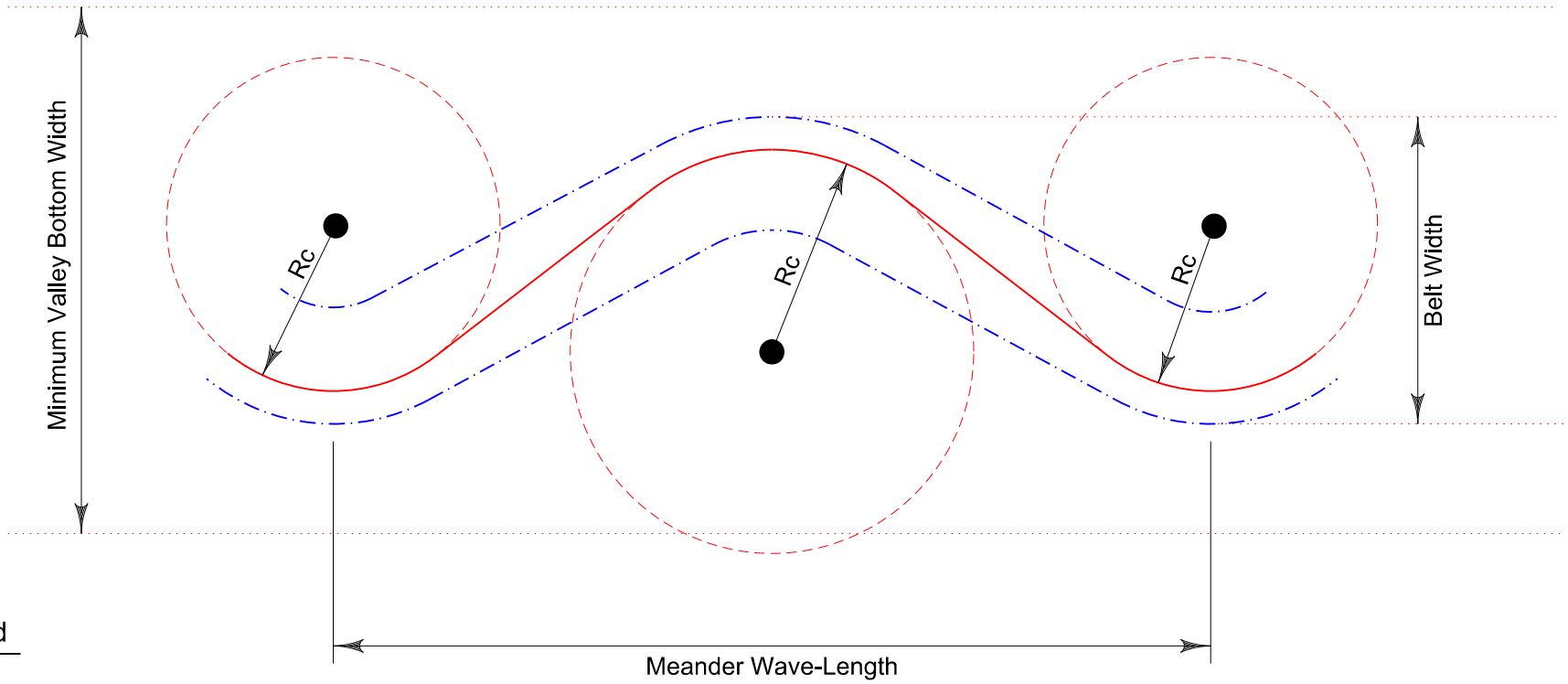
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: E-63

EXHIBIT 49

DATE:

Typical Meander Pattern for Rosgen Stream Type "C"
Stream INT3MS



Legend

Bankfull

Thalweg

Bankfull Width=9'
Radius of Curvature (Rc) Ranges from 22' to 27'
Belt Width Ranges from 72' to 100'
Meander Wave-Length Ranges from 81' to 126'
Approximate Proposed Reach Length = 2228'
Proposed Sinuosity is Approximately 1.20 (1.2 or greater)
Proposed Stream Gradient Ranges from 0.67% to 1.25%
Proposed Valley Slope Ranges from 0.8% to 1.5%
Minimum Valley Bottom Width = 110'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: INT-3MS | EXHIBIT 50

DATE:

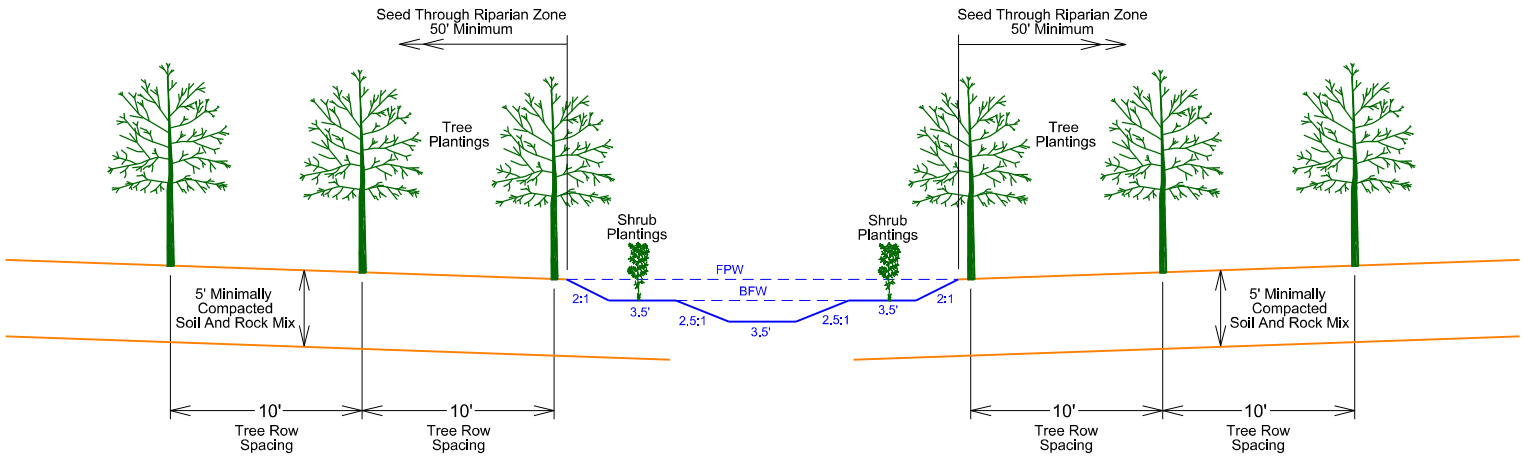
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 9'
* Bankfull Max. Depth = 1.1'
* Bankfull Area = 6.88SF
* Bankfull Mean Depth = 0.76'
* Flood-Prone Width (FPW) = 20.4' Min
* W/D Ratio = 12
* Entrenchment Ratio = 2.26
* 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 INT3MS
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

STREAM: INT-3MS

ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

EXHIBIT 51

DATE:

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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.

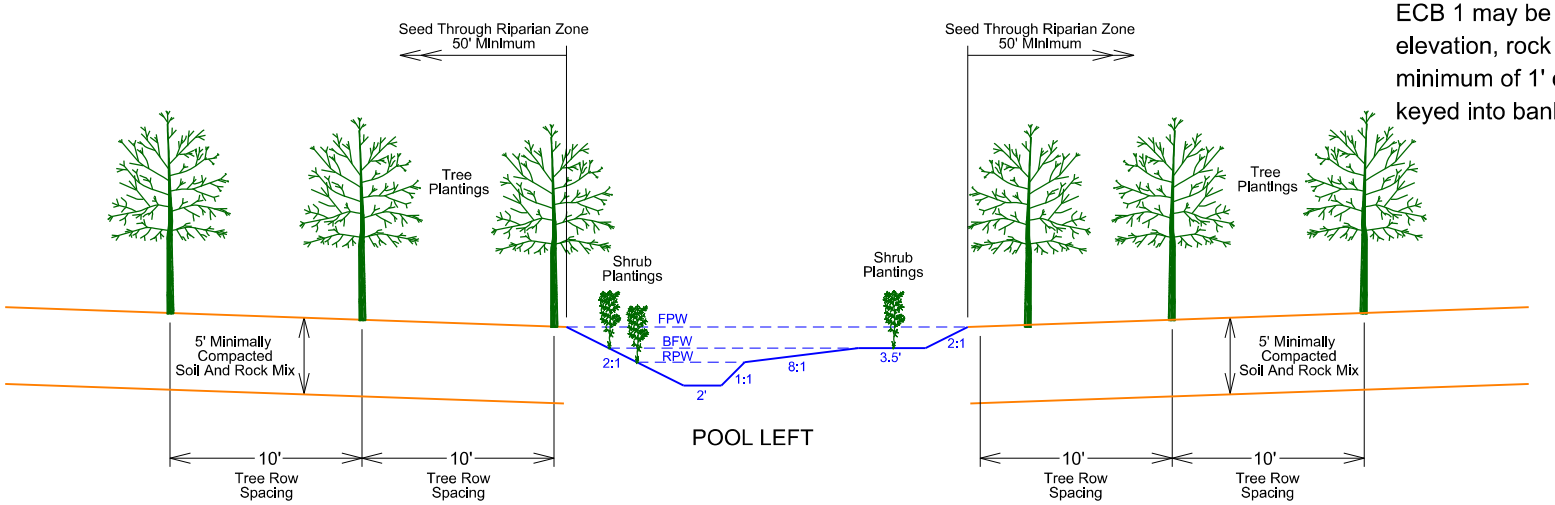
E.C.B. 2 shall meet the following specifications:
* Netting:100% Biodegradable, natural fiber.
* Matrix Material:100% straw.
* Stitching:Biodegradable thread on 1.5 inch centers.
* Shear stress:1.855 lbs. / SQ. FT.
* Velocity:6 feet per second.
* Longevity:up to 12 months.
* North American Green S150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

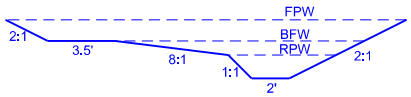
In bend sections, E.C.B. 1 may be placed along the inside bend (Point Bar). Blanket installation shall begin at the bottom of the point bar slope (just above Residual Pool Elevation) and extend to Flood Prone Elevation. E.C.B. 2 may be placed beyond this location as needed.

Proposed Channel Dimensions
* Bankfull Width (BFW) = 13'
* Bankfull Max. Depth = 1.1'
* Bankfull Area = 11.47SF
* Bankfull Mean Depth = 0.88'
* Flood-Prone Width (FPW) = 20.9' Min
* W/D Ratio = 14.7
* Residual Pool Max. Depth = 1.21'
* Residual Pool (RPW) Width = 5.6'
* Bench Width= 3.5 Min

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.

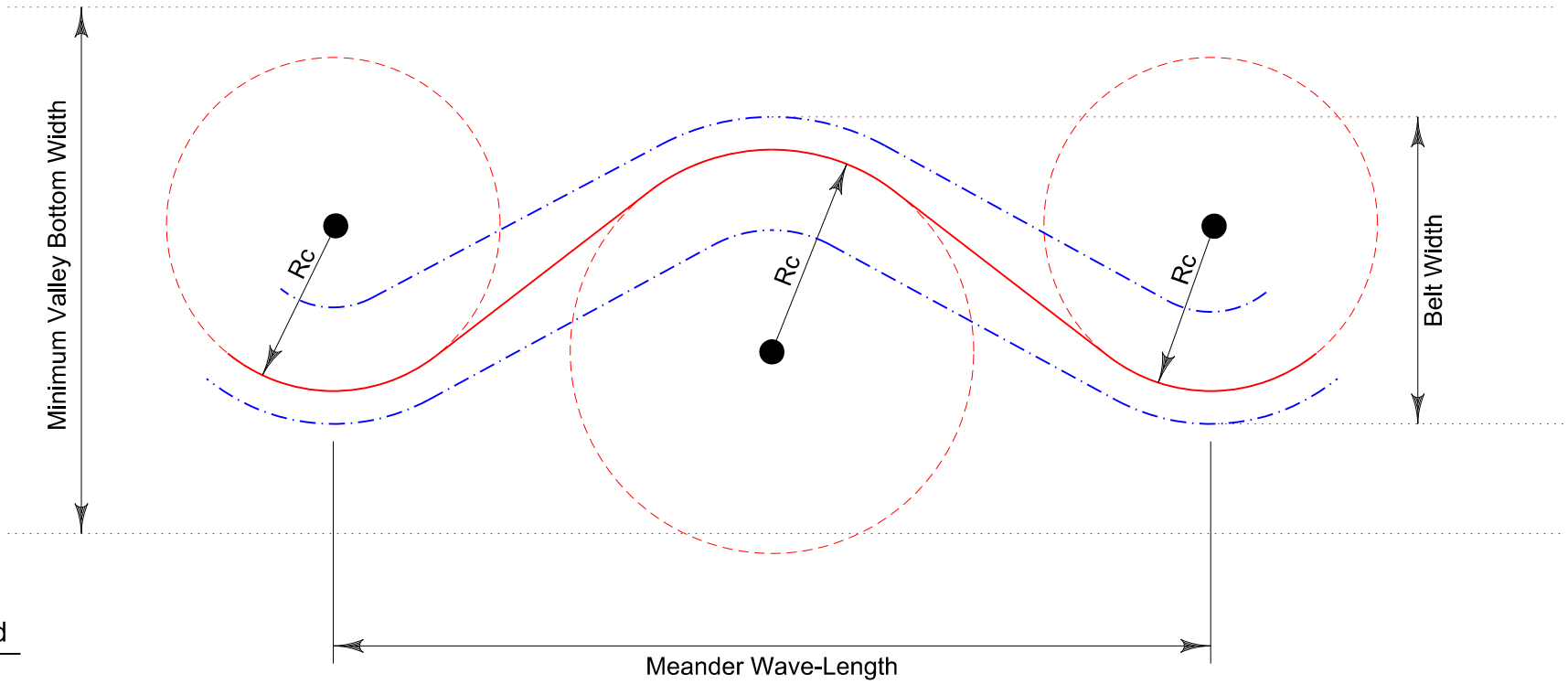


Typical Pool Cross Section Stream INT3MS
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS
COUNTY: OHIO
STATE: KY
NEAR: CENTERTOWN
ITEM: PROPOSED TYPICAL POOL CROSS SECTION
STREAM: INT-3MS
EXHIBIT 52
DATE:

Typical Meander Pattern for Rosgen Stream Type "C"
Stream INT3DS



Legend

Bankfull

Thalweg

Bankfull Width=14.75'
Radius of Curvature (Rc) Ranges from 36' to 44'
Belt Width Ranges from 118' to 162'
Meander Wave-Length Ranges from 133' to 206'
Approximate Proposed Reach Length = 609'
Proposed Sinuosity is Approximately 1.26 (1.2 or greater)
Proposed Stream Gradient Ranges from 0.04% to 0.83%
Proposed Valley Slope Ranges from 0.05% to 1%
Minimum Valley Bottom Width = 185'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: INT-3DS | EXHIBIT 53

DATE:

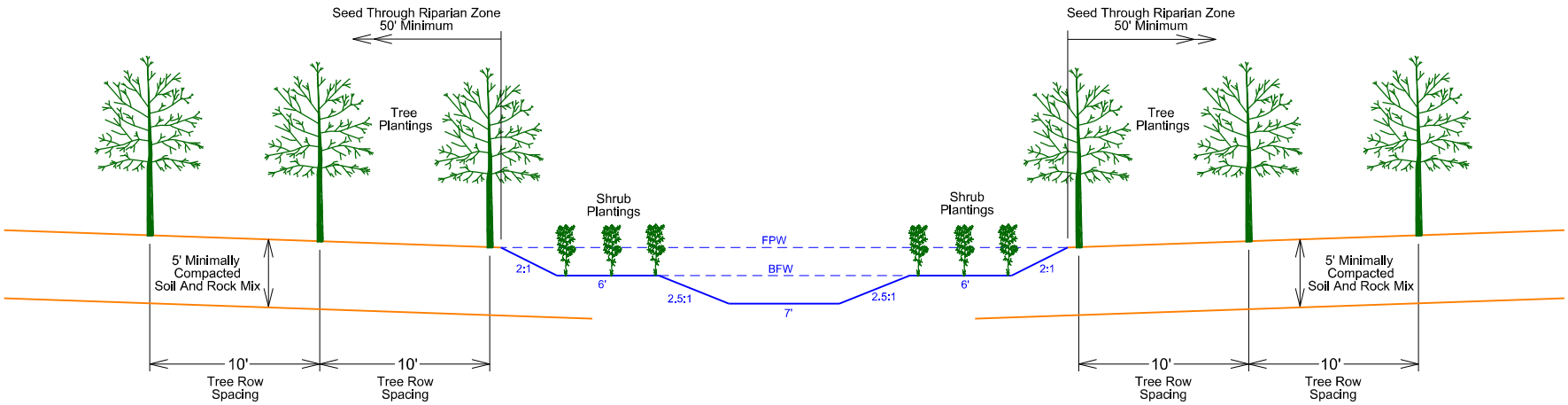
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 14.75'
* Bankfull Max. Depth = 1.65'
* Bankfull Area = 17.53SF
* Bankfull Mean Depth = 1.19'
* Flood-Prone Width (FPW) = 33.4'
* W/D Ratio = 12.41
* Entrenchment Ratio = 2.26 Min
* Bench Width = 6' 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 INT3DS
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | STREAM: INT-3DS

ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION | EXHIBIT 54

DATE:

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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.

