APPENDIX B

DTI Standards and Specifications and ACP Variance Request Approvals

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY
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Mailing address: P.O. Box 1105, Richmond, Virginia 23218
www.deq.virginia.gov

Molly Joseph Ward
Secretary of Natural Resources

David K. Paylor
Director

(804) 698-4000
1-800-592-5482

July 5, 2017

Ms. Amanda B. Tornabene
Director Environmental Services
Dominion Energy Services Inc.
5000 Dominion Boulevard,
Glen Allen, VA 23060

Subject: Dominion Energy Transmission, Inc: Annual Standards and Specifications for Erosion & Sediment Control and Stormwater Management

Dear Ms. Tornabene:

The Virginia Department of Environmental Quality (DEQ) hereby approves the Annual Standards and Specifications for Erosion & Sediment Control (ESC) and Stormwater Management (SWM) for Dominion Energy Transmission, Inc. (DETI) as revised June 2017.

Please note that your approved Annual Standards and Specifications include the following requirements:

1. Projects with land disturbing activities $\geq$10,000 ft^2 or $\geq$ 2,500 ft^2 in Chesapeake Bay Preservation Areas require a DETI review and approval of an ESC plan;
2. Projects with land disturbing activities $\geq$1 acre or $\geq$ 2,500 ft^2 in Chesapeake Bay Preservation Areas require a DETI review and approval of a SWM plan;
3. ESC variance requests must be submitted to DEQ and will be reviewed in accordance with ESC (9VAC25-840-50) requirements;
4. SWM exception requests must be submitted to DEQ and will be reviewed in accordance SWM (9VAC25-870-57) requirements;
5. Requests for use of Guidance Memorandum No:15-2003 - Postdevelopment Stormwater Management Implementation Guidance for Linear Utility Projects must be submitted to DEQ for approval;
6. The following information must be submitted to DEQ at least two weeks in advance of the commencement of land-disturbing activities for each project. Notifications shall be sent by email to: linearprojects@deq.virginia.gov.
    - i: Project name;
    - ii: Project location (including nearest intersection, latitude and longitude, access point, traversed localities);

iii: On-site project manager name and contact info;
iv: Responsible Land Disturber (RLD) name and contact info;
v: DEQ-Certified ESC and SWM Inspector name and contact info;
vi: Project description;
vii: Acreage of disturbance for project; and
viii: Project start and finish date.

Also please note that Appendix G of your approved Annual Standards and Specifications includes ACP Project requirements. Requirements that are specific to the Atlantic Coast Pipeline (ACP) project include the following:

1. Notification information identified in item 6 above is required for each separate land disturbance construction area spread;
2. In addition to DETI's internal review process, the site specific ESC (9VAC25-840-40) and SWM (9VAC25-870-55) plan is required to be submitted to DEQ for review and approval;
3. The initial draft and final site specific ESC and SWM plan, and supporting documents must be posted on ACP's website for public view;
4. Inspection reports conducted by ACP as well as complaint logs and complaint responses must be submitted to DEQ in accordance with the Annual Standards and Specifications requirements for the ACP project.

Attachment B of your submittal also includes deviations from the Virginia Erosion and Sediment Control Handbook (VESCH) for the ACP Project. These alternative ESC practices and procedures are not considered ESC variances as long as the alternate measures proposed meet the regulatory requirement of the minimum standards (9VAC25-840-40). DEQ uses the VESCH as guidance on the acceptable methods to meet the required minimum standards. DEQ believes that these alternative methods in Attachment B may be used for the ACP project to meet the regulatory requirements of the minimum standards contingent on DEQ review and approval of the site specific ESC plan. If in the field these alternatives are found to be deficient, other ESC measures will be necessary to ensure compliance with the regulatory requirements.

To ensure compliance with approved specifications, the Virginia Erosion and Sediment Control Law and the Virginia Stormwater Management Act, DEQ staff will conduct random site inspections, respond to complaints, and provide on-site technical assistance with specific erosion and sediment control and stormwater management measures and plan implementation.

Section 62.1-44.15:55.E of the Virginia Erosion and Sediment Control law and Section 62.1-44.15:31.D of the Virginia Stormwater Management Act authorizes the state to charge fees for costs incurred in implementing the standards and specifications program. Please see the enclosed invoice for Annual Standards and Specifications services.

Please contact Hannah Zegler (804-698-4206) or Larry Gavan (804-698-4040) should you have any questions concerning your Annual Standard and Specifications requirements.

Sincerely,

Frederick K. Cunningham
Director, Office of Water Permits

Cc: Karl Kratzer
Robert Hare
Melanie Davenport, DEQ-CO
Ben Leach, DEQ-CO
Larry Gavan, DEQ-CO
Hannah Zegler, DEQ-CO

Case Decision Information:
As provided by Rule 2A:2 of the Supreme Court of Virginia, you have thirty days from the date of service (the date you actually received this decision or the date it was mailed to you, whichever occurred first) within which to appeal this decision by filing a notice of appeal in accordance with the Rules of the Supreme Court of Virginia with the Director, Department of Environmental Quality. In the event that this decision is served on you by mail, three days are added to that period.

Dominion Energy Services, Inc.
5000 Dominion Boulevard, Glen Allen, VA 23060
DominionEnergy.com

June 29, 2017

BY OVERNIGHT OF EXPRESS MAIL

Mr. Fred Cunningham
Office of Stormwater Management
629 East Main Street
Richmond, VA 23219

RE: Dominion Transmission, Inc.
Annual Standards and Specifications- June 23 Revision
Alternative ESC Practices and Procedures – June 23 Revision

Dear Mr. Cunningham:

Enclosed for your review are the revised *Annual Standards and Specifications for Erosion and Sediment Control and Stormwater Management for Construction and Maintenance of Gas Transmission Facility Projects* for Dominion Energy Transmission, Inc. The specifications have been revised to incorporate all of the comments received on June 20, 2017 from the DEQ. All requested changes have been made in the document with the exception of Comment 5.

Regarding Comment 5: (Appendix I, p.34) – Please change 'VESCP Authority' to "AS&S holder".

Response: The language requested for edit refers to an internal policy document which is provided for reference only. The definition used in that document comports directly with the language in the regulations. The requirement for the AS&S holder (DETI) to have properly certified personnel is clearly articulated in Section 2 of the AS&S document.

The Annual Standards and Specifications (inclusive of all Appendices) are enclosed as **Attachment A**. A digital copy of the document with track changes has been included for your review.

Concurrently, we are submitting the revised Alternative ESC Practices and Procedures proposed for use on the Atlantic Coast Pipeline (ACP) project, along with supporting information. The adaptations/ alternative practices are summarized in a table, and typical scenarios for steep slope hazard mitigation are provided. The variances requests are enclosed as **Attachment B**, and are requested due to the unique constraints and challenges for the project.

We respectfully request approval of these Annual Standards and Specifications and the concurrently submitted variance requests. If you have any questions concerning this submittal or need additional information, please contact Karl R. Kratzer at (804) 273-2914 or Karl.R.Kratzer@dom.com.

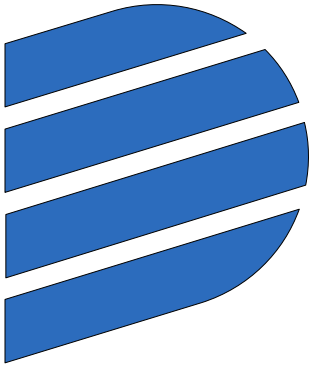
Sincerely,



Amanda B Tornabene
Director Environmental Services (Corporate Air, Gas Infrastructure, Power Delivery)

Enclosures
cc: Mr. Karl Kratzer
Mr. Robert Hare

bcc: Pam Faggert
Amanda Tornabene
Neil Robinson
Richard Gangle
Hannah Zegler, VADEQ



Dominion Energy®

2017

ANNUAL STANDARDS AND SPECIFICATIONS FOR EROSION AND SEDIMENT CONTROL AND STORMWATER MANAGEMENT FOR CONSTRUCTION AND MAINTENANCE OF GAS TRANSMISSION FACILITY PROJECTS IN VIRGINIA

Submitted By:

Dominion Energy Transmission, Inc.

707 East Main Street, 19th Floor, Richmond, Virginia 23219

JUNE 2017

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1. ANNUAL STANDARDS AND SPECIFICATIONS ADMINISTRATION

Dominion Energy Transmission Inc. (DETI) is responsible for administering, implementing and complying with the Annual Standards and Specifications for Erosion and Sediment Control (ESC) and Stormwater Management (SWM) for Gas Transmission Facility Development. In accordance with Va. Code §§ 62.1-44.15:54.E and 62.1-44.15:27.F, this document serves as the annual submittal to the Virginia Department of Environmental Quality (DEQ) of standards and specifications developed so that DETI can continue to operate under Annual Standards and Specifications for ESC and SWM. This document addresses stormwater management and ESC and establishes general specifications for the control of erosion and sedimentation and stormwater runoff management as a result of land-disturbing activities[1] performed during the construction, operation and maintenance of natural gas pipelines. These Annual Standards and Specifications for ESC and SWM shall be consistent with the requirements of the Virginia Erosion and Sediment Control Law and associated regulations and the Virginia Stormwater Management Act and associated regulations, where applicable. The specifications shall apply to applicable natural gas transmission facility projects pursuant to subdivision 1 of § 62.1-44.15:55 of the Code of Virginia, which allows annual standards and specifications for, "Construction, installation or maintenance of electric transmission, natural gas and telephone utility lines and pipelines, and water and sewer lines." DETI projects not provided for in subdivision 1, and not otherwise exempted from ESC or SWM requirements, will comply with the requirements of the local or state authority in the locality in which the project is located.

In accordance with federal law, construction stormwater permits issued under a delegated National Pollutant Discharge Elimination System (NPDES) permit like the one in place in Virginia cannot be required unless there is a triggering event (i.e., the release of a hazardous substance in excess of its reportable quantity or a discharge that contributes to a violation of a water quality standard). See 33 U.S.C. § 1342(l)(2); 40 C.F.R. § 122.26(c)(1)(iii); Natural Resources Defense Council v. United States Environmental Protection Agency, 526 F.3d 591 (9th Cir. 2008) (invalidating EPA's unconditional exemption in 40 C.F.R. § 122.26(a)(2) and reinstating the conditional exemption). This exemption is embodied in the Virginia Stormwater Management Program (VSMP) Regulation in 9VAC25-870-380A(2) which states: "*The board*

[1] For stormwater management compliance, "*Land disturbance" or "land-disturbing activity" means a manmade change to the land surface that potentially changes its runoff characteristics including clearing, grading, or excavation, except that the term shall not include those exemptions specified in § 62.1-44.15:34 of the Code of Virginia*. For Erosion and Sediment Control compliance, ""*Land-disturbing activity" means any man-made change to the land surface that may result in soil erosion from water or wind and the movement of sediments into state waters or onto lands in the Commonwealth, including, but not limited to, clearing, grading, excavating, transporting, and filling of land…*" with exemptions defined per § 62.1-44.15:51, and

may not require a state permit for discharges of stormwater runoff from mining operations or oil and gas exploration, production, processing or treatment operations, or transmission facilities, composed entirely of flows that are from conveyances or systems of conveyances (including but not limited to pipes, conduits, ditches, and channels) used for collecting and conveying precipitation runoff and that are not contaminated by contact with or that has not come into contact with, any overburden, raw material, intermediate products, finished product, by-product or waste products located on the site of such operations."

DETI intends to follow the provisions outlined in DEQ Guidance Memorandum No. 15-2003 (GM15-2003), when applicable. GM15-2003 provides guidance on stormwater implementation for linear utility projects under the Virginia Stormwater Management Program. The guidance document describes general terms and conditions under which linear utility projects are expected to operate if they are to maintain exemption from Stormwater Management Plan submission and CGP coverage requirements. The review for initial applicability of GM15-2003 to a specific project will be conducted and documented by Dominion using DEQ-certified Plan Reviewers early in the project planning process. DETI will then contact DEQ for a preliminary review to determine whether GM15-2003 will be applicable to the project, prior to the development of detailed ESC and SWM plans. The preliminary submission and review must include sufficient information (estimated extent of land disturbance, estimated land cover conditions, anticipated sequence of construction, anticipated drainage features and receiving outfalls, etc.) for DEQ to review applicability under the Guidance Memorandum and notify DETI if a SWM plan will be required. DEQ has indicated that the review and coordination to determine if a SWM plan waiver will be issued will typically take less than 30 days (typically 7 days for initial review and then subsequent time for revisions, meetings and coordination). DEQ advises that face-to-face project review meetings with the project proponent are often an easy way to secure feedback early in the planning process. If DEQ concurs that the project qualifies under GM15-2003, detailed erosion control plans will be developed (and annotated in accordance with the guidance memorandum), reviewed and approved by Dominion prior to engaging in land disturbance. DETI may be required by DEQ to produce additional documentation of water quantity or water quality calculations/analysis to demonstrate the applicability of Guidance Memo No. 15-2003. If GM15-2003 is determined to not be applicable, the stormwater-related technical criteria set forth in Appendix B must be implemented, unless an exception is secured. Note that permanent access roads are generally not envisioned to qualify under GM 15-2003 and will require stormwater management or an exception from the DEQ (see Appendix B for more information/discussion).

The gas transmission facilities covered under these Annual Standards and Specifications from ESC and SWM are envisioned to primarily include conventional buried pipeline systems consistent with subdivision 1 of § 62.1-44.15:55 of the Code of Virginia including associated

valves, pigging facility launchers and receivers, odorization facilities, measurement and regulation stations, points of delivery, compressor stations, and necessary access. These Annual Standards and Specifications for ESC and SWM must be submitted annually to DEQ for review and approval. DETI is responsible for ensuring that individual project plans are developed and implemented in compliance with these Annual Standards and Specifications and applicable laws and regulations. As a holder of Annual Standards and Specifications, DETI ensures compliance with these Annual Standards and Specifications for ESC and SWM for gas pipeline projects through self-administration of these Standards and Specifications, including plan review, inspections, and overall compliance rather than the individual localities in which the projects are located. DETI may be required to submit relevant project documentation and plans for covered activities to the DEQ. DEQ receives regular notifications of the work done by DETI, and provides random site inspections and inspections in response to complaints to assure compliance. Enforcement shall be administered by the DEQ and the State Water Control Board where applicable. DEQ and the State Water Control Board has the authority to enforce these specifications, to take enforcement actions, and to charge fees for the costs of review and approval of standards and specifications, project inspections and compliance pursuant to § 62.1-44.15:55(D).2.

These Annual Standards and Specifications for ESC and SWM also assist DETI in meeting the standards of the Federal Energy Regulatory Commission (FERC) Upland Erosion Revegetation and Maintenance Plan (Plan) and the FERC Wetland and Waterbody Construction and Mitigation Procedures (Procedures) (FERC, 2013). A copy of the Plan and Procedures can be found in Appendix C and D. DETI and its construction contractors must implement this plan as appropriate for all construction in Virginia unless a project-specific variance to the Virginia Erosion and Sediment Control Laws and regulation and/or exception under the Virginia Stormwater Management Act and associated regulations has been reviewed and granted by the DEQ. In instances where the requirements or practices differ between the Virginia Erosion and Sediment Control Handbook and the FERC Plan and Procedures guidance, the more stringent criteria shall be applied. The Annual Standards and Specifications will be compared to FERC's Plan and Procedures to determine the appropriate (i.e., whichever is more stringent) best management practices. Project variance and exception requests will be considered freestanding of this Annual Standards and Specifications submission and will be considered by DEQ on a site-specific basis.

Approved deviation requests (DEQ approved deviations from guidance documents (e.g. VESCH)) and the associated DEQ approval letters will also be appended to these Annual Standards in Appendix H, since these technical modifications to practices may be applied more broadly to many projects.

DETI anticipates that gas transmission projects will remain exempt from the *General VPDES Permit for Discharges of Stormwater from Construction Activities* (9VAC25-880) (also referred to more generally as the construction general permit) pursuant to federal and state exemptions. Each project will be reviewed for consistency with these exemptions or the appropriate requirements and GM15-2003, and applicable stormwater management provisions (see Appendix B) are incorporated in these Annual Standards and Specifications for ESC and SWM if the DEQ requires a construction general permit (CGP) for a specific project, or determines that GM15-2003 will not apply.

1.1 PROJECT TRACKING AND REPORTING

DETI is responsible for providing project tracking and e-notification to DEQ of all regulated land-disturbing activities subject to these Annual Standards and Specifications to comply with applicable ESC requirements pursuant to 9VAC25-840-65 and applicable SWM requirements pursuant to 9VAC25-870-170.

The DETI project team must electronically notify the DEQ of any project that DETI intends to construct in Virginia to start the project permitting process. The following information is required to be included in the e-notification two weeks prior to initiating the regulated land disturbing activity (LDA):

- Project name or project number
- Project location (including nearest intersection, latitude, and longitude)
- On-site project manager name and contact info
- Responsible Land Disturber (RLD) name and contact info
- Project description
- Acreage of disturbance for project
- Project start and finish date
- Any variances/waivers/exceptions associated with the project

Notification must be made electronically to Linearprojects@deq.virginia.gov. Other questions should be directed to Larry Gavan (804-698-4040) and Hannah Zegler (804-698-4206).

Under the Construction General Permit (CGP), if applicable, the operator shall post the notice of coverage letter at a publicly accessible location near an active part of the construction project (e.g. where pipeline crosses a public road). The operator shall maintain the posted information until the termination of the general permit. The operator will also make the SWPPP available as follows:

1. Operators with day-to-day operational control over SWPPP implementation shall have a copy of the SWPPP available at a central location on-site for use by those

identified as having responsibilities under the SWPPP whenever they are on the construction site.

2. The operator shall make the SWPPP and all amendments, modifications, and updates available upon request to the department, the VSMP authority, the EPA, the VESCP authority, local government officials, or the operator of a municipal separate storm sewer system receiving discharges from the construction activity. If an on-site location is unavailable to store the SWPPP when no personnel are present, notice of the SWPPP's location must be posted near the main entrance of the construction site.

The operator shall make the SWPPP available for public review in an electronic format or in hard copy. Information for public access to the SWPPP shall be posted and maintained in accordance with Part II C. If not provided electronically, public access to the SWPPP may be arranged upon request at a time and at a publicly accessible location convenient to the operator or his designee but shall be no less than once per month and shall be during normal business hours. Information not required to be contained within the SWPPP by this general permit is not required to be released.

1.2 EROSION AND SEDIMENT CONTROL - Quarterly Reports

DETI will report, on a quarterly basis, a listing of each regulated land-disturbing activity for which an ESC plan (and a SWM plan if applicable) has been approved under these Annual Standards and Specifications for ESC and SWM, and the construction status (construction ongoing, not started, completed during quarter), to DEQ quarterly. The report must include the following:

- Project name or project number
- Project location (including nearest intersection, latitude, and longitude)
- On-site project manager name and contact info (if applicable)
- Responsible Land Disturber (RLD) name and contact info
- Project description
- Acreage of disturbance for project
- Anticipated project start and finish date
- Any approved variances/exceptions associated with the project

1.3 STORMWATER MANAGEMENT – Annual Reports

Stormwater Management Plans will be required for DETI projects when projects are unable to satisfy the terms and conditions contained in DEQ Guidance Memo No. 15-2003, or are determined not to be exempt from associated requirements of the *General VPDES Permit for Discharges of Stormwater from Construction Activities* (9VAC25-880) (referred to more generally as the construction general permit or CGP). When applicable, DETI will assure that SWM plans and associated Stormwater Pollutant Prevention Plans (SWPPPs) and CGP registrations statements are prepared, reviewed, and approved prior to initiating regulated land disturbing activities. The technical criteria for SWM are addressed in Appendix B of these Annual Standards and Specifications for ESC and SWM.

On a fiscal year basis (July 1 to June 30), DETI will report to the department by October 1 of each year in a format provided by DEQ. The information to be provided shall include the following:

1. Information on each permanent stormwater management facility completed during the fiscal year to include type of stormwater management facility, geographic coordinates, acres treated, and the surface waters or karst features into which the stormwater management facility will discharge;

2. Number and type of enforcement actions during the fiscal year; and

3. Number of exceptions granted during the fiscal year.

1.4 RECORDKEEPING

DETI must keep records in accordance with the following:

- All individual project records, including approved plans, inspection records, documented field changes, and CGP registration statements (if applicable) must be maintained for a period of three years after completion of the project or state permit termination. This period of retention shall be extended automatically during the course of any unresolved litigation regarding the regulated activity or regarding control standards applicable to DETI, or as requested by the State Water Control Board.
- A construction record drawing for all permanent, structural stormwater management facilities (“as-built”) with seal and signature of a Virginia-licensed Professional Engineer must be maintained by DETI in perpetuity, or until the stormwater facility is removed.
- Stormwater management facility inspection records must be documented and retained for at least five years from the date of inspection.

1.5 PLAN DESIGN, REVIEW, AND APPROVAL

This section outlines requirements for Erosion and Sediment Control and Stormwater Management, along with applicable plan contents for review and approval by DEQ certified personnel (as described in Section 2 of this document) prior to initiating regulated land disturbing activities.

1.5.1 ESC REQUIREMENTS

DETI follows the policies and procedures described in the Virginia Erosion and Sediment Control Handbook (VESCH). The use of the VESCH, along with accompanying technical documents and guidance, is strongly preferred. DETI utilizes a comprehensive design, review and approval program that includes review for consistency with both the general specifications for Minimum Standards and Specifications (STDS & SPEC) and the FERC Plan and Procedures. The FERC Plan and Procedures (Appendices C and D) are hereby incorporated by reference and must be utilized on all FERC-regulated DETI projects. In the event of differences between the FERC Plan and Procedures and the VESCH criteria, the more stringent criteria shall apply. The Annual Standards and Specifications will be compared to FERC's Plan and Procedures to determine the appropriate (i.e., whichever is more stringent) best management practices. The general specifications for ESC apply to land-disturbing activities and are included in these Annual Standards and Specifications by reference, as follows:

- Virginia Erosion and Sediment Control Law (§62.1-44 et seq. as amended);
- Virginia Erosion and Sediment Control Regulations (9VAC25-840 et seq. as amended);
- Virginia Erosion and Sediment Control and Stormwater Management Certification Regulations (9VAC25-850 et seq. as amended);
- Virginia Erosion and Sediment Control Handbook, 1992, as amended, and related technical documents and guidance specifications;
- Technical Bulletins and Memos, as amended, on the DEQ website.

ESC plans and documents must be submitted to the designated Plan Reviewer (defined in Section 2.2) for review and approval. Plans must be reviewed and approved by DEQ certified personnel (*as described in Section 2, Personnel Roles and Responsibilities*) to ensure compliance with these Annual Standards and Specifications for ESC and SWM and reviewed by DETI for consistency with the FERC Plan and Procedures guidance. Any non-VESCH control measures incorporated into plans must include all applicable practical information including definition, purpose, conditions where practice applies, planning considerations, design criteria, construction specifications, design tables and plates and maintenance/inspection requirements. Should non-VESCH control measures fail to effectively control soil erosion, sediment deposition, and non-agricultural runoff, then VESCH control measures shall be utilized. All documents submitted for

review must include the appropriate information, as described below (and shown in the flow chart below) in addition to the ESC Plan Checklist (Appendix A).

1.5.2 ESC PLAN CONTENTS

As applicable, ESC drawings must include the following:

a) Minimum standards 1 through 19 as applicable;
b) General Erosion and Sediment Control Notes ES-1 through ES-9 (Appendix E);
c) Total area of disturbance. If the project is phased, the total area of disturbance for each phase must be noted;
d) Pre-development and post-development land cover conditions
e) Construction sequence of operations with staged implementation of ESC measures for each phase;
f) Existing features that will be demolished or removed that may require ESC measures;
g) Erosion and Sediment Control Critical Areas identification and discussion;
h) Location of various support activities including, but not limited to, areas where wash water may occur; storage area for chemicals, fuels and fertilizers; concrete wash out areas; vehicle fueling and maintenance areas; sanitary waste facilities and construction waste storage; and
i) Information suitable for drainage and ESC review (may include drainage areas, flow paths, points of analysis, outfalls, or other drainage patterns) should be submitted (either on the plans or in supporting documentation).
j) When applicable, the location of the on-site rain gauge must be included.

The Erosion and Sediment Control Plan Checklist is included in Appendix A.

1.5.3 SWM REQUIREMENTS

Portions of these Annual Standards and Specifications related to Stormwater Management shall apply to regulated land-disturbing activities which are not exempted under GM 15-2003 from SWM plan submission and/or projects which are required to obtain CGP coverage. The following requirements shall apply, when applicable, and are hereby incorporated by reference:

- Virginia Stormwater Management Act (§62.1-44 et seq. as amended);
- Virginia Stormwater Management Permit Regulations (9VAC25-870 et seq. as amended);
- Virginia Stormwater Management Handbook, 1999, as amended; and
- Technical Bulletins and Memos, as amended, on the DEQ website.
- DEQ Guidance Memorandum No. 15-2003 (GM 15-2003)
- Construction General Permit Regulation 9VAC25-880 et seq.
- Standards and Specifications for stormwater practices as published on the Virginia Stormwater BMP Clearinghouse (http://www.vwrrc.vt.edu/swc/index.html).

Off-site credit use should be coordinated with the DEQ Central Office Nutrient Credit Coordinator (Derick Winn, Office of Stormwater Permits: 804-698-4114).

1.5.4 SWM PLAN CONTENTS

ESC and SWM/SWPPP plans and documents must be submitted to the designated Plan Reviewer (certified in accordance with Section 2 of this document) for review and approval. Plans must be reviewed to ensure compliance with these Annual Standards and Specifications for ESC and SWM.

If applicable, the stormwater management plan shall be implemented as approved or modified by DETI and shall be developed in accordance with the following:

1. A stormwater management plan for a land-disturbing activity shall apply the stormwater management technical criteria set forth in this part to the entire land-disturbing activity. Individual lots in new residential, commercial, or industrial developments shall not be considered separate land-disturbing activities.

2. A stormwater management plan shall consider all sources of surface runoff and all sources of subsurface and groundwater flows converted to surface runoff.

A complete stormwater management plan shall include the following elements:

1. Information on the type of and location of stormwater discharges, information on the features to which stormwater is being discharged including surface waters or karst features if present, and predevelopment and postdevelopment drainage areas;

2. Contact information including the name, address, telephone number, and email address of the owner and the tax reference number and parcel number of the property or properties affected;

3. A narrative that includes a description of current site conditions and final site conditions or if allowed by the VSMP authority, the information provided and documented during the review process that addresses the current and final site conditions;

4. A general description of the proposed stormwater management facilities and the mechanism through which the facilities will be operated and maintained after construction is complete;

5. Information on the proposed stormwater management facilities, including (i) the type of facilities; (ii) location, including geographic coordinates; (iii) acres treated; and (iv) the surface waters or karst features into which the facility will discharge;

6. Hydrologic and hydraulic computations, including runoff characteristics;

7. Documentation and calculations verifying compliance with the water quality and quantity requirements of these regulations;

8. A map or maps of the site that depicts the topography of the site and includes:

a. All contributing drainage areas;

b. Existing streams, ponds, culverts, ditches, wetlands, other water bodies, and floodplains;

c. Soil types, geologic formations if karst features are present in the area, forest cover, and other vegetative areas;

d. Current land use including existing structures, roads, and locations of known utilities and easements;

e. Sufficient information on adjoining parcels to assess the impacts of stormwater from the site on these parcels;

f. The limits of clearing and grading, and the proposed drainage patterns on the site;

g. Proposed buildings, roads, parking areas, utilities, and stormwater management facilities; and

h. Proposed land use with tabulation of the percentage of surface area to be adapted to various uses, including but not limited to planned locations of utilities, roads, and easements;

9. If an operator intends to meet the requirements established in 9VAC25-870-63 or 9VAC25-870-66 through the use of off-site compliance options, where applicable, then a letter of availability from the off-site provider must be included; and

10. If payment of a fee is required with the stormwater management plan submission by the VSMP authority, the fee and the required fee form in accordance with Part XIII (9VAC25-870-700 et seq.) must have been submitted.

Elements of the stormwater management plans that include activities regulated under Chapter 4 (§ 54.1-400 et seq.) of Title 54.1 of the Code of Virginia shall be appropriately sealed and signed by a professional registered in the Commonwealth of Virginia pursuant to Article 1 (§ 54.1-400 et seq.) of Chapter 4 of Title 54.1 of the Code of Virginia.

A construction record drawing for permanent stormwater management facilities shall be submitted to the VSMP authority in accordance with 9VAC25-870-108 and 9VAC25-870-112.

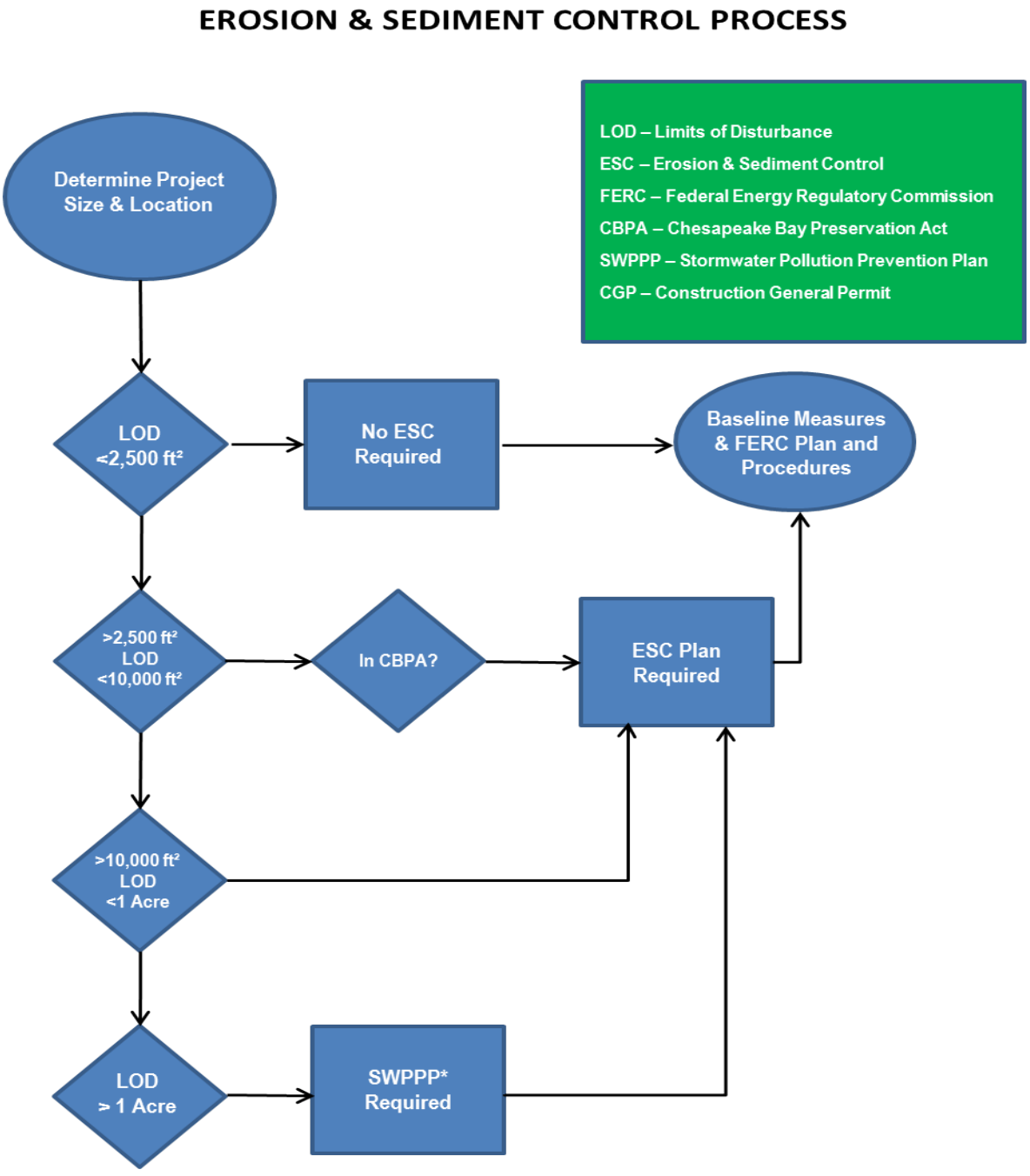
The construction record drawing shall be appropriately sealed and signed by a professional registered in the Commonwealth of Virginia, certifying that the stormwater management facilities have been constructed in accordance with the approved plan.

DETI Plan Review personnel (see Section 2.0) will verify whether a SWM plan is required for submission (as outlined above) and will document that the required elements above are included, when applicable. In addition to the above elements, the following documentation will be reviewed and approved prior to initiating the land disturbing activity:

- If applicable, the Stormwater Pollution Prevention Plan (SWPPP), inclusive of registration statement, Pollution Prevention Plan, Erosion and Sediment Control Plan, and Stormwater Management Plan and Calculations;
- If a SWPPP and/or CGP is required for a project, applicable TMDL information and general information shall be included, in addition to the required registration statement.
- Post-construction maintenance requirements of permanent BMPs, if applicable (See Appendix B);
- Manufacturer's recommended maintenance and inspection of manufactured permanent BMPs (per the BMP Clearinghouse);
- Post-construction inspection requirements for permanent BMPs;
- A map or digital file, including the appropriate base data, delineating the area treated by the BMP;
- A map or digital file, including the appropriate base data, depicting the applicable area used to determine percent impervious cover; and
- SWM Plan Checklist (Appendix B).

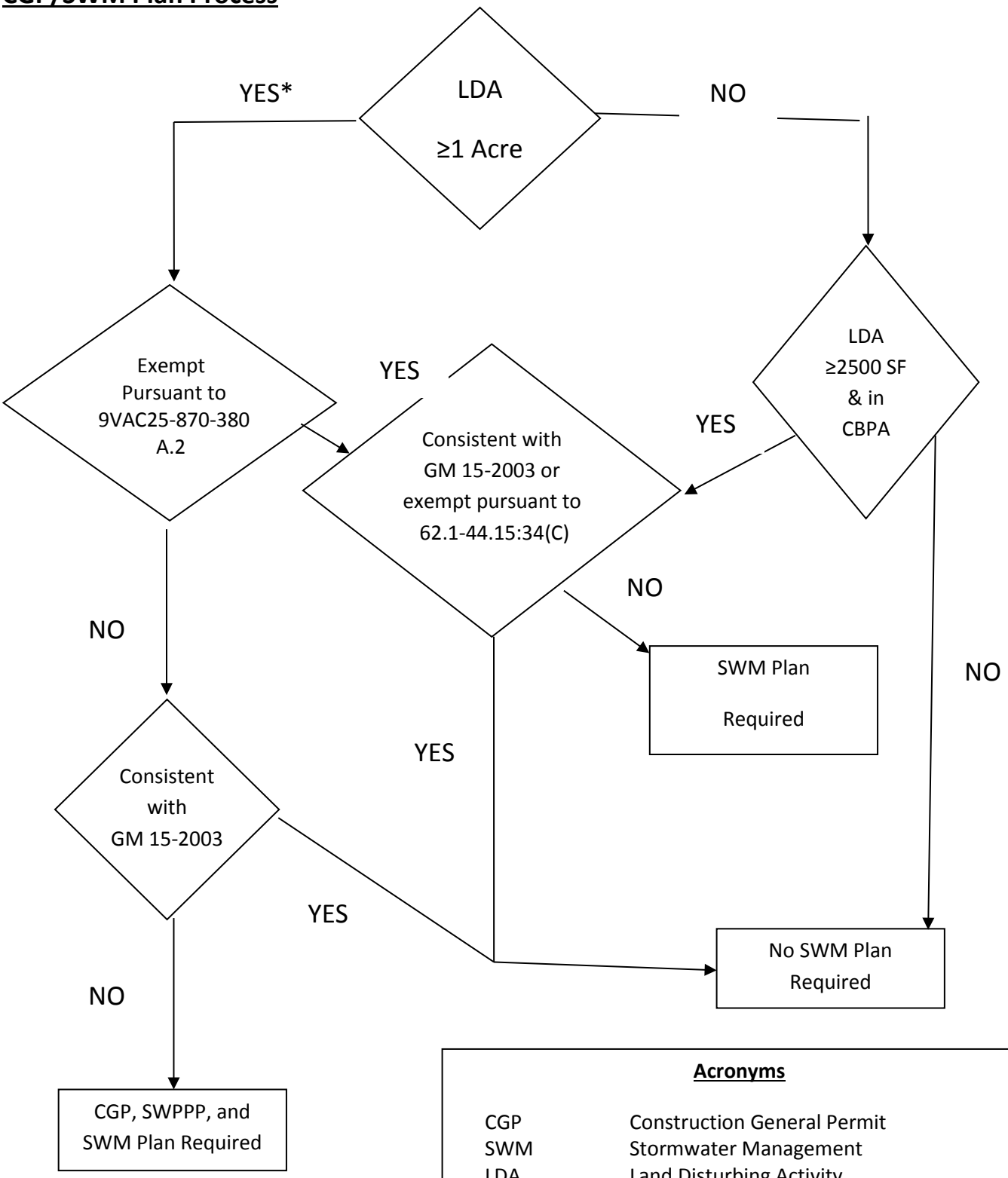
1.5.5 REVISIONS

All revisions to the approved Erosion and Sediment Control Plan or the approved Stormwater Management Plan for the project require review and approval by DEQ certified Plan Reviewer for ESC (and SWM, when applicable). Changes shall be documented and dated on the plans.



* See Figure 2 – next page

CGP/SWM Plan Process



Acronyms

CGP	Construction General Permit
SWM	Stormwater Management
LDA	Land Disturbing Activity
SF	Square Feet
CBPA	Chesapeake Bay Preservation Area
GM 15-2003	Guidance Memo No. 15-2003
SWPPP	Stormwater Pollution Prevention Plan

*SWPPP required for all projects disturbing ≥ 1 acre.

2. PERSONNEL ROLES AND RESPONSIBILITIES

DETI will be the plan approval authority and administrator for the DETI Annual Standards and Specifications for ESC and SWM. A description of the expected administrative roles and associated required certifications[2] is provided below. Note that roles may be combined for staff resource purposes as long as the person responsible for each task is fully qualified for all assigned roles. The ESC plans and SWM plans/SWPPP (where applicable) must be included in all pipeline construction specifications and DETI must assure that the contractor is aware of their responsibility prior to starting any construction activities by covering this specification during pre-construction training and meetings. DETI must provide quality assurance for the ESC and SWM plans as well as guidance, as needed, for implementation of ESC and SWM measures on all projects. DETI may enter into agreements or contracts with contractors to assist with carrying out the certification requirements set forth in the ESC and SWM Law and Regulations.

2.1 PROGRAM ADMINISTRATOR

The Program Administrator will be responsible for the management and coordination of these Annual Standards and Specifications for ESC and SWM. The Program Administrator must be certified as an ESC (and SWM when applicable) Combined Administrator by DEQ or provisionally certified. This role may be conducted by a third party as directed by DETI.

2.2 PLAN REVIEWER

The Plan Reviewer will be responsible for the review of ESC and SWM portions of project plans for compliance with these Annual Standards and Specifications and applicable laws and regulations. The Plan Reviewer must be certified as an ESC (and SWM when applicable) Plan Reviewer by DEQ or provisionally certified. This role may be conducted by a third party firm preparing the plans as directed by DETI.

2.3 CONSTRUCTION SITE SUPERVISOR

The Construction Site Supervisor will have direct oversight of all personnel that prepare, construct, maintain and rehabilitate a given project. The Supervisor also has control over site-specific construction plans, including the ability to make modifications to those plans. This person must ensure compliance with ESC, SWPPP, and Virginia Stormwater Management Program (VSMP) requirements as well as compliance with these Annual Standards and Specifications. The Construction Site Supervisor is authorized to direct workers at a site to carry out activities in accordance with these and other permit conditions. The Construction Site Supervisor must be certified as a Responsible Land Disturber (RLD) by DEQ.

[2] Detailed directions for obtaining certifications can be found via the DEQ website at: http://www.deq.virginia.gov/ConnectWithDEQ/TrainingCertification.aspx

2.4 ENVIRONMENTAL INSPECTOR

The Environmental Inspector (EI) will serve as the primary point of contact for on-site environmental compliance. The EI will provide expert technical support on a wide range of environmental issues and is responsible for:

- ESC Plan, FERC Plan and Procedures and environmental conditions of FERC's Orders compliance;
- Verifying that the limits of disturbance (LOD) and locations of access roads are visibly marked before clearing and maintained throughout construction;
- Proper maintenance of environmental records on site;
- Advising the Environmental Construction Coordinator (ECC) on site-specific environmental concerns;
- Educating company inspectors and personnel on site-specific environmental concerns and requirements; and
- Reporting any non-compliance and problem areas.

An EI is required on projects involving oversight by the FERC, and DETI may assign them on other projects as well. The EI must be certified as an ESC (and SWM, when applicable) Inspector by DEQ or provisionally certified. This role may be conducted by a certified, third party firm as directed by DETI. At least one EI is required for each construction spread during construction and restoration. DETI must ensure that the number and experience of EI's assigned to each construction spread will be appropriate for the length of the construction spread and the number/significance of resources affected.

2.5 ENVIRONMENTAL CONSTRUCTION COORDINATOR

The Environmental Construction Coordinator (ECC) will serve as part of the environmental team relative to environmental compliance within DETI. The ECC has the responsibility of ensuring full compliance with applicable laws, environmental rules, regulations, permits, and company policies that pertain to their projects. The ECC's roles and responsibilities may include:

- Ensure compliance with applicable federal, state, and local environmental regulations, permits, company standards, and procedures, and facility procedures at assigned projects;
- Promote environmental stewardship;
- Coordinate with EI's and contractors to ensure site environmental compliance;
- Serve as primary site coordinator with Dominion Environmental Services (DES), internal departments, and external agencies regarding environmental issues;
- Serve as contact with community or local public to resolve environmental emergencies, complaints, or problems;
- Maintain environmental permits, plans, and various compliance records; and

- Assist with environmental emergency response activities.

2.6 EROSION AND SEDIMENT CONTROL AND STORMWATER INSPECTOR

The Erosion and Sediment Control Inspector will be responsible for the inspection and compliance with ESC and SWM/SWPPP practices, as applicable, as well as those practices outlined in these Annual Standards and Specifications. These responsibilities will typically be shared between the EI and the ESC/SWM Inspector. The Inspector must be certified as an ESC (and SWM when applicable) Inspector by DEQ or provisionally certified. This role may be conducted by a third-party firm preparing the plans as directed by DETI. DETI must ensure that inspection staff is suitable for the size and scope of the project.

3. TECHNICAL CRITERIA

3.1 EROSION AND SEDIMENT CONTROL

DETI must employ erosion and sediment control measures for all land-disturbing activities associated with the construction and maintenance of gas transmission facility projects.

The minimum standards set forth in 9 VAC 25-840-40 and the control practices laid out in the Virginia Erosion and Sediment Control Handbook (VESCH) shall be applied to the planning, design, construction, and maintenance of ESC and SWM plans (when applicable).

1. Permanent or temporary soil stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site. Temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain dormant for longer than 14 days. Permanent stabilization shall be applied to areas that are to be left dormant for more than one year.

2. During construction of the project, soil stock piles and borrow areas shall be stabilized or protected with sediment trapping measures. The applicant is responsible for the temporary protection and permanent stabilization of all soil stockpiles on site as well as borrow areas and soil intentionally transported from the project site.

3. A permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized. Permanent vegetation shall not be considered established until a ground cover is achieved that is uniform, mature enough to survive and will inhibit erosion.

4. Sediment basins and traps, perimeter dikes, sediment barriers and other measures intended to trap sediment shall be constructed as a first step in any land-disturbing activity and shall be made functional before upslope land disturbance takes place.

5. Stabilization measures shall be applied to earthen structures such as dams, dikes and diversions immediately after installation.

6. Sediment traps and sediment basins shall be designed and constructed based upon the total drainage area to be served by the trap or basin.

a. The minimum storage capacity of a sediment trap shall be 134 cubic yards per acre of drainage area and the trap shall only control drainage areas less than three acres.

b. Surface runoff from disturbed areas that is comprised of flow from drainage areas greater than or equal to three acres shall be controlled by a sediment basin. The minimum storage capacity of a sediment basin shall be 134 cubic yards per acre of drainage area. The outfall system shall, at a minimum, maintain the structural integrity of the basin during a 25-year storm of 24-hour duration. Runoff coefficients used in runoff calculations shall correspond to a bare earth condition or those conditions expected to exist while the sediment basin is utilized.

7. Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion. Slopes that are found to be eroding excessively within one year of permanent stabilization shall be provided with additional slope stabilizing measures until the problem is corrected.

8. Concentrated runoff shall not flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, flume or slope drain structure.

9. Whenever water seeps from a slope face, adequate drainage or other protection shall be provided.

10. All storm sewer inlets that are made operable during construction shall be protected so that sediment-laden water cannot enter the conveyance system without first being filtered or otherwise treated to remove sediment.

11. Before newly constructed stormwater conveyance channels or pipes are made operational, adequate outlet protection and any required temporary or permanent channel lining shall be installed in both the conveyance channel and receiving channel.

12. When work in a live watercourse is performed, precautions shall be taken to minimize encroachment, control sediment transport and stabilize the work area to the greatest extent possible during construction. Nonerodible material shall be used for the construction of causeways and cofferdams. Earthen fill may be used for these structures if armored by nonerodible cover materials.

13. When a live watercourse must be crossed by construction vehicles more than twice in any six-month period, a temporary vehicular stream crossing constructed of nonerodible material shall be provided.

14. All applicable federal, state and local requirements pertaining to working in or crossing live watercourses shall be met.

15. The bed and banks of a watercourse shall be stabilized immediately after work in the watercourse is completed.

16. Underground utility lines shall be installed in accordance with the following standards in addition to other applicable criteria:

a. No more than 500 linear feet of trench may be opened at one time.

b. Excavated material shall be placed on the uphill side of trenches.

c. Effluent from dewatering operations shall be filtered or passed through an approved sediment trapping device, or both, and discharged in a manner that does not adversely affect flowing streams or off-site property.

d. Material used for backfilling trenches shall be properly compacted in order to minimize erosion and promote stabilization.

e. Restabilization shall be accomplished in accordance with this chapter.

f. Applicable safety requirements shall be complied with.

17. Where construction vehicle access routes intersect paved or public roads, provisions shall be made to minimize the transport of sediment by vehicular tracking onto the paved surface. Where sediment is transported onto a paved or public road surface, the road surface shall be cleaned thoroughly at the end of each day. Sediment shall be removed from the roads by shoveling or sweeping and transported to a sediment control disposal area. Street washing shall be allowed only after sediment is removed in this manner. This provision shall apply to individual development lots as well as to larger land-disturbing activities.

18. All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization or after the temporary measures are no longer needed, unless otherwise authorized by the VESCP authority. Trapped sediment and the disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion and sedimentation.

19. Properties and waterways downstream from development sites shall be protected from sediment deposition, erosion and damage due to increases in volume, velocity and peak flow rate of stormwater runoff for the stated frequency storm of 24-hour duration in accordance with the following standards and criteria. Stream restoration and relocation projects that incorporate natural channel design concepts are not man-made channels and shall be exempt from any flow rate capacity and velocity requirements for natural or man-made channels:

a. Concentrated stormwater runoff leaving a development site shall be discharged directly into an adequate natural or man-made receiving channel, pipe or storm sewer system. For those sites where runoff is discharged into a pipe or pipe system, downstream stability analyses at the outfall of the pipe or pipe system shall be performed.

b. Adequacy of all channels and pipes shall be verified in the following manner:

(1) The applicant shall demonstrate that the total drainage area to the point of analysis within the channel is one hundred times greater than the contributing drainage area of the project in question; or

(2) (a) Natural channels shall be analyzed by the use of a two-year storm to verify that stormwater will not overtop channel banks nor cause erosion of channel bed or banks.

(b) All previously constructed man-made channels shall be analyzed by the use of a ten-year storm to verify that stormwater will not overtop its banks and by the use of a two-year storm to demonstrate that stormwater will not cause erosion of channel bed or banks; and

(c) Pipes and storm sewer systems shall be analyzed by the use of a ten-year storm to verify that stormwater will be contained within the pipe or system.

c. If existing natural receiving channels or previously constructed man-made channels or pipes are not adequate, the applicant shall:

(1) Improve the channels to a condition where a ten-year storm will not overtop the banks and a two-year storm will not cause erosion to the channel, the bed, or the banks; or

(2) Improve the pipe or pipe system to a condition where the ten-year storm is contained within the appurtenances;

(3) Develop a site design that will not cause the pre-development peak runoff rate from a two-year storm to increase when runoff outfalls into a natural channel or will not cause the pre-development peak runoff rate from a ten-year storm to increase when runoff outfalls into a man-made channel; or

(4) Provide a combination of channel improvement, stormwater detention or other measures which is satisfactory to the VESCP authority to prevent downstream erosion.

d. The applicant shall provide evidence of permission to make the improvements.

e. All hydrologic analyses shall be based on the existing watershed characteristics and the ultimate development condition of the subject project.

f. If the applicant chooses an option that includes stormwater detention, he shall obtain approval from the VESCP of a plan for maintenance of the detention facilities. The plan shall set forth the maintenance requirements of the facility and the person responsible for performing the maintenance.

g. Outfall from a detention facility shall be discharged to a receiving channel, and energy dissipators shall be placed at the outfall of all detention facilities as necessary to provide a stabilized transition from the facility to the receiving channel.

h. All on-site channels must be verified to be adequate.

i. Increased volumes of sheet flows that may cause erosion or sedimentation on adjacent property shall be diverted to a stable outlet, adequate channel, pipe or pipe system, or to a detention facility.

j. In applying these stormwater management criteria, individual lots or parcels in a residential, commercial or industrial development shall not be considered to be separate development projects. Instead, the development, as a whole, shall be considered to be a single development project. Hydrologic parameters that reflect the ultimate development condition shall be used in all engineering calculations.

k. All measures used to protect properties and waterways shall be employed in a manner which minimizes impacts on the physical, chemical and biological integrity of rivers, streams and other waters of the state.

l. Any plan approved prior to July 1, 2014, that provides for stormwater management that addresses any flow rate capacity and velocity requirements for natural or man-made

channels shall satisfy the flow rate capacity and velocity requirements for natural or man-made channels if the practices are designed to (i) detain the water quality volume and to release it over 48 hours; (ii) detain and release over a 24-hour period the expected rainfall resulting from the one year, 24-hour storm; and (iii) reduce the allowable peak flow rate resulting from the 1.5, 2, and 10-year, 24-hour storms to a level that is less than or equal to the peak flow rate from the site assuming it was in a good forested condition, achieved through multiplication of the forested peak flow rate by a reduction factor that is equal to the runoff volume from the site when it was in a good forested condition divided by the runoff volume from the site in its proposed condition, and shall be exempt from any flow rate capacity and velocity requirements for natural or man-made channels as defined in any regulations promulgated pursuant to § 62.1-44.15:54 or 62.1-44.15:65 of the Act.

m. For plans approved on and after July 1, 2014, the flow rate capacity and velocity requirements of § 62.1-44.15:52 A of the Act and this subsection shall be satisfied by compliance with water quantity requirements in the Stormwater Management Act (§ 62.1-44.15:24 et seq. of the Code of Virginia) and attendant regulations, unless such land-disturbing activities are in accordance with 9VAC25-870-48 of the Virginia Stormwater Management Program (VSMP) Regulations.

n. Compliance with the water quantity minimum standards set out in 9VAC25-870-66 of the Virginia Stormwater Management Program (VSMP) Regulations shall be deemed to satisfy the requirements of subdivision 19 of this subsection.

3.2 GENERAL DESCRIPTION OF CONSTRUCTION ACTIVITIES

The stages of construction typically include: survey and planning, mowing and clearing, grubbing and grading, trenching, pipe assembly (including stringing, bending, welding, testing, coating, and lowering-in), backfilling, final grading, and restoration. The erosion and sediment control measures to be installed for each of these stages are described below. If any denuded area will remain idle for more than 14 days, temporary stabilization (temporary seed, mulch, additional sediment barriers as directed by the ECC) must be applied within seven (7) days to that area.

3.2.1 CONSTRUCTION WORK AREAS

Construction work areas, also called the LOD, include all access roads, staging areas, temporary pipe yards and contractor yards, and the construction right-of-way. To the extent possible, previously disturbed areas will be used for construction to minimize new impacts. Landowner agreement and appropriate permits must be obtained prior to the use of any area for construction activities. Erosion and sediment control plans apply to all construction work areas.

The construction right-of-way will include the permanent pipeline right-of-way and temporary right-of-way for the length of the project. Additional workspace may be required in certain areas. The construction right-of-way may be widened (subject to compliance with all applicable survey, plan preparation and approval, and mitigation requirements) in areas such as steep slopes and topsoil conservation areas to ensure safe construction or for storage of excess spoil.

Following construction, all disturbed areas must be restored with an approved vegetative cover directed by the landowner, permits these Annual Standards and Specifications. All temporary work areas must be restored to pre-construction conditions and uses.

DETI must provide the contractor with a construction line list that describes any special requirements (i.e. timber salvage, topsoil segregation, restoration measures, fencing requirements, etc.) requested by landowners. The contractor must comply with these special requirements.

DETI must also obtain the necessary right-of-way permits (i.e. federal, state, stream crossing, wetland crossing, road crossing permits, etc.) for the installation of pipeline. Permit requirements may be more stringent than the requirements of this plan and, if so, the more restrictive requirements will be implemented. The contractor must obtain permits that may be required for activities such as burning, blasting, and transportation.

3.2.2 SURVEY AND PLANNING

In most cases the LOD will be selected in advance and included in all surveys, landowner negotiations and permitting. Any work areas selected by the contractor must receive appropriate review and permitting prior to their use. The limits of the approved work areas, boundaries of environmentally sensitive areas, and the location of the facilities must be marked in the field prior to the start of mechanized activities. Changes to the LOD must be denoted/marked up on the ESC plans and recorded in the SWPPP (if applicable). Any changes affecting overall permitted disturbed area or potential affecting compliance with stormwater or ESC criteria must be reviewed and approved in advance in accordance with Section 1.5.5 (Revisions).

Environmentally sensitive areas are those that are more susceptible to serious erosion problems and thus may require enhanced erosion and sediment control measures. Examples of such areas may include steep slopes and sinkholes down-gradient of project activities. Examples of specialized controls that may be used in these areas include specialized pipeline construction methods that combine several construction stages, thereby reducing earth disturbance. Additional details for working in steep slopes can be found below in Section 3.4 Special Procedures.

3.2.3 CLEARING AND MOWING

The initial tree clearing may be performed by either non-mechanized or mechanized means. Non-mechanized methods entail the use of crews accessing the construction work areas on foot and cutting timber with handheld chainsaws. Trees are removed when mechanized equipment is

mobilized to the project. Erosion and sedimentation control measures must be installed as a **first step** in any land-disturbing activity after clearing and must be made functional before upslope land disturbance takes place.

Vegetation will be cut at ground level and un-merchantable timber (i.e. brush, stumps, slash, and tree tops) may be disposed of by chipping and distribution along the upland right-of-way or by burning, if allowed. Burning must be avoided if practicable. Merchantable timber will be cut and stacked along the outboard edge of the construction right-of-way in upland areas as directed by the landowner or the Construction Supervisor. If chips are spread along the right-of-way, they must be spread at no more than 1-ton per acre and an additional application of 11 pounds of nitrogen per acre, at least 50% is slow release, must be made to affected areas. If necessary, the desirable trees will be protected by fencing and armoring. If chipping is to serve as "Mulching" for Erosion and Sediment Control purposes, then mulching should be consistent with the application rates from ESC Standard and Specification 3.35.

3.2.4 GRUBBING AND GRADING

This step involves grubbing stumps, removing and segregating topsoil where applicable, and leveling the construction right-of-way to create a safe operating area for equipment and vehicles. Topsoil and subsoil disturbed during grading operations will not be mixed with foreign material (i.e. stumps and slash). The disposal methods described above for clearing debris also apply to stumps. In addition, stumps may not be buried in the right-of-way in upland, non-agricultural, non-residential areas. Grading must be delayed at environmentally sensitive areas that will be treated as separate construction areas (i.e. steep slopes) until the contractor is prepared to complete all other construction activities at that site in the shortest practicable time.

Erosion and sedimentation control measures must be installed as a **first step** in any land-disturbing activity and must be made functional before upslope land disturbance takes place.

3.3 EROSION AND SEDIMENT CONTROL PRACTICES

The following are the more commonly used practices applied to pipeline construction (from Virginia Uniform Coding System for Erosion and Sedimentation Control Practices). The use of the VESCH, along with accompanying technical documents, guidance and practices is strongly preferred. The VESCH and related technical documents and guidance specifications are incorporated by reference into these Annual Standards and Specifications. Details for those practices marked with an * are included in Appendix A. For full details, refer to the 1992 VESCH. Non-VESCH measures are included herein but may be further reviewed and approved by DEQ on a project-specific basis.

Practice	**Title**	**Key**
3.01*	Safety Fence	SAF

3.02*	Temporary Stone Construction Entrance	CE
3.03	Construction Road Stabilization (Temp)	CRS
3.04*	Straw Bale Barrier	STB
3.05*	Silt Fence	SF
3.07*	Storm Drain Inlet Protection	IP
3.08*	Culvert Inlet Protection	CIP
3.09*	Temporary Diversion Dike	DD
3.10*	Temporary Fill Diversion	FD
3.11*	Temporary ROW Diversion/Water Bars	RWD
3.12*	Diversion	DV
3.13	Temporary Sediment Trap	ST
3.14	Temporary Sediment Basin	SB
3.15	Temporary Slope Drain	TSD
3.17	Stormwater Conveyance Channel	SCC
3.18*	Outlet Protection	OP
3.19*	Riprap	RR
3.20*	Rock Check Dams	CD
3.21	Level Spreader	LS
3.22	Vegetative Streambank Stabilization	VSS
3.23	Structural Streambank Stabilization	SSS
3.24*	Temporary Vehicular Stream Crossing	SC
3.25*	Utility Stream Crossing	USC
3.26*	Dewatering Structure	DS
3.29	Surface Roughening	SR
3.30	Topsoiling	TO

3.31	Temporary Seeding	TS
3.32	Permanent Seeding	PS
3.34	Bermudagrass & Zoysiagrass Est.	BE/ZE
3.35	Mulching	MU
3.36*	Soil Stabilization Blankets & Matting	B/M
3.37	Trees, Shrubs, Vines & Ground Cover	VEG
3.38	Tree Preservation & Protection	TP
3.39	Dust Control	DC

The following practices are identified as baseline measures for minimizing erosion and enhancing revegetation in accordance with the FERC Plan, found in Appendix C. They are listed by Plan section reference.

IV.B	Topsoil Segregation	TSS
IV.F.1	Temporary Slope Breakers	TSB
IV.F.2	Temporary Trench Plugs	TTP
V.C	Soil Compaction	SCO
VI.	Off-Road Vehicle Control	ORV

In instances where the requirements or practices differ between the VESCH and the FERC Plan and Procedures guidance, the more stringent criteria shall be applied. *(e.g. FERC TSB spacing criterion are not as stringent as VESCH RWD spacing criterion, so the VESCH criterion would be applied.)* The following practices and measures are identified as baseline measures for minimizing erosion and sediment control and are not found in the VESCH or the Plans and Procedures. These include:

Timber Mat Stabilization	TM

DETI utilizes construction timber mats to provide access through areas such as wetlands and waterbodies, some agricultural fields, steep slopes, and other areas as determined by the Construction Supervisor. This practice reduces soil compaction and provides a stable travel lane for contractors along the project right-of-way, thus minimizing land disturbance. This practice may be incorporated in addition to the VESCH-related practices and requirements.

The use of construction timber may generally not constitute soil disturbance or a change in hydrology. Therefore, the installation of timber mat access roads and work pads is not considered a regulated land-disturbing activity and these areas are generally not included in land disturbance area calculations.

Geotextile Bag/Dewatering Bag GB

DETI utilizes geotextile bags for dewatering and velocity reduction on a majority of pipeline construction projects in lieu of straw bale dewatering practices illustrated in DS (Std. 3.26 Dewatering Structure). The purpose, definition, conditions of application and planning considerations are identical. Design criteria and specifications vary by dewatering bag manufacturer. A variety of geotextile dewatering bag products are available on the market. When incorporated into a plan, all manufacturers' guidance on the use, design, sizing, maintenance and application of the geotextile dewatering bag shall be followed.

3.4 SPECIAL PROCEDURES

The following procedures and practices are commonly utilized on pipeline construction sites and may have standards established by more than one regulation.

3.4.1 WETLAND AND WATERBODY CROSSINGS (PROCEDURES V & VI)

Sections V and VI of the FERC Procedures outline methods for crossing wetlands and waterbodies. See Appendix D for additional details regarding equipment bridges and crossing methodologies including: dry-ditch, flume, and horizontal direction drill.

3.4.2 TIME WINDOWS FOR CONSTRUCTION (PROCEDURES V.B.1)

Unless expressly permitted or further restricted by the appropriate federal or state agency in writing on a site-specific basis, crossings must be constructed during the following time windows:

- Coldwater Fisheries - June 1 through September 30;
- Coolwater and Warmwater Fisheries - June 1 through November 30;
- Natural Trout Streams - restrictions set forth by the Virginia Department of Game and Inland Fisheries (VDGIF), October 1st through March 31st for Brown Trout (*Salmo trutta*) and Brook Trout (*Salvelinus fontinalis*), March 15th through May15th for Rainbow Trout (*Oncorhynchus mykiss*) and March 15th through June 30th for the Roanoke Logperch (*Percina rex*); and
- Stockable Trout Streams - there are no time of year restrictions for stockable trout streams; however, as required by the VDGIF, DETI must consult with the VDGIF regional offices before constructing in stockable trout streams.
- Time-of-Year Restrictions (TOYR) – TOYR may be applied to certain construction activities for protection of certain species (e.g. listed freshwater mussels, bat hibernaculum, etc.) as required by UFWS and/or wetland permitting agencies. Applicable TOYR will be described in permit documentation and enforced by the ECC.

3.4.3 POTENTIAL EROSION PROBLEM AREAS/CRITICAL AREAS

Critical Areas, or potential erosion problem areas, **as described in VESCH** will be protected by project specific BMPs. A list of potential critical areas is included in **Appendix J**. Special attention will be given to those slopes that are near surface waters. The discharge of soils from failed slopes into surface waters is a serious occurrence and may result in environmental non-compliance. Critical Areas must be identified in the Erosion and Sediment Control narrative and appropriate management measures must be provided. Critical areas are defined as areas on the site which have potentially serious erosion problems (steep slopes, channels, wet weather/underground springs, etc.).

Potential erosion problem areas or critical areas (see slope length and gradient erodibility criteria in VESCH), including but not limited to areas with 30º slopes (58%) or greater, will be protected by belted silt retention fence and permanent slope breakers. Slope breakers (aka right-of-way diversions) will be placed in the appropriate spacing listed in VESCH Std. and Spec. 3.11 (RWD) in areas with greater than 14º slopes (25% slopes). Spacing shall be 50 ft. when slopes are 25-40%, and 25 ft. when in excess of 40%. In addition to the criteria for RWD on slopes steeper than 25%, RWD should be installed at the designer's discretion and consistent with the VESCH 3.11 RWD specification.

Care will be taken to avoid areas of steep slopes as much as practical; however, areas which could not be avoided will be addressed with waterbars and Rolled Erosion Control Product (RECP). RECPs must be consistent with VESCH Std. and Spec. 3.36 for Soil Stabilization Blankets and Matting. In the event that subsurface flow is encountered, an Under Drain will be utilized, as necessary, to divert water outside of the LOD. If encountered, seeps can be mitigated by using seep collectors placed down-slope of areas showing seepage. Armored fill placed at the toe of the slope may be used in areas of steep slopes in addition to a perforated drain pipe to divert subsurface water away from the cut slope. If a slip occurs Dominion will install super silt fence, gabion baskets, jersey barriers or other portable containment devices to keep the slip from impacting areas outside the LOD or waters of the state. Steep slopes will be avoided to the maximum extent practicable and are limited. Those areas will be restored with erosion control blanket and Dominion will implement the slip prevention items mentioned above as needed. Please also see DETI's *Slope Stability Policy and Procedure for Pipeline Design, Construction and Right of Way Maintenance* (Appendix I) for additional details regarding Dominion's internal policy regarding slips.

3.4.4 ADDITIONAL CRITERION – ACP/OTHER LARGE PROJECTS

The Department of Environmental Quality, in some instances, exercises discretionary authority on certain large projects to apply more stringent additional criteria than those normally applied

under these Standards and Specifications. The Atlantic Coast Pipeline (ACP) project is an example of one of these large projects. The special conditions for the ACP project are contained in Appendix G and will be adhered to, in addition to the minimum criteria outlined in this document. Project managers at DETI should be advised that projects with significant disturbed acreage (e.g. > 50 acres) are likely to face additional scrutiny by DEQ and certain additional criterion may apply. Early coordination with DEQ for large projects is recommended.

3.4.5 SWPPP APPLICABILITY

Per the request of DEQ, DETI commits to develop and implement Stormwater Pollution Prevention Plans (SWPPPs) for all projects that equal or exceed 1 acre of disturbance, even if exemptions from a permit are granted (via oil and gas exemption and/or GM 15-2003). The ESC and SWM Plan requirements are addressed separately in this document. In addition to those requirements, DETI will include the relevant general information and the SWPPP. The components DETI to be included in the SWPPP include the following:

SWPPP Contents

1. General Information (as described in section A.1 of Part II of the CGP): Subsections (d) & (e) only
2. Erosion and Sediment Control Plan (addressed separately herein)
3. SWM Plan (addressed separately herein, if no SWM Plan waiver secured)
4. Pollution Prevention Plan (as described in Section A.4 of Part II of the CGP)
5. SWPPP Requirements for Impaired Waters, etc. (as described in Section A.5 of Part II of the CGP)
6. Qualified Personnel (as described in Section A.6 of Part II of the CGP)
7. Individuals or positions with delegated authority to sign inspection reports or modify the SWPPP.
8. Certification: "I certify under penalty of the law that I have read and understand this document and that this document and all attachments were prepared in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations."

SWPPP Provisions to be Implemented by DETI:

1. Provisions for SWPPP Amendments, Modifications, and Updates (as described in Section B of Part II of the CGP, excluding references to federal officials and Part III.K)

2. SWPPP Implementation (as described in Section E of Part II of the CGP, excluding references to general permit coverage)
3. SWPPP Inspections (as described in Section F of Part II of the CGP, excluding references to the general permit and certifications pursuant to Part III.K)
4. Corrective Actions (as described in Section G of Part II of the CGP)

3.5 MAINTENANCE

Right-of-ways are generally maintained by mowing not more frequently than once every three years by the pipeline patrol and when necessary for inspection purposes. In no case will routine vegetation mowing or clearing occur during the migratory bird nesting season between April 15 and August 1 of any year unless specifically approved in writing by the responsible land management agency or the U.S Fish and Wildlife Service.

Maintenance of permanent right-of-ways in wetlands will be performed on an "as-needed" basis and will consist of limited cutting of growth as required to permit operation and maintenance pursuant to Dominion requirements. Native herbaceous and woody shrub species must be allowed to reestablish in wetland right-of-way. However, to facilitate periodic corrosion and leak surveys, a corridor not exceeding 10 feet in width centered on the pipeline may be maintained at a frequency necessary to maintain an herbaceous state. Herbicides or pesticides will not be used in or within 100 feet of a wetland, except as allowed by the appropriate federal or state agency.

In all cases, right-of-ways will be left in a natural vegetated state and may not be mowed or bush hogged more than four times per year in accordance with the management guidelines for *Open Space* in Table 1 of the *Virginia Runoff Reduction Method Instructions and Documentation.* Section 7c FERC projects will follow the FERC Plan and Procedures guidance criteria for the restoration of disturbed lands to a hydrologically functional state.

3.6 EMERGENCY PROVISIONS

In the event of an emergency, DETI reserves the right to conduct land-disturbing activities in response to a public emergency, including grid reliability issues, to avoid imminent endangerment to human health or the environment in accordance with exemptions cited in Virginia Code §62.1-44.15:34. In such situations, the DEQ shall be advised of the disturbance within seven days of commencing the land-disturbing activity, and compliance with the administrative requirements of these Annual Standards and Specification is required within 30 days of commencing the land-disturbing activity.

3.7 INSPECTIONS

DETI or its designated representative will continue to be responsible for routine inspections for compliance with the erosion and sediment control and stormwater management (where

applicable) regulations and any FERC Certificate. Certified personnel as outlined in Section 2 must conduct all inspections.

For all projects, DETI or its designated representative will be responsible for periodic inspections in compliance with 9 VAC 25-840-60(B).1. Specifically, DETI or its designated representative will provide for an inspection during or immediately following initial installation of erosion and sediment controls, at least once in every two-week period, within 48 hours following any runoff producing storm event, and at the completion of the project, or in accordance with an alternate inspection approved by the State Water Control Board.

For FERC-regulated projects, DETI or its designated representative will be responsible for periodic inspections in compliance with FERC Plan II.B.13. Specifically, FERC Plan related inspections must be conducted;

- on a daily basis in areas of active construction or equipment operation;
- on a weekly basis in areas with no construction or equipment operation; and
- within 24 hours of each 0.5 inch of rainfall.

Pipeline projects must avoid discharges of concentrated runoff to surface waters unless permitted discharges (such as dewatering) have been appropriately filtered, treated or settled prior to being discharged in a dispersed manner.

In instances where a project is subject to Stormwater Management requirements, inspections must be conducted in accordance with the inspection frequencies outlined in Appendix B (Section 5).

3.8 ENFORCEMENT

While DETI continues to hold its employees, consultants and contractors to strict environmental compliance standards, regulatory enforcement will be administered by DEQ. DETI may be required to submit relevant project documentation and plans for covered activities to the DEQ to ensure consistency with these Annual Standards and Specifications and applicable permit requirements. The State Water Control Board has the authority to enforce approved specifications and charge fees equal to the lower of (i) $1000 or (ii) an amount sufficient to cover the costs associated with standard and specification review and approval, project inspections and compliance. The Virginia DEQ will serve as the VESCP and VSMP authority and will perform random site inspections or inspections in response to a complaint to assure compliance with the associated laws/regulations and these Annual Standards and Specifications. Construction contracting firms retained by DETI must be required to comply with all contractual obligations, and DETI must enforce their compliance to the extent legally available, as necessary.

APPENDIX A

ESC Plan Checklist

Erosion and Sediment Control Practice Details

The following construction details are taken from the Virginia Erosion and Sediment Control Handbook (VESCH), Third Edition, 1992, as amended. Specific details and guidelines are covered more completely in Chapter 3 of the VESCH.

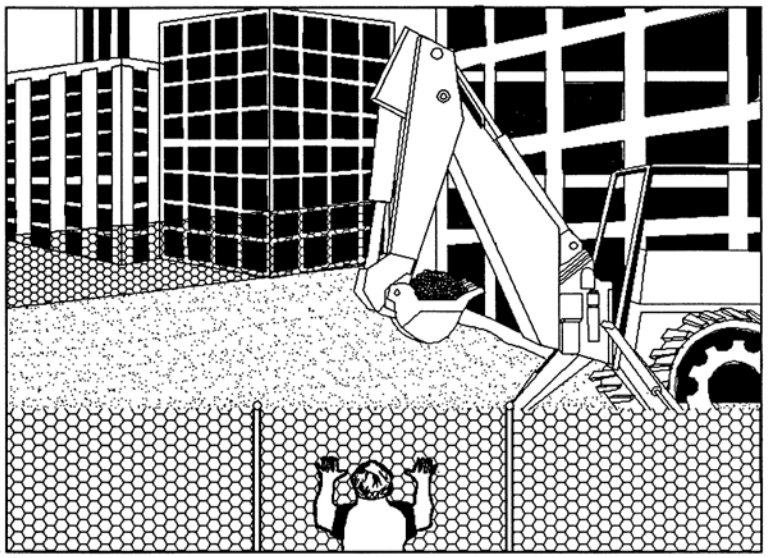
The Contractor must go to the VESCH to reference practices that are covered in the specification but not listed below.

Practice	Title	Key
3.01	Safety Fence	SAF
3.02	Temporary Stone Construction Entrance	CE
3.04	Straw Bale Barrier	STB
3.05	Silt Fence	SF
3.07	Storm Drain Inlet Protection	IP
3.08	Culvert Inlet Protection	CIP
3.09	Temporary Diversion Dike	DD
3.10	Temporary Fill Diversion	FD
3.11	Temporary Right-Of-Way Diversion	RWD
3.12	Diversion	DV
3.18	Outlet Protection	OP
3.19	RipRap	RR
3.20	Rock Check Dams	CD
3.24	Temporary Vehicular Stream Crossing	SC
3.25	Utility Stream Crossing	USC
3.26	Dewatering Structure	DS
3.36	Soil Stabilization Blankets & Matting	B/M

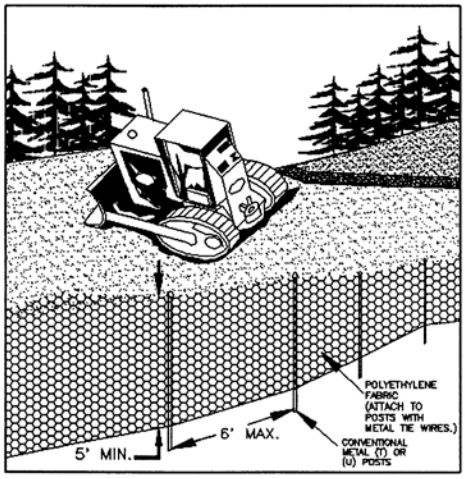
The following items are specific to the practices within this document and are not found in the VESCH manual. Details for these items are located at the end of this appendix following the items listed above.

Timber Mat Stabilization	TM
Geotextile Bag/Dewatering Bag	GB
Bleeder Drain and Outlet	BD
Trench Plug Drain	TP

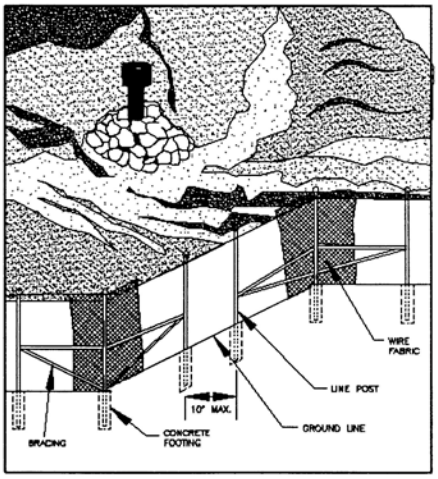
SAFETY FENCE



PERSPECTIVE VIEW



PERSPECTIVE VIEW
PLASTIC FENCE

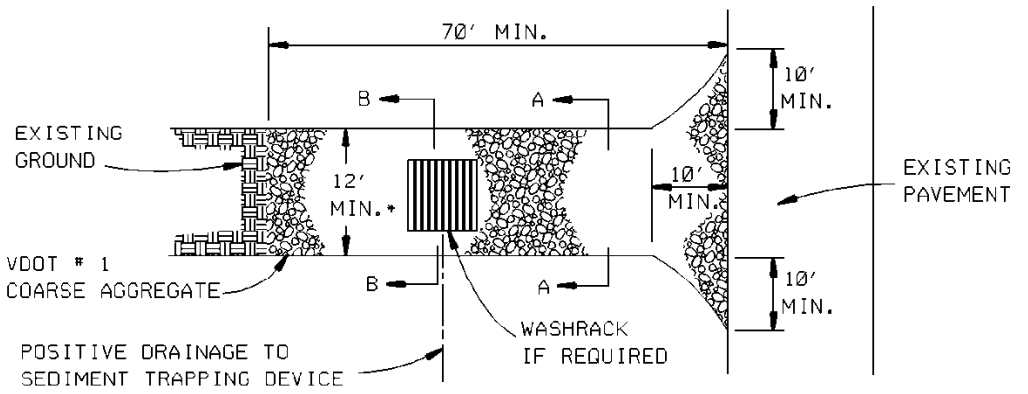


PERSPECTIVE VIEW
METAL FENCE

Source: Adapted from Conwed Plastics and VDOT Road and Bridge Standards

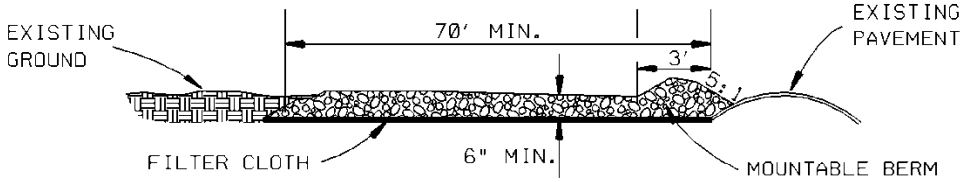
Plate 3.01-1

STONE CONSTRUCTION ENTRANCE - 3.02

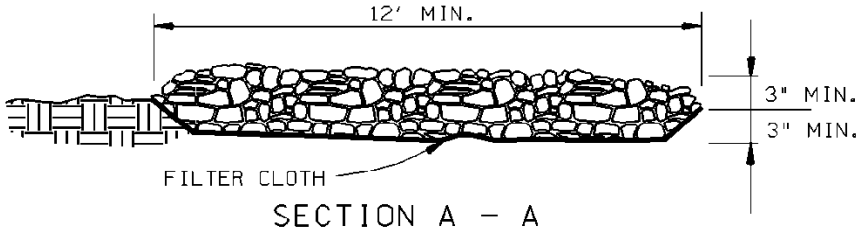


* MUST EXTEND FULL WIDTH OF INGRESS AND EGRESS OPERATION

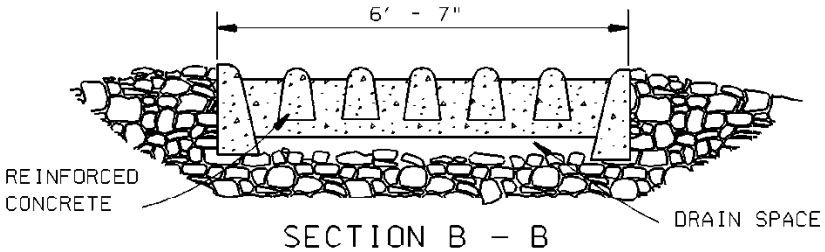
PLAN VIEW



ELEVATION



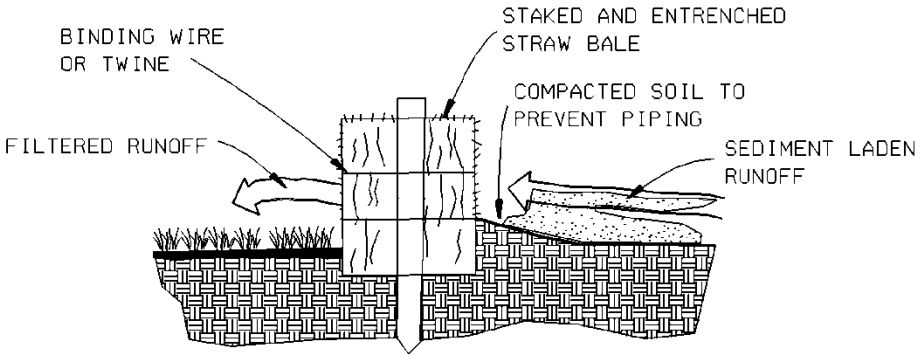
SECTION A - A



SECTION B - B

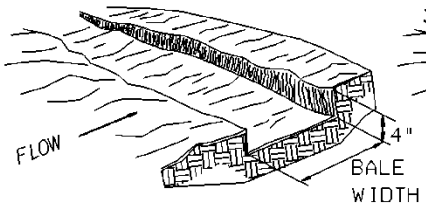
vss302.dgn

STRAW BALE BARRIER - 3.04

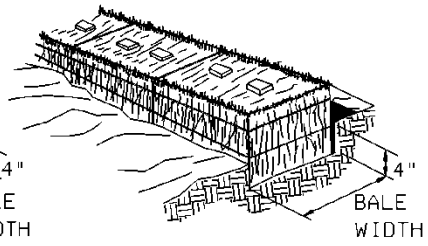


PROPERLY INSTALLED STRAW BALE
CROSS SECTION

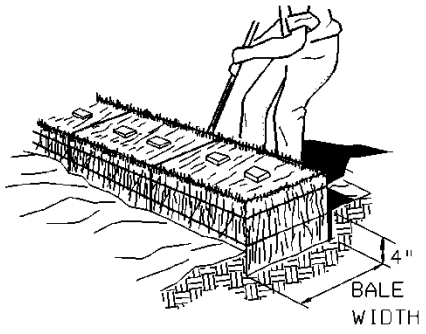
1. EXCAVATE THE TRENCH



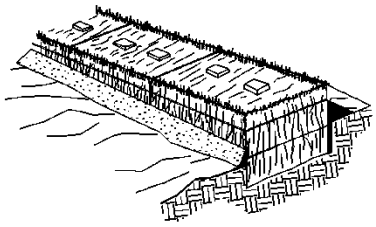
2. PLACE AND STAKE STRAW BALES



3. WEDGE LOOSE STRAW BETWEEN BALES



4. BACKFILL AND COMPACT THE
EXCAVATED SOIL

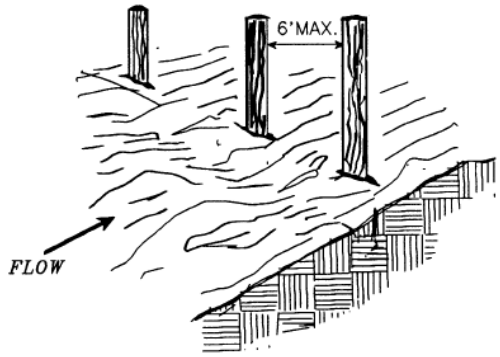


CONSTRUCTION OF STRAW BALE BARRIER

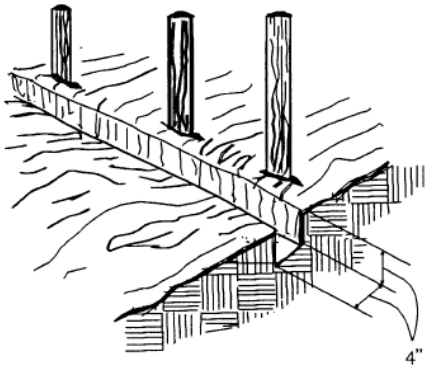
va6304.dgn

CONSTRUCTION OF A SILT FENCE (WITHOUT WIRE SUPPORT)

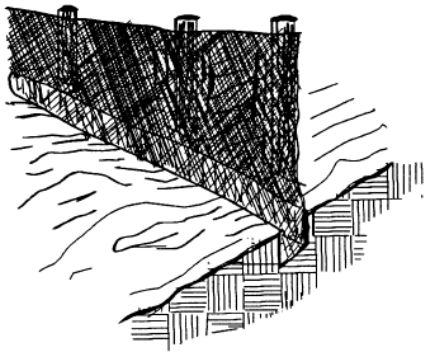
1. SET THE STAKES.



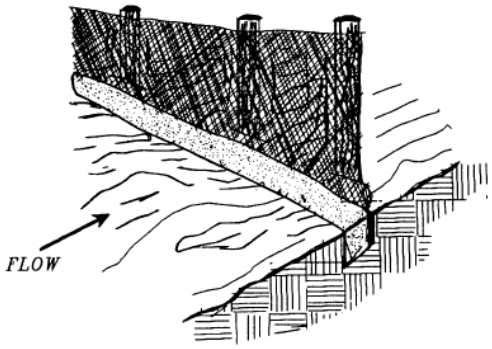
2. EXCAVATE A 4"X 4" TRENCH UPSLOPE ALONG THE LINE OF STAKES.



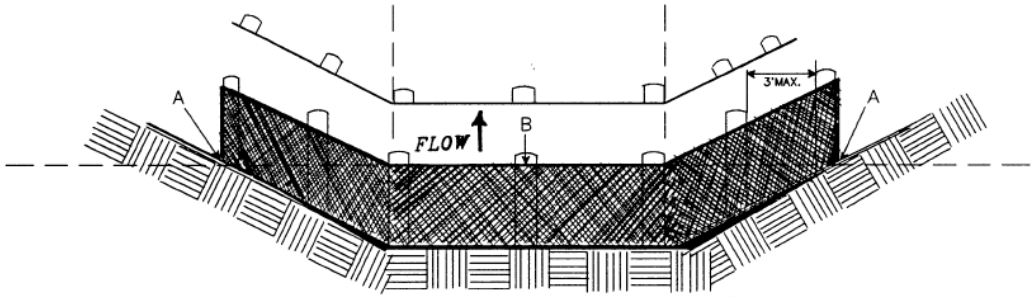
3. STAPLE FILTER MATERIAL TO STAKES AND EXTEND IT INTO THE TRENCH.



4. BACKFILL AND COMPACT THE EXCAVATED SOIL.



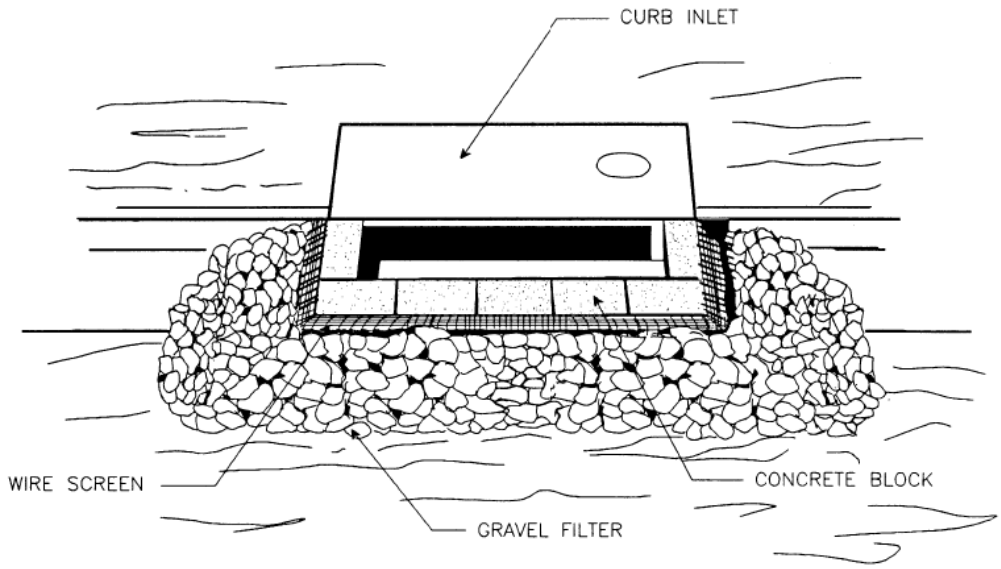
SHEET FLOW INSTALLATION
(PERSPECTIVE VIEW)

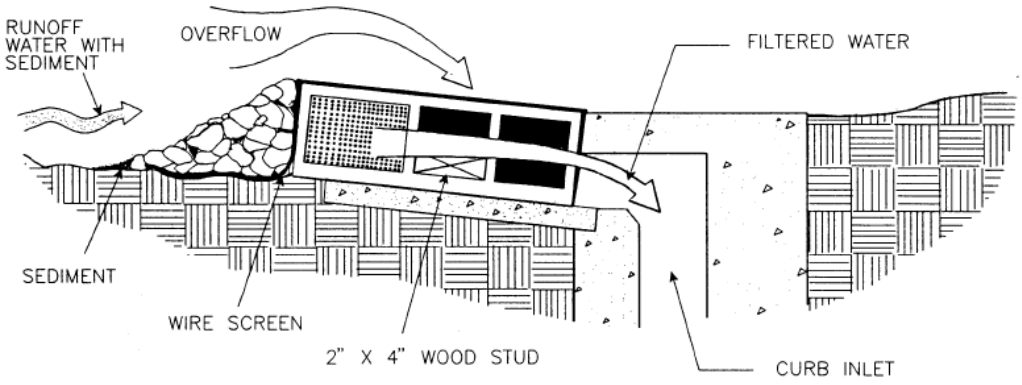


POINTS A SHOULD BE HIGHER THAN POINT B.

DRAINAGEWAY INSTALLATION
(FRONT ELEVATION)

BLOCK & GRAVEL CURB INLET SEDIMENT FILTER



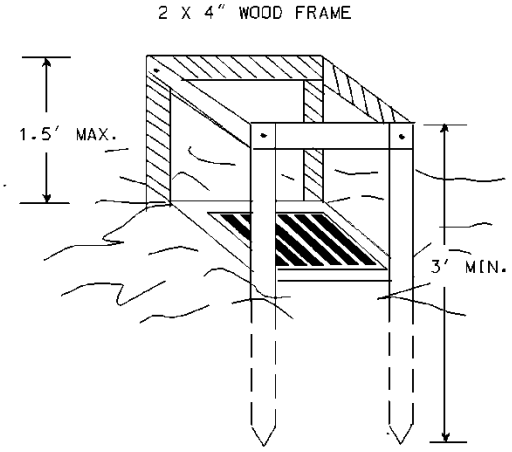


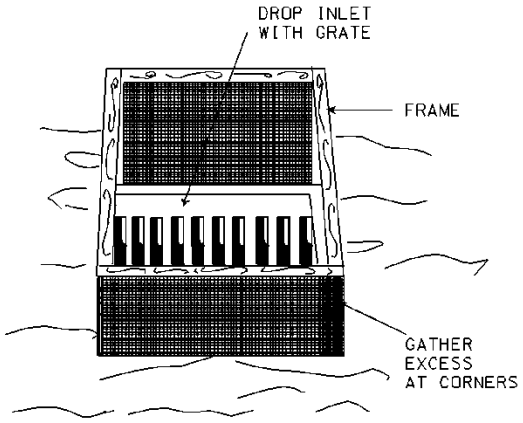
SPECIAL APPLICATION

THIS METHOD OF INLET PROTECTION IS APPLICABLE AT CURB INLETS WHERE AN OVERFLOW CAPABILITY IS NECESSARY TO PREVENT EXCESSIVE PONDING IN FRONT OF THE STRUCTURE.

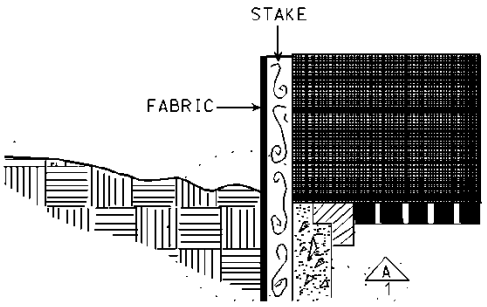
* GRAVEL SHALL BE VDOT #3, #357 OR #5 COARSE AGGREGATE

SILT FENCE DROP INLET PROTECTION - 3.07-1

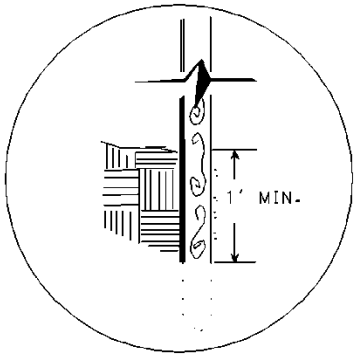




PERSPECTIVE VIEWS



ELEVATION OF STAKE AND FABRIC ORIENTATION

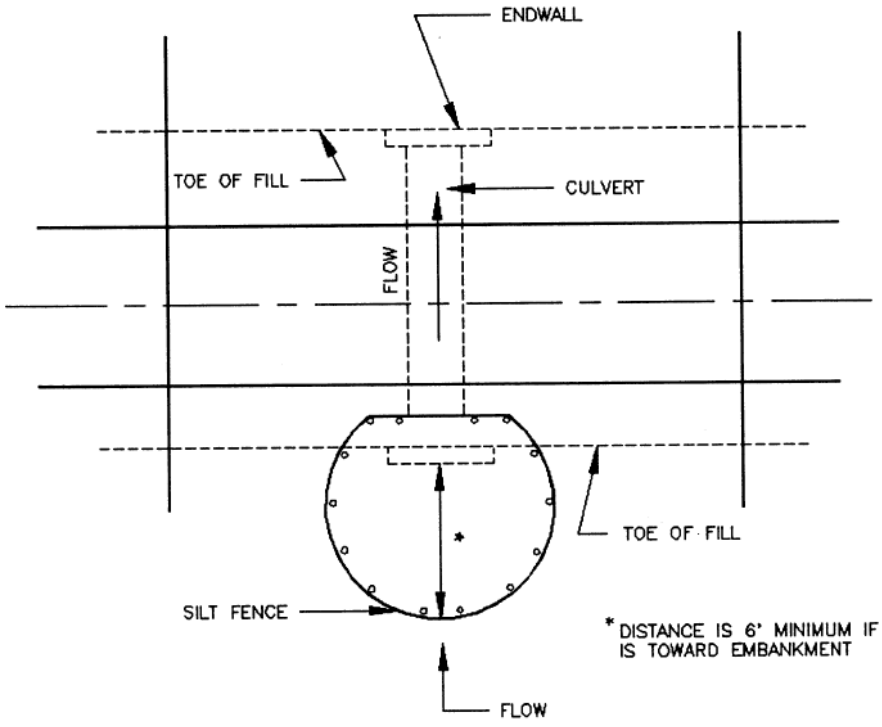


DETAIL A

SPECIFIC APPLICATION

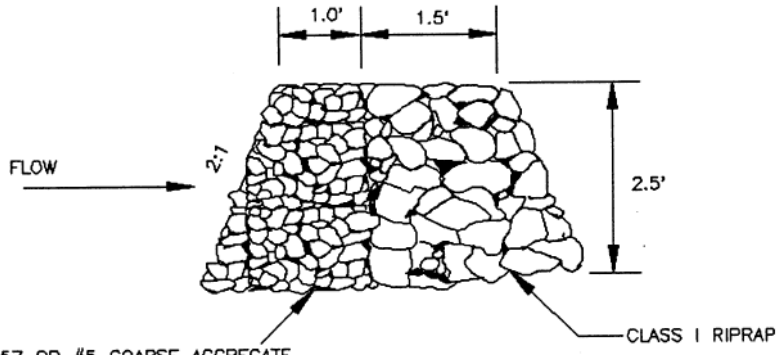
THIS METHOD OF INLET PROTECTION IS APPLICABLE WHERE THE INLET DRAINS A RELATIVELY FLAT AREA (SLOPE NO GREATER THAN 5%) WHERE THE INLET SHEET OR OVERLAND FLOWS (NOT EXCEEDING 1 C.F.S.) ARE TYPICAL. THE METHOD SHALL NOT APPLY TO INLETS RECEIVING CONCENTRATED FLOWS, SUCH AS IN STREET OR HIGHWAY MEDIANS.

SILT FENCE CULVERT INLET PROTECTION



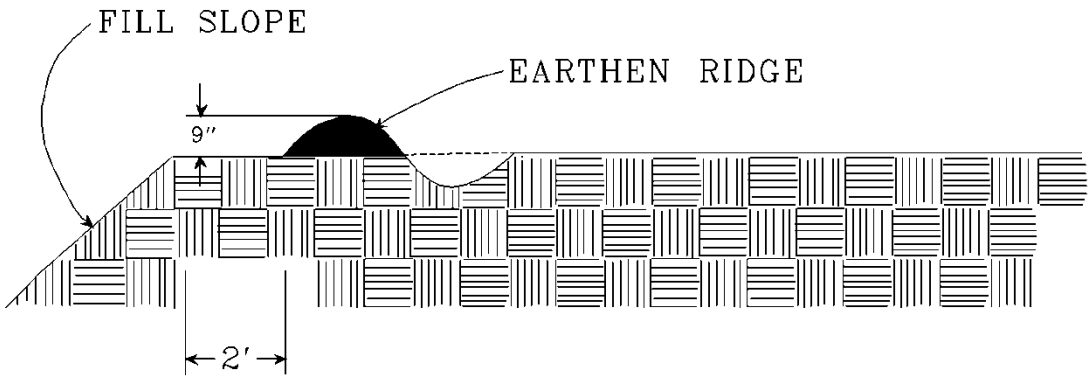
* DISTANCE IS 6' MINIMUM IF FLOW IS TOWARD EMBANKMENT

OPTIONAL STONE COMBINATION **

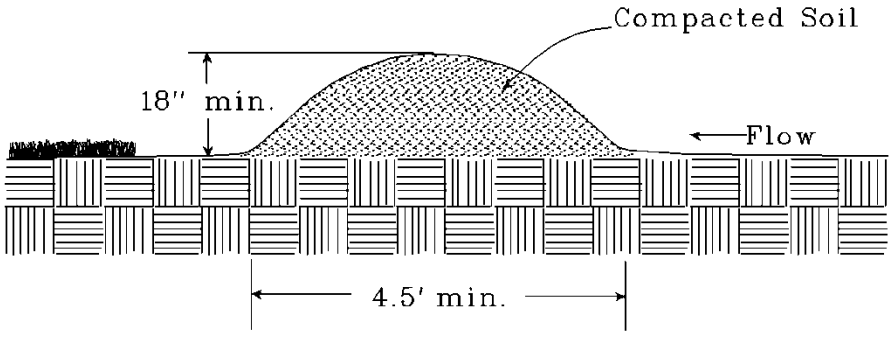


** VDOT #3, #357 OR #5 COARSE AGGREGATE TO REPLACE SILT FENCE IN " HORSESHOE " WHEN HIGH VELOCITY OF FLOW IS EXPECTED

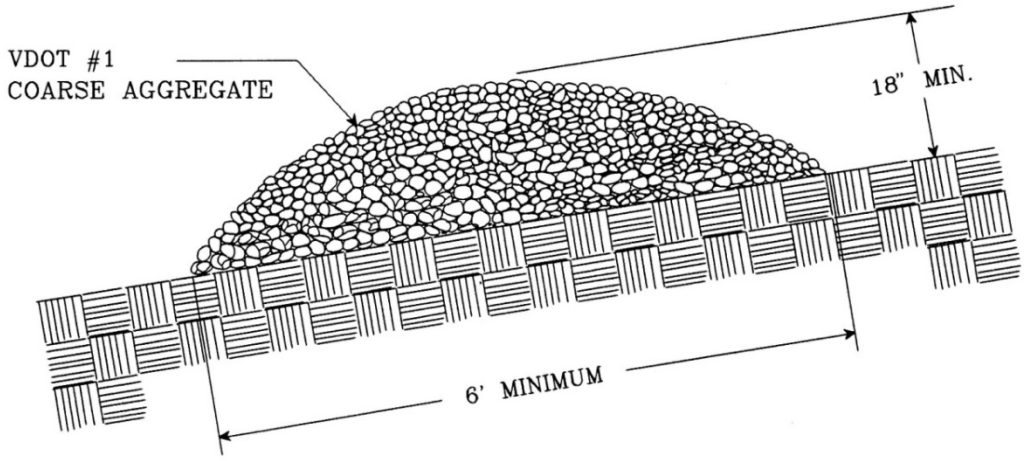
TEMPORARY FILL DIVERSION - 3.10



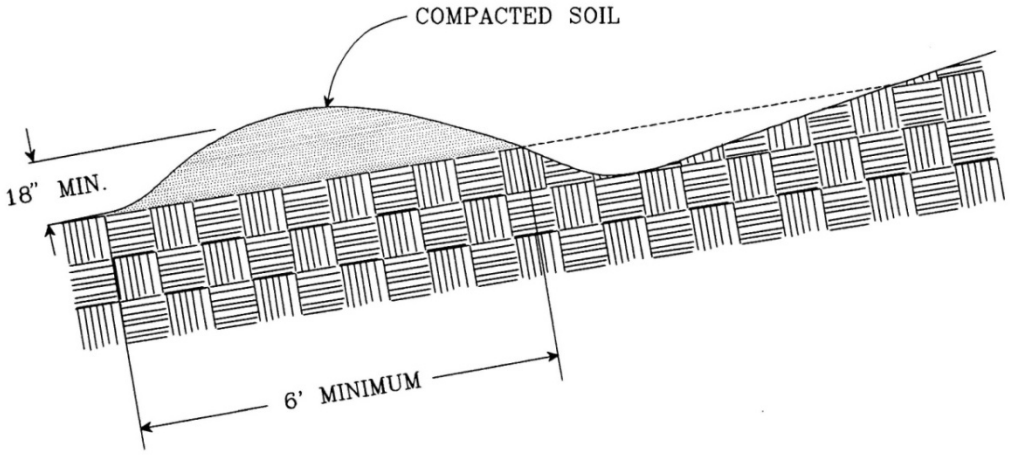
TEMPORARY DIVERSION DIKE - 3.09



TEMPORARY RIGHT-OF-WAY DIVERSIONS

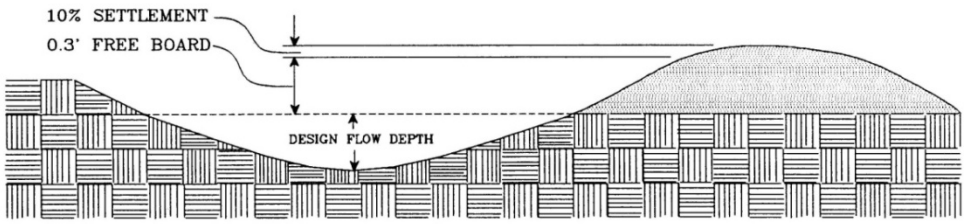


TYPICAL GRAVEL STRUCTURE

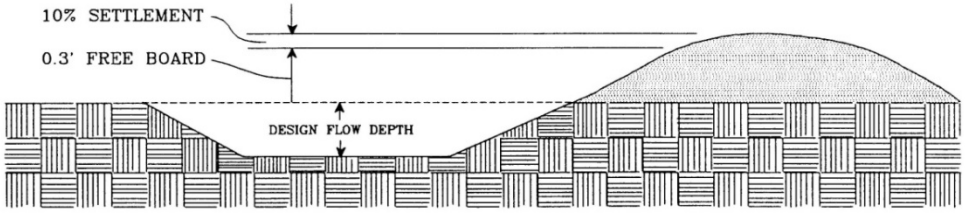


TYPICAL EARTHEN STRUCTURE

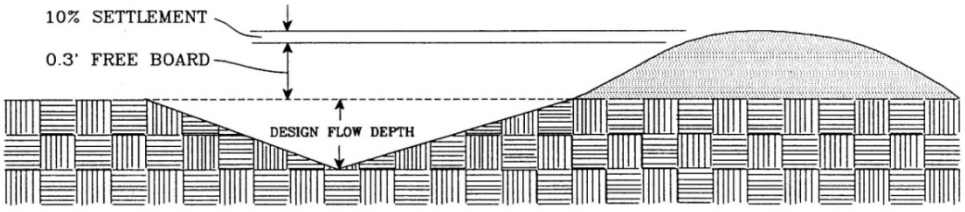
DIVERSIONS



TYPICAL PARABOLIC DIVERSION

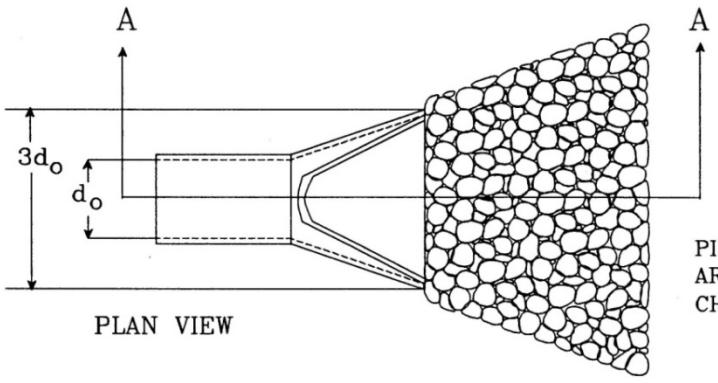


TYPICAL TRAPEZOIDAL DIVERSION



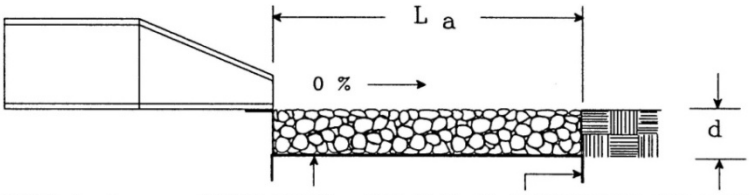
TYPICAL VEE-SHAPED DIVERSION

PIPE OUTLET CONDITIONS



PLAN VIEW

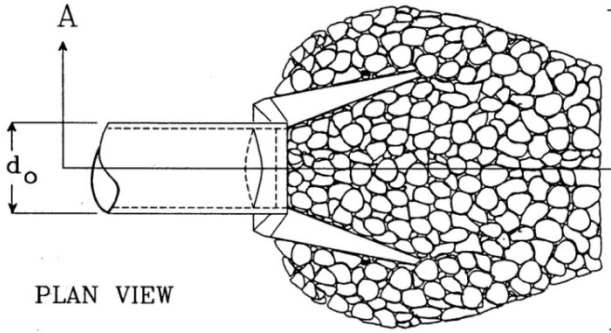
PIPE OUTLET TO FLAT AREA WITH NO DEFINED CHANNEL



SECTION A–A

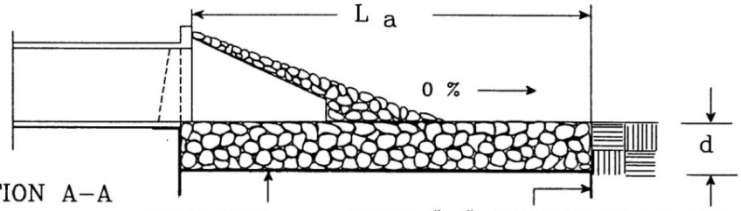
FILTER CLOTH

KEY IN 6"–9"; RECOMMENDED FOR ENTIRE PERIMETER



PLAN VIEW

PIPE OUTLET TO WELL DEFINED CHANNEL



SECTION A–A

FILTER CLOTH

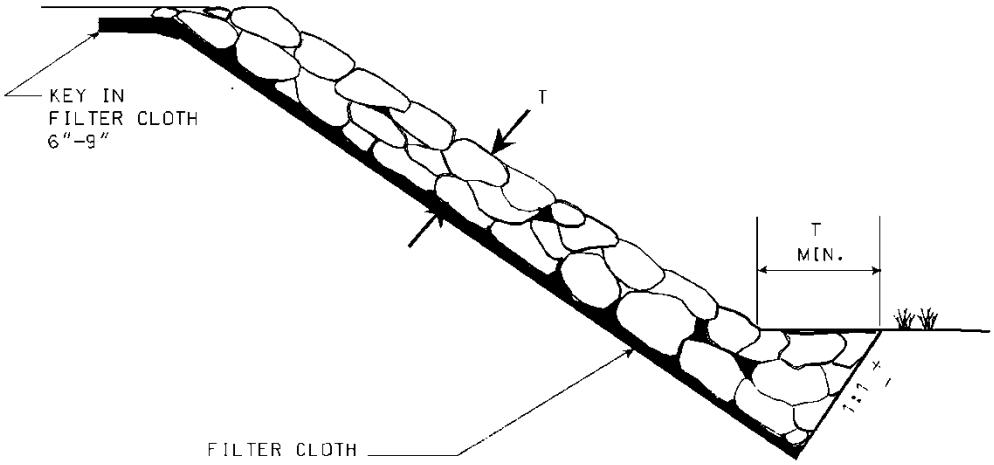
KEY IN 6"–9"; RECOMMENDED FOR ENTIRE PERIMETER

NOTES: 1. APRON LINING MAY BE RIPRAP, GROUTED RIPRAP, GABION BASKET, OR CONCRETE.
2. La IS THE LENGTH OF THE RIPRAP APRON AS CALCULATED USING PLATES 3.18–3 AND 3.18–4.
3. d = 1.5 TIMES THE MAXIMUM STONE DIAMETER, BUT NOT LESS THAN 6 INCHES.

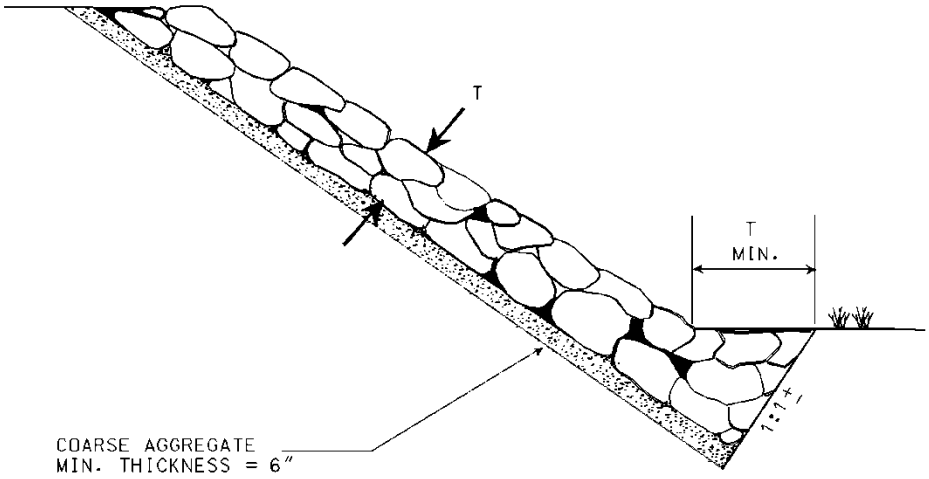
TOE REQUIREMENTS FOR BANK STABILIZATION - 3.19

FILTER CLOTH UNDERLINER

(PREFERRED)

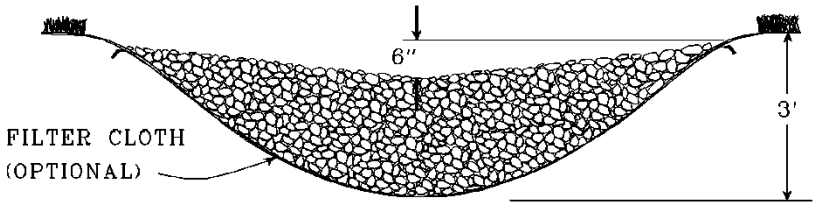


GRANULAR FILTER

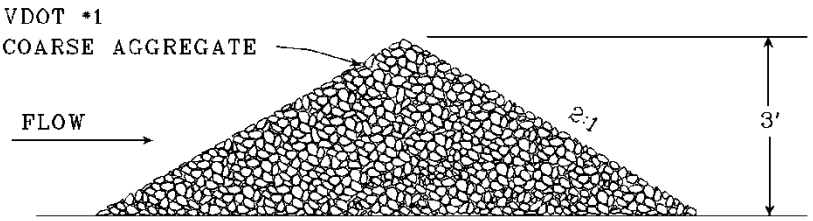


ROCK CHECK DAM - 3.20

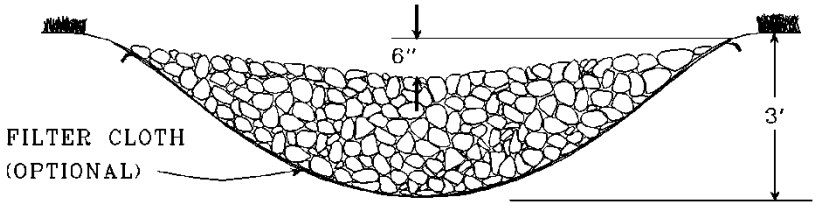
2 ACRES OR LESS OF DRAINAGE AREA:



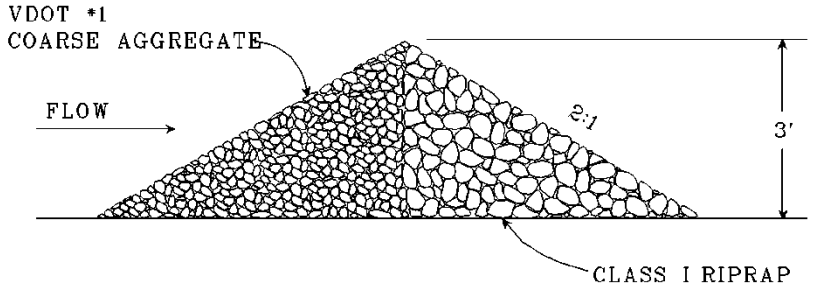
(DOWNSTREAM VIEW)



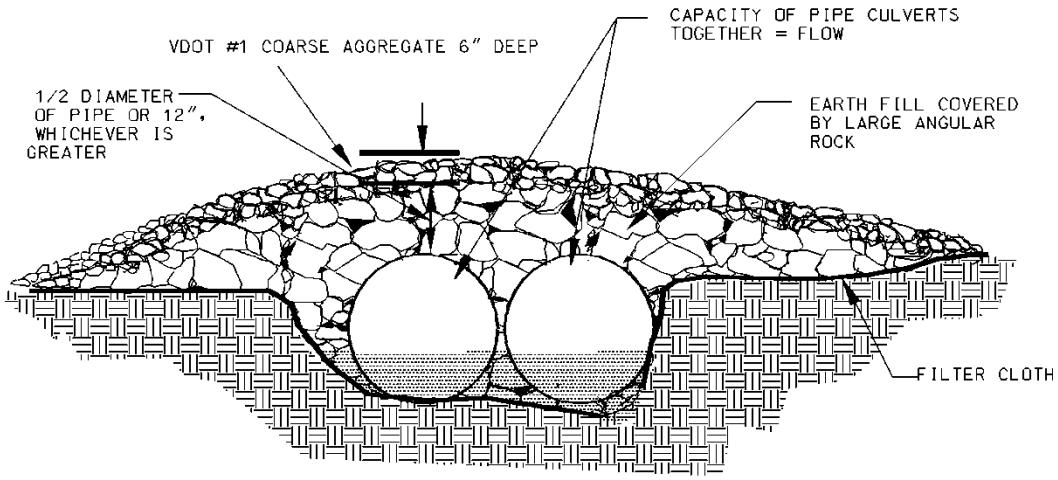
2-10 ACRES OF DRAINAGE AREA:



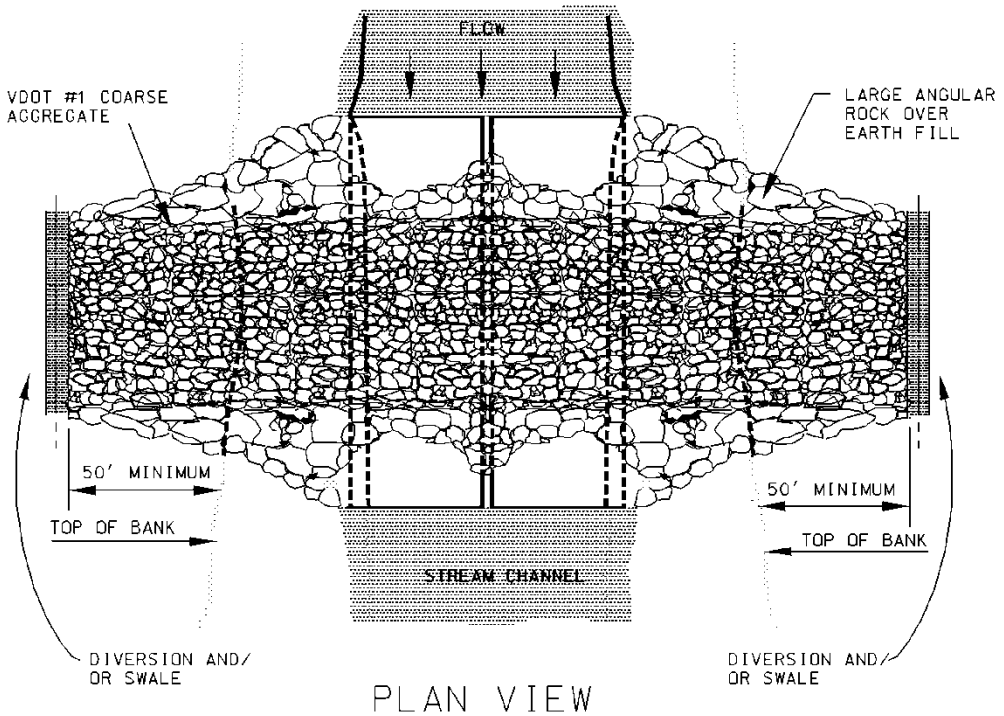
(DOWNSTREAM VIEW)



TEMPORARY CULVERT CROSSING - 3.24

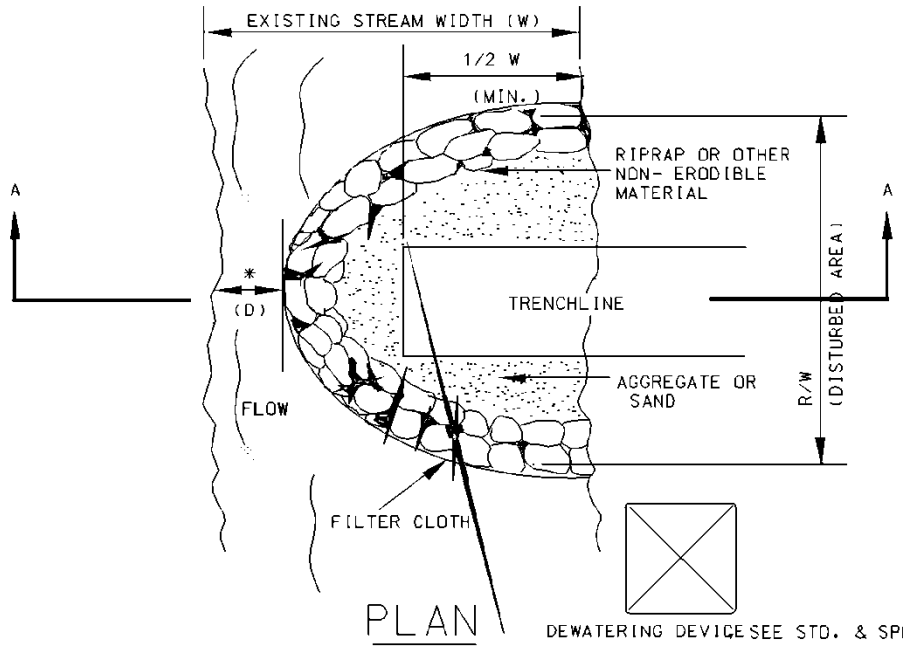


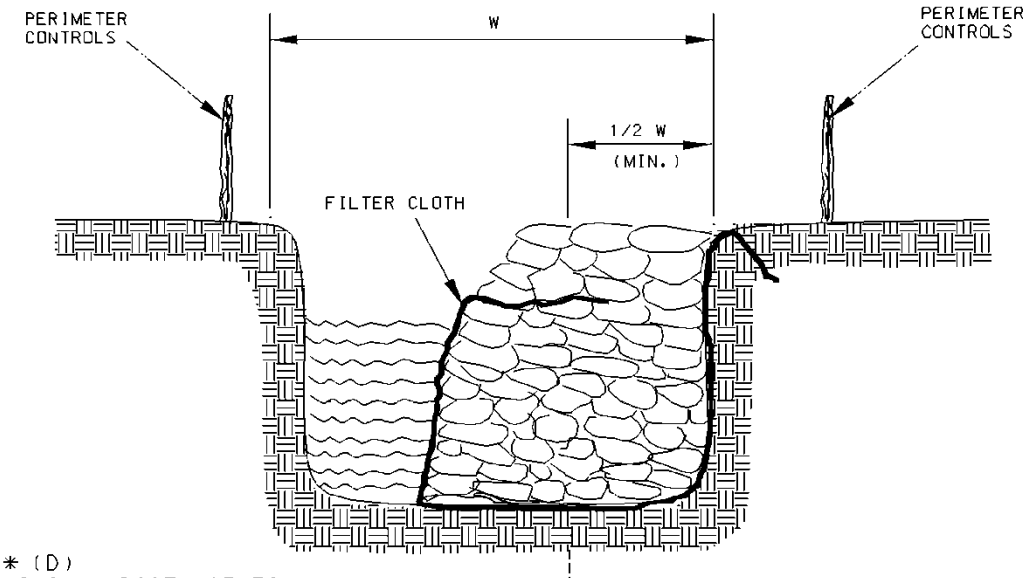
ELEVATION



PLAN VIEW

COFFERDAM CROSSING - 3.25

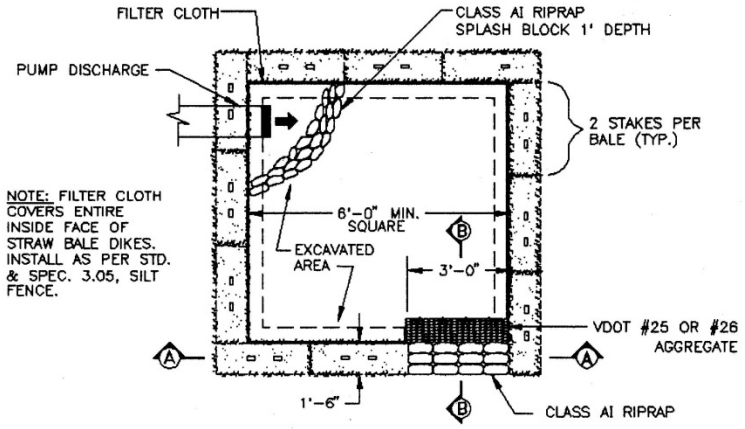




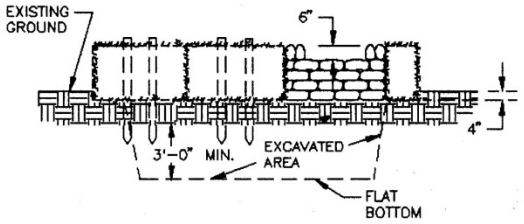
* (D)
MINIMUM DISTANCE TO BE 25% OF TOTAL WIDTH (W) OF THE STREAM.

SECTION A-A

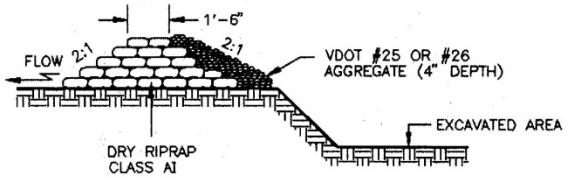
STRAW BALE/SILT FENCE PIT



PLAN VIEW



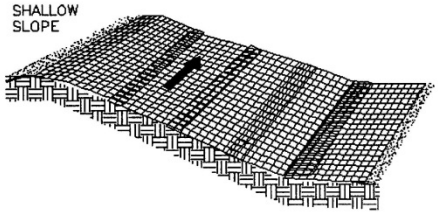
CROSS-SECTION A-A



CROSS-SECTION B-B

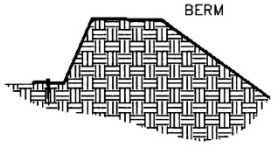
TYPICAL ORIENTATION OF TREATMENT – 1 (SOIL STABILIZATION BLANKET)

SHALLOW SLOPE

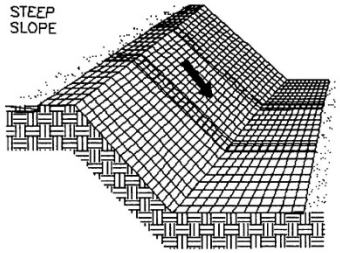


ON SHALLOW SLOPES, STRIPS OF NETTING PROTECTIVE COVERINGS MAY BE APPLIED ACROSS THE SLOPE.

WHERE THERE IS A BERM AT THE TOP OF THE SLOPE, BRING THE MATERIAL OVER THE BERM AND ANCHOR IT BEHIND THE BERM.

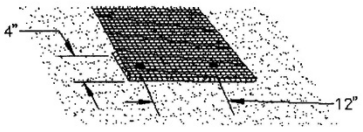


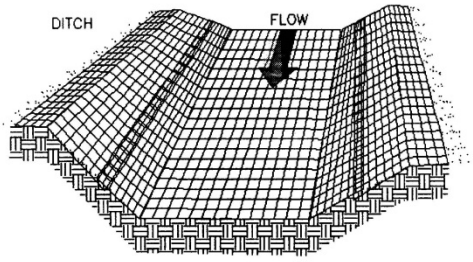
STEEP SLOPE



ON STEEP SLOPES, APPLY PROTECTIVE COVERING PARALLEL TO THE DIRECTION OF FLOW AND ANCHOR SECURELY.

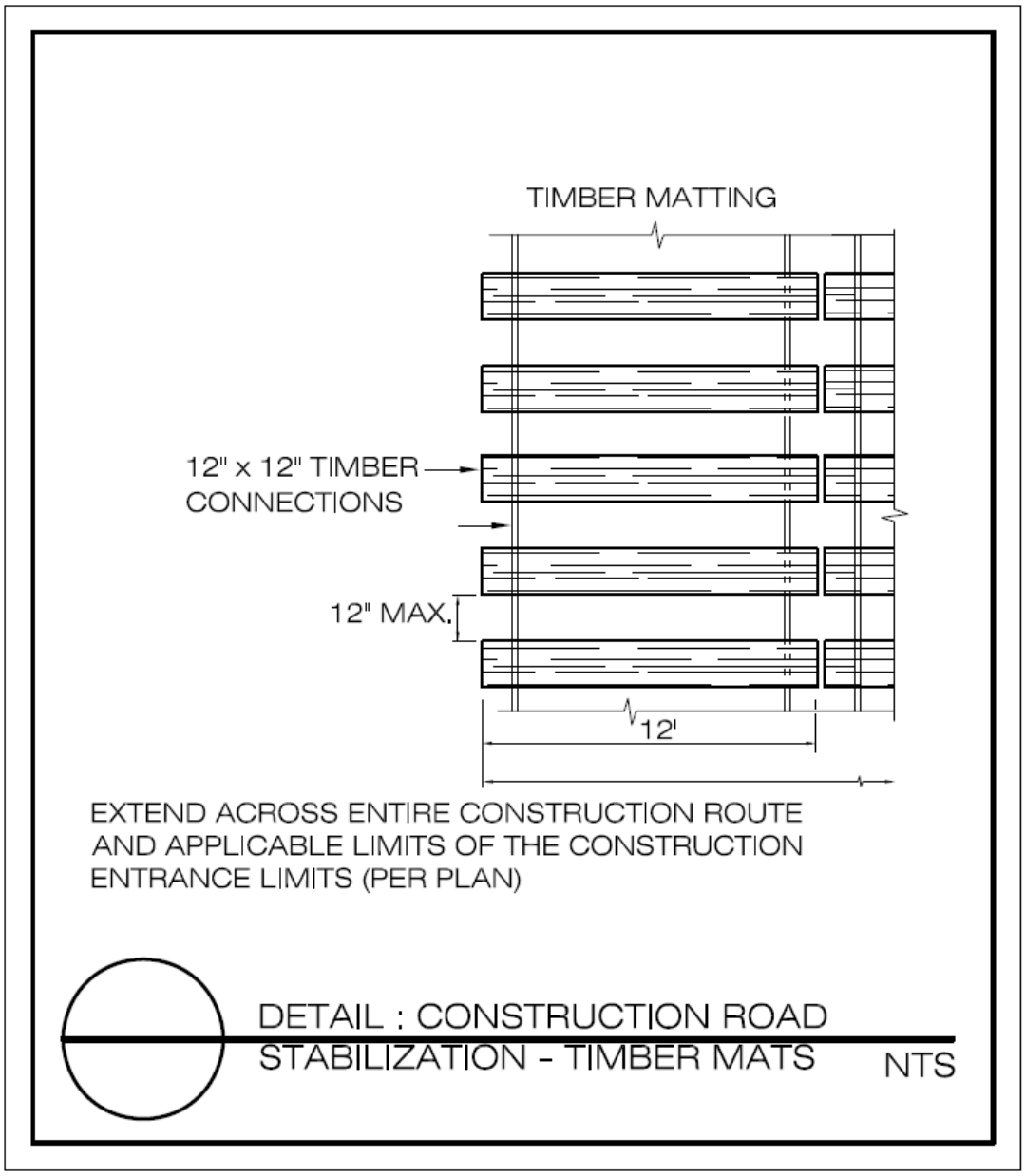
BRING MATERIAL DOWN TO A LEVEL AREA BEFORE TERMINATING THE INSTALLATION. TURN THE END UNDER 4" AND STAPLE AT 12" INTERVALS.





IN DITCHES, APPLY PROTECTIVE COVERING PARALLEL TO THE DIRECTION OF FLOW. USE CHECK SLOTS AS REQUIRED. AVOID JOINING MATERIAL IN THE CENTER OF THE DITCH IF AT ALL POSSIBLE.

TIMBER MAT STABILIZATION



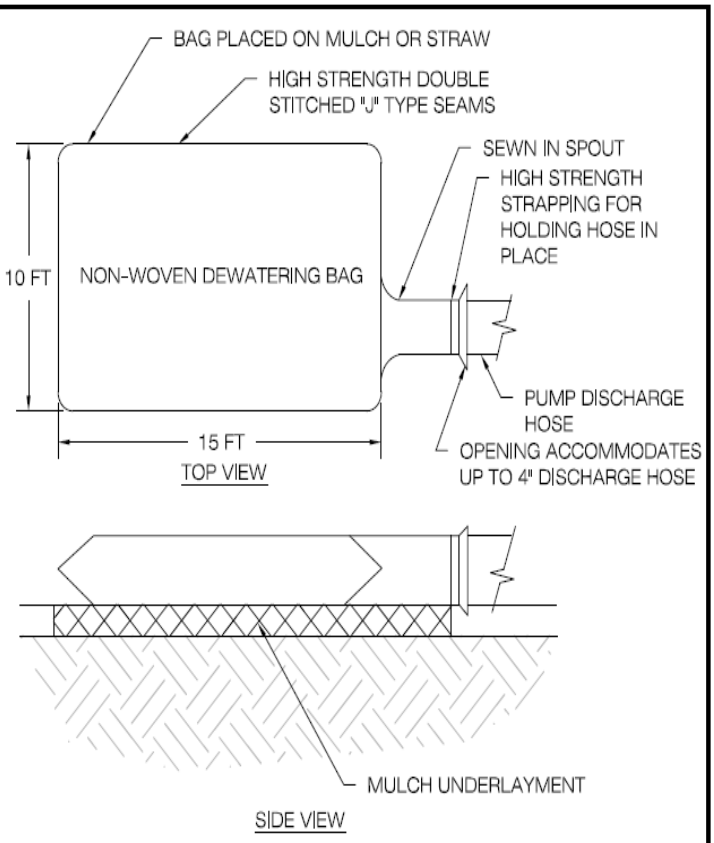
GEOTEXTILE/DEWATERING BAG

THE DEWATERING BAG SHALL BE MADE OF NON-WOVEN GEOTEXTILE WITH A MIN. SURFACE AREA OF 225 SQUARE FEET PER SIDE. ALL STRUCTURAL SEEMS SHALL BE SEWN WITH A DOUBLE STITCH USING A DOUBLE NEEDLE MACHINE WITH HIGH STRENGTH THREAD. THE SEAM STRENGTH SHALL WITHSTAND 100 LB/IN USING ASTM D-4884 TEST METHOD, THE DEWATERING BAG SHALL HAVE A NOZZLE LARGE ENOUGH TO ACCOMMODATE A FOUR INCH DISCHARGE HOSE, THE NOZZLE SHALL BE SEALED TIGHTLY AROUND THE DISCHARGE HOSE WITH A STRAP OR SIMILAR DEVICE TO PREVENT UNTREATED WATER FROM ESCAPING, THE GEOTEXTILE FABRIC SHALL BE A NON-WOVEN FABRIC WITH THE FOLLOWING PROPERTIES:

GEOTEXTILE FABRIC FOR DEWATERING BAG			
PROPERTIES	TEST METHOD	UNITS	DEWATERING BAG 12 OZ
WEIGHT	ASTM D-3776	OZ/YD	12
GRAB TENSILE	ASTM D-4632	LBS.	300
PUNCTURE	ASTM D-4833	LBS.	175
FLOWRATE	ASTM D-4491	GAL/MIN/FT2	70
PERMITIVITY	ASTM D-4491	1.3 SEC-1	1
MULLEN BURST	ASTM D-3786	LBS.IN2	580
UV RESISTANT	ASTM D-4355	%	70
AOS % RETAINED	ASTM D-4751	0.40-0.80 MM	100

NOTE:
ALL PROPERTIES ARE MINIMUM AVERAGE ROLL VALUE EXCEPT THE WEIGHT OF THE FABRIC WHICH IS GIVEN FOR INFORMATION ONLY.

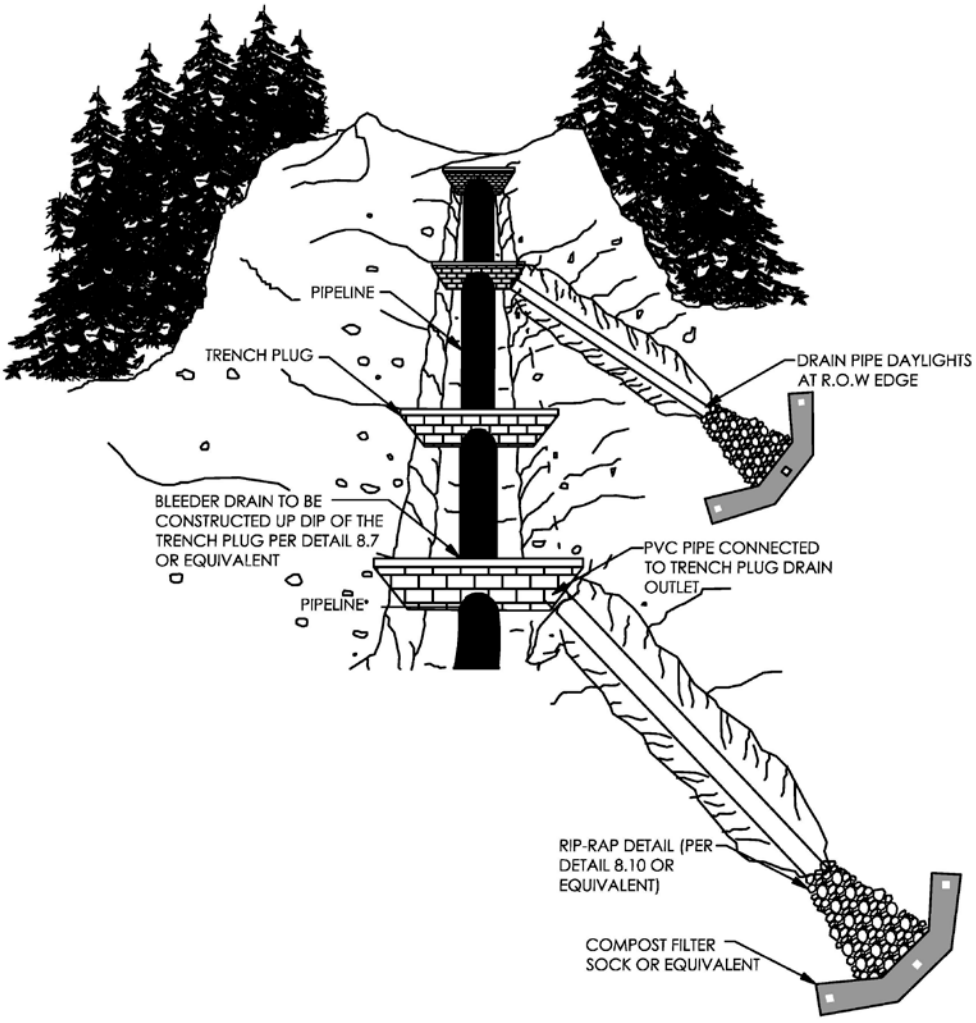
CONSTRUCTION:
THE DEWATERING BAG SHALL BE INSTALLED OVER A 3 INCH GRAVEL BASE TO PROMOTE INFILTRATION AND DEWATERING OF THE BAG.



DETAIL: GEOTEXTILE BAG (DEWATERING BAG)

NTS

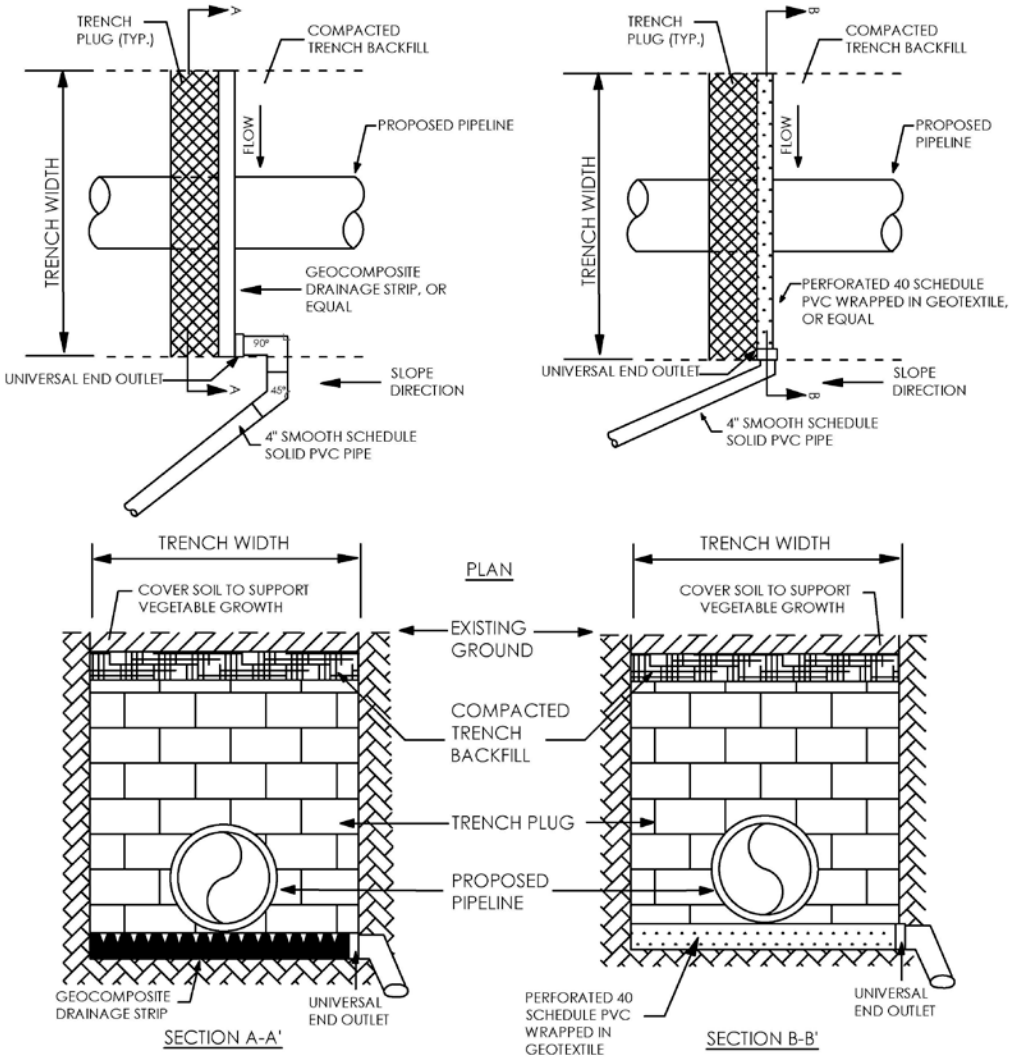
Where trenching activities are proposed in high slip potential soils and in areas where existing ground slopes are greater than 3:1, bleeder drains shall be installed to passively drain water from the trench area. The following illustration shows a drain placed at every second trench plug.



NOT TO SCALE

SLIP PREVENTION: BLEEDER DRAIN AND OUTLET DETAIL

Two (2) types of trench plug drains are illustrated below. Geocomposite Drainage Strips or Perforated Schedule 40 PVC placed behind the trench plug and below the pipeline are effective ways to passively drain water. Both methods show Schedule 40 PVC discharge pipe at a minimum of a 2% grade.



NOT TO SCALE

SLIP PREVENTION: TRENCH PLUG DRAIN DETAILS

APPENDIX B

Stormwater Management

SWM Plan Checklist

1. STORMWATER MANAGEMENT

The intent of the Virginia Stormwater Management Program (VSMP) regulations is to improve water quality through runoff reduction and other stormwater control practices and establish water quantity requirements. The baseline level for the stormwater technical criteria is a forested/open space condition.

Under 9 VAC 25-870, regulated land-disturbing activities are required to meet the stormwater technical criteria for water quality and water quantity metrics as outlined in Part IIB. The water quality and quantity criterion are largely directed at avoiding, minimizing and mitigating impacts due to changes in hydrology and stormwater pollutant loads associated with changes in land cover. Each project will be reviewed to evaluate consistency with DEQ Guidance Memorandum No. 15-2003. The guidance memorandum stipulates a number of conditions which must be satisfied for linear utility projects if a Stormwater Management Plan will not be required. Specifically, the following conditions must be satisfied:

- The project does not significantly alter the predevelopment runoff characteristics of the land surface after the completion of construction and final stabilization.
- The project is managed so that less than one (1) acre of land disturbance occurs on a daily basis.
- The disturbed land where work has been completed is adequately stabilized on a daily basis.
- The environment is protected from erosion and sedimentation damage associated with the land-disturbing activity.
- The owner and/or construction activity operator designs, installs, implements and maintains pollution prevention measures to:
    - *Minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other wash waters;*
    - *Minimize the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, pesticides, herbicides, detergents, sanitary waste, and other materials present on-site to precipitation and to stormwater;*
    - *Minimize the discharge of pollutants from spills and leaks and implement chemical spill and leak prevention and response procedures;*
    - *Prohibit the discharge of wastewater from the washout of concrete;*
    - *Prohibit the discharge of wastewater from the washout and cleanout of stucco, paint, form release oils, curing compounds, and other construction materials; and*

- *Prohibit the discharge of fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance.*

- DETI must provide reasonable assurance to DEQ that all of the above conditions will be satisfied. **This may be accomplished by incorporating these conditions into an Erosion and Sediment Control Plan developed for the project.**

Right-of-ways must be maintained in a Forest/Open Space condition consistent with the Virginia Runoff Reduction Method Instructions & Documentation, which stipulate that rights-of-way considered as Forest/Open space must be restored to a hydrologically functional state and "be left in a natural vegetated state (can include areas that will be bush hogged no more than four times per year)," in accordance with Table 1 of the Virginia Runoff Reduction Method (VRRM) Instructions and Documentation. The forestry and vegetative management practices employed by DETI within the right-of-way comply with the VRRM recommendations for open space. Where the right-of-way consists of forest or open space conditions prior to the construction activity, and will remain in a forested or open space condition under post-developed conditions (e.g. undisturbed or restored to a hydrologically functional state and all surfaces will remain as permeable surfaces which are mowed no more than once every three years, in accordance with FERC Plan Guidelines or maintained in accordance with Table 1 referenced above), runoff curve numbers are identical under the Virginia Runoff Reduction Method. DETI may be required to provide documentation to DEQ of water quantity analysis, and may be required to document consistency with and applicability of DEQ Guidance Memorandum No. 15-2003.

DETI will submit project information to DEQ for preliminary review of whether a SWM plan is required (see Section 1.0 of Main Document). Department of Environmental Quality (DEQ) Guidance Memo No. 15-2003 (Appendix F) addresses this for linear development projects in stating, "…the construction of aboveground or underground utilities may not result in changes to the predevelopment runoff characteristics of the land surface after the completion of construction and final stabilization." The guidance memorandum goes on further to state that, "If the project will not result in significant changes to the predevelopment runoff characteristics after the completion of construction and final stabilization…," the requirement for a CGP permit may be waived (this would be separate from the more general exemptions for oil and gas transmission described in Section 1 of the main document). DEQ will review preliminary project information to advise DETI whether a SWM plan is required.

For projects requesting waiver of Stormwater Plan, DEQ requires information to be submitted that reasonably demonstrates that the project will not significantly change the predevelopment runoff characteristics of the land surface after the completion of construction and final stabilization. Information submitted to DEQ may include:

- Pre- and post-construction drainage areas and land cover conditions.

- Limits of disturbance
- Methodology for the restoration of land cover conditions to predevelopment conditions.
- ESC Plan excluding 9VAC25-840-40.19.m. & n. (The full Erosion and Sediment Control Plan would be available later in the process, after the preliminary review discussed above and in Section 1 of the main document).

If DEQ determines that the project meets the criteria for granting a waiver, then DEQ will waive the requirement for the preparation and implementation of a stormwater management plan. This waiver allows the recipient to exclude the following regulatory sections:

- SWM Quality – 9VAC25-870-63 and -65
- SWM Quantity – 9VAC25-870-66
- ESC MS-19 – 9VAC25-840-40.19.m. & n.

Information shall be submitted to DEQ Central Office for review with a transmittal letter specifically requesting a SWM Plan waiver. DEQ, as the VSMP Authority, will evaluate each project on an individual basis.

If DEQ waives the requirement for a SWM plan, DETI will utilize the DEQ linear projects guidance and will incorporate the conditions stipulated in GM 15-2003 into the Erosion and Sediment Control plan for the project (See *Additional Note*s in Appendix E).

Each project must be reviewed by a certified SWM Plan Reviewer (qualifications described in Section 2 of the main document) to verify exemption. In certain instances, a project may have an element which does result in significant change to predevelopment runoff characteristics after the land-disturbing activity is completed. In those instances, (generally where the addition of impervious surfaces or conversion of forest to managed turf in combination are expected to cause significant changes in predevelopment runoff characteristics), a SWM plan must be prepared, reviewed, approved, and implemented in accordance with 9VAC25-870 and 9VAC25-880 (if applicable).

DETI access roads will be grouped into four categories based on the extent of improvements required to prepare the road for use to support the project. Depending on the improvements, the impact on stormwater runoff characteristics will range from no expected impact to a material impact. Specifically, the four categories are defined below; all access roads, or access road segments, will be assigned a category that is depicted on the corresponding alignment sheet and access road plans.

1. Existing road with no improvements proposed – includes those existing roads that are in a condition such that no improvements are needed to prepare the road for use to support the project (e.g., asphalt surfaced roads).

2. Existing road with minor improvements proposed – includes those existing roads that contain either a compacted earth or gravel surface and the current road configuration (i.e., width, grade, etc.) is adequate to support the project. Roads in this category may receive supplemental gravel to improve the surface condition; however, the footprint of the road would not be expanded (i.e., no additional impervious surface).

3. Existing road with major improvements proposed – includes those existing roads that will receive an expanded footprint (i.e., the impervious surface post-construction may exceed that existing preconstruction) in order to prepare the road for use to support the project.

4. New road – includes roads not located within the limits of an existing road.

Access roads in categories 2, 3 and 4 will involve varying degrees of land disturbance, and thus appropriate erosion and sediment controls (e.g., sediment barriers) will be identified and depicted on the plans. No Post-construction stormwater management criteria will apply to categories 1 & 2 because the roads are existing and there is no additional impervious surface. Access roads in categories 3 and 4 may also require drainage improvements (e.g.,
road side ditches and ditch relief culverts). The general approach to locating sediment barriers along access roads will be to provide sediment barriers when a resource (e.g., wetland, waterbody) is downgradient of and within 200 feet of an access road.

Access roads in categories 3 and 4 involve improvements that are expected to result in a material change to the existing stormwater runoff characteristics as a result of the addition of impervious surface. These access roads must meet the Stormwater management requirements for quality and quantity.

Access roads in categories 3& 4 will be identified as to whether they are temporary (meant to serve the project initial construction and then removed and restored after construction is complete) or permanent.

Temporary access roads will be restored/rehabilitated to establish a firm stand of erosion-resistant vegetation and restored to a hydrologically functional state prior to completion of the project. All non-porous stone surfacing will be removed and porous stone ballast will be removed where it impedes infiltration. Any defined ditches or topographic alterations which significantly alter predevelopment runoff characteristics will be graded and topsoiled to match pre-development drainage patterns and avoid concentration of runoff. In accordance with the maintenance guidelines herein, these vegetated areas will be mowed no more than four times per year and will be considered open space. For FERC 7c projects, soils restoration will follow the FERC plan and procedures and will typically include provisions for Soil Restoration, Soil Compaction, Topsoil Segregation, Replacement and Soil Conditioning, and Re-Contouring.

In some instances, permanent access roads may be required for the construction or long-term maintenance and operation of the utility infrastructure. Each instance where a permanent access road is proposed will be reviewed for consistency with stormwater quality and quantity requirements. If DETI is of the opinion that the increases in runoff relative to pre-development conditions are not significant, DETI may request an exception from the stormwater management criteria from DEQ. A request for an exception must demonstrate that the request is in accordance with the provisions for exceptions in the VSMP regulations (9VAC25-870-57 & 9VAC25-870-122) and that the activity avoids and minimizes impacts to stormwater runoff. DEQ will scrutinize each exception request, so early coordination is advised.

2. TECHNICAL REQUIREMENTS

2.1 WATER QUALITY

Part IIB of the stormwater regulations states that the total phosphorous load will not exceed 0.41-pound per acre per year (lb./ac/yr.) for new development activities. The Land Cover Guidance for the VRRM defines provides for certain areas (including "Utility rights-of-way that will be left in a natural vegetated state") under certain operational conditions to be considered forested/open space and not as managed turf for the purposes of stormwater quality and quantity compliance. In accordance with the above, DETI will coordinate with DEQ on the applicability of GM15-2003 and whether a SWM plan is required. If a SWM plan is required (e.g. due to significant changes to predevelopment runoff characteristics, or other requirements which trigger the need for CGP coverage or post-construction SWM), DETI must develop and implement a SWM plan consistent with the applicable requirements of 9VAC25-870 and 9VAC25-880. The VRRM Spreadsheet is a tool which regulated entities may use to document general water quality planning and consistency with the technical requirements of 9VAC25-870 (et seq).

2.2 WATER QUANTITY

As identified in the VSMP regulations, the technical criteria for water quantity are designed to ensure the protection of State waters from the potential harm of unmanaged stormwater runoff. This is generally achieved through the incorporation of techniques to address localized flooding and the protection of downstream channels. The specific technical criteria to be applied for water quantity analysis and compliance are contained in 9VAC25-870-66.

2.2.3 PRIOR DEVELOPED LANDS

As noted previously, DETI will provide for an initial evaluation of each project to ascertain whether the project may be exempt from CGP permit coverage and whether there is a significant

change in predevelopment runoff characteristics that might trigger the need for a Stormwater Management Plan and associated controls (pursuant to GM15-2003). DETI will obtain concurrence from DEQ early in the process if a SWM plan is not required pursuant to GM15-2003. Permanent facilities with significant impervious cover (such as compressor stations) are expected to provide for a stormwater management plan and associated controls if needed, even though these facilities may remain exempt from permit coverage. For portions of pipeline easements which traverse prior developed lands (e.g. under turf-intensive uses such as ballfields, or under existing parking lots or road segments), DETI does not expect to provide improvements to existing runoff conditions if predevelopment conditions are restored. DEQ has clarified that it is not their expectation that permanent best management practices be installed on restored right-of-way. As discussed earlier, DEQ will review the overall project (at an early stage), including soil restoration conditions, to identify whether SWM plan preparation is waived for these activities.

Where predevelopment land cover conditions are changed significantly triggering requirements for post construction stormwater quality and quantity requirements, post-construction Best Management Practices (BMPs) may be required to comply with water quality and water quantity criteria and MS-19 of the Erosion and Sediment Control Regulations. In such instances, the outfall within the project must comply with Part IIB or Part IIC (where applicable) of the stormwater regulations to assess compliance. This may include the "Energy Balance" method described by item B.3.a of 9VAC25-870-66. In these instances, water quantity criteria for flood control and channel protection must be addressed and managed through the preparation of a SWM plan consistent with 9VAC25-870 and 9VAC25-880.

These Annual Standards and Specifications for ESC and SWM also assist in meeting the standards of the Federal Energy Regulatory Commission (FERC) Upland Erosion Revegetation and Maintenance Plan (Plan) and the FERC Wetland and Waterbody Construction and Mitigation Procedures (Procedures). DETI and its construction contractors must implement this plan as appropriate for all construction in Virginia unless a variance to the Virginia Erosion and Sediment Control Regulations has been submitted to and granted approval by the DEQ.

3. STORMWATER MANAGEMENT BMPS

Stormwater Management BMPs used for consistency with these specifications should be approved by DEQ and contained in the Virginia Stormwater BMP Clearinghouse. For projects requiring post-construction SWM BMPs, DETI must report the following annually each year to DEQ:

Number and types of SWM BMPs installed;

Geographic coordinates of each BMP;

Drainage area or watershed size served; and

Receiving stream or hydrologic unit.

4. STORMWATER MAINTENANCE

Each project plan must be reviewed by certified personnel described in Section 2 (main document) to ascertain whether the specific project is exempt from post-construction stormwater quality and quantity requirement, or whether SWM planning is required (with DEQ concurrence). If post-construction SWM is required, non-structural BMPs allowed by the permit will be the preferred option. A maintenance plan for both the non-structural and any additional structural BMPs must be developed to ensure compliance with requirements for routine inspection or reporting in the Virginia Stormwater BMP Clearinghouse specifications. Maintenance requirements for non-structural BMPs must be identified and incorporated into inspection documentation during routine patrolling of the right-of-way by certified personnel. Any structural BMPs would require a more formal inspection. Each stormwater management facility will be inspected by DETI, as the owner of the facility, at least once every five years; and all inspections will be documented. Corrective measures must be carried out as soon as practicably feasible when needed. Long-term maintenance of structural SWM facilities must be conducted in accordance with 9VAC25-870-112. To be consistent with the provisions of 9VAC25-870-112, maintenance plans for the stormwater facilities must be submitted to DETI for formal review and approval prior to initiating the land disturbing activity, made available to DEQ upon request, and must provide for inspections and maintenance and the submission of inspection and maintenance reports to the DEQ. DETI transmission easements over land under which permanent stormwater management facilities will be placed must further assure the following:

- Be stated to run with the land;
- Provide for all necessary access to the property for purposes of maintenance and regulatory inspections;
- And, be enforceable by all appropriate governmental parties.