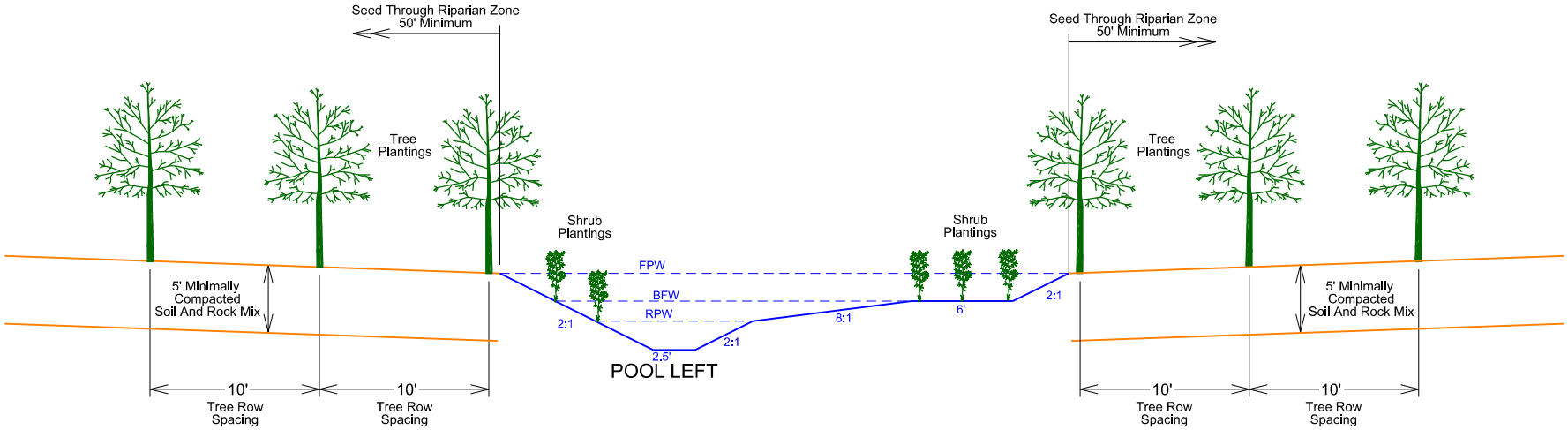
E.C.B. 2 shall meet the following specifications:
* Netting:100% Biodegradable, natural fiber.
* Matrix Material:100% straw.
* Stitching:Biodegradable thread on 1.5 inch centers.
* Shear stress:1.855 lbs. / SQ. FT.
* Velocity:6 feet per second.
* Longevity:up to 12 months.
* North American Green S150 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) = 21'
* Bankfull Max. Depth = 2.87'
* Bankfull Area = 27.77SF
* Bankfull Mean Depth = 1.32'
* Flood-Prone Width (FPW) = 33.6' Min
* W/D Ratio = 15.9
* Residual Pool Max. Depth = 1.7'
* Residual Pool (RPW) Width = 9.3'
* Bench Width= 6' Min

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.



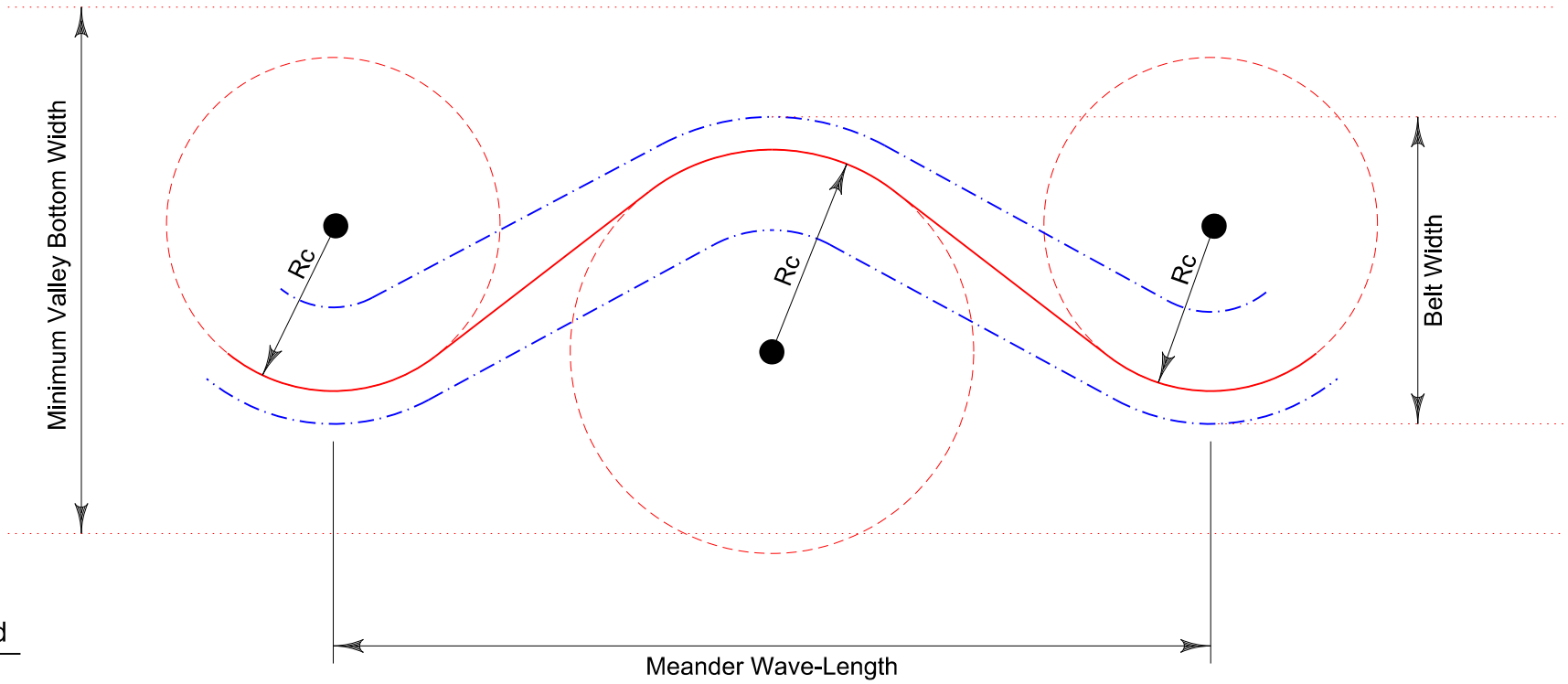
Note
* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

Typical Pool Cross Section Stream INT3DS
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS
COUNTY: OHIO
STATE: KY
NEAR: CENTERTOWN
ITEM: PROPOSED TYPICAL POOL CROSS SECTION
STREAM: INT-3DS
EXHIBIT 55
DATE:

Typical Meander Pattern for Rosgen Stream Type "E"
Stream INT4US



Legend

Bankfull

Thalweg

Bankfull Width=5.8'
Radius of Curvature (Rc) Ranges from 14' to 19'
Belt Width Ranges from 58' to 90' (Some Deviation Allowable)
Meander Wave-Length Ranges from 52' to 81' (Some Deviation Allowable)
Approximate Proposed Reach Length = 1871'
Proposed Sinuosity is Approximately 1.51 (1.5 or greater)
Proposed Stream Gradient Ranges from 0.8% to 1.2%
Proposed Valley Slope Ranges from 1.2% to 1.8%
Minimum Valley Bottom Width = 97'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: INT-4US | EXHIBIT 56

DATE:

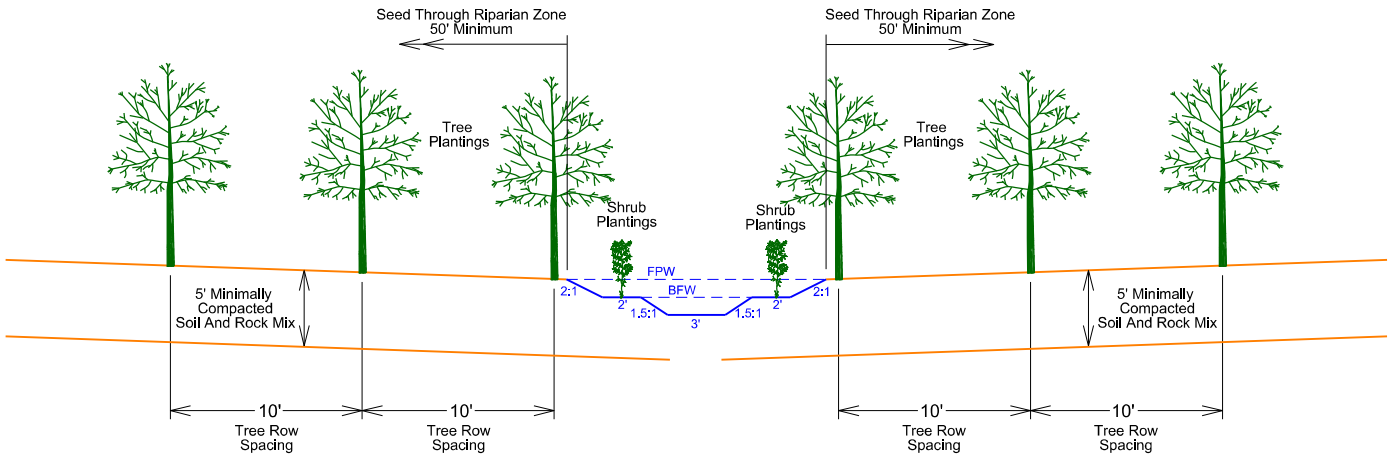
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 5.8'
* Bankfull Max. Depth = 0.93'
* Bankfull Area = 4.01SF
* Bankfull Mean Depth = 0.71'
* Flood-Prone Width (FPW) = 13.5' Min
* W/D Ratio = 8.22
* Entrenchment Ratio = 2.3
* 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 INT4US
Rosgen Stream Type "E"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

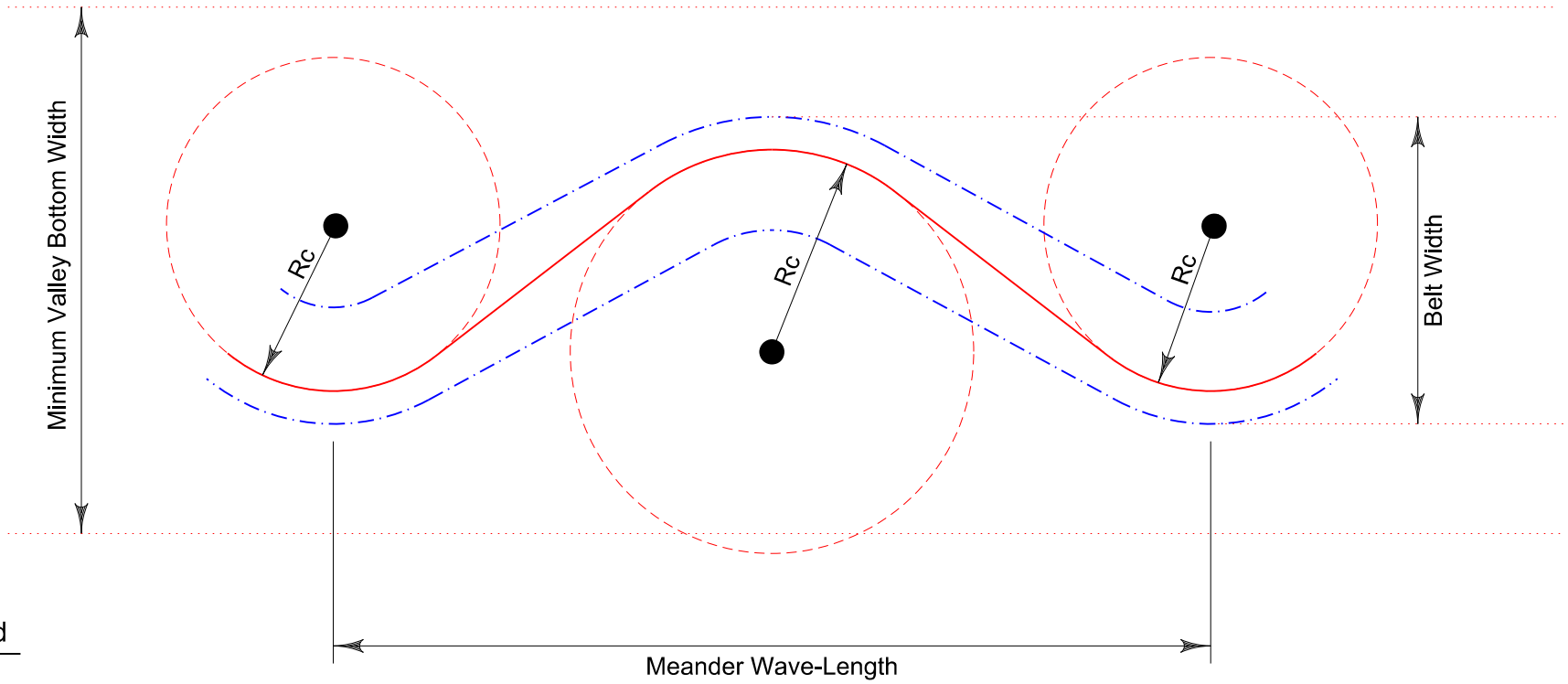
ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: INT-4US

EXHIBIT 57

DATE:

Typical Meander Pattern for Rosgen Stream Type "C"
Stream INT4MS



Legend

Bankfull

Thalweg

Bankfull Width=10'
Radius of Curvature (Rc) Ranges from 25' to 30'
Belt Width Ranges from 80' to 110'
Meander Wave-Length Ranges from 90' to 140'
Approximate Proposed Reach Length = 2462'
Proposed Sinuosity is Approximately 1.21 (1.2 or greater)
Proposed Stream Gradient Ranges from 0.67% to 1.25%
Proposed Valley Slope Ranges from 0.8% to 1.5%
Minimum Valley Bottom Width = 120'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: INT-4MS | EXHIBIT 58

DATE:

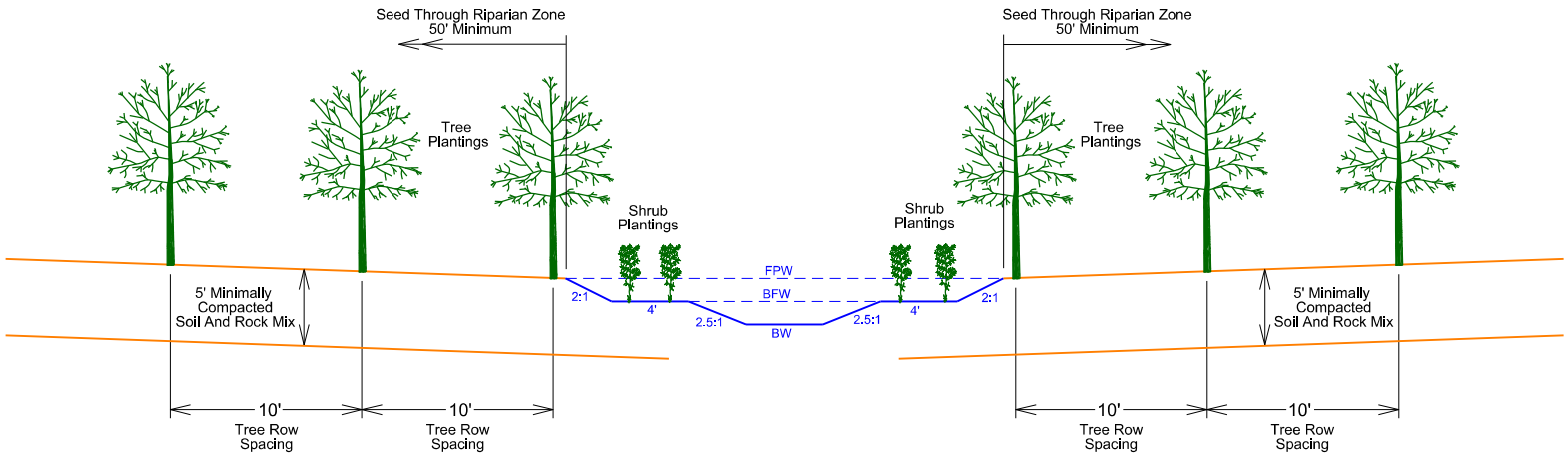
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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'
* Bankfull Max. Depth = 1.2'
* Bankfull Area = 8.4SF
* Bankfull Mean Depth = 0.84'
* Flood-Prone Width (FPW) = 22.8'
* W/D Ratio = 12
* Entrenchment Ratio = 2.28 Min
* Bench Width = 4' 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 INT4MS
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: INT-4MS

EXHIBIT 59

DATE:

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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.