5. INSPECTIONS FOR STORMWATER MANAGEMENT

DETI or its designated representative will continue to be responsible for periodic inspections for compliance with the CGP, if required, erosion and sediment control regulations and any FERC Certificate. Certified personnel, as outlined in Section 2 of the main document, must conduct all inspections.

Inspections for compliance with the SWPPP (and relevant SWM and ESC elements) must occur in accordance with the following:

Inspections must be conducted at the following frequency:

(1) At least once every five business days; or

(2) At least once every 10 business days and no later than 48 hours following a measurable storm event. In the event that a measurable storm event occurs when there are more than 48 hours between business days, the inspection must be conducted no later than the next business day.

A measurable storm event means a rainfall event producing 0.25 inches of rain or greater over 24 hours. Where areas have been temporarily stabilized or land-disturbing activities will be suspended due to continuous frozen ground conditions and stormwater discharges are unlikely, the inspection frequency may be reduced to once per month. If weather conditions (such as above freezing temperatures or rain or snow events) make discharges likely, the operator must immediately resume the regular inspection frequency.

DETI's SWPPP inspections will be conducted by Certified Personnel as identified in Section 2 and will serve also as the periodic inspections.

For projects discharging to exceptional waters identified in 9VAC25-260-30.A.3.c, or to surface waters identified as impaired in the 2012 § 305(b)/303(d) Water Quality Assessment Integrated Report or for which a Total Maximum Daily Load (TMDL) wasteload allocation has been established and approved prior to the term of this general permit for (i) sediment or a sediment-related parameter (i.e., total suspended solids or turbidity) or (ii) nutrients (i.e., nitrogen or phosphorus), the following additional requirements will apply:

a. The exceptional water(s), impaired water(s), approved TMDL(s), and pollutant(s) of concern, when applicable, must be identified in the SWPPP;

b. Permanent or temporary soil stabilization must be applied to denuded areas within seven days after final grade is reached on any portion of the site;

c. Nutrients must be applied in accordance with manufacturer's recommendations or an approved nutrient management plan and will not be applied during rainfall events; and

d. The applicable SWPPP inspection requirements specified in Part II F 2 must be amended as follows:

(1) Inspections must be conducted at a frequency of (i) at least once every four business days or (ii) at least once every five business days and no later than

48 hours following a measurable storm event. In the event that a measurable storm event occurs when there are more than 48 hours between business days, the inspection must be conducted on the next business day; and

APPENDIX C

Federal Energy Regulatory Commission Upland Erosion Revegetation and Maintenance Plan (Plan)



Federal Energy Regulatory Commission

Office of Energy Projects

May 2013

UPLAND EROSION CONTROL, REVEGETATION, AND MAINTENANCE PLAN

Washington, DC 20426

MAY 2013 VERSION

UPLAND EROSION CONTROL, REVEGETATION, AND MAINTENANCE PLAN

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UPLAND EROSION CONTROL, REVEGETATION, AND MAINTENANCE PLAN (PLAN)

I. APPLICABILITY

A. The intent of this Plan is to assist project sponsors by identifying baseline mitigation measures for minimizing erosion and enhancing revegetation. Project sponsors shall specify in their applications for a new FERC authorization and in prior notice and advance notice filings, any individual measures in this Plan they consider unnecessary, technically infeasible, or unsuitable due to local conditions and fully describe any alternative measures they would use. Project sponsors shall also explain how those alternative measures would achieve a comparable level of mitigation.

Once a project is authorized, project sponsors can request further changes as variances to the measures in this Plan (or the applicant's approved plan). The Director of the Office of Energy Projects (Director) will consider approval of variances upon the project sponsor's written request, if the Director agrees that a variance:

1. provides equal or better environmental protection;

2. is necessary because a portion of this Plan is infeasible or unworkable based on project-specific conditions; or

3. is specifically required in writing by another federal, state, or Native American land management agency for the portion of the project on its land or under its jurisdiction.

Sponsors of projects planned for construction under the automatic authorization provisions in the FERC's regulations must receive written approval for any variances in advance of construction.

Project-related impacts on wetland and waterbody systems are addressed in the staff's Wetland and Waterbody Construction and Mitigation Procedures (Procedures).

II. SUPERVISION AND INSPECTION

A. ENVIRONMENTAL INSPECTION

1. At least one Environmental Inspector is required for each construction spread during construction and restoration (as defined by section V). The number and experience of Environmental Inspectors assigned to each construction spread shall be appropriate for the length of the construction spread and the number/significance of resources affected.

2. Environmental Inspectors shall have peer status with all other activity inspectors.

3. Environmental Inspectors shall have the authority to stop activities that violate the environmental conditions of the FERC's Orders, stipulations of other environmental permits or approvals, or landowner easement agreements; and to order appropriate corrective action.

B. RESPONSIBILITIES OF ENVIRONMENTAL INSPECTORS

At a minimum, the Environmental Inspector(s) shall be responsible for:

1. Inspecting construction activities for compliance with the requirements of this Plan, the Procedures, the environmental conditions of the FERC's Orders, the mitigation measures proposed by the project sponsor (as approved and/or modified by the Order), other environmental permits and approvals, and environmental requirements in landowner easement agreements.

2. Identifying, documenting, and overseeing corrective actions, as necessary to bring an activity back into compliance;

3. Verifying that the limits of authorized construction work areas and locations of access roads are visibly marked before clearing, and maintained throughout construction;

4. Verifying the location of signs and highly visible flagging marking the boundaries of sensitive resource areas, waterbodies, wetlands, or areas with special requirements along the construction work area;

5. Identifying erosion/sediment control and soil stabilization needs in all areas;

6. Ensuring that the design of slope breakers will not cause erosion or direct water into sensitive environmental resource areas, including cultural resource sites, wetlands, waterbodies, and sensitive species habitats;

7. Verifying that dewatering activities are properly monitored and do not result in the deposition of sand, silt, and/or sediment into sensitive environmental resource areas, including wetlands, waterbodies, cultural resource sites, and sensitive species habitats; stopping dewatering activities if such deposition is occurring and ensuring the design of the discharge is changed to prevent reoccurrence; and verifying that dewatering structures are removed after completion of dewatering activities;

8. Ensuring that subsoil and topsoil are tested in agricultural and residential areas to measure compaction and determine the need for corrective action;

9. Advising the Chief Construction Inspector when environmental conditions (such as wet weather or frozen soils) make it advisable to restrict or delay construction activities to avoid topsoil mixing or excessive compaction;

10. Ensuring restoration of contours and topsoil;

11. Verifying that the soils imported for agricultural or residential use are certified as free of noxious weeds and soil pests, unless otherwise approved by the landowner;

12. Ensuring that erosion control devices are properly installed to prevent sediment flow into sensitive environmental resource areas (e.g., wetlands, waterbodies, cultural resource sites, and sensitive species habitats) and onto roads, and determining the need for additional erosion control devices;

13. Inspecting and ensuring the maintenance of temporary erosion control measures at least:

    a. on a daily basis in areas of active construction or equipment operation;

    b. on a weekly basis in areas with no construction or equipment operation; and

    c. within 24 hours of each 0.5 inch of rainfall;

14. Ensuring the repair of all ineffective temporary erosion control measures within 24 hours of identification, or as soon as conditions allow if compliance with this time frame would result in greater environmental impacts;

15. Keeping records of compliance with the environmental conditions of the FERC's Orders, and the mitigation measures proposed by the project sponsor in the application submitted to the FERC, and other federal or state environmental permits during active construction and restoration;

16. Identifying areas that should be given special attention to ensure stabilization and restoration after the construction phase; and

17. Verifying that locations for any disposal of excess construction materials for beneficial reuse comply with section III.E.

III. PRECONSTRUCTION PLANNING

The project sponsor shall do the following before construction:

A. CONSTRUCTION WORK AREAS

1. Identify all construction work areas (e.g., construction right-of-way, extra work space areas, pipe storage and contractor yards, borrow and disposal areas, access roads) that would be needed for safe construction. The project sponsor must ensure that appropriate cultural resources and biological surveys are conducted, as determined necessary by the appropriate federal and state agencies.

2. Project sponsors are encouraged to consider expanding any required cultural resources and endangered species surveys in anticipation of the need for activities outside of authorized work areas.

3. Plan construction sequencing to limit the amount and duration of open trench sections, as necessary, to prevent excessive erosion or sediment flow into sensitive environmental resource areas.

B. DRAIN TILE AND IRRIGATION SYSTEMS

1. Attempt to locate existing drain tiles and irrigation systems.

2. Contact landowners and local soil conservation authorities to determine the locations of future drain tiles that are likely to be installed within 3 years of the authorized construction.

3. Develop procedures for constructing through drain-tiled areas, maintaining irrigation systems during construction, and repairing drain tiles and irrigation systems after construction.

4. Engage qualified drain tile specialists, as needed to conduct or monitor repairs to drain tile systems affected by construction. Use drain tile specialists from the project area, if available.

C. GRAZING DEFERMENT

Develop grazing deferment plans with willing landowners, grazing permittees, and land management agencies to minimize grazing disturbance of revegetation efforts.

D. ROAD CROSSINGS AND ACCESS POINTS

Plan for safe and accessible conditions at all roadway crossings and access points during construction and restoration.

E. DISPOSAL PLANNING

Determine methods and locations for the regular collection, containment, and disposal of excess construction materials and debris (e.g., timber, slash, mats, garbage, drill cuttings and fluids, excess rock) throughout the construction process. Disposal of materials for beneficial reuse must not result in adverse environmental impact and is subject to compliance with all applicable survey, landowner or land management agency approval, and permit requirements.

F. AGENCY COORDINATION

The project sponsor must coordinate with the appropriate local, state, and federal agencies as outlined in this Plan and/or required by the FERC's Orders.

1. Obtain written recommendations from the local soil conservation authorities or land management agencies regarding permanent erosion control and revegetation specifications.

2. Develop specific procedures in coordination with the appropriate agencies to prevent the introduction or spread of invasive species, noxious weeds, and soil pests resulting from construction and restoration activities.

3. Develop specific procedures in coordination with the appropriate agencies and landowners, as necessary, to allow for livestock and wildlife movement and protection during construction.

4. Develop specific blasting procedures in coordination with the appropriate agencies that address pre- and post-blast inspections; advanced public notification; and mitigation measures for building foundations, groundwater wells, and springs. Use appropriate methods (e.g., blasting mats) to prevent damage to nearby structures and to prevent debris from entering sensitive environmental resource areas.

G. SPILL PREVENTION AND RESPONSE PROCEDURES

The project sponsor shall develop project-specific Spill Prevention and Response Procedures, as specified in section IV of the staff's Procedures. A copy must be filed with the Secretary of the FERC (Secretary) prior to construction and made available in the field on each construction spread. The filing requirement does not apply to projects constructed under the automatic authorization provisions in the FERC's regulations.

H. RESIDENTIAL CONSTRUCTION

For all properties with residences located within 50 feet of construction work areas, project sponsors shall: avoid removal of mature trees and landscaping within the construction work area unless necessary for safe operation of construction equipment, or as specified in landowner agreements; fence the edge of the construction work area for a distance of 100 feet on either side of the residence; and restore all lawn areas and landscaping immediately following clean up operations, or as specified in landowner agreements. If seasonal or other weather conditions prevent compliance with these time frames, maintain and monitor temporary erosion controls (sediment barriers and mulch) until conditions allow completion of restoration.

I. WINTER CONSTRUCTION PLANS

If construction is planned to occur during winter weather conditions, project sponsors shall develop and file a project-specific winter construction plan with the FERC application. This filing requirement does not apply to projects constructed under the automatic authorization provisions of the FERC's regulations.

The plan shall address:

1. winter construction procedures (e.g., snow handling and removal, access road construction and maintenance, soil handling under saturated or frozen conditions, topsoil stripping);

2. stabilization and monitoring procedures if ground conditions will delay restoration until the following spring (e.g., mulching and erosion controls, inspection and reporting, stormwater control during spring thaw conditions); and

3. final restoration procedures (e.g., subsidence and compaction repair, topsoil replacement, seeding).

IV. INSTALLATION

A. APPROVED AREAS OF DISTURBANCE

1. Project-related ground disturbance shall be limited to the construction right-of-way, extra work space areas, pipe storage yards, borrow and disposal areas, access roads, and other areas approved in the FERC's Orders. Any project-related ground disturbing activities outside these areas will require prior Director approval. This requirement does not apply to activities needed to comply with the Plan and Procedures (i.e., slope breakers, energy-dissipating devices, dewatering structures, drain tile system repairs) or minor field realignments and workspace shifts per landowner needs and requirements that do not affect other landowners or sensitive environmental resource areas. All construction or restoration activities outside of authorized areas are subject to all applicable survey and permit requirements, and landowner easement agreements.

2. The construction right-of-way width for a project shall not exceed 75 feet or that described in the FERC application unless otherwise modified by a FERC Order. However, in limited, non-wetland areas, this construction right-of-way width may be expanded by up to 25 feet without Director approval to accommodate full construction right-of-way topsoil segregation and to ensure safe construction where topographic conditions (e.g., side-slopes) or soil limitations require it. Twenty-five feet of extra construction right-of-way width may also be used in limited, non-wetland or non-forested areas for truck turn-arounds where no reasonable alternative access exists.

   Project use of these additional limited areas is subject to landowner or land management agency approval and compliance with all applicable survey and permit requirements. When additional areas are used, each one shall be identified and the need explained in the weekly or biweekly construction reports to the FERC, if required. The following material shall be included in the reports:

   a. the location of each additional area by station number and reference to previously filed alignment sheets, or updated alignment sheets showing the additional areas;

   b. identification of the filing at FERC containing evidence that the additional areas were previously surveyed; and

c. a statement that landowner approval has been obtained and is available in project files.

Prior written approval of the Director is required when the authorized construction right-of-way width would be expanded by more than 25 feet.

B. TOPSOIL SEGREGATION

1. Unless the landowner or land management agency specifically approves otherwise, prevent the mixing of topsoil with subsoil by stripping topsoil from either the full work area or from the trench and subsoil storage area (ditch plus spoil side method) in:

   a. cultivated or rotated croplands, and managed pastures;

   b. residential areas;

   c. hayfields; and

   d. other areas at the landowner's or land managing agency's request.

2. In residential areas, importation of topsoil is an acceptable alternative to topsoil segregation.

3. Where topsoil segregation is required, the project sponsor must:

   a. segregate at least 12 inches of topsoil in deep soils (more than 12 inches of topsoil); and

   b. make every effort to segregate the entire topsoil layer in soils with less than 12 inches of topsoil.

4. Maintain separation of salvaged topsoil and subsoil throughout all construction activities.

5. Segregated topsoil may not be used for padding the pipe, constructing temporary slope breakers or trench plugs, improving or maintaining roads, or as a fill material.

6. Stabilize topsoil piles and minimize loss due to wind and water erosion with use of sediment barriers, mulch, temporary seeding, tackifiers, or functional equivalents, where necessary.

C. DRAIN TILES

1. Mark locations of drain tiles damaged during construction.

2. Probe all drainage tile systems within the area of disturbance to check for damage.

3. Repair damaged drain tiles to their original or better condition. Do not use filter-covered drain tiles unless the local soil conservation authorities and the landowner agree. Use qualified specialists for testing and repairs.

4. For new pipelines in areas where drain tiles exist or are planned, ensure that the depth of cover over the pipeline is sufficient to avoid interference with drain tile systems. For adjacent pipeline loops in agricultural areas, install the new pipeline with at least the same depth of cover as the existing pipeline(s).

D. IRRIGATION

Maintain water flow in crop irrigation systems, unless shutoff is coordinated with affected parties.

E. ROAD CROSSINGS AND ACCESS POINTS

1. Maintain safe and accessible conditions at all road crossings and access points during construction.

2. If crushed stone access pads are used in residential or agricultural areas, place the stone on synthetic fabric to facilitate removal.

3. Minimize the use of tracked equipment on public roadways. Remove any soil or gravel spilled or tracked onto roadways daily or more frequent as necessary to maintain safe road conditions. Repair any damages to roadway surfaces, shoulders, and bar ditches.

F. TEMPORARY EROSION CONTROL

Install temporary erosion controls immediately after initial disturbance of the soil. Temporary erosion controls must be properly maintained throughout construction (on a daily basis) and reinstalled as necessary (such as after backfilling of the trench) until replaced by permanent erosion controls or restoration is complete.

1. Temporary Slope Breakers

   a. Temporary slope breakers are intended to reduce runoff velocity and divert water off the construction right-of-way. Temporary slope

breakers may be constructed of materials such as soil, silt fence, staked hay or straw bales, or sand bags.

b. Install temporary slope breakers on all disturbed areas, as necessary to avoid excessive erosion. Temporary slope breakers must be installed on slopes greater than 5 percent where the base of the slope is less than 50 feet from waterbody, wetland, and road crossings at the following spacing (closer spacing shall be used if necessary):

Slope (%)	Spacing (feet)
5 - 15	300
>15 - 30	200
>30	100

c. Direct the outfall of each temporary slope breaker to a stable, well vegetated area or construct an energy-dissipating device at the end of the slope breaker and off the construction right-of-way.

d. Position the outfall of each temporary slope breaker to prevent sediment discharge into wetlands, waterbodies, or other sensitive environmental resource areas.

2. Temporary Trench Plugs

Temporary trench plugs are intended to segment a continuous open trench prior to backfill.

a. Temporary trench plugs may consist of unexcavated portions of the trench, compacted subsoil, sandbags, or some functional equivalent.

b. Position temporary trench plugs, as necessary, to reduce trenchline erosion and minimize the volume and velocity of trench water flow at the base of slopes.

3. Sediment Barriers

Sediment barriers are intended to stop the flow of sediments and to prevent the deposition of sediments beyond approved workspaces or into sensitive resources.

a. Sediment barriers may be constructed of materials such as silt fence, staked hay or straw bales, compacted earth (e.g., driveable berms across travelways), sand bags, or other appropriate materials.

b. At a minimum, install and maintain temporary sediment barriers across the entire construction right-of-way at the base of slopes greater than 5 percent where the base of the slope is less than 50 feet from a waterbody, wetland, or road crossing until revegetation is successful as defined in this Plan. Leave adequate room between the base of the slope and the sediment barrier to accommodate ponding of water and sediment deposition.

c. Where wetlands or waterbodies are adjacent to and downslope of construction work areas, install sediment barriers along the edge of these areas, as necessary to prevent sediment flow into the wetland or waterbody.

4. Mulch

a. Apply mulch on all slopes (except in cultivated cropland) concurrent with or immediately after seeding, where necessary to stabilize the soil surface and to reduce wind and water erosion. Spread mulch uniformly over the area to cover at least 75 percent of the ground surface at a rate of 2 tons/acre of straw or its equivalent, unless the local soil conservation authority, landowner, or land managing agency approves otherwise in writing.

b. Mulch can consist of weed-free straw or hay, wood fiber hydromulch, erosion control fabric, or some functional equivalent.

c. Mulch all disturbed upland areas (except cultivated cropland) before seeding if:

(1) final grading and installation of permanent erosion control measures will not be completed in an area within 20 days after the trench in that area is backfilled (10 days in residential areas), as required in section V.A.1; or

(2) construction or restoration activity is interrupted for extended periods, such as when seeding cannot be completed due to seeding period restrictions.

d. If mulching before seeding, increase mulch application on all slopes within 100 feet of waterbodies and wetlands to a rate of 3 tons/acre of straw or equivalent.

e. If wood chips are used as mulch, do not use more than 1 ton/acre and add the equivalent of 11 lbs/acre available nitrogen (at least 50 percent of which is slow release).

f. Ensure that mulch is adequately anchored to minimize loss due to wind and water.

g. When anchoring with liquid mulch binders, use rates recommended by the manufacturer. Do not use liquid mulch binders within 100 feet of wetlands or waterbodies, except where the product is certified environmentally non-toxic by the appropriate state or federal agency or independent standards-setting organization.

h. Do not use synthetic monofilament mesh/netted erosion control materials in areas designated as sensitive wildlife habitat, unless the product is specifically designed to minimize harm to wildlife. Anchor erosion control fabric with staples or other appropriate devices.

V. RESTORATION

A. CLEANUP

1. Commence cleanup operations immediately following backfill operations. Complete final grading, topsoil replacement, and installation of permanent erosion control structures within 20 days after backfilling the trench (10 days in residential areas). If seasonal or other weather conditions prevent compliance with these time frames, maintain temporary erosion controls (i.e., temporary slope breakers, sediment barriers, and mulch) until conditions allow completion of cleanup.

   If construction or restoration unexpectedly continues into the winter season when conditions could delay successful decompaction, topsoil replacement, or seeding until the following spring, file with the Secretary for the review and written approval of the Director, a winter construction plan (as specified in section III.I). This filing requirement does not apply to projects constructed under the automatic authorization provisions of the FERC's regulations.

2. A travel lane may be left open temporarily to allow access by construction traffic if the temporary erosion control structures are installed as specified in section IV.F. and inspected and maintained as specified in sections II.B.12 through 14. When access is no longer required the travel lane must be removed and the right-of-way restored.

3. Rock excavated from the trench may be used to backfill the trench only to the top of the existing bedrock profile. Rock that is not returned to the trench shall be considered construction debris, unless approved for use as mulch or for some other use on the construction work areas by the landowner or land managing agency.

4. Remove excess rock from at least the top 12 inches of soil in all cultivated or rotated cropland, managed pastures, hayfields, and residential areas, as well as other areas at the landowner's request. The size, density, and distribution of rock on the construction work area shall be similar to adjacent areas not disturbed by construction. The landowner or land management agency may approve other provisions in writing.

5. Grade the construction right-of-way to restore pre-construction contours and leave the soil in the proper condition for planting.

6. Remove construction debris from all construction work areas unless the landowner or land managing agency approves leaving materials onsite for beneficial reuse, stabilization, or habitat restoration.

7. Remove temporary sediment barriers when replaced by permanent erosion control measures or when revegetation is successful.

B. PERMANENT EROSION CONTROL DEVICES

1. Trench Breakers

a. Trench breakers are intended to slow the flow of subsurface water along the trench. Trench breakers may be constructed of materials such as sand bags or polyurethane foam. Do not use topsoil in trench breakers.

b. An engineer or similarly qualified professional shall determine the need for and spacing of trench breakers. Otherwise, trench breakers shall be installed at the same spacing as and upslope of permanent slope breakers.

c. In agricultural fields and residential areas where slope breakers are not typically required, install trench breakers at the same spacing as if permanent slope breakers were required.

d. At a minimum, install a trench breaker at the base of slopes greater than 5 percent where the base of the slope is less than 50 feet from a waterbody or wetland and where needed to avoid draining a waterbody or wetland. Install trench breakers at wetland boundaries, as specified in the Procedures. Do not install trench breakers within a wetland.

2. Permanent Slope Breakers

a. Permanent slope breakers are intended to reduce runoff velocity, divert water off the construction right-of-way, and prevent sediment deposition into sensitive resources. Permanent slope breakers may be constructed of materials such as soil, stone, or some functional equivalent.

b. Construct and maintain permanent slope breakers in all areas, except cultivated areas and lawns, unless requested by the landowner, using spacing recommendations obtained from the local soil conservation authority or land managing agency.

In the absence of written recommendations, use the following spacing unless closer spacing is necessary to avoid excessive erosion on the construction right-of-way:

Slope (%)	Spacing (feet)
5 - 15	300
>15 - 30	200
>30	100

c. Construct slope breakers to divert surface flow to a stable area without causing water to pool or erode behind the breaker. In the absence of a stable area, construct appropriate energy-dissipating devices at the end of the breaker.

d. Slope breakers may extend slightly (about 4 feet) beyond the edge of the construction right-of-way to effectively drain water off the disturbed area. Where slope breakers extend beyond the edge of the construction right-of-way, they are subject to compliance with all applicable survey requirements.

C. SOIL COMPACTION MITIGATION

1. Test topsoil and subsoil for compaction at regular intervals in agricultural and residential areas disturbed by construction activities. Conduct tests on the same soil type under similar moisture conditions in undisturbed areas to approximate preconstruction conditions. Use penetrometers or other appropriate devices to conduct tests.

2. Plow severely compacted agricultural areas with a paraplow or other deep tillage implement. In areas where topsoil has been segregated, plow the subsoil before replacing the segregated topsoil.

If subsequent construction and cleanup activities result in further compaction, conduct additional tilling.

3. Perform appropriate soil compaction mitigation in severely compacted residential areas.

D. REVEGETATION

1. General

a. The project sponsor is responsible for ensuring successful revegetation of soils disturbed by project-related activities, except as noted in section V.D.1.b.

b. Restore all turf, ornamental shrubs, and specialized landscaping in accordance with the landowner's request, or compensate the landowner. Restoration work must be performed by personnel familiar with local horticultural and turf establishment practices.

2. Soil Additives

Fertilize and add soil pH modifiers in accordance with written recommendations obtained from the local soil conservation authority, land management agencies, or landowner. Incorporate recommended soil pH modifier and fertilizer into the top 2 inches of soil as soon as practicable after application.

3. Seeding Requirements

a. Prepare a seedbed in disturbed areas to a depth of 3 to 4 inches using appropriate equipment to provide a firm seedbed. When hydroseeding, scarify the seedbed to facilitate lodging and germination of seed.

b. Seed disturbed areas in accordance with written recommendations for seed mixes, rates, and dates obtained from the local soil conservation authority or the request of the landowner or land management agency. Seeding is not required in cultivated croplands unless requested by the landowner.

c. Perform seeding of permanent vegetation within the recommended seeding dates. If seeding cannot be done within those dates, use appropriate temporary erosion control measures discussed in section IV.F and perform seeding of permanent vegetation at the beginning of the next recommended seeding season. Dormant seeding or temporary

seeding of annual species may also be used, if necessary, to establish cover, as approved by the Environmental Inspector. Lawns may be seeded on a schedule established with the landowner.

d. In the absence of written recommendations from the local soil conservation authorities, seed all disturbed soils within 6 working days of final grading, weather and soil conditions permitting, subject to the specifications in section V.D.3.a through V.D.3.c.

e. Base seeding rates on Pure Live Seed. Use seed within 12 months of seed testing.

f. Treat legume seed with an inoculant specific to the species using the manufacturer's recommended rate of inoculant appropriate for the seeding method (broadcast, drill, or hydro).

g. In the absence of written recommendations from the local soil conservation authorities, landowner, or land managing agency to the contrary, a seed drill equipped with a cultipacker is preferred for seed application.

Broadcast or hydroseeding can be used in lieu of drilling at double the recommended seeding rates. Where seed is broadcast, firm the seedbed with a cultipacker or roller after seeding. In rocky soils or where site conditions may limit the effectiveness of this equipment, other alternatives may be appropriate (e.g., use of a chain drag) to lightly cover seed after application, as approved by the Environmental Inspector.

VI. OFF-ROAD VEHICLE CONTROL

To each owner or manager of forested lands, offer to install and maintain measures to control unauthorized vehicle access to the right-of-way. These measures may include:

A. signs;

B. fences with locking gates;

C. slash and timber barriers, pipe barriers, or a line of boulders across the right-of-way; and

D. conifers or other appropriate trees or shrubs across the right-of-way.

VII. POST-CONSTRUCTION ACTIVITIES AND REPORTING

A. MONITORING AND MAINTENANCE

1. Conduct follow-up inspections of all disturbed areas, as necessary, to determine the success of revegetation and address landowner concerns. At a minimum, conduct inspections after the first and second growing seasons.

2. Revegetation in non-agricultural areas shall be considered successful if upon visual survey the density and cover of non-nuisance vegetation are similar in density and cover to adjacent undisturbed lands. In agricultural areas, revegetation shall be considered successful when upon visual survey, crop growth and vigor are similar to adjacent undisturbed portions of the same field, unless the easement agreement specifies otherwise.

   Continue revegetation efforts until revegetation is successful.

3. Monitor and correct problems with drainage and irrigation systems resulting from pipeline construction in agricultural areas until restoration is successful.

4. Restoration shall be considered successful if the right-of-way surface condition is similar to adjacent undisturbed lands, construction debris is removed (unless otherwise approved by the landowner or land managing agency per section V.A.6), revegetation is successful, and proper drainage has been restored.

5. Routine vegetation mowing or clearing over the full width of the permanent right-of-way in uplands shall not be done more frequently than every 3 years. However, to facilitate periodic corrosion/leak surveys, a corridor not exceeding 10 feet in width centered on the pipeline may be cleared at a frequency necessary to maintain the 10-foot corridor in an herbaceous state. In no case shall routine vegetation mowing or clearing occur during the migratory bird nesting season between April 15 and August 1 of any year unless specifically approved in writing by the responsible land management agency or the U.S. Fish and Wildlife Service.

6. Efforts to control unauthorized off-road vehicle use, in cooperation with the landowner, shall continue throughout the life of the project. Maintain signs, gates, and permanent access roads as necessary.

B. REPORTING

1. The project sponsor shall maintain records that identify by milepost:

   a. method of application, application rate, and type of fertilizer, pH modifying agent, seed, and mulch used;

   b. acreage treated;

   c. dates of backfilling and seeding;

   d. names of landowners requesting special seeding treatment and a description of the follow-up actions;

   e. the location of any subsurface drainage repairs or improvements made during restoration; and

   f. any problem areas and how they were addressed.

2. The project sponsor shall file with the Secretary quarterly activity reports documenting the results of follow-up inspections required by section VII.A.1; any problem areas, including those identified by the landowner; and corrective actions taken for at least 2 years following construction.

   The requirement to file quarterly activity reports with the Secretary does not apply to projects constructed under the automatic authorization, prior notice, or advanced notice provisions in the FERC's regulations.

APPENDIX D

Federal Energy Regulatory Commission Wetland and Waterbody Construction and Mitigation Procedures (Procedures)



Federal Energy Regulatory Commission

Office of Energy Projects

May 2013

WETLAND AND WATERBODY CONSTRUCTION AND MITIGATION PROCEDURES

Washington, DC 20426

MAY 2013 VERSION

WETLAND AND WATERBODY CONSTRUCTION AND MITIGATION PROCEDURES

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WETLAND AND WATERBODY
CONSTRUCTION AND MITIGATION PROCEDURES (PROCEDURES)

I. APPLICABILITY

A. The intent of these Procedures is to assist project sponsors by identifying baseline mitigation measures for minimizing the extent and duration of project-related disturbance on wetlands and waterbodies. Project sponsors shall specify in their applications for a new FERC authorization, and in prior notice and advance notice filings, any individual measures in these Procedures they consider unnecessary, technically infeasible, or unsuitable due to local conditions and fully describe any alternative measures they would use. Project sponsors shall also explain how those alternative measures would achieve a comparable level of mitigation.

Once a project is authorized, project sponsors can request further changes as variances to the measures in these Procedures (or the applicant's approved procedures). The Director of the Office of Energy Projects (Director) will consider approval of variances upon the project sponsor's written request, if the Director agrees that a variance:

1. provides equal or better environmental protection;

2. is necessary because a portion of these Procedures is infeasible or unworkable based on project-specific conditions; or

3. is specifically required in writing by another federal, state, or Native American land management agency for the portion of the project on its land or under its jurisdiction.

Sponsors of projects planned for construction under the automatic authorization provisions in the FERC's regulations must receive written approval for any variances in advance of construction.

Project-related impacts on non-wetland areas are addressed in the staff's Upland Erosion Control, Revegetation, and Maintenance Plan (Plan).

B. DEFINITIONS

1. "Waterbody" includes any natural or artificial stream, river, or drainage with perceptible flow at the time of crossing, and other permanent waterbodies such as ponds and lakes:

   a. "minor waterbody" includes all waterbodies less than or equal to 10 feet wide at the water's edge at the time of crossing;

   b. "intermediate waterbody" includes all waterbodies greater than 10 feet wide but less than or equal to 100 feet wide at the water's edge at the time of crossing; and

   c. "major waterbody" includes all waterbodies greater than 100 feet wide at the water's edge at the time of crossing.

2. "Wetland" includes any area that is not in actively cultivated or rotated cropland and that satisfies the requirements of the current federal methodology for identifying and delineating wetlands.

II. PRECONSTRUCTION FILING

A. The following information must be filed with the Secretary of the FERC (Secretary) prior to the beginning of construction, for the review and written approval by the Director:

1. site-specific justifications for extra work areas that would be closer than 50 feet from a waterbody or wetland; and

2. site-specific justifications for the use of a construction right-of-way greater than 75-feet-wide in wetlands.

B. The following information must be filed with the Secretary prior to the beginning of construction. These filing requirements do not apply to projects constructed under the automatic authorization provisions in the FERC's regulations:

1. Spill Prevention and Response Procedures specified in section IV.A;

2. a schedule identifying when trenching or blasting will occur within each waterbody greater than 10 feet wide, within any designated coldwater fishery, and within any waterbody identified as habitat for federally-listed threatened or endangered species. The project sponsor will revise the schedule as necessary to provide FERC staff at least 14 days advance notice. Changes within this last 14-day period must provide for at least 48 hours advance notice;

3. plans for horizontal directional drills (HDD) under wetlands or waterbodies, specified in section V.B.6.d;

4. site-specific plans for major waterbody crossings, described in section V.B.9;

5. a wetland delineation report as described in section VI.A.1, if applicable; and

6. the hydrostatic testing information specified in section VII.B.3.

III. ENVIRONMENTAL INSPECTORS

A. At least one Environmental Inspector having knowledge of the wetland and waterbody conditions in the project area is required for each construction spread. The number and experience of Environmental Inspectors assigned to each construction spread shall be appropriate for the length of the construction spread and the number/significance of resources affected.

B. The Environmental Inspector's responsibilities are outlined in the Upland Erosion Control, Revegetation, and Maintenance Plan (Plan).

IV. PRECONSTRUCTION PLANNING

A. The project sponsor shall develop project-specific Spill Prevention and Response Procedures that meet applicable requirements of state and federal agencies. A copy must be filed with the Secretary prior to construction and made available in the field on each construction spread. This filing requirement does not apply to projects constructed under the automatic authorization provisions in the FERC's regulations.

1. It shall be the responsibility of the project sponsor and its contractors to structure their operations in a manner that reduces the risk of spills or the accidental exposure of fuels or hazardous materials to waterbodies or wetlands. The project sponsor and its contractors must, at a minimum, ensure that:

a. all employees handling fuels and other hazardous materials are properly trained;

b. all equipment is in good operating order and inspected on a regular basis;

c. fuel trucks transporting fuel to on-site equipment travel only on approved access roads;

d. all equipment is parked overnight and/or fueled at least 100 feet from a waterbody or in an upland area at least 100 feet from a wetland boundary. These activities can occur closer only if the Environmental Inspector determines that there is no reasonable alternative, and the

project sponsor and its contractors have taken appropriate steps (including secondary containment structures) to prevent spills and provide for prompt cleanup in the event of a spill;

e. hazardous materials, including chemicals, fuels, and lubricating oils, are not stored within 100 feet of a wetland, waterbody, or designated municipal watershed area, unless the location is designated for such use by an appropriate governmental authority. This applies to storage of these materials and does not apply to normal operation or use of equipment in these areas;

f. concrete coating activities are not performed within 100 feet of a wetland or waterbody boundary, unless the location is an existing industrial site designated for such use. These activities can occur closer only if the Environmental Inspector determines that there is no reasonable alternative, and the project sponsor and its contractors have taken appropriate steps (including secondary containment structures) to prevent spills and provide for prompt cleanup in the event of a spill;

g. pumps operating within 100 feet of a waterbody or wetland boundary utilize appropriate secondary containment systems to prevent spills; and

h. bulk storage of hazardous materials, including chemicals, fuels, and lubricating oils have appropriate secondary containment systems to prevent spills.

2. The project sponsor and its contractors must structure their operations in a manner that provides for the prompt and effective cleanup of spills of fuel and other hazardous materials. At a minimum, the project sponsor and its contractors must:

a. ensure that each construction crew (including cleanup crews) has on hand sufficient supplies of absorbent and barrier materials to allow the rapid containment and recovery of spilled materials and knows the procedure for reporting spills and unanticipated discoveries of contamination;

b. ensure that each construction crew has on hand sufficient tools and material to stop leaks;

c. know the contact names and telephone numbers for all local, state, and federal agencies (including, if necessary, the U. S. Coast Guard and the National Response Center) that must be notified of a spill; and

d. follow the requirements of those agencies in cleaning up the spill, in excavating and disposing of soils or other materials contaminated by a spill, and in collecting and disposing of waste generated during spill cleanup.

B. AGENCY COORDINATION

The project sponsor must coordinate with the appropriate local, state, and federal agencies as outlined in these Procedures and in the FERC's Orders.

V. WATERBODY CROSSINGS

A. NOTIFICATION PROCEDURES AND PERMITS

1. Apply to the U.S. Army Corps of Engineers (COE), or its delegated agency, for the appropriate wetland and waterbody crossing permits.

2. Provide written notification to authorities responsible for potable surface water supply intakes located within 3 miles downstream of the crossing at least 1 week before beginning work in the waterbody, or as otherwise specified by that authority.

3. Apply for state-issued waterbody crossing permits and obtain individual or generic section 401 water quality certification or waiver.

4. Notify appropriate federal and state authorities at least 48 hours before beginning trenching or blasting within the waterbody, or as specified in applicable permits.

B. INSTALLATION

1. Time Window for Construction

Unless expressly permitted or further restricted by the appropriate federal or state agency in writing on a site-specific basis, instream work, except that required to install or remove equipment bridges, must occur during the following time windows:

a. coldwater fisheries - June 1 through September 30; and

b. coolwater and warmwater fisheries - June 1 through November 30.

2. Extra Work Areas

a. Locate all extra work areas (such as staging areas and additional spoil storage areas) at least 50 feet away from water's edge, except where

the adjacent upland consists of cultivated or rotated cropland or other disturbed land.

b. The project sponsor shall file with the Secretary for review and written approval by the Director, site-specific justification for each extra work area with a less than 50-foot setback from the water's edge, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land. The justification must specify the conditions that will not permit a 50-foot setback and measures to ensure the waterbody is adequately protected.

c. Limit the size of extra work areas to the minimum needed to construct the waterbody crossing.

3. General Crossing Procedures

a. Comply with the COE, or its delegated agency, permit terms and conditions.

b. Construct crossings as close to perpendicular to the axis of the waterbody channel as engineering and routing conditions permit.

c. Where pipelines parallel a waterbody, maintain at least 15 feet of undisturbed vegetation between the waterbody (and any adjacent wetland) and the construction right-of-way, except where maintaining this offset will result in greater environmental impact.

d. Where waterbodies meander or have multiple channels, route the pipeline to minimize the number of waterbody crossings.

e. Maintain adequate waterbody flow rates to protect aquatic life, and prevent the interruption of existing downstream uses.

f. Waterbody buffers (e.g., extra work area setbacks, refueling restrictions) must be clearly marked in the field with signs and/or highly visible flagging until construction-related ground disturbing activities are complete.

g. Crossing of waterbodies when they are dry or frozen and not flowing may proceed using standard upland construction techniques in accordance with the Plan, provided that the Environmental Inspector verifies that water is unlikely to flow between initial disturbance and final stabilization of the feature. In the event of perceptible flow, the project sponsor must comply with all applicable Procedure requirements for "waterbodies" as defined in section I.B.1.

4. Spoil Pile Placement and Control

   a. All spoil from minor and intermediate waterbody crossings, and upland spoil from major waterbody crossings, must be placed in the construction right-of-way at least 10 feet from the water's edge or in additional extra work areas as described in section V.B.2.

   b. Use sediment barriers to prevent the flow of spoil or silt-laden water into any waterbody.

5. Equipment Bridges

   a. Only clearing equipment and equipment necessary for installation of equipment bridges may cross waterbodies prior to bridge installation. Limit the number of such crossings of each waterbody to one per piece of clearing equipment.

   b. Construct and maintain equipment bridges to allow unrestricted flow and to prevent soil from entering the waterbody. Examples of such bridges include:

      (1) equipment pads and culvert(s);
      (2) equipment pads or railroad car bridges without culverts;
      (3) clean rock fill and culvert(s); and
      (4) flexi-float or portable bridges.

      Additional options for equipment bridges may be utilized that achieve the performance objectives noted above. Do not use soil to construct or stabilize equipment bridges.

   c. Design and maintain each equipment bridge to withstand and pass the highest flow expected to occur while the bridge is in place. Align culverts to prevent bank erosion or streambed scour. If necessary, install energy dissipating devices downstream of the culverts.

   d. Design and maintain equipment bridges to prevent soil from entering the waterbody.

   e. Remove temporary equipment bridges as soon as practicable after permanent seeding.

   f. If there will be more than 1 month between final cleanup and the beginning of permanent seeding and reasonable alternative access to the right-of-way is available, remove temporary equipment bridges as soon as practicable after final cleanup.

g. Obtain any necessary approval from the COE, or the appropriate state agency for permanent bridges.

6. Dry-Ditch Crossing Methods

a. Unless approved otherwise by the appropriate federal or state agency, install the pipeline using one of the dry-ditch methods outlined below for crossings of waterbodies up to 30 feet wide (at the water's edge at the time of construction) that are state-designated as either coldwater or significant coolwater or warmwater fisheries, or federally-designated as critical habitat.

b. Dam and Pump

(1) The dam-and-pump method may be used without prior approval for crossings of waterbodies where pumps can adequately transfer streamflow volumes around the work area, and there are no concerns about sensitive species passage.

(2) Implementation of the dam-and-pump crossing method must meet the following performance criteria:

(i) use sufficient pumps, including on-site backup pumps, to maintain downstream flows;
(ii) construct dams with materials that prevent sediment and other pollutants from entering the waterbody (e.g., sandbags or clean gravel with plastic liner);
(iii) screen pump intakes to minimize entrainment of fish;
(iv) prevent streambed scour at pump discharge; and
(v) continuously monitor the dam and pumps to ensure proper operation throughout the waterbody crossing.

c. Flume Crossing

The flume crossing method requires implementation of the following steps:

(1) install flume pipe after blasting (if necessary), but before any trenching;

(2) use sand bag or sand bag and plastic sheeting diversion structure or equivalent to develop an effective seal and to divert stream flow through the flume pipe (some modifications to the stream bottom may be required to achieve an effective seal);

(3) properly align flume pipe(s) to prevent bank erosion and streambed scour;

(4) do not remove flume pipe during trenching, pipelaying, or backfilling activities, or initial streambed restoration efforts; and

(5) remove all flume pipes and dams that are not also part of the equipment bridge as soon as final cleanup of the stream bed and bank is complete.

d. Horizontal Directional Drill

For each waterbody or wetland that would be crossed using the HDD method, file with the Secretary for the review and written approval by the Director, a plan that includes:

(1) site-specific construction diagrams that show the location of mud pits, pipe assembly areas, and all areas to be disturbed or cleared for construction;

(2) justification that disturbed areas are limited to the minimum needed to construct the crossing;

(3) identification of any aboveground disturbance or clearing between the HDD entry and exit workspaces during construction;

(4) a description of how an inadvertent release of drilling mud would be contained and cleaned up; and

(5) a contingency plan for crossing the waterbody or wetland in the event the HDD is unsuccessful and how the abandoned drill hole would be sealed, if necessary.

The requirement to file HDD plans does not apply to projects constructed under the automatic authorization provisions in the FERC's regulations.

7. Crossings of Minor Waterbodies

Where a dry-ditch crossing is not required, minor waterbodies may be crossed using the open-cut crossing method, with the following restrictions:

a. except for blasting and other rock breaking measures, complete instream construction activities (including trenching, pipe installation, backfill, and restoration of the streambed contours) within 24 hours.

Streambanks and unconsolidated streambeds may require additional restoration after this period;

b. limit use of equipment operating in the waterbody to that needed to construct the crossing; and

c. equipment bridges are not required at minor waterbodies that do not have a state-designated fishery classification or protected status (e.g., agricultural or intermittent drainage ditches). However, if an equipment bridge is used it must be constructed as described in section V.B.5.

8. Crossings of Intermediate Waterbodies

Where a dry-ditch crossing is not required, intermediate waterbodies may be crossed using the open-cut crossing method, with the following restrictions:

a. complete instream construction activities (not including blasting and other rock breaking measures) within 48 hours, unless site-specific conditions make completion within 48 hours infeasible;

b. limit use of equipment operating in the waterbody to that needed to construct the crossing; and

c. all other construction equipment must cross on an equipment bridge as specified in section V.B.5.

9. Crossings of Major Waterbodies

Before construction, the project sponsor shall file with the Secretary for the review and written approval by the Director a detailed, site-specific construction plan and scaled drawings identifying all areas to be disturbed by construction for each major waterbody crossing (the scaled drawings are not required for any offshore portions of pipeline projects). This plan must be developed in consultation with the appropriate state and federal agencies and shall include extra work areas, spoil storage areas, sediment control structures, etc., as well as mitigation for navigational issues. The requirement to file major waterbody crossing plans does not apply to projects constructed under the automatic authorization provisions of the FERC's regulations.

The Environmental Inspector may adjust the final placement of the erosion and sediment control structures in the field to maximize effectiveness.

10. Temporary Erosion and Sediment Control

Install sediment barriers (as defined in section IV.F.3.a of the Plan) immediately after initial disturbance of the waterbody or adjacent upland.

Sediment barriers must be properly maintained throughout construction and reinstalled as necessary (such as after backfilling of the trench) until replaced by permanent erosion controls or restoration of adjacent upland areas is complete. Temporary erosion and sediment control measures are addressed in more detail in the Plan; however, the following specific measures must be implemented at stream crossings:

a. install sediment barriers across the entire construction right-of-way at all waterbody crossings, where necessary to prevent the flow of sediments into the waterbody. Removable sediment barriers (or driveable berms) must be installed across the travel lane. These removable sediment barriers can be removed during the construction day, but must be re-installed after construction has stopped for the day and/or when heavy precipitation is imminent;

b. where waterbodies are adjacent to the construction right-of-way and the right-of-way slopes toward the waterbody, install sediment barriers along the edge of the construction right-of-way as necessary to contain spoil within the construction right-of-way and prevent sediment flow into the waterbody; and

c. use temporary trench plugs at all waterbody crossings, as necessary, to prevent diversion of water into upland portions of the pipeline trench and to keep any accumulated trench water out of the waterbody.

11. Trench Dewatering

Dewater the trench (either on or off the construction right-of-way) in a manner that does not cause erosion and does not result in silt-laden water flowing into any waterbody. Remove the dewatering structures as soon as practicable after the completion of dewatering activities.

C. RESTORATION

1. Use clean gravel or native cobbles for the upper 1 foot of trench backfill in all waterbodies that contain coldwater fisheries.

2. For open-cut crossings, stabilize waterbody banks and install temporary sediment barriers within 24 hours of completing instream construction activities. For dry-ditch crossings, complete streambed and bank stabilization before returning flow to the waterbody channel.

3. Return all waterbody banks to preconstruction contours or to a stable angle of repose as approved by the Environmental Inspector.

4. Install erosion control fabric or a functional equivalent on waterbody banks at the time of final bank recontouring. Do not use synthetic monofilament

mesh/netted erosion control materials in areas designated as sensitive wildlife habitat unless the product is specifically designed to minimize harm to wildlife. Anchor erosion control fabric with staples or other appropriate devices.

5. Application of riprap for bank stabilization must comply with COE, or its delegated agency, permit terms and conditions.

6. Unless otherwise specified by state permit, limit the use of riprap to areas where flow conditions preclude effective vegetative stabilization techniques such as seeding and erosion control fabric.

7. Revegetate disturbed riparian areas with native species of conservation grasses, legumes, and woody species, similar in density to adjacent undisturbed lands.

8. Install a permanent slope breaker across the construction right-of-way at the base of slopes greater than 5 percent that are less than 50 feet from the waterbody, or as needed to prevent sediment transport into the waterbody. In addition, install sediment barriers as outlined in the Plan.

   In some areas, with the approval of the Environmental Inspector, an earthen berm may be suitable as a sediment barrier adjacent to the waterbody.

9. Sections V.C.3 through V.C.7 above also apply to those perennial or intermittent streams not flowing at the time of construction.

D. POST-CONSTRUCTION MAINTENANCE

1. Limit routine vegetation mowing or clearing adjacent to waterbodies to allow a riparian strip at least 25 feet wide, as measured from the waterbody's mean high water mark, to permanently revegetate with native plant species across the entire construction right-of-way. However, to facilitate periodic corrosion/leak surveys, a corridor centered on the pipeline and up to 10 feet wide may be cleared at a frequency necessary to maintain the 10-foot corridor in an herbaceous state. In addition, trees that are located within 15 feet of the pipeline that have roots that could compromise the integrity of the pipeline coating may be cut and removed from the permanent right-of-way. Do not conduct any routine vegetation mowing or clearing in riparian areas that are between HDD entry and exit points.

2. Do not use herbicides or pesticides in or within 100 feet of a waterbody except as allowed by the appropriate land management or state agency.

3. Time of year restrictions specified in section VII.A.5 of the Plan (April 15 – August 1 of any year) apply to routine mowing and clearing of riparian areas.

VI. WETLAND CROSSINGS

A. GENERAL

1. The project sponsor shall conduct a wetland delineation using the current federal methodology and file a wetland delineation report with the Secretary before construction. The requirement to file a wetland delineation report does not apply to projects constructed under the automatic authorization provisions in the FERC's regulations.

   This report shall identify:

   a. by milepost all wetlands that would be affected;

   b. the National Wetlands Inventory (NWI) classification for each wetland;

   c. the crossing length of each wetland in feet; and

   d. the area of permanent and temporary disturbance that would occur in each wetland by NWI classification type.

   The requirements outlined in this section do not apply to wetlands in actively cultivated or rotated cropland. Standard upland protective measures, including workspace and topsoiling requirements, apply to these agricultural wetlands.

2. Route the pipeline to avoid wetland areas to the maximum extent possible. If a wetland cannot be avoided or crossed by following an existing right-of-way, route the new pipeline in a manner that minimizes disturbance to wetlands. Where looping an existing pipeline, overlap the existing pipeline right-of-way with the new construction right-of-way. In addition, locate the loop line no more than 25 feet away from the existing pipeline unless site-specific constraints would adversely affect the stability of the existing pipeline.

3. Limit the width of the construction right-of-way to 75 feet or less. Prior written approval of the Director is required where topographic conditions or soil limitations require that the construction right-of-way width within the boundaries of a federally delineated wetland be expanded beyond 75 feet. Early in the planning process the project sponsor is encouraged to identify site-specific areas where excessively wide trenches could occur and/or where spoil piles could be difficult to maintain because existing soils lack adequate unconfined compressive strength.

4. Wetland boundaries and buffers must be clearly marked in the field with signs and/or highly visible flagging until construction-related ground disturbing activities are complete.

5. Implement the measures of sections V and VI in the event a waterbody crossing is located within or adjacent to a wetland crossing. If all measures of sections V and VI cannot be met, the project sponsor must file with the Secretary a site-specific crossing plan for review and written approval by the Director before construction. This crossing plan shall address at a minimum:

   a. spoil control;

   b. equipment bridges;

   c. restoration of waterbody banks and wetland hydrology;

   d. timing of the waterbody crossing;

   e. method of crossing; and

   f. size and location of all extra work areas.

6. Do not locate aboveground facilities in any wetland, except where the location of such facilities outside of wetlands would prohibit compliance with U.S. Department of Transportation regulations.

B. INSTALLATION

1. Extra Work Areas and Access Roads

   a. Locate all extra work areas (such as staging areas and additional spoil storage areas) at least 50 feet away from wetland boundaries, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land.

   b. The project sponsor shall file with the Secretary for review and written approval by the Director, site-specific justification for each extra work area with a less than 50-foot setback from wetland boundaries, except where adjacent upland consists of cultivated or rotated cropland or other disturbed land. The justification must specify the site-specific conditions that will not permit a 50-foot setback and measures to ensure the wetland is adequately protected.

   c. The construction right-of-way may be used for access when the wetland soil is firm enough to avoid rutting or the construction right-of-way has been appropriately stabilized to avoid rutting (e.g., with timber riprap, prefabricated equipment mats, or terra mats).

      In wetlands that cannot be appropriately stabilized, all construction equipment other than that needed to install the wetland crossing shall

use access roads located in upland areas. Where access roads in upland areas do not provide reasonable access, limit all other construction equipment to one pass through the wetland using the construction right-of-way.

d. The only access roads, other than the construction right-of-way, that can be used in wetlands are those existing roads that can be used with no modifications or improvements, other than routine repair, and no impact on the wetland.

2. Crossing Procedures

a. Comply with COE, or its delegated agency, permit terms and conditions.

b. Assemble the pipeline in an upland area unless the wetland is dry enough to adequately support skids and pipe.

c. Use "push-pull" or "float" techniques to place the pipe in the trench where water and other site conditions allow.

d. Minimize the length of time that topsoil is segregated and the trench is open. Do not trench the wetland until the pipeline is assembled and ready for lowering in.

e. Limit construction equipment operating in wetland areas to that needed to clear the construction right-of-way, dig the trench, fabricate and install the pipeline, backfill the trench, and restore the construction right-of-way.

f. Cut vegetation just above ground level, leaving existing root systems in place, and remove it from the wetland for disposal.

The project sponsor can burn woody debris in wetlands, if approved by the COE and in accordance with state and local regulations, ensuring that all remaining woody debris is removed for disposal.

g. Limit pulling of tree stumps and grading activities to directly over the trenchline. Do not grade or remove stumps or root systems from the rest of the construction right-of-way in wetlands unless the Chief Inspector and Environmental Inspector determine that safety-related construction constraints require grading or the removal of tree stumps from under the working side of the construction right-of-way.

h. Segregate the top 1 foot of topsoil from the area disturbed by trenching, except in areas where standing water is present or soils are

saturated. Immediately after backfilling is complete, restore the segregated topsoil to its original location.

i. Do not use rock, soil imported from outside the wetland, tree stumps, or brush riprap to support equipment on the construction right-of-way.

j. If standing water or saturated soils are present, or if construction equipment causes ruts or mixing of the topsoil and subsoil in wetlands, use low-ground-weight construction equipment, or operate normal equipment on timber riprap, prefabricated equipment mats, or terra mats.

k. Remove all project-related material used to support equipment on the construction right-of-way upon completion of construction.

3. Temporary Sediment Control

Install sediment barriers (as defined in section IV.F.3.a of the Plan) immediately after initial disturbance of the wetland or adjacent upland. Sediment barriers must be properly maintained throughout construction and reinstalled as necessary (such as after backfilling of the trench). Except as noted below in section VI.B.3.c, maintain sediment barriers until replaced by permanent erosion controls or restoration of adjacent upland areas is complete. Temporary erosion and sediment control measures are addressed in more detail in the Plan.

a. Install sediment barriers across the entire construction right-of-way immediately upslope of the wetland boundary at all wetland crossings where necessary to prevent sediment flow into the wetland.

b. Where wetlands are adjacent to the construction right-of-way and the right-of-way slopes toward the wetland, install sediment barriers along the edge of the construction right-of-way as necessary to contain spoil within the construction right-of-way and prevent sediment flow into the wetland.

c. Install sediment barriers along the edge of the construction right-of-way as necessary to contain spoil and sediment within the construction right-of-way through wetlands. Remove these sediment barriers during right-of-way cleanup.

4. Trench Dewatering

Dewater the trench (either on or off the construction right-of-way) in a manner that does not cause erosion and does not result in silt-laden water flowing into any wetland. Remove the dewatering structures as soon as practicable after the completion of dewatering activities.

C. RESTORATION

1. Where the pipeline trench may drain a wetland, construct trench breakers at the wetland boundaries and/or seal the trench bottom as necessary to maintain the original wetland hydrology.

2. Restore pre-construction wetland contours to maintain the original wetland hydrology.

3. For each wetland crossed, install a trench breaker at the base of slopes near the boundary between the wetland and adjacent upland areas. Install a permanent slope breaker across the construction right-of-way at the base of slopes greater than 5 percent where the base of the slope is less than 50 feet from the wetland, or as needed to prevent sediment transport into the wetland. In addition, install sediment barriers as outlined in the Plan. In some areas, with the approval of the Environmental Inspector, an earthen berm may be suitable as a sediment barrier adjacent to the wetland.

4. Do not use fertilizer, lime, or mulch unless required in writing by the appropriate federal or state agency.

5. Consult with the appropriate federal or state agencies to develop a project-specific wetland restoration plan. The restoration plan shall include measures for re-establishing herbaceous and/or woody species, controlling the invasion and spread of invasive species and noxious weeds (e.g., purple loosestrife and phragmites), and monitoring the success of the revegetation and weed control efforts. Provide this plan to the FERC staff upon request.

6. Until a project-specific wetland restoration plan is developed and/or implemented, temporarily revegetate the construction right-of-way with annual ryegrass at a rate of 40 pounds/acre (unless standing water is present).

7. Ensure that all disturbed areas successfully revegetate with wetland herbaceous and/or woody plant species.

8. Remove temporary sediment barriers located at the boundary between wetland and adjacent upland areas after revegetation and stabilization of adjacent upland areas are judged to be successful as specified in section VII.A.4 of the Plan.

D. POST-CONSTRUCTION MAINTENANCE AND REPORTING

1. Do not conduct routine vegetation mowing or clearing over the full width of the permanent right-of-way in wetlands. However, to facilitate periodic corrosion/leak surveys, a corridor centered on the pipeline and up to 10 feet wide may be cleared at a frequency necessary to maintain the 10-foot corridor in an herbaceous state. In addition, trees within 15 feet of the pipeline with roots that could compromise the integrity of pipeline coating may be selectively cut and removed from the permanent right-of-way. Do not conduct any routine vegetation mowing or clearing in wetlands that are between HDD entry and exit points.

2. Do not use herbicides or pesticides in or within 100 feet of a wetland, except as allowed by the appropriate federal or state agency.

3. Time of year restrictions specified in section VII.A.5 of the Plan (April 15 – August 1 of any year) apply to routine mowing and clearing of wetland areas.

4. Monitor and record the success of wetland revegetation annually until wetland revegetation is successful.

5. Wetland revegetation shall be considered successful if all of the following criteria are satisfied:

   a. the affected wetland satisfies the current federal definition for a wetland (i.e., soils, hydrology, and vegetation);

   b. vegetation is at least 80 percent of either the cover documented for the wetland prior to construction, or at least 80 percent of the cover in adjacent wetland areas that were not disturbed by construction;

   c. if natural rather than active revegetation was used, the plant species composition is consistent with early successional wetland plant communities in the affected ecoregion; and

   d. invasive species and noxious weeds are absent, unless they are abundant in adjacent areas that were not disturbed by construction.

6. Within 3 years after construction, file a report with the Secretary identifying the status of the wetland revegetation efforts and documenting success as defined in section VI.D.5, above. The requirement to file wetland restoration reports with the Secretary does not apply to projects constructed under the automatic authorization, prior notice, or advance notice provisions in the FERC's regulations.

   For any wetland where revegetation is not successful at the end of 3 years after construction, develop and implement (in consultation with a

professional wetland ecologist) a remedial revegetation plan to actively revegetate wetlands. Continue revegetation efforts and file a report annually documenting progress in these wetlands until wetland revegetation is successful.

VII. HYDROSTATIC TESTING

A. NOTIFICATION PROCEDURES AND PERMITS

1. Apply for state-issued water withdrawal permits, as required.

2. Apply for National Pollutant Discharge Elimination System (NPDES) or state-issued discharge permits, as required.

3. Notify appropriate state agencies of intent to use specific sources at least 48 hours before testing activities unless they waive this requirement in writing.

B. GENERAL

1. Perform 100 percent radiographic inspection of all pipeline section welds or hydrotest the pipeline sections, before installation under waterbodies or wetlands.

2. If pumps used for hydrostatic testing are within 100 feet of any waterbody or wetland, address secondary containment and refueling of these pumps in the project's Spill Prevention and Response Procedures.

3. The project sponsor shall file with the Secretary before construction a list identifying the location of all waterbodies proposed for use as a hydrostatic test water source or discharge location. This filing requirement does not apply to projects constructed under the automatic authorization provisions of the FERC's regulations.

C. INTAKE SOURCE AND RATE

1. Screen the intake hose to minimize the potential for entrainment of fish.

2. Do not use state-designated exceptional value waters, waterbodies which provide habitat for federally listed threatened or endangered species, or waterbodies designated as public water supplies, unless appropriate federal, state, and/or local permitting agencies grant written permission.

3. Maintain adequate flow rates to protect aquatic life, provide for all waterbody uses, and provide for downstream withdrawals of water by existing users.

4. Locate hydrostatic test manifolds outside wetlands and riparian areas to the maximum extent practicable.

D. DISCHARGE LOCATION, METHOD, AND RATE

1. Regulate discharge rate, use energy dissipation device(s), and install sediment barriers, as necessary, to prevent erosion, streambed scour, suspension of sediments, or excessive streamflow.

2. Do not discharge into state-designated exceptional value waters, waterbodies which provide habitat for federally listed threatened or endangered species, or waterbodies designated as public water supplies, unless appropriate federal, state, and local permitting agencies grant written permission.

APPENDIX E

General Notes

APPENDIX E

General Notes

TABLE 6-1

GENERAL EROSION AND SEDIMENT CONTROL NOTES

ES-1: Unless otherwise indicated, all vegetative and structural erosion and sediment control practices will be constructed and maintained according to minimum standards and specifications of the Virginia Erosion and Sediment Control Handbook and Virginia Regulations 4VAC50-30 Erosion and Sediment Control Regulations.

ES-2: The plan approving authority must be notified one week prior to the pre-construction conference, one week prior to the commencement of land disturbing activity, and one week prior to the final inspection.

ES-3: All erosion and sediment control measures are to be placed prior to or as the first step in clearing.

ES-4: A copy of the approved erosion and sediment control plan shall be maintained on the site at all times.

ES-5: Prior to commencing land disturbing activities in areas other than indicated on these plans (including, but not limited to, off-site borrow or waste areas), the contractor shall submit a supplementary erosion control plan to the owner for review and approval by the plan approving authority.

ES-6: The contractor is responsible for installation of any additional erosion control measures necessary to prevent erosion and sedimentation as determined by the plan approving authority.

ES-7: All disturbed areas are to drain to approved sediment control measures at all times during land disturbing activities and during site development until final stabilization is achieved.

ES-8: During dewatering operations, water will be pumped into an approved filtering device.

ES-9: The contractor shall inspect all erosion control measures periodically and after each runoff-producing rainfall event. Any necessary repairs or cleanup to maintain the effectiveness of the erosion control devices shall be made immediately.

NOTE: General Notes incorporated into plans must use the current regulatory reference to 9VAC25-840 (and not 4VAC50-30, as cited above).

The following additional notes may be required by DEQ if a SWM Plan Waiver or CGP waiver is granted.

Additional Notes:

- *The project may not significantly alter the predevelopment runoff characteristics of the land surface after completion of construction and final stabilization;*

- The project may not significantly alter the predevelopment runoff characteristics of the land surface after the completion of construction and final stabilization.
- The project will be managed so that less than one (1) acre of land disturbance occurs on a daily basis.
- The disturbed land where work has been completed is adequately stabilized on a daily basis.
- The environment must be protected from erosion and sedimentation damage associated with the land-disturbing activity.
- DETI and/or the construction activity operator must design, install, implement and maintain pollution prevention measures to:

    - *Minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other wash waters;*

    - *Minimize the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, pesticides, herbicides, detergents, sanitary waste, and other materials present on-site to precipitation and to stormwater;*

    - *Minimize the discharge of pollutants from spills and leaks and implement chemical spill and leak prevention and response procedures;*

    - *Prohibit the discharge of wastewater from the washout of concrete;*

    - *Prohibit the discharge of wastewater from the washout and cleanout of stucco, paint, form release oils, curing compounds, and other construction materials; and*

    - *Prohibit the discharge of fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance.*

- DETI must provide reasonable assurance to DEQ that all of the above conditions will be satisfied. This may be accomplished by incorporating these conditions into an Erosion and Sediment Control Plan developed for the project.

TABLE 6-1

GENERAL EROSION AND SEDIMENT CONTROL NOTES

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- DETI and/or the construction activity operator must design, install, implement and maintain pollution prevention measures to:

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    - *Minimize the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, pesticides, herbicides, detergents, sanitary waste, and other materials present on-site to precipitation and to stormwater;*

    - *Minimize the discharge of pollutants from spills and leaks and implement chemical spill and leak prevention and response procedures;*

    - *Prohibit the discharge of wastewater from the washout of concrete;*

    - *Prohibit the discharge of wastewater from the washout and cleanout of stucco, paint, form release oils, curing compounds, and other construction materials; and*

    - *Prohibit the discharge of fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance.*

- DETI must provide reasonable assurance to DEQ that all of the above conditions will be satisfied. This may be accomplished by incorporating these conditions into an Erosion and Sediment Control Plan developed for the project.

APPENDIX F

Linear Utility Projects Guidance

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER DIVISION

Subject: **Guidance Memo No. 15-2003**
Postdevelopment Stormwater Management Implementation Guidance for Linear Utility Projects under the Virginia Stormwater Management Program Regulation, 9VAC25-870

To: Regional Directors and Local VSMP Administrators

From: Melanie D. Davenport, Director

Date: April 23, 2015

Copies: James Golden, Jeff Steers, Fred Cunningham, Joan Salvati, Allan Brockenbrough, Jerome Brooks, Regional Stormwater Compliance Managers

Summary:

Section 76 (Linear Development Projects) of the Virginia Stormwater Management Program (VSMP) Regulation, 9VAC25-870, sets forth the postdevelopment stormwater management requirements for linear development projects. The purpose of this guidance document is to clarify the implementation of Section 76 with regards to the construction of linear utilities (e.g., waterlines, sewer lines, electric lines, telephone lines, oil and gas distribution pipelines, etc.) and was developed for use by the Department and local VSMP Authorities.

Electronic Copy:

An electronic copy of this guidance document in PDF format is available for staff internally on DEQNET, and for the general public on DEQ's website at: http://www.deq.virginia.gov/Programs/Water/Laws,Regulations,Guidance/Guidance/WaterPermitGuidance.aspx.

Contact Information:

Please contact Drew Hammond, Office of Stormwater Management, at (804) 698-4037 or Andrew.Hammond@deq.virginia.gov with any questions regarding the application of this guidance.

Disclaimer:

This document is provided as guidance and, as such, sets forth standard operating procedures for the agency. However, it does not mandate or prohibit any particular action not otherwise required or prohibited by law or regulation. If alternative proposals are made, such proposals will be reviewed and accepted or denied based on their technical adequacy and compliance with appropriate laws and regulations.

Postdevelopment Stormwater Management Implementation Guidance for Linear Utility Projects under the Virginia Stormwater Management Program Regulation, 9VAC25-870

Definitions:

"Land disturbance" or "land-disturbing activity" means a manmade change to the land surface that potentially changes its runoff characteristics including clearing, grading, or excavation, except that the term shall not include those exemptions specified in § 62.1-44.15:34 of the Code of Virginia.

"Linear development project" means a land-disturbing activity that is linear in nature such as, but not limited to, (i) the construction of electric and telephone utility lines, and natural gas pipelines; (ii) construction of tracks, rights-of-way, bridges, communication facilities and other related structures of a railroad company; (iii) highway construction projects; (iv) construction of stormwater channels and stream restoration activities; and (v) water and sewer lines. Private subdivision roads or streets shall not be considered linear development projects.

"Postdevelopment" refers to conditions that reasonably may be expected or anticipated to exist after completion of the land development activity on a specific site.

"Predevelopment" refers to the conditions that exist at the time that plans for the land development of a tract of land are submitted to the VSMP authority. Where phased development or plan approval occurs (preliminary grading, demolition of existing structures, roads and utilities, etc.), the existing conditions at the time prior to the first item being submitted shall establish predevelopment conditions.

"Stabilized" means land that has been treated to withstand normal exposure to natural forces without incurring erosion damage.

"Stormwater management plan" means a document(s) containing material for describing methods for complying with the requirements of the VSMP Regulation, 9VAC25-870.

"Virginia Stormwater Management Program (VSMP) authority" means an authority approved by the Board after September 13, 2011 to operate a Virginia Stormwater Management Program or the Department.

Regulatory Text:

9VAC25-870-76. Linear development projects.

Linear development projects shall control postdevelopment stormwater runoff in accordance with a site-specific stormwater management plan or a comprehensive watershed stormwater management plan developed in accordance with these regulations.

Guidance:

Section 76 of the VSMP Regulation, 9VAC25-870, establishes the requirement that linear development projects control postdevelopment stormwater runoff in accordance with a site-specific stormwater management plan or a comprehensive watershed stormwater management plan. The purpose of this guidance document is to clarify the implementation of Section 76 with regard to the construction of linear utilities (e.g., waterlines, sewer lines, electric lines, telephone lines, oil and gas distribution pipelines, etc.) and was developed for use by the Department and local VSMP Authorities.

The VSMP Regulation does not distinguish between various types of linear development projects such as aboveground or underground utilities, highway construction, rights-of-way, bridges, tracks and related structures of a railroad company. The Department of Environmental Quality (DEQ) recognizes that the construction of aboveground or underground linear utilities may not result in changes to the predevelopment runoff characteristics of the land surface after the completion of construction and final stabilization. Also, the application of the postdevelopment water quantity and water quality controls to these types of projects and the preparation and implementation of a stormwater management plan may provide minimum water quality benefit. Examples of such projects include:

- The installation of underground utilities (e.g., waterlines, sewer lines, oil and gas distribution pipelines) beneath existing impervious cover (e.g., asphalt pavement, concrete pavement) that will be returned to its predevelopment condition after the completion of construction and final stabilization;

- The installation of underground utilities (e.g., waterlines, sewer lines, oil and gas distribution pipelines) beneath existing pervious cover (e.g., forest/open space, managed turf) that will be returned to its predevelopment condition after the completion of construction and final stabilization; or

- The installation of aboveground (i.e., overhead) utility lines.

DEQ staff or the local VSMP authority should utilize their best professional judgment when evaluating aboveground or underground linear utility projects. If the project will not result in significant changes to the predevelopment runoff characteristics of the land surface after the completion of construction and final stabilization, then DEQ or the local VSMP authority, at their discretion, may waive the requirement for the preparation and implementation of a stormwater management plan. DEQ recognizes that on a site specific basis a stormwater management plan may be required especially if the linear utility project will significantly alter the predevelopment runoff characteristics of the land surface.

In addition, the construction of aboveground or underground linear utilities may be conducted without requiring coverage under the General VPDES Permit for Discharges of Stormwater from Construction Activities (Construction General Permit) provided that:

- The project does not significantly alter the predevelopment runoff characteristics of the land surface after the completion of construction and final stabilization;

- The project is managed so that less than one (1) acre of land disturbance occurs on a daily basis;

- The disturbed land where work has been completed is adequately stabilized on a daily basis;

- The environment is protected from erosion and sedimentation damage associated with the land-disturbing activity;

- The owner and/or construction activity operator designs, installs, implements, and maintains pollution prevention measures to:

    - Minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other wash waters;

    - Minimize the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, pesticides, herbicides, detergents, sanitary waste, and other materials present on-site to precipitation and to stormwater;

    - Minimize the discharge of pollutants from spills and leaks and implement chemical spill and leak prevention and response procedures;

    - Prohibit the discharge of wastewater from the washout of concrete;

    - Prohibit the discharge of wastewater from the washout and cleanout of stucco, paint, form release oils, curing compounds, and other construction materials; and

    - Prohibit the discharge of fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance.

- The owner and/or construction activity operator provides reasonable assurance to DEQ or the local VSMP Authority that all of the above conditions will be satisfied. This may be accomplished by incorporating these conditions into an erosion and sediment control plan developed for the project.

As previously noted, DEQ staff or the local VSMP authority should utilize their best professional judgment when evaluating aboveground or underground linear utility projects. If the owner and/or construction activity operator provides reasonable assurance to DEQ or the local VSMP Authority that all of the aforementioned conditions will be satisfied, then the linear utility project may be conducted without requiring coverage under the Construction General Permit. Please note that this does not relieve the owner and/or construction activity operator from complying with any and all other applicable federal, state, and local requirements. DEQ or the local VSMP Authority reserves the right to require a registration statement for Construction General Permit coverage if the aforementioned conditions are not satisfied.

If the linear utility project will significantly alter the predevelopment runoff characteristics of the land surface requiring postdevelopment stormwater management or if other site specific conditions warrant Construction General Permit coverage, DEQ or the local VSMP authority may require a registration statement for permit coverage.

APPENDIX G

ACP Specific Requirements

Per the request received from DEQ by letter dated May 16, 2016 for the Atlantic Coast Pipeline (ACP) Project, **DETI has agreed to incorporate the following more stringent conditions into the planning and implementation phases of Erosion and Sediment Control and Stormwater Management for ACP**:

1. In addition to DETI's internal review process, individual project-specific plans will be submitted to DEQ for review and approval.
2. Given the nature of critical infrastructure, the project-specific Erosion and Sediment Control and Stormwater Management plans and DEQ approval will be made available to DEQ and may be made available to others as agreed upon in a memorandum to be negotiated between DETI and DEQ.
3. Inspection reports conducted by DETI as well as complaint logs and complaint responses will be submitted to DEQ.
4. DETI will provide for payment to DEQ of reasonable costs incurred by DEQ to hire additional technical expertise to assist DEQ in plan review and compliance activities for the ACP project, as articulated in the MOA current being negotiated with DEQ for the Atlantic Coast Pipeline project.

ACP Alternative ESC Practices or Procedures	
Handbook Specification	**Rationale for Alternative Method (as applicable)**
VESCH **Std. & Spec. 3.01 (Safety Fence)** "The polyethylene web of the plastic safety fence shall be secured to a conventional metal 'T' or "U" post driven into the ground to a minimum depth of 18 inches."	Stakes will be installed to the maximum extent of 18" as practical in the field to ensure the functionality of the safety fence. In areas where adequate embedment depth cannot be achieved, due to terrain/substrate constraints; additional measures including but not limited to sandbags, mounded earth, etc. will be utilized to secure the fence.
VESCH **Std. & Spec. 3.02 (Stone Construction Entrance)** "The entrance shall be maintained in a condition which will prevent tracking or flow of mud onto public rights-of-way. This may require periodic top dressing with additional stone or the washing and reworking of existing stone as conditions demand and repair and /or cleanout of any structures used to trap sediment. All materials spilled, dropped, washed, or tracked from vehicles onto roadways or into storm drains must be removed immediately. The use of water trucks to remove materials dropped, washed, or tracked onto roadways will not be permitted under any circumstances."	Instead, follow Virginia Minimum Standard MS-17 "Where construction vehicle access routes intersect paved or public roads, provisions shall be made to minimize the transport of sediment by vehicular tracking onto the paved surface. Where sediment is transported onto a paved or public road surface, the road surface shall be cleaned thoroughly at the end of each day. Sediment shall be removed from the roads by shoveling or sweeping and transported to a sediment control disposal area. Street washing shall be allowed only after sediment is removed in this manner."
VESCH **Std. & Spec. 3.11 (Temporary ROW Diversion)** "Grade- Positive drainage (with less than 2% slope) should be provided to a stabilized outlet, sediment-trapping facility, or a vegetative buffer strip of adequate size."	Exemption requested to increase fall slope of temporary ROW diversion to greater than 2 percent to help prevent temporary ROW diversion and overall potential slope failures by allowing the water to move off of the limits of disturbance. Temporary ROW diversions will have energy dissipating devices (coir logs, belted silt retention fence, rock aprons, etc.) installed at the outfall to slow and filter the water prior to exiting the limits of disturbance.
VESCH **Std. & Spec. 3.24 (Temporary Vehicular Stream Crossing)** "If the structure will remain in place for up to 14 days, the culvert shall be large enough to convey the flow from a 2-year frequency storm without appreciably altering the stream flow characteristics."	Exception requested to allow use of the 1-year frequency storm to size culverts that will be in place for up to 14 days since use of the 2-year frequency storm often results in culverts that are larger than the waterbody cross-section. Exception requested that if application of Std. & Spec. 3.24 results in a culvert that is larger than the cross-section of the waterbody, the selected culvert size will be based on that which can be accommodated without modification of the stream geometry.