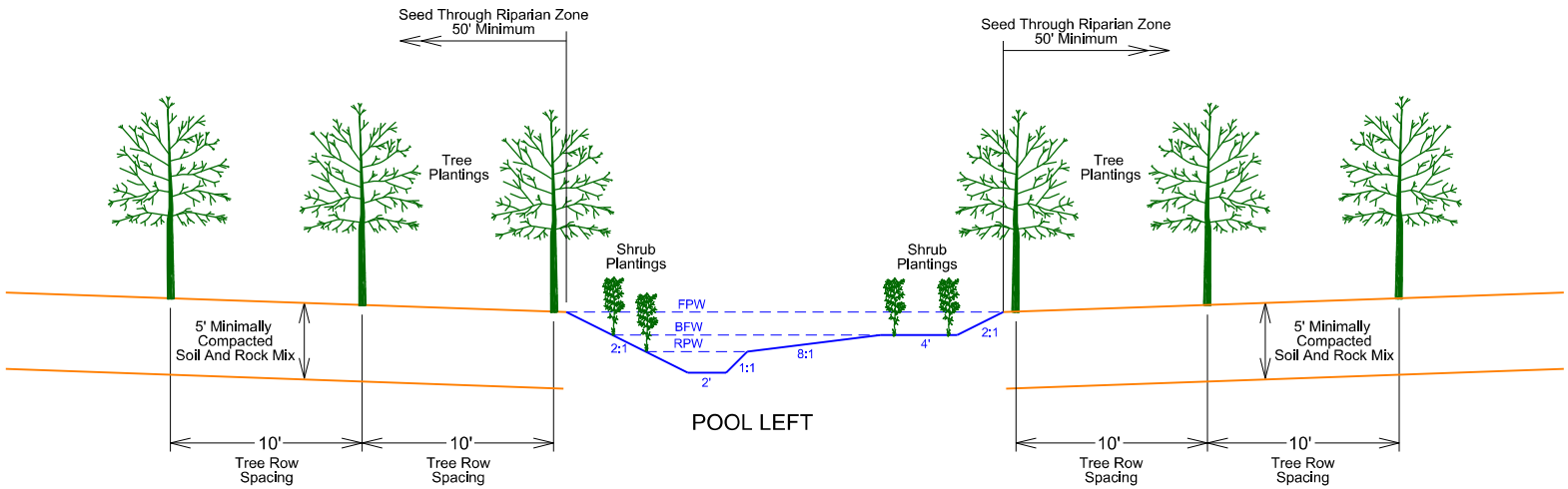
E.C.B. 2 shall meet the following specifications:
* Netting:100% Biodegradable, natural fiber.
* Matrix Material:100% straw.
* Stitching:Biodegradable thread on 1.5 inch centers.
* Shear stress:1.855 lbs. / SQ. FT.
* Velocity:6 feet per second.
* Longevity:up to 12 months.
* North American Green S150 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'
* Bankfull Max. Depth = 1.97'
* Bankfull Area = 12.8SF
* Bankfull Mean Depth = 0.91'
* Flood-Prone Width (FPW) = 22.8' Min
* W/D Ratio = 15.3
* Residual Pool Max. Depth = 1.09'
* Residual Pool (RPW) Width = 5.29'
* Bench Width= 4' Min

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.



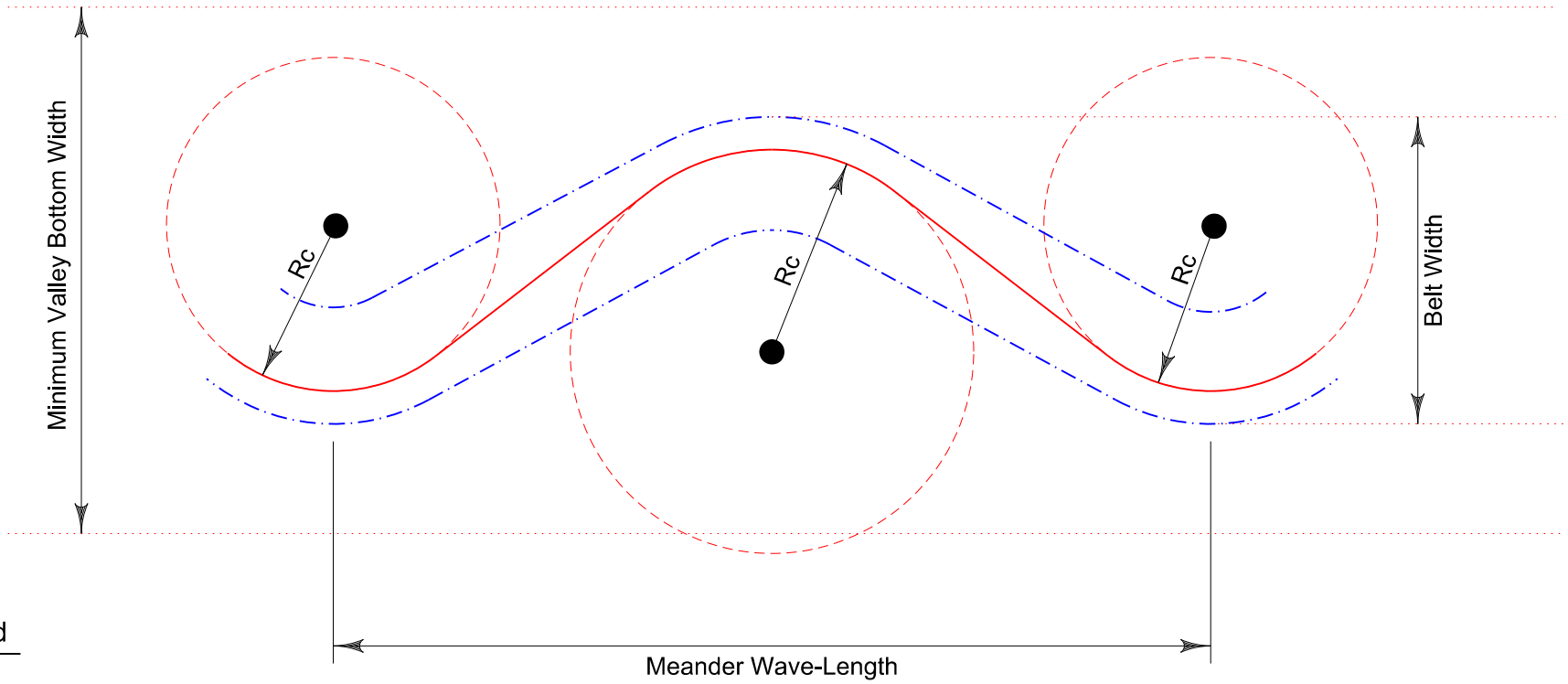
Note
* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

Typical Pool Cross Section Stream INT4MS
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS
COUNTY: OHIO
STATE: KY
NEAR: CENTERTOWN
STREAM: INT-4MS
ITEM: PROPOSED TYPICAL POOL CROSS SECTION
EXHIBIT 60
DATE:

Typical Meander Pattern for Rosgen Stream Type "C"
Stream INT4DS



Legend

Bankfull

Thalweg

Bankfull Width=13.25'
Radius of Curvature (Rc) Ranges from 33' to 40'
Belt Width Ranges from 106' to 146'
Meander Wave-Length Ranges from 119' to 186'
Approximate Proposed Reach Length = 2009'
Proposed Sinuosity is Approximately 1.21 (1.2 or greater)
Proposed Stream Gradient Ranges from 0.25% to 0.83%
Proposed Valley Slope Ranges from 0.3% to 1%
Minimum Valley Bottom Width = 170'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: INT-4DS | EXHIBIT 61

DATE:

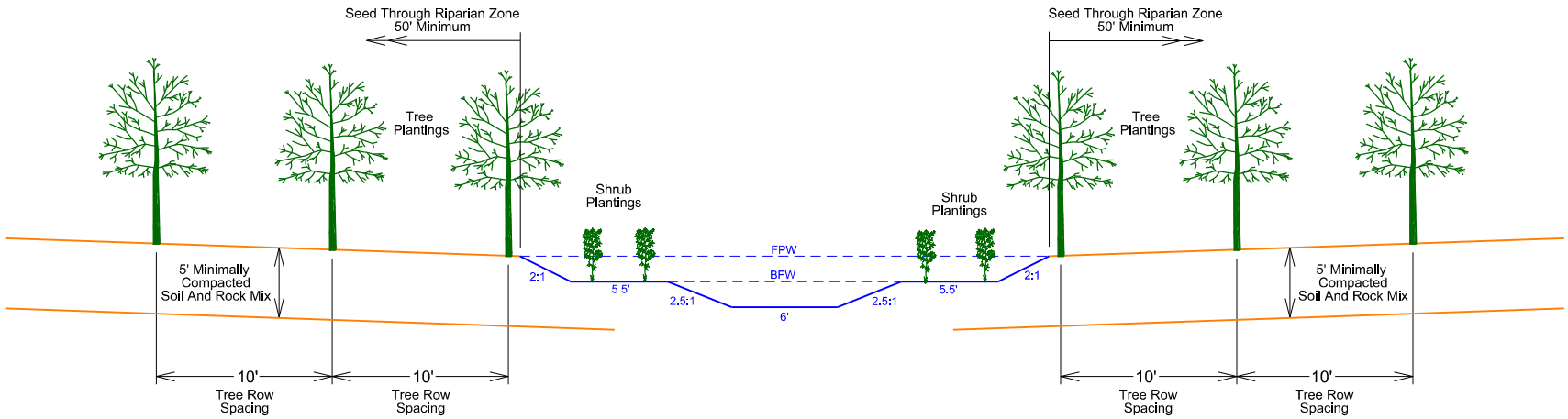
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 13.25'
* Bankfull Max. Depth = 1.45'
* Bankfull Area = 13.96SF
* Bankfull Mean Depth = 1.05'
* Flood-Prone Width (FPW) = 30' Min
* W/D Ratio = 12.58
* Entrenchment Ratio = 2.26 Min
* Bench Width = 5.5' 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 INT4DS
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: INT-4DS

EXHIBIT 62

DATE:

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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.

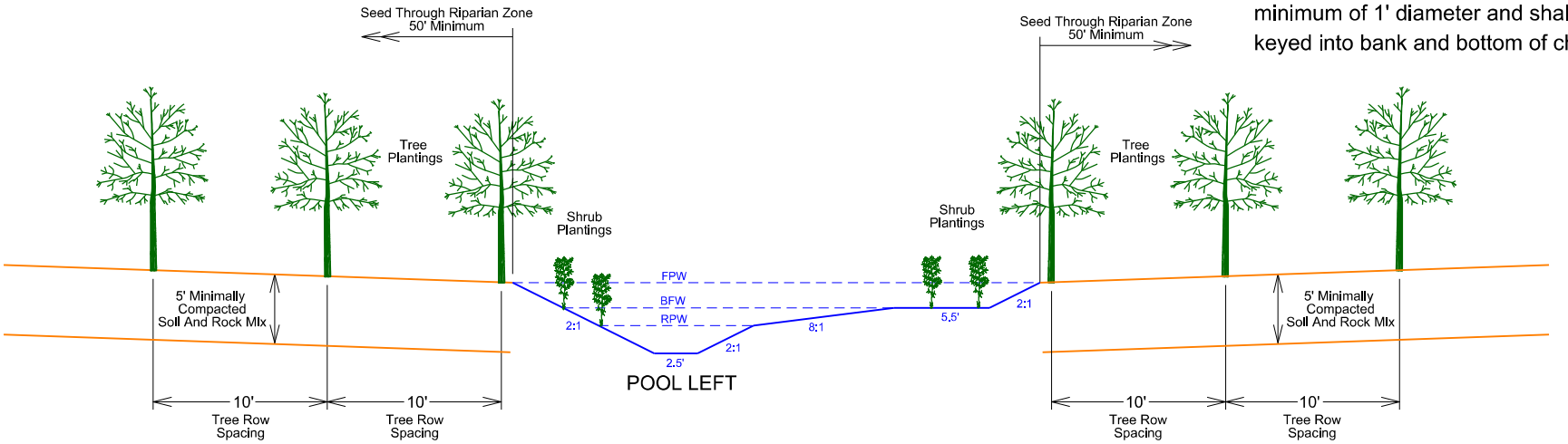
E.C.B. 2 shall meet the following specifications:
* Netting:100% Biodegradable, natural fiber.
* Matrix Material:100% straw.
* Stitching:Biodegradable thread on 1.5 inch centers.
* Shear stress:1.855 lbs. / SQ. FT.
* Velocity:6 feet per second.
* Longevity:up to 12 months.
* North American Green S150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

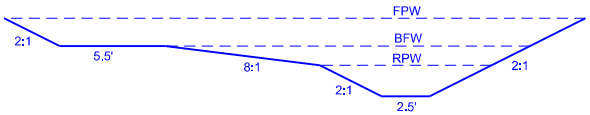
In bend sections, the outside bend may be stabilized with a combination of Erosion Control Blanket Type 1 (E.C.B. 1) and shrub plantings. E.C.B. 1 shall be anchored in at residual pool elevation and extend to Flood Prone Elevation. Beyond this elevation E.C.B. 2 may be placed throughout the riparian 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 = 2.62'
* Bankfull Area = 23.25SF
* Bankfull Mean Depth = 1.22'
* Flood-Prone Width (FPW) = 30.3 Min'
* W/D Ratio = 15.6
* Residual Pool Max. Depth = 1.61'
* Residual Pool (RPW) Width = 8.93'
* Bench Width= 5.5 Min

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 INT4DS
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

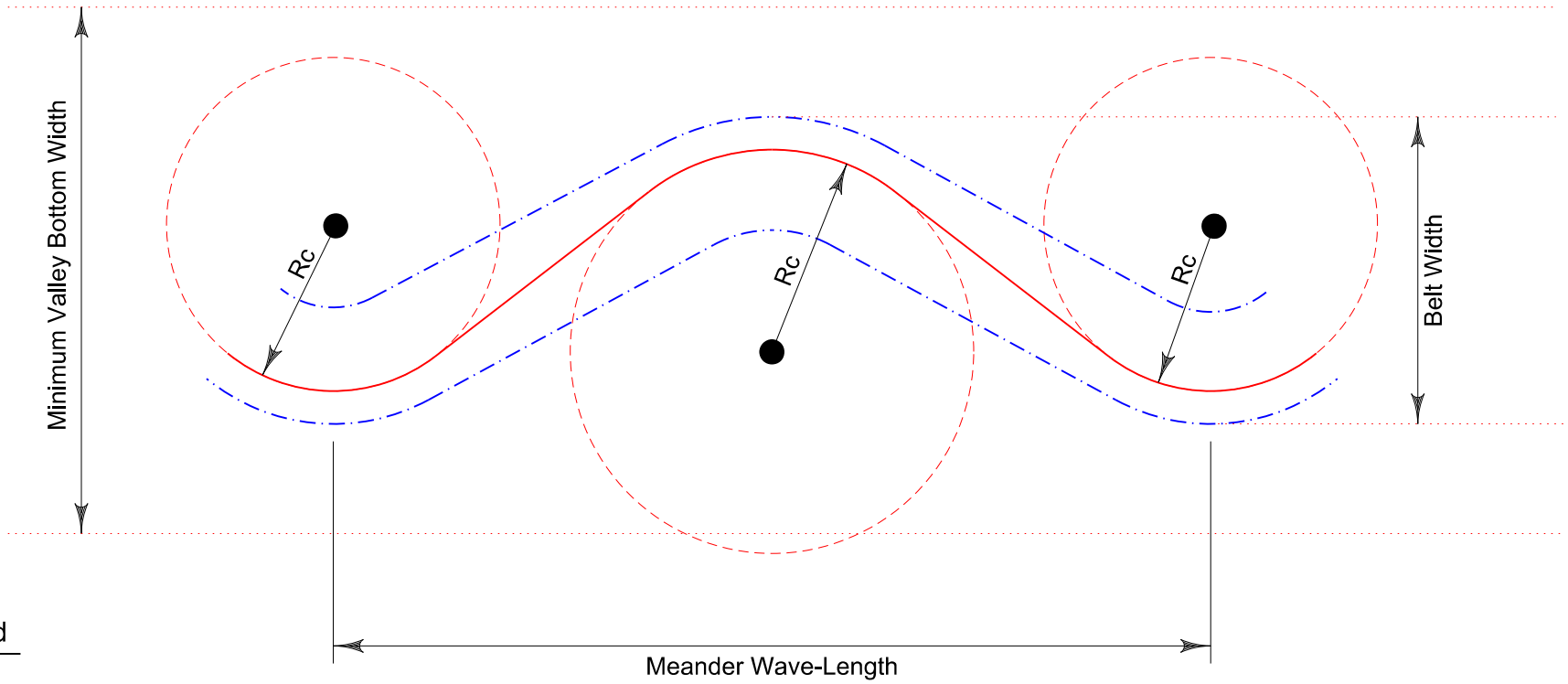
ITEM: PROPOSED TYPICAL POOL CROSS SECTION

STREAM: INT-4DS

EXHIBIT 63

DATE:

Typical Meander Pattern for Rosgen Stream Type "C"
Stream INT5US/DS



Legend

Bankfull

Thalweg

Bankfull Width=10'
Radius of Curvature (Rc) Ranges from 25' to 30'
Belt Width Ranges from 80' to 110'
Meander Wave-Length Ranges from 90' to 140'
Approximate Proposed Reach Length = 2509'
Proposed Sinuosity is Approximately 1.20 (1.2 or greater)
Proposed Stream Gradient Ranges from 0.67% to 1.25%
Proposed Valley Slope Ranges from 0.8% to 1.5%
Minimum Valley Bottom Width = 120'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: INT-5US/DS | EXHIBIT 64

DATE:

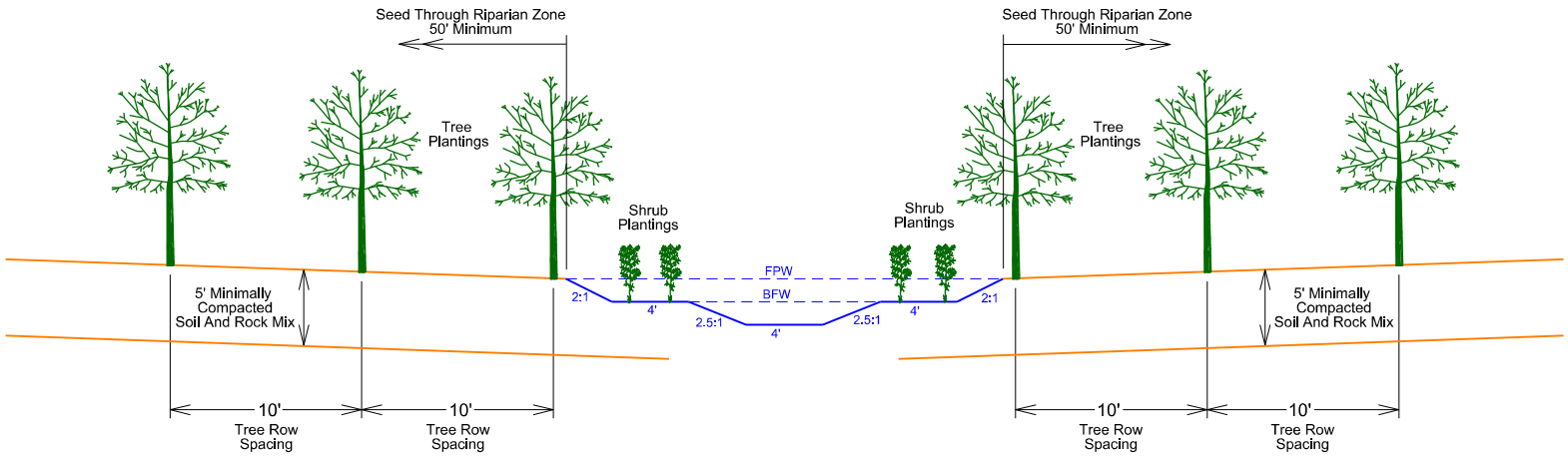
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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'
* Bankfull Max. Depth = 1.2'
* Bankfull Area = 8.4SF
* Bankfull Mean Depth = 0.84'
* Flood-Prone Width (FPW) = 22.8'
* W/D Ratio = 12
* Entrenchment Ratio = 2.28 Min
* Bench Width = 4' 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 INT5US/DS
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: INT-5US/DS

EXHIBIT 65

DATE:

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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.

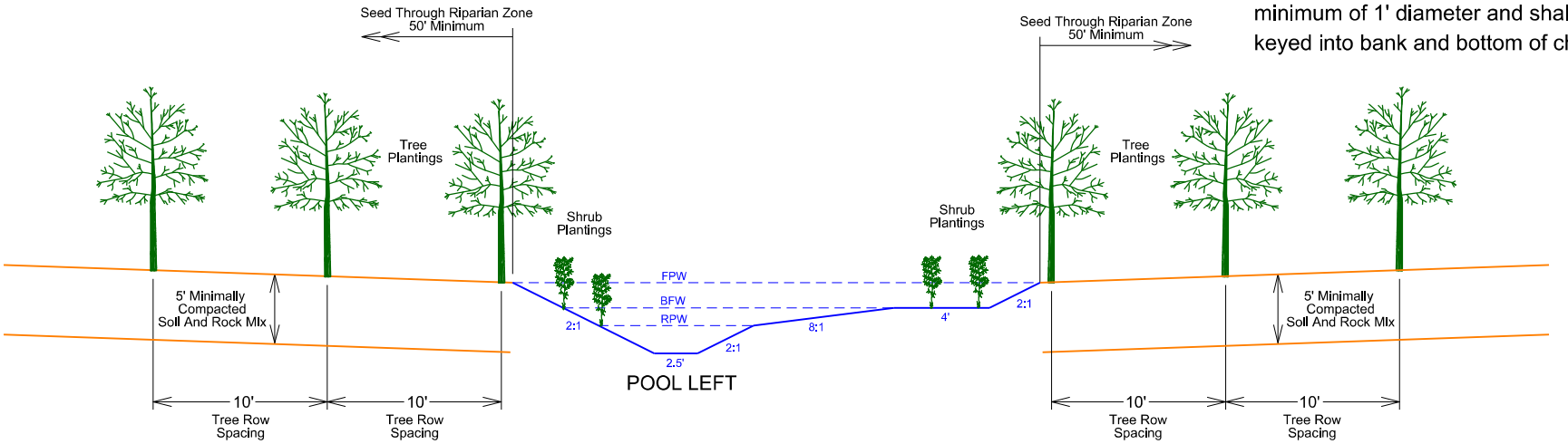
E.C.B. 2 shall meet the following specifications:
* Netting:100% Biodegradable, natural fiber.
* Matrix Material:100% straw.
* Stitching:Biodegradable thread on 1.5 inch centers.
* Shear stress:1.855 lbs. / SQ. FT.
* Velocity:6 feet per second.
* Longevity:up to 12 months.
* North American Green S150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

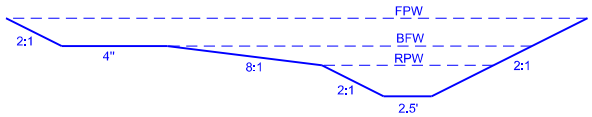
In bend sections, the outside bend may be stabilized with a combination of Erosion Control Blanket Type 1 (E.C.B. 1) and shrub plantings. E.C.B. 1 shall be anchored in at residual pool elevation and extend to Flood Prone Elevation. Beyond this elevation E.C.B. 2 may be placed throughout the riparian 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'
* Bankfull Max. Depth = 1.97'
* Bankfull Area = 12.8SF
* Bankfull Mean Depth = 0.91'
* Flood-Prone Width (FPW) = 22.8 Min'
* W/D Ratio = 15.3
* Residual Pool Max. Depth = 1.09'
* Residual Pool (RPW) Width = 5.29'
* Bench Width= 4.0' Min

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.





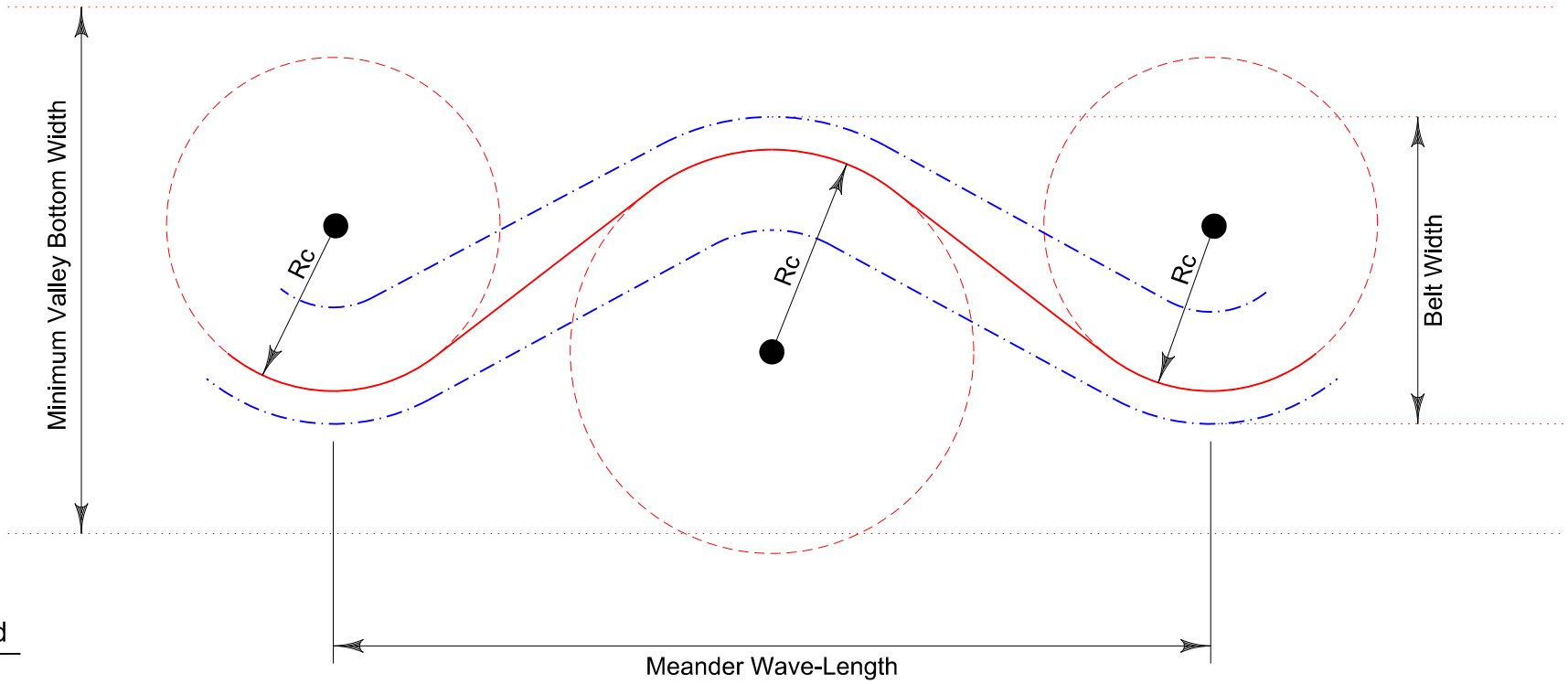
Note
* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

Typical Pool Cross Section Stream INT5US/DS
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS
COUNTY: OHIO
STATE: KY
NEAR: CENTERTOWN
ITEM: PROPOSED TYPICAL POOL CROSS SECTION
STREAM: INT-5US/DS
EXHIBIT 66
DATE:

Typical Meander Pattern for Rosgen Stream Type "C"
Stream INT6US



Legend

Bankfull

Thalweg

Bankfull Width=7.9'
Radius of Curvature (Rc) Ranges from 19' to 24'
Belt Width Ranges from 63' to 87'
Meander Wave-Length Ranges from 71' to 111'
Approximate Proposed Reach Length = 936'
Proposed Sinuosity is Approximately 1.24 (1.2 or greater)
Proposed Stream Gradient Ranges from 0.42% to 1.2%
Proposed Valley Slope Ranges from 0.5% to 1.4%
Minimum Valley Bottom Width = 95'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: INT-6US | EXHIBIT 67

DATE:

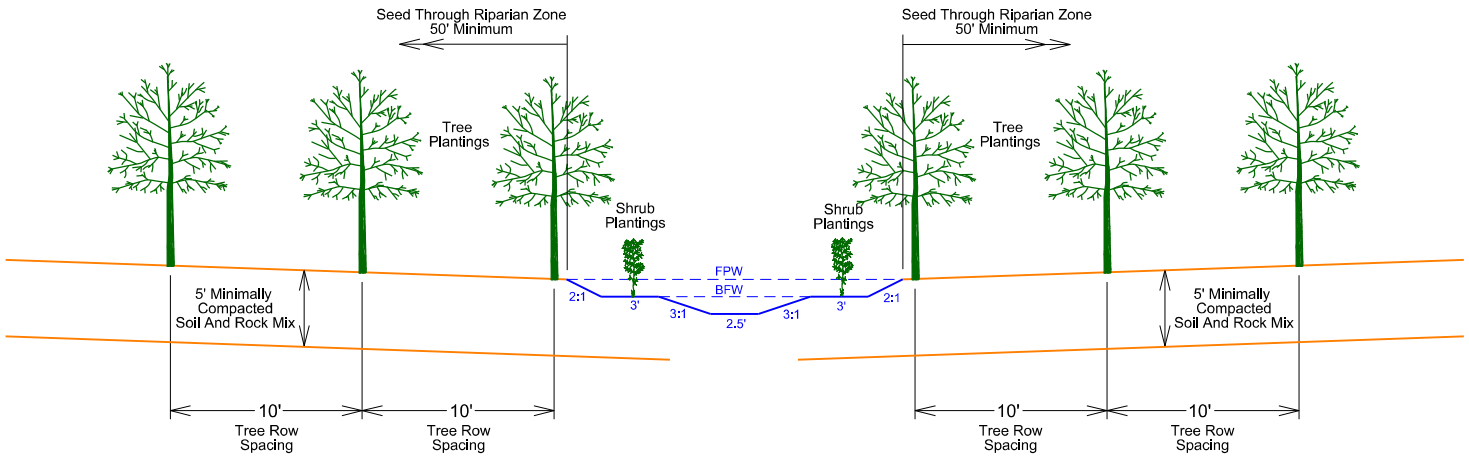
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 7.9'
* Bankfull Max. Depth = 0.9'
* Bankfull Area = 4.68SF
* Bankfull Mean Depth = 0.59'
* Flood-Prone Width (FPW) = 17.5' Min
* W/D Ratio = 13.4
* Entrenchment Ratio = 2.21 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 INT6US
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: INT-6US

EXHIBIT 68

DATE:

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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.

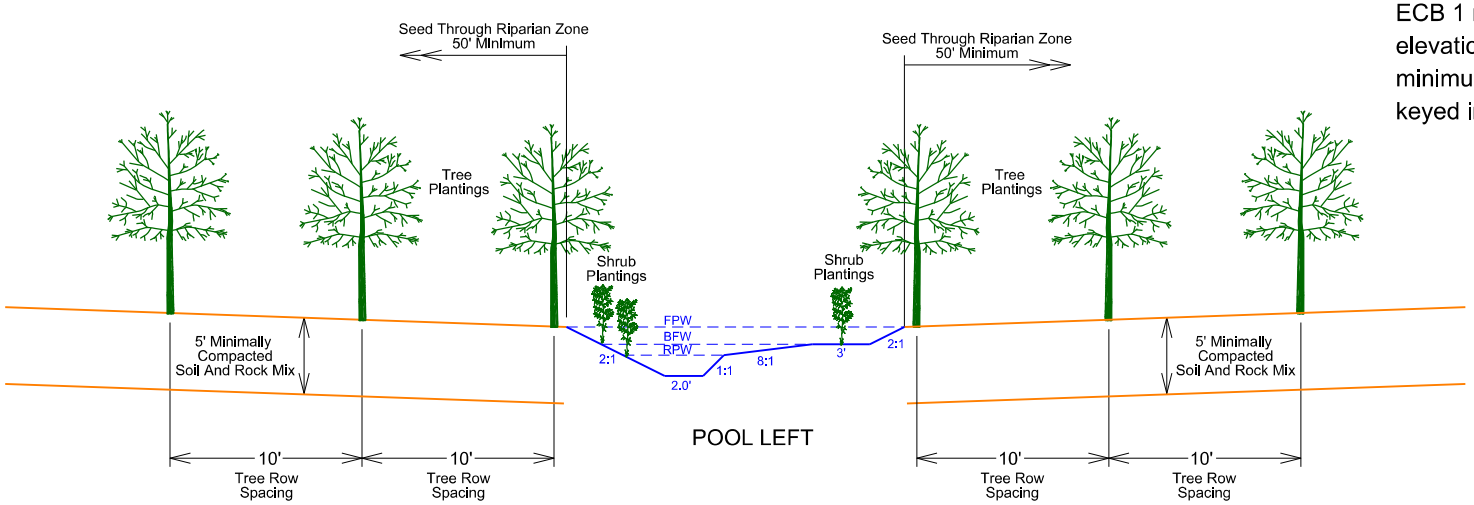
E.C.B. 2 shall meet the following specifications:
* Netting:100% Biodegradable, natural fiber.
* Matrix Material:100% straw.
* Stitching:Biodegradable thread on 1.5 inch centers.
* Shear stress:1.855 lbs. / SQ. FT.
* Velocity:6 feet per second.
* Longevity:up to 12 months.
* North American Green S150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

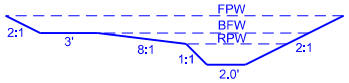
Proposed Channel Dimensions
* Bankfull Width (BFW) = 11'
* Bankfull Max. Depth = 0.9'
* Bankfull Area = 8.59SF
* Bankfull Mean Depth = 0.78'
* Flood-Prone Width (FPW) = 17.6' Min
* W/D Ratio = 14.1
* Residual Pool Max. Depth = 1.08'
* Residual Pool (RPW) Width = 5.2'
* Bench Width= 3.0' Min

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.