VESCH **Std.& Spec. 3.26 (Dewatering Structure)** <u>For a Straw Bale/Silt Fence Pit</u> "Measure shall consist of straw bales, silt fence, a stone outlet (a combination of VDOT Class AI Riprap and VDOT #25 or #26 Aggregate) and a wet storage pit" "The excavated area should be a minimum of 3 feet below the base of the perimeter measures (straw bales or silt fence)."	In some cases, ACP could use a modified dewatering structure in combination with a filter bag. The structure is similar to the straw bale/silt fence pit described in the VESCH, but the wet storage area is not excavated 3 ft below the perimeter measures since the structures are placed off the right-of-way in well vegetated areas. The filter bag discharges into the dewatering structure for additional filtration through the straw bales. Additional energy dissipating devices may be installed downgradient of the dewatering structure, as necessary. It is noted that filter bags are often installed off the right-of-way to avoid discharge to denuded areas on the right-of-way and to benefit from additional filtration provided by the vegetation that exists off the right-of-way. Prior to installing a dewatering structure off the right-of-way appropriate coordination with the landowner will occur. Installation and removal of the referenced dewatering practice does not involve ground disturbance.
VESCH **Std. & Spec. 3.31 (Temporary Seeding**) Liming: An evaluation should be conducted to determine if lime is necessary for temporary seeding. Fertilizer: Shall be applied as 600 lbs./acre of 10-20-10 (14 lbs./1,000 sq. ft.) or equivalent nutrients. Lime and fertilizer shall be incorporated into the top 2 to 4 inches of the soil, if possible.	It is noted that, in accordance with Virginia Minimum Standard MS-2 will be adhered to by protecting stockpiles with sediment trapping measures (i.e. perimeter controls). Additionally, if during routine inspections it is observed that temporary seed is not successfully establishing within 14 days, the appropriate amendments will be considered and if needed, will be incorporated in accordance with ESC Technical Bulletin #4. Temporary and permanent stabilization shall be applied strictly in accordance with MS-1.
VESCH **Std. & Spec. 3.36 (Soil Stabilization Blankets and Matting)** "Site Preparation- After site has been shaped and	Exception to removing all "clods and rocks" more than 1" in diameter. Erosion control blankets and matting will be installed according to manufacturers' specifications and in a way that

ACP Alternative ESC Practices or Procedures	
Handbook Specification	**Rationale for Alternative Method (as applicable)**
graded to approved design, prepare a friable seeded relatively free from clods and rocks more than 1 inch in diameter, and any foreign material that will prevent contact of the soil stabilization mat with the soil surface."	achieves intimate contact with soils/substrate to help reduce the potential for erosion underneath the installed fabric.

APPENDIX H

Approved Deviations

Deviations from technical guidance documents that have been approved by DEQ for alterations to existing practices or additional practices should be catalogued with these annual standards and be incorporated into future revisions to the Standards and Specifications, if applicable. Both the deviation request and the approval letter should be inserted in this appendix upon approval.

Deviation Request Log

Request Date	Std &Spec.	Approval Date	Summary	Approved (Y/N)

APPENDIX I

Slope Stability Policy and Procedure for Pipeline Design, Construction and Right of Way Maintenance

NOTE: *In instances where the VESCH criteria and the Slope Stability Policy differ, the more stringent of the two criteria shall apply.*

Slope Stability Policy and Procedure for Pipeline Design, Construction and Right of Way Maintenance

Dominion Transmission, Inc.

Engineering Services Reference Manual

Revised 12/1/2016

Slope Stability Policy and Procedure for Pipeline Design, Construction and Right of Way Maintenance

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ACRONYM LIST

BMP – Best management practice
CLSM – Controlled low strength material
DCNR – (Pennsylvania) Department of Conservation and Natural Resources
DTI – Dominion Transmission, Inc.
DTM – Digital terrain model
E&S – Erosion and Sediment
E&SC – Erosion and sediment control
ECC – Environmental Compliance Coordinator
EI – Environmental Inspector
EIES – Energy Infrastructure Environmental Services
FERC – Federal Energy Regulatory Commission
GIS – Geographic information system
GPS – Global positioning system
HDD – Horizontal Directional Drill
LiDAR – Light Detection and Ranging
LMS – Learning management system
LOD – Limit of disturbance
MD - Maryland
MSE – Mechanically stabilized earth
NOT – Notice of Termination
NRCS – National Cooperative Soil Survey
NRI – Natural Resource Inventory
OEPA – Ohio Environmental Protection Agency
OGRIP – Ohio Geographically Referenced Information Program
PAMAP – Pennsylvania Map
ROW – Right of way
RSS – Reinforced Soil Slope
SWPPP – Stormwater Pollution Prevention Plan
TWS – Temporary work space
USDA – United States Department of Agriculture
USGS – United States Geological Survey

VESCP – Virginia Erosion and Sediment Control Program
WSS – Web Soil Survey
WV – West Virginia
WVDEP – West Virginia Department of Environmental Protection
WVDOH – West Virginia Department of Highways
WVGES – West Virginia Geological and Economic Survey

Slope Stability Policy and Procedure for Pipeline Design, Construction and Right of Way Maintenance

POLICY:

The following slope stability procedure must be utilized as part of the development and execution of any Dominion Transmission, Inc. (DTI) pipeline project. The possibility of slope failures including landslides, will be considered during the routing, design, construction, restoration and post-construction phases of a pipeline project to avoid, reduce, or mitigate the incidence of slope failures on DTI pipeline projects. Specifically, DTI personnel and contractors engaged in pipeline projects must be trained to understand this policy and conform to the following procedure.

PROCEDURE:

1.0 Applicability

This policy and procedure will become effective on September 30, 2016. The applicability table shown below provides the details of which sections of the procedure are applicable for new pipeline projects, active pipeline projects and pipeline replacement projects.

Table 1: Applicability Sections for New Pipeline Projects, Pipeline Replacement Projects, and Existing ROW.

Applicable Sections	New pipeline projects that begin permitting after 9/30/2016	Pipeline Replacement Projects in Existing ROW	Slope Failures on Existing ROW
2.0 Introduction	X	X	
2.1 Slope Failure Susceptibility	X	X	
2.2 Types of Slope Failures	X	X	
2.3 Slope Failure Causes	X	X	
3.0 Pipeline Route Selection	X		
3.1 Preliminary Route Selection	X		
3.2 Desktop Study	X		
3.2.1 Existing Landslide Maps and Data	X		
3.2.2 Define Slopes of Greater than 30 Degrees	X	X	
3.2.3 USDA Natural Resources Conservation Service Soil Surveys	X	X	
3.2.4 Light Detection and Ranging (LiDAR)	X		

Table 1: Applicability Sections for New Pipeline Projects, Pipeline Replacement Projects, and Existing ROW, Continued.

Applicable Sections	New pipeline projects that begin permitting after 9/30/2016	Pipeline Replacement Projects in Existing ROW	Slope Failures on Existing ROW
3.2.5 Mine Study	X		
3.2.6 Desktop Study Mapping	X		
3.3 Field Reconnaissance	X	X	
3.4 Desktop Slope Failure Risk Assessment	X		
3.5 Selection of Preventative Measures for Identified High Risk Slope Failure Locations	X		
3.5.1 Selection of Preventative Measures for Pipeline Replacement Projects		X	
4.0 Pipeline Design and Engineering	X	X	
4.1 Excavation Minimization	X	X	X
4.2 Document Slope Failure Areas on Project Plans	X	X	
4.3 Temporary Work Space (TWS)	X	X	X
4.4 Include Additional Drainage	X	X	X
4.5 Engineered Details	X	X	X
4.6 Construction Stormwater Permit	X	X	
4.7 Stormwater Pollution Prevention Plan	X	X	
4.8 Documentation of Design Information	X		
5.0 Pipeline Preconstruction Planning	X	X	

Table 1: Applicability Sections for New Pipeline Projects, Pipeline Replacement Projects, and Existing ROW, Continued.

Applicable Sections	New pipeline projects that begin permitting after 9/30/2016	Pipeline Replacement Projects in Existing ROW	Slope Failures on Existing ROW
5.1 Slope Failure Training	X	X	X
5.1.1 Training	X	X	X
5.1.2 Environmental Permit Transition	X	X	X
5.2 Slope Failure Mitigation and Response Materials	X	X	
6.0 Addressing Slope failures during Construction	X	X	
6.1 Inspections	X	X	
6.2 Responding to Slope Failures	X	X	X
6.2.1 Evaluate Priority	X	X	X
6.2.2 Install Temporary BMPs	X	X	X
6.2.3 Gather Data	X	X	X
6.2.4 Select Slope Failure Repair Approach	X	X	X
6.2.5 Install Short Term Stabilizing Measures	X	X	X
6.2.6 Implement and Document Slope Failure Repair	X	X	X
6.2.7 Documentation of Repairs	X	X	X
7.0 Addressing Slope Failures after Construction	X	X	X
8.0 Slope Failures Caused by a Third Party	X	X	X

2.0 Introduction

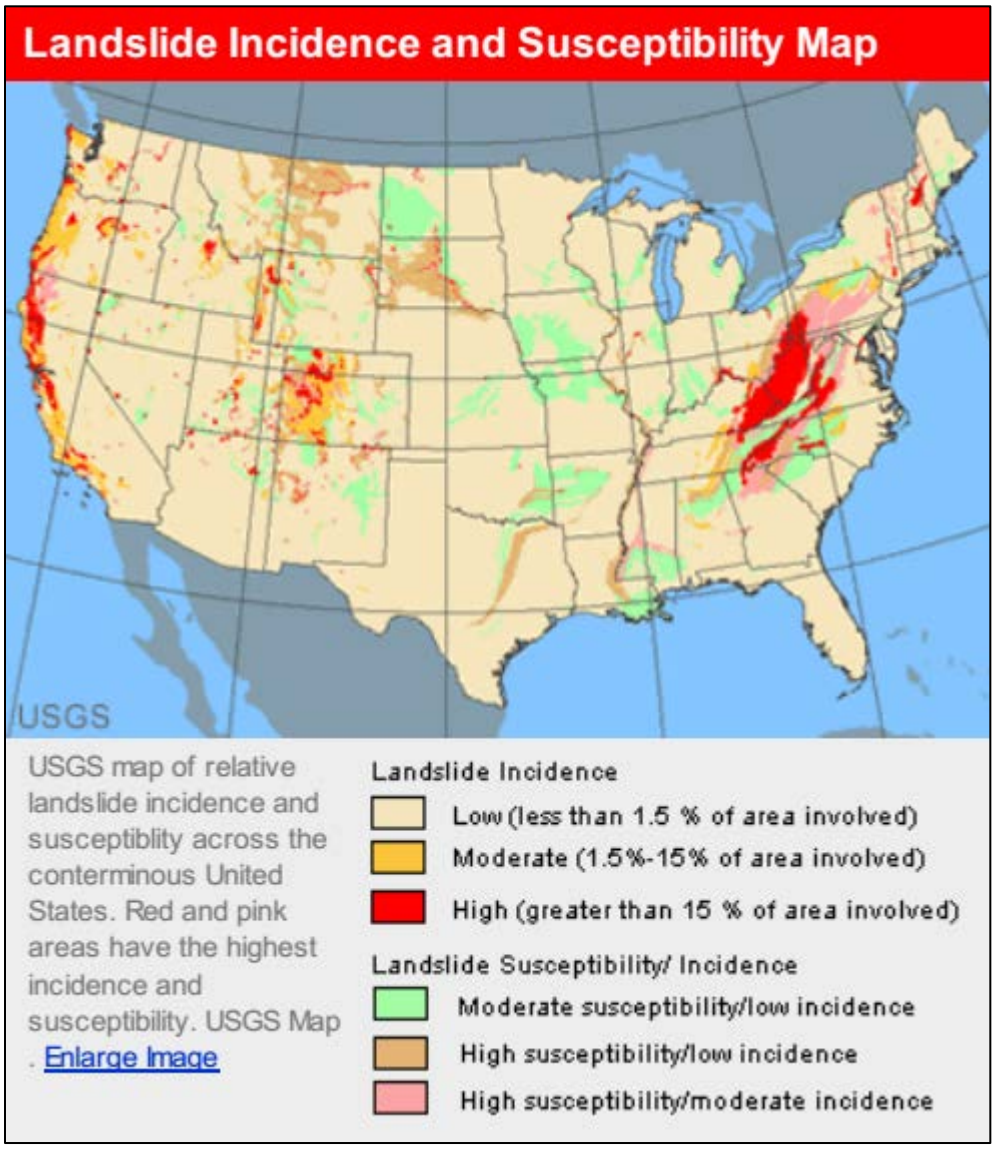
Slope failures, also referred to as landslides or slips on pipeline right-of-ways (ROW) can create adverse erosion control conditions, result in sediment deposits in adjacent waterways, cause landowner complaints, and/or damage the pipeline or other infrastructure. Additionally, slope failures can be costly to repair. Recognizing that the location of slope failures can be challenging to predict, the purpose of this procedure is to avoid and/or reduce the number and severity of slope failures that occur on new Dominion pipeline ROW, and planned expansion of existing Dominion ROW. Every pipeline project and slope failure is unique. Therefore, the specific requirements during project planning and implementation are dependent upon the site-specific conditions. The procedure provides the following:

- A method of identifying potential slope failures;
- Preventative measures;
- A method of protecting waterbodies from slope failure material runoff;
- Containment procedures for slope failure material;
- Remediation procedures; and,
- Training requirements.

2.1 Slope Failure Susceptibility

Slope failures are plentiful and occur naturally in a large portion of the DTI operating area, and in particular the Appalachian Plateau and Valley and Ridge Provinces. Susceptibility is generally associated with cohesive soils (Silts and Clays) formed on steeper slopes that are triggered by precipitation, gravity and human activities. This region has some of the highest landslide or slope failure susceptibility in the United States, as indicated in Figure 1, which shows a USGS landslide map of the conterminous United States, and Figure 2, which shows a smaller scale map of DTI's operating area, with the locations having the highest risk of landslides shown in red.

Figure 1 – Landslide Susceptibility Map of the United States[1]



[1] USGS - Landslide Overview Map of the Conterminous United States

Dominion

PIPELINE TRANSMISSION SYSTEM
LEGEND

- TRANSMISSION COMPRESSOR STATION
- PRODUCTION COMPRESSOR STATION
- STORAGE COMPRESSOR STATION
- MEASURING AND REGULATING FACILITY
- DOMINION TRANSMISSION
- JOINT OWNERSHIP/PARTNERSHIP INTEREST
- DOMINION EAST OHIO
- LNG TERMINAL
- POINT OF GAS RECEIPT
- POINT OF GAS DELIVERY TO AFFILIATES
- POINT OF GAS DELIVERY TO NON-AFFLIATES
- GAS STORAGE POOL
- OTHER PIPELINES
- DOMINION HOPE

SCALE
50 30 10 0 50 100 150 MILES

Revised 06/09/16 MPR

LANDSLIDE INCIDENCE	
	LOW (LESS THAN 1.5% OF AREA INVOLVED)
	MODERATE (1.5%–15% OF AREA INVOLVED)
	HIGH (GREATER THAN 15% OF AREA INVOLVED)
LANDSLIDE SUSCEPTIBILITY/INCIDENCE	
	MODERATE SUSCEPTIBILITY/LOW INCIDENCE
	HIGH SUSCEPTIBILITY/LOW INCIDENCE
	HIGH SUSCEPTIBILITY/MODERATE INCIDENCE

PREPARED BY:
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Landslides are common in the mountainous terrain of Virginia due to the presence of steep slopes and highly fractured bedrock overlain by shallow soils. The greatest landslide hazards are present in western and southwestern Virginia. Areas of low-relief such as the Piedmont and Coastal Plain also have landslides but these are generally smaller and generated by human disturbance.

Landslides have occurred throughout the majority of Pennsylvania. However, most landslides occur in southwestern Pennsylvania in areas where shallow soils are developed on steep slopes that have clay-rich bedrock. Areas such as this include the Waynesburg Hills and Pittsburgh Low Plateau sections of the Appalachian Plateaus province.

Landslides are rare or nonexistent throughout much of Ohio due to a lack of steep slopes and/or lack of geologic units prone to failure. However, there are a few areas of Ohio that experience frequent landslides. Portions of eastern and southern Ohio are characterized by steep slopes and several hundred feet of local relief. Bedrock of Mississippian, Pennsylvanian, and Permian ages, thick colluvium, and thick lake silts and outwash formed in association with Pleistocene glaciers make these areas particularly prone to slope failures. Red mudstones lose strength when they become wet and are the most slide-prone rocks in eastern Ohio. The state has experienced slope failures in areas where thick colluvium has developed, such as in Hamilton and Clermont County and the Scioto River Valley. The north-eastern half of Ohio along the Lake Erie shoreline experiences continual erosion, preventing the natural achievement of slope stability.

New York is not categorized as a state with a serious landslide threat as most of the state's soil consists of dense glacial till comprised mostly of granular material that is not prone to landsliding. However, landslides have occurred across all of New York State, from the Adirondacks to Long Island where soft cohesive soils exist. The most common type of landslides that occur in New York are due to the combination of New York's physiography and glacial history with most landslides occurring along major rivers and lake valleys were there were previously glacial lakes. These lakes result in glacial lake deposits (silts and clays) and are generally associated with steeper slopes.

2.1.1 Appalachian Highlands Region

The geology of the Appalachian Highlands is a primary contributor to the high incidence of slope failures. The Appalachian Plateau Province in West Virginia and Pennsylvania occurs west of the Appalachian Front, and coincides with the highest incidence of slope failures. This region contains narrow valleys and

steep sided slopes with some deeper valleys. Overburden soils generally consist of colluvium overlying shallow bedrock. Colluvium is soil and debris (rock, tree material, etc.) that accumulate at the base of a slope or along the side slope by mass wasting or sheet erosion. It generally includes angular rock fragments, not sorted according to size, and could contain larger portions of bedrock. The sedimentary bedrock is mostly of the Permian-Pennsylvanian age that is relatively flat-lying and consists of cyclic sequence of sandstone, red beds, shale, limestone, and coal from the Dunkard and Monongahela Groups. Bedrock from the underlying Conemaugh Group is present in the deeper valleys. Because of the region's steep topography, abundant rainfall, low shear strength rocks, and soils with low residual strength, landslides have resulted in major infrastructure and property damage. In addition, large portions of West Virginia are extensively underlain by deep mining operations and strip mines that can also be associated with ground movements.

Southeast of the Appalachian Plateau, the flanks of the Appalachian Ridges and the Blue Ridge are covered by colluvium that is highly susceptible to sliding. Because the colluvium covers many types of bedrock, the map designations of landslide incidence and susceptibility cross formational boundaries. The designations do not correspond so closely in these areas to the units on the geologic map of the United States as they do in most areas west of the Mississippi. Most slope movements in the colluvium consist of slowly moving debris slides although many debris avalanches and debris flows can occur. Rainfall and the subsequent increase in groundwater conditions is a common trigger for landslides in this region, with the factors being the soil types and shape of the land surface, all of which relate to the underlying bedrock geology, and in many cases to slope modifications by human activity. Widespread occurrences of landslides coincide with major rainfall events, especially when the remnants of large storms track over the mountains.

In the Great Valley of Pennsylvania, Maryland, West Virginia and Virginia, east of the Appalachian Ridges, broad areas of Cambrian and Ordovician limestone contain pockets of thick residual clay that is moderately susceptible to sliding. This clay forms many small earth flows and slumps, especially along highway cuts.

2.1.2 Piedmont Region

East of the Appalachian Mountains, is the Piedmont Province of Maryland, Pennsylvania and Virginia. The province is a dissected rolling plain formed on residual soil from deeply weathered metamorphic rocks, and is bordered on the east by a dissected terraced plain on thick deposits of sand, gravel, and

clay. Most of the region is free of landslides, except in the Lower Cretaceous clays of Maryland and Virginia, where the incidence of slumps and earth flows is high.

2.1.3 Atlantic Coastal Plain Region

The low dissected Atlantic Coastal plain of Maryland and Virginia is generally free of slope instability due to the moderate terrain in the majority of the area. However, there are localized areas in eastern Maryland with relatively steep slopes that have a high incidence of slope failures. In addition, a majority of Southern Maryland is highly susceptible to slope failure where the Marlboro Clay is exposed. A poorly exposed outcropping of Marlboro Clay begins in Prince Georges County and continues southwest for approximately 20 miles reaching into Charles County. Slope failures are particularly numerous in the east-central and south-western portions of Prince Georges County. Also, in the valleys of Piscataway and Mattawoman Creeks, the clay is mostly buried beneath Holocene alluvium.

2.2 Types of Slope Failures

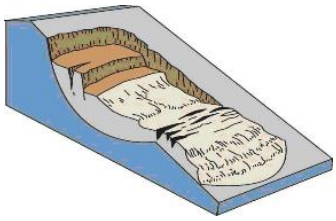
The term landslide or slip as it pertains to geologic reference can be defined as[2]: 1. the downward falling or sliding of a mass of soil, detritus, or rock, on or from a steep slope; 2. the mass itself. Other terms used to describe slips include landslides, land slips, land movements, slumps, slides, etc. The term “head scarp” refers to the tear in the ground surface located at the top of a slip. The term “toe bulge” refers to the mound of failed soil at the base of the slip.

The most common types of slips are described below[3], and a representation of some typical slips observed on pipeline ROW are presented in Figure 3.

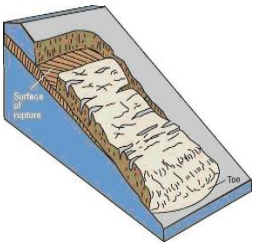
[2] http://dictionary.reference.com/browse/landslide

[3] FEMA Landslide Loss Reduction: A Guide for State and Local Government Planning

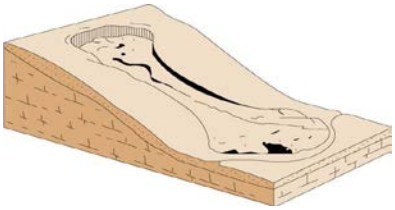
Figure 3 – Types of Slope Failures



Rotational Slide



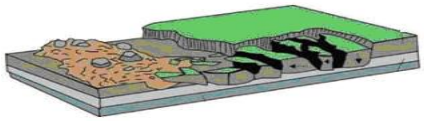
Translational Slide



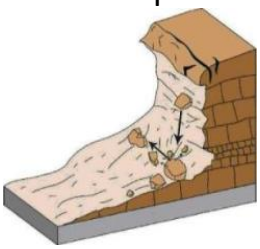
Earthflow



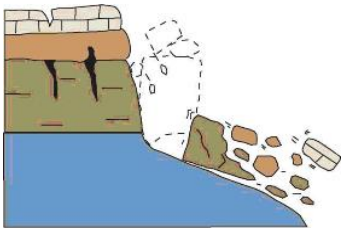
Creep



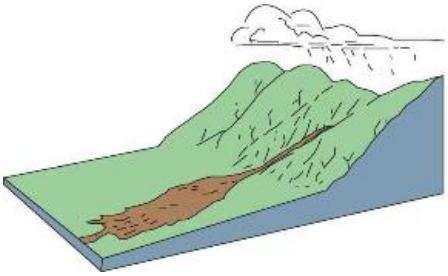
Lateral Spread



Falls



Topple



Debris Flow

Source: USGS

- *Rotational Slides* – Movement of soil and debris downslope in a distinctive rotational motion. A "slump" is an example of a small rotational slide.
- *Translational Slide* – Down slope movement of soil and/or rock on a relatively planar surface and has little rotational movement or backward tilting. The mass commonly slides out on top of the original ground surface.
- *Earthflow* – Unchannelized flow of water, soil, rock, and vegetation that moves downslope.
- *Creep* – Imperceptibly slow, steady downward movement of a slope. Evidence of creep can be indicated by curved tree trunks, bent or tilted fences or retaining walls, and hummocky ground surface.
- *Lateral Spread* – Nearly horizontal movement of geologic materials; usually occurs on very gentle slopes.
- *Falls* – Abrupt movement of masses of soil or rock that becomes detached from steep slopes or cliffs. Movement generally occurs by free-fall, bouncing, and rolling. These movements are promoted by undercutting, differential weathering, excavation, or erosion.
- *Topple* – A block of rock that tilts or rotates forward on a pivot point and then separates from the main mass, falling to the slope below.
- *Debris Flow* – A moving mass of loose mud, sand, soil, rock, water and air that travels down a slope under the influence of gravity. To be considered a debris flow, the moving material must be loose and capable of "flow" and at least 50% of the material must be sand-size particles or larger.

2.3 Causes of Slope Failures

Slope Failures can be caused by nature, by man, or a combination of both. A listing of common contributing factors to slips is below.

Human Activities

- Removal of shallow bedrock on steep slopes and replacement with a weaker backfill material, such as soil fill;
- Removal of vegetation and trees;
- Changes in slope configuration, such as additional load placed on the top of the soil mass, or removal of material near the bottom of the soil mass (such as trenching for pipeline construction); and,
- Changes to the surface water or groundwater regime, such as the addition of water to a slope.

Natural Factors

- Weather;
- Erosion of toe support;
- Weathering of bedrock can produce weak, slope failure-prone materials;
- Earthquakes; and,
- Rapid lowering or rising of water level.

3.0 Pipeline Route Selection

Pipeline route selection is an important component of avoiding or minimizing the impacts of slope failures for new natural gas pipelines. The route selection process described in this document must be used for all DTI projects that include the construction of new natural gas pipelines or re-alignment of existing pipelines. DTI will avoid or mitigate the adverse effects of slope failures by following a route selection process that incorporates identification, avoidance, and/or mitigation. This process is an iterative process, and it includes preliminary route selection, desktop studies, field reconnaissance, landowner discussions and landowner considerations, temporary and permanent access road identification, and environmental factors as inputs to developing a final route. Multiple iterations of each step in the process may be necessary to develop a route that avoids or reduces the risk of slope failures.

3.1 Preliminary Route Selection

Preliminary routing includes establishing a preliminary route that serves as a starting point for the project team, and the final route will likely vary from this preliminary route. A preliminary route can be established using tools such as topographic maps, Google Earth™, available light detection and ranging (LiDAR) data, and other computer mapping software. Considerations during preliminary routing include slope failure-prone areas and construction techniques. Preliminary routing will avoid or minimize routing parallel to slopes, also known as “side hilling”, as this construction technique requires excessive excavation of material, increases the construction limits of disturbance, and results in a right-of-way that is difficult to restore and to stabilize. During preliminary route layout, care must be taken to traverse slopes perpendicular to topographic contours, and to avoid traversing slopes greater than 30 degrees (58 percent) to the maximum extent practicable. If traversing slopes of greater than 30 degrees (58 percent) cannot be avoided, it must be minimized, and these areas will be a focus of the desktop study and further evaluation during the field reconnaissance process discussed below in Section 3.3.

3.2 Desktop Study

The purpose of the desktop study is to further evaluate the preliminary route and make route adjustments prior to conducting the field reconnaissance. The DTI Project Team/field engineer, in consultation with DTI Engineering Management must decide at the beginning of a project the appropriate data to be considered during the desktop study. For small projects, the desktop study may only consist of a review of the route, and identification of steep slope areas that can be avoided. For longer projects, the desktop study should be more extensive and can include all of the items discussed below. The desktop study includes a review of existing data on slope failures and slope failure-prone areas, to allow the DTI Project Team/field engineer to make corresponding alterations in the route to avoid or minimize routing across existing slope failures and slope failure-prone areas, and to identify areas that must be crossed that will require additional review during field reconnaissance and project design.

The DTI Project Team/field engineer must define the study corridor at the beginning of the study to provide ample coverage for route alterations either during the desktop study or the field reconnaissance study. Because the potential for route adjustments is greater for longer pipelines, the desktop study corridor must be wider than for shorter pipelines. The minimum width of a study corridor during the desktop review phase is 1000 feet, but may be expanded if necessary based on the project specifics. Geographic information system (GIS) is the most efficient method to conduct the desktop study. A project-specific GIS database can be developed using various information sources including, but not limited to those listed below. Additional information in the GIS includes topography, residential and commercial structures, land use, geology, streams, wetlands, cultural resource sites, cultural features such as roads, railroads, public lands and cemeteries to be used during the desktop study to refine the pipeline route prior to beginning the field reconnaissance. Potential access roads must be identified during the desktop study for further evaluation during the field reconnaissance.

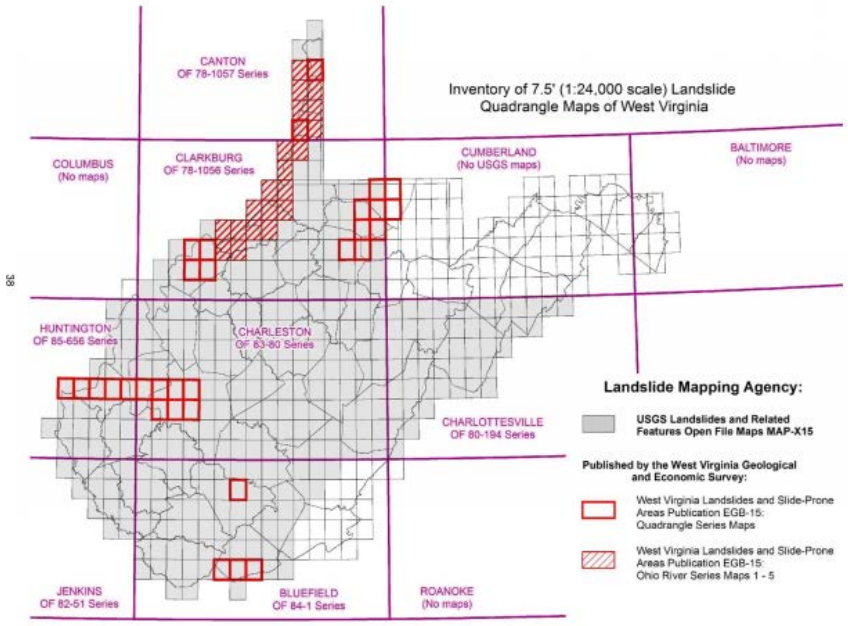
3.2.1 Existing Landslide Maps and Data

The United States Geological Survey (USGS) maintains publically available GIS data for a digital compilation of landslide overview mapping of the conterminous United States at http://pubs.usgs.gov/of/1997/ofr-97-0289/ . This dataset consists of polygons enclosing areas of landslide incidence and susceptibility for the conterminous United States. The purpose of this dataset is

to give the user a general indication of areas that may be susceptible to landslides, and is not suitable for local planning or site selection without further investigation on the ground.

For a portion of West Virginia, maps of old landslides and slide-prone areas were compiled in 1976 by the West Virginia Geological and Economic Survey (WVGES) in WVGES Publication EGB-15a, West Virginia Landslides and Slide-Prone Areas, P. Lessing, et. al, 1976. Landslides and slide-prone areas were mapped on USGS 7.5 minute quadrangles. Thirty-six 7.5 minute quadrangles are available as georeferenced images from the WV GIS Technical Center. The GIS data can be accessed here WVGISTC: GIS Data Clearinghouse, and areas covered by the data are shown in Figure 4 below. Non-georeferenced maps are available for the remaining USGS quadrangles shown in gray in Figure 4. These maps are available for download and can be georeferenced for projects that occur in areas where the georeferenced data are not directly available from the WV GIS Tech Center. State-specific information other than from USGS as discussed above are not available for Maryland, Ohio, New York, Pennsylvania or Virginia.

Figure 4 – Landslide Mapping in West Virginia



The maps must be used in the desktop study to identify areas of past slope failures, the slopes at the highest risk for slope failures, and the route adjusted to the extent practicable to avoid the highest hazard areas.

3.2.2 Define Slopes of Greater than 30 Degrees.

The desktop study must identify the degree of slope for the entire route. There are several methods to identify and define the degree of slope, either by direct measurement from topographic maps or using various computer programs. The DTI Project Team/field engineer will select an appropriate method based on the size of the project. The DTI Project Team/field engineer may select a slope angle that is shallower than 30 degrees on a project-specific bases.

3.2.3 USDA Natural Resources Conservation Service Soil Surveys

The United States Department of Agriculture (USDA) National Cooperative Soil Survey (NRCS) web-based Web Soil Survey (WSS) (http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm) provides georeferenced soil maps. The DTI Project Team/field engineer will review the soil survey information related to soil landscapes, soil formation, soil limitations for various land uses, and properties of the soils in the survey areas. In particular, information related to soil origin, slope steepness, drainage characteristics, typical soil profile with layer thickness, approximate depth to bedrock, and slope failure-prone soils can be obtained from the soil survey. Additionally, archived soil surveys are available for selected portions of West Virginia (http://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=WV), and may provide additional interpretation of soil conditions, land use applications, and soil hazards.

The objective of soil surveys is to separate major landforms that have similar land use, and not to delineate exact boundaries of soil type. Therefore, soil surveys provide a broad overview of soil conditions but are not designed for site-specific evaluations.

3.2.4 Light Detection and Ranging (LiDAR)

LiDAR is a remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light. LiDAR is capable of producing high resolution mapping of the earth's surface including very subtle topographic features such as headscarps, lobate features, and hummocky topography indicative of past or active slope failures.

For projects that include construction of new pipelines, the DTI Project Team/field engineer may use publicly available LiDAR data in the desk top study. If publicly available LiDAR data is not available, the project specific LiDAR data may be obtained if the DTI Project Team/field engineer and Engineering Management decides it is necessary. LiDAR data is available for purchase from select vendors for portions of the DTI system. Where LiDAR data is unavailable for purchase, it may be deemed necessary to obtain project-specific LiDAR data by flying the route. The DTI Project Team/field engineer and Engineering Management must determine if the route should be flown to obtain LiDAR data. If the DTI Project Team/field engineer determines that project specific LiDAR is not necessary, that decision must be documented in the Desktop study documentation. Typical LiDAR coverage ranges from 1000 feet to 4000 feet in width.

LiDAR data is analyzed by developing a digital terrain model (DTM) that can be imported to various computer aided drafting software suites. The DTM can be imported into the project GIS during the desktop study and used to identify past slope failures, steep slopes and other terrain features useful in routing the pipeline.

Publically available LiDAR data are available to varying degrees for each state as shown below;

Maryland: LiDAR data and other mapping data are available from the Maryland iMAP program located at http://imap.maryland.gov/Pages/lidar-topography-server.aspx

New York: LiDAR is available for portions of New York from the New York State Elevation Data site (http://gis.ny.gov/elevation/).

Ohio: LiDAR data for Ohio are available through the Ohio Geographically Referenced Information Program at http://ogrip.oit.ohio.gov/)

Pennsylvania: LiDAR data for Pennsylvania are available at the PAMAP website athttp://www.pamap.dcnr.state.pa.us/

Virginia: LiDAR is available for portions of Virginia from the Virginia LiDAR Database at http://www.virginialidar.com/index-3.html#.V3Qtw032apo

West Virginia: As of July 2015, LiDAR data is available from the WV GIS Tech Center for all or portions of Berkley, Gilmer, Jackson, Jefferson, Morgan, Webster, and Wyoming counties of West Virginia.

3.2.5 Mine Study

A mining study should occur in areas of suspected resource mining. Underground and surface coal mining is extensive throughout West Virginia, southwestern Pennsylvania, western Virginia, and southeastern Ohio. A study of state agency data bases should be checked for potential impacts to the pipeline route. Depending on the type of mining, the impacts could range from ground subsidence or ground movement from uncontrolled backfilling of strip mines or auger mining to longwall mine panel subsidence. Publically available mine mapping from state agencies are shown below:

New York
Department of Environmental Conservation - Mining & Reclamation
http://www.dec.ny.gov/cfmx/extapps/MinedLand/search/mines/
Information on the mines can be found by location, permit information or mine identification

Ohio
Division of Geological Survey - Division of Mineral Resources
https://gis.ohiodnr.gov/MapViewer/?config=OhioMines
Information for the coal seam and mine names are given

Pennsylvania
Pennsylvania Mine Map Atlas - Pennsylvania State University
http://www.minemaps.psu.edu/
Information on the Mine Map and the coal seam and mine names are given

Virginia
Virginia Department of Mines, Minerals and Energy
https://www.dmme.virginia.gov/DM/DMMappingCenter.shtml
Maps and Resource Center for mapping with mining status and coal mine outlines

West Virginia
West Virginia Geological & Economic Survey
http://ims.wvgs.wvnet.edu/index.html
All Mining Map - Information on the seam and mine names are given

3.2.6 Desktop Study Mapping

At the conclusion of the desktop study, a map will be generated that shows a composite of the desktop study results identifying the areas of high risk for slope failures including; slopes greater than 30 degrees (58 percent), past slope failures, slope failure-prone areas based on USGS mapping and/or LiDAR data, surface or near-surface mine areas that could impact stability and areas where shallow bedrock exists.

The purpose of the mapping is to document and locate areas where further evaluation during the field reconnaissance is necessary. The information from the desktop study must be used in conjunction with other desktop data (streams, wetlands, residences, roads, cultural features, etc.) to revise the preliminary route to avoid as many high hazard areas as practicable. Slope failure-prone areas that cannot be avoided, must be identified for further evaluation during the field reconnaissance.

3.3 Field Reconnaissance

Field reconnaissance must be performed by individuals experienced in the identification and assessment of slope failures, other geohazards, and pipeline constructability to enhance the data obtained during the desktop study. This geohazard field reconnaissance can be performed in conjunction with identification of environmental features (i.e., streams, wetlands), but must include an emphasis on risk indicators for future slope failures. In particular, the following information are to be recorded with a hand-held GPS unit or other suitable mapping device, field notes, and photographs: existing slope failures, hummocky topography, head scarps, toe bulges, seeps and springs, tilted utility poles and fence posts, misaligned fences or guardrails, tilted trees, curved tree trunks, bedrock outcrops, sink holes, and mine spoil.

Based on the project conditions, the field reconnaissance can be limited to those areas identified during the desktop study as having increased risk of slope failures and potentially other impacts. The DTI Project Team/field engineer in consultation with DTI Engineering Management must determine if the field reconnaissance is to be performed on the entire pipeline alignment. The study corridor for field reconnaissance must be no less than the planned LOD, but may be up to 600 feet or greater in width.

3.4 Desktop Slope Failure Risk Assessment

Following data collection through the desktop study and field reconnaissance, a desktop slope failure risk assessment will be performed using the Desktop Slope Failure Risk Assessment Matrix included in Appendix A for new pipeline projects. For pipeline replacement projects, the DTI Project Team/field engineer will use the results of the field reconnaissance discussed in Section 3.3 to identify existing and previous slope failures and designate those areas as High Risk.

Using the guidance information included in Appendix A, each potential slope failure area identified in the desktop study and field reconnaissance will be assigned a numerical value for the following:

- Low, Moderate, or High probability of additional slope movement; and,
- Low, Moderate, or High probability of significant impact to pipeline, waterbodies, roadways, adjacent property, or other features.

Multiplying these two numerical values provides a risk score, as shown in the Slope Failure Risk Matrix in Figure 5 (included in Appendix A). The resulting risk score will be tabulated to prioritize the slope failures based on risk of future movement and degree of impact. This prioritization will allow for selection of 1) risks which can be avoided through a reroute or special construction design; 2) risks which are feasible to address as part of construction; 3) risks which cannot be avoided and will be handled as a future maintenance repair, if necessary.

Figure 5 – Desktop Slope Failure Risk Assessment Matrix

Probability of significant impact to pipeline, waterbodies, roadways, adjacent property, or other features	**Probability of additional slope movement**		
	High Probability (3)	**Moderate Probability (2)**	**Low Probability (1)**
High Probability (3)	High Risk (9)	High Risk (6)	Moderate Risk (3)
Moderate Probability (2)	High Risk (6)	Moderate Risk (4)	Low Risk (2)
Low Probability (1)	Moderate Risk (3)	Low Risk (2)	Low Risk (1)

3.5 Selection of Preventative Measures for Identified High Risk Slope Failure Locations

Following risk prioritization as outlined in Section 3.4 above, those areas along the preliminary route that have a risk score of "High" will be assigned a preventative measure. The DTI Project Team/field engineer and DTI Engineering Management must select preventative measures appropriate for each high risk location identified during the slope failure risk assessment. The DTI Project Team/field engineer also will determine if preventative measures are necessary for any of the moderate risk

locations. This determination can be based on landowner concerns, highly sensitive resources in the area (trout streams, freshwater mussel streams, residential areas, transportation corridors, other utilities or other considerations. Potential preventative measures are listed below:

- Reroute around the slope failure hazard.
- Adjust the pipeline route through the slope failure hazard to minimize the consequence if slope failure were to occur. For instance, if a cross slope cannot be avoided, route the pipeline on the upslope side of the ROW and/or bury the pipe within bedrock to minimize risk to the pipeline integrity if a slope failure were to occur.
- Define locations that require engineered details, such as specialized backfill. This will include areas with slopes steeper than 30 degrees (58 percent).
- Define locations to perform a preemptive repair of an existing slope failure through which the pipeline passes.
- Adjust Temporary Work Space (TWS) limits such that soil stockpiling is not permitted along ridgelines where known slope failures are present immediately downslope of the LOD.
- In rare cases, Horizontal Directional Drill (HDD) under the hazard. However, it is not expected that HDD will be a viable options in most cases due to site constraints, such as steep terrain, that make HDD infeasible. Additionally, the increased impacts resulting from larger ground disturbance associated with HDD may increase the risk of slope failures.
- Identify and provide sufficient permanent access roads to facilitate inspection and repair in high risk slope failure locations after restoration.

3.5.1 Selection of Preventive Measures for Pipeline Replacement Projects

A Desktop Slope Failure Risk Assessment is not required for pipeline replacement projects. Therefore, the selection of preventive measures for pipeline replacement projects must be done using information gathered during the field reconnaissance. Any existing slope failure will be considered a high risk, and the project team should select an appropriate preventative measure to address that slope failure. Potential preventative measures are listed below:

- Reroute around the slope failure hazard.
- Adjust the pipeline route through the slope failure hazard to minimize the consequence if slope failure were to occur. For instance, if a cross slope cannot be avoided, route the pipeline on the upslope side of the ROW and/or bury the pipe within bedrock to minimize risk to the pipeline integrity if a slope failure were to occur.

- Define locations that require engineered details, such as specialized backfill. This will include areas with slopes steeper than 30 degrees (58 percent).
- Define locations to perform a preemptive repair of an existing slope failure through which the pipeline passes.
- Adjust Temporary Work Space (TWS) limits such that soil stockpiling is not permitted along ridgelines where known slope failures are present immediately downslope of the LOD.
- In rare cases, Horizontal Directional Drill (HDD) under the hazard. However, it is not expected that HDD will be a viable options in most cases due to site constraints, such as steep terrain, that make HDD infeasible. Additionally, the increased impacts resulting from larger ground disturbance associated with HDD may increase the risk of slope failures.
- Identify and provide sufficient permanent access roads to facilitate inspection and repair in high risk slope failure locations after restoration.

4.0 Pipeline Design and Engineering

Slope failure-prone areas that were identified through the desktop study and field reconnaissance during the pipeline route selection phase must be properly engineered if avoidance is not an option. Additionally, preventative measures for high-risk slope failure areas were assigned to prioritize the work. Some of the selected preventative measures will be implemented during the engineering and design phase, as described in this section.

4.1 Excavation Minimization

Pipeline construction activities can result in conditions that can cause slope failures including removal of shallow bedrock on steep slopes and replacement with a weaker backfill material, removal of vegetation and trees, changes in slope configuration, and changes to the surface water or groundwater regime. Therefore, care must be taken to minimize excavation to that necessary to safely install the pipeline in areas prone to slope failures. The pipeline trench should be excavated to minimize the volume of material excavated and requiring subsequent restoration. The prepared pipe should be welded and or bent to match the trench profile rather than expanding the trench profile to accommodate the pipeline. Road crossings and bore pits are to be designed to minimize excavation through the use of shoring. Adequate extra work space is to be determined during project design, to prevent storing excavated material on steep slopes.

4.2 Document Slope Failure Areas on Project Plans

Slope failures and slope failure-prone areas must be included in the project plans. The following items must be included on the Stormwater Pollution Prevention Plans (SWPPP) and the Erosion and Sediment (E&S) control plans:

- Slope failure areas having high risk, as determined in Section 3.4 (not applicable for pipeline replacement projects);
- Existing slope failures; and,
- Slopes steeper than 30 degrees (58 percent).

The above items will be clearly identified on the plans using legend items, shading, or call outs such that the information is conveyed to the construction personnel and that awareness of the hazard is communicated.

4.3 Temporary Work Space (TWS)

As discussed in Section 3.5, TWS limits must be identified during the route selection phase so that soil stockpiling is not permitted along ridgelines in high risk areas, or where known slope failures are present immediately downslope of the LOD. Similarly, the limits of TWS must be adjusted to avoid placement over existing slope failures.

4.4 Include Additional Drainage

The project plans and specifications must include provisions for additional subsurface drainage on slopes greater than 30 degrees (58 percent). Include callouts and details in the E&S plans for location and type of drainage.

4.5 Engineered Details

Project-specific engineered details and specifications must be developed for those slope failure-prone areas requiring engineered preventative measures, as identified in Section 3.5. These locations will likely include areas with slopes steeper than 30 degrees (58 percent), or locations requiring pre-emptive repair of an existing slope failure in the proposed pipeline corridor.

It is important to understand that there is no one particular type of repair approach that works for all slope failures. Selection of the most cost effective preventative measure generally requires the following steps:

1. Detailed subsurface exploration to determine the condition of existing materials, depth of failure surface, depth to bedrock or stable soils, and groundwater conditions.
2. Slope stability modeling of the existing slope and the proposed preventative measure(s). This is done to verify that the repair will provide sufficient improvement in the stability of the final slope. Surface topography, laboratory strength testing, and groundwater information are necessary to perform this type of analysis.
3. Perform an Alternatives Feasibility Study to assess suitability of possible preventative and/or repair measures. Associated construction costs of each alternative can be evaluated as well.

Given difficult site access and time constraints for most pipeline projects in this region, some of these steps may not be feasible. Absent this information, conservative assumptions can be made as to the soil strength parameters, and the depth and type of failure surface for design based on good engineering principles and best professional judgment.

In general, the following engineered design methods apply to slope failure prevention and correction, and are presented in general order of increasing cost. Selection of the most appropriate engineered prevention measure or combination thereof, is dependent on individual site conditions and constraints. The DTI Project Team/field engineer and Engineering Management must also consider input from landowners, permitting agencies, and the Federal Energy Regulatory Commission (FERC) as applicable to evaluate all the factors that influence the design and construction of engineered design methods. Example typicals are shown in Appendix B. These typicals are provided as potential examples, and must be tailored to meet the site-specific requirements for each slope failure location.

- Drainage Improvement:
  - Provide subsurface drainage at seep locations through granular fill and outlet pipes.
  - Incorporate drainage into trench breakers using granular fill.
  - Intercepting groundwater seeps and diverting off ROW.
- Buttressing slopes with Sakrete trench breakers.
- Change Slope Geometry:
  - Reduce the slope by cutting at the top, or incorporating a toe buttress.
  - On many overly steepened slopes the depth to bedrock is relatively shallow and slope failures often occur at the interface between the overburden soil and the bedrock. By removing the overburden soil and leaving the bedrock exposed, this could eliminate these types of slope failures. Continued erosion of the soft exposed bedrock should be anticipated.

  - Modifications to E&S BMPs may be required to manage stormwater runoff between the final ROW slope configuration and existing grades beyond the ROW. One alternative approach to manage stormwater is to direct runoff to a defined channel within the ROW to carry surface water downslope. The channel must be stabilized with rip rap or by other means and be directed to an appropriately-sized stabilized outlet.

- Bench and Regrade with Controlled Backfill:
  - A common slope failure repair approach for slopes up to 30 degrees (58 percent) includes removal of the failed soil mass and reconstruction of the slope by cutting level benches into competent soil or rock beneath the failure plane, installing subsurface drainage, and placing compacted soil or other material as backfill.
- Use Alternate Backfill:
  - Removal of the existing fill soil and replacement with rock fill, such as shot rock (WVDOH Item 704.8 or equivalent) can be beneficial in slope failure repair because it improves drainage, provides a higher friction strength, and generally weighs less than a compacted soil backfill. This method is effective on slopes as steep as 38 degrees (78 percent), but should not be expected to vegetate.
  - The potential use of controlled low strength material (CLSM), such as cementitious flowable fill, as backfill within the pipeline trench could be considered as a method to reduce the pipeline trench from collecting and transporting water. The challenge is placing this material incrementally up the slope and containing it long enough for the flowable fill to harden and gain strength. **Note: Dominion policy does not allow the use of CLSM containing fly ash as filler. Therefore a flowable fill using fine aggregates or sand must be used.**
- Chemical Stabilization of Backfill:
  - Chemical modifiers, such as cement and lime, have successfully been used to dry cohesive soils that are saturated beyond the optimum moisture content, and are often used to extend the construction season. When used at higher concentrations, these modified soils can exhibit increased strength properties that can benefit slope failure stabilization projects on slopes up to 30 degrees (58 percent) or greater.
- Geogrid Reinforced Slope:
  - For slopes steeper than 30 degrees (58 percent), construction of a reinforced soil slope (RSS) may be necessary to match existing grades. A RSS consists of benching into the existing slope, installing subsurface drains, and incorporating geogrid reinforcement into compacted backfill.

- Retaining Structures:
  - Numerous types of retaining structures can be effective for slope failure prevention and repair, and are often used in combination with the repair approaches discussed previously. However, structural approaches are generally expensive since they require specialized equipment for installation on remote sites with challenging access. From the standpoint of protecting the pipeline, the most economical solution in certain cases may be to install a retaining wall and then regrade the slope below. In some cases, the slope below the retaining structure may continue to move.
  - One structural approach includes installation of soil nails with surface mesh to anchor the surficial soils to the underlying competent soil or rock. The soil nail spacing and length are designed based on the soil/rock conditions and the depth of sliding. If desired, the surface mesh can be sized to permit vegetation growth through the mesh.
  - Another alternative is the proprietary Geopier SRT system, which utilizes patented plate pile steel reinforcing elements to stabilize slopes. This system is advertised for use on slope failures less than 15 feet in depth where the soil conditions consist of an upper zone of unstable soil over stable soil or soft rock, since the pile elements must penetrate below the sliding surface into stable material. If shallow bedrock is present, predrilling of each plate pile could be required.
  - Other structural retaining wall options include gabion baskets, modular blocks, geocells, H-pile and lagging, drilled shafts, tieback walls, sheet piles, and mechanically stabilized earth (MSE).

4.6 Construction Stormwater Permit

State agency construction stormwater permits and the Federal Energy Regulatory Commission (FERC) require that restoration of the ROW be performed to match preconstruction grade. These requirements sometimes can be problematic on slopes steeper than 30 degrees (58 percent) where pipeline construction activities remove the shallow bedrock and replace it with weaker soil fill. The soil fill has lower internal shear strength than the natural rock and is unstable on these steep slopes, thus increasing the risk of slope failures. To prevent this known slope failure root cause, slopes could be reconstructed to a shallower grade than the existing slope. If the final restored slope is 30 degrees (58 percent) or less, this approach would allow restoration of the ROW using fill materials comprised of natural soil and rock fragments without engineering design. If adjustments to the final grade are implemented, then the pipeline embedment must be increased sufficiently to maintain adequate cover depth. Additionally, modifications to stormwater Best Management Practices (BMPs) will be required since the ROW will likely be at lower elevation than the surrounding hillside, which could preclude

installation of waterbars to divert water off ROW. An option to manage this stormwater effort is to direct the runoff to a defined channel within the ROW to convey surface water downslope. Any change in topography may require an individual construction stormwater permit rather than the general permit, which could add significant time to the permitting timeline and require additional review by permitting agencies along with the potential for a public comment period. This approach would require landowner approval and FERC approval if on a FERC project.

4.7 Stormwater Pollution Prevention Plan (SWPPP)

The SWPPP must include a discussion of the methods implemented to avoid slope failures and a plan of action should slope failures occur. The below paragraph provides a template that can be modified with specific measures to be used on a project.

> *Potential erosion problem areas, including but not limited to areas with 30^0 slopes or greater, will be protected by silt fence and permanent slope breakers. Slope breakers will be placed a minimum of 75 feet apart in areas with greater than 25^0 slopes. Care has been taken to avoid areas of steep slopes as much as practical; however, areas which could not be avoided will be addressed with (INSERT ENGINEERING MEASURES, e.g. waterbars, Rolled Erosion Control Product). In the event that subsurface flow is encountered, an under drain will be utilized, as necessary, to divert water outside of the LOD. If encountered, seeps can be mitigated by using seep collectors placed downslope of areas showing seepage. Armored fill placed at the toe of the slope may be used in areas of steep slopes in addition to a perforated drain pipe to divert subsurface water away from the cut slope. If a slope failure occurs Dominion will (INSERT CONTAINMENT MEASURES, e.g. install super silt fence, gabion baskets, jersey barriers or other portable containment devices) to keep the slope failure from impacting areas outside the LOD or waters of the state. Steep slopes have been avoided to the maximum extent practicable. Steep slopes will be restored with erosion control blanket and Dominion will implement the slope failure prevention items mentioned above as needed.*

Maryland: Slopes equal to, or greater than, 15 percent are classified as “steep slopes” and must be shown on the NRI plan. The standard symbol for steep slopes must be used on the plan and included in the legend.

New York: The New York State Standards for Erosion and Sediment Control Manual requests site plans which delineate and avoid disturbing wetlands, stream corridors and, to the extent practicable, wood lots, steep slopes and other environmentally sensitive areas. The plans should also minimize impacts by

maintaining vegetative buffer strips between disturbed area and water resources. Additionally, an E&SC plan should be prepared for all land development and construction activity when uncontrolled erosion and sedimentation is anticipated and should, at a minimum, include sites on slopes that exceed 15%, sites in areas of severe erosion potential, sites within 100 feet and draining to wetland, sites within 100 feet draining to a watercourse, and/or sites with a high percentage of colloidal solids.

Ohio: Oil and gas pipeline construction activities are conditionally exempt from stormwater discharge permitting in Ohio. However, the Ohio Rainwater and Land Development Manual provides limited best practices for steep slopes. Additionally, the Ohio Environmental Protection Agency (OEPA) defines steep slopes as those that are 15 percent or greater.

Pennsylvania: According to the Erosion and Sediment Pollution Control Program Manual, critical areas should be covered with erosion control fabric. Critical areas are defined as part of a disturbed area which poses the greatest threat of sediment pollution to a receiving water. Any slope 3H:1V or steeper directly above a surface water is considered a steep slope and a critical area.

Virginia: According to the General VPDES Permit for Discharge of Stormwater from Construction Activities, a legible site plan must be submitted that identifies the limits of land disturbance including steep slopes and natural buffers around surface waters that will not be disturbed, as well as minimize(s) the disturbance of steep slopes is required as part of the permitting process.

West Virginia: WVDEP requires that the SWPPP include information on slide prone areas and the methods to be implemented to both avoid slope failures and a plan of action should slope failures occur.

4.8 Documentation of Design Information

The following documentation must be developed and filed in the DTI Engineering Documentum filing system.

- Desktop Study mapping and documentation of route adjustments to avoid slope failures and slope failure-prone areas;
- Slope failure Risk Assessment and identification of high risk areas; and
- Selected avoidance or mitigation method for each high risk slope failure location identified in the slope failure risk assessment

5.0 Pipeline Preconstruction Planning

5.1 Slope Failure Training

Training in this procedure consists of annual training on the ~~e~~ procedure, and project-specific review at the Environmental Permit Transition meeting.

5.1.1 Training

DTI personnel with responsibility for pipeline routing, construction, or operation must be trained in this procedure on an annual basis. The training may be completed by an online learning management system (LMS) module or may be conducted by Energy Infrastructure Environmental Services (EIES) personnel, or DTI Engineering Management. At a minimum, the following personnel will be trained;

- Engineering Directors and Managers;
- Design and construction engineers;
- Operations Directors, Managers and Supervisors;
- Construction supervisors; and
- Construction and operations Environmental Compliance Coordinators (ECC).

The training must include the following;

- types and causes of slope failures;
- routing avoidance and desktop methods;
- field reconnaissance;
- risk prioritization;
- pipeline design and engineering to prevent slope failures;
- addressing slope failures during construction;
- addressing slope failures post construction; and,
- reporting requirements.

5.1.2 Environmental Permit Transition

Prior to beginning construction, DTI and contractor personnel with responsibility for the pipeline construction must attend the Permit Transition with EIES. The EIES Permitting Lead will schedule the Permit Transition meeting to rollout the permits and clearances. The meeting will include a review of all environmental permits. At a minimum, the following personnel must attend the Environmental Permit Transition meeting;

- Permit Lead
- Project supervisor;
- Operations Supervisor/Manager (if available);
- ECC; and
- Environmental Inspector (EI) (if identified).

Recommended attendees at the Permit Transition meeting include the following;

- Construction engineer;
- Contractor supervisors, superintendents, and foreman - Policy can be reviewed with contractor at separate pre-construction meeting if cannot attend permit transition meeting;
- DTI inspectors; and

If the contractor cannot attend the environmental permit transition meeting, this policy will be reviewed with the contractor at a separate preconstruction meeting. The Environmental Permit Transition meeting will review the environmental permit conditions, training requirements, inspection requirements, and reference to this policy and procedure.

5.2 Slope Failure Mitigation and Response Materials

The DTI Construction Supervisor must identify during the preconstruction phase, the materials to be maintained onsite during construction to address a slope failure and to prevent slope failures from impacting waters of the state. These materials may include belted silt retention fence, super silt fence, jersey barriers, sakrete bags, gabion baskets, soil additives, drain pipe, stone, geotextile, or portable containment structures.

6.0 Addressing Slope Failures During Construction

6.1 Inspections

For projects with a construction stormwater permit or other E&S plan approved by a regulatory agency, inspection and maintenance of all E&S control structures shall be completed and documented. The ROW and E&S control devices will be inspected by the EI or person designated by the DTI Construction Supervisor. A record of weekly and storm event inspections will be maintained onsite for the duration of the project by the Project EI or Project Supervisor. Inspection forms will include the date(s) and names(s) of personnel making the inspection and results (including any major observations and corrective actions taken or needed). Any major observation and corrective action needed will be carried over to subsequent inspection reports until completely resolved. The inspection records must be maintained onsite during construction and retained by DTI Engineering for a minimum period of three (3) years after final stabilization. Completed inspection reports must be provided to the Construction ECC on a routine basis during construction, and the Construction ECC will conduct periodic site visits to review inspection records and to complete environmental self-assessments on select projects. Construction stormwater inspection requirements vary by state. The below table summarizes these requirements which are further detailed in the subsequent sections.

Table 2. Construction Stormwater Inspection Requirements by State.

State	Inspection Frequency	Rainfall Inspection	Inspection Records	Sign Posting
Maryland	Weekly	The following day after rainfall event resulting in runoff.	Inspection records maintained for three (3) years from the date that permit terminated.	NA
New York	< 5 acres – every 7 days > 5 acres disturbed at one time – at least 2 times every 7 calendar days separated by 2 full calendar days	NA	Inspection reports retained for 5 years following submittal of the NOT.	NA
Ohio	Every 7 calendar days	Within 24 hours of a 0.5” storm event that occurs within a 24 hour period.	Inspection reports retained for 3 years following the submittal of the NOT.	NA

Pennsylvania	Weekly	Within 24 hours after a measurable rainfall event	Inspection reports retained for 3 years from the date of the termination of coverage.	NA
Virginia	Every 5 business days or at least every 10 business days and →	Within 48 hours following any runoff producing measurable storm event.	Inspection report retained for 3 years from the expiration or termination of the permit.	Post copy of notice of coverage letter.
West Virginia	Every 7 calendar days for actively disturbed areas and Every 14 calendar days for restored areas	Within 24 hours after a storm event > 0.5" of rain in a 24 hour period.	Inspection reports retained for 2 years.	Sign posted within 24 hrs. of submitting NOI.

6.1.1 FERC Requirements

For FERC projects, inspections are required in accordance with the FERC Plan. FERC inspections are required on a daily basis in areas of active construction or equipment operation, on a weekly basis in areas with no construction or equipment operation, and within 24 hours of each 0.5 inch of rainfall. All grade surfaces, walls, dams and structures, vegetation, E&SC measures and other protective devices must be maintained in good and effective condition and promptly repaired or restored, even if damaged by a third party.

6.1.2 Maryland

The December 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control can be found at the following site:

http://www.mde.state.md.us/programs/water/stormwatermanagementprogram/soilerosionandsedimentcontrol/pages/programs/waterprograms/sedimentandstormwater/erosionsedimentcontrol/esc_standards.aspx

According to the Maryland Soil Erosion and Sediment Control Manual SECTION A-3 SEDIMENT CONTROL PRINCIPLES, the owner is responsible for conducting routine inspections and required maintenance. At a minimum, the site and all controls should be inspected weekly and the next day after each rain event. However, the approval authority may require more frequent inspections, especially adjacent to sensitive areas or in impaired watersheds. A written inspection report is part of every inspection. In addition,

Maryland requires a "Responsible Person" to act as an inspector. The responsible personnel involved in the construction project shall have a Certificate of Training at a Maryland Department of the Environment (MDE) approved training program for the control of erosion and sediment prior to beginning the project. Additionally, the owner or developer shall certify right of entry for periodic on-site evaluation by the appropriate enforcement authority and/or MDE.

6.1.3 New York

The following excerpts are from *Part IV. Inspection and Maintenance Requirements of the New York, Department of Environmental Conservation, SPDES General Permit for Stormwater Discharges from Construction Activity*. A copy of the entire document and appendices can be found at the following location**:**

http://www.dec.ny.gov/docs/water_pdf/gp015002.pdf

A qualified inspector must conduct site inspections. The qualified inspector qualifications are a: - licensed Professional Engineer, Certified Professional in Erosion and Sediment Control (CPESC), Registered Landscape Architect, or someone working under the direct supervision of, and at the same company as, the licensed Professional Engineer or Registered Landscape Architect, provided they have received four (4) hours of Department endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other Department endorsed entity.

The qualified inspector shall conduct site inspections where soil disturbance activities are on-going at least once every seven (7) calendar days. In areas where disturbance is greater than five (5) acres of soil at any one time or in sensitive areas, the inspector shall conduct at least two (2) site inspections every seven (7) calendar days. The two (2) inspections shall be separated by a minimum of two (2) full calendar days. During temporarily suspended work (e.g. winter shutdown) and when *temporary stabilization* measures have been applied to all disturbed areas, a site inspection should be completed at least once every thirty (30) calendar days.

6.1.4 Ohio

The following excerpt is from the *Ohio Environmental Protection Agency, General Permit Authorization for Stormwater Discharges Associated with Construction Activity under the National Pollutant Discharge Elimination System.* A copy of the entire document can be found at the following location**:**

http://www.epa.ohio.gov/Portals/35/permits/OHC000004_GP_Final.pdf

At a minimum, procedures in an SWPPP shall provide that all controls on the site are inspected at least once every seven calendar days and within 24 hours after any storm event greater than one-half inch of

rain per 24 hour period. The inspection frequency may be reduced to at least once every month if the entire site is temporarily stabilized or runoff is unlikely due to weather conditions. The permittee shall assign "qualified inspection personnel" to conduct these inspections to ensure that the control practices are functional and to evaluate whether the SWPPP is adequate and properly implemented.

6.1.5 Pennsylvania

The following excerpt is from the *March 2012 Pennsylvania Department of Environmental Protection (PADEP) Erosion and Sediment Pollution Control Program Manual.* A copy of the entire document can be found at the following location**:**

http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-88925/363-2134-008.pdf

PADEP requires a maintenance program that provides for the operation and maintenance of BMPs and the inspection of BMPs on a weekly basis and after each stormwater event, including the repair or replacement of BMPs to ensure effective and efficient operation. The program must provide the completion of a written report documenting each inspection and all BMP repair or replacement and maintenance activities.

Pennsylvania has no certification requirement for E&SC inspectors.

6.1.6 Virginia

The following excerpt is from the *Virginia Department of Environmental Quality, General VPDES Permit for Discharges of Stormwater from Construction Activity.* A copy of the entire document can be found at the following location**:**

http://www.deq.virginia.gov/Portals/0/DEQ/Water/Regulations/9VAC25-880-VPDESConstructionSWGPRegulation.pdf

Virginia requires Inspections to be conducted at a frequency of at least once every five business days and no later than 48 hours following a measurable storm event. In the event that a measurable storm event occurs when there are more than 48 hours between business days, the inspection shall be conducted on the next business day; and representative inspections used by utility line installation, pipeline construction, or other similar linear construction activities shall inspect all outfalls discharging to surface waters identified as impaired or for which a TMDL wasteload allocation has been established and approved prior to the term of this general permit.

Virginia requires a "Certified Inspector" to complete all E&SC inspections. Certified Inspector means an employee or agent of a VESCP authority who holds a certificate of competence from the Board in

the area of project inspection or is enrolled in the Board's training program for project inspection and successfully completes such program within one year after enrollment. The Virginia Regulation can be found at the following site:

http://register.dls.virginia.gov/details.aspx?id=3945

6.1.7 West Virginia

The following is summarized from *Section G. Other Requirements of the West Virginia Department of Environmental Protection, Division of Water and Waste Management, General Water Pollution Control Permit* for Stormwater Associated with Oil and Gas Related Construction Activities. A copy of the entire document can be found at the following location:

http://www.dep.wv.gov/WWE/Programs/stormwater/csw/Documents/OG%20stormwater%20GP%203_10_15.pdf

Inspections must be completed by individuals experienced and trained in E&S control inspections. Inspections must be completed and documented at least once every *seven (7) calendar days* for actively disturbed areas, *14 calendar days* for restored areas (restored areas includes pavement, buildings, stable waterways, a healthy, vigorous stand of perennial grass that uniformly covers at least 70 percent of the ground) and *within 24 hours* after any storm event greater than one-half (0.5) inch of rain per 24-hour period. The Project area will continue to follow the preceding schedule until a Notice of Termination (NOT) has been submitted and is approved by WVDEP. Slope failure repairs, soil conditioning, fertilization, reseeding, and mulching will be performed as required.

6.2 Responding to Slope Failures

In the event a slope failure is documented during an inspection, the following steps must be followed. Each step is discussed in detail in the following subsections and summarized in Table 2.

1. Contact the ECC immediately and they will notify EIES who will help evaluate the priority of the slope failure based on the document “Slope Failure Priority Guidance” in Appendix D. The ECC will complete any required reporting to regulatory agencies.
2. Install temporary BMPs to contain slope failure material and to prevent the slope failure from impacting waters of the state.
3. Gather data on slope failure and submit to Dominion Engineering and EIES.
4. Determine repair method and whether the repair is field-directed or engineering-directed.
5. Install short term field stabilizing measures, if applicable.
6. Implement and document slope failure repair.

Table 3. Slope failure Reporting and Repair Responsibility Matrix.

Responsible Party	Action	Time Frame
Construction Supervisor	Report Slope failures to the ECC upon discovery, who will work with EIES to evaluate slope failure using Slope Failure Priority Guidance (Appendix D)	Immediately upon discovery
Construction Supervisor	Install temporary BMPs to contain slope failure material/prevent slope failure from impacting waters of the state	As soon as practicable
ECC	Notify state environmental agency if required	Immediately
Construction Supervisor	Complete Slope Failure Information and Reporting Form (Appendix C)	Within 5 business days of discovery of slope failure
Engineering Team	Complete Slope Failure Repair Assessment Form (Appendix C) and determine if slope failure repair will be field-directed or engineering-directed.	Within 10 business days of receipt of Slope failure Evaluation Reporting Form
Engineering Team	Design repair of Engineering-directed repairs	As soon as practicable
Construction Supervisor	Install short term stabilizing measures for Priority 1 and 2 slope failures that will not be repaired within 60 days of discovery	As soon as practicable
Construction Supervisor	Implement slope failure repair	As soon as practicable
Construction Supervisor	Document slope failure repair	Upon completion of repair

6.2.1 Evaluate Priority

Upon observation of a slope failure, the ECC must be contacted to assist in the Slope Failure Priority determination using the Slope Failure Priority Guidance in Appendix D. The ECC will contact the appropriate entity for all Priority 1 and 2 Slope failures, as specified in Appendix D.

6.2.2 Install Temporary BMPs

DTI's Construction Supervisor or the EI must direct the contractor to install temporary BMPs for containment of slope failure material to protect waterbodies from slope failure material and runoff. Typical details for temporary containment measures, including silt fence, silt sock, super silt fence, and jersey barriers, are included in the SWPPP. Selection of the appropriate BMPs must be determined by the EI in consultation with the DTI Construction Supervisor so that runoff from the slope failure material is contained and waterbodies, if present, are protected. It is noted that temporary BMPs will not arrest future slope movements, and follow up actions to remediate the slope failure must be implemented as soon as practicable.

6.2.3 Gather Data

The Construction Supervisor will obtain site data of the slope failure by completing the Slope failure Information and Reporting Form provided in Appendix C, and will submit this information to DTI Engineering and EIES within five (5) business days of discovering the slope failure. The slope failure information and reporting form included in Appendix C may be used to document slope failure information. In particular, the following minimum information will be obtained and communicated:

- Name of observer;
- Date;
- Slope failure location, including latitude and longitude;
- Slope failure dimensions;
- Site photographs;
- Site sketch;
- Evidence of preexisting slope failures;
- Presence of surface water or groundwater;
- Estimate of slope steepness;
- Estimate of slope failure type (i.e., rotational, translational, earthflow, etc.); and
- Slope failure priority based on Slope Failure Priority Guidance (Appendix D).

6.2.4 Select Slope Failure Repair Approach

Within ten (10) business days of receiving the slope failure data form, DTI Engineering will evaluate whether the slope failure repair is to be field-directed or engineering-directed, and whether to engage a specialist in slope failure evaluation and repair (i.e., geotechnical engineer). The attached score sheet has been developed to assist in determining the appropriate direction of the repair and whether to engage a specialist. In general, field-directed repairs are to be limited to slope failures that are on slopes flatter than 30 degrees (58 percent), can be repaired by installation of drainage measures and earthwork, and have low consequence of future failure. Slope failures that occur on steep slopes, extend outside the ROW, pose increased consequence of future failure, or require construction techniques outside the pipeline contractor's typical construction methods are to be directed by DTI Engineering.

Selection of the most appropriate slope failure repair method is dependent on individual site conditions and constraints. Section 3.5 above provides a discussion on typical repair approaches.

- If the slope failure repair will be field-directed, then the EI and Construction Supervisor will determine the most appropriate repair approach. In general, this will involve installation of drainage, minor slope regrading, and replacement of the failed soil on benches.
- If the slope failure repair will be engineering-directed, then the Project Engineer will lead development of the slope failure repair plan.
- If a geotechnical engineer is engaged, then the Project Engineer will coordinate with the specialist to select and design the repair. This may require field exploration, stability modeling, alternatives feasibility study, and preparation of construction plans.

6.2.5 Install Short Term Stabilizing Measures

In addition to installation of temporary BMPs per Section 5.2, Priority 1 and 2 slope failures that will not be repaired within 60 days of discovery, and other slope failures that will not be repaired within 120 days of discovery will have short term stabilizing measures applied. The following is a list of possible short term stabilizing measures that can be considered:

- Remove soil at the top of the slope failure to unload the slope;
- Install a toe buttress using soil or rock fill, gabion baskets or similar devices;
- If possible, perform minor regrading of the slope with some level of compaction to smooth out the existing scarps and reduce the number of pockets in which water can collect;

- Direct drainage away from the slope failure through waterbars, diversion ditches, or temporary drains;
- Place plastic on the failed slope to protect the soils from rainfall and surface runoff; and
- Monitor the slope failure for signs of slope movement, especially after periods of heavy rain fall. If additional movement is detected or visible (i.e. cracks or scarps), notify Dominion Engineering for assistance.

Even with temporary measures, there is still a risk of additional slope movement. Therefore, long term slope failure repair measures must be implemented.

6.2.6 Implement Slope Failure Repair The slope failure repair must be completed in an efficient and timely manner, and implemented in accordance with the slope failure repair approach selected following this procedure.

6.2.7 Document Repair

The slope failure repair must be documented by the Construction Supervisor, and documentation stored in the DTI Engineering Documentum filing system. Documentation must include the following;

- Name of person completing documentation;
- Date repair was completed;
- Repair location, including latitude and longitude;
- As-built of repair showing locations of installed devices including, subsurface drainage devices, ditching, water bars, buttressing, etc.;
- Method of repair; and
- Photos of repair.

7.0 Addressing Slope Failures After Construction

In the event of a slope failure occurring after construction and prior to regulatory agency approval of a Notice of Termination (NOT) the stormwater permit, the DTI Project Team/field engineer must follow the procedures described in Section 6.0. DTI financial policies provide an out-of-cycle budget request mechanism to reopen a project budget with the proper justification to address slope failures that are a result of construction after the project budget has been closed. The out of cycle budget request can be used to address slope failures that occur in the time period between NOT submittal and regulatory agency approval of the NOT, and to ensure inspections continue until the NOT is approved.

In the event that a slope failure is discovered after approval of the NOT through routine pipeline patrols or other methods of inspection, DTI Operations must report the slope failure to the ECC who will assist EIES in the determination of the slope failure priority classification as a Priority 1 (immediate danger to environment or human health), Priority 2 (sediment laden run-off has entered a water body, Priority 3 (sediment has not reached water body, but appears imminent), or Priority 4 (poses little or no threat to the environment). In addition, DTI Operations must contact DTI Field Engineering for assistance to review the condition and develop a repair plan in accordance with this Policy and Procedure for Slope failure Avoidance, Identification, Prevention, and Remediation.

8.0 Slope Failures Caused by a Third Party

If it is determined that a slope failure is caused by the actions of a third party and not related to pipeline construction or activities by DTI, the DTI Engineering Team or Operations will contact the DTI Land, Lease, and ROW group to make notification to the third party of the slope failure.