POOL LEFT

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



POOL RIGHT

Typical Pool Cross Section Stream INT6US
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

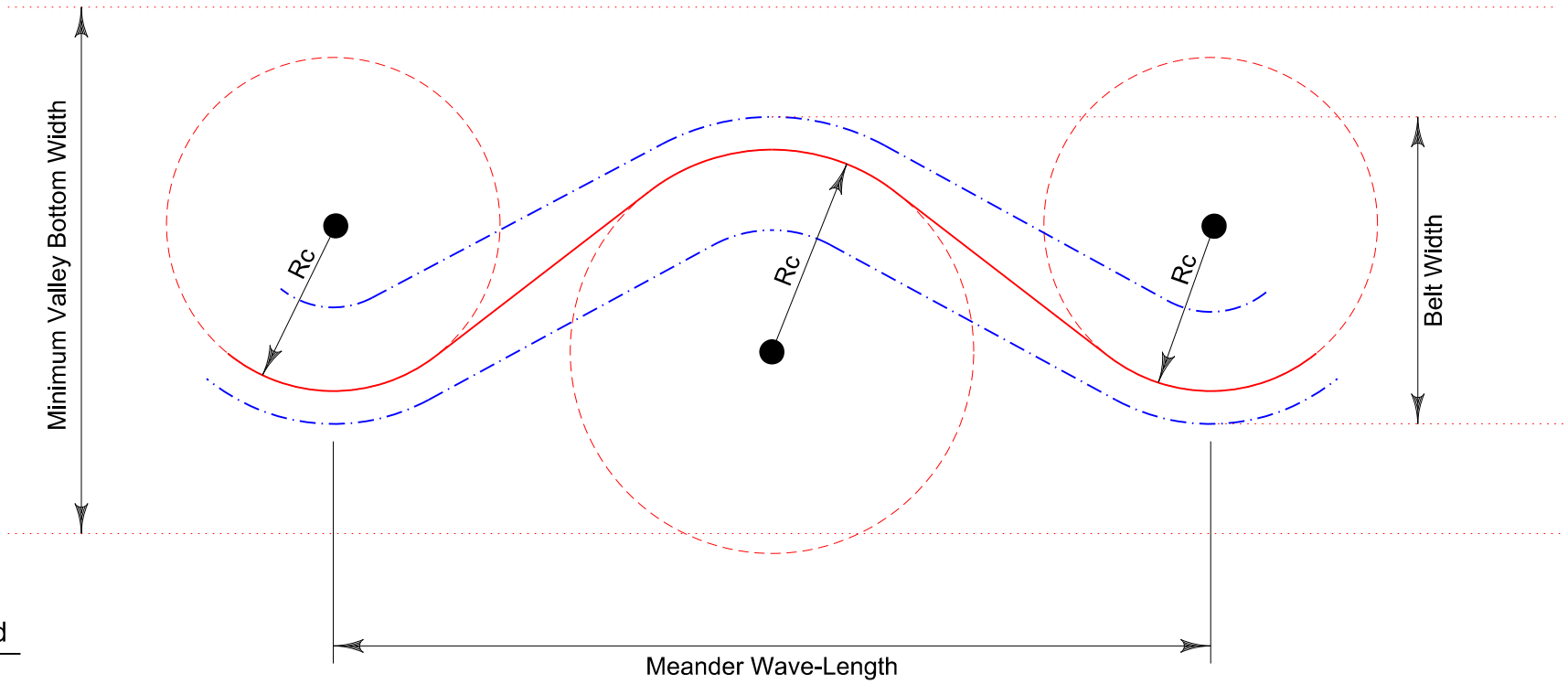
ITEM: PROPOSED TYPICAL POOL CROSS SECTION

STREAM: INT-6US

EXHIBIT 69

DATE:

Typical Meander Pattern for Rosgen Stream Type "C"
Stream INT1UM



Legend

Bankfull

Thalweg

Bankfull Width=12.75'
Radius of Curvature (Rc) Ranges from 31' to 38.5'
Belt Width Ranges from 102' to 140'
Meander Wave-Length Ranges from 114' to 179'
Approximate Proposed Reach Length = 3512'
Proposed Sinuosity is Approximately 1.23 (1.2 or greater)
Proposed Stream Gradient Ranges from 0.3% to 0.7%
Proposed Valley Slope Ranges from 0.4% to 0.85%
Minimum Valley Bottom Width = 165'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: INT-1UM | EXHIBIT 7O

DATE:

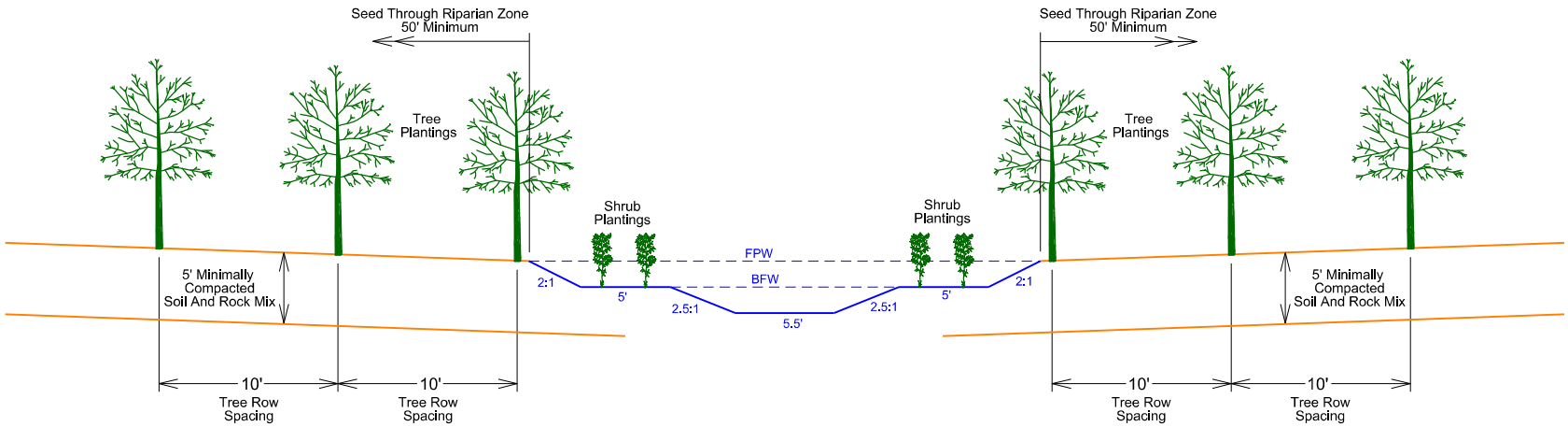
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 12.75'
* Bankfull Max. Depth = 1.45'
* Bankfull Area = 13.23SF
* Bankfull Mean Depth = 1.04'
* Flood-Prone Width (FPW) = 28.5'
* W/D Ratio = 12.29
* Entrenchment Ratio = 2.23 Min
* Bench Width = 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 INT1UM
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: INT-1UM

EXHIBIT 71

DATE:

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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.

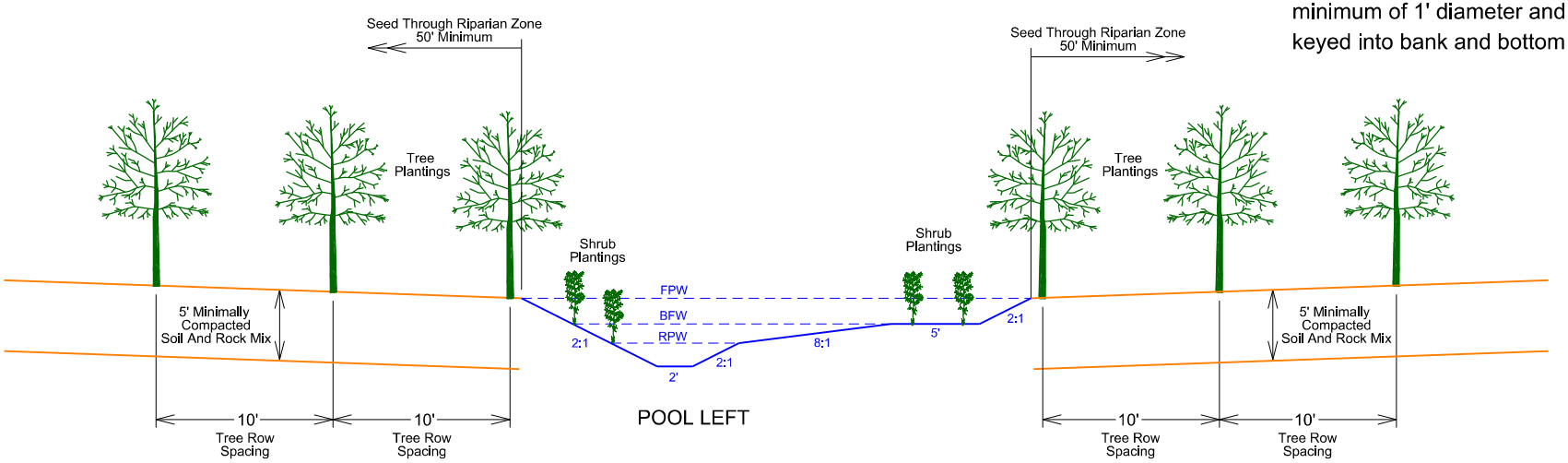
E.C.B. 2 shall meet the following specifications:
* Netting:100% Biodegradable, natural fiber.
* Matrix Material:100% straw.
* Stitching:Biodegradable thread on 1.5 inch centers.
* Shear stress:1.855 lbs. / SQ. FT.
* Velocity:6 feet per second.
* Longevity:up to 12 months.
* North American Green S150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

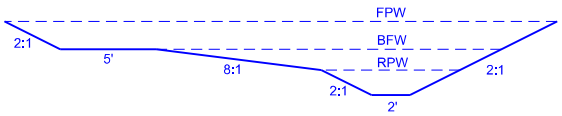
In bend sections, the outside bend may be stabilized with a combination of Erosion Control Blanket Type 1 (E.C.B. 1) and shrub plantings. E.C.B. 1 shall be anchored in at residual pool elevation and extend to Flood Prone Elevation. Beyond this elevation E.C.B. 2 may be placed throughout the riparian 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) = 18'
* Bankfull Max. Depth = 2.39'
* Bankfull Area = 19.63SF
* Bankfull Mean Depth = 1.09'
* Flood-Prone Width (FPW) = 28.8' Min
* W/D Ratio = 16.5
* Residual Pool Max. Depth = 1.31'
* Residual Pool (RPW) Width = 7.24'
* Bench Width= 5' Min

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.





POOL RIGHT

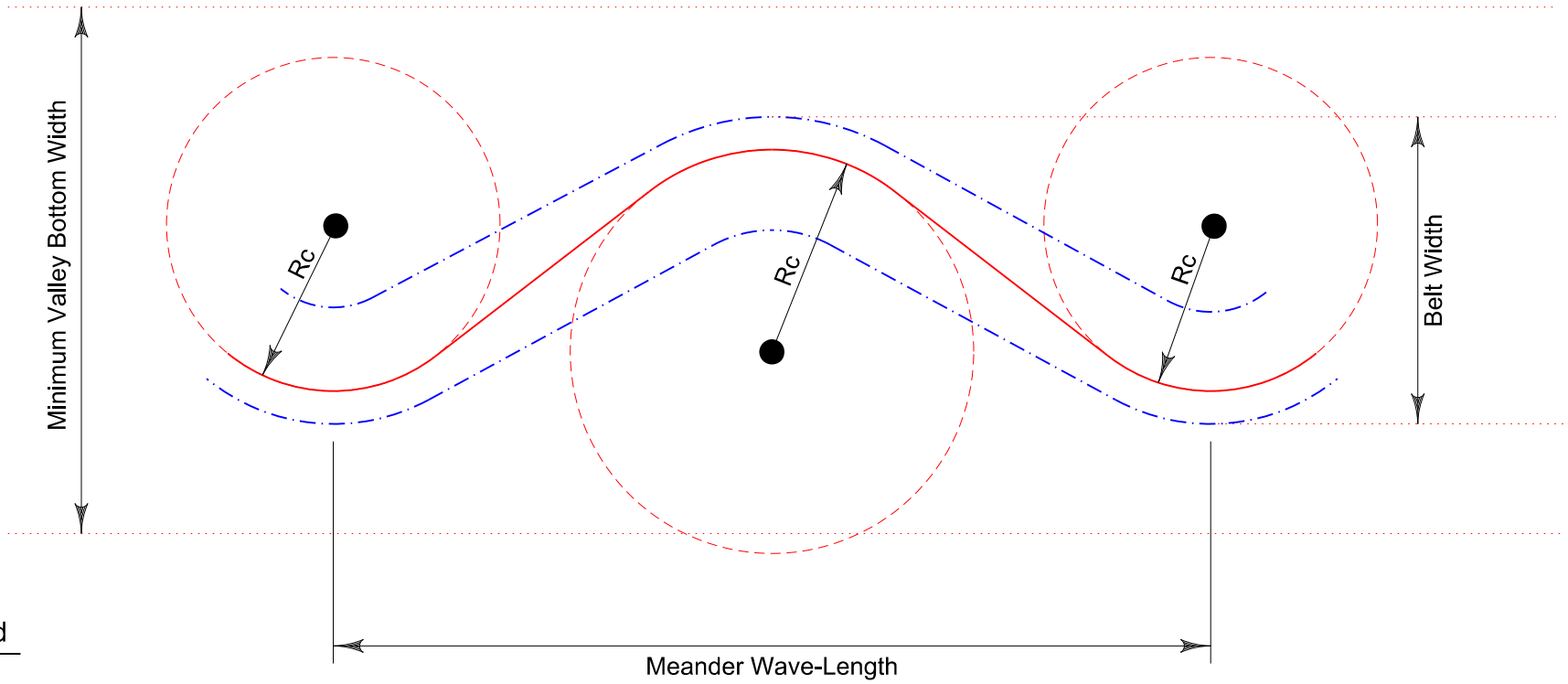
Note
* Tree spacing shown (10' x 10') is based on bare root seedlings. See mitigation plan for other tree planting options.

Typical Pool Cross Section Stream INT1UM
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS
COUNTY: OHIO
STATE: KY
NEAR: CENTERTOWN
STREAM: INT-1UM
ITEM: PROPOSED TYPICAL POOL CROSS SECTION
EXHIBIT 72
DATE:

Typical Meander Pattern for Rosgen Stream Type "C"
Stream INT1DS



Legend

Bankfull

Thalweg

Bankfull Width=15.75'
Radius of Curvature (Rc) Ranges from 39' to 48'
Belt Width Ranges from 126' to 173'
Meander Wave-Length Ranges from 142' to 220'
Approximate Proposed Reach Length = 3312'
Proposed Sinuosity is Approximately 1.21 (1.2 or greater)
Proposed Stream Gradient Ranges from 0.3% to 0.7%
Proposed Valley Slope Ranges from 0.35% to 0.85%
Minimum Valley Bottom Width = 200'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: INT-IDS | EXHIBIT 73

DATE:

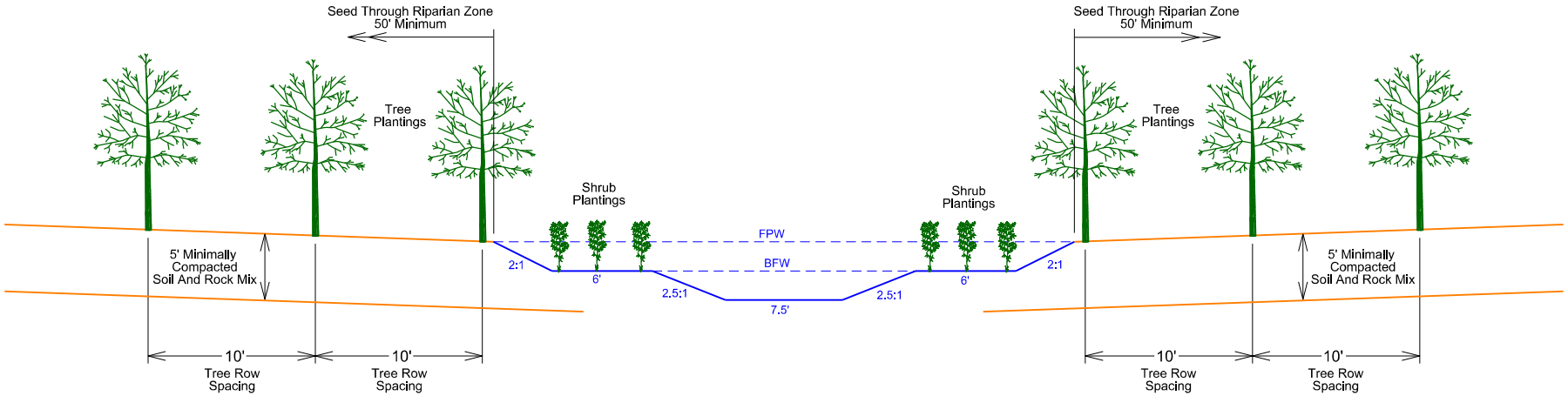
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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) = 15.75'
* Bankfull Max. Depth = 1.75'
* Bankfull Area = 19.9SF
* Bankfull Mean Depth = 1.26'
* Flood-Prone Width (FPW) = 34.75' Min
* W/D Ratio = 12.5
* Entrenchment Ratio = 2.21 Min
* Bench Width = 6' 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 INT1DS
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | STREAM: INT-IDS

ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION | EXHIBIT 74

DATE:

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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.

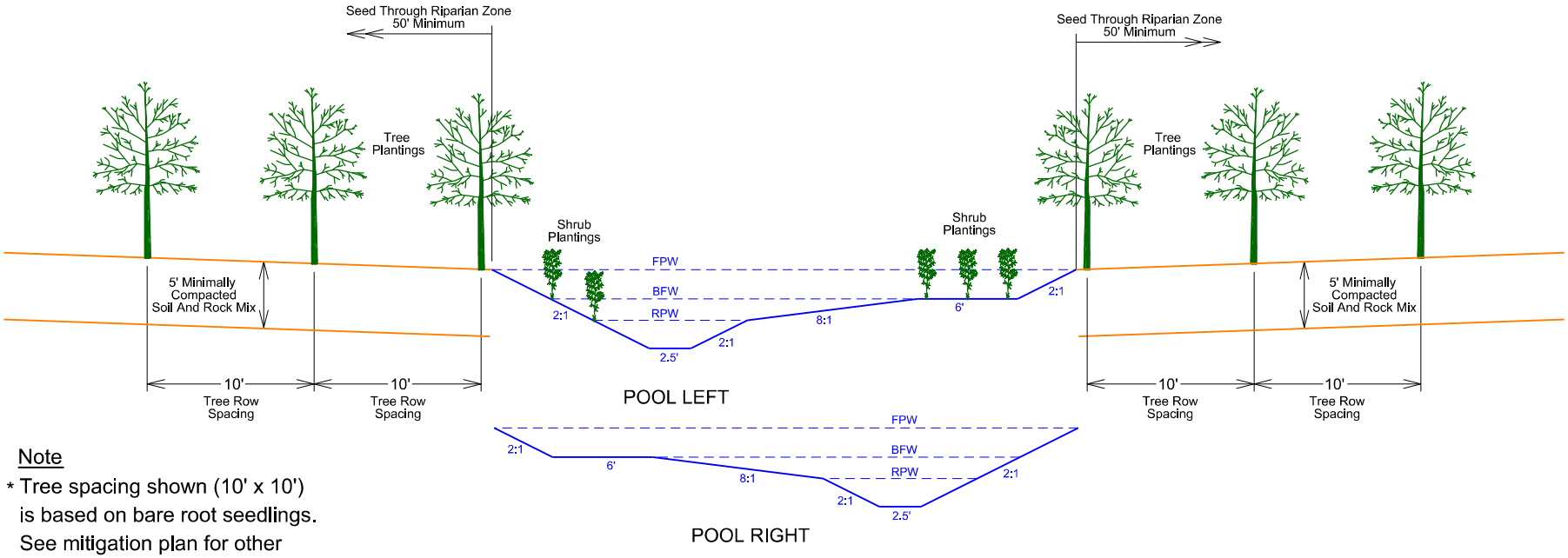
E.C.B. 2 shall meet the following specifications:
* Netting:100% Biodegradable, natural fiber.
* Matrix Material:100% straw.
* Stitching:Biodegradable thread on 1.5 inch centers.
* Shear stress:1.855 lbs. / SQ. FT.
* Velocity:6 feet per second.
* Longevity:up to 12 months.
* North American Green S150 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) = 22'
* Bankfull Max. Depth = 2.96'
* Bankfull Area = 29.83SF
* Bankfull Mean Depth = 1.36'
* Flood-Prone Width (FPW) = 35' Min
* W/D Ratio = 16.2
* Residual Pool Max. Depth = 1.69'
* Residual Pool (RPW) Width = 9.24'
* Bench Width= 6' Min

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 INT1DS
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

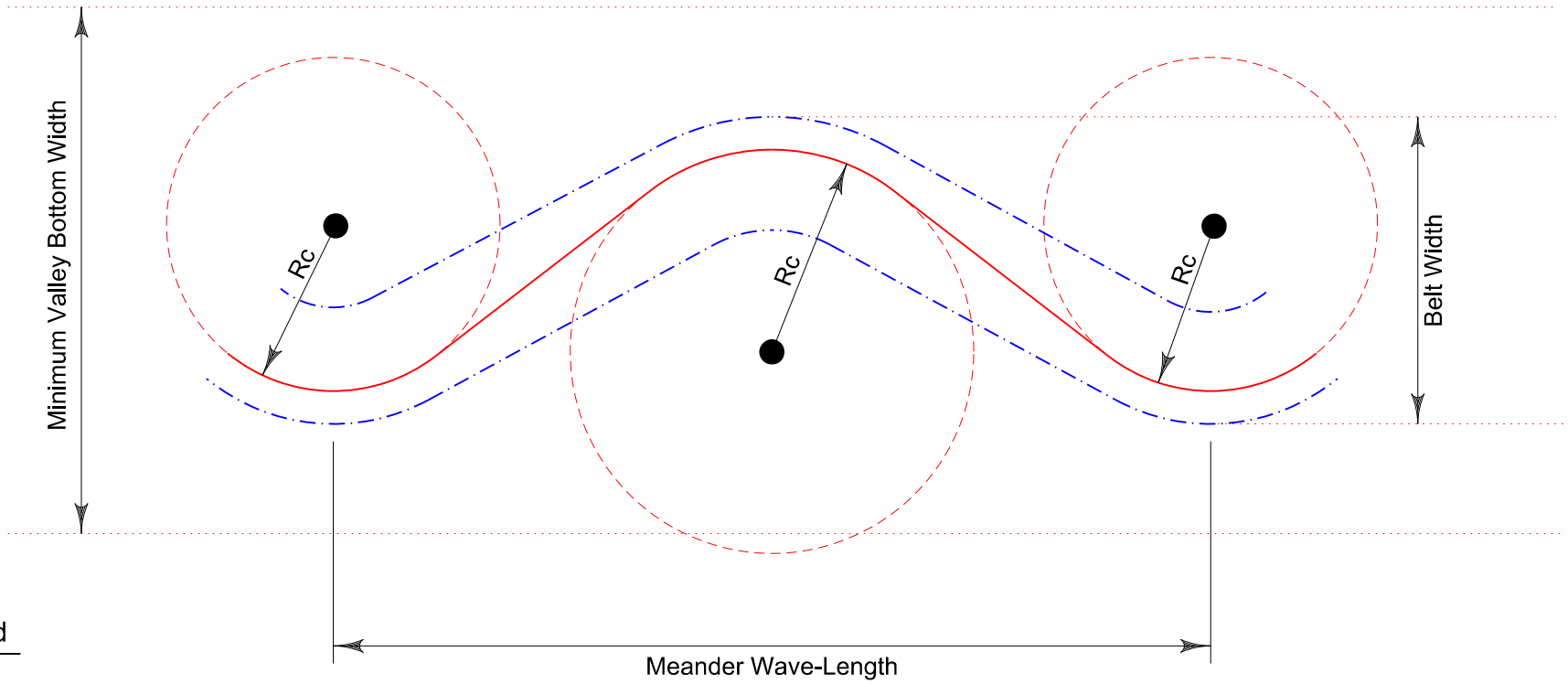
ITEM: PROPOSED TYPICAL POOL CROSS SECTION

STREAM: INT-IDS

EXHIBIT 75

DATE:

Typical Meander Pattern for Rosgen Stream Type "C"
Stream INT2DS



Legend

Bankfull

Thalweg

Bankfull Width=8.5'
Radius of Curvature (Rc) Ranges from 21' to 26'
Belt Width Ranges from 68' to 94'
Meander Wave-Length Ranges from 77' to 119'
Approximate Proposed Reach Length = 1858'
Proposed Sinuosity is Approximately 1.23 (1.2 or greater)
Proposed Stream Gradient Ranges from 0.67% to 1.25%
Proposed Valley Slope Ranges from 0.8% to 1.5%
Minimum Valley Bottom Width = 110'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO | STATE: KY | NEAR: CENTERTOWN | ITEM: PROPOSED TYPICAL MEANDOR PATTERN | STREAM: INT-2DS | EXHIBIT 76

DATE:

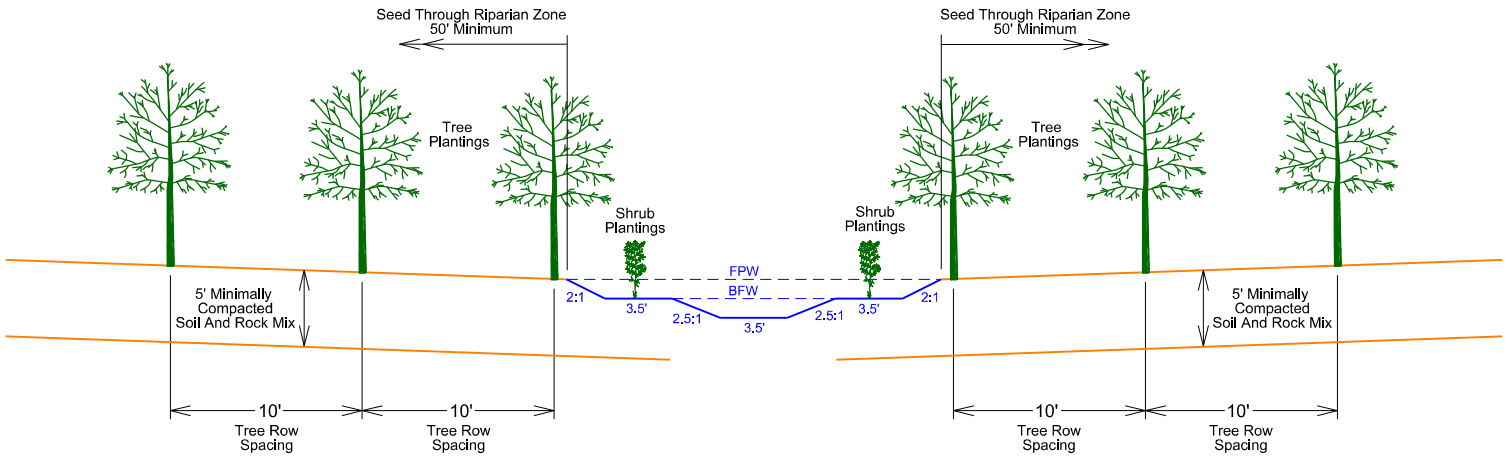
EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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'
* Bankfull Area = 6SF
* Bankfull Mean Depth = 0.71'
* Flood-Prone Width (FPW) = 19.5' Min
* W/D Ratio = 12.04
* Entrenchment Ratio = 2.29 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 INT2DS
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

ITEM: PROPOSED TYPICAL RIFFLE CROSS SECTION

STREAM: INT-2DS

EXHIBIT 77

DATE:

EROSION CONTROL BLANKET (may be used as needed)

E.C.B. I 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.

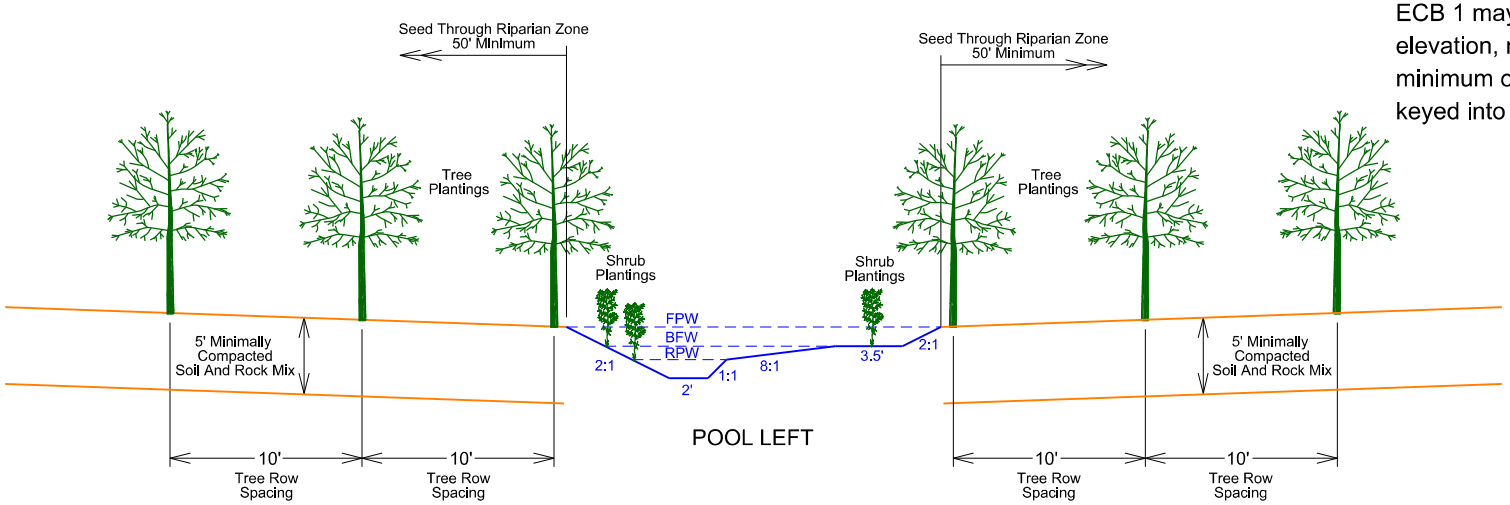
E.C.B. 2 shall meet the following specifications:
* Netting:100% Biodegradable, natural fiber.
* Matrix Material:100% straw.
* Stitching:Biodegradable thread on 1.5 inch centers.
* Shear stress:1.855 lbs. / SQ. FT.
* Velocity:6 feet per second.
* Longevity:up to 12 months.
* North American Green S150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

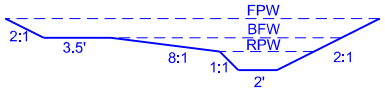
In bend sections, E.C.B. 1 may be placed along the inside bend (Point Bar). Blanket installation shall begin at the bottom of the point bar slope (just above Residual Pool Elevation) and extend to Flood Prone Elevation. E.C.B. 2 may be placed beyond this location as needed.