APPENDIX A

Desktop Slope Failure Risk Assessment

Desktop Slope Failure Risk Assessment Matrix

Probability of significant impact to pipeline, waterbodies, roadways, adjacent property, or other features	**Probability of additional slope movement**		
	High Probability (3)	**Moderate Probability (2)**	**Low Probability (1)**
High Probability (3)	High Risk (9)	High Risk (6)	Moderate Risk (3)
Moderate Probability (2)	High Risk (6)	Moderate Risk (4)	Low Risk (2)
Low Probability (1)	Moderate Risk (3)	Low Risk (2)	Low Risk (1)

<u>Probability of additional slope movement</u>

- Low
  - Slope 22° (40%) or flatter
  - No bedrock outcrops visible
  - No evidence of previous slope movement (bent trees, fence posts, utility poles)
  - No mapped landslide is present
- Moderate
  - Slope 22° to 30° (40% to 58%)
  - Bedrock outcrops possible or limited to small portion of the slope
  - Possible evidence of previous slope movement (bent trees, fence posts, utility poles)
  - Mapped landslides present in the area, but not within the LOD
- High
  - Slope steeper than 30° (58%)
  - Bedrock outcrops prevalent or cover a sizeable portion of the slope
  - Evidence of previous slope movement (bent trees, fence posts, utility poles)
  - Mapped landslide is present within the LOD
  - Existing landslide is present based on field observations

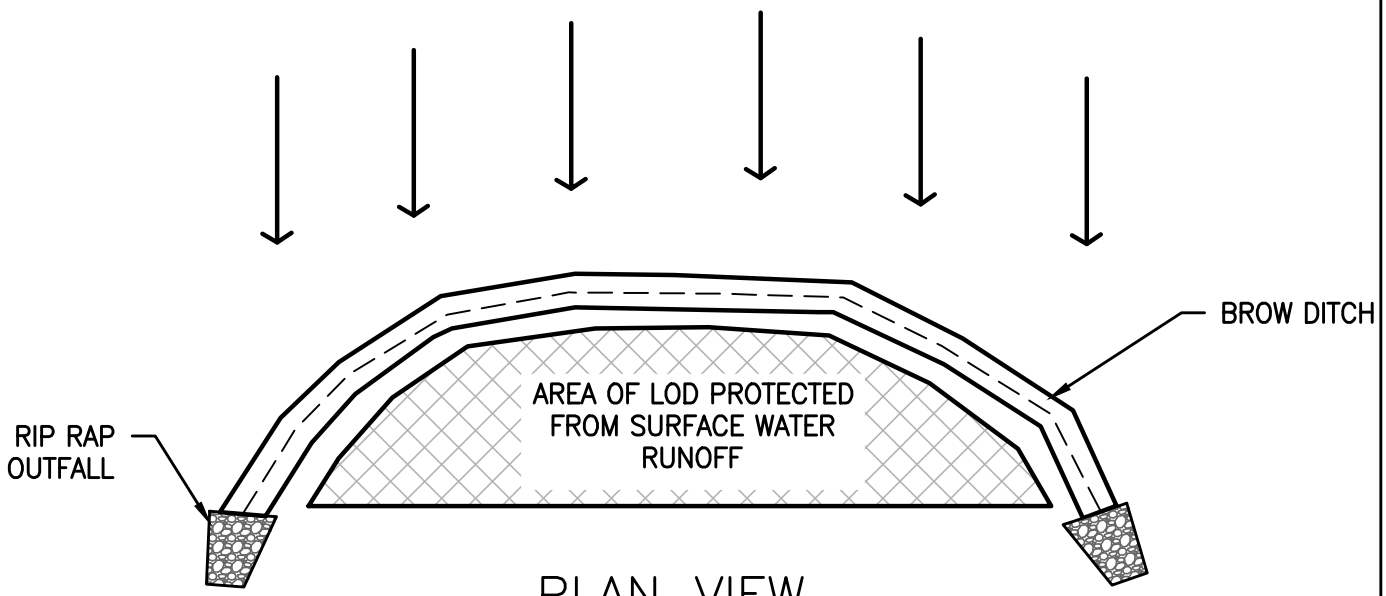
<u>Probability of significant impact to pipeline, waterbodies, roadways, adjacent property, or other features</u>

- Low
  - Pipeline traveling directly up and down the slope
  - Waterbodies or roadways are located 50 feet or more from toe of slope
- Moderate

    - Pipeline traveling directly up and down the slope and slope is 30° (58%) or steeper
    - Pipeline crossing the slope (sidehilling), but will likely be installed below top of bedrock surface
    - Waterbodies or roadways are located 20 to 50 feet or more from toe of slope
- High
    - Pipeline crossing the slope (sidehilling), but will not be installed below top of bedrock surface, or top of bedrock surface is unknown
    - Waterbodies or roadways are located less than 20 feet from toe of slope

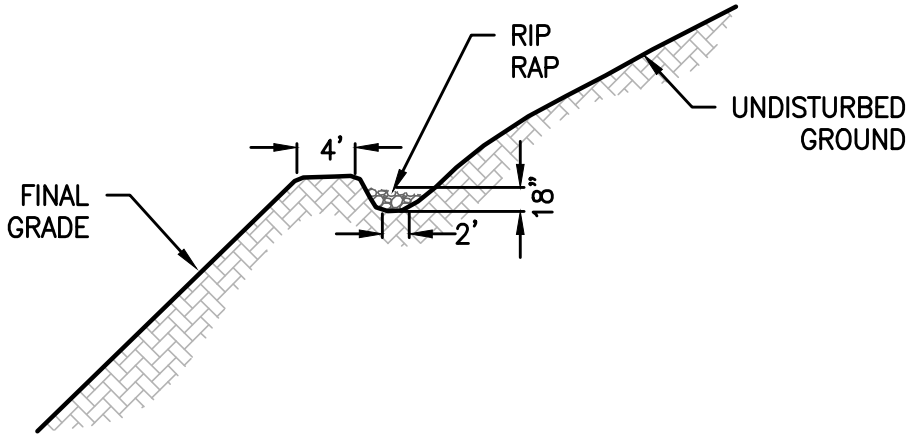
APPENDIX B

Select Typicals



PLAN VIEW

N.T.S.



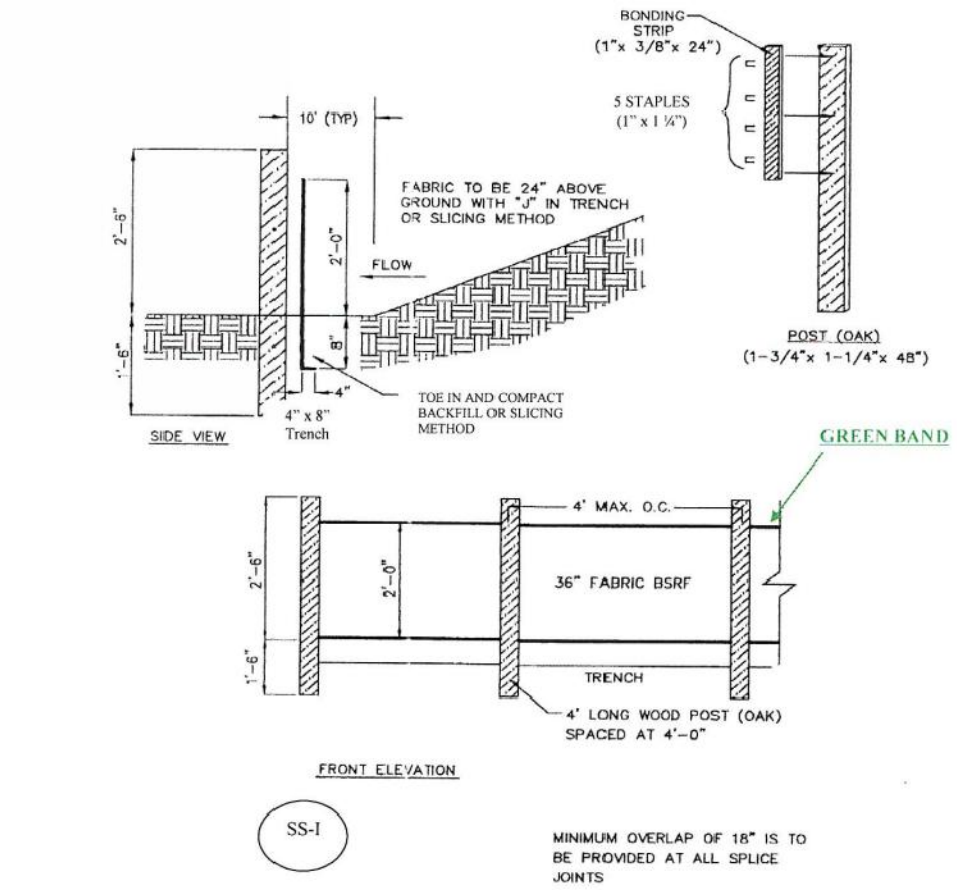
SECTION

N.T.S.

BROW DITCH DETAIL

BELTED SILT RETENTION FENCE
INSTALLATION DETAIL
PRIORITY 1 – GREEN BAND

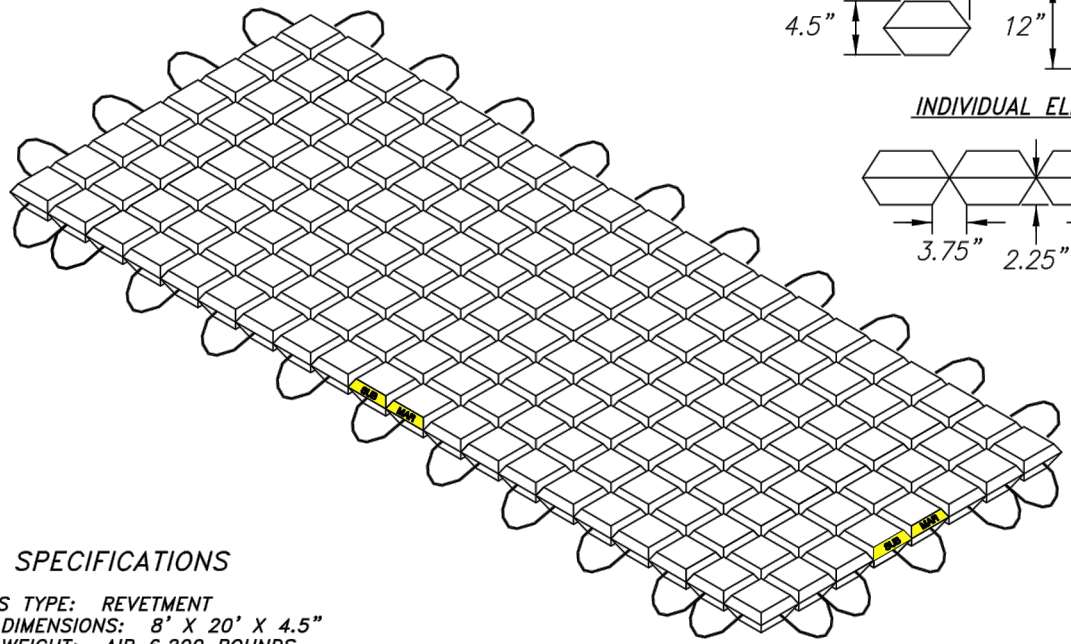
SILT-SAVER, INC.

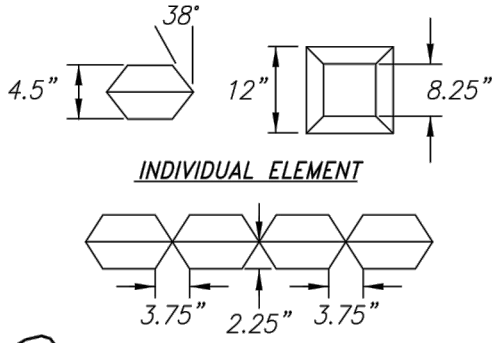


BELTED SILT RETENTION FENCE (BSRF)

SILT-SAVER, INC.
• 1094 Culpepper Drive • Conyers, GA 30094 •
Office 770-388-7818 • Fax 770-388-7640 • Toll Free 1-888-382-SILT (7458) • Website www.siltsaver.com •

BELTED SILT RETENTION FENCE





SPECIFICATIONS

MATTRESS TYPE: REVETMENT
MATTRESS DIMENSIONS: 8' X 20' X 4.5"
MATTRESS WEIGHT: AIR 6,200 POUNDS
MATTRESS WEIGHT SUBMERGED: 3,600 POUNDS (APPROX.)
CONCRETE DENSITY: 145 LBS. PER CU. FT., 4,000 PSI
160 ELEMENTS: 5/8" ULTRA VIOLET STABILIZED COPOLYMER
EXTRUDED FIBER ROPE, MINIMUM TENSILE STRENGTH 9,500 POUNDS

805 Dunn Street
Houma, LA 70360
Ph. 985-868-0001
Fax 985-851-0108
Email: submar@submar.com
Website: www.submar.com

SUBMAR
Synergy with Nature

SUBMAR
STANDARD 8.00'x20.00'
MAT DETAIL

4.5" CONCRETE MATTRESS

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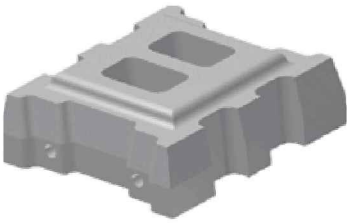
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DATE:	CHECKED BY:	DRAWN BY:	SCALE:	CONTACT:	PHONE. #:
01/03/13	DWD	KPF	N.T.S.		

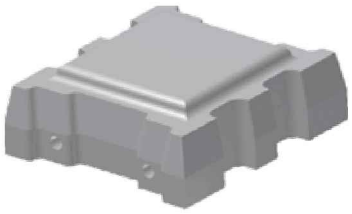
SUBMAR MATTRESS DETAIL

CONTECH®
ENGINEERED SOLUTIONS

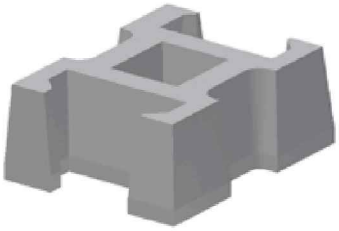
ARMORTEC® Product Details



ArmorFlex® - Open Cell



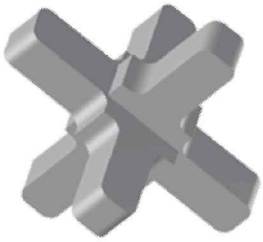
ArmorFlex® - Close Cell



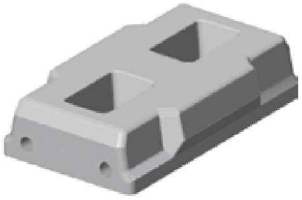
ArmorLoc®



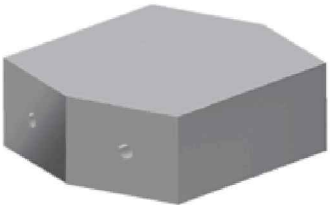
ArmorWedge®



A-Jacks®



ArmorStone®

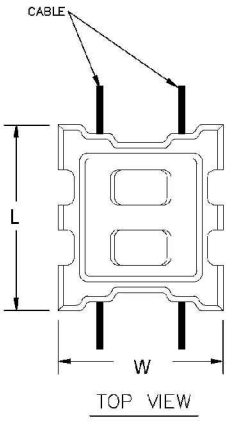


ArmorRoad®

MANUFACTURING SPECIFICATION
ASTM D6684-04

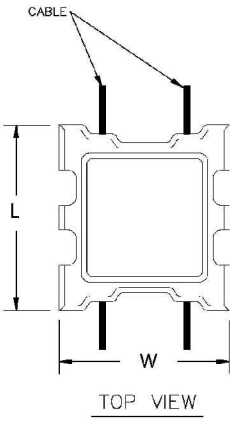
ARMORTEC®
Erosion Control Solutions

ArmorFlex® (not to scale)



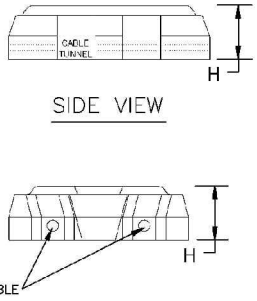
TOP VIEW

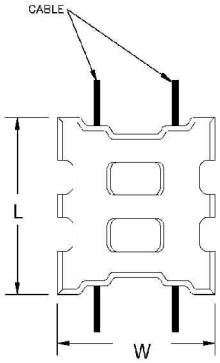
Open Cell Block



TOP VIEW

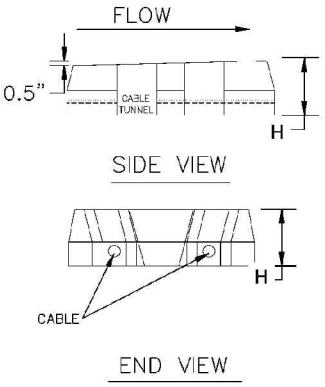
Close Cell Block

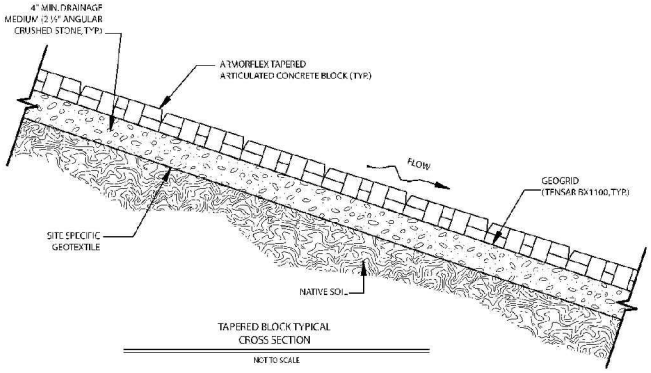




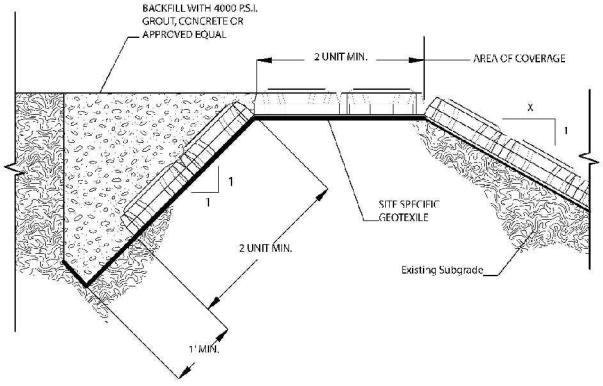
TOP VIEW

Tapered Series





Tapered Series - Cross Section

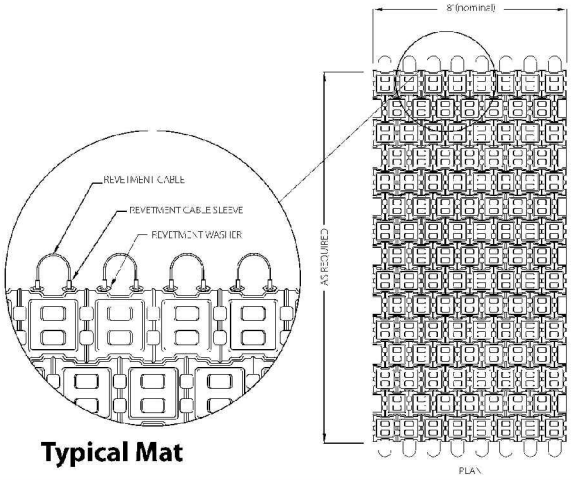


Top of Slope - Standard Detail

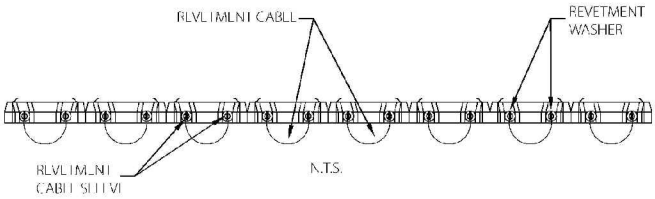
ArmorFlex Unit Specification

Concrete Block Class	Open/Closed Cell	Nominal Dimensions			Gross Area/ (sq. ft.)	Block Weight		Open Area %
		L	W	H		lbs	lbs/sq. ft.	
30s	Open	13.0	11.6	4.75	0.98	33-35	34-36	20
50s	Open	13.0	11.6	6.00	0.98	42-45	43-46	20
40	Open	17.4	15.5	4.75	1.77	59-64	33-36	20
50	Open	17.4	15.5	6.00	1.77	76-82	43-46	20
70	Open	17.4	15.5	8.50	1.77	108-117	61-66	20
40L	Open	17.4	23.6	4.75	2.58	97-105	38-41	20
70L	Open	17.4	23.6	8.50	2.58	174-188	68-73	20
45s	Closed	13.0	11.6	4.75	0.98	39-42	38-43	10
55s	Closed	13.0	11.6	6.00	0.98	50-54	49-55	10
45	Closed	17.4	15.5	4.75	1.77	71-77	40-43	10
55	Closed	17.4	15.5	6.00	1.77	91-98	52-56	10
85	Closed	17.4	15.5	8.50	1.77	136-146	77-83	10
45L	Closed	17.4	23.6	4.75	2.58	109-118	42-46	10
85L	Closed	17.4	23.6	8.50	2.58	207-223	80-87	10
High Velocity Application Block Classes								
40-T	Open	17.4	15.5	4.75	1.77	58-63	33-35	20
50-T	Open	17.4	15.5	6.00	1.77	75-81	43-46	20
70-T	Open	17.4	15.5	8.50	1.77	116-124	65-70	20

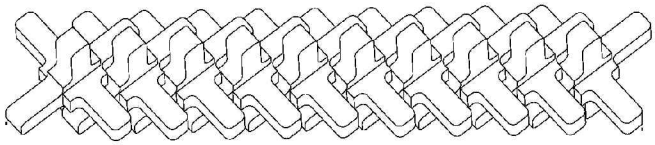
ArmorFlex® cont. (not to scale)



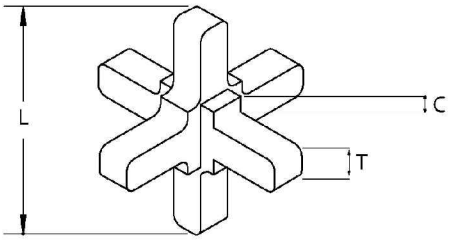
Typical Mat



A-Jacks® (not to scale)



A-Jacks Placement Profile

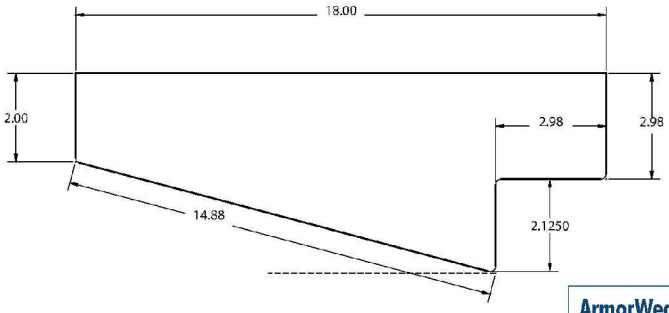


A-Jacks Unit

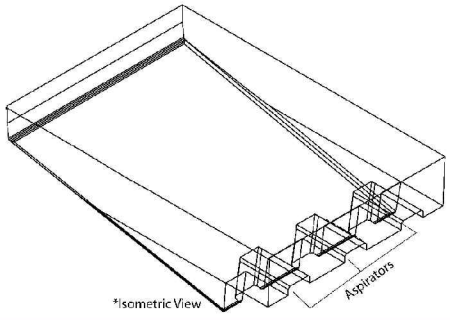
A-Jacks Unit Specification

A-JACKS	L(IN)	T(IN)/H(IN)	C(IN)	VOL(FT^3)	WT (LBS)
AJ-24	24	4	1.84	0.56	78
AJ-48	48	7.36	3.68	4.49	629
AJ-72	72	11.04	5.52	15.14	2.120
AJ-96	96	14.72	7.396	35.87	5.022
AJ-120	120	18.40	9.20	70.69	9.699

ArmorWedge® (not to scale)



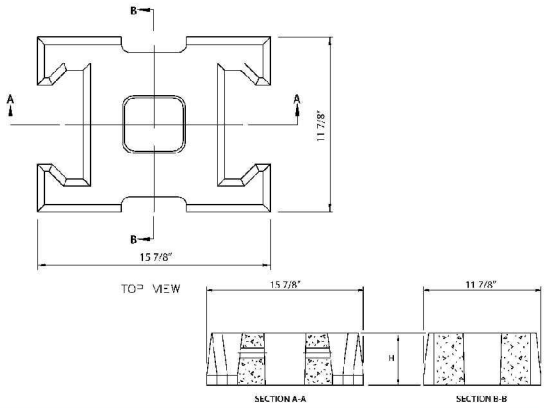
Side View - Typical Block



ArmorWedge Unit Specification

UNIT DIMENSION	UNIT WEIGHT (LBS/FT^3)	SYSTEM WEIGHT (LBS/FT^3)	UNIT COVERAGE (SF)	COMPRESSIVE STRENGTH (PSI)	MAXIMUM ABSORPTION (LBS/FT^3)
12x18	130-140	54-59	1.1875	4000	12

ArmorLoc® (not to scale)

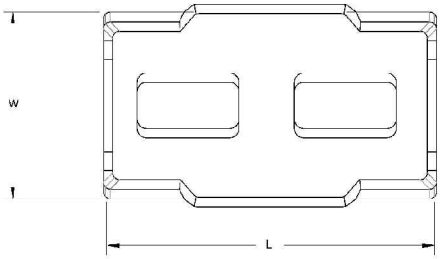


ArmorLoc Unit Specification

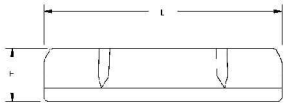
BLOCK	TECHNICAL DATA			DIMENSIONS AND WEIGHTS				
	Specific Weight lbs/ft³	Compressive Strength psi	Max Absorption, Avg. of 3 units 10 lbs/ft³	Thickness Inches (H)	Gross Area/ Grid ft²	Weights/ Grid lbs	Weights/ Area lbs/ft²	Open Area %
3510	130-140	4000 min	10	4	1.0	30-35	30-35	25
4511	130-140	4000 min	10	5.25	1.1	44-50	40-45	20
5011	130-140	4000 min	10	6	1.1	50-54	40-45	20

*Open-cell block shown. Closed-cell block also available.

ArmorStone® (not to scale)



PLAN

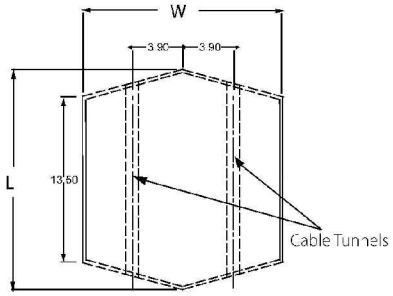


FRONT

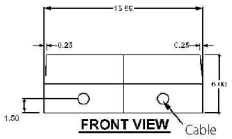
ArmorStone Unit Specification

CONCRETE BLOCK CLASS		NOMINAL DIMENSIONS (IN.)			UNIT COVERAGE (SF)	BLOCK		OPEN AREA %
		L	W	H		UNIT WEIGHT LBS.	SYSTEMS WEIGHTS LBS./SF	
AS 40	Open	18.00	10.00	4.50	1.25	50-54	40-44	25
AS 55	Closed	18.00	10.00	4.50	1.25	61-66	49-53	5

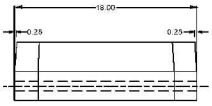
ArmorRoad® (not to scale)



TOP VIEW



FRONT VIEW



SIDE VIEW

ArmorRoad Unit Specification

BLOCK	TYPE	L	W	H	SF COVERAGE PER UNIT	WEIGHT LBS PER UNIT	SF PER TRUCK LOAD
Mat	Closed	18.00	15.60	6.00	1.74	105-109	750
Individual	Closed	18.00	15.60	6.00	1.74	100-104	750

ARMORTEC Minimum Physical Requirements per ASTM 06684-04

MIN. DENSITY (IN AIR) LBS/FT³		MIN. COMPRESSIVE STRENGTH PSI		MAX WATER ABSORPTION LBS/FT³	
Ave. of 3 Units	Individual Unit	Ave. of 3 Units	Individual Unit	Ave. of 3 Units	Individual Unit
130	125	4,000	3,500	9.1	11.7

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NDS
WE PUT WATER IN ITS PLACE

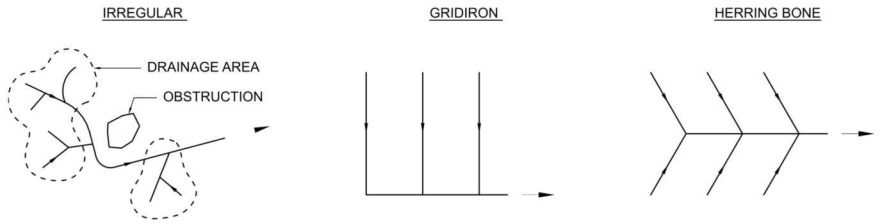
French Drains

Subsurface drainage systems have been in common use for centuries. They take many forms, but are all similar in design and function to the traditional French drain. French drains are excavated trenches filled with aggregate surrounding a slotted or perforated pipe that conveys excess surface and groundwater to a discharge point away from the drainage area. **EZ***flow* drainage products can be used as a substitution for conventional aggregate in French drain systems.

PLACEMENT

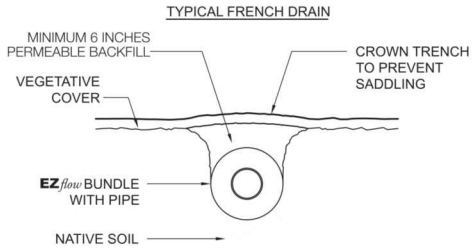
EZ*flow* drainage French drains should be laid out strategically to dewater irregular, poorly drained areas. A defined pattern such as a herring bone and gridiron should be used to drain complete areas including lawns, athletic fields, golf course greens and sand traps. These patterns include laterals that drain to collectors that discharge to an outfall. In general, laterals should not be longer than 50 feet and collectors no longer than 100 feet without increasing the pipe diameter downstream. In addition, the slope of each downgradient run should increase throughout the length of the system.

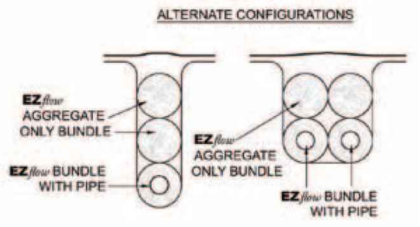
Trench depth and spacing will vary depending on soil texture of the area being drained. Trench depth can also be limited by outlet conditions in flatter areas. Lines may be spaced widely and deeply in sandy soils, and are generally placed shallower and closer together in clay soils.

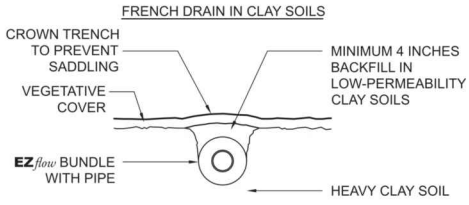


PRODUCT

The 7-inch **EZ***flow* drainage bundles with integrated 3-inch pipe are appropriate for small area residential subsurface drainage systems. 10-inch bundles with 4-inch pipe can be used to drain areas of up to two acres in poorly drained organic soils. In larger areas or if there is over 200 feet of pipe upstream, the 15-inch bundles with 6-inch pipe are recommended.





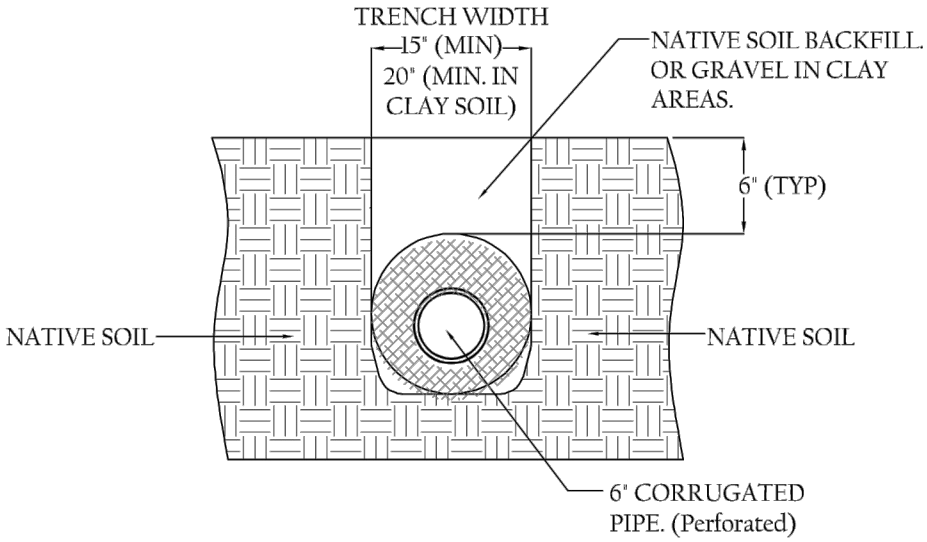


Minimum Recommended Depth of Cover*	
Condition	**Depth (in.)**
Residential area, commercial lawn mowers	6**
Athletic fields with consistent activity	8
Areas with occasional light vehicular traffic	12

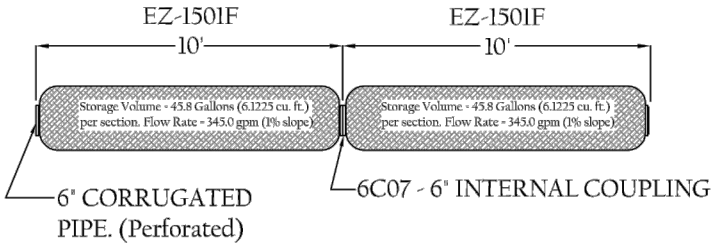
* It is recommended that **EZ***flow* drainage systems be installed a minimum of 6 inches below existing or planned subsurface irrigation lines.
** In low-permeability clay soils, trenches can be placed with a minimum 4 inches of permeable backfill.

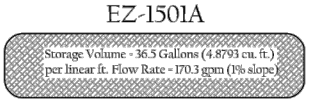
EZflow

TRENCH DRAIN DETAIL



SECTION





PLAN VIEW

ADDITIONAL COVER MAY BE REQUIRED BASED ON SITE CONDITIONS. 12" COVER REQUIRED TO OBTAIN AN H-10 LOAD RATING. CONSULT WITH A LOCAL ENGINEER FOR SITE SPECIFIC REQUIREMENTS.

EZflow™
AGGREGATE DRAINAGE SYSTEM

TECHNICAL SERVICES
1-888-825-4716
techservice@ndspro.com

N. T. S.

TRENCH DRAIN DETAIL

French Drain Installation Instructions

The steps below offer typical installation practices for French drains and will vary based on site conditions. These practices are also applicable to landscape plant bed drains and for wet areas on golf courses.

1. Identify the area to be drained and mark off lateral and collector lines before digging beginning trench excavation.



2. Start excavating the trench at the discharge point or where connections to downstream piping will be made. Trench width should be equal to the diameter of the bundle being used. Trench depth will reflect existing terrain, desired drainage line slope and length, height of bundles(s) and required cover thickness. Ensure proper slopes by using a transit or builder's level and grade the trench bottom evenly for proper flow.

3. Place the **EZ***flow* drainage bundle with pipe end to end along the edge of the trench. Use an end cap at the system high point and fully insert the proper couplings at all bundle-to-bundle connections. Lay the connected bundles with pipe in trench, stacking aggregate-only bundles above these bundles as needed.



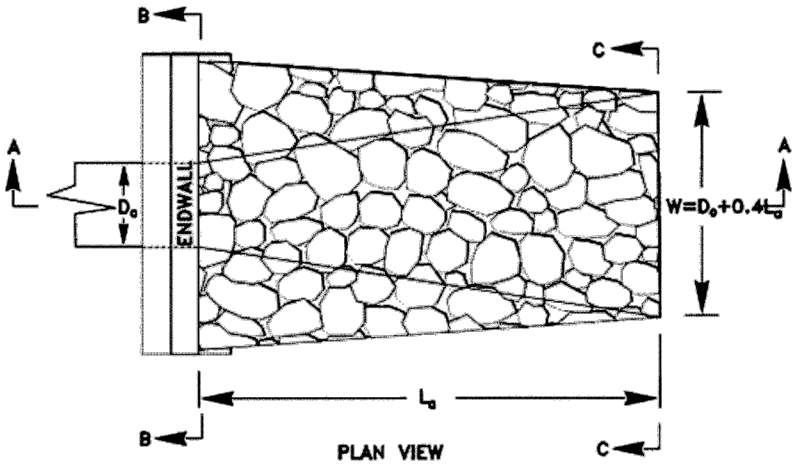
4. Place a minimum of 4-inches permeable backfill (see recommended depths of cover on page 6) over the bundles without compaction. Additional sand/backfill can be placed and compacted normally above the loose fill to prevent trench saddling. Cover trench with sod or topsoil and seed to finish installation.

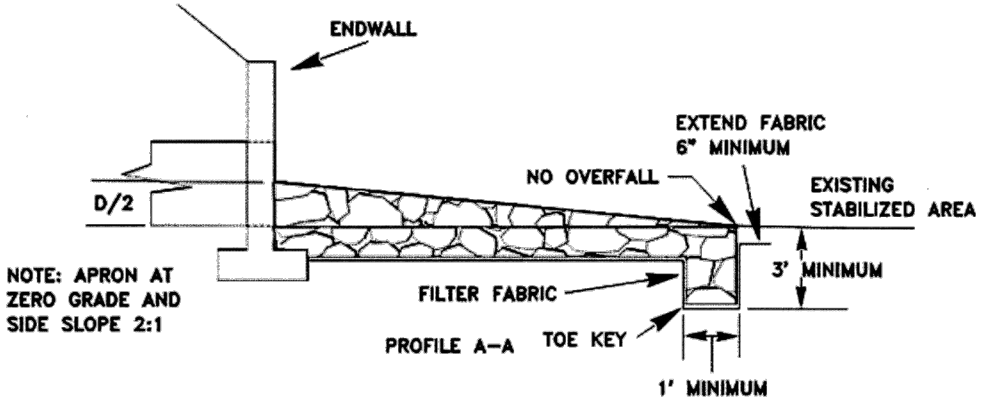
TRENCH DRAIN DETAIL

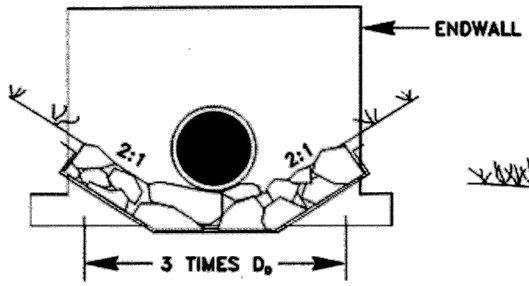
FIGURE 3.17.3

OUTLET PROTECTION

DISCHARGE TO UNCONFINED SECTION
(MINIMUM TAILWATER)

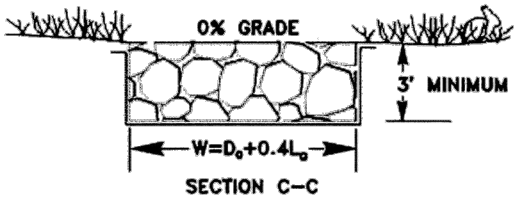






SECTION B–B

d



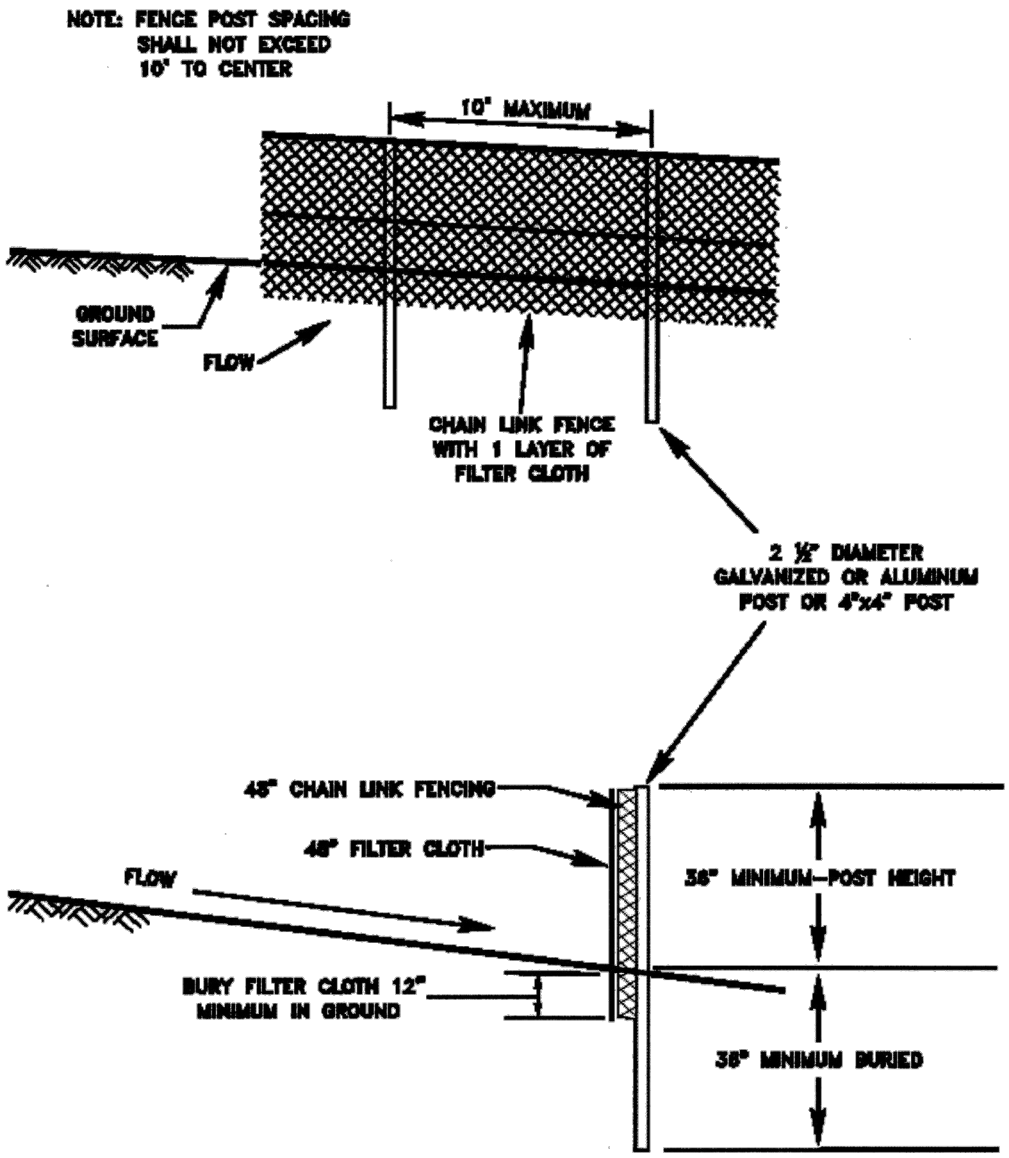
SECTION C–C

FROM NEW YORK STANDARDS AND SPECIFICATIONS
FOR EROSION AND SEDIMENT CONTROL

OUTLET PROTECTION DETAIL

FIGURE 3.28.1

SUPER SILT FENCE



SUPER SILT FENCE DETAIL

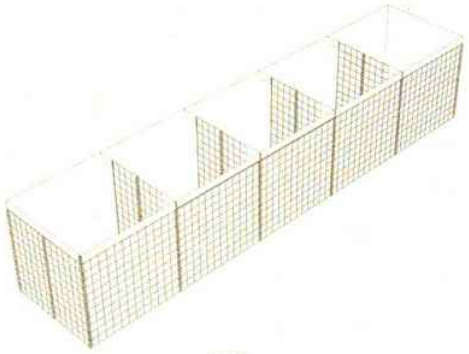
BARRICAGE™ FLOOD

SHIELD | FLOOD | EARTH | ROCK

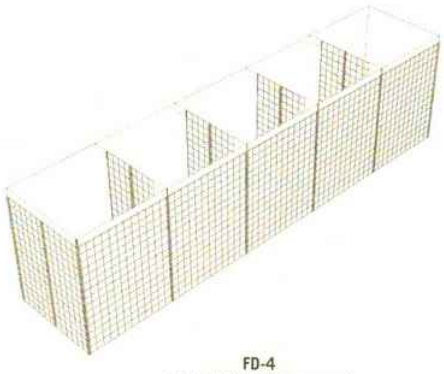
BarriCage™ geotextile-lined civil system for flood-defense applications. Interior grids free of geotextile fabric allow the fill to compact between cells. Easily fillable with dirt, sand, or gravel. Spiral corners join to other units with included connecting pins. Plastic ties are provided to secure geotextile lining and prevent fill from falling between system joints.



Connecting Pin | Plastic Tie



FD-3
H-3' W-3' L-15' (5 cages)



FD-4
H-4' W-3' L-15' (5 cages)

GENERAL SPECIFICATIONS:

Galvanized welded wire system to ASTM A 974-97 standards with geotextile lining. Lining is high-quality, nonwoven geotextile made of polypropylene fibers designed to form a high-strength fabric. Geotextile liner is available in tan color.

WELDED WIRE GRID CONTAINER	
Wire	
Wire Guage	8.5 American SWG, steel
Wire Diameter	0.155"/3.937mm
Wire Tensile Strength	80-110 ksi 550-760 kPa
Corrosion Protection	Zn-5Al-MM to ASTM A 856A/A 856M-03 minimum coating weight 0.8oz/Ft²/240g/m²
Grid	
Wire Spacing	3" x 3"
Tolerance on Line Wire Spacing	+/- 1/8"
Cross Wire Straightness Across Test Panel	Limit of deviation 1/4" in 72"
Mesh Strength	70% of wire tensile strength
Panels	
Squareness	In 4' diagonals shall not vary by more than 5/8"
Flatness	In 6' not more than 2" from plane

GEOTEXTILE	STANDARD	VALUE
Mechanical Properties		
Grab Tensile Strength (Machine Direction)	ASTM D 4632	170lbs.
Grab Tensile Strength (Cross Direction)	ASTM D 4632	170lbs.
Grab Elongation (Machine Direction)	ASTM D 4632	50%
CBR Puncture	ASTM D 6241	450lbs.
Endurance Resistance		
Trapezoidal Tear (Machine Direction)	ASTM D 4533	70lbs.
Trapezoidal Tear (Cross Direction)	ASTM D 4533	70lbs.
UV Resistance (% retained after 500 hrs)	ASTM D 4355	90%
Hydraulic Properties		
Apparent Opening Size*	ASTM D 4751	70 US Std. Sieve
Permittivity*	ASTM D 4491	1.50sec⁻¹
Permeability*	ASTM D 4491	.38 cm/sec
Water Flow*	ASTM D 4491	110 gpm/ft²

*At time of manufacturing. Handling may change these properties.

a product of landmark. EARTH SOLUTIONS, INC.

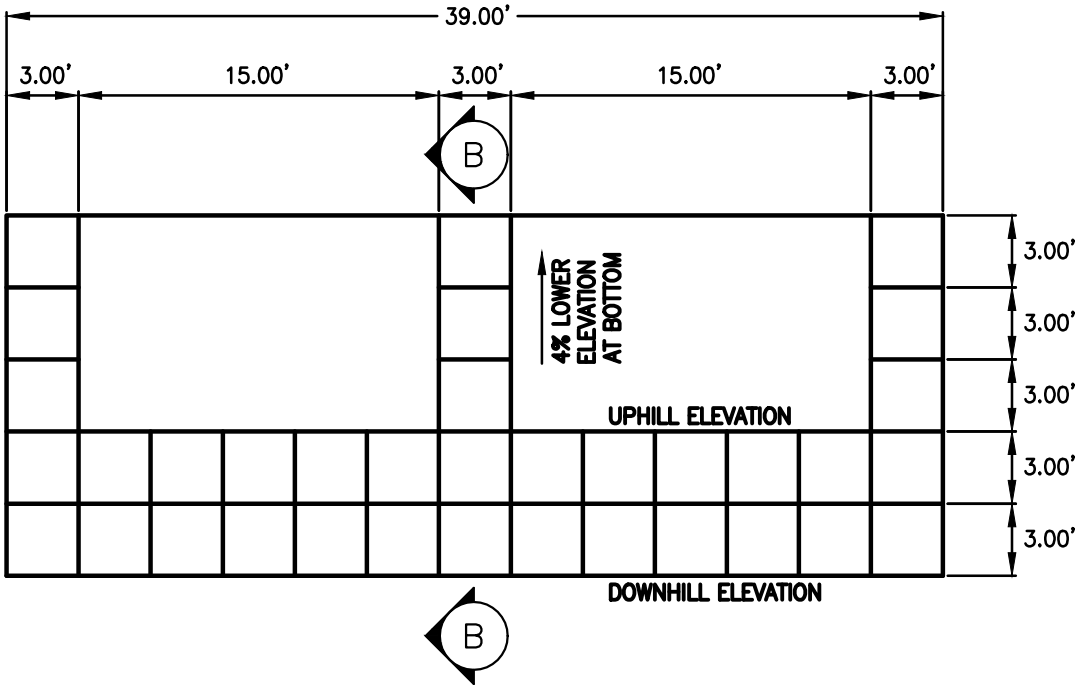
The given values were obtained through a series of testing performed by our suppliers and other outside testing facilities. The information included herein is subject to change at any time without notice from Landmark Earth Solutions™, Inc.

LandmarkEarthSolutions.com | (888) 574-6473 (#3)

BarriCage gabion system meets all ASTM A974 requirements and specifications. All trademarks owned by Landmark Earth Solutions, Inc.
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barricage™

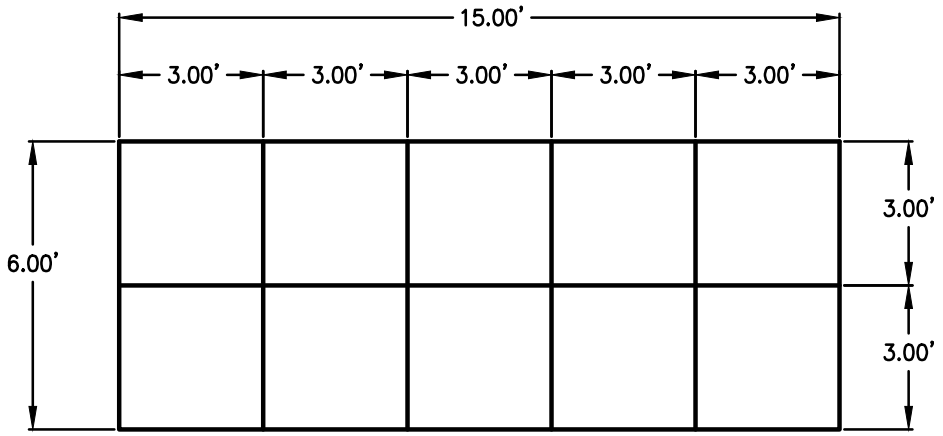
BARRICAGE CONTAINMENT DETAIL



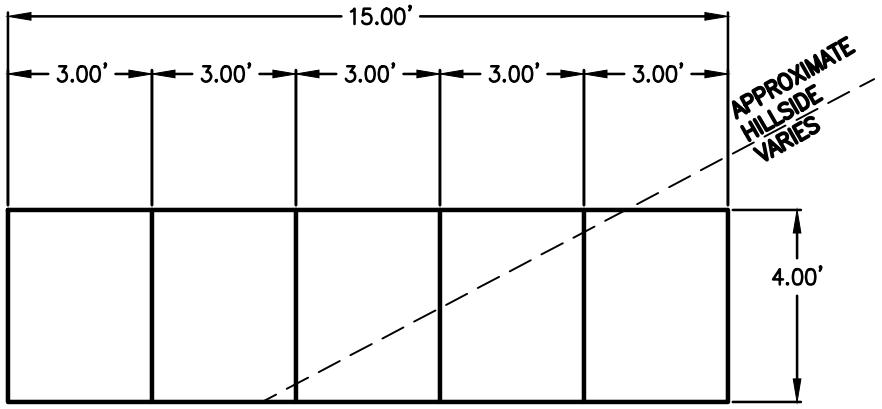
PLAN VIEW
N.T.S.

NOTE:
THIS PRODUCT FOR USE AS A TEMPORARY BUTTRESS
OR CONTAINMENT. NOT FOR PERMANENT USE.

BARRICAGE CONTAINMENT DETAIL



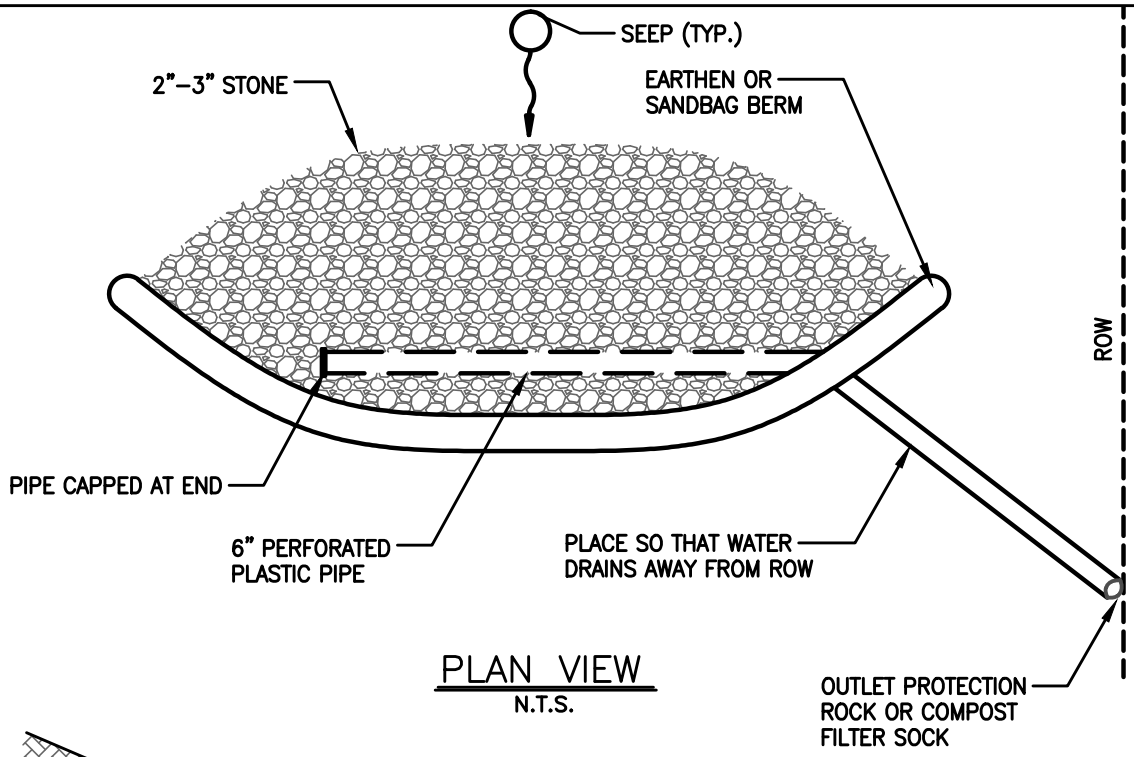
AERIAL VIEW
N.T.S.



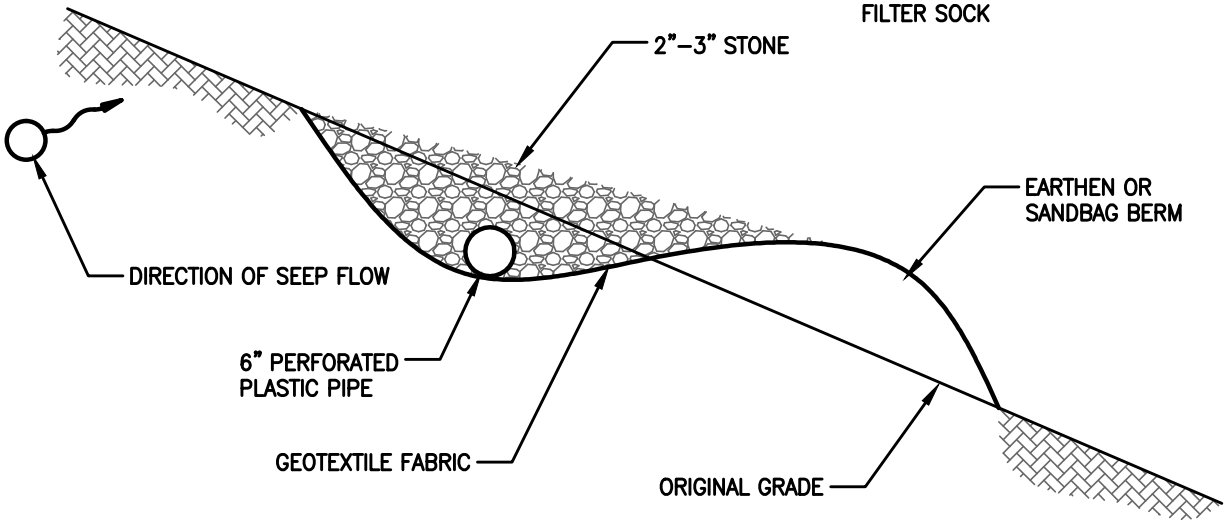
SECTION B
N.T.S.

NOTE:
THIS PRODUCT FOR USE AS A TEMPORARY BUTTRESS
OR CONTAINMENT. NOT FOR PERMANENT USE.

BARRICAGE CONTAINMENT DETAIL



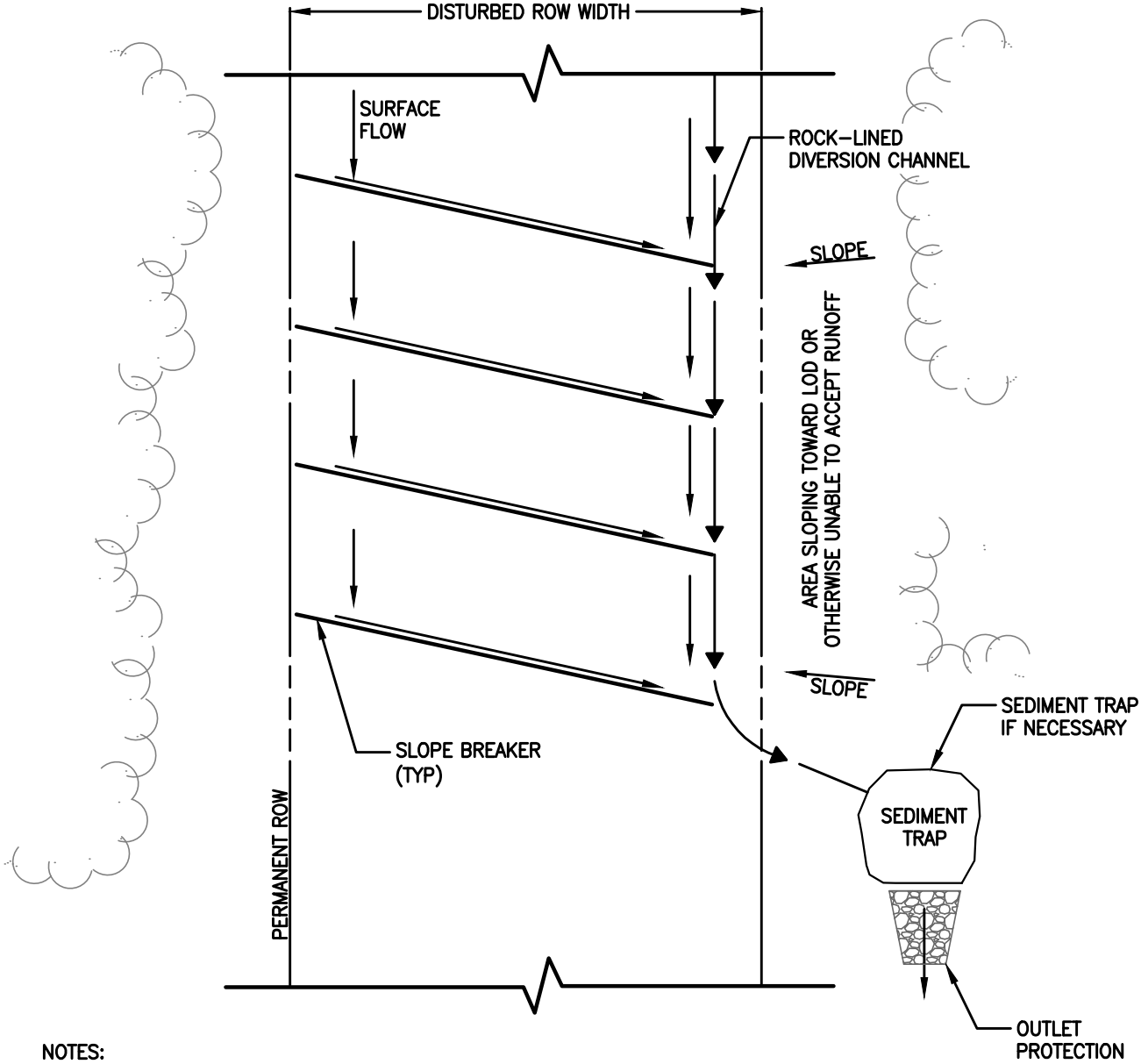
PLAN VIEW
N.T.S.



SECTION
N.T.S.

NOTE:
BERMS MAY BE CONSTRUCTED USING SANDBAGS TEMPORARILY DURING CONSTRUCTION. PERMANENT BERMS TO BE CONSTRUCTED USING COMPACTED EARTH.

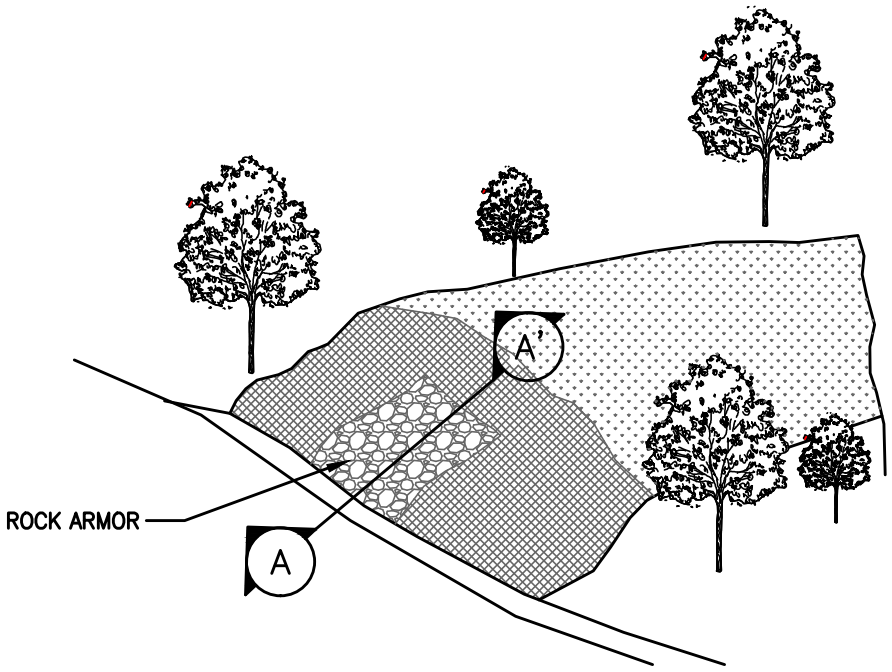
SEEP COLLECTOR DETAIL



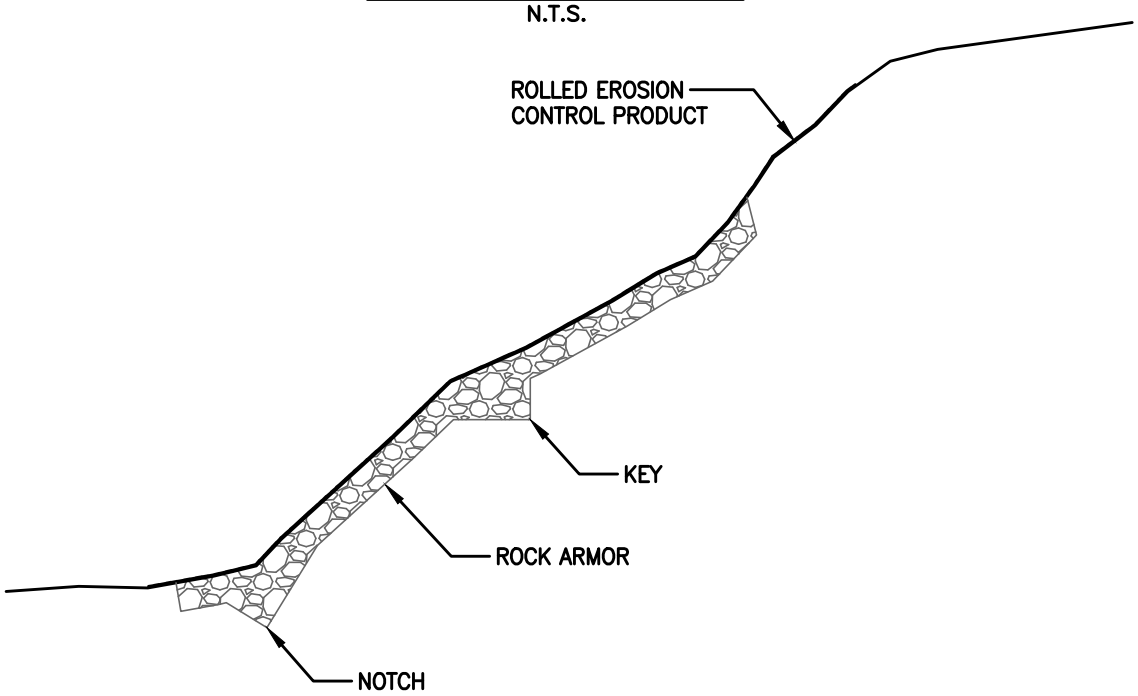
NOTES:

1. CHANNEL AND SLOPE BREAKER LAYOUT WILL NEED TO BE FIELD ADJUSTED TO CONFORM TO SITE CONDITIONS
2. CHANNEL MAY REQUIRE STONE CHECK DAMS, ROLLED EROSION CONTROL PRODUCTS AND OTHER SITE SPECIFIC EROSION AND SEDIMENT CONTROL MEASURES AS NECESSARY
3. SEDIMENT TRAP MAY BE REQUIRED WHERE SUFFICIENT VEGETATIVE COVER EXISTS DOWNSLOPE OF DIVERSION CHANNEL
4. SEDIMENT TRAP WILL REQUIRE SIZING BY AN ENGINEER

CROSS DRAIN DETAIL

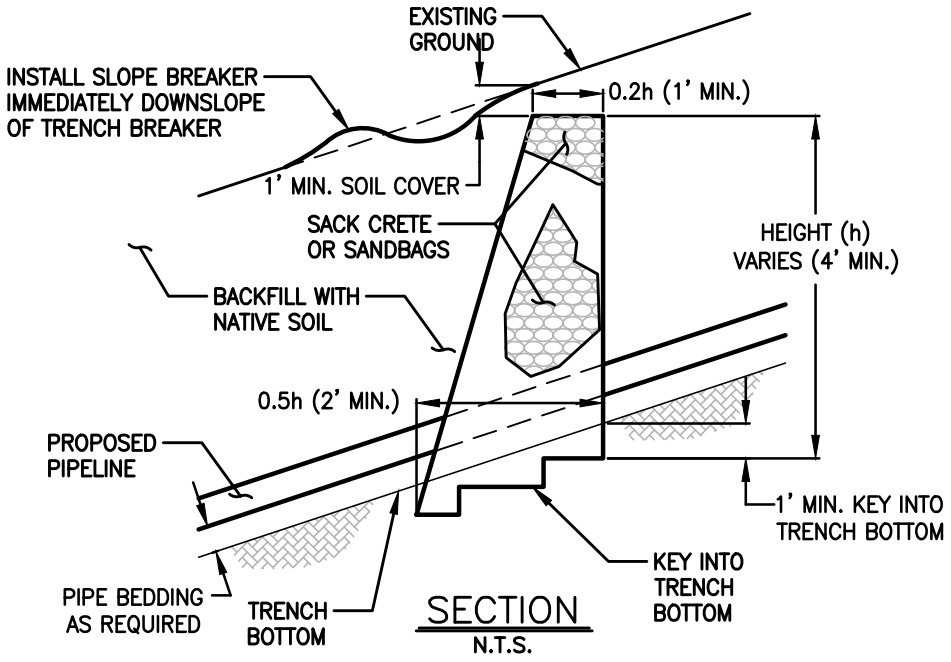


PERSPECTIVE VIEW
N.T.S.

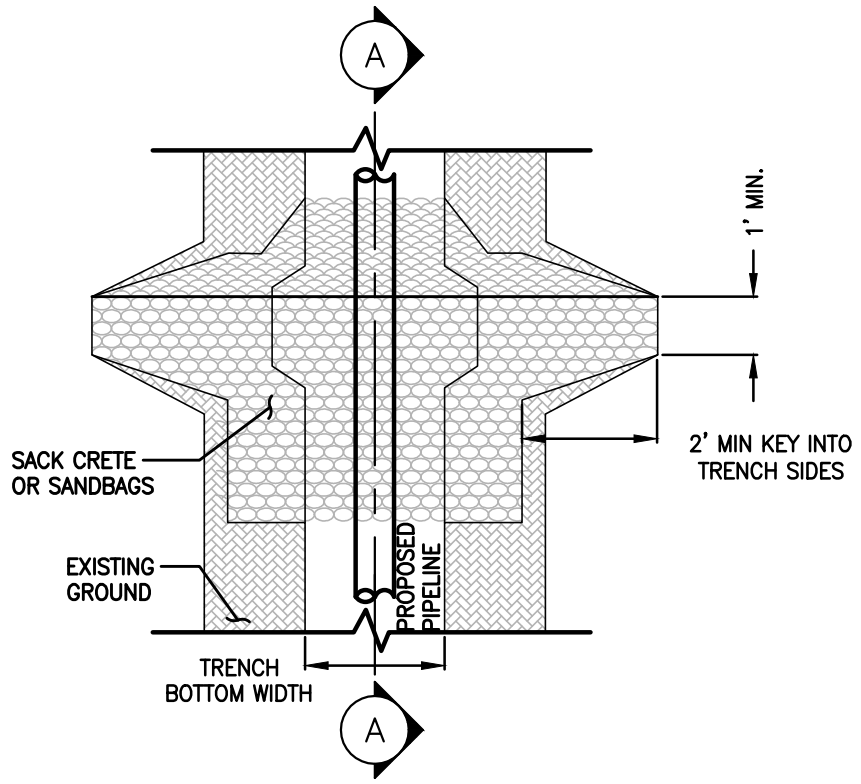


A–A' ROCK ARMOR ON STEEP SLOPE
N.T.S.

ROCK FILTER BLANKET DETAIL

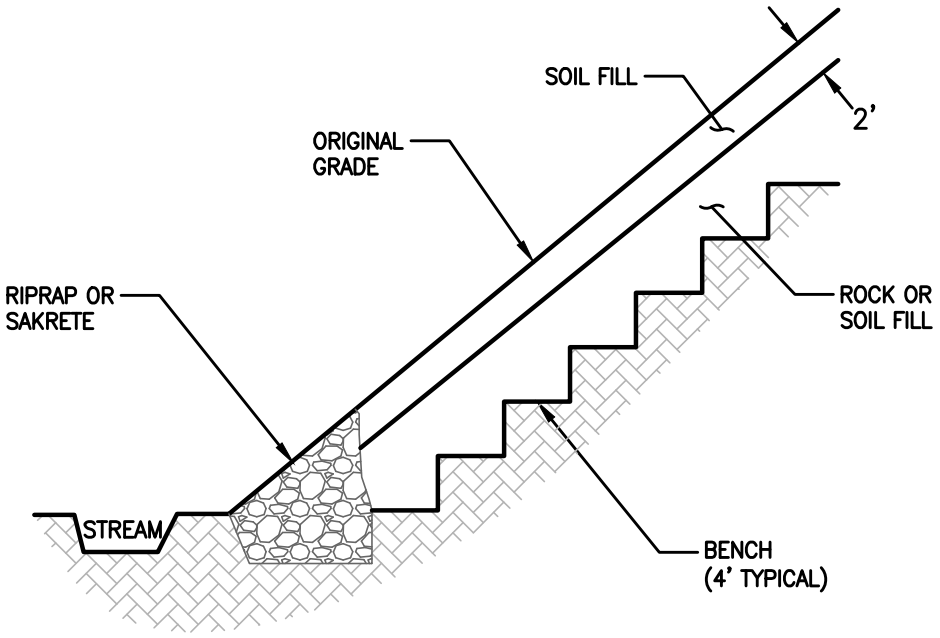


SECTION
N.T.S.

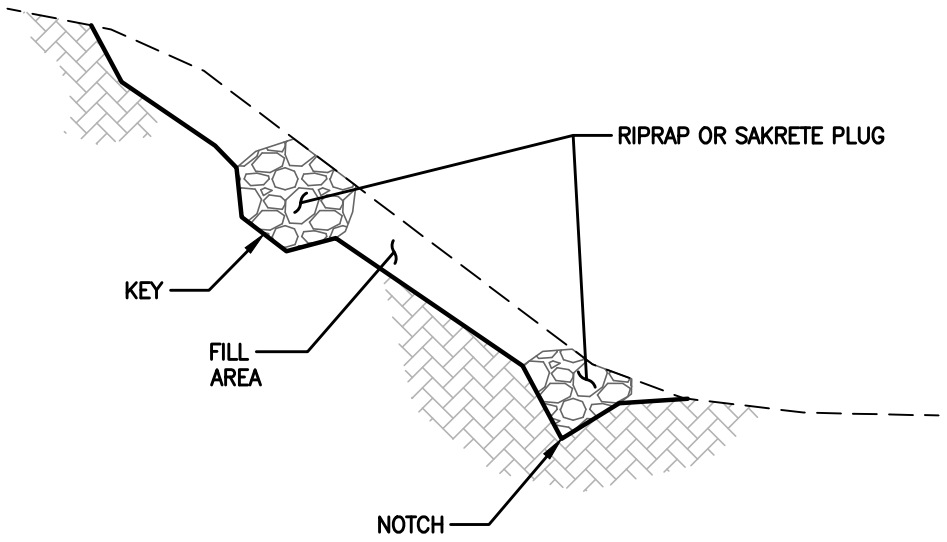


PLAN VIEW
N.T.S.

TRENCH PLUG AND WATERBAR DETAIL

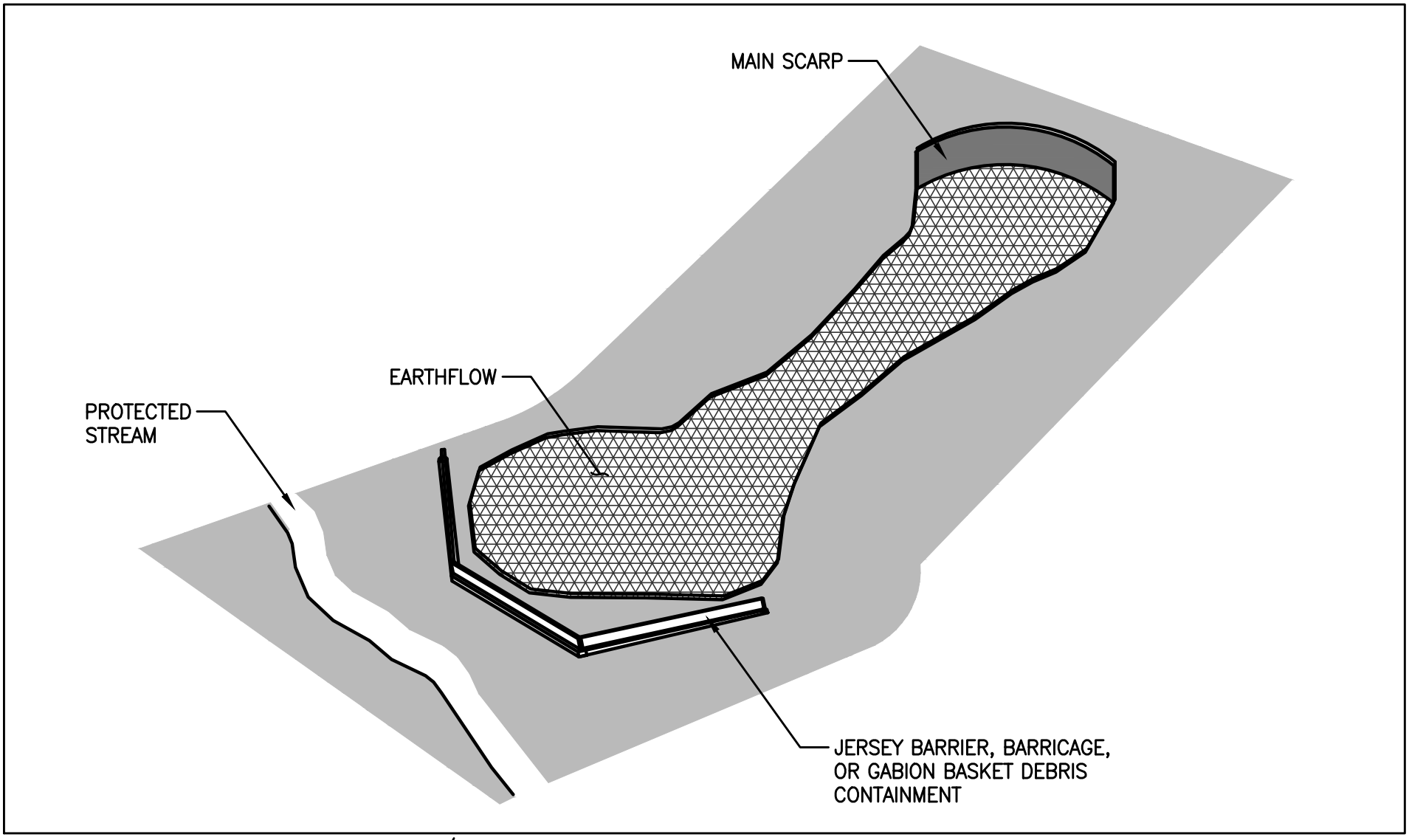


BENCH AND REGRADE TYPICAL
N.T.S.

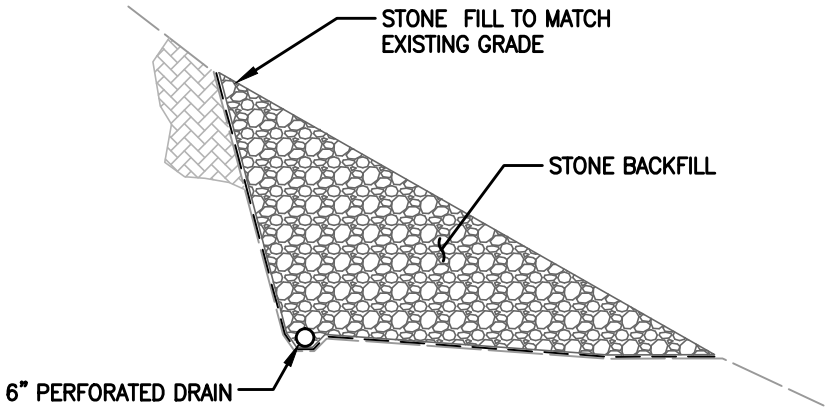


KEYING TYPICAL
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BENCH AND REGRADE WITH CONTROLLED BACKFILL DETAIL

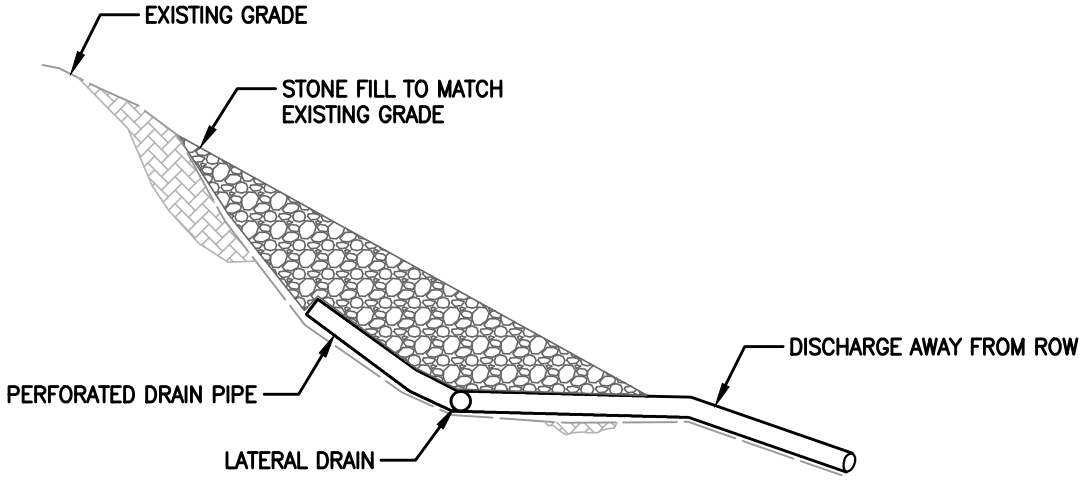


GABION BASKET/JERSEY BARRIER CONTAINMENT DETAIL



STONE WITH DRAIN TO RESTORE FAILING SLOPE

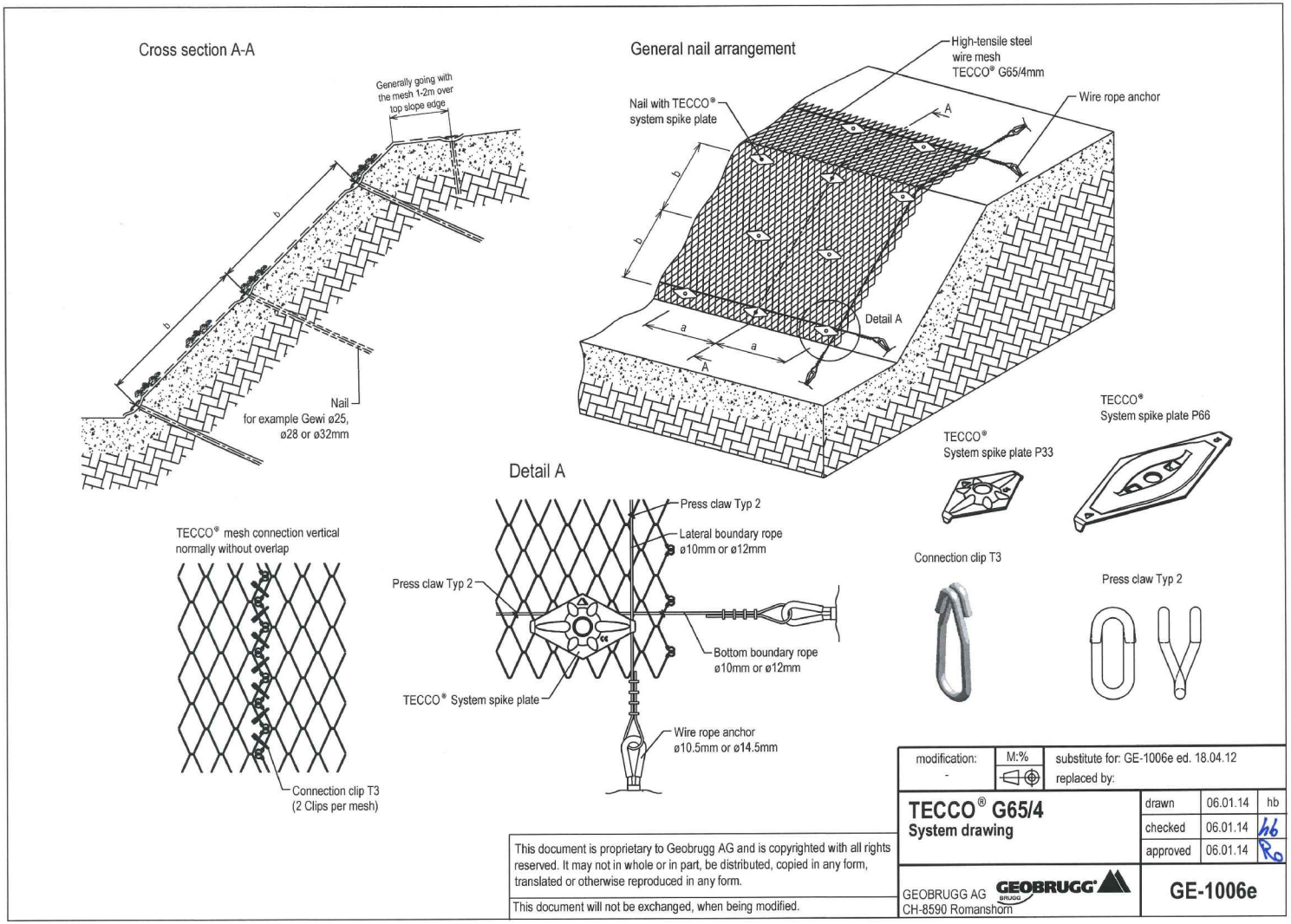
N.T.S.



SMALL SLIP REPAIR WITH LATERAL

N.T.S.

ROCK FILL ON SLOPES BETWEEN 30–38 DEGREES DETAIL



modification: -	M:%	substitute for: GE-1006e ed. 18.04.12 replaced by:

TECCO® G65/4
System drawing

drawn	06.01.14	hb
checked	06.01.14	hb
approved	06.01.14	RO

GEOBRUGG AG
CH-8590 Romanshorn

GE-1006e

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GEOBRUGG–TECCO SYSTEM – WIRE MESH STABILIZATION

APPENDIX C

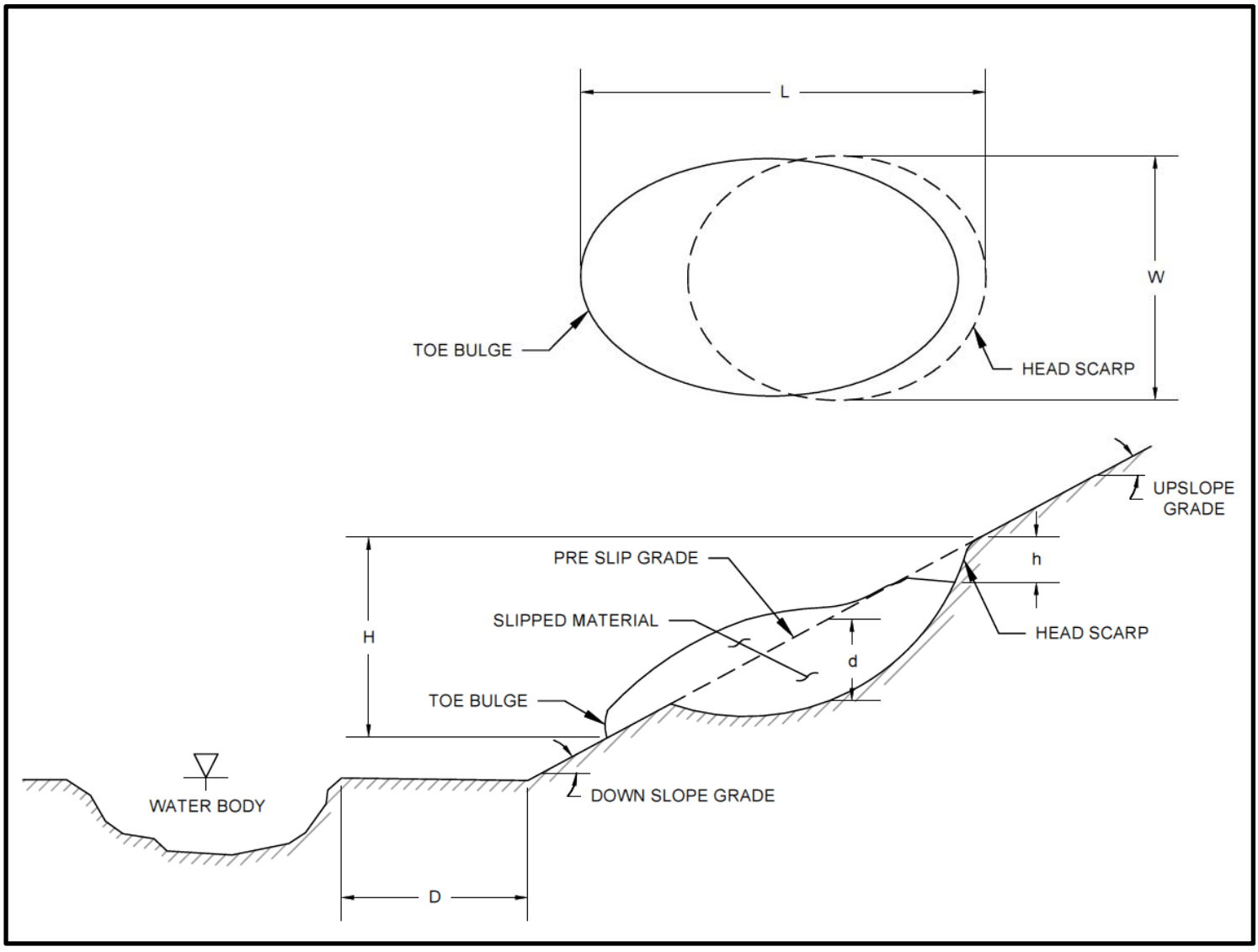
Forms

SLOPE FAILURE INFORMATION AND REPORTING FORM

Pipeline Name	
Slope Failure Station	GPS Coordinates Latitude _____ Longitude _____

Name of Observer	
Date	

Slope Failure Priority per Guidance in Appendix D Policy	○ 1 ○ 2 ○ 3 ○ 4



Slope Characteristics

General dimensions (Rough estimate) *See above sketch for dimension key	Length, ***L*** (ft): _____ Width, ***W*** (ft): _____ Head Scarp Height, ***H*** (ft):_____ Height of total slope failure area, ***h*** (ft):_____ Distance from base of slope to waterbody, ***D*** (ft)_____ Estimated maximum depth of failure surface, ***d*** (ft)_____
Slope Angle	At failure ◯ 20° or flatter ◯ 22° to 30° ◯ 30° to 38° ◯ Steeper than 38°
	Upslope ◯ 20° or flatter ◯ 22° to 30° ◯ 30° to 38° ◯ Steeper than 38°
	Downslope ◯ 20° or flatter ◯ 22° to 30° ◯ 30° to 38° ◯ Steeper than 38°
Slope direction relative to pipeline	◯ Pipeline is parallel to slope (up and down slope) ◯ Some amount of cross slope ◯ Pipeline is perpendicular to slope (cross slope, or sidehilling)
Slope type	◯ Natural ◯ Cut ◯ Fill ◯ Cut and fill
Presence of surface water	◯ Yes ◯ No ◯ Unknown Describe: _____
Presence of groundwater	◯ Yes ◯ No ◯ Unknown Describe: _____
Rock outcrops	◯ Yes ◯ No ◯ Possible Describe location:
Rock type	☐ Shale ☐ Mudstone /Claystone ☐ Siltstone ☐ Sandstone ☐ Limestone ☐ Coal ☐ Interbedded ☐ Others _____
Is there evidence of tree movement?	Perpendicular or leaning tree trunks is evidence of recent movement Describe: _____
Look at trunks	Tree trunk bending and going vertical is evidence of previous slide movement Describe: _____

Slope Failure Characteristics

Failure surface appearance	◯ Circular ◯ Hummocky ◯ Terraced
Type of movement	◯ Rotational slide ◯ Translational block slide ◯ Debris slide ◯ Complex
Failure material(s)	◯ Soil ◯ Rock ◯ Both Describe:
Head scarp	Describe:
Secondary scarps	Describe:
Evidence of toe bulge	◯ Yes ◯ No ◯ Possible
Evidence of erosion	☐ Head ☐ Toe ☐ Flank ☐ Body ☐ None
Is failure within pipeline ROW	◯ Permanent ◯ Temporary ◯ Outside LOD
Current impact to adjacent structures or properties	☐ Waterbody ☐ Pipeline/Utilities ☐ Roads ☐ Railroad ☐ Residential ☐ Buildings ☐ Bridge ☐ None ☐ Others_____ Distance from toe of slope (ft): _____
Potential impact to adjacent structures or properties	☐ Waterbody ☐ Pipeline/Utilities ☐ Roads ☐ Railroad ☐ Residential ☐ Buildings ☐ Bridge ☐ None ☐ Others _____ Horizontal distance from toe of slope (ft): _____

Existing remediation	☐ Drainage ☐ Bio-stabilization ☐ Slope geometry correction ☐ Retaining structures ☐ Internal slope reinforcement ☐ Erosion control ☐ Chemical stabilization ☐ None ☐ Others _____ Describe:

Other

Site access	☐ Site is accessible by permanent road, or active temporary access road ☐ Site access requires traversing steep slopes or long distance along ROW
Contractor availability	☐ Pipeline contractor still on site ☐ Pipeline contractor no longer on site, but still responsible for ROW restoration ☐ Pipeline contractor not contractually obligated for ROW restoration ☐ Specialty contractor required for anticipated repair method

Comments	

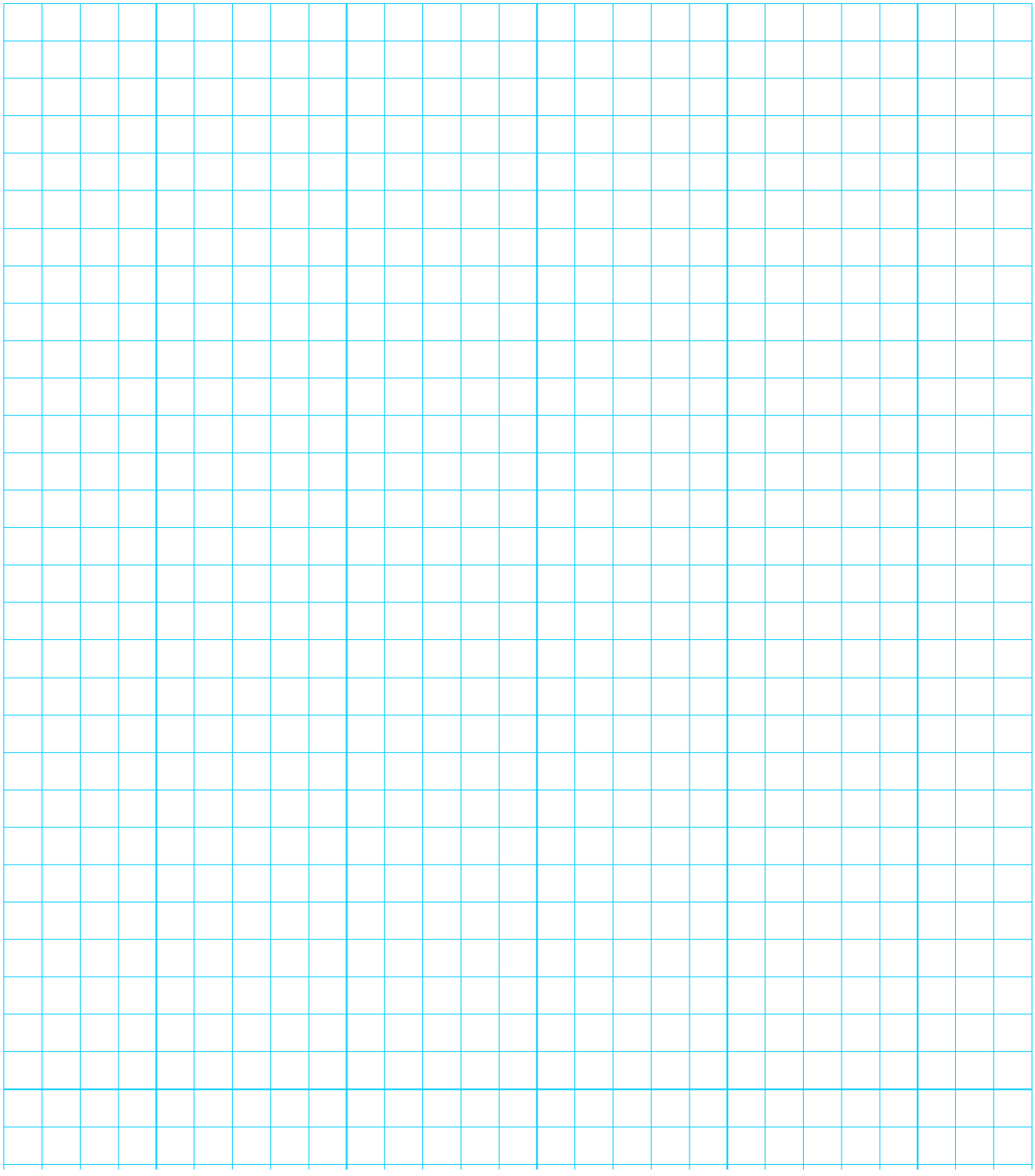
Photo Log

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SLOPE FAILURE SKETCH

Plan View and Cross-Section

Pipeline Name	Slope Failure Station



SLOPE FAILURE REPAIR ASSESSMENT FORM

Use this form to evaluate whether repair of an existing slope failure will be field-directed or engineering-directed, and whether to engage a specialist in slope failure evaluation and repair (i.e., geotechnical engineer).

PIPELINE NAME: _____ **SLOPE FAILURE STATION:** _____ **DATE:** _____

FILLED OUT BY: _____ **PROJECT MANAGER:** _____

Criteria	Value	Selected Score
Slope Steepness		
Flatter than 20 degrees	1	
20 degrees to 30 degrees	5	
30 degrees to 38 degrees	10	
Steeper than 38 degrees	20	
Slope Direction Relative to Pipeline		
Pipeline is parallel to slope (i.e., up and down the slope)	1	
Some amount of cross slope	5	
Pipeline is perpendicular to slope (i.e., cross slope, or sidehilling)	10	
Evidence of Pre-existing Slope Failures		
None	1	
Mapped slope failures are present at the site, or pipeline plans indicate this location is a slope failure-prone hazard	5	
Tree trunks in the vicinity bend and go vertical	10	
Slope Failure Location		
Slope failure and material is fully within ROW	1	
Slope failure or material extends beyond ROW	10	
Consequence of Future Movement		
No Potential for Impact to pipeline, water bodies, roadways or private property	1	
Slope failure has potential to cause danger to human health and the environment (compromises other utilities, pipeline rupture, blocked public roadway(s), fish kill, release of pipeline fluids, sediment/debris in stream)	3	
Slope failure has caused an immediate danger to human health and the environment (compromises other utilities, pipeline rupture, blocked public roadway(s), fish kill, release of pipeline fluids, sediment/debris in stream)	5	
Site Access		
Site is accessible by permanent road or active temp. access road	1	
Site access requires traversing steep slopes or long distance along ROW	5	
Contractor Availability		
Pipeline contractor still on site	1	
Pipeline contractor no longer on site, but still responsible for ROW restoration	3	
Pipeline contractor not contractually obligated for ROW restoration	5	
Specialty contractor required for anticipated slope failure repair method	10	
	TOTAL	**0**

	Score
Field-directed repair	7-25
Engineering-directed repair	20-35
Engage third party specialist (i.e., geotechnical engineer)	30-70

APPENDIX D
Slope Failure Priority Guidance

Slope Failure Priority Guidance



- If you identify a slope failure on an *actively permitted construction project*, you must immediately notify the Environmental Compliance Coordinator (ECC). The ECC will coordinate with Energy Environmental Infrastructure Services (EIES) to determine the slope failure priority and the regulatory agency notification requirements. The ECC will notify the appropriate regulatory agencies as applicable.
- The ECC and EIES will work with you to identify the slope failure priority (see below).
- The ECC will provide immediate notification to the appropriate regulatory agency as required. **NOTE**: most regulatory agencies define immediate as "upon awareness and knowledge," and generally expects this to occur within 2 hours.
- If the ECC cannot be reached, contact the permitting lead in EIES. If neither the ECC nor the EIES permitting lead can be reached, please review the Slope Failure Priority Guidance below and prioritize the slope failure. For all priority 1 and 2 slope failures, immediate notification must be made to the appropriate regulatory agency. In most states this is the state emergency Spill Line, but not the National Response Center.

Slope Failure Priority Guidance

Priority 1 Slope Failure:

Definition: A slope failure which has caused an immediate danger to human health and/or the environment. This type of slope failure requires an emergency response.

Criteria: If any one of the following criteria exists, it is a Priority 1 slope failure.

- Compromises or threatens other utilities.
- Active and/or functional pipeline is broken or detached.
- A public roadway which may be used for emergency vehicles is blocked.
- A fish kill has been observed and/or reported in the general vicinity.
- Release of aqueous phase hydrocarbons (i.e. condensate). If aqueous phase hydrocarbons have been released to surface water additional notification to the National Response Center may be required.

Required Actions: Depending on the criteria met above, at least one or more of the following actions must be taken for a Priority 1 slope failure.

- Contact 811 or the appropriate one call for utilities.
- Notify the appropriate state Spill Line.
- Contact responsible party if not Dominion and potential to impact our right of way.
- Contact any other outside agencies for emergency purposes as necessary.

Priority 2 Slope Failure:

Definition: A slope failure or associated migration of sediment and/or debris, which has reached a waterway causing Conditions Not Allowable in state waters.

Criteria: If any one of the following criteria exists, it is a Priority 2 slope failure.

- Slope failure material or sediment laden runoff has entered water body.
- A pipeline is exposed but not broken.

Required Actions: At least one of the following actions must be taken for a Priority 2 slope failure.

- Contact 811 or the appropriate one call for utilities.
- Notify the appropriate state Spill Line.
- Contact responsible party if not Dominion and potential to impact our right of way.
- Contact any other outside agencies for emergency purposes as necessary.

Priority 3 Slope Failure:

Definition: A slope failure, slide or associated migration of sediment and/or debris that has not yet reached state waters.

Criteria: If any one of the following criteria exists, it is a Priority 3 slope failure.

- Impact to the water body is imminent.

Required Actions:

- Notify responsible party if not Dominion and potential to impact our right of way.

Priority 4 Slope Failure:

Definition: A slope failure that poses little or no environmental threat.

Criteria:

- No water body in the immediate area.
- Low/no probability of Conditions Not Allowable (Sediment in water body, E&S controls not maintained).
- Pipeline is not in danger of exposure, severing, detaching or rupture.

Required Action:

- Notify responsible party if not Dominion and potential to impact our right of way.

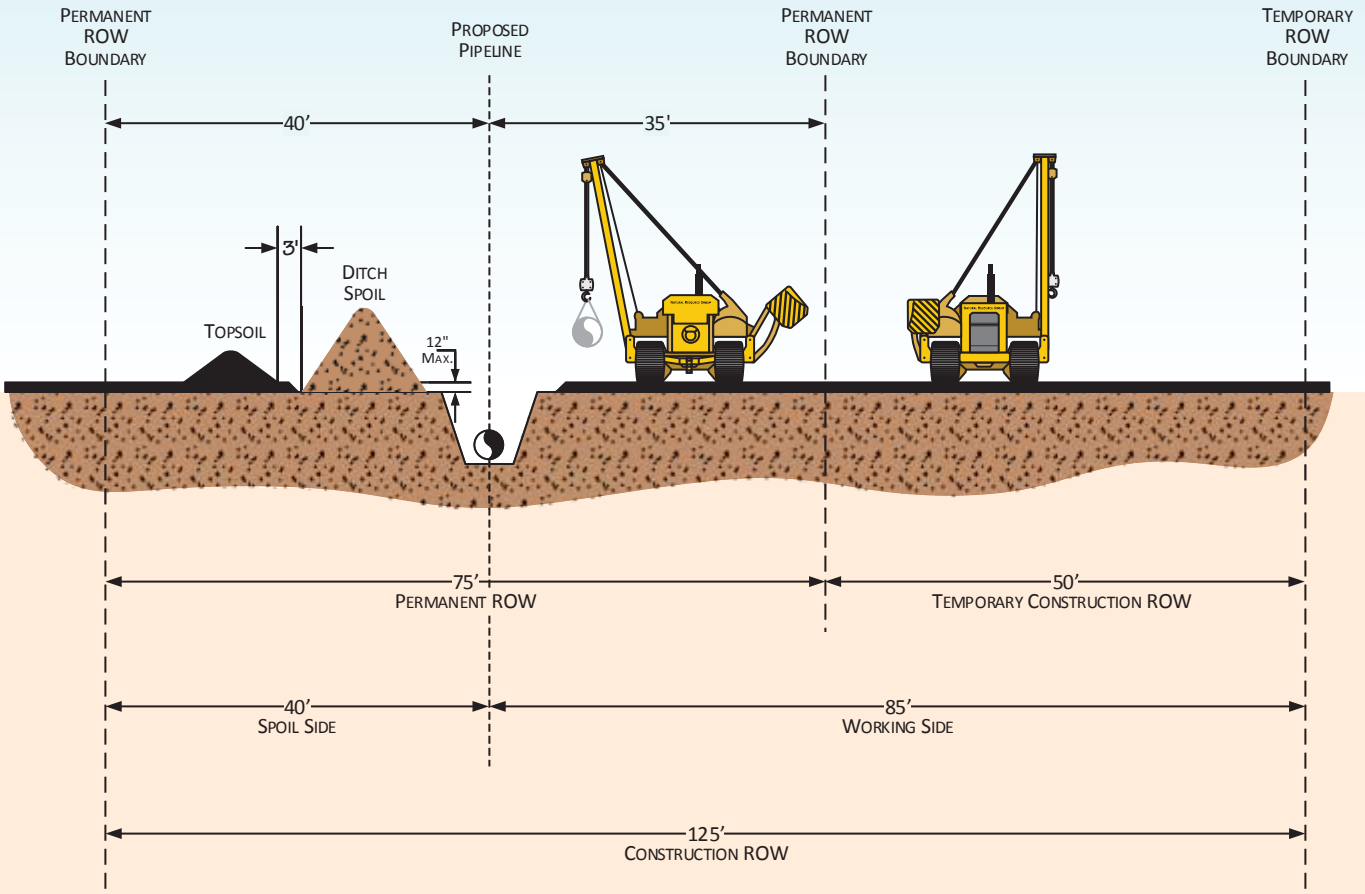
Appendix J - DEQ List of Potential Critical Areas

DEQ developed the following list of potential critical areas, derived from VESCH and other sources, to aid plan preparers in identifying potential critical areas on a project. These areas should be considered when preparing a plan and identifying critical areas. Extra attention should be directed to these areas if they have potentially serious problems or are sensitive to sediment impacts.

A. Steep Slopes:
    i. Ranges of slope gradient erodibility:
        1. 0-7% → Low erosion hazard
        2. 7-15% → Moderate erosion hazard
        3. ≥ 15% → High erosion hazard
    ii. Erosion hazard becomes greater as the slopes length increases. Erosion hazard will become critical if the slope exceeds:
        1. 0-7% ☐ 300 feet
        2. 7-15% ☐ 150 feet
        3. >15% ☐ 75 feet
B. Areas with high erodibility, high reactivity of soils, etc.
    i. 0.23 and lower → low erodibility
    ii. 0.23 to 0.36 → moderate erodibility
    iii. ≥ 0.36 → high erodibility
    iv. Soil pH
C. Areas that flow to environmentally sensitive areas (e.g. State waters including wetlands)
D. Areas that require Virginia Wetland Protection permits
E. Areas containing threatened or endangered species or their habitat, etc.
F. Sink holes, wet weather/underground springs, karst areas, etc.
G. Sensitive agricultural soils
H. Other Potential Critical areas –
    i. Fragipans
    ii. Lacustrine soils
    iii. Dense basal tills
    iv. Soils with seasonally high water table
    v. Soils with less than 5 feet of depth to bedrock
    vi. Subsurface drainage areas
    vii. Open ditches
    viii. Diversions
    ix. Diversion terraces
    x. Buried utility lines (for farmstead consumptive use)
    xi. Water sources (developed springs, wells, etc…)
    xii. Grassed waterways
    xiii. Water impoundment structures (dams and ponds)
    xiv. Unnamed water flows

APPENDIX J

DEQ List of Potential Critical Areas



PROFILE

NOTES:

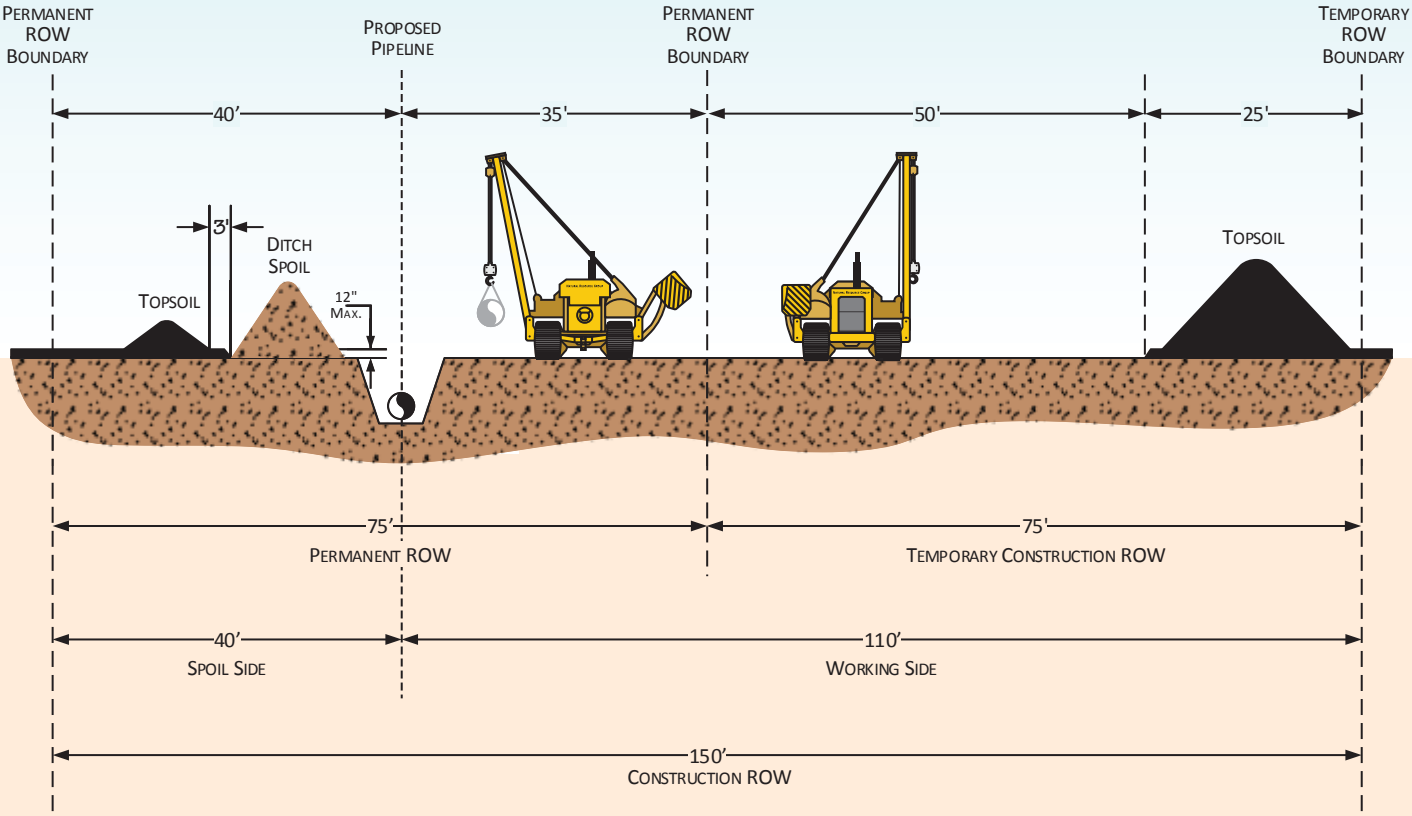
1. CONSTRUCTION RIGHT-OF-WAY WILL TYPICALLY BE 125' WIDE CONSISTING OF 75' OF PERMANENT RIGHT-OF-WAY AND 50' OF TEMPORARY CONSTRUCTION RIGHT-OF-WAY. ADDITIONAL TEMPORARY WORKSPACE WILL BE NECESSARY AT MAJOR ROAD, RAIL, RIVER CROSSINGS, SIDESLOPES, WHERE FULL RIGHT-OF-WAY TOPSOIL STRIPPING IS CONDUCTED, AND OTHER SPECIAL CIRCUMSTANCES AS REQUIRED.

For environmental review purposes only.

Atlantic Coast Pipeline

Atlantic Coast Pipeline
AP-1 (42" Outside Diameter)
Typical Construction Right-of-Way
Non-Agricultural Areas

NATURAL RESOURCE GROUP
an ERM Group company



PROFILE

NOTES:

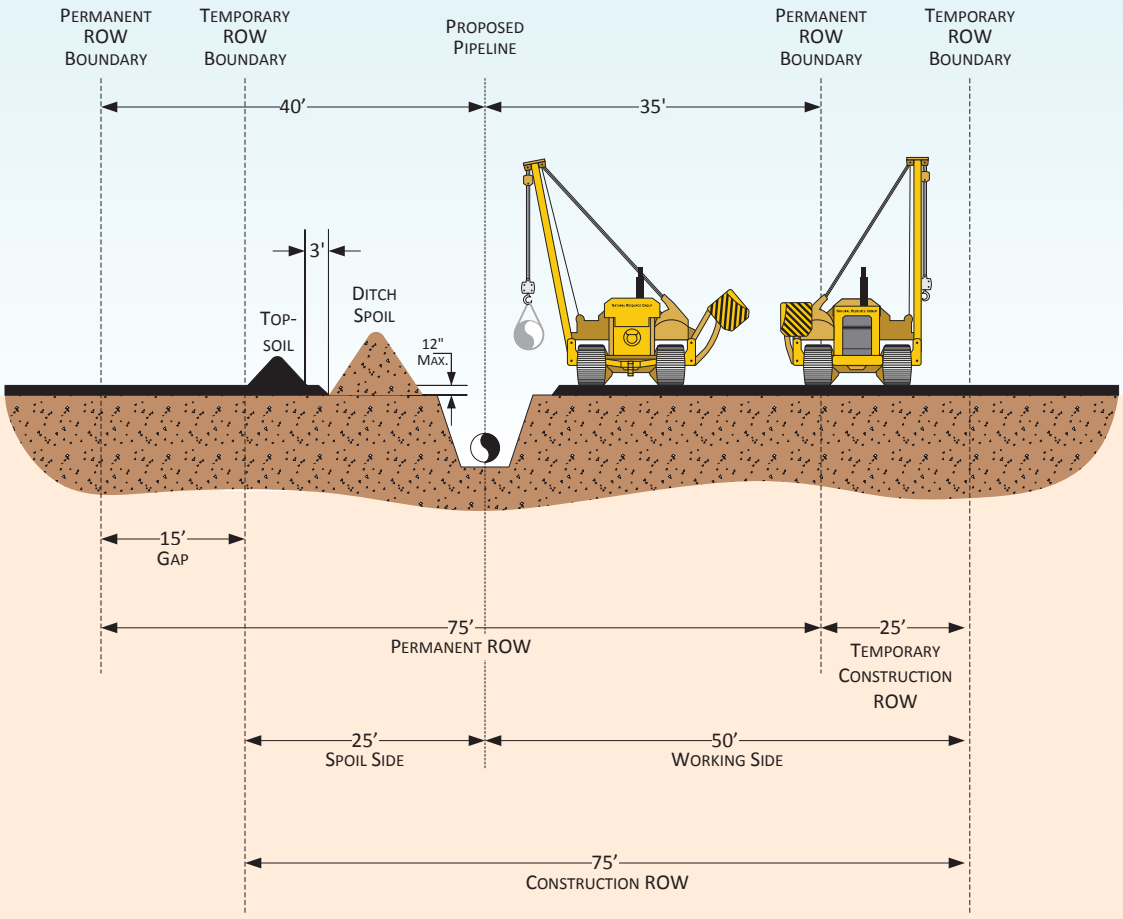
1. IN AGRICULTURAL AREAS WHERE FULL WIDTH TOPSOIL STRIPPING IS REQUIRED, AN ADDITIONAL 25' OF TEMPORARY WORKSPACE WILL BE REQUIRED. IN THIS SCENARIO, THE CONSTRUCTION RIGHT-OF-WAY WILL BE 150' WIDE, CONSISTING OF 75' OF PERMANENT RIGHT-OF-WAY AND 75' OF TEMPORARY CONSTRUCTION RIGHT-OF-WAY. ADDITIONAL TEMPORARY WORKSPACE WILL BE NECESSARY AT MAJOR ROAD, RAIL, RIVER CROSSINGS, SIDESLOPES, AND OTHER SPECIAL CIRCUMSTANCES AS REQUIRED.

For environmental review purposes only.

Atlantic Coast Pipeline

Atlantic Coast Pipeline
AP-1 (42" Outside Diameter)
Typical Construction Right-of-Way
Agricultural Areas

NATURAL RESOURCE GROUP
an ERM Group company



PROFILE

NOTES:

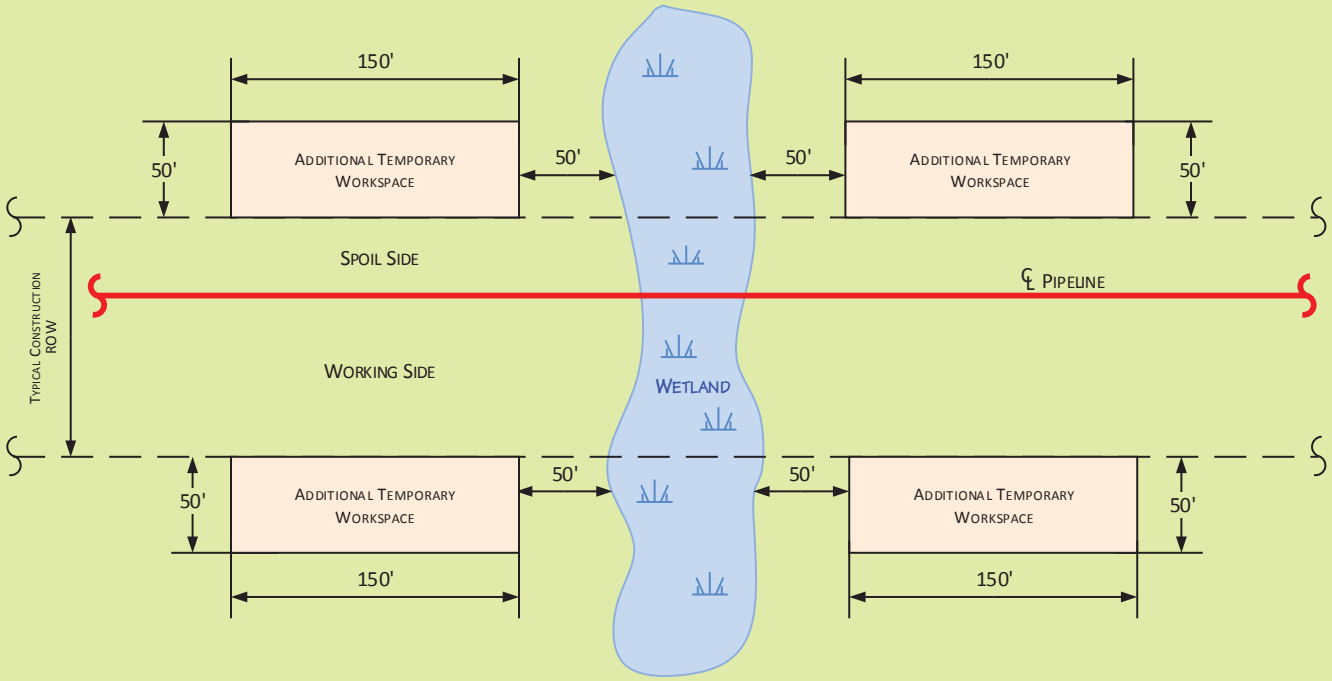
1. CONSTRUCTION RIGHT-OF-WAY WILL TYPICALLY BE 75' WIDE WITH 25' ON THE SPOIL SIDE AND 50' ON THE WORKING SIDE. THE PERMANENT ROW WILL BE 75' WIDE WITH 40' ON THE SPOIL SIDE AND 35' ON THE WORKING SIDE. THIS WILL LEAVE A 15' GAP BETWEEN THE AREA OF DISTURBANCE DURING CONSTRUCTION AND THE BOUNDARY OF THE PERMANENT ROW. NO IMPACT IS EXPECTED IN THIS AREA.
2. DURING CONSTRUCTION, A WORKING SIDE OF 50 FEET IN WETLANDS WILL BE NECESSARY GIVEN THE DIAMETER OF THE PIPE.
3. DURING OPERATIONS, ATLANTIC PROPOSES A STANDARD PERMANENT EASEMENT IN WETLANDS CONSISTENT WITH OTHER SEGMENTS OF THE PIPELINE. MAINTENANCE ACTIVITIES IN THE PERMANENT EASEMENT WILL BE CONSISTENT WITH THE PROCEDURES.

For environmental review purposes only.

Atlantic Coast Pipeline SM

Atlantic Coast Pipeline
AP-1 (42" Outside Diameter)
Typical Construction Right-of-Way In Wetlands

NATURAL RESOURCE GROUP
an ERM Group company



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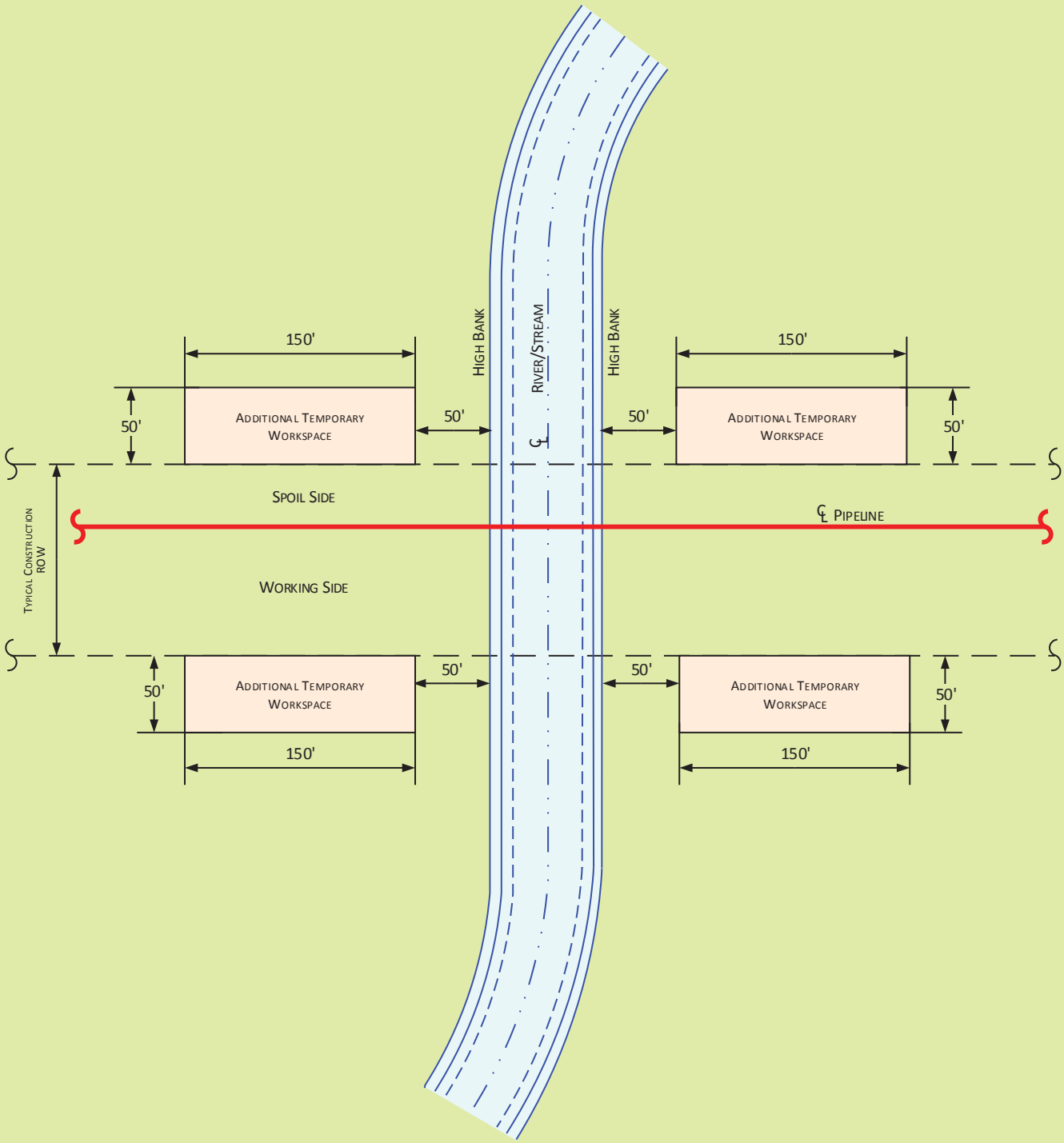
Atlantic Coast Pipeline

AP-1 (42" Outside Diameter)

Typical Additional Temporary Workspace at Wetland Crossings

an ERM Group company

K:_CLIENT_PROJECTS\D-F\DOM\ACP\CROSSINGS\XING_WETLAND_LARGE.VSD, Date: 10/10/2014, REVISED: 4/15/2015 DRAWN BY: McGregor



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Atlantic Coast Pipeline

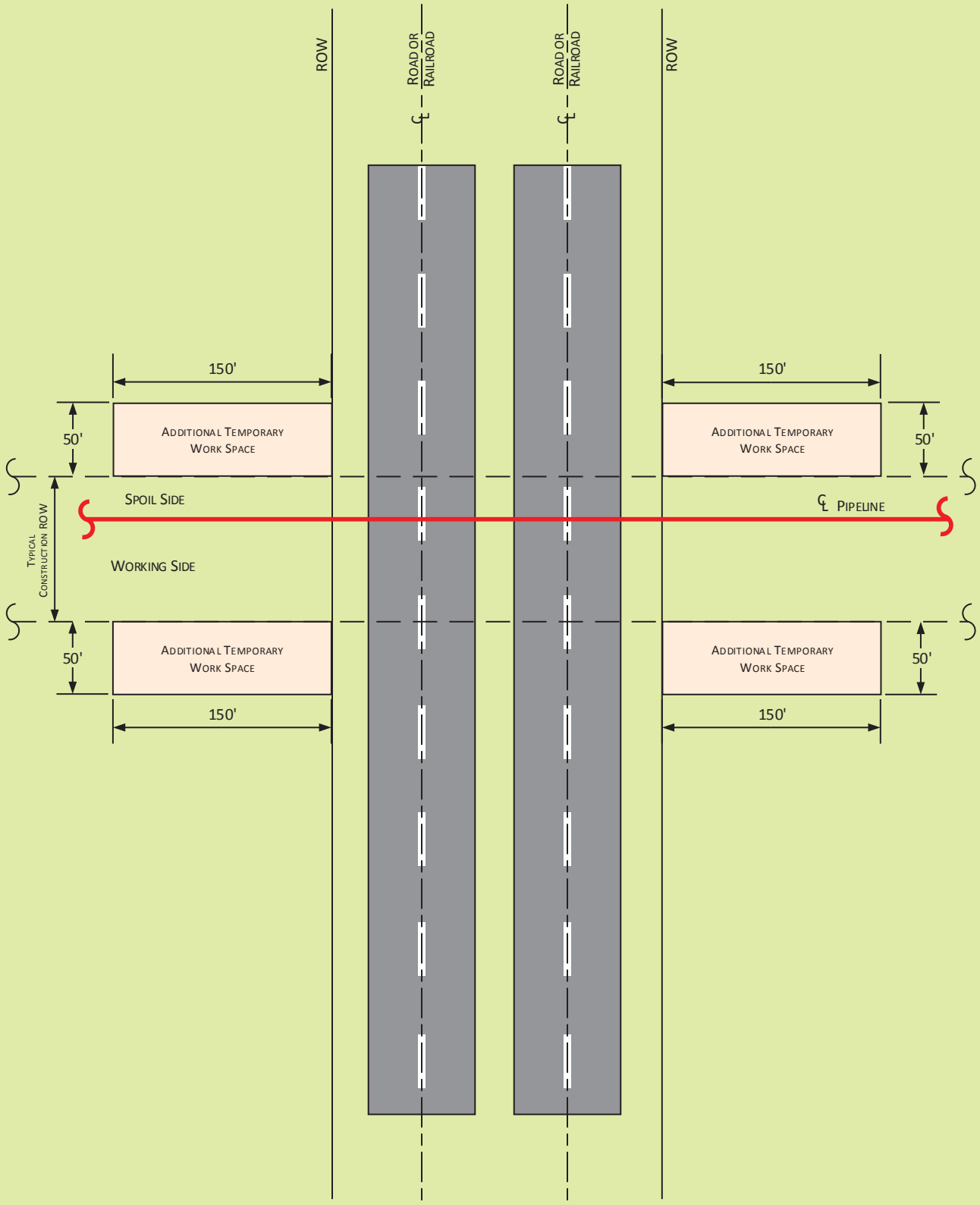
AP-1 (42" Outside Diameter)

Typical Additional Temporary Workspace at Waterbody Crossings Greater Than 10 Feet Wide

an ERM Group company

K:_CLIENT_PROJECTS\D-F\DOM\ACP\CROSSINGS\XING_STREAM_LARGE.VSD, Date: 10/10/2014, REVISED: 4/15/2015

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Atlantic Coast Pipeline

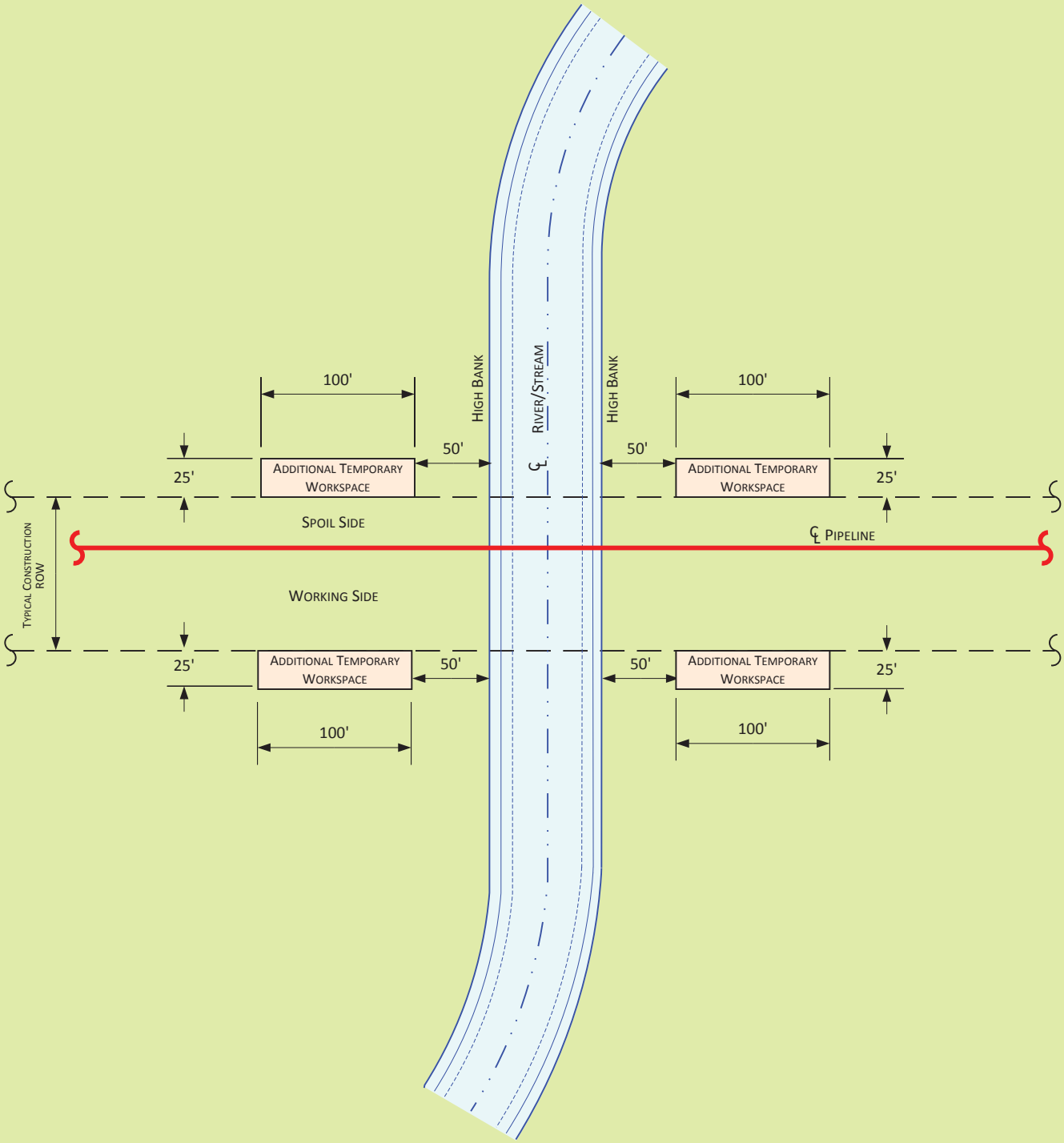
AP-1 (42" Outside Diameter)

Typical Additional Temporary Workspace at Bored Crossings for Two-Lane Roads and Railroads

an ERM Group company

K:_CLIENT_PROJECTS\D-F\DOM\ACP\CROSSINGS\XING_BORED_ROADS_AP1.VSD, Date: 10/10/2014, REVISED: 4/15/2015

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For environmental review purposes only.

Atlantic Coast Pipeline

AP-1 (42" Outside Diameter)

Typical Additional Workspace at Waterbodies Less Than 10 Feet Wide

AP-2 (36" Outside Diameter), AP-3 (20" Outside Diameter), and AP-4 and AP-5 (16" Outside Diameter)

Typical Additional Workspace at All Waterbodies

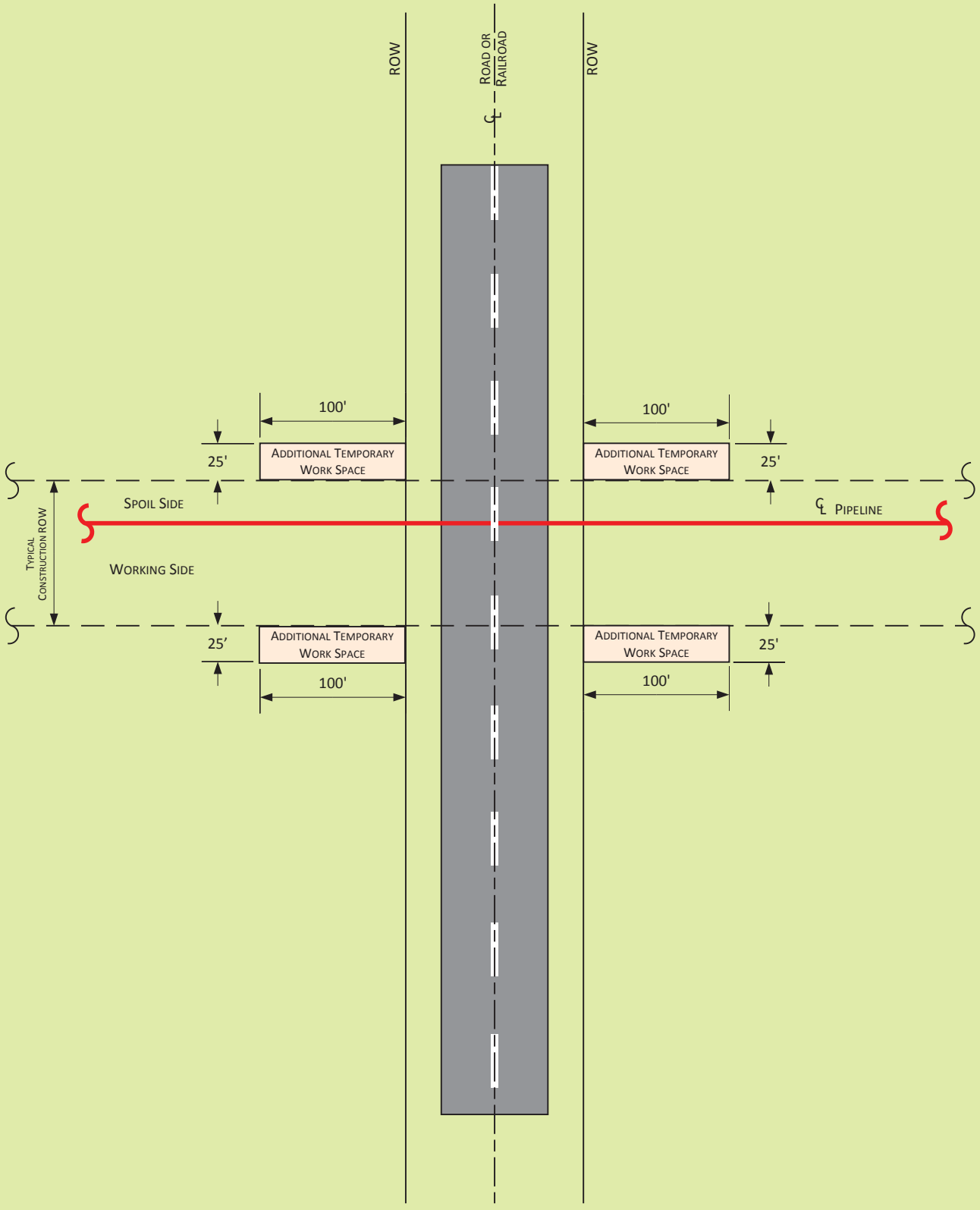
Atlantic Coast Pipeline SM

NATURAL RESOURCE GROUP

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K:_CLIENT_PROJECTS\D-F\DOM\ACP\CROSSINGS\XING_STREAM_SMALL.VSD, Date: 10/10/2014, REVISED: 4/15/2015

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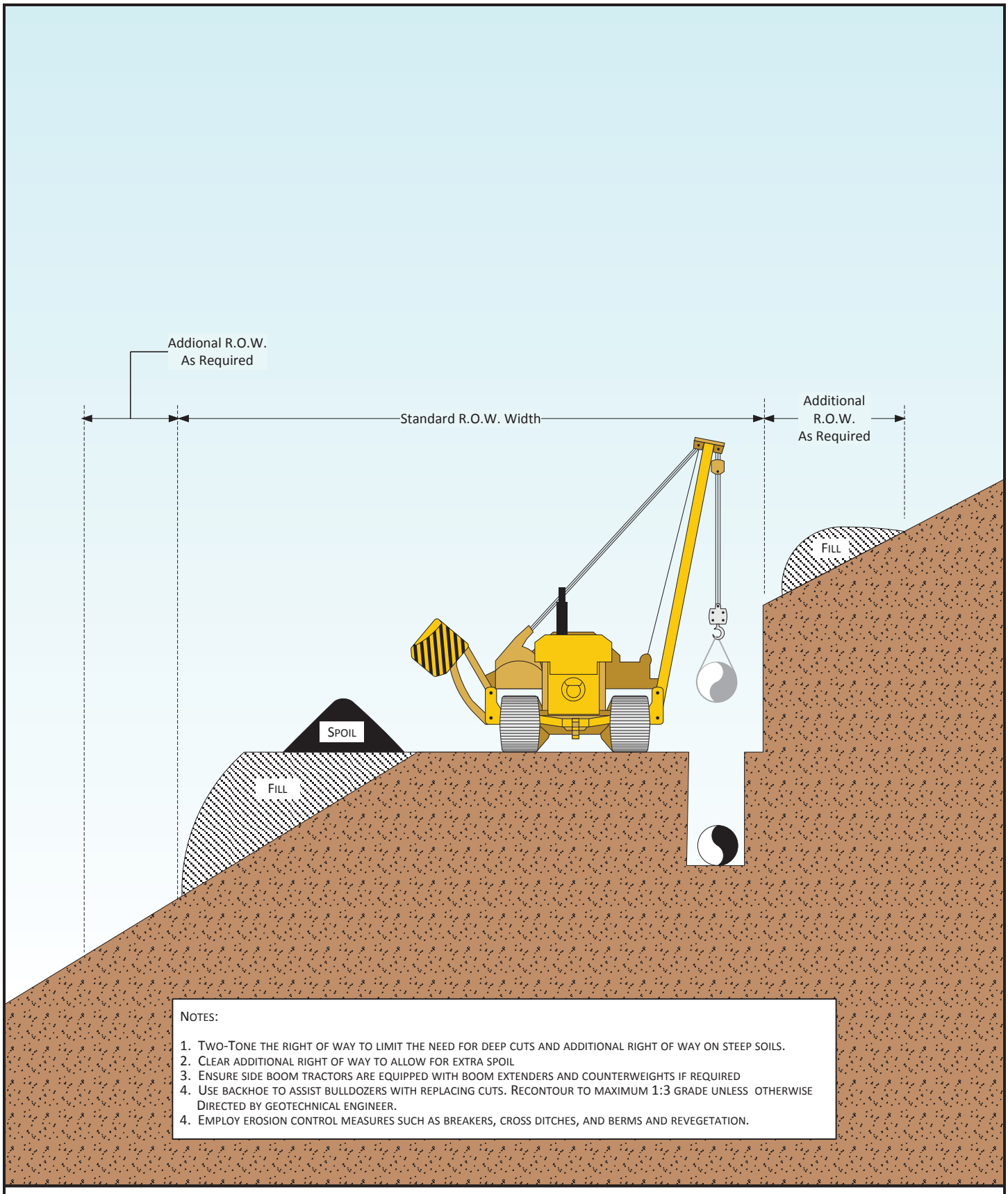
Atlantic Coast Pipeline SM

Atlantic Coast Pipeline

AP-1 (42" Outside Diameter)
Typical Additional Temporary Workspace at Single-Lane Roads
AP-2 (36" Outside Diameter), AP-3 (20" Outside Diameter), and AP-4 and AP-5 (16" Outside Diameter)
Typical Additional Workspace at all Bored Roads

NATURAL RESOURCE GROUP
an ERM Group company

K:_CLIENT_PROJECTS\D-F\DOM\ACP\CROSSINGS\XING_BORED_ROADS_ALL.VSD, Date: 10/10/2014, REVISED: 4/15/2015 DRAWN BY: McGregor



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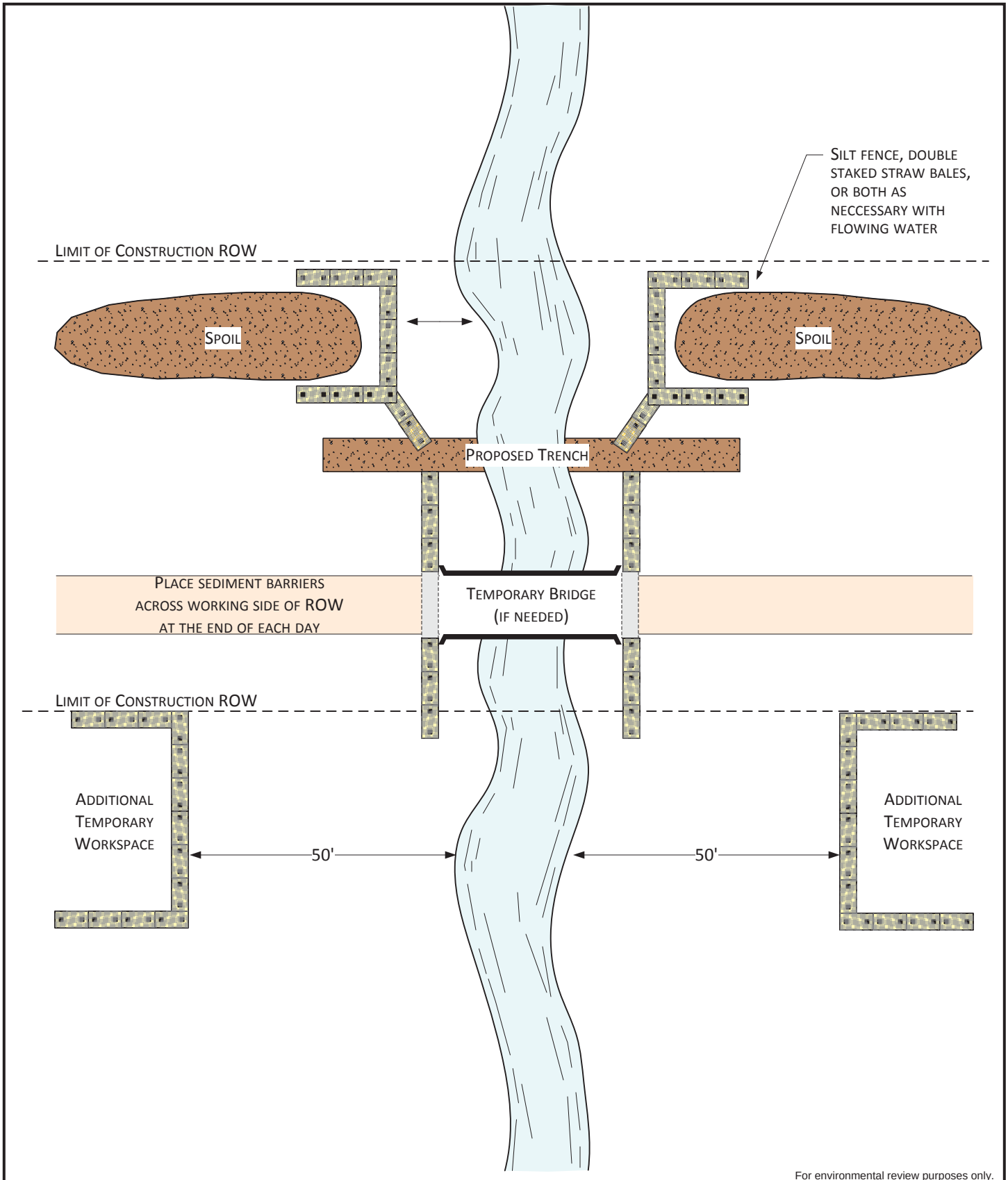
1. TWO-TONE THE RIGHT OF WAY TO LIMIT THE NEED FOR DEEP CUTS AND ADDITIONAL RIGHT OF WAY ON STEEP SOILS.
2. CLEAR ADDITIONAL RIGHT OF WAY TO ALLOW FOR EXTRA SPOIL
3. ENSURE SIDE BOOM TRACTORS ARE EQUIPPED WITH BOOM EXTENDERS AND COUNTERWEIGHTS IF REQUIRED
4. USE BACKHOE TO ASSIST BULLDOZERS WITH REPLACING CUTS. RECONTOUR TO MAXIMUM 1:3 GRADE UNLESS OTHERWISE DIRECTED BY GEOTECHNICAL ENGINEER.
4. EMPLOY EROSION CONTROL MEASURES SUCH AS BREAKERS, CROSS DITCHES, AND BERMS AND REVEGETATION.

Atlantic Coast Pipeline℠

Atlantic Coast Pipeline and Supply Header Projects

Cut and Fill Construction

NATURAL RESOURCE GROUP
an ERM Group company



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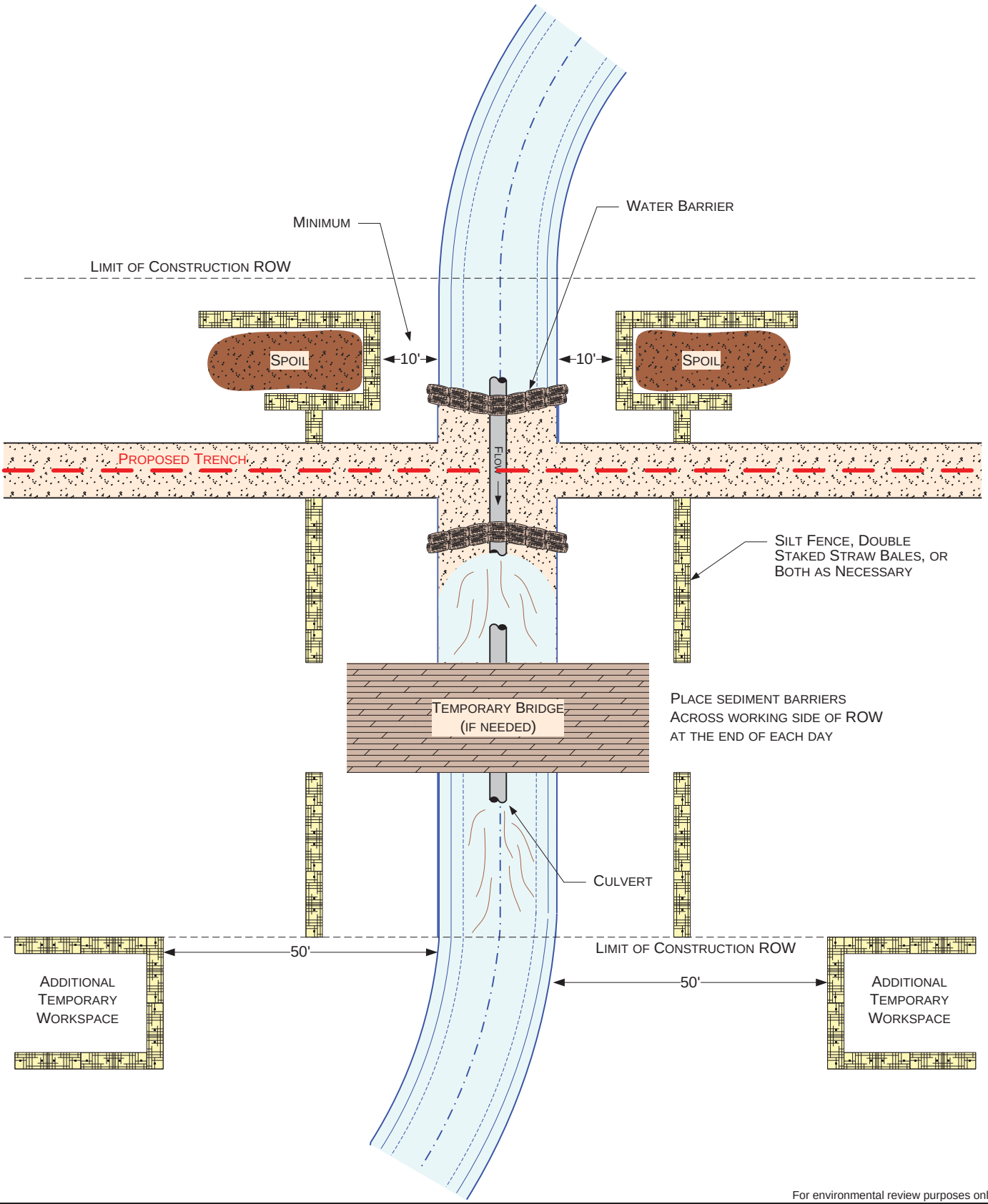
Atlantic Coast Pipeline

AP-1 (42" Outside Diameter), AP-2 (36" Outside Diameter), AP-3 (20" Outside Diameter), and AP-4 and AP-5 (16" Outside Diameter)

Typical Waterbody Crossing
Open Cut Method

an ERM Group company

K:_CLIENT_PROJECTS\D-F\DOM\ACP\CROSSINGS\XING_STREAM_OPEN_CUT.VSD, Date: 10/10/2014, REVISED: 4/15/2015 DRAWN BY: McGregor



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Atlantic Coast Pipeline

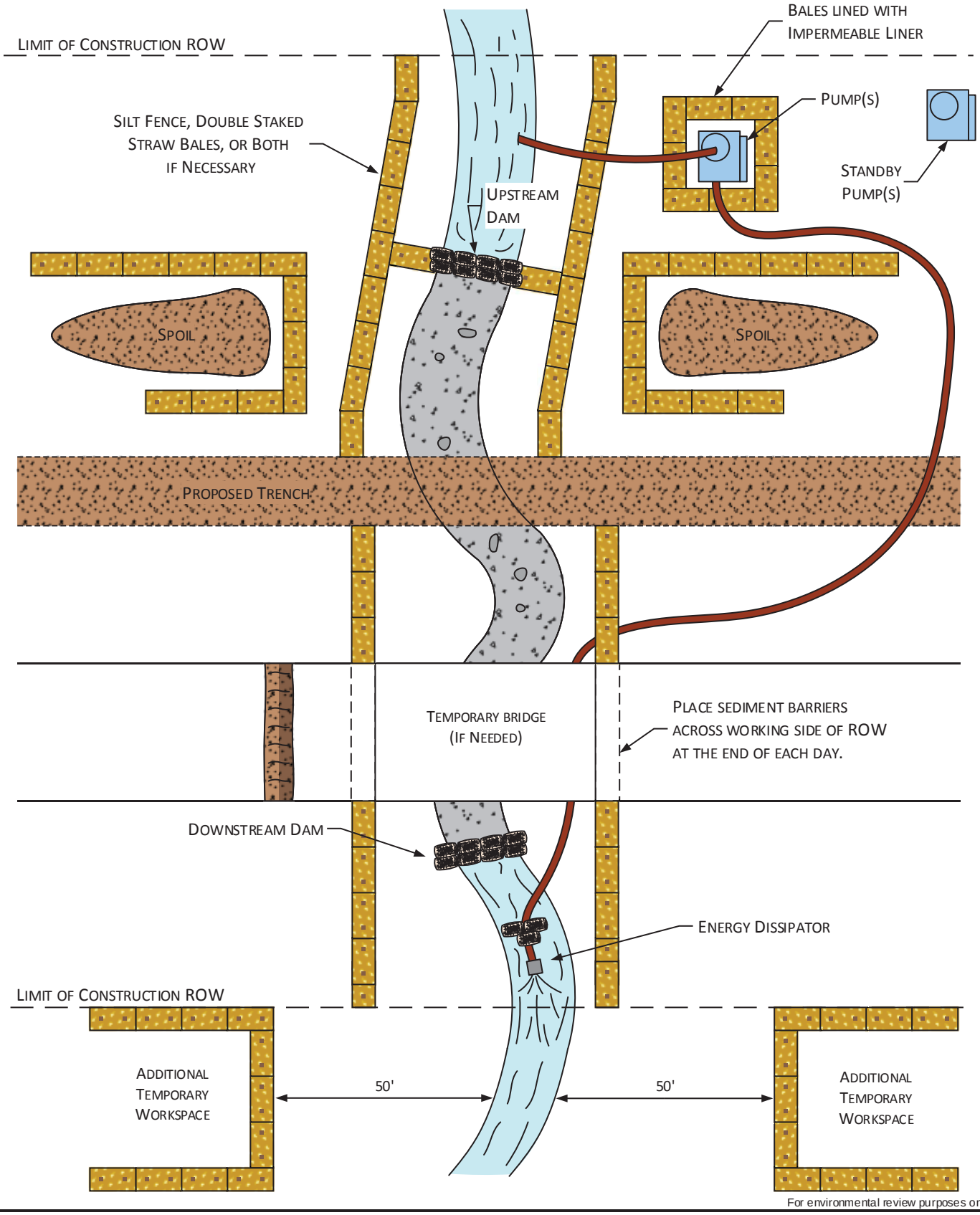
AP-1 (42" Outside Diameter), AP-2 (36" Outside Diameter), AP-3 (20" Outside Diameter), and AP-4 and AP-5 (16" Outside Diameter)

Typical Waterbody Crossing
Flume Method

an ERM Group company

K:_CLIENT_PROJECTS\D-F\DOM\ACP\CROSSINGS\XING_STREAM_FLUME.VSD, Date: 10/10/2014, REVISED: 4/15/2015

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Atlantic Coast Pipeline

Atlantic Coast Pipeline

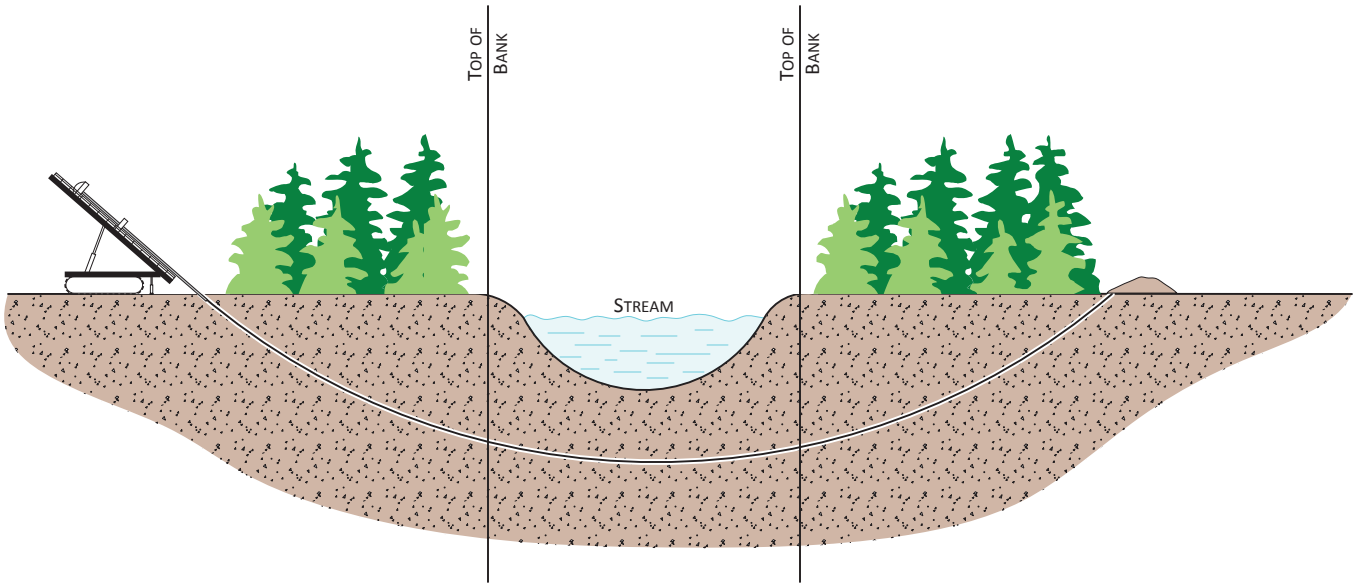
Typical Waterbody Crossing

Dam and Pump Method

NATURAL RESOURCE GROUP
an ERM Group company

K:_CLIENT_PROJECTS\D-F\DOM\ACP\CROSSINGS\XING_STREAM_DAM_AND_PUMP.VSD, Date: 10/10/2014, REVISED: 4/15/2015

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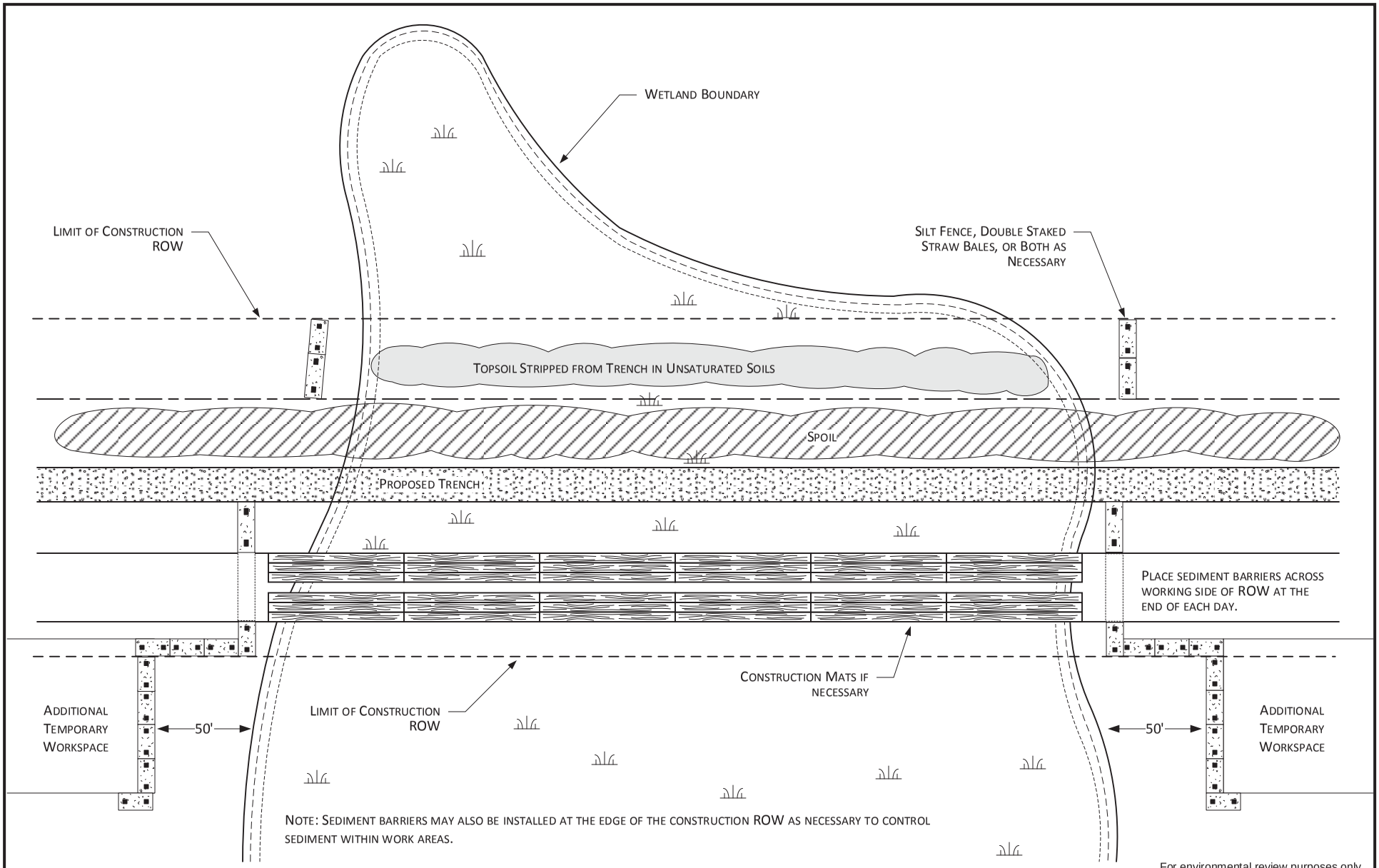


For environmental review purposes only.