Proposed Channel Dimensions
* Bankfull Width (BFW) = 12'
* Bankfull Max. Depth = 1'
* Bankfull Area = 9.36SF
* Bankfull Mean Depth = 0.78'
* Flood-Prone Width (FPW) = 19.5' Min
* W/D Ratio = 15.4
* Residual Pool Max. Depth = 0.97'
* Residual Pool (RPW) Width = 4.93'
* Bench Width= 3.5' Min

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 INT2DS
Rosgen Stream Type "C"
Scale: 1"=10'

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

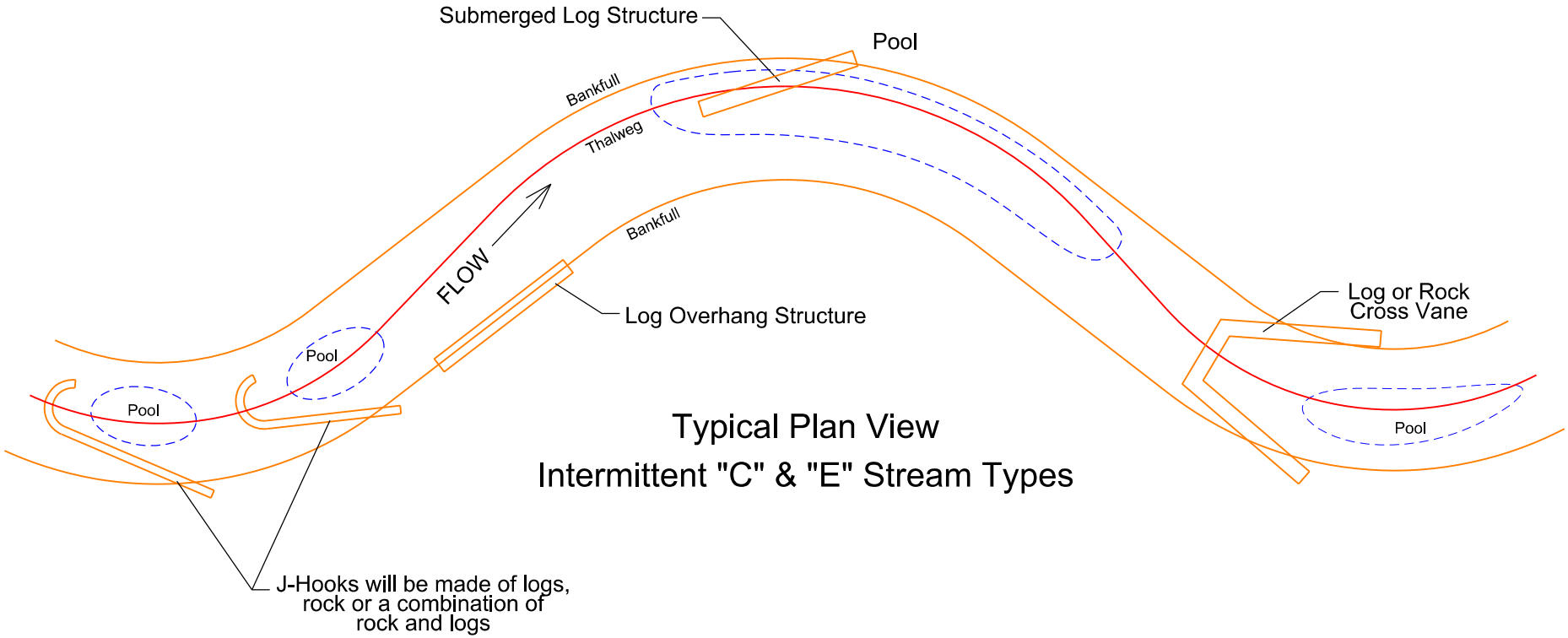
NEAR: CENTERTOWN

ITEM: PROPOSED TYPICAL POOL CROSS SECTION

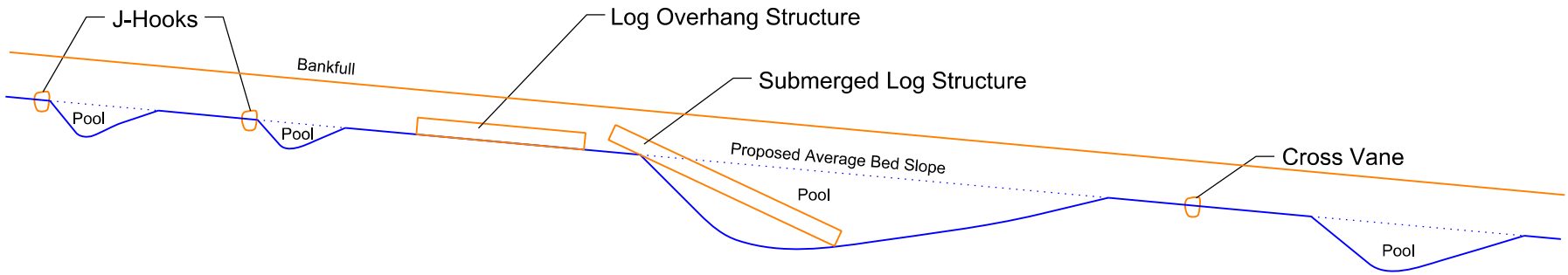
STREAM: INT-2DS

EXHIBIT 78

DATE:



Typical Plan View
Intermittent "C" & "E" Stream Types



Pools, J-Hooks, Cross Vanes or submerged logs will be placed in outside meander bends on Intermittent "C" & "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 location of structures will be determined by the engineer or his representative based on need for grade control due to greater than desired grade changes or where potential bank erosion is anticipated and to add randomness and diversity for ecological enhancement.

Typical Profile View
Intermittent "C" & "E" Stream Types

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

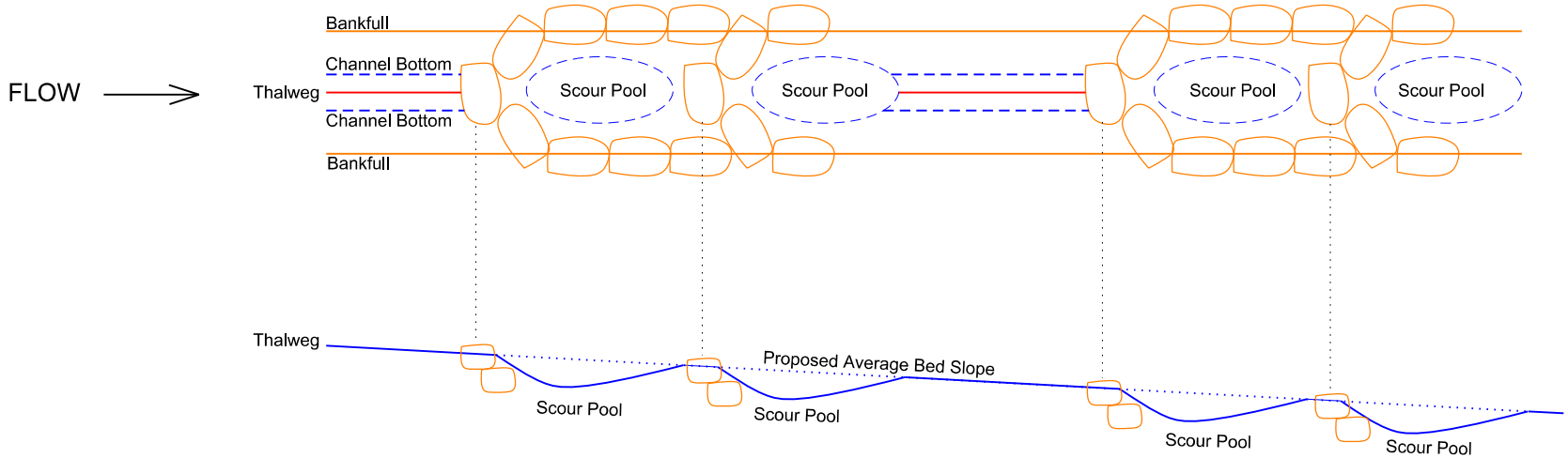
ITEM: TYPICAL PLAN AND PROFILE VIEW

STREAM: UT'S OF LEWIS CK, W.F. LEWIS CK., GREEN RIVER

EXHIBIT 79

DATE:

Typical Plan View
Rock Step Structure
Intermittent "B" And Ephemeral "B" & "Ba" Stream Types

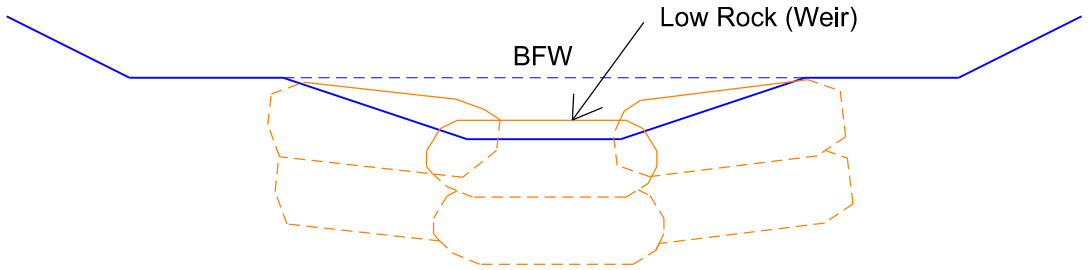


Typical Profile
Intermittent "B" and Ephemeral "B" & "Ba" Stream Types
Step-Pool Channel

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 Intermittent "B" and ephemeral "B" & "Ba" Stream Types where needed for grade control and energy dissipation.

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 ½ 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 ½ the bank full depth and running ⅓ of the length of the bankfull width. Logs should be buried below the stream bottom to prevent scour.



Typical Section of Rock Step Structure

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

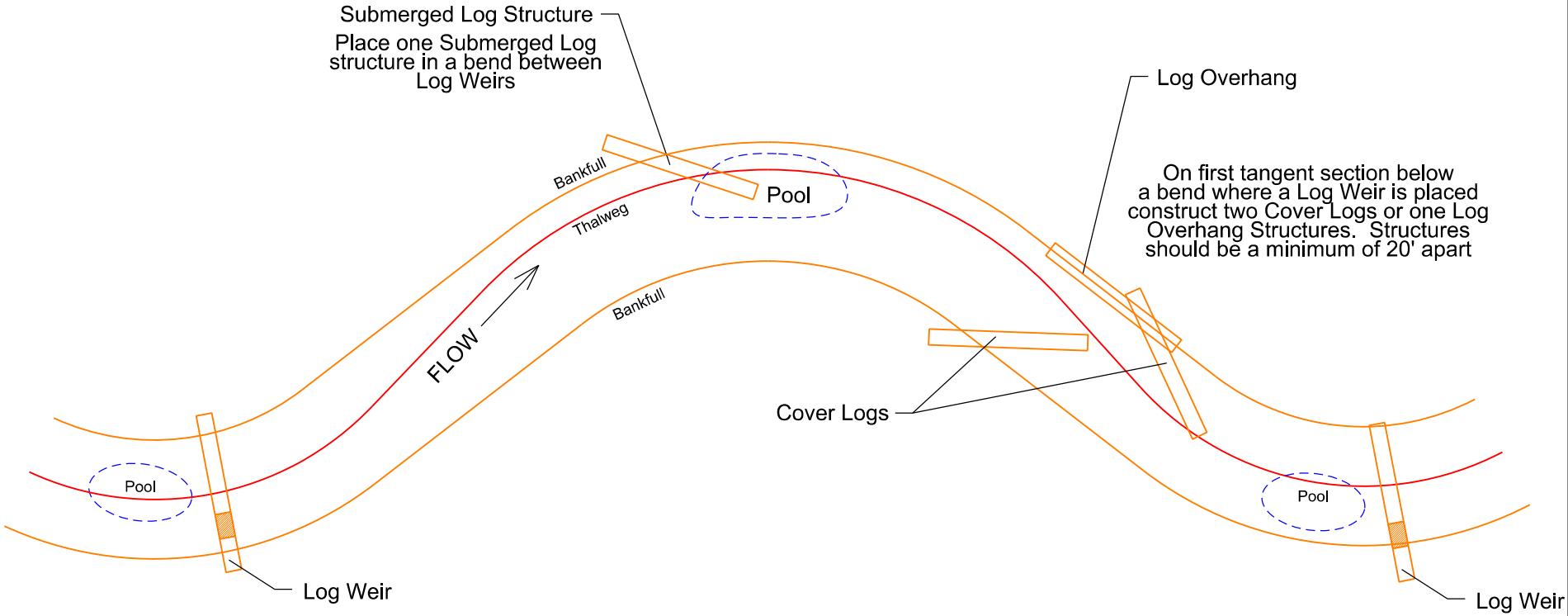
ITEM: TYPICAL PLAN AND PROFILE VIEW

STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER

EXHIBIT 80

DATE:

Typical Plan View
Ephemeral "B" Stream Types



Note: Meander Length may vary.
Generally place a Log Weir every 200'-300' along the stream reach at the beginning of a bend in the stream.

T.H.E. Engineers, Inc.

PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS

COUNTY: OHIO

STATE: KY

NEAR: CENTERTOWN

ITEM: TYPICAL PLAN AND PROFILE VIEW

STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER

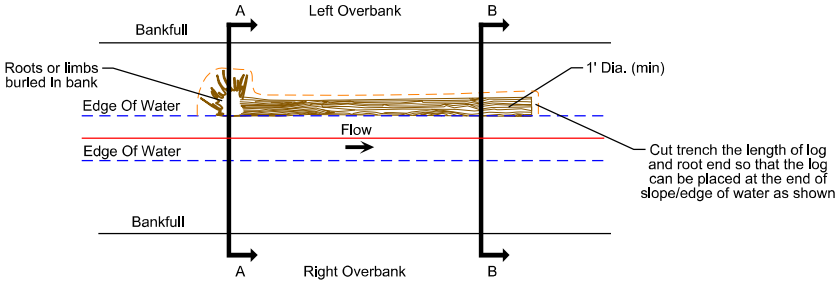
EXHIBIT 8I

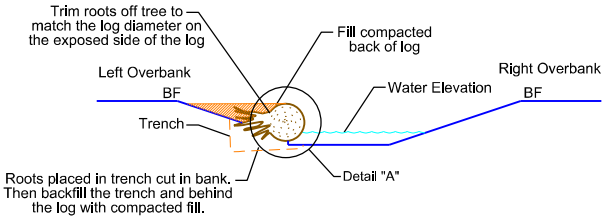
DATE:

Habitat Structure Details

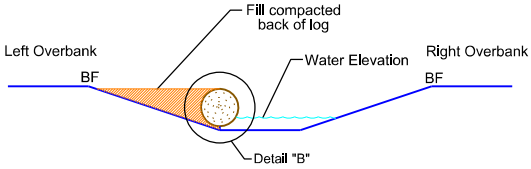
Intermittent "C" & "E" Type Streams

Log Overhang Structure

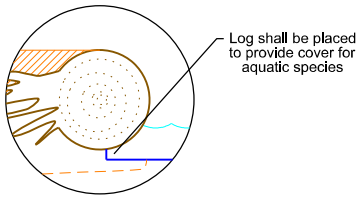




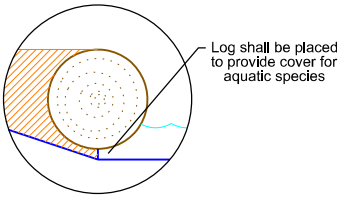
Section A-A



Section B-B

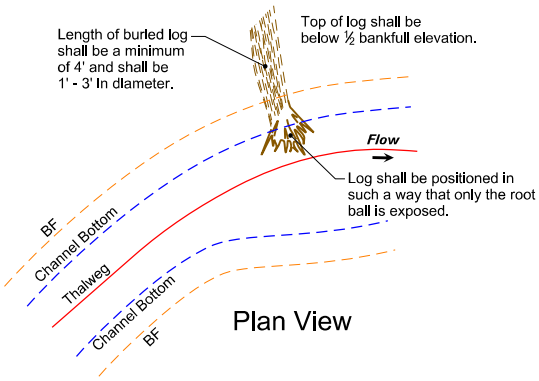


Detail "A"



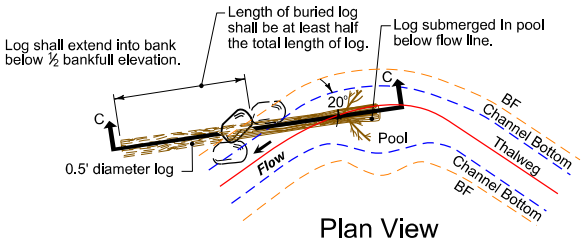
Detail "B"

Root Wad

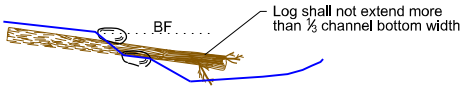


Plan View

Submerged Log Structure



Plan View



Section C-C

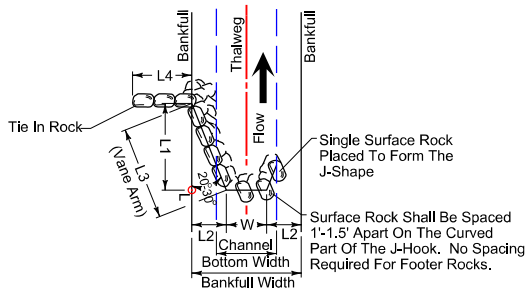
T.H.E. Engineers, Inc.	PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER	
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: HABITAT STRUCTURE DETAILS	EXHIBIT 82

DATE:

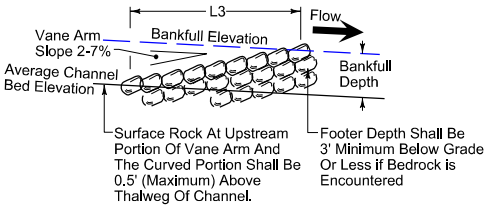
Stability And Habitat Structure Details

Intertmittent "C" & "E" Type Streams

Rock J-Hook

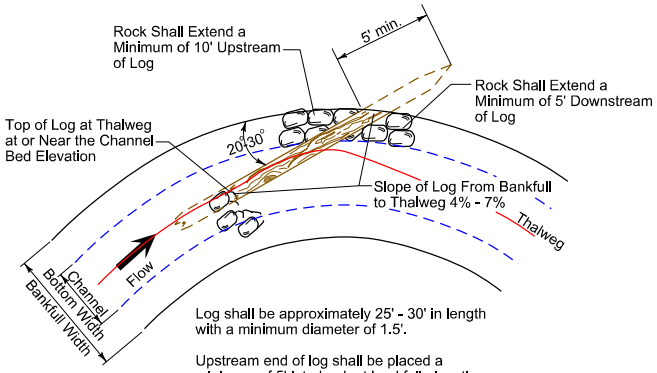


(Plan View)



(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.