Atlantic Coast Pipeline
AP-1 (42" Outside Diameter), AP-2 (36" Outside Diameter), AP-3 (20" Outside Diameter), and AP-4 and AP-5 (16" Outside Diameter)
Typical Waterbody Crossing
Directional Drill Method

an ERM Group company

K:_CLIENT_PROJECTS\D-F\DOM\ACP\CROSSINGS\XING_STREAM_HDD.VSD, Date: 10/10/2014, REVISED: 4/15/2015 DRAWN BY: McGregor



For environmental review purposes only.

Atlantic Coast Pipeline

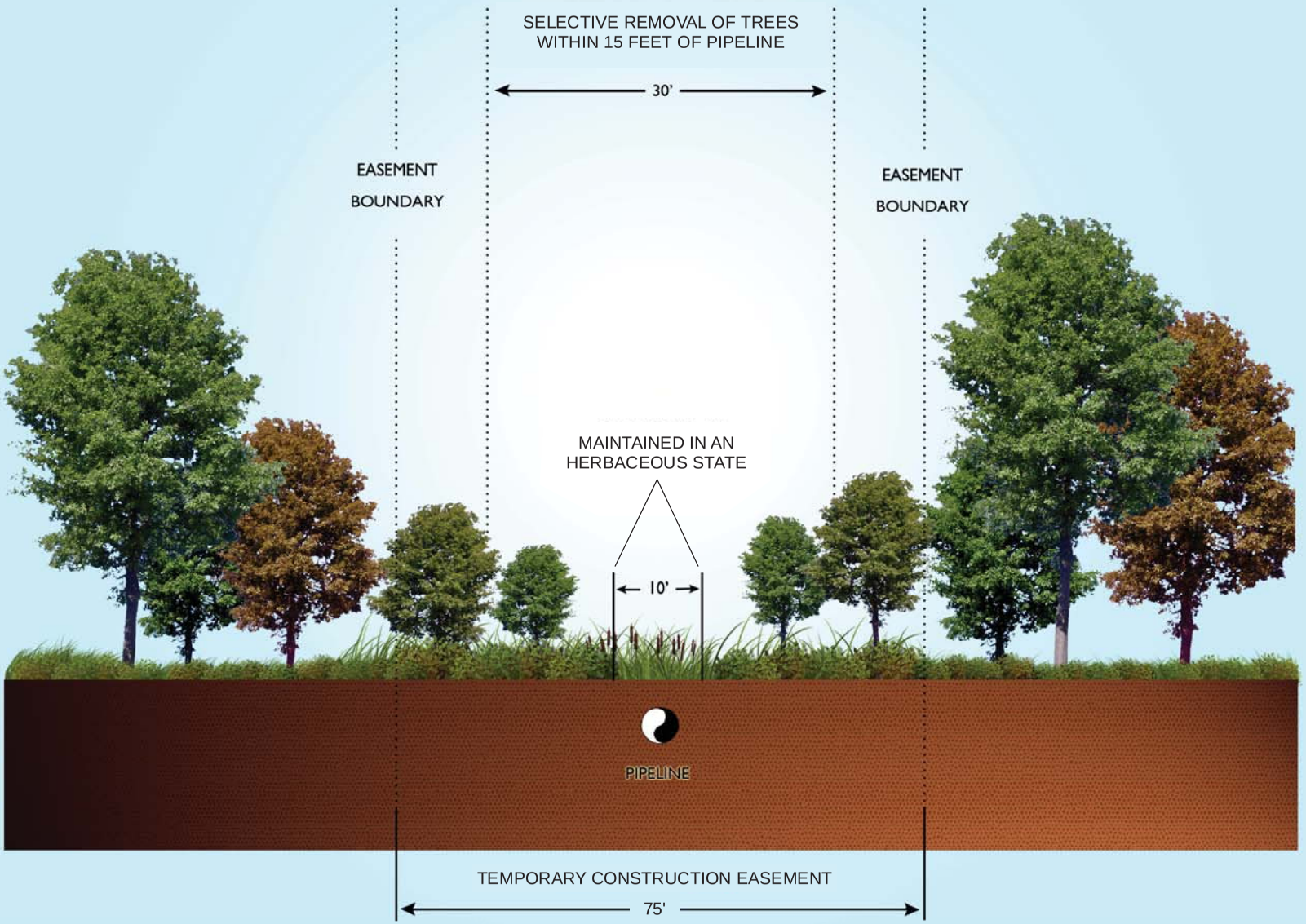
AP-1 (42" Outside Diameter), AP-2 (36" Outside Diameter), AP-3 (20" Outside Diameter), and AP-4 and AP-5 (16" Outside Diameter)

Typical Wetland Crossing
Open Cut Method

an ERM Group company

K:_CLIENT_PROJECTS\D-F\DOM\ACP\CROSSINGS\XING_WETLAND_OPEN_CUT.VSD, Date: 10/10/2014, REVISED: 4/15/2015

DRAWN BY: McGregor



Atlantic Coast Pipeline and Supply Header Project

Corridor Wetland Maintenance

an ERM Group company

FILE: M:\Clients\D-F\DOM\SRPP_ArcGIS\COE_Report\COE_Report_Figures_DRS_ACP_CR_ROW_Maintenance.mxd, REVISED: 08/26/2015, SCALE: Not to Scale

DRAWN BY: Randy McGregor

APPENDIX C

Site Specific Construction Typicals

ATLANTIC COAST PIPELINE PROJECT

COMMUNICATION TOWER (TYPICAL)

EROSION & SEDIMENT CONTROL PLAN

EROSION & SEDIMENT CONTROL PLAN NARRATIVE

THE FOLLOWING EROSION AND SEDIMENT CONTROL PLAN SHALL PROVIDE A TYPICAL STANDARD FOR BEST MANAGEMENT PRACTICES FOR THE ATLANTIC COAST PIPELINE COMMUNICATION TOWER SITES. THE COMMUNICATION TOWER SITE LAYOUT MAY NOT HAVE ALL EQUIPMENT AND COMPONENTS DEPICTED, BUT THE SITE FOOTPRINT SHALL BE CONSISTENT. COLLECTIVELY, THERE ARE 3 SITES IN WEST VIRGINIA, 19 SITES IN VIRGINIA, AND 10 SITES IN NORTH CAROLINA. THE EROSION AND SEDIMENT (E&S) CONTROL MEASURES FOR THE COMMUNICATION TOWER CONSTRUCTION ACTIVITIES PRIMARILY CONSIST OF BUT ARE NOT LIMITED TO ROCK CONSTRUCTION ENTRANCE, COMPOST FILTER SOCK, SILT FENCE, AND TEMPORARY AND PERMANENT SEEDING AND MULCHING. BEST MANAGEMENT PRACTICES (BMP) SPECIFICATIONS FOR THE E&S CONTROL PLAN (E&SCP) ARE TO BE UTILIZED BY THE CONSTRUCTION CONTRACTOR ACCORDING TO THE PROVIDED PLAN.

GENERAL CONSTRUCTION NOTES:

1. DISCHARGES ORIGINATING FROM OFF-SITE SOURCES, WHICH FLOW THROUGH OR ACROSS THE AREAS DISTURBED BY CONSTRUCTION, MAY BE DIVERTED AROUND THE ACTIVE CONSTRUCTION AREA WHENEVER POSSIBLE.
2. PERFORM PERMANENT OR TEMPORARY SOIL STABILIZATION WITHIN 7 DAYS WHEN SITE IS AT FINAL GRADE AND ON SITES THAT ARE NOT AT FINAL GRADE, BUT WILL REMAIN DORMANT FOR MORE THAN 14 DAYS.
3. DUE TO VARYING SITE CONDITIONS, ADDITIONAL SEDIMENT CONTROL BMPS MAY BE NECESSARY BEYOND THE MEASURES SHOWN ON THE E&S CONTROL PLAN.
4. AT MINIMUM, ALL BMPS ARE TO BE INSPECTED ONCE EVERY SEVEN CALENDAR DAYS AND WITHIN 24 HOURS AFTER ANY STORM EVENT GREATER THAN 0.5-INCH PER 24-HOUR PERIOD DURING THE ENTIRE PROJECT. ALL REQUIRED PERMITS MUST BE OBTAINED PRIOR TO STARTING WORK.
5. DURING CONSTRUCTION, THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONSTRUCTION, STABILIZATION AND MAINTENANCE OF ALL EXISTING AND PROPOSED SITE EROSION & SEDIMENTATION CONTROL DEVICES AND FACILITIES.
6. AS SITE SPECIFIC CONDITIONS MAY WARRANT, THE E&SC PLAN MAY REQUIRE MINOR MODIFICATIONS TO ENSURE PROPER PROTECTION OF RECEIVING WATERS. THE RESPECTIVE PROJECT ENVIRONMENTAL INSPECTOR (EI) WILL IDENTIFY SITE SPECIFIC AREAS WHERE A CERTAIN BMP MODIFICATION(S) IS NECESSARY TO EITHER OMIT OR ENHANCE BMPS IN SUCH AREAS. THIS PROCESS ENTAILS THE EI TO IDENTIFY LOCATIONS WHERE BMPS WILL NEED TO BE ALTERED, SUBSTITUTED OR OMITTED AND CONTACT THE DOMINION COMPLIANCE SPECIALIST TO REVIEW PROPOSED CHANGES. UPON REVIEW AND APPROVAL BY THE DOMINION COMPLIANCE SPECIALIST, THE EI WILL REDLINE, DATE, AND SIGN THE E&SCP DRAWING(S) DEPICTING THE REDLINE CHANGE(S). ONCE THIS PROCESS IS COMPLETED, THE EI WILL NOTIFY THE DEP OF SUCH MINOR MODIFICATION REDLINE AMENDMENTS AS REQUIRED BY THE GENERAL PERMIT.

BMP INSTALLATION AND REMOVAL SEQUENCE

THE STAGING OF EARTHMOVING ACTIVITIES FOR THIS PROJECT IS A GENERAL DESCRIPTION OF THE WORK REQUIRED. ALL WORK SHALL BE COMPLETED IN ACCORDANCE WITH COMPANY STANDARDS, THE STATE DEPARTMENT OF ENVIRONMENTAL QUALITY REGULATIONS AND ALL OTHER APPLICABLE FEDERAL, STATE OR LOCAL REQUIREMENTS.

THE APPROVED EROSION AND SEDIMENTATION CONTROL PLAN INCLUDING THE SOIL EROSION CONTROL DRAWINGS AND NARRATIVE SHALL BE AVAILABLE ON SITE AT ALL TIMES DURING EARTH DISTURBANCE.

1. STAKE/FLAG ALL LIMITS OF DISTURBANCE FOR CONSTRUCTION ACTIVITIES, CLEARLY IDENTIFYING WETLAND AND STREAM EDGES. INSTALL SIGNS TO DESIGNATE THE AREA TO IDENTIFY IMPORTANT PROJECT ATTRIBUTES SUCH AS WETLAND/STREAM BOUNDS, EXCLUSION AREAS ETC.
2. INSTALL ROCK CONSTRUCTION ENTRANCES IMMEDIATELY BEFORE INITIAL DISTURBANCES. THE ROCK CONSTRUCTION ENTRANCES TO BE UNDERLAIN BY FILTER FABRIC. ALL CONSTRUCTION TRAFFIC SHOULD USE ONLY ROCK CONSTRUCTION ENTRANCE FOR INGRESS AND EGRESS. ALL MUD OR SEDIMENT TRACKED ONTO THE EXISTING ROADWAY SHALL BE REMOVED BY THE CONTRACTOR AS NECESSARY.
3. INSTALL SILT FENCE AND COMPOST FILTER SOCKS AS NECESSARY ALONG THE ACCESS ROADS TO PREVENT SEDIMENT LADEN RUNOFF FROM ENTERING DOWNSTREAM WATER BODIES. MAINTAIN THE ACCESS ROADS AS REQUIRED, ASSOCIATED DITCHES, AND NECESSARY OUTLET PROTECTION.
4. PRIOR TO AND SIMULTANEOUS WITH GRADING AND EXCAVATION, INSTALL REMAINING EROSION CONTROL DEVICES (ECD) SHOWN ON THE PLANS.
5. COMMENCE GRADING AND ASSOCIATED CUT AND FILL SLOPES. THE EARTH MOVING ACTIVITY SHALL BEGIN IN AREA OF CUT SO THAT THE CUTS CAN BE PLACED IN AREAS OF FILL.
6. FINALIZE UTILITY INSTALLATION AND PLACE TOPSOIL ON THE CUT AND FILL AREAS. STABILIZE CUT AND FILL SLOPES, AFTER PLACEMENT OF STOCKPILED TOPSOIL ON EXCAVATED SLOPES, AND AS DIRECTED.
7. RE-DISTRIBUTION OF WET SEDIMENT FROM DEVICES AND FACILITIES SHALL ONLY BE PERMITTED UPHILL OF AN EFFECTIVE SEDIMENT CONTROL DEVICE OR FACILITY. SEDIMENT LADEN RUNOFF SHALL NOT BE ALLOWED TO FLOW DIRECTLY INTO WATER BODIES.
8. ANY EXPOSED TOPSOIL PILES SHOULD BE STABILIZED & SEEDED PER THE PERMIT REGULATIONS, AND BY TABLES SHOWN ON THE APPROVED EROSION CONTROL PLANS AND MULCHED WITH STRAW AS SPECIFIED BY THE PROJECT OWNER.
9. UPON MINIMUM 70% VEGETATIVE STABILIZATION, REMOVE TEMPORARY SEDIMENT CONTROLS. REMOVE ACCUMULATED SEDIMENTS WITHIN THE TRAPS, RE-GRADE TRAPS TO FINAL CONTOURS. STABILIZE SITE PER THE PLANS.

SEQUENCE OF CONSTRUCTION

1. LIMITS OF CONSTRUCTION MUST BE FIELD MARKED PRIOR TO CLEARING, INSTALLATION OF SEDIMENT CONTROL MEASURES, CONSTRUCTION, OR OTHER LAND DISTURBING ACTIVITIES.
2. DETAILED SEQUENCE OF CONSTRUCTION:
   a. INSTALL STABILIZED CONSTRUCTION ENTRANCE.
   b. CLEAR AND GRADE FOR INSTALLATION OF ECDS.
   c. INSTALL SEDIMENT CONTROL DEVICES.
   d. PREPARE TEMPORARY PARKING AND STORAGE AREA(S).
   e. CLEAR AND GRUB THE SITE, AS REQUIRED.
   f. START CONSTRUCTION OF THE SITE IMPROVEMENTS.
   g. BEGIN GRADING THE SITE.
   h. INSTALL UTILITIES.
   i. PERFORM FINAL GRADING AND INSTALL PERMANENT SEEDING AND PLANTING.
   j. REMOVE ALL TEMPORARY EROSION AND SEDIMENT CONTROL DEVICES (ONLY IF SITE IS STABILIZED).

MAINTENANCE SCHEDULE

AFTER FULL REVEGETATION HAS BEEN ACHIEVED, ALL BMPS WILL BE REMOVED AND ANY LAND DISTURBED BY REMOVAL WILL BE PERMANENTLY STABILIZED. UNLESS OTHERWISE SPECIFIED, ALL MAINTENANCE MUST BE COMPLETED IMMEDIATELY AFTER AN INSPECTION IDENTIFIES THAT A BMP IS NOT FUNCTIONING AS REQUIRED.

- SEDIMENT MUST BE REMOVED WHERE ACCUMULATION REACHES ONE-HALF THE ABOVE GROUND HEIGHT OF THE CONTROL MEASURE.
- EROSION CONTROL MEASURES, WHICH HAVE BEEN UNDERMINED OR TOPPED, MUST IMMEDIATELY BE REPAIRED.
- OTHER REQUIRED REPAIRS OR MAINTENANCE SHALL BE MADE IMMEDIATELY.
- TEMPORARY AND PERMANENT E&S CONTROL BMPS SHALL BE MAINTAINED AND REPAIRED AS NEEDED TO ASSURE CONTINUED PERFORMANCE OF THEIR INTENDED FUNCTION.

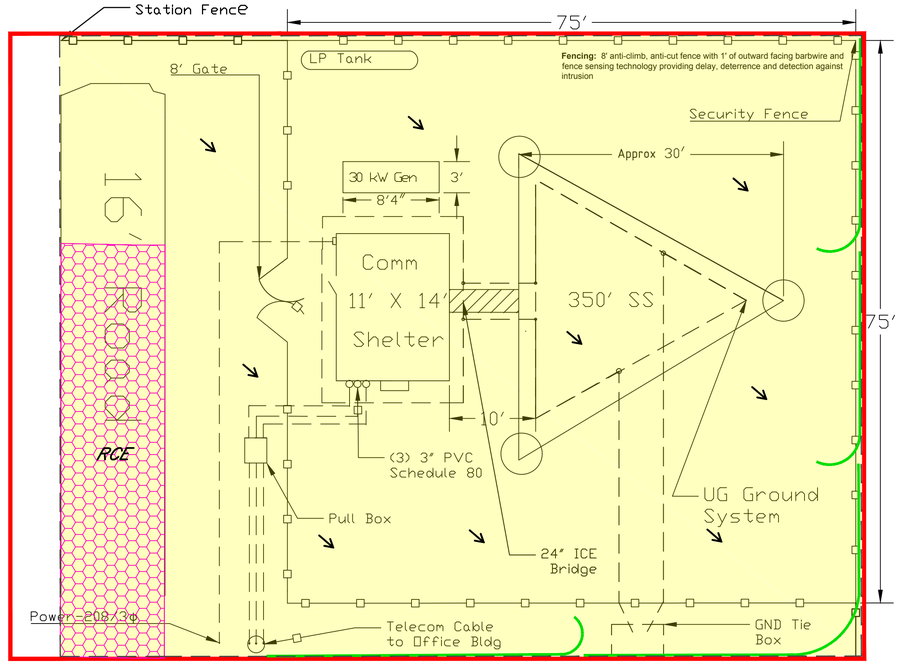
SEEDING AND MULCHING

SEE SEED MIXES SPECIFIED IN THE ACP PROJECT RESTORATION PLAN.

SEEDBED PREPARATION: AREAS TO BE SEEDED SHALL BE DISKED TO A DEPTH OF 4-IN TO 6-IN WHENEVER FEASIBLE, AND SMOOTHLY GRADED.

3. IN TOPSOILED AREAS, SOIL TO BE REDISTRIBUTED EVENLY AND STABILIZED PRIOR TO SEEDING.
4. STABILIZATION MEASURES SHALL BE INITIATED AS SOON AS PRACTICABLE IN PORTIONS OF THE SITE WHERE CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED, BUT IN NO CASE MORE THAN 21 DAYS AFTER THE CONSTRUCTION ACTIVITY IN THAT PORTION OF THE SITE HAS PERMANENTLY CEASED.
5. WHERE THE INITIATION OF STABILIZATION MEASURES WITHIN 7 DAYS AFTER CONSTRUCTION ACTIVITY TEMPORARILY OR PERMANENTLY CEASES IS PRECLUDED BY SNOW COVER, STABILIZATION MEASURES SHALL BE INITIATED AS SOON AS CONDITIONS ALLOW.
6. AREAS WHERE THE SEED HAS FAILED TO GERMINATE ADEQUATELY (UNIFORM PERENNIAL VEGETATIVE COVER WITH A DENSITY OF 70%) WITHIN 30 DAYS, SEEDING AND MULCHING MUST BE RE-SEEDED IMMEDIATELY, OR AS SOON AS WEATHER CONDITIONS ALLOW.

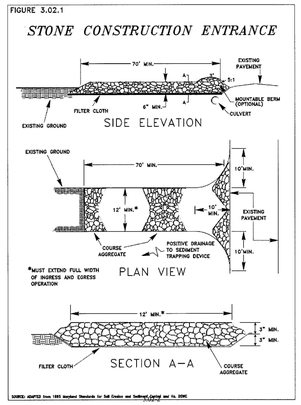
SITE PLAN

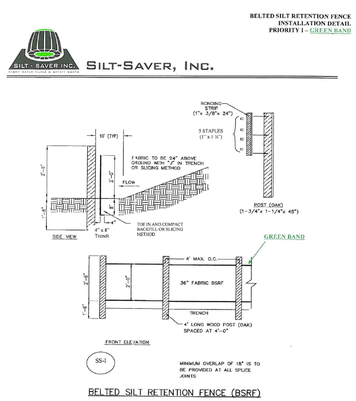


LEGEND

- LIMITS OF CONSTRUCTION
- LIMITS OF DISTURBANCE
- PROPOSED FEATURE
- PROPOSED FENCE
- PROPOSED COMPOST FILTER SOCK OR SILT FENCE
- ROCK CONSTRUCTION ENTRANCE (OR APPROVED ALT.)
- FLOW ARROW (PROPOSED)

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GENERAL NOTES AND COMMENTS:

ERM HAS DEPICTED EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES (BMPS) ON THESE PLAN SHEETS PREPARED BY OTHERS FOR USE BY CONTRACTOR TO CONTROL EROSION AND SEDIMENTATION DURING CONSTRUCTION OF THIS PROJECT. ERM IS RESPONSIBLE FOR THE NATURE AND LOCATION OF THE DEPICTED BMPS AS OF THE DATE SIGNED AND SEALED BASED ON THE SOURCE DATA PROVIDED. ERM RETAINS NO RESPONSIBILITY OR LIABILITY FOR INFORMATION DEVELOPED, PREPARED OR OTHERWISE PROVIDED BY OTHERS, OR FOR INACCURACIES OF SOURCE DATA PROVIDED BY OTHERS. ERM ASSUMES NO RESPONSIBILITY OR LIABILITY FOR DESIGNS OR WORK PRODUCTS OF ANY TYPE TO THE EXTENT THAT THEY ARE BASED UPON OR DERIVED FROM SUCH INCORRECT INFORMATION OR DATA.

SYM.	DATE	BY	REVISION INFORMATION	PROJECT/TASK	APP.
0	03/07/17	WTS	ISSUED FOR REVIEW	-	-

SEAL

DANIEL E. GOLDSTEIN
Lic. No. 019639
PROFESSIONAL ENGINEER

ERM Environmental Resources Management

DRAWN:	WTS	03/07/17
CHECKED:	-	-
APP. FOR BID:		
APP. FOR CONST.:		
SCALE:	AS NOTED	

Atlantic Coast Pipeline, LLC

925 White Oaks Blvd. Bridgeport, West Virginia 26330 / 681-842-8000

TITLE: **ATLANTIC COAST PIPELINE COMMUNICATION TOWER ESC PLAN - TYPICAL**

DISTRICT:	COUNTY:	STATE:	GROUP	DWG. NO.	REV.
-	-	-	-	1 - 1	0

DIR/FILE: ACP\COMMUNICATION TOWER

APPENDIX D

Communication Tower Construction Typicals

ATLANTIC COAST PIPELINE, LLC
ATLANTIC COAST PIPELINE

Stormwater Pollution Prevention Plan

APPENDIX E

Erosion and Sediment Control and Stormwater Management Plan

for

Buckingham Compressor Station and

Woods Corner M&R Station

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Figure 1-1 Buckingham Compressor Station Location

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Attachment 1 Erosion and Sediment Control and Stormwater Management Drawings and Supporting Calculations

LIST OF ACRONYMS AND ABBREVIATIONS

ACP	Atlantic Coast Pipeline
BMP	best management practice
BSRF	Belted Silt Retention Fence
DTI	Dominion Transmission, Inc.
EI	Environmental Inspector
ESC	erosion and sediment control
ESC Plan	Erosion and Sediment Control Plan
FERC	Federal Energy Regulatory Commission
lb/ac/yr	pounds per acre per year
M&R	metering and regulating
M&R Station	Woods Corner M&R Station
NRCS	U.S. Department of Agriculture, Natural Resources Conservation Service
NWI	National Wetlands Inventory
NWP	Nationwide Permit
SWM	stormwater management
SWM Plan	Stormwater Management Plan
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VDEQ	Virginia Department of Environmental Quality
VESCH	Virginia Erosion and Sediment Control Handbook
VESCP	Virginia Erosion and Sedimentation Control Program
VRRM	Virginia Runoff Reduction Method
VSMP	Virginia Stormwater Management

Professional Engineer Certification

In accordance with Article 1 (§ 54.1-400 et seq.) of Chapter 4 of Title 54.1 of the Code of Virginia, Virginia Erosion and Sediment Control Regulations (9 Virginia Administrative Code [VAC] 25-840 et seq., as amended) and Virginia Stormwater Management Program Regulations (9 VAC 25-870 et seq., as amended), I hereby certify that I have reviewed, and being familiar with the provisions of the above regulations, attest that the Erosion and Sediment Controls (ESC) and Stormwater Management (SWM) requirements in this plan have been prepared in accordance with good engineering practices, including consideration of applicable industry standards, and with the requirements of Article 1 (§ 54.1-400 et seq.) of Chapter 4 of Title 54.1 of the Code of Virginia, 9 VAC 25-840 et seq., as amended and 9 VAC 25-870 et seq., as amended.

Seal:



Stephen J. Raugh
Printed Name of Registered Professional Engineer

Signature of Registered Professional Engineer

Date 03-31-17

0402028864 Virginia
Registration No. State

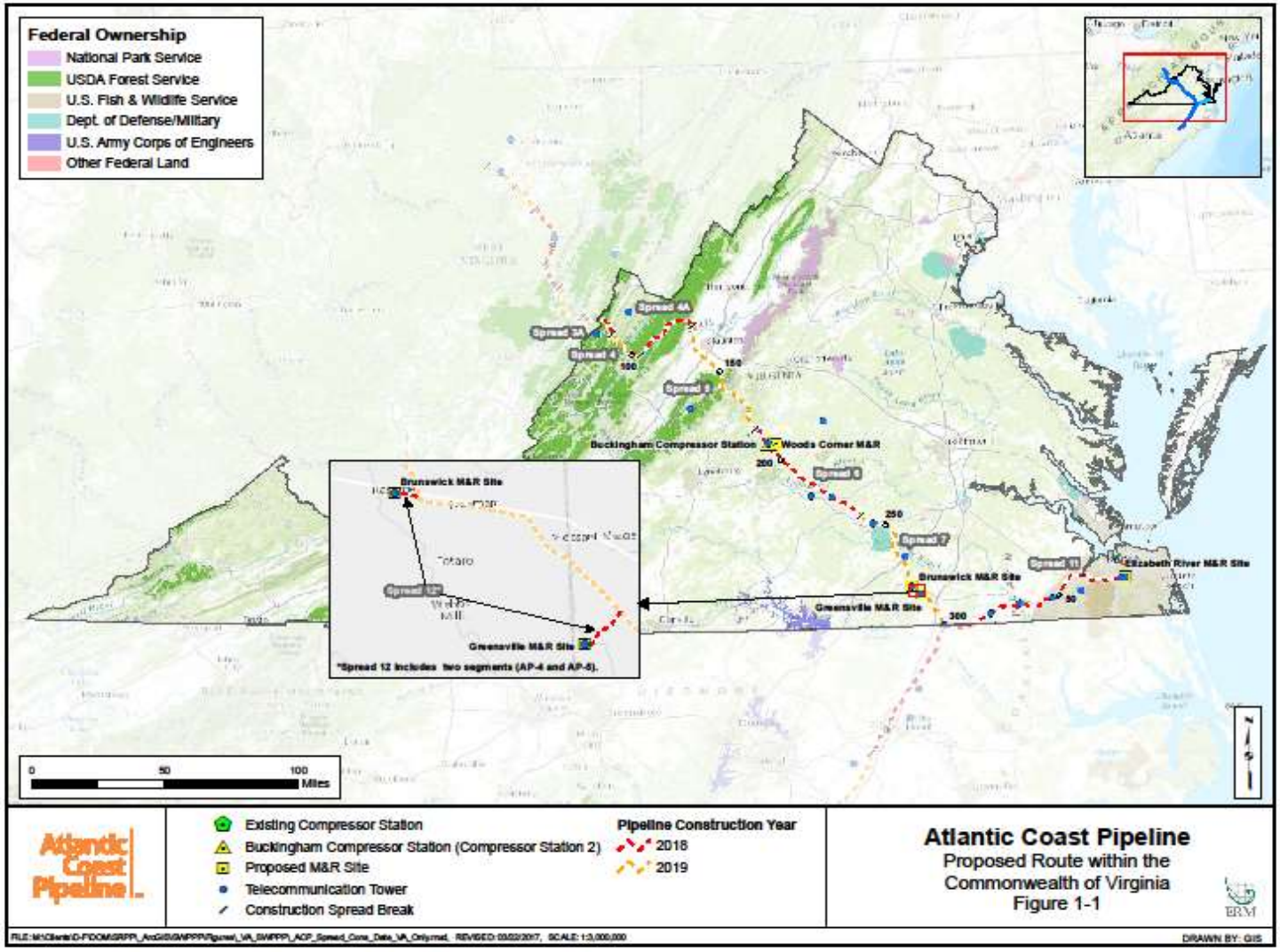
1.0 INTRODUCTION

As part of the Atlantic Coast Pipeline (ACP), Dominion Transmission Inc. (DTI) is proposing to construct an approximately 12-acre compressor station with a co-located metering and regulating station approximately six miles west of the town of Buckingham, Virginia. The compressor station, referred to as the Buckingham Compressor Station (Compressor Station 2), will be co-located with the Woods Corner Metering and Regulating Station (M&R Station). Both units will hereafter be referred to as the Compressor Station.

The purpose of this Appendix is to specifically address existing site conditions; planned land-disturbing activities; construction sequence and procedures; erosion and sediment control (ESC) measures; and post-construction stormwater management (SWM) methods to be used at the Compressor Station. This Appendix is intended to supplement the main body of the Stormwater Pollution Prevention Plan (SWPPP), which primarily addresses the linear portion of the Project. However, general provisions contained within the main body of the SWPPP, including pollution prevention practices and procedures; roles and responsibilities of personnel; inspection and maintenance; employee training; and notification, recordkeeping, and reporting will be followed during construction of the Compressor Station, as applicable to the aboveground facility. Land-disturbing activities will conform, at a minimum, to the same regulations and guidelines listed in Section 2.0 of the SWPPP, as appropriate and applicable. In circumstances where multiple overlapping regulatory requirements and guidelines apply, DTI selected the more stringent or protective of the requirements and guidelines set forth by the Federal Energy Regulatory Commission (FERC) and the Virginia Department of Environmental Quality (VDEQ).

A description of the Compressor Station is provided in the following sections. A Site Plan is provided in Attachment 1. Figure 1-1 below shows the location of the Compressor Station in relation to the ACP Project.

BUCKINGHAM COMPRESSOR STATION LOCATION



2.0 LOCATION AND DESCRIPTION

The Compressor Station will be located at milepost 191.6 in Buckingham County, VA where the AP-1 mainline will intersect existing Transco transmission pipelines. The Compressor Station will impact 27 acres during construction and 12 acres during operation and is located in the northern portion of a larger parcel. The larger parcel is identified in Buckingham County records as Parcel Number 91-60 with a lot description of six miles west of Buckingham on Route 56. The general vicinity around the Compressor Station is a mix of agricultural/undeveloped forestland, with Route 56 forming a portion of the southern boundary of the project area.

2.1 EXISTING SITE CONDITIONS

The Compressor Station is currently undeveloped wooded land. An existing natural gas pipeline right-of-way crosses the proposed Compressor Station along the eastern boundary.

A roadside drainage ditch is located adjacent to the southern boundary of the Compressor Station alongside Route 56 that runs southeast to northwest. Wetlands are located along the northern and southern portions of the Compressor Station as described in Section 2.11 below.

2.2 EXISTING AND PROPOSED TOPOGRAPHY

The topography at the Compressor Station is characterized by flat to gently sloping terrain with an elevation of approximately 585 feet above mean sea level. The proposed development will retain the existing topography of flat to gently sloping terrain with grading to direct stormwater toward drainage basins planned along the northeastern sides of the property.

Existing topography of the Compressor Station can be found on the topographical map, Attachment 1. In addition, the proposed grading plan for the Compressor Station is also provided in Attachment 1.

2.3 PROMINENT VEGETATION

The current Compressor Station site location is undeveloped wooded land. The Compressor Station will be developed with one dekatherm building (used to house equipment such as gas chromatographs, communications equipment, etc.) as well as a regulation skid, a metering skid, a microwave tower, and a small supply building surrounded by a chain-link security fence. In addition, aboveground sections of piping, gas filter/separator, meters, a tank, and regulators will be present. Existing forested areas will be preserved on the northern portion of the property and along the southern portion of the Compressor Station along Route 56. Trees will be planted as a buffer between the existing Transco Pipelines and the Compressor Station. Vehicles will enter the Compressor Station using new impervious access roads from Route 56. If existing roads are damaged during construction, DTI will restore these roads to preconstruction condition or better. The proposed Site Plan is provided in Attachment 1.

2.4 LAND-DISTURBING ACTIVITIES AND ASSOCIATED WORK AREAS

Construction of the Compressor Station will affect approximately 27 acres of land. Of that, 12 acres of land affected will be retained for operation of the new Compressor Station. The Site Plan included in Attachment 1 depicts the proposed land use with a tabulation of the percentage of surface area to be adapted to various uses, including but not limited to planned locations of utilities, structures, roads, parking areas, SWM facilities, and easements.

2.5 CONSTRUCTION SCHEDULE

Subject to receipt of the required permits and regulatory approvals, initial construction activities are expected to commence in November 2017. DTI anticipates that the Compressor Station construction will be completed in the four quarter of 2019.

2.6 ADJACENT PROPERTIES

The proposed Compressor Station will be located in an undeveloped forested area with limited residential. DTI will use a combination of management practices and control measures to limit the erosion and transport of soil to adjacent properties and waterbodies.

Multiple landowners maintain private residences in the parcels immediately adjacent to the Compressor Station. There is a timbering stand owned by Plum Creek Timberlands, LP situated on Parcels 91-21 and 106-35 situated to the south of the Compressor Station.

2.7 OFF-SITE AREAS

This ESC and SWM Plan addresses land-disturbing activities within the Compressor Station. Project plans do not include any additional off-site land-disturbing activities (such as borrow sites or disposal areas). Similar to adjacent properties, DTI will minimize any potential impact to off-site areas during the Project.

2.8 SOILS

Based on a review of the Virginia Division of Mineral Resources Geologic Map of Virginia (1993), the surficial geologic unit at the site is Metagraywacke, Quartzrose Schist, and Melange. According to the U.S. Geological Survey (USGS), Mategraywakes are quartzose chlorite or biotite schists that contain very fine to coarse granules of blue quarters. In Buckingham County, rocks in the unit are progressively more tectonized from east to west across the outcrop belt; in the western portion, the dominant lithology is a polydeformed, mylonitic mica schist with abundant quartz-rich boudins where transposed pinstriped lamination or segregation layers at a high angle to mylonitic schistosity is characteristic.

According to the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), soils beneath the Compressor Station are mapped as well drained (Bentley-Penhook complex) with depth to water table ranging from 30 to 39 inches. These soils consist of sandy clay loam overlain by a 3 to 3.5 foot layer of clay to a sandy loam. These soils are the primary soils underlying the central and southern portions of the Compressor Station, with Delanco loam to the north. Delanco loam is moderately well drained with depth to water table

ranging from 12 to 30 inches. These soils consist of silt loam overlain by a 3-foot layer of clay loam. The remaining portion of the Compressor Station is mapped in the Codorus-Hatboro complex and Littlejoe-Bentley complex. The Codorus-Hatboro complex is somewhat poorly drained with a depth to water table between 6-18 inches. The Littlejoe-Bentley complex is well-drained with a depth to water table at more than 80 inches.

The NRCS assigns soils to one of four hydrologic soil groups based on estimates of runoff potential, as follows:

- Group A: Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

- Group B: Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

- Group C: Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

- Group D: Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter applies to drained areas and the second applies to undrained areas.

The hydrologic soil groups assigned by NRCS for the soils mapped at the Compressor Station are as follows: Bentley-Penhook (Group C); Delanco (Group C/D); Codorus-Hatboro (Group B/D); and Littlejoe-Bentley (Group B).

2.9 RECEIVING WATERS

The Compressor Station drains to the northeast to the wetlands on the property, which then drains east to Ripley Creek. Ripley Creek flows east to Walton Fork and then into the Slate River. The Compressor Station is located within the Walton Fork-Ripley Creek watershed, identified by the USGS as hydrological unit code 020802031304. DTI does not intend to connect to and/or discharge into a municipal separate storm sewer system (MS4).

2.10 EXCEPTIONAL AND IMPAIRED WATERS

The proposed Compressor Station does not impact Tier 3 exceptional waters identified in 9 Virginia Administrative Code (VAC) 25-260-30 A.

DTI reviewed the 2014 list of 305(b)/303(d) Impaired Waters for the Commonwealth of Virginia to identify waterbodies classified as impaired or for which a Total Maximum Daily Load (TMDL) wasteload allocation has been established and approved for (i) sediment or a sediment-related parameter (i.e., total suspended solids or turbidity) or (ii) nutrients (i.e. nitrogen or phosphorus) (VDEQ, 2015). The Compressor Station drains to Ripley Creek, Walton Fork, and then the Slate River (a tributary of the James River), none of which have been designated as impaired for any sediment, nutrient, or related parameter. Portions of the Slate River have been designated as impaired for Escherichia coli; an approved TMDL plan has been published for the affected portion of the Slate River. However, the Compressor Station will be located within the Chesapeake Bay watershed which has a wasteload allocation to reduce nitrogen, phosphorus and sediment discharges into the Bay. The location of the Chesapeake Bay TMDL watershed is shown in **Figure 2.18-1** of the main body of the SWPPP.

In accordance with the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law and associated regulations, where applicable, the following will be implemented for construction activities within the Chesapeake Bay TMDL Watershed:

- Permanent or temporary soil stabilization will be applied to denuded areas within 7 days after final grade is reached on any portion of the site;
- Nutrients will be applied in accordance with manufacture's recommendations or an approved nutrient management plan and will not be applied during rainfall events,
- Inspection requirements are as follows:
    - Inspections will be conducted at a frequency of (i) at least once every five business days or (ii) at least once every ten business days and no later than 48 hours following a measurable storm event (a measurable storm event is defined as a rainfall event producing 0.25 inches of rain or greater over 24 hours). In the event a measurable storm event occurs when there are more than 48 hours between business days, the inspection will be conducted on the next business day; (see Section 8.1 of the SWPPP),
    - Representative inspections used by linear construction projects will include all outfalls discharging to surface waters identified as impaired or for which a TMDL wasteload allocation has been established. **Note that inspections of the Compressor Station will include all disturbed areas (i.e. representative inspections are only applicable to the linear portion of the Project – not to aboveground facilities).**

2.11 CRITICAL/SENSITIVE AREAS

Pre-construction assessments and field surveys were completed by DTI to delineate the location of critical or sensitive environmental areas within the areas of land disturbance proposed by the Compressor Station.

2.11.1 Wetlands and Waterbodies

The Compressor Station has been sited such that impacts to wetlands will be avoided and minimized to the maximum extent practicable. During the routing phase of the ACP Project, Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) data, was used to provide a preliminary analysis of wetland resources and to assess where wetland impacts could be avoided or minimized. NWI data was also used to estimate the number, size, and locations of wetlands within the construction areas prior to conducting wetland delineations in the field.

DTI conducted field surveys during the 2015 field season to identify and delineate wetlands at the proposed Buckingham Compressor Station. Temporary construction and operational activities at the Compressor Station will not impact any acres of wetland, which will remain northeast and south of the station, as shown on the Site Plan in Attachment 1. The wetlands, which on-site exist beyond the area of land disturbance and continue onto the adjacent property, will be protected during construction with a belted silt retention fence, as discussed in Section 3.1.4 below.

2.11.2 Threatened and Endangered Species

DTI consulted with the USFWS Ecological Services Field Office in Virginia to identify federally and Commonwealth-listed endangered, threatened, and proposed species as potentially occurring in the ACP Project area. Field surveys and consultations with the USFWS regarding these species are on-going. Virginia has separate acts protecting threatened and endangered species. DTI requested and received data on known occurrences of Commonwealth-listed species in Virginia from the Virginia Department of Conservation and Recreation's Natural Heritage Program. DTI additionally has consulted and continues to consult with the Virginia Department of Game and Inland Fisheries and Virginia Department of Conservation and Recreation regarding impacts on Commonwealth-listed threatened and endangered species.

There are no endangered, threatened, or proposed species that are known to occur at the proposed Buckingham Compressor Station.

3.0 EROSION AND SEDIMENT CONTROL

All ESC measures to be undertaken as part of this Project will be done in accordance with the VDEQ-approved DTI Standards and Specifications. These standards and specifications will be met through the implementation of the FERC's Upland Erosion Control, Revegetation, and Maintenance Plan and Wetland and Waterbody Construction and Mitigation Procedures, Minimum Standards of the Virginia Erosion and Sediment Control Regulations (9VAC25-840-40), by the design, construction and maintenance of the Erosion and Sedimentation Controls in accordance with the Virginia Erosion and Sedimentation Control Handbook (VESCH) (1992, 3rd Edition), and the application of environmental site design principles.

3.1 GENERAL BUCKINGHAM COMPRESSOR STATION CONSTRUCTION

Compressor Station construction stages and the ESC measures to be installed for each of these stages are described below. The ESC drawings for the Compressor Station, including typical drawings of general ESC measures, are provided in Attachment 1.

During construction, the effectiveness of temporary erosion control devices will be monitored by DTI's Environmental Inspectors (EIs). The effectiveness of permanent erosion control measures will be monitored for the life of the project by DTI operating personnel during the long-term operation and maintenance of the Compressor Station.

Site Preparation

- Survey and flag the construction site and mark environmentally-sensitive areas (i.e. boundary of wetland and vegetated filter strip).
- Only vehicular traffic used for diversion dike construction should be allowed within 10 feet of the limits of disturbance boundary.
- Install temporary construction entrance.
- Install safety fences prior to ESC installation.
- Conduct initial clearing, limited to that necessary to install temporary sediment barriers.
- Install all perimeter ESCs prior to any bulk earth-moving activity (road grading, log skidding, grubbing, etc.). ESC measures will be inspected and maintained throughout construction.
- Construction runoff should be directed towards the sediment basin and sediment trap with diversion dikes.
- Clear and grub site.
- Segregate topsoil where necessary.

Compressor Station Construction

- Begin site bulk grading.
- Grade entrance road, laydown areas, and parking areas.
- Grade building pads and dig excavations for footings, foundations, and utilities.
- Install utilities.
- Construct buildings and pipeline metering and regulation facilities.
- Spread topsoil on disturbed areas, as needed.

- Complete finish grading.
- Install impervious base around buildings and Compressor Station facilities.

Restoration

- Conduct site restoration and cleanup. As soon as slopes, channels, ditches, and other disturbed areas reach final grade, they must be stabilized within seven days.
- Apply soil amendments, permanent seed, mulch and/or erosion control fabric, as necessary.
- Restore temporary access roads or any paved surfaces to original condition.
- Remove temporary sediment barriers from an area when replaced by permanent erosion control measures or when the area has been successfully restored to uniform perennial vegetation. Temporary erosion control best management practices (BMPs) will not be removed until inspection by the EI to confirm site stabilization.

Stormwater Management Treatment Swale Construction

- Grading of the dry swale will not commence until the contributing drainage area has been stabilized by vegetation and perimeter erosion and sediment controls have been removed and cleaned out.
- Pre-treatment cells should be excavated to trap sediments before reaching planned filter beds.
- Minimize soil compaction by excavating from the sides of the dry swale area to achieve design depth and dimensions.
- Dry swale bottom should be scarified to promote infiltration.
- A filter fabric with minimum 6-inch overlap should be placed on underground of the dry swale. Stone that provides the storage layer is placed over the filter bed. Before placing the remaining stone jacket, the underdrain pipe is perforated and its slope checked. After placing the remaining stone jacket, #57 stone is placed to 3 inches above the top of the underdrain, then pea gravel is added as a filter layer.
- Soil media is added in 12-inch lifts to meet top elevation of the dry swale.
- Erosion control fabric is installed where needed, and preparations for landscaping features (planting holes for trees and shrubs, spreading seed, etc.) are completed.
- Landscaping is watered weekly during the first 2 months for proper establishment and growth.

Dry Detention Pond Construction

- Installation of the permanent riser should be started during the construction phase of the sediment basin, and all appropriate procedures should be followed to prevent turbid water discharge during the conversion of the pond from a sediment basin to an ext detention pond.
- Grading of the pond will not commence until the contributing drainage area has been stabilized.
- Install E&S controls, and clear and strip the project area.
- Excavate the core trench and install the spillway pipe and outflow structure.
- Embankments are constructed in 8 to 12-inch lifts following appropriate compaction requirements.
- The elevation and contours are achieved with excavation/grading techniques.
- Outlet protection is installed and exposed soils are stabilized with temporary seed mixtures.
- The pond buffer area is planted.

3.1.1 Survey and Flagging

- The limits of the approved work areas, boundaries of the delineated wetland, boundaries of the treatment swales, and the location of the underground utilities must be marked in the field prior to the start of mechanized activities.
- Orange plastic fencing may be more useful than flagging to assure that equipment operators stay out of critical areas. Only unavoidable work should take place within critical areas and their buffers.
- Per VESCH **Std. & Spec. 3.01 (Safety Fence)**, safety fencing will be installed as needed during grading at public access points or around open unattended excavations to warn pedestrians of possible hazards.
- Flagging or marking will be maintained throughout construction.
- Trees to be protected will be flagged by the EIs and if determined necessary, protected with fencing or armoring prior to clearing.
- Per VESCH **Std. & Spec. 3.38 (Tree Preservation and Protection)**, at a minimum the limits of clearing will be located outside the drip line of any tree to be retained and, in no case, closer than 5 feet to the trunk of any tree to be retained. In addition, heavy equipment, vehicular traffic, or stockpiles will not be permitted within the drip line of any tree to be retained.

3.1.2 Construction Entrance

In accordance with VESCH **Std. & Spec 3.02 (Stone Construction Entrance)**, a construction entrance will be constructed at any point where construction equipment leaves the right-of-way and enters a paved public road or other paved surface. Typically, a construction entrance is comprised of filter fabric overlain by 6 inches of coarse aggregate (Virginia Department of Transportation #1) extending a minimum of 70 feet from the edge of the pavement. The area of the entrance must be excavated 3 inches prior to laying the filter fabric underliner. The entrance must extend the full width of the vehicular ingress and egress area and have a minimum 12-foot width. Conveyance of surface water through culverts under the entrance will be provided, as necessary. If such as conveyance is impossible, the construction of a "mountable" berm with 5:1 slopes will be permitted.

The construction entrance must function to remove mud from vehicles and equipment leaving the site. As mud accumulates on the entrance, clean stone must be added or the tire mats lifted and shaken to remove mud. Any mud that is carried onto the pavement must be thoroughly removed by the end of the day by shoveling or sweeping. The mud will be returned to the site. The use of water to remove sediment tracked onto roadways is not permitted.

If the majority of the mud is not removed by the vehicles traveling over the stone, then tires of the vehicles must be washed before entering the public road. A wash rack may be used to make washing more convenient and effective. Wash water must be carried away from the entrance to a settling area to remove sediment before discharge.

Maintenance of the construction entrance may require periodic top dressing with additional stone and cleanout of any structures used to trap sediment. If inadvertent sediment tracking occurs on the public roadway, the road will be cleaned thoroughly by the end of each day.

3.1.3 Wind Erosion Control

Consistent with VESCH **Std. & Spec. 3.39 (Wind Erosion Contro**l), the following temporary sediment controls will be used, as applicable, to minimize the surface and air movement of dust during land disturbing and construction activities:

- In areas with little or no construction traffic, a vegetative-stabilized surface will reduce dust emissions.
- Mulch will be used in areas without heavy traffic pathways.
- Tillage should be used only in an emergency situation before wind erosion begins. Plowing on the windward side of the site with chisel-type plows spaced approximately 12 inches apart.
- The contractors will have one or more water trucks available per spread that will load water from approved permitted sources to spray areas for dust control.
- Use of spray-on adhesives may be used on mineral soils only.

- Use crushed stone or course gravel to stabilize roads and other areas during construction.

- A board fence, wind fence, or sediment fence may be used to control air currents and blowing soil. Place barriers perpendicular to prevailing air currents at intervals of about 15 times the barrier height.

- Calcium chloride may be applied by a mechanical spreader as loose, dry granules or flakes at a rate that keeps the surface moist but not so high as to cause water pollution or plant damage.

3.1.4 Silt Fencing

Silt Fencing, constructed of synthetic filter fabric stretched across and attached to supporting posts, and in some cases a wire support fence, will be placed across or at the toe of a slope or in a minor drainage way to intercept and detain sediment and decrease flow velocities from drainage areas of limited size. Silt fencing is applicable where sheet and rill erosion or small concentrated flows may be a problem. In accordance with VESCH **Std. & Spec 3.05 (Silt Fence),** DTI will adhere to the following general construction and maintenance specifications if congruent with the manufacturer's recommended installation and use. In the event of conflicting specifications, DTI will always follow the manufacturer's recommendations on proper installation and use of a product.

- Silt fencing will be used where the size of the drainage area is not more than one-quarter acre per 100 feet of silt fence length; the maximum slope length behind the barrier is 100 feet; and the maximum gradient behind the barrier is 50 percent (2:1).

- Silt fencing can be used in minor swales or ditches where the maximum contributing drainage area is no greater than 1 acre and flow is no greater than 1 cubic feet per second. In ditches or swales where higher velocity flow is expected, rock check dams should be used in place of silt fence.

- Silt fencing will not be used in areas where rock or some other hard surface prevents the full and uniform depth anchoring of the barrier.

- If wooden stakes are utilized for silt fence construction, they must have a diameter of 2 inches when oak is used and 4 inches when pine is used. Wooden stakes must have a minimum length of 5 feet. Fabric will not be stapled to existing trees.

- If steel posts are utilized, they must have a minimum weight of 1.33 pounds per linear foot and have a minimum length of 5 feet. Posts will be placed a maximum of 6 feet apart.

- The height of the fence will be a minimum of 16 inches above grade and will not exceed 34 inches above ground elevation.

- Filter cloth will be spliced together only at support posts with a minimum 6-inch overlap.

- When wire support is not used, extra-strength filter fabric will be fastened to the upslope side of the posts using one inch long (minimum) heavy-duty wire staples or tie wires and eight inches of the fabric will be extended into the trench. The posts will be placed a maximum of 6 feet apart.

- When wire support is used, the wire mesh fence must be fastened securely to the upslope side of the posts using heavy duty wire staples at least one inch long, tire wires or hog rings. The posts will be placed a maximum of 10 feet apart.

- If silt fence is to be constructed across a ditch line or swale, the measure must be of sufficient length to eliminate end flow and the configuration will resemble an arc with the ends oriented upslope. Extra-strength filter fabric must be used for ditch lines or swales with a maximum 3-foot spacing of posts.

- Remove accumulated sediments when sediment reaches half the above-ground height of the fence.

Belted Silt Retention Fence (BSRF)

The primary silt fence product planned for use on the ACP, including the Compressor Station, is a patented Belted Silt Retention Fence (BSRF) product which is available in two designs used to address different site conditions, as follows:

- BSRF Priority 1 (green band) is a heavy-duty silt fence constructed with a 36-inch, non-woven, spun-bond fabric with an internal scrim incorporated into the fabric for additional strength and durability. The system utilizes wood stakes spaced at 4-feet and a specific method of attachment. The system is functionally equivalent to wire back and metal steel post silt fence and is designed for the protection of high priority areas, including wetlands and waterbodies.

- BSRF Priority 2 (black band) is a medium-duty silt fence constructed with a 36-inch, non-woven, spun-bond fabric that is calendared on one side. The system utilizes wood stakes spaced at 6-feet and a specific method of attachment.

Drawings and specifications for BSRF are provided in Attachment 1.

3.1.5 Temporary Diversion Dike

A temporary ridge of compacted soil constructed at the top of a sloping disturbed area will be used to divert stormwater runoff from upslope drainage areas away from the unprotected slope. Temporary diversion dikes can also be constructed at the base of a slope to protect adjacent and downstream areas by diverting sediment-laden runoff from a disturbed area to a sediment-trapping control measure. A temporary diversion dike is effective when the control limits of a silt fence are exceeded. The temporary diversion dike must be installed as a first step

in the land-disturbing activity at locations shown on the construction alignment sheets and must be functional prior to upslope land disturbance. In accordance with VESCH **Std. & Spec 3.09** (Temporary Diversion Dike), DTI will adhere to the following general construction and maintenance specifications:

- The maximum allowable drainage area is 5 acres.
- The minimum height measured on the upslope side of the dike is 18 inches.
- The dike should be compacted to prevent failure and have side slopes 1.5:1 or flatter with a minimum base width of 4.5 feet.
- The channel behind the dike will have a parabolic or trapezoidal cross-section shape to avoid high velocity flow which could arise in a v-shaped ditch. The channel will have a positive grade to a stabilized outlet.
- The diversion dike and channel will be stabilized immediately following installation with temporary or permanent vegetation. Where channel slope is greater than 2%, Rolled Erosion Control Product (RECP), or equivalent, will be used to stabilize soil until vegetation is established.

The temporary diversion dike will be inspected and repairs made to the dike, flow channel, outlet or sediment trapping area, as necessary. Once every day in active construction areas, whether a storm event has occurred or not, the measure will be inspected and repairs made if needed. Damages caused by construction traffic or other activity must be repaired before the end of each working day.

3.1.6 Temporary Sediment Trap

A temporary ponding area formed by constructing an earthen embankment with a stone outlet may be used to detain sediment-laden runoff from small disturbed areas (where total drainage area is less than three acres) to allow sediment to settle out prior to discharge. The sediment trap may be constructed either independently or in conjunction with a temporary diversion dike as a suitable option for outlet control. The temporary sediment trap must be installed as a first step in the land-disturbing activity at locations shown on the construction alignment sheets and must be functional prior to upslope land disturbance. In accordance with VESCH **Std. & Spec 3.13** (Temporary Sediment Trap), DTI will adhere to the following general construction and maintenance specifications:

- The maximum useful life of a temporary sediment trap is 18 months. Traps will be replaced should the construction period exceed 18-months. Sediment traps may need to be replaced sooner than 18 months (on an as needed basis) if at any time they cease to be effective. This will be determined based on the regularly scheduled inspections of these traps. Erosional control inspection and maintenance will continue on all parts of the project at all times until the landscape is deemed stable.
- The total contributing drainage area to a sediment trap is less than 3 acres.

- The sediment trap must be designed to have an initial storage volume of 134 cubic yards per acre of drainage area with a minimum 2:1 length to width ratio, if possible. Half of the 134 cubic yards per acre of storage volume must be in the form of a permanent pool or wet storage.

- Side slopes of the excavated area should be no steeper than 1:1 and the maximum depth of excavation within the wet storage area should be 4 feet.

- Outlet requirements include a combined coarse aggregate/riprap stone section of the embankment (VDOT #3, #357 or #5 Coarse Aggregate and Class I riprap).

- Filter cloth will be placed at the stone-soil interface. The length of the stone outlet will be detailed on the construction alignment sheets and will be designed at 6 feet times the total drainage area in acres. The crest of the stone outlet must be at least 1.0 foot below the top of the embankment.

- The maximum height of the embankment will be 5 feet measured to the base of the stone outlet. Side slopes of the embankment will be 2:1 or flatter.

- Fill material will be free of roots or other woody vegetation, large stones, or organic matter and compacted in 6-inch lifts.

- The temporary sediment trap will be stabilized immediately following installation with temporary or permanent vegetation.

- Remove accumulated sediments when sediment reaches ½ the design storage volume. Sediment removed will be deposited in a disturbed area in a manner that it will not erode and cause sedimentation problems.

- Stone will be replaced if it becomes choked with sediment.

3.1.7 Temporary Sediment Basin

A temporary sediment basin follows the information set forth in 3.1.6 above, but whose total drainage area is greater than three acres.

3.1.8 Site Dewatering

Dewatering may be periodically conducted to remove accumulated groundwater or precipitation from the construction area, including from within excavations. The need for erosion controls as well as the type of control used will vary depending on the type and amount of sediment within the water, and volume and rate of discharge.

Geotextile Bag/Dewatering Filter Bag

DTI utilizes geotextile bags for dewatering and velocity reduction on a majority of pipeline construction projects as well as the straw bale dewatering practice illustrated in the VESCH **Std. & Spec. 3.26 (Dewatering Structure)**. The purpose, definition, conditions of application and planning considerations are identical. Design criteria and specifications vary by dewatering bag manufacturer; a variety of geotextile dewatering bag products are available on the market. The manufacturers' guidance on the use, design, sizing, maintenance, and application of the geotextile dewatering bag will be followed.

- Conduct dewatering (on or off the construction site) in such a manner that does not cause erosion and does not result in silt-laden water flowing into any waterbody, wetland, or off-site property.

- Elevate and screen the intake of each hose used to withdraw the water from the trench to minimize pumping of deposited sediments.

- A dewatering bag may not be needed if there is a well-stabilized, vegetated area on-site to which water can be discharged. The area must be stabilized so that it can filter sediment and at the same time withstand the velocity of the discharged water without eroding. Per VESCH **Std. & Spec 3.26**, a minimum filtering length of 75 feet must be available in order for such a method to be feasible.

- Remove dewatering structures as soon as practicable after the completion of dewatering activities or sooner if sediment build-up prevents the bag from functioning properly. If the bag becomes half full of sediment, discard and replace with a new bag.

VESCH Standard Dewatering Structure

As warranted by site conditions, a standard dewatering structure may be used per the construction and maintenance specifications in VESCH **Std. & Spec 3.26 (Dewatering Structure)**, including the use of a portable sediment tank, filter box, or straw bale/silt fence pit. The dewatering structure must be sized (and operated) to allow pumped water to flow through the filtering device without overtopping the structure. The filtering devices must be inspected frequently and repaired or replaced once the sediment build-up prevents the structure from functioning as designed. The accumulated sediment which is removed from a dewatering device must be spread on-site and stabilized or disposed of at an approved disposal site.

3.2 SPECIAL CONSTRUCTION PROCEDURES

Sensitive areas (e.g., wetland) will be treated as separate construction entities. Sensitive areas require additional ESC procedures. Additional controls will be shown on the drawings in Attachment 1.

3.2.1 Winter Construction

DTI has developed and filed a project-specific winter construction plan with the FERC application.

The plan addresses:

- Winter construction procedures (e.g., snow handling and removal, soil handling under saturated or frozen conditions, topsoil stripping);
- Stabilization and monitoring procedures if ground conditions will delay restoration until the following spring (e.g., mulching and erosion controls, inspection and reporting, stormwater control during spring thaw conditions); and
- Where areas have been temporarily stabilized or land-disturbing activities will be suspended due to continuously frozen ground conditions, and stormwater discharges are unlikely, the inspection frequency may be reduced to once per month. If weather conditions (such as above freezing temperatures or rain or snow events) make discharges likely, the operator will immediately resume the regular inspection frequency.

3.2.2 Wetlands

Construction procedures are to comply with the U.S. Army Corps of Engineers (USACE), or its delegated agency, permit terms and conditions.

The Buckingham Compression Station will not impact any wetlands and as such, no permit terms or conditions apply. However, DTI will employ belted silt fence at the Compressor Station to ensure the protection of the wetlands located in the northeastern portion of the site.

4.0 EROSION AND SEDIMENT CONTROL MINIMUM STANDARDS

The Virginia ESC regulations specify minimum standards that must be followed for all regulated land-disturbing activities, where applicable to a specific project. Modifying or waiving any of the ESC regulations, including the 19 minimum standards, on a project-specific basis, requires a written variance request to VDEQ for review and approval. DTI will construct the Compressor Station in accordance with the following criteria, techniques, and methods per minimum standards set forth in 9 VAC 25-840-40, as applicable.

Minimum Standard 1 – Permanent or temporary soil stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site. Temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain dormant for longer than 14 days. Permanent stabilization shall be applied to areas that are to be left dormant for more than one year.

Minimum Standard 2 - During construction of the project, soil stock piles and borrow areas shall be stabilized or protected with sediment trapping measures. The applicant is responsible for the temporary protection and permanent stabilization of all soil stockpiles on site as well as borrow areas and soil intentionally transported from the project site.

Minimum Standard 3 – A permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized. Permanent vegetation shall not be considered established until a ground cover is achieved that is uniform, mature enough to survive and will inhibit erosion.

Minimum Standard 4 – Sediment basins and traps, perimeter dikes, sediment barriers and other measures intended to trap sediment shall be constructed as a first step in any land-disturbing activity and shall be made functional before upslope land disturbance takes place.

Minimum Standard 5 – Stabilization measures shall be applied to earthen structures such as dams, dikes, and diversions immediately after installation.

Minimum Standard 6 – Sediment traps and sediment basins shall be designed and constructed based upon the total drainage area to be served by the trap or basin.

6.a. The minimum storage capacity of a sediment trap shall be 134 cubic yards per acre of drainage area and the trap shall only control drainage areas less than 3 acres.

6.b. Surface runoff from disturbed areas that is comprised of flow from drainage areas greater than or equal to 3 acres shall be controlled by a sediment basin. The minimum storage capacity of a sediment basin shall be 134 cubic yards per acre of drainage area. The outfall system shall, at a minimum, maintain the structural integrity of the basin during a 25-year storm of 24-hour duration. Runoff coefficients used in runoff calculations shall correspond to a bare earth condition or those conditions expected to exist while the sediment basin is utilized

Minimum Standard 7 – Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion. Slopes that are found to be eroding excessively within one year of permanent stabilization shall be provided with additional slope stabilizing measures until the problem is corrected.

Minimum Standard 8 – Concentrated runoff shall not flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, flume or slope drain structure.

Minimum Standard 9 – Whenever water seeps from a slope face, adequate drainage or other protection shall be provided.

Minimum Standard 10 – All storm sewer inlets that are made operable during construction shall be protected so that sediment-laden water cannot enter the conveyance system without first being filtered or otherwise treated to remove sediment

Minimum Standard 11 – Before newly constructed stormwater conveyance channels or pipes are made operational, adequate outlet protection and any required temporary or permanent channel lining shall be installed in both the conveyance channel and receiving channel.

Minimum Standard 12 – When work in a live watercourse is performed, precautions shall be taken to minimize encroachment, control sediment transport and stabilize the work area to the greatest extent possible during construction. Nonerodible material shall be used for the construction of causeways and cofferdams. Earthen fill may be used for these structures if armored by nonerodible cover materials.

Minimum Standard 13 – When a live watercourse must be crossed by construction vehicles more than twice in any six-month period, a temporary vehicular stream crossing constructed of nonerodible material shall be provided.

Minimum Standard 14 – All applicable federal, state and local requirements pertaining to working in or crossing live watercourses shall be met.

Minimum Standard 15 – The bed and banks of a watercourse shall be stabilized immediately after work in the watercourse is completed.

Minimum Standard 16 – Underground utility lines shall be installed in accordance with the following standards in addition to other applicable criteria:

16.a. No more than 500 linear feet of trench may be opened at one time.

16.b. Excavated material shall be placed on the uphill side of trenches.

16.c. Effluent from dewatering operations shall be filtered or passed through an approved sediment trapping device, or both, and discharged in a manner that does not adversely affect flowing streams or off-site property.

16.d. Material used for backfilling trenches shall be properly compacted in order to minimize erosion and promote stabilization.

16.e. Restabilization shall be accomplished in accordance with this chapter.

16.f. Applicable safety requirements shall be complied with.

Minimum Standard 17 – Where construction vehicle access routes intersect paved or public roads, provisions shall be made to minimize the transport of sediment by vehicular tracking onto the paved surface. Where sediment is transported onto a paved or public road surface, the road surface shall be cleaned thoroughly at the end of each day. Sediment shall be removed from the roads by shoveling or sweeping and transported to a sediment control disposal area. Street washing shall be allowed only after sediment is removed in this manner. This provision shall apply to individual development lots as well as to larger land-disturbing activities.

Minimum Standard 18 - All temporary ESC measures shall be removed within 30 days after final site stabilization or after the temporary measures are no longer needed, unless otherwise authorized by the Virginia Erosion and Sedimentation Control Program (VESCP) authority. Trapped sediment and the disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion and sedimentation.

Minimum Standard 19 - Properties and waterways downstream from development sites shall be protected from sediment deposition, erosion and damage due to increases in volume, velocity, and peak flow rate of stormwater runoff for the stated frequency storm of 24-hour duration in accordance with the following standards and criteria. Stream restoration and relocation projects that incorporate natural channel design concepts are not man-made channels and shall be exempt from any flow rate capacity and velocity requirements for natural or man-made channels:

19.a. Concentrated stormwater runoff leaving a development site shall be discharged directly into an adequate natural or man-made receiving channel, pipe or storm sewer system. For those sites where runoff is discharged into a pipe or pipe system, downstream stability analyses at the outfall of the pipe or pipe system shall be performed.

19.b. Adequacy of all channels and pipes shall be verified in the following manner:

19.b.(1) The applicant shall demonstrate that the total drainage area to the point of analysis within the channel is one hundred times greater than the contributing drainage area of the project in question; or

19.b.(2)(a) Natural channels shall be analyzed by the use of a two-year storm to verify that stormwater will not overtop channel banks nor cause erosion of channel bed or banks.

19.b.(2)(b) All previously constructed man-made channels shall be analyzed by the use of a 10-year storm to verify that stormwater will not overtop

its banks and by the use of a two-year storm to demonstrate that stormwater will not cause erosion of channel bed or banks; and

19.b.(2)(c) Pipes and storm sewer systems shall be analyzed by the use of a 10-year storm to verify that stormwater will be contained within the pipe or system.

19.c. If existing natural receiving channels or previously constructed man-made channels or pipes are not adequate, the applicant shall:

19.c.(1) Improve the channels to a condition where a 10-year storm will not overtop the banks and a two-year storm will not cause erosion to the channel, the bed, or the banks; or

19.c.(2) Improve the pipe or pipe system to a condition where the 10-year storm is contained within the appurtenances;

19.c.(3) Develop a site design that will not cause the pre-development peak runoff rate from a two-year storm to increase when runoff outfalls into a natural channel or will not cause the pre-development peak runoff rate from a 10-year storm to increase when runoff outfalls into a man-made channel; or

19.c.(4) Provide a combination of channel improvement, stormwater detention or other measures which is satisfactory to the VESCP authority to prevent downstream erosion.

19.d. The applicant shall provide evidence of permission to make the improvements.

19.e. All hydrologic analyses shall be based on the existing watershed characteristics and the ultimate development condition of the subject project.

19.f. If the applicant chooses an option that includes stormwater detention, he shall obtain approval from the VESCP of a plan for maintenance of the detention facilities. The plan shall set forth the maintenance requirements of the facility and the person responsible for performing the maintenance.

19.g. Outfall from a detention facility shall be discharged to a receiving channel, and energy dissipators shall be placed at the outfall of all detention facilities as necessary to provide a stabilized transition from the facility to the receiving channel.

19.h. All on-site channels must be verified to be adequate.

19.i. Increased volumes of sheet flows that may cause erosion or sedimentation on adjacent property shall be diverted to a stable outlet, adequate channel, pipe or pipe system, or to a detention facility.

19.j. In applying these stormwater management criteria, individual lots or parcels in a residential, commercial or industrial development shall not be considered to be separate development projects. Instead, the development, as a whole, shall be considered to be a single development project. Hydrologic parameters that reflect the ultimate development condition shall be used in all engineering calculations.

19.k. All measures used to protect properties and waterways shall be employed in a manner which minimizes impacts on the physical, chemical and biological integrity of rivers, streams and other waters of the state.

19.l. Any plan approved prior to July 1, 2014, that provides for SWM that addresses any flow rate capacity and velocity requirements for natural or man-made channels shall satisfy the flow rate capacity and velocity requirements for natural or man-made channels if the practices are designed to (i) detain the water quality volume and to release it over 48 hours; (ii) detain and release over a 24-hour period the expected rainfall resulting from the one year, 24-hour storm; and (iii) reduce the allowable peak flow rate resulting from the 1.5, 2, and 10-year, 24-hour storms to a level that is less than or equal to the peak flow rate from the site assuming it was in a good forested condition, achieved through multiplication of the forested peak flow rate by a reduction factor that is equal to the runoff volume from the site when it was in a good forested condition divided by the runoff volume from the site in its proposed condition, and shall be exempt from any flow rate capacity and velocity requirements for natural or man-made channels as defined in any regulations promulgated pursuant to §62.1-44.15:54 or 62.1-44.15:65 of the Act.

19.m. For plans approved on and after July 1, 2014, the flow rate capacity and velocity requirements of §62.1-44.15:52 A of the Act and this subsection shall be satisfied by compliance with water quantity requirements in the Stormwater Management Act (§62.1-44.15:24 et seq. of the Code of Virginia) and attendant regulations, unless such land-disturbing activities are in accordance with 9 VAC 25-870-48 of the Virginia Stormwater Management Program (VSMP) Regulation or are exempt pursuant to subdivision C 7 of §62.1-44.15:34 of the Act.

19.n. Compliance with the water quantity minimum standards set out in 9 VAC 25-870-66 of the VSMP Regulation shall be deemed to satisfy the requirements of this subdivision 19.

5.0 POST-CONSTRUCTION STORMWATER MANAGEMENT

Where pre-development land cover conditions are changed significantly, triggering requirements for post-construction stormwater quality and quantity, post-construction BMPs may be required to comply with water quality and water quantity criteria of the Stormwater Management Regulations and Minimum Standard 19 of the Erosion and Sediment Control Regulations.

The post-construction land cover at the Compressor Station will be comprised of a combination of managed turf, forest/open space, and impervious surfaces, potentially resulting in increases in nutrient loading, runoff volume, and peak flow rate. At this location, the need for post-construction SWM BMPs was evaluated as discussed below.

5.1 PRE-DEVELOPMENT AND POST-DEVELOPMENT DRAINAGE AREAS

As noted in Sections 2.1 and 2.2, the pre-development conditions at the Compressor Station are primarily characterized as undeveloped woodlands. The topography at the Compressor Station is characterized by flat to gently sloping terrain with an elevation of approximately 585 feet above mean sea level. The proposed development will retain the existing topography of flat to gently sloping terrain with grading to direct stormwater toward drainage basins planned along the northeastern sides of the property.

In the post-development condition, approximately 8.71 acres of the M&R Station site will be surfaced with impervious material to create a suitable foundation for the required structures and equipment. Additionally, minor grading will occur to direct stormwater runoff toward a stormwater management treatment swale that will be constructed to convey stormwater from the site towards the two stormwater management areas in the northeastern portion of the site.

Delineation of the drainage watersheds and proposed management practices are shown on the SWM drawings and supporting calculations in Attachment 1. The drawings depict the proposed land uses at the site, and a tabulation of the percentage of surface area to be adapted to various uses, including but not limited to planned locations of utilities, roads, and parking lots. The drawings also show the final drainage patterns and flow paths of the stormwater, in addition to the relationship of the site to upstream and downstream properties and drainage systems. The Compressor Station is located within a 500-year Federal Emergency Management Agency floodplain.

Stormwater quality and quantity calculations were performed for pre- and post-development conditions and are described in Section 5.2 below.

5.2 PRE-DEVELOPMENT AND POST-DEVELOPMENT STORMWATER CALCULATIONS

5.2.1 Water Quantity

A hydrologic analysis for the existing (pre-development) and for the proposed (post-development) conditions, including runoff rates, volumes, and velocities, identifying the methodologies used and supporting calculations are presented in this section.

Channel protection and flood protection will be addressed in accordance with the minimum standards set forth in 9 VAC25-870-66, which are established pursuant to the requirements of § 62.1-44.15:28 of the Code of Virginia. Compliance with the minimum standards set out in this section will be deemed to also satisfy the requirements of Minimum Standard 19 of 9 VAC25-840-40 (Minimum standards; Virginia Erosion and Sediment Control Regulations, Section 4.0).

Channel Protection

Runoff from the site sheet flows towards the rear of the site, aided by diversion dikes in Phase I and stormwater management (SWM) Treatment Swales in Phase II that exist along the perimeter of the Compressor Station. Along the main and northern portion of the site where the Compressor Station is to be located, SWM Treatment Swales direct stormwater from the southern and highest topographic position of the site, northwest around the site, and then downgradient towards the east into two stormwater management basins. In this area, a diversion dike along the southeast and northeastern portions of the site similarly move into the stormwater management basins. Additional sheet flow from the main portion site will flow towards a belted silt retention fence towards the wetlands beyond the Compressor Station. Within the portion of the site located south of the Transco Pipeline easement, runoff flows via a southern stormwater diversion dike and eastern treatment swale to a dry pond located in a topographic low. From the dry pond, which is located in the most southern portion of the site, runoff may sheet flow towards wetlands located south of the Compressor Station.

Since stormwater flow from the Compressor Station will be released into a natural stormwater conveyance system, the maximum peak flow rate from the one-year, 24-hour storm following the land-disturbing activity was calculated. The supporting calculations are provided in Attachment 1.

Flood Protection

Concentrated stormwater flow will be released into a stormwater conveyance system and will meet one of the following criteria as demonstrated by use of acceptable hydrologic and hydraulic methodologies:

1. Concentrated stormwater flow to stormwater conveyance systems that currently do not experience localized flooding during the 10-year, 24-hour storm event: The point of discharge releases stormwater into a stormwater conveyance system that, following the land-disturbing activity, confines the post-development peak flow rate from the 10-year, 24-hour storm event within the stormwater conveyance system. Detention of stormwater or downstream improvements may be incorporated into the approved land-disturbing activity to meet this criterion, at the discretion of the VSMP authority.

2. Concentrated stormwater flow to stormwater conveyance systems that currently experience localized flooding during the 10-year, 24-hour storm event: The point of discharge either:

a. Confines the post-development peak flow rate from the 10-year, 24-hour storm event within the stormwater conveyance system to avoid the localized flooding. Detention of stormwater or downstream improvements may be incorporated into the approved land disturbing activity to meet this criterion, at the discretion of the VSMP authority; or

b. Releases a post-development peak flow rate for the 10-year 24-hour storm event that is less than the predevelopment peak flow rate from the 10-year, 24-hour storm event. Downstream stormwater conveyance systems do not require any additional analysis to show compliance with flood protection criteria if this option is utilized.

3. Limits of analysis. Unless the methodology identified in 2 b above is utilized to comply with the flood protection criteria, stormwater conveyance systems will be analyzed for compliance with flood protection criteria to a point where:

a. The site's contributing drainage area is less than or equal to 1.0 percent of the total watershed area draining to a point of analysis in the downstream stormwater conveyance system;

b. Based on peak flow rate, the site's peak flow rate from the 10-year, 24-hour storm event is less than or equal to 1.0 percent of the existing peak flow rate from the 10-year, 24-hour storm event prior to the implementation of any stormwater quantity control measures; or

c. The stormwater conveyance system enters a mapped floodplain or other flood-prone area, adopted by ordinance, of any locality.

The supporting calculations are provided in Attachment 1.

5.2.2 Water Quality

In order to protect the quality of Commonwealth waters and to control the discharge of stormwater pollutants from regulated activities, the following minimum design criteria and statewide standards for SWM will be applied to the site in accordance with 9 VAC25-870-63.

1. New development. The total phosphorus load of new development projects will not exceed 0.41 pounds per acre per year (lb/ac/yr), as calculated pursuant to 9 VAC25-870-65.

The VSMP regulations suggest the use of the Virginia Runoff Reduction Method (VRRM) for compliance with the water quality criteria in accordance with 9VAC25-870-65. The VRRM New Development spreadsheet was utilized to calculate the runoff reduction and pollutant removal capabilities of the selected post-construction stormwater BMPs based on the proposed land cover characteristics.

The approximate 12-acre Compressor Station will have the following land cover characteristics:

- 26.29 acres of Forest/Open Space – This total is inclusive of the preserved wetland and conserved open space on the eastern side of the site, and the proposed diversion dikes/treatment swales around the perimeter of the property.

- 22.28 acres of Managed Turf – This is inclusive of the disturbed and graded side slopes of the Compressor station pad.

- 8.71 acres of Impervious Cover – This is inclusive of the Compressor Station pad, the equipment areas, and the paved access road.

Based on the land cover characteristics, the post-development treatment volume for the Compressor Station was calculated to be 50,632 cubic feet (ft^3) and the total phosphorus produced from the site was 31.81 lb/yr. With a required phosphorus load of 0.41 lb/ac/yr for new development, the phosphorus load is required to be reduced by 8.33 lb/ac/yr.

Post-Development Project (Treatment Volume and Loads)

Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) – undisturbed, protected forest/open space or reforested land		7.86	16.00	2.43	26.29 *
Managed Turf (acres) – disturbed, graded for yards or other turf to be mowed/managed		14.34	6.05	1.99	22.28
Impervious Cover (acres)		4.79	3.61	0.31	8.71
					57.28

** Forest/Open Space areas must be protected in accordance with the Virginia Runoff Reduction Method*

Constants

Annual Rainfall (inches)	43
Target Rainfall Event (inches)	1.00
Total Phosphorus (TP) EMC (mg/L)	0.26
Total Nitrogen (TN) EMC (mg/L)	1.86
Target TP Load (lb/acre/yr)	0.41
Pj (unitless correction factor)	0.90

Runoff Coefficients (Rv)

	A Soils	B Soils	C Soils	D Soils
Forest/Open Space	0.02	0.03	0.04	0.05
Managed Turf	0.15	0.20	0.22	0.25
Impervious Cover	0.95	0.95	0.95	0.95

Post-Development Requirement for Site Area

TP Load Reduction Required (lb/yr)	8.33

The site is proposed to be graded in a way that the site and the access road sheet flows to the SWM treatment swale on the southwest and northwest sides of the Compressor Station site. Based on the grading and location of the BMPs, the contributing drainage areas in acres were entered into the appropriate rows in the VRRM spreadsheet for the selected BMPs. The selected BMPs were able to reduce the phosphorus load by 11.54 lb/yr, an excess of the target total phosphorus reduction by 3.66 lb/yr remaining after applying BMP load reductions.

Total Phosphorus

FINAL POST-DEVELOPMENT TP LOAD (lb/yr)	31.81
TP LOAD REDUCTION REQUIRED (lb/yr)	8.33
TP LOAD REDUCTION ACHIEVED (lb/yr)	11.54
TP LOAD REMAINING (lb/yr):	20.27
REMAINING TP LOAD REDUCTION REQUIRED (lb/yr):	0.00 **
	** TARGET TP REDUCTION EXCEEDED BY 3.22 LB/YEAR **

The supporting calculations are provided in Attachment 1.

5.3 POST-CONSTRUCTION/PERMANENT STORMWATER BMPS

Post-construction/permanent stormwater BMPs will be addressed through the construction and use of three stormwater management ponds that will serve as dry retention basins and through the use of stormwater management treatment swales and diversion dikes.

5.3.1 Dry Retention Basins

Three stormwater management ponds will be used at the Compressor Station, which will receive water drained from the site via stormwater management treatment swales, stormwater management diversion dikes, and sheet flow. All three ponds are considered dry ponds and are used for water quantity.

Two stormwater management ponds will be constructed in the northeast portion of the site, and one additional stormwater management pond will be constructed in the southern portion of the site. Along the main and northern portion of the Compressor Station, SWM Treatment Swales direct stormwater from the highest topographic position in the south in a northwestern movement towards the downgradient stormwater management basins in the east. A diversion dike along the southeast and northeastern portion of the main portion site (north of the Transco Pipeline easement) similarly moves runoff into the stormwater management basins.

Within the portion of the site located south of the Transco Pipeline easement, runoff flows via a southern stormwater diversion dike and eastern treatment swale to a dry pond located in a topographic low. From the dry pond, which is located in the most southern portion of the site, runoff may sheet flow towards wetlands located south of the Compressor Station.

5.3.2 SWM Treatment Swales

Stormwater management treatment swales will direct runoff along the northwest, northern, and northeast portions of the site into two stormwater management dry ponds. A treatment swale located along the southern portion of the site will direct runoff to a stormwater management dry pond located in the southern portion of the Compressor Station.

5.4 LONG-TERM MAINTENANCE

In accordance with DTI's Standards and Specifications, long-term maintenance of structural SWM facilities must be conducted in accordance with 9VAC25-870-112. To be consistent with the provisions of 9VAC25-870-112, maintenance plans for the stormwater facilities must be submitted to DTI for formal review and approval prior to initiating the land disturbing activity, made available to VDEQ upon request, and must provide for inspections and maintenance and the submission of inspection and maintenance reports to the VDEQ. DTI transmission easements over land under which permanent SWM facilities will be placed must further assure the following:

- Be stated to run with the land;

- Provide for all necessary access to the property for purposes of maintenance and regulatory inspections; and

- And, be enforceable by all appropriate governmental parties.

According to VDEQ Stormwater Design Specification No. 10 (**Dry Swales**), dry swales must be covered by a drainage easement to allow inspection and maintenance. Conserved open space areas must be protected by a perpetual easement or deed restriction that assigns the responsible party to ensure that no future development, disturbance or clearing may occur within the area.

5.5 MAINTENANCE INSPECTIONS

Annual inspections are used to trigger maintenance operations such as sediment removal and spot revegetation. Ideally, inspections should be conducted in the spring of each year.

Inspectors should check for:

- 95% turf cover or vegetation density has been achieved in the bed and banks of the dry swale.

- Sediment buildup at curb cuts, gravel diaphragms or pavement edges that prevents flow from getting into the dry swale, and check for other signs of bypassing.

- Any winter- or salt-killed vegetation.

- Clogging or accumulated sand, sediment, and trash in inflow points, and removal if necessary.

- Evidence of any rill or gully erosion in the dry swale side slopes and grass filter strips, and associated repair.

- Evidence of excessive ponding or concentrated flows, and take appropriate remedial action.

- Bare soil or sediment sources in the contributing drainage area if sediment accumulation is noted, and immediately stabilize.

- Clogged or slow-draining soil media, a crust formed on the top layer, inappropriate soil media, or other causes of insufficient filtering time, and restore proper filtration characteristics.

- Evidence of undercutting or erosion at upstream and downstream check dams, and removal of trash or blockages at weepholes.

Corrective measures must be carried out as soon as practicably feasible when needed.

5.6 ONGOING MAINTENANCE

Once established, dry swales have minimal maintenance needs outside of the spring clean-up, regular mowing, and pruning and management of trees and shrubs. Adjustments may need to be made to the dry swale if water remains on the surface for more than 48 hours after a storm, including changes to the grading, rehabilitation of the surface infiltration, or underdrain repairs.

6.0 POLLUTION PREVENTION PRACTICES AND PROCEDURES

The same pollution prevention practices and procedures provided in Section 6.0 of the main body of the SWPPP will be used at the Compressor Station, as applicable.

7.0 ROLES AND RESPONSIBILITIES

DTI will use the same qualified personnel and Responsible Land Disturber at the Compressor Station as identified in Section 7.0 in the main body of the SWPPP.

8.0 INSPECTION AND MAINTENANCE

The same inspection and maintenance requirements provided in Section 8.0 in the main body of the SWPPP are applicable to the Compressor Station, with the exception of representative inspections which only apply to the pipeline ROW.

9.0 EMPLOYEE TRAINING

The employee training program described in Section 9.0 in the main body of the SWPPP applies to the Compressor Station.

10.0 NOTIFICATION, RECORDKEEPING, AND REPORTING

Refer to Section 10.0 of the main body of the SWPPP for notification, recordkeeping, and reporting requirements.

In addition, according to DTI's Standards and Specifications for projects requiring post-construction SWM BMPs, DTI must report the following annually each year to VDEQ:

- Number and types of SWM BMPs installed;
- Geographic coordinates of each BMP;
- Drainage area or watershed size served; and
- Receiving stream or hydrologic unit.

11.0 REFERENCES

Dominion Transmission, Inc., 2017. 2017 Standards and Specification, Erosion and Sediment Control and Stormwater Management for Construction and Maintenance of Pipeline Projects in Virginia. March 2017.

Federal Energy Regulatory Commission. 2013a. Upland Erosion Control, Revegetation, and Maintenance Plan. Available online at http://www.ferc.gov/industries/gas/enviro/plan.pdf

Federal Energy Regulatory Commission. 2013b. Wetland and Waterbody Construction and Mitigation Procedures. Available online at http://www.ferc.gov/industries/gas/enviro/procedures.pdf

LandScope America. 2014. *Mid-Atlantic Coastal Plain.* Available online at: http://www.landcope.org/explore/natural_geographies/ecoregions/Mid-Atlantic%20Coastal%20Plain/. Accessed March 2017.

Soil Survey Staff. Web Soil Survey. Natural Resources Conservation Service, U.S. Department of Agriculture. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed March 2017.

Soil Survey Staff. 2015b. Official Soil Series Descriptions. Natural Resources Conservation Service, U.S. Department of Agriculture. Available online at https://soilseries.sc.egov.usda.gov/. Accessed March 2017.

U.S. Geological Survey. 1994. Hydrological Units Maps: United States Geological Survey Water-Supply Paper 2294. Available online at: http://pubs.usgs.gov/wsp/wsp2294/pdf/wsp_2294.pdf. Accessed March 2017.

Virginia Department of Environmental Quality. 1992. Virginia Erosion and Sediment Control Handbook. Available online at http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications/ESCHandbook.aspx. Accessed March 2017.

Virginia Department of Environmental Quality. 2011 *Virginia A DEQ Stormwater Design Specification No. 10* Version 1.9, Available online at Virginia Stormwater BMP Clearinghouse http://www.vwrrc.vt.edu/swc/ Accessed March 2017.

Virginia Department of Environmental Quality. Final 2014 305(b)/303(d) Water Quality Assessment Integrated Report; GIS Data. Available online at: http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments/2014305(b)303(d)IntegratedReport.aspx Accessed March 2017.

ATTACHMENT 1

Erosion and Sediment Control and Stormwater Management Drawings and Supporting Calculations

[ESC Plans Provided Seperately]

Project Description

File Name	38333 Buckingham Compressor-POA1.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	NO
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	Jun 03, 2016	00:06:00
End Analysis On	Jun 04, 2016	00:06:00
Start Reporting On	Jun 03, 2016	00:06:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:06:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	4
Nodes	6
Junctions	2
Outfalls	3
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	4
Channels	1
Pipes	1
Pumps	0
Orifices	1
Weirs	1
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1	Rain Gage-01	Time Series	TS-10	Cumulative	inches	Virginia	Buckingham	10	5.09	SCS Type II 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-bypass	21.68	60.00	5.09	1.35	29.35	29.57	0 00:20:00
2	Sub-ExPOA1	40.60	64.00	5.09	1.64	66.54	47.81	0 00:37:04
3	Sub-POA1	41.48	70.00	5.09	2.10	87.23	84.01	0 00:25:00
4	Sub-POND	19.80	74.43	5.09	2.47	48.97	33.37	0 00:44:07

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-01	Junction	565.00	572.00	565.00	572.00	0.00	30.47	573.00	0.00	0.00	0 12:34	16.65	112.00
2	Jun-02	Junction	564.80	564.80	564.80	564.80	0.00	4.33	566.30	0.00	0.50	0 00:00	0.00	0.00
3	Out-ExPOA1	Outfall	562.00					47.47	562.00					
4	Out-POA1	Outfall	562.00					81.11	562.00					
5	Out-POA1_managed	Outfall	0.00					30.16	558.54					
6	Stor-01	Storage Node	566.00	574.00	570.00		0.00	33.15	572.57				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Link-01	Pipe	Jun-01	Jun-02	100.00	565.00	564.80	0.2000	18.000	0.0150	4.33	4.07	1.06	2.68	1.50	1.00	107.00	SURCHARGED
2	Link-02	Channel	Jun-02	Out-POA1_managed	843.00	564.80	558.00	0.8100	24.000	0.0320	4.19	70.77	0.06	2.15	0.54	0.27	0.00	
3	Orifice-01	Orifice	Stor-01	Jun-01		566.00	565.00		6.000		1.48							
4	Weir-01	Weir	Stor-01	Jun-01		566.00	565.00				29.00							

Subbasin Hydrology

Subbasin : Sub-bypass

Input Data

Area (ac) 21.68
Weighted Curve Number 60.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	24.50	-	60.00
Composite Area & Weighted CN	24.50		60.00

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft²)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

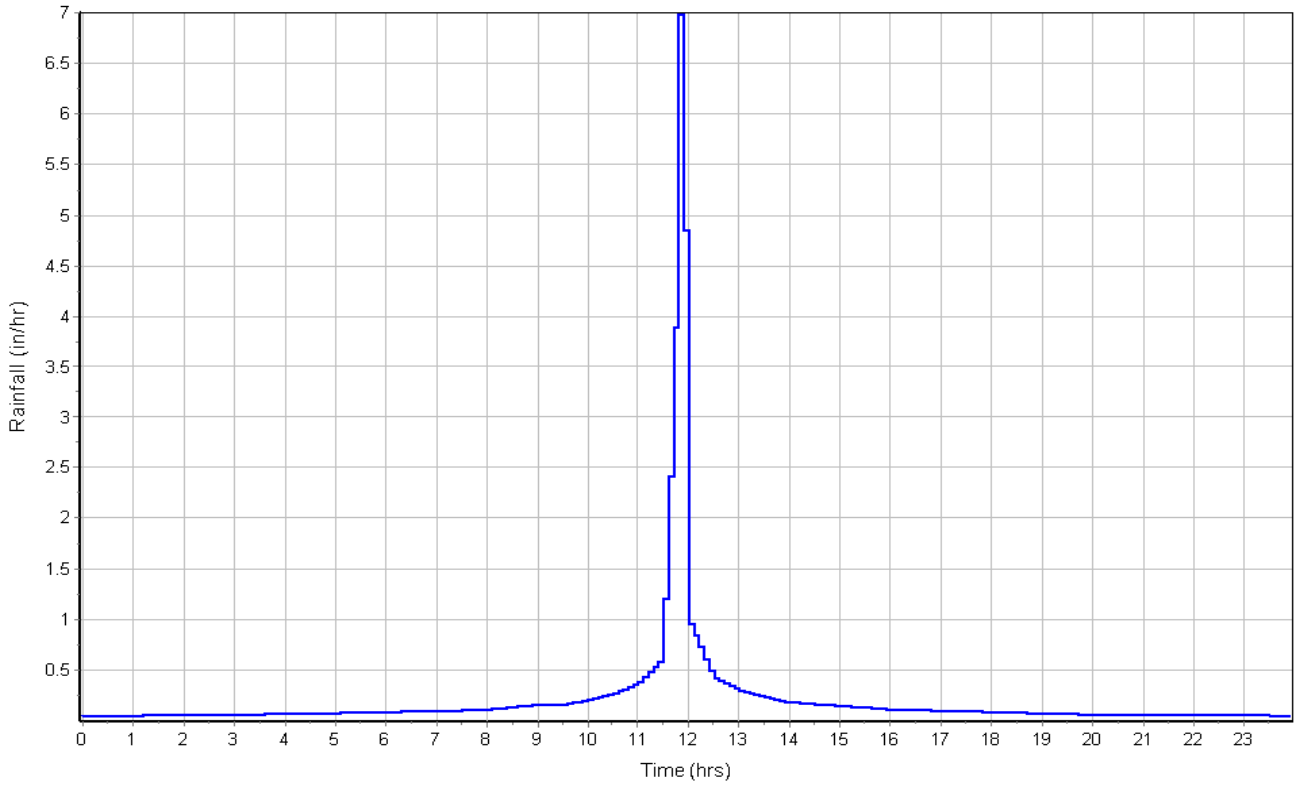
User-Defined TOC override (minutes): 20

Subbasin Runoff Results

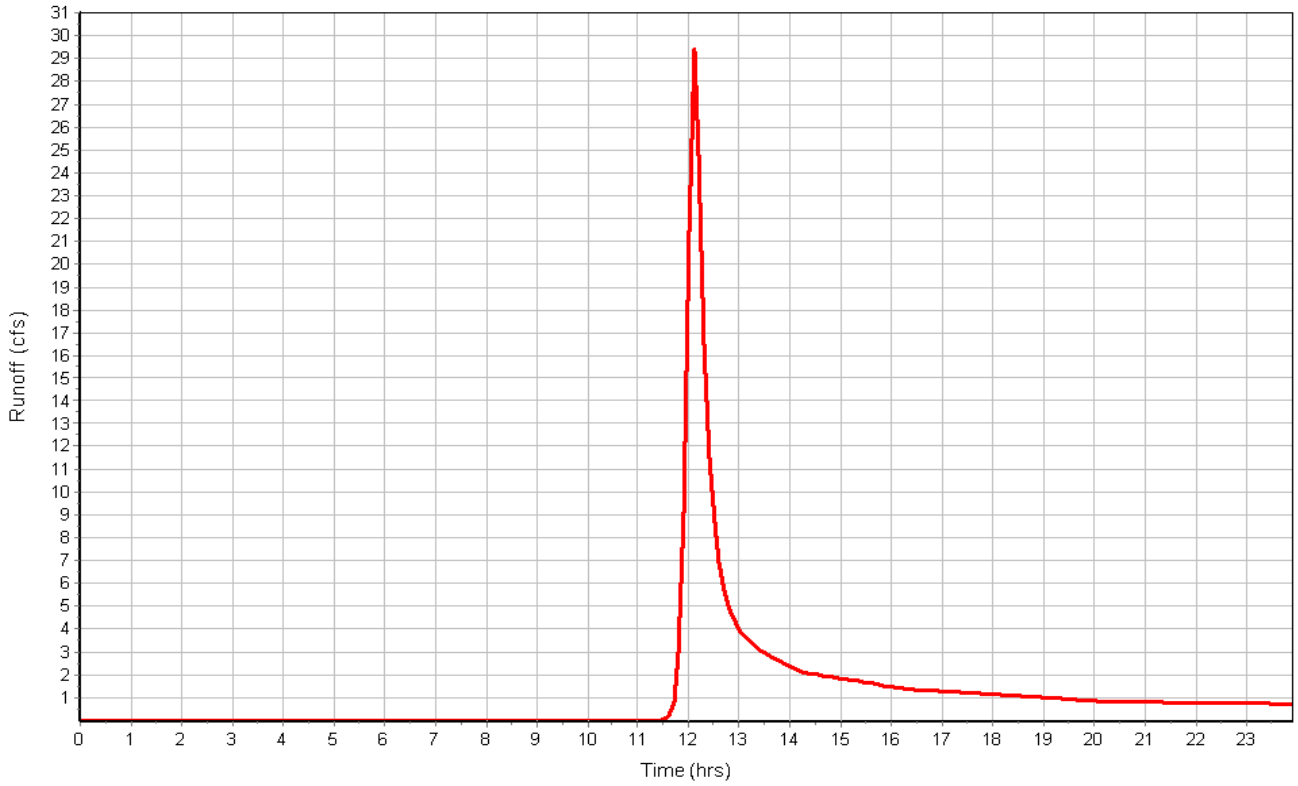
Total Rainfall (in) 5.09
Total Runoff (in) 1.35
Peak Runoff (cfs) 29.57
Weighted Curve Number 60.00
Time of Concentration (days hh:mm:ss) 0 00:20:00

Subbasin : Sub-bypass

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-ExPOA1

Input Data

Area (ac) 40.60
Weighted Curve Number 64.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	20.00	-	64.00
Composite Area & Weighted CN	20.00		64.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.8	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	3	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.37	0.00	0.00
Velocity (ft/sec) :	0.05	0.00	0.00
Computed Flow Time (min) :	30.98	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	885	0.00	0.00
Slope (%) :	2.25	0.00	0.00
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.42	0.00	0.00
Computed Flow Time (min) :	6.10	0.00	0.00

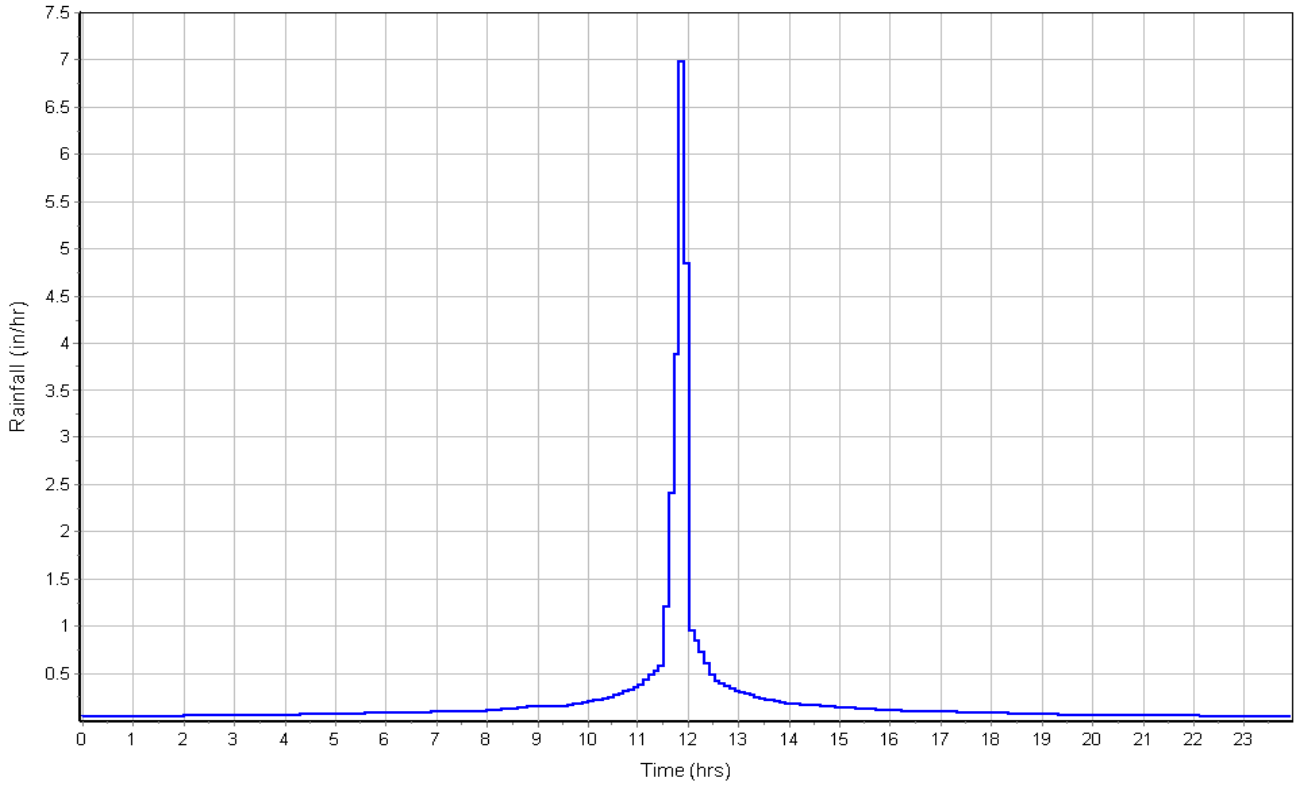
Total TOC (min) 37.07

Subbasin Runoff Results

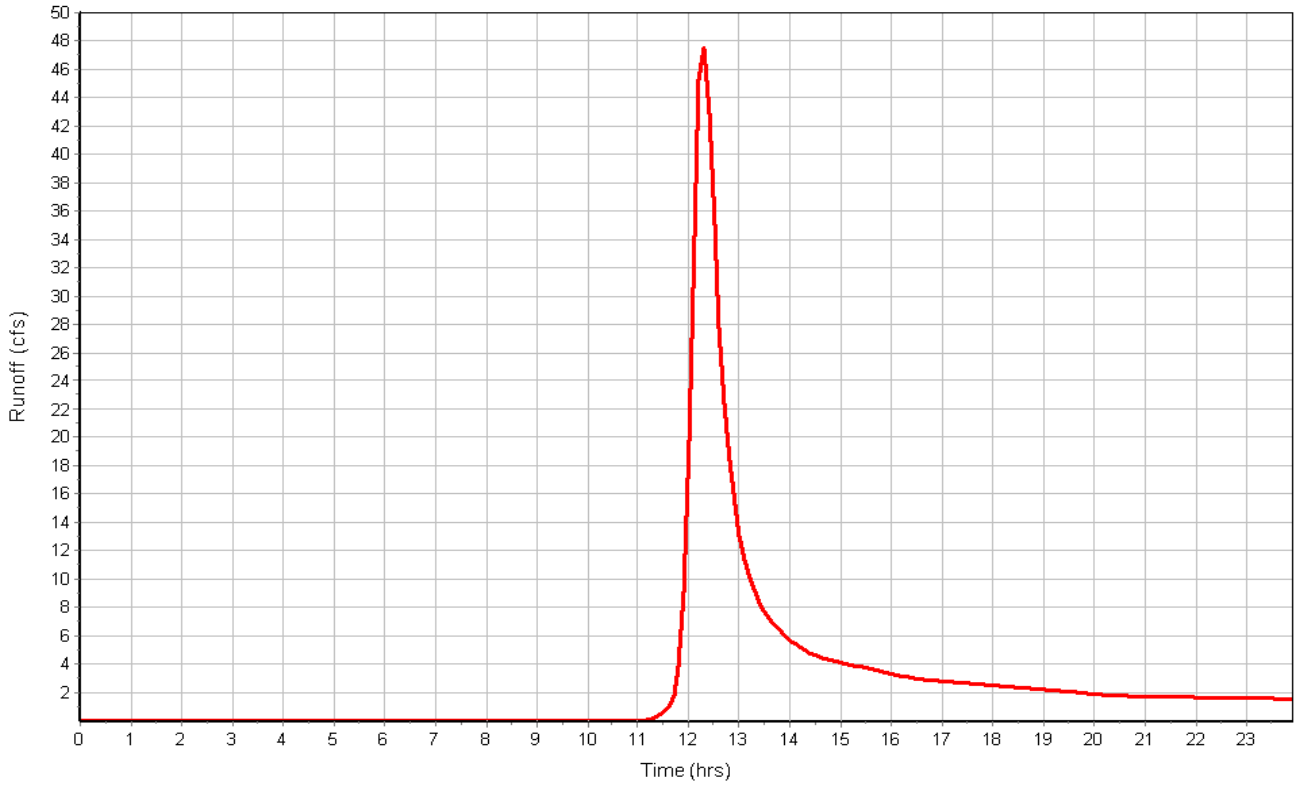
Total Rainfall (in) 5.09
Total Runoff (in) 1.64
Peak Runoff (cfs) 47.81
Weighted Curve Number 64.00
Time of Concentration (days hh:mm:ss) 0 00:37:04

Subbasin : Sub-ExPOA1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-POA1

Input Data

Area (ac) 41.48
Weighted Curve Number 70.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	22.00	-	70.00
Composite Area & Weighted CN	22.00		70.00

Time of Concentration

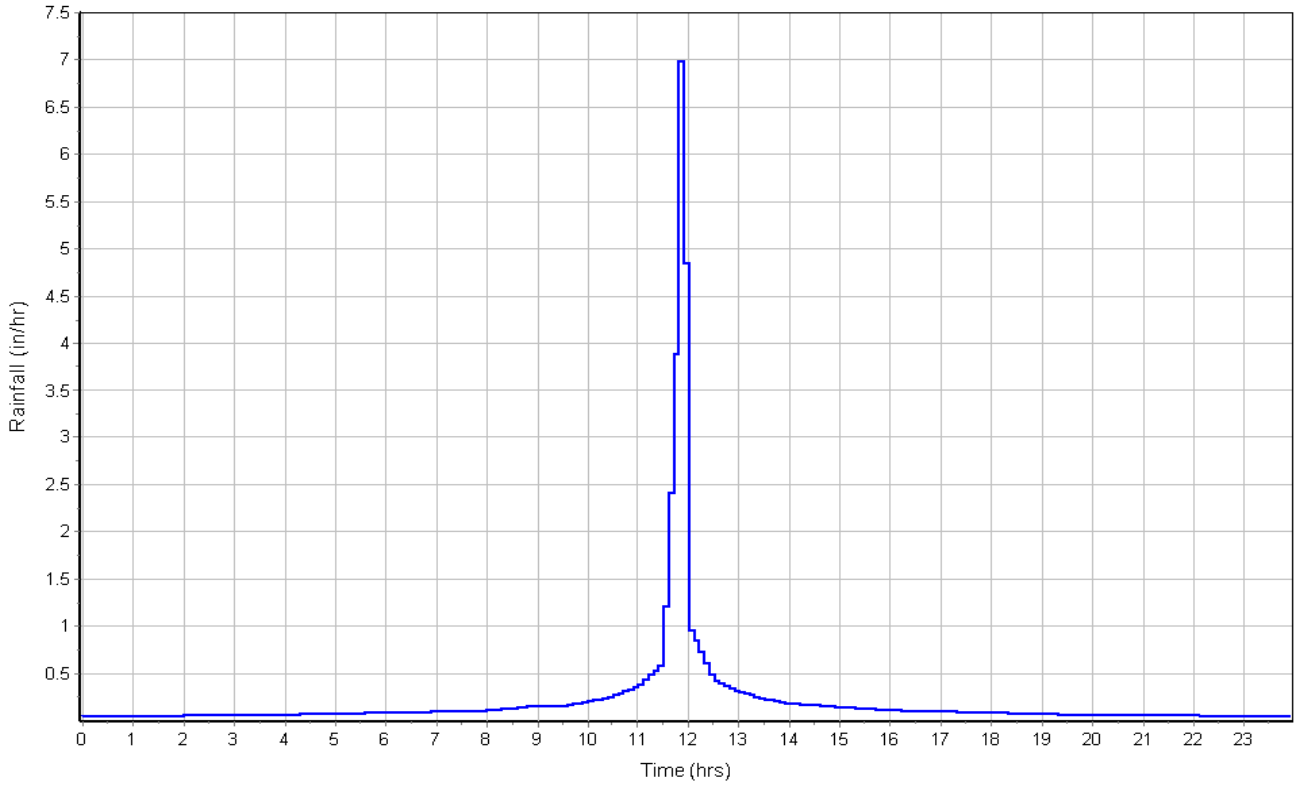
User-Defined TOC override (minutes): 25.00

Subbasin Runoff Results

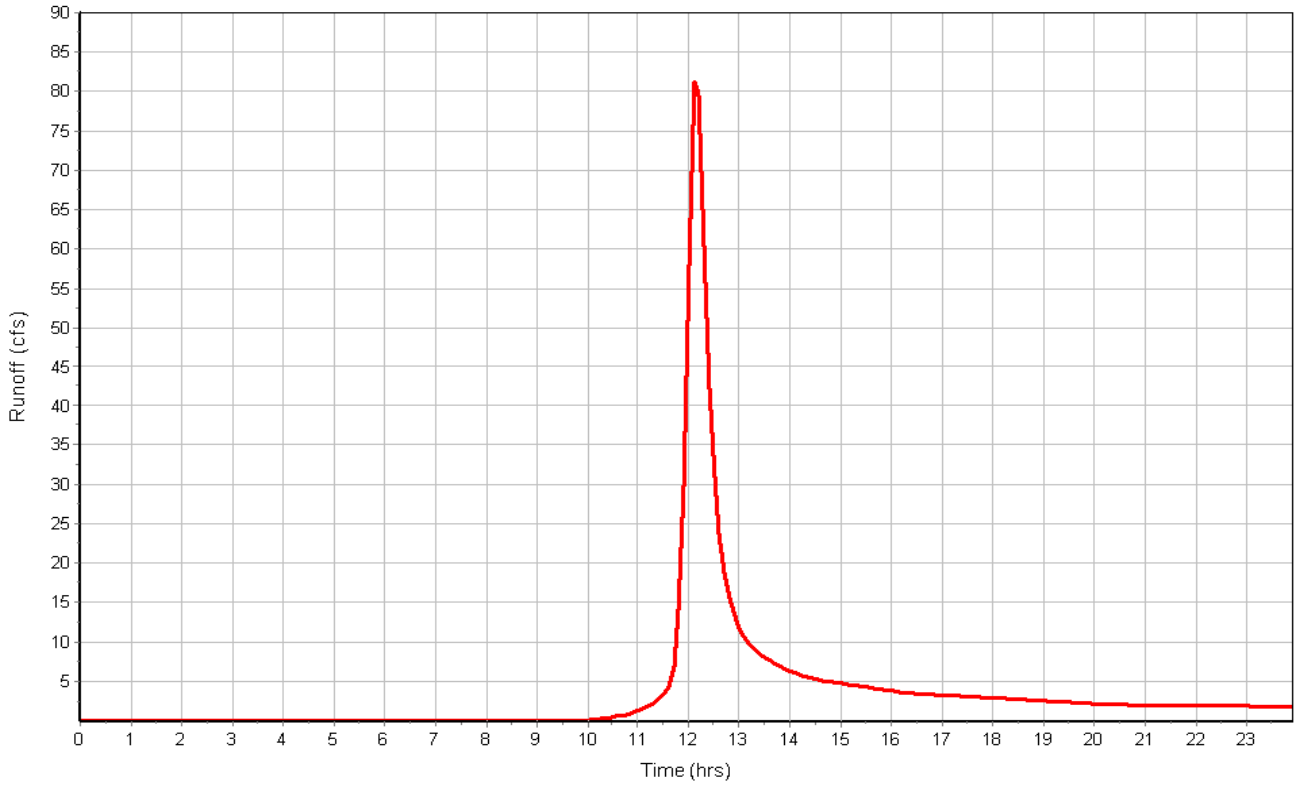
Total Rainfall (in) 5.09
Total Runoff (in) 2.10
Peak Runoff (cfs) 84.01
Weighted Curve Number 70.00
Time of Concentration (days hh:mm:ss) 0 00:25:00

Subbasin : Sub-POA1

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-POND

Input Data

Area (ac) 19.80
Weighted Curve Number 74.43
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	10.30	B	61.00
Gravel roads	9.50	C	89.00
Composite Area & Weighted CN	19.80		74.43

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.8	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	1.58	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.50	0.00	0.00
Velocity (ft/sec) :	0.04	0.00	0.00
Computed Flow Time (min) :	39.28	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	650	0.00	0.00
Slope (%) :	2.07	0.00	0.00
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.32	0.00	0.00
Computed Flow Time (min) :	4.67	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.018	0.00	0.00
Flow Length (ft) :	129	0.00	0.00
Channel Slope (%) :	2	0.00	0.00
Cross Section Area (ft²) :	20	0.00	0.00
Wetted Perimeter (ft) :	16.65	0.00	0.00
Velocity (ft/sec) :	13.23	0.00	0.00
Computed Flow Time (min) :	0.16	0.00	0.00

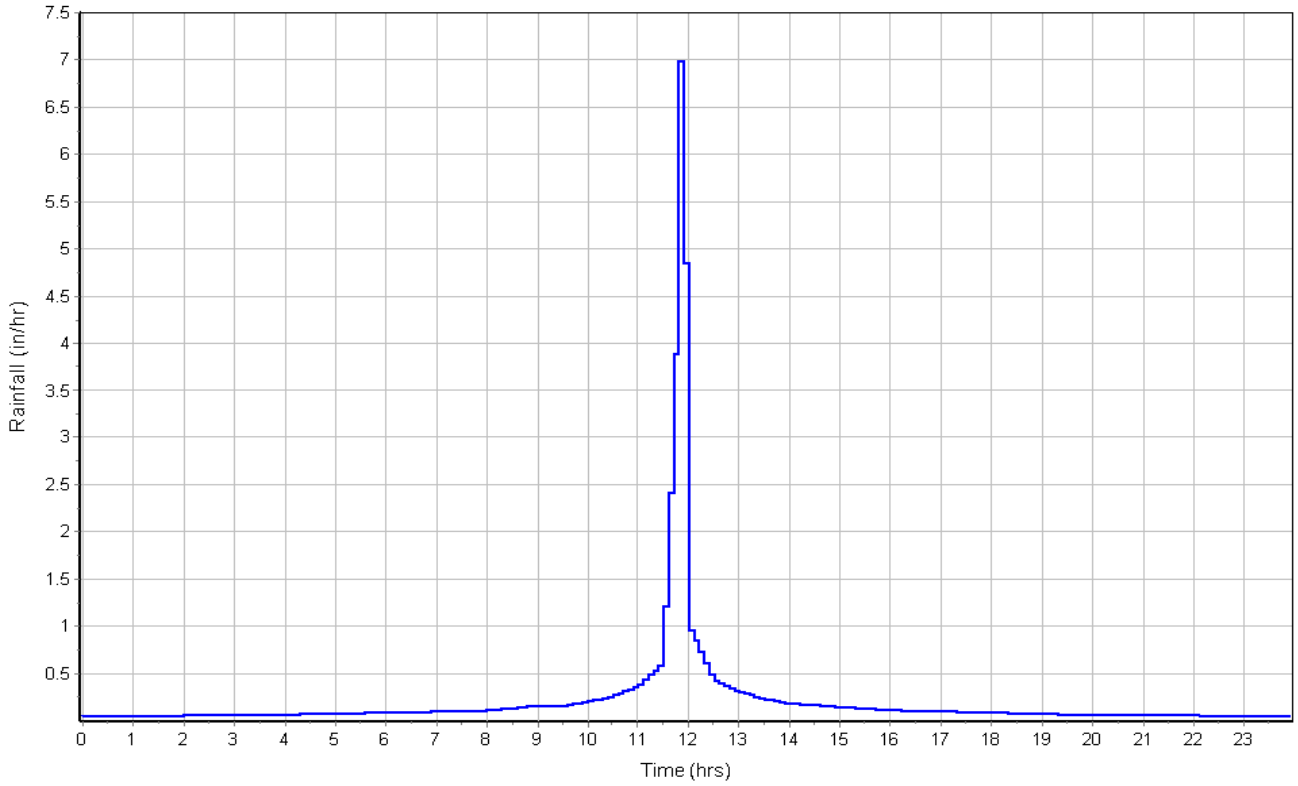
Total TOC (min) 44.12

Subbasin Runoff Results

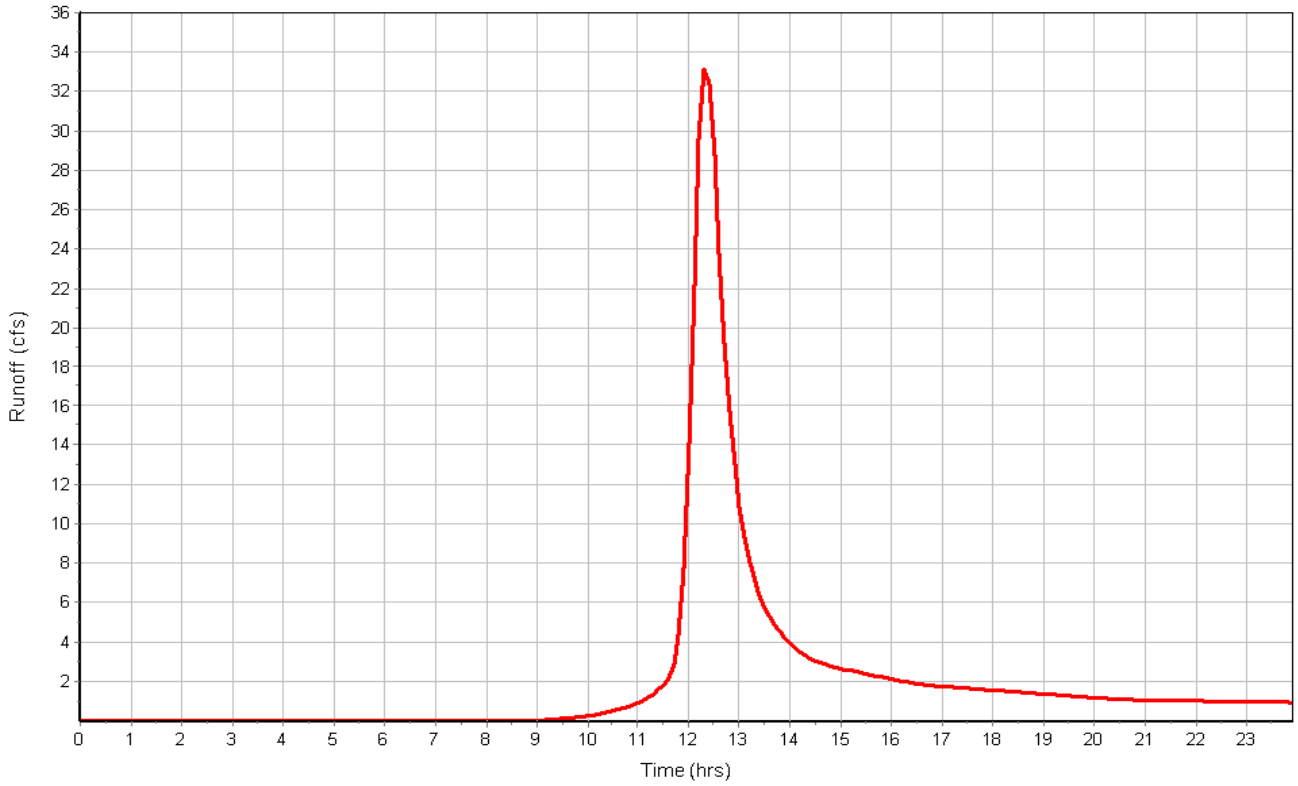
Total Rainfall (in) 5.09
Total Runoff (in) 2.47
Peak Runoff (cfs) 33.37
Weighted Curve Number 74.43
Time of Concentration (days hh:mm:ss) 0 00:44:07

Subbasin : Sub-POND

Rainfall Intensity Graph



Runoff Hydrograph



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (in)
1	Jun-01	565.00	572.00	7.00	565.00	0.00	572.00	0.00	0.00	0.00
2	Jun-02	564.80	564.80	0.00	564.80	0.00	564.80	0.00	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-01	30.47	0.00	573.00	8.00	0.00	0.00	565.92	0.92	0 12:20	0 12:34	16.65	112.00
2	Jun-02	4.33	0.00	566.30	1.50	0.00	0.50	565.21	0.41	0 12:20	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	Link-02	843.00	564.80	0.00	558.00	558.00	6.80	0.8100	Trapezoidal	2.000	14.000	0.0320	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Link-02	4.19	0 14:12	70.77	0.06	2.15	6.53	0.54	0.27	0.00		

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate	No. of Barrels
1	Link-01	100.00	565.00	0.00	564.80	0.00	0.20	0.2000	CIRCULAR	18.000	18.000	0.0150	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Link-01	4.33	0 14:07	4.07	1.06	2.68	0.62	1.50	1.00	107.00		SURCHARGED

Storage Nodes

Storage Node : Stor-01

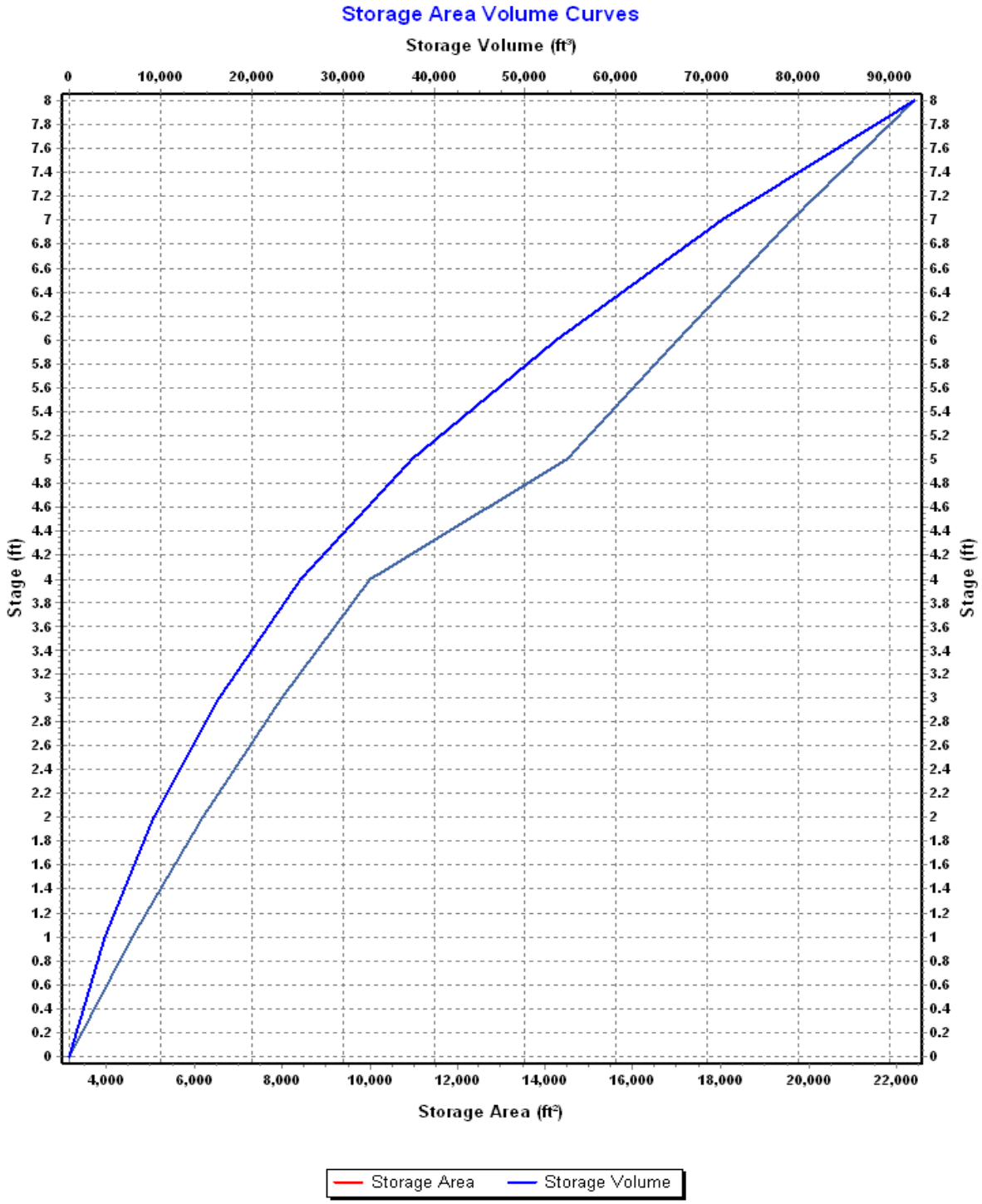
Input Data

Invert Elevation (ft)	566.00
Max (Rim) Elevation (ft)	574.00
Max (Rim) Offset (ft)	8.00
Initial Water Elevation (ft)	570.00
Initial Water Depth (ft)	4.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Storage-01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	3155	0.000
1	4581	3868.00
2	6200	9258.50
3	8000	16358.50
4	10000	25358.50
5	14500	37608.50
6	16994	53355.50
7	19600	71652.50
8	22400	92652.50


Storage Area Volume Curves
Storage Volume (ft³)
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
Stage (ft)
Stage (ft)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
4.4
4.6
4.8
5
5.2
5.4
5.6
5.8
6
6.2
6.4
6.6
6.8
7
7.2
7.4
7.6
7.8
8
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
20,000
22,000
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : Stor-01 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-01	Rectangular	No	572.00	6.00	20.00	2.00	3.33

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	Orifice-01	Side	CIRCULAR	No	6.00			570.00	0.61

Output Summary Results

Peak Inflow (cfs)	33.15
Peak Lateral Inflow (cfs)	33.15
Peak Outflow (cfs)	30.47
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	572.57
Max HGL Depth Attained (ft)	6.57
Average HGL Elevation Attained (ft)	571.03
Average HGL Depth Attained (ft)	5.03
Time of Max HGL Occurrence (days hh:mm)	0 12:33
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

Project Description

File Name ..... 38333 Buckingham Compressor-POA2.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-20
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	NO
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	Jun 03, 2016	00:06:00
End Analysis On	Jun 04, 2016	00:06:00
Start Reporting On	Jun 03, 2016	00:06:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:06:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	5
Junctions	2
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	4
Channels	1
Pipes	1
Pumps	0
Orifices	1
Weirs	1
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1	Rain Gage-01	Time Series	TS-10	Cumulative	inches	Virginia	Buckingham	10	5.09	SCS Type II 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-ExPOA2	13.52	70.00	5.09	2.10	28.43	16.47	0 00:54:03
2	Sub-POA2	13.52	74.00	5.09	2.44	32.93	28.87	0 00:29:55

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-02	Junction	568.00	574.00	568.00	574.00	0.00	12.51	568.86	0.00	6.14	0 00:00	0.00	0.00
2	Jun-03	Junction	566.80	566.80	566.80	566.80	0.00	12.51	567.66	0.00	1.14	0 00:00	0.00	0.00
3	Out-ExPOA2	Outfall	562.00					16.29	562.00					
4	Out-POA2	Outfall	562.00					12.49	562.80					
5	Stor-02	Storage Node	568.00	574.00	568.00		0.00	28.84	573.28				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Link-03	Pipe	Jun-02	Jun-03	25.00	567.00	566.80	0.8000	18.000	0.0150	12.51	19.95	0.63	11.91	0.85	0.57	0.00	Calculated
2	Link-04	Channel	Jun-03	Out-POA2	320.00	566.80	562.00	1.5000	24.000	0.0320	12.49	96.51	0.13	3.58	0.79	0.40	0.00	
3	Orifice-02	Orifice	Stor-02	Jun-02		568.00	568.00		9.000		4.82							
4	Weir-02	Weir	Stor-02	Jun-02		568.00	568.00				7.69							

Subbasin Hydrology

Subbasin : Sub-ExPOA2

Input Data

Area (ac) 13.52
Weighted Curve Number 70.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	13.52	-	70.00
Composite Area & Weighted CN	13.52		70.00

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft²)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.8	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	.92	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.37	0.00	0.00
Velocity (ft/sec) :	0.03	0.00	0.00
Computed Flow Time (min) :	49.70	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	830	0.00	0.00
Slope (%) :	3.88	0.00	0.00
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.18	0.00	0.00
Computed Flow Time (min) :	4.35	0.00	0.00

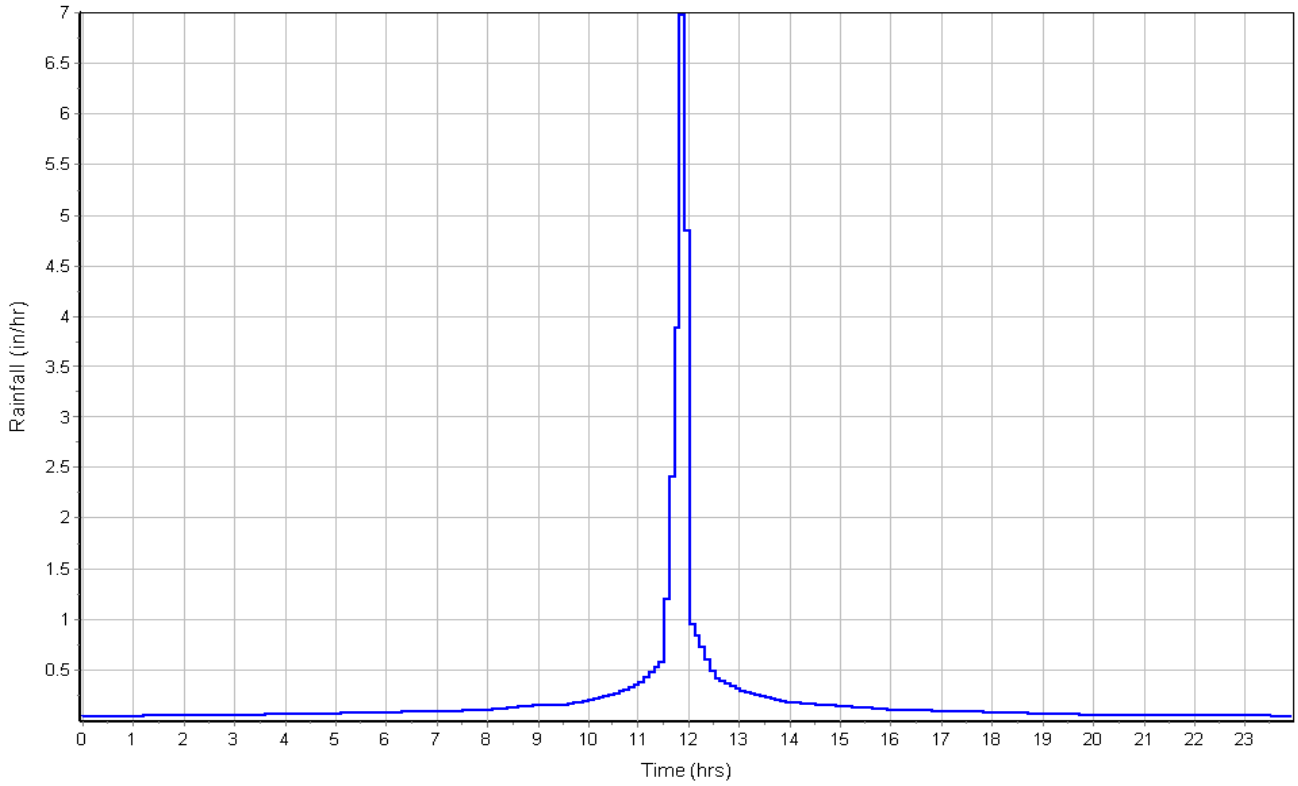
Total TOC (min) 54.05

Subbasin Runoff Results

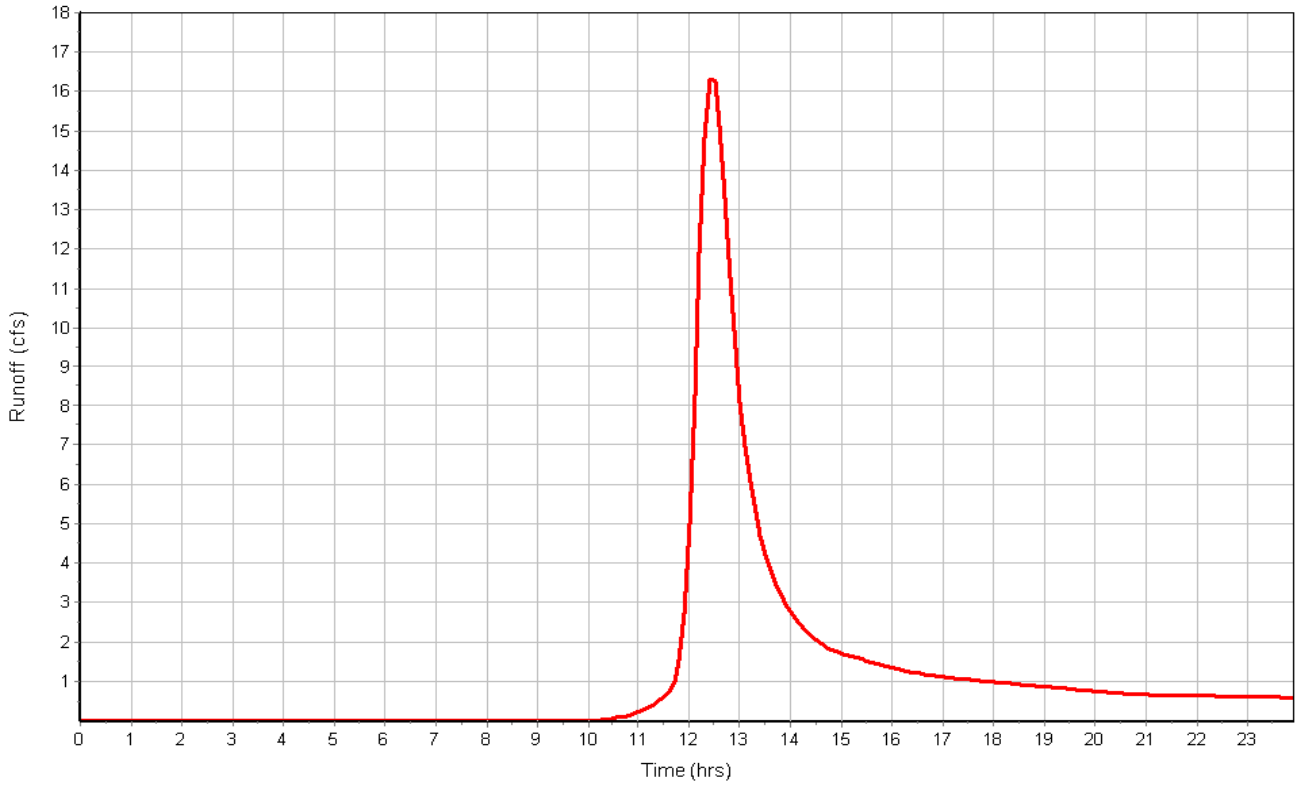
Total Rainfall (in)	5.09
Total Runoff (in)	2.10
Peak Runoff (cfs)	16.47
Weighted Curve Number	70.00
Time of Concentration (days hh:mm:ss)	0 00:54:03

Subbasin : Sub-ExPOA2

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-POA2

Input Data

Area (ac) 13.52
Weighted Curve Number 74.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	6.76	B	69.00
50 - 75% grass cover, Fair	6.76	C	79.00
Composite Area & Weighted CN	13.52		74.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.4	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	1	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.37	0.00	0.00
Velocity (ft/sec) :	0.06	0.00	0.00
Computed Flow Time (min) :	27.61	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	443	0.00	0.00
Slope (%) :	3.88	0.00	0.00
Surface Type :	Unpaved	Paved	Unpaved
Velocity (ft/sec) :	3.18	0.00	0.00
Computed Flow Time (min) :	2.32	0.00	0.00

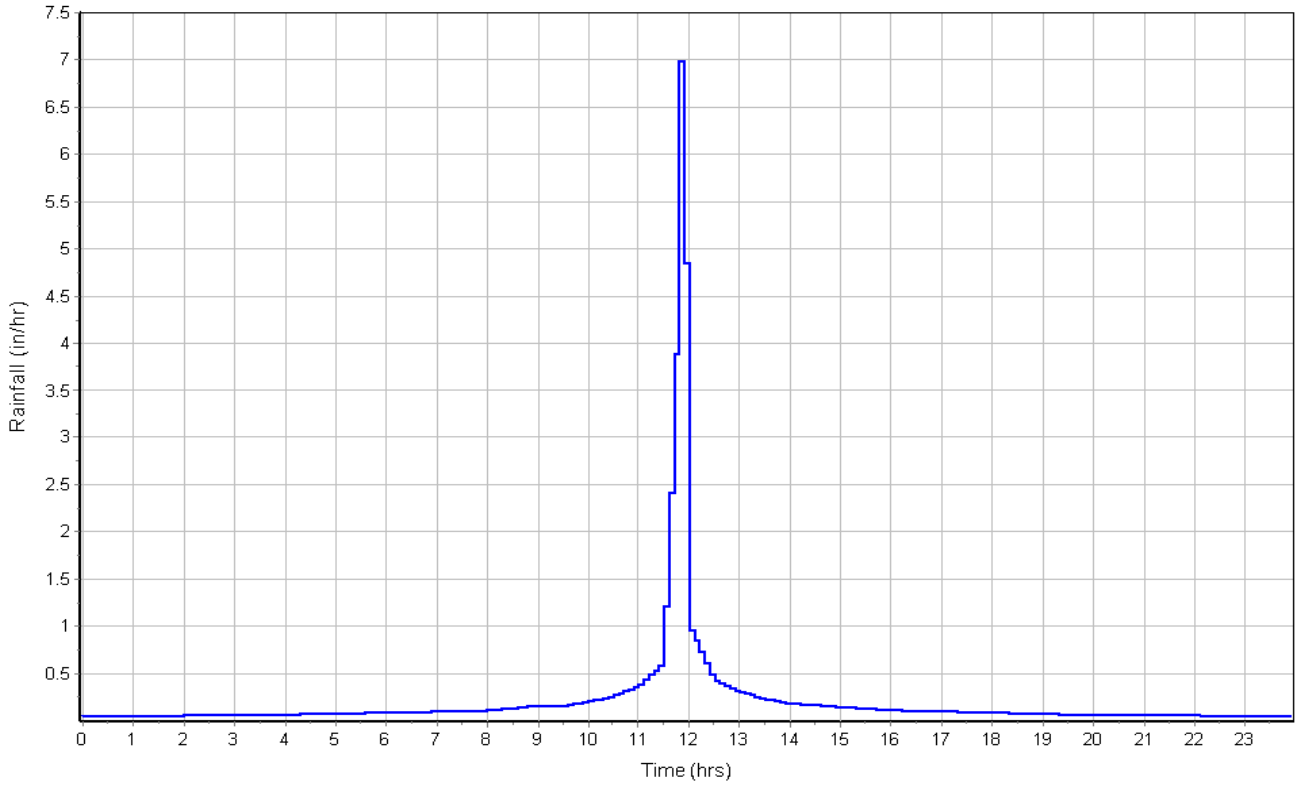
Total TOC (min) 29.93

Subbasin Runoff Results

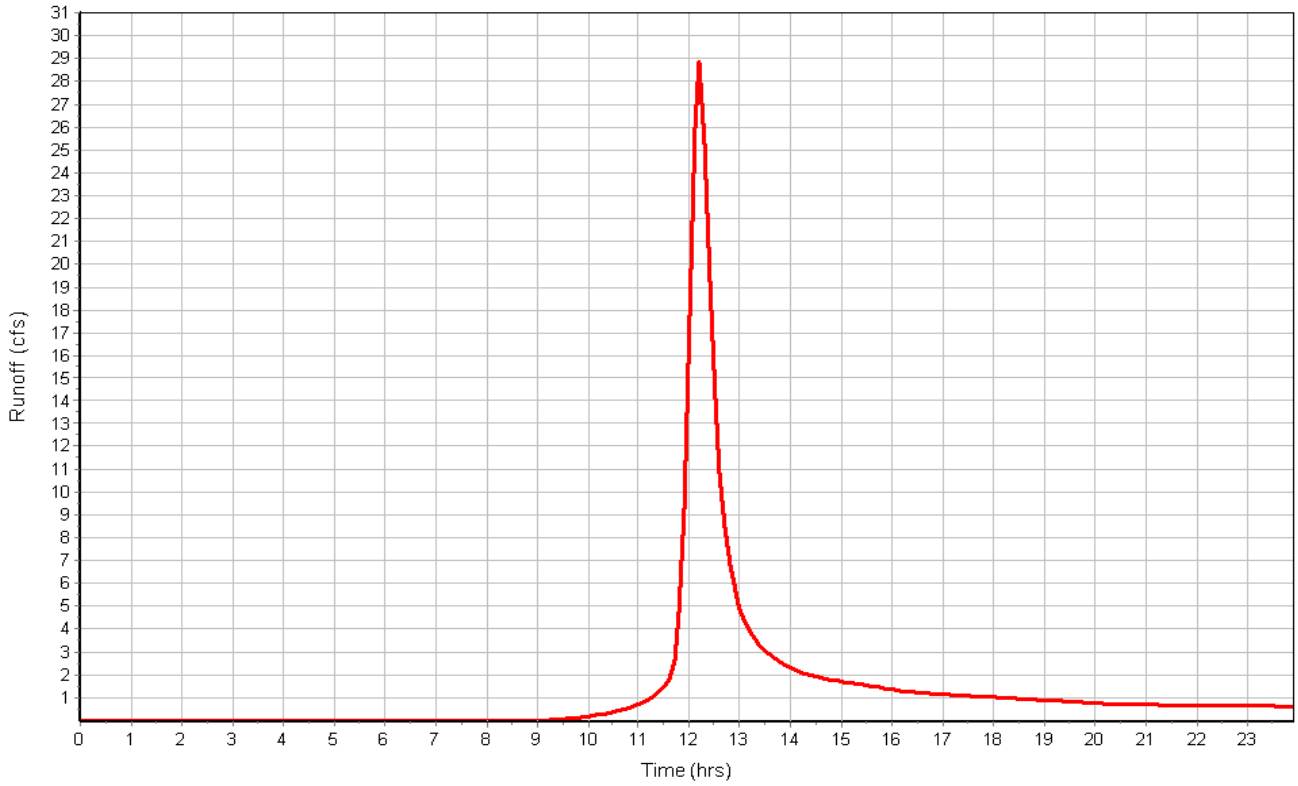
Total Rainfall (in) 5.09
Total Runoff (in) 2.44
Peak Runoff (cfs) 28.87
Weighted Curve Number 74.00
Time of Concentration (days hh:mm:ss) 0 00:29:56

Subbasin : Sub-POA2

Rainfall Intensity Graph



Runoff Hydrograph



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (in)
1	Jun-02	568.00	574.00	6.00	568.00	0.00	574.00	0.00	0.00	0.00
2	Jun-03	566.80	566.80	0.00	566.80	0.00	566.80	0.00	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-02	12.51	0.00	568.86	0.86	0.00	6.14	568.18	0.18	0 12:39	0 00:00	0.00	0.00
2	Jun-03	12.51	0.00	567.66	0.86	0.00	1.14	566.98	0.18	0 12:39	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	Link-04	320.00	566.80	0.00	562.00	0.00	4.80	1.5000	Trapezoidal	2.000	14.000	0.0320	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Link-04	12.49	0 12:40	96.51	0.13	3.58	1.49	0.79	0.40	0.00		

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate	No. of Barrels
1	Link-03	25.00	567.00	-1.00	566.80	0.00	0.20	0.8000	CIRCULAR	18.000	18.000	0.0150	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Link-03	12.51	0 12:39	19.95	0.63	11.91	0.03	0.85	0.57	0.00		Calculated

Storage Nodes

Storage Node : Stor-02

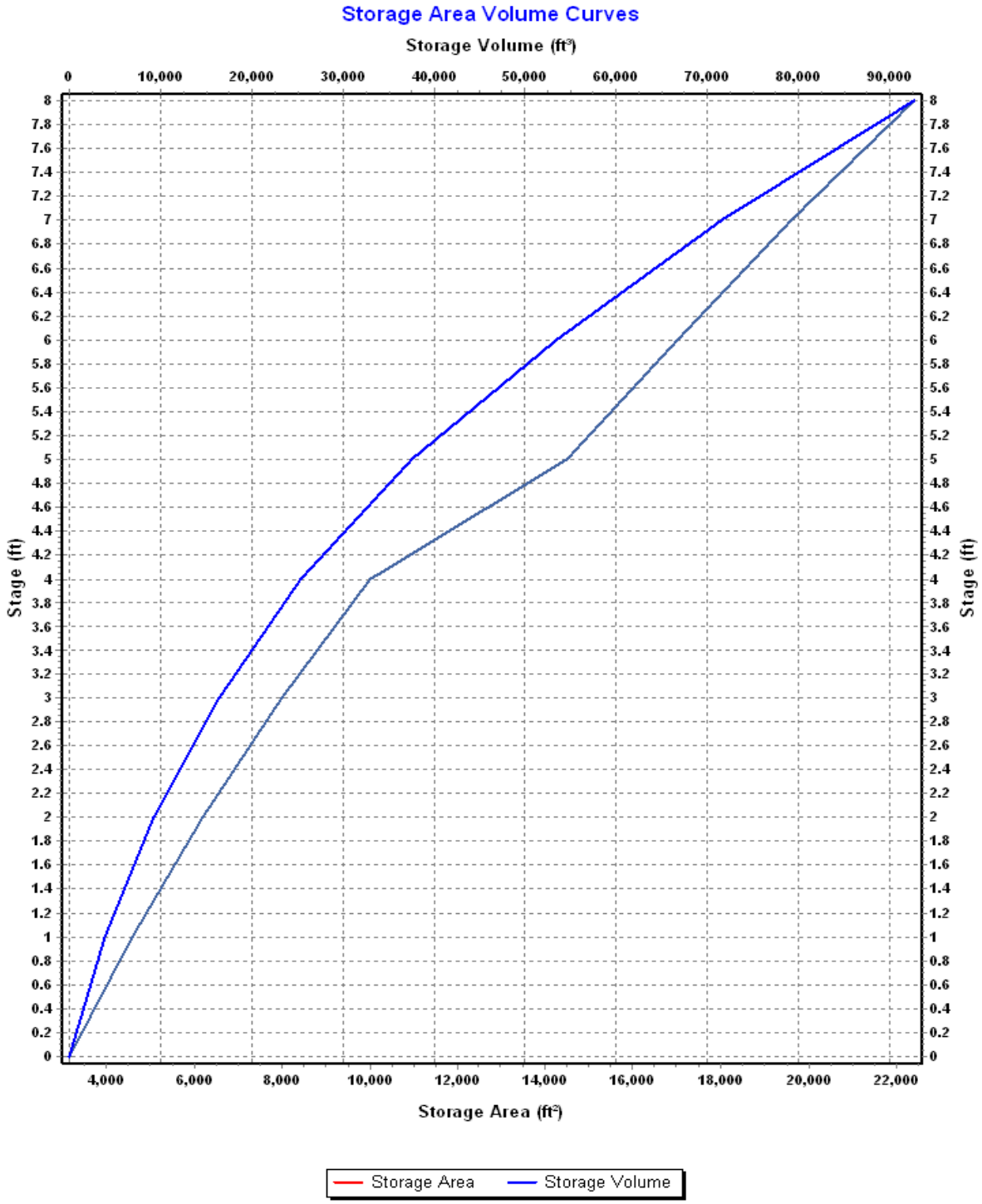
Input Data

Invert Elevation (ft) 568.00
Max (Rim) Elevation (ft) 574.00
Max (Rim) Offset (ft) 6.00
Initial Water Elevation (ft) 568.00
Initial Water Depth (ft) 0.00
Ponded Area (ft²) 0.00
Evaporation Loss 0.00

Storage Area Volume Curves

Storage Curve : Storage-01

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	3155	0.000
1	4581	3868.00
2	6200	9258.50
3	8000	16358.50
4	10000	25358.50
5	14500	37608.50
6	16994	53355.50
7	19600	71652.50
8	22400	92652.50


Storage Area Volume Curves
Storage Volume (ft³)
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
Stage (ft)
Stage (ft)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
4.4
4.6
4.8
5
5.2
5.4
5.6
5.8
6
6.2
6.4
6.6
6.8
7
7.2
7.4
7.6
7.8
8
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
20,000
22,000
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : Stor-02 (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-02	Rectangular	No	573.00	5.00	16.00	2.00	3.33

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	Orifice-02	Side	CIRCULAR	No	9.00			568.00	0.61

Output Summary Results

Peak Inflow (cfs)	28.84
Peak Lateral Inflow (cfs)	28.84
Peak Outflow (cfs)	12.51
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	573.28
Max HGL Depth Attained (ft)	5.28
Average HGL Elevation Attained (ft)	569.07
Average HGL Depth Attained (ft)	1.07
Time of Max HGL Occurrence (days hh:mm)	0 12:39
Total Exfiltration Volume (1000-ft³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

Project Description

File Name ..... 38333 Buckingham Compressor-POA3.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-20
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Kinematic Wave
Enable Overflow Ponding at Nodes ..... NO
Skip Steady State Analysis Time Periods ..... NO

Analysis Options

Start Analysis On ..... Jun 03, 2016 00:06:00
End Analysis On ..... Jun 04, 2016 00:06:00
Start Reporting On ..... Jun 03, 2016 00:06:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:06:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	2
Junctions	0
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	0
Links	0
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1	Rain Gage-01	Time Series	TS-10	Cumulative	inches	Virginia	Buckingham	10	5.09	SCS Type II 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-ExPOA3	3.82	70.00	5.09	2.10	8.03	6.03	0 00:37:09
2	Sub-POA3	2.89	70.00	5.09	2.10	6.08	4.65	0 00:36:10

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-ExPOA3	Outfall	562.00					0.00	0.00					
2	Out-POA3	Outfall	562.00					0.00	0.00					

Subbasin Hydrology

Subbasin : Sub-ExPOA3

Input Data

Area (ac) 3.82
Weighted Curve Number 70.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	13.52	-