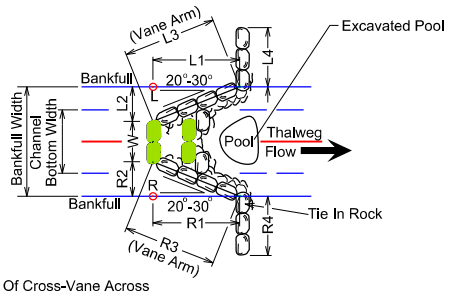
Downstream end of log shall be placed in the channel bottom at center of thalweg.

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.

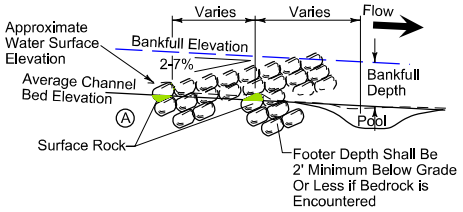
The log at bankfull shall be buried into the channel bank a minimum of 5'.

Double Invert Cross Vane



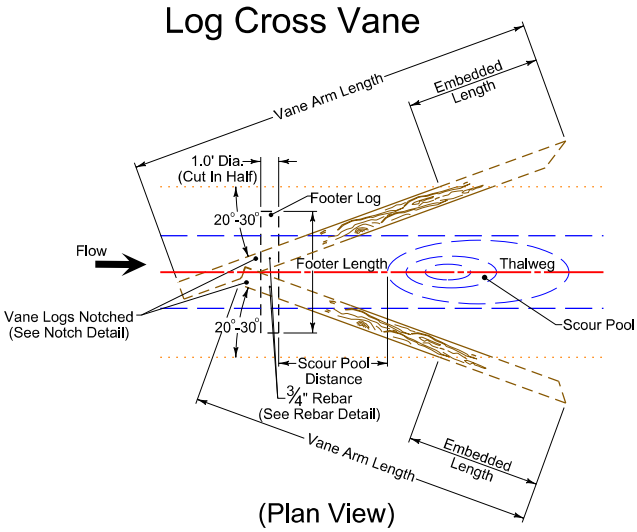
Top Of Cross-Vane Across Width (W) Is Level. Surface Rock In This Level (Upstream) Portion Is 0.5' (Maximum) Above Thalweg Of Channel.

(Plan View)

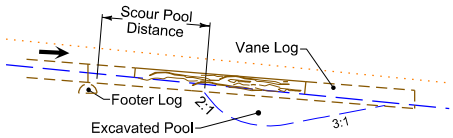


(Profile)

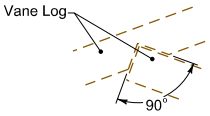
Log Cross Vane



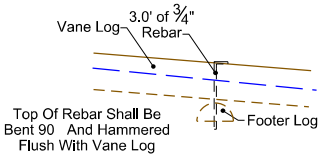
(Plan View)



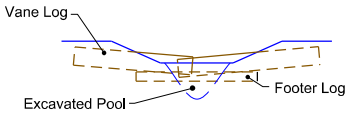
(Profile)



(Notch Detail)



(Rebar Detail)



(Cross Section View)

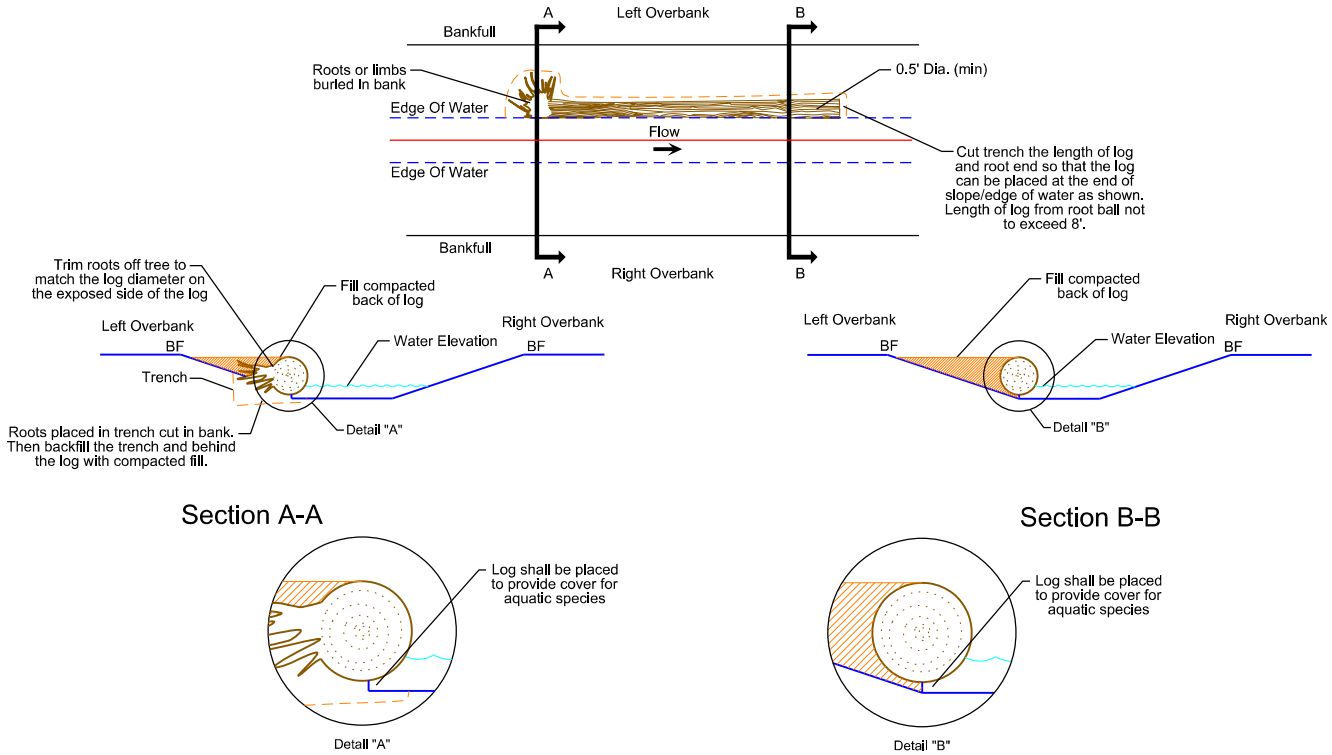
T.H.E. Engineers, Inc.	PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER	
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: STABILITY & HABITAT STRUCTURE DETAILS	EXHIBIT 83

DATE:

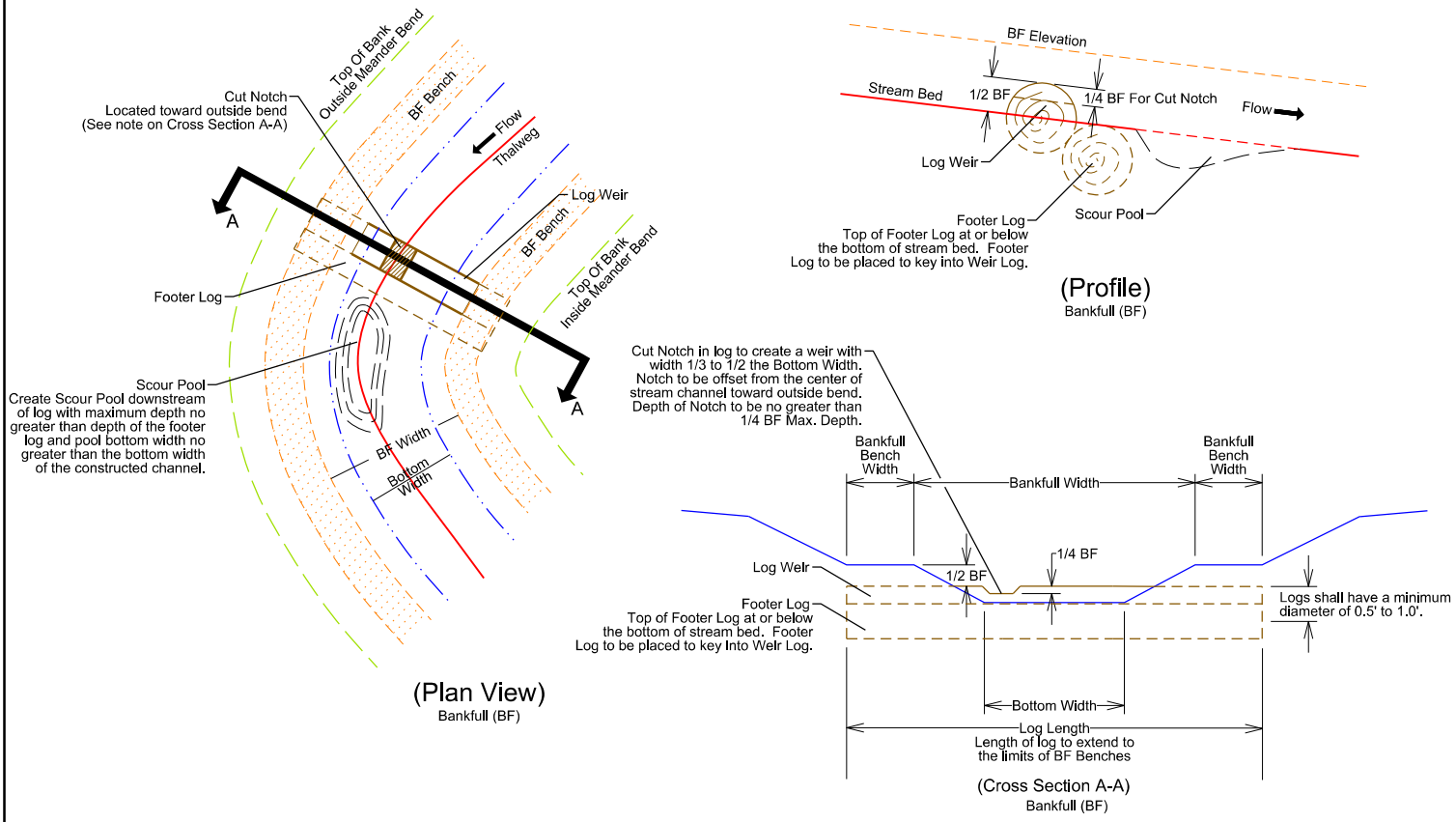
Habitat Structure Details

Ephemeral "B" Type Streams

Log Overhang Structure



Log Weir



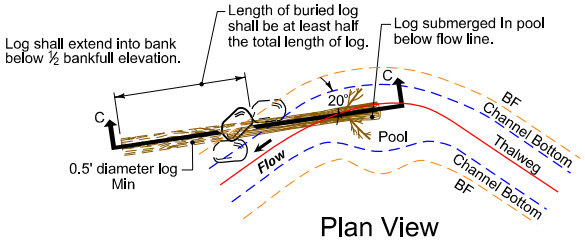
T.H.E. Engineers, Inc.	PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER	
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: HABITAT STRUCTURE DETAILS	EXHIBIT 84

DATE:

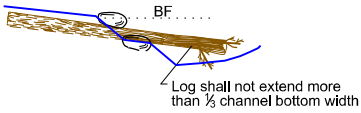
Habitat Structure Details

Ephemeral "B" Type Streams

Submerged Log Structure

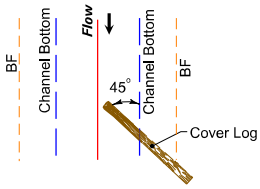


Plan View

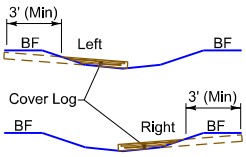


Section C-C

Cover Log



Plan View



Cross Section View

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 ¼ to½ channel bottom width. The log shall be angled in upstream direction.

Log will alternate sides. (See Plan Sheets)

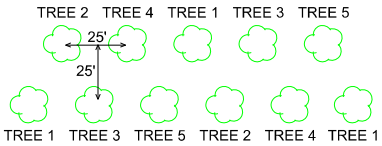
T.H.E. Engineers, Inc.	PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER	
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: HABITAT STRUCTURE DETAILS	EXHIBIT 85

DATE:

RIPARIAN ZONE PLANTING NOTES

(USE OPTION ONE OR OPTION TWO FOR TREE PLANTINGS)

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



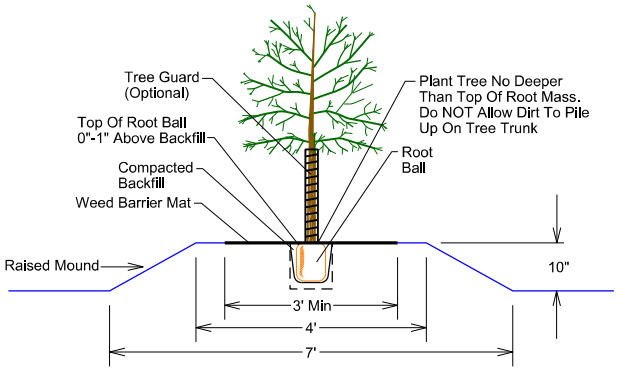
RPM RIPARIAN TREE PLANTINGS (OPTION ONE)

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

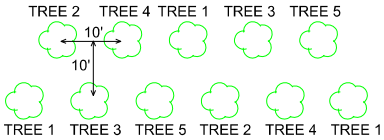
RECOMMENDED PROCEDURES FOR PLANTING RPM TREES

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) at approximately four feet.
2. The hole shall be approximately the same size as the container (10 inch diameter-8 inch depth).
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. Do not disturb rootball after container has been removed.
6. ✱ 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.
7. 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



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



TREE PLANTING (OPTION TWO)

1. Trees shall be contalner grown or bare root.
2. Bare root stock must be a minimum 30" (inches) In helght and planted on 10' x 10' spacIng In a staggered pattern.
3. Three-gallon trees shall be planted on 19' x 19' spacing in a staggered pattern.
4. 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.

INTERMITTENT STREAM TREE LIST	EPHEMERAL STREAM TREE LIST
Tree 1: Shellbark hickory (Carya laciniosa)	Tree 1: Shagbark hickory (Carya glabra)
Tree 2: Cherrybark oak (Quercus pagoda)	Tree 2: American beech (Fagus grandifolia)
Tree 3: Willow oak (Quercus phellos)	Tree 3: Shingle oak (Quercus imbricaria)
Tree 4: Water oak (Quercus nigra)	Tree 4: Post oak (Quercus stellata)
Tree 5: White oak (Quercus alba)	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 fruiticosa)

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:

Switchgrass (Panicum virgatum)	20%
Virginia Wild Rye (Elymus virginicus)	20%
Rough Barnyard Grass (Echinochloa muricata)	10%
Annual Rye (Lolium perenne)	10%
Big bluestream (Andropogon gerardii)	20%
Forking panic grass/smooth panic grass (Dichanthelium dichotomum/ dichotomiflorum)	20%

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.

T.H.E. Engineers, Inc.	PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: PLANTING NOTES	EXHIBIT 86

DATE:

Streams To Be Mitigated On Site
Lewis Creek West

Stream	Impact Stream Length (ft)	Proposed Stream Stream Length (ft)
E25	555	836
E27	929	1028
E29	1377	1976
E30	658	772
E31	811	907
E34US	929	903
E34DS	1472	1424
E42	729	934
E43	1963	2123
E44	1156	1442
E47	1476	1702
E48	1598	1924
E49	985	1366
E51US	804	878
E51MS/DS	1001	1570
E52	521	676
E54	834	1277
E61US	880	984
E61DS	930	1386
E63	1486	1688
INT3MS	797	2228
INT3DS	1112	609
INT4US	2240	1871
INT4MS	1416	2462
INT4DS	1968	2009
INT5US/DS	747/1045	2509
INT6US	517	936
INT1UM	2136	3512
INT1DS	2805	3312
INT2DS	1674	1858
	MITIGATION TOTALS: Ephemeral = 25796 ft. Intermittent = 21306 ft.	

T.H.E. Engineers, Inc.	PROJECT: LEWIS CREEK WEST SITE-PROPOSED STREAMS			STREAM: UT'S OF LEWIS CK., W.F. LEWIS CK., GREEN RIVER	
	COUNTY: OHIO	STATE: KY	NEAR: CENTERTOWN	ITEM: STREAM LENGTHS	EXHIBIT 87

DATE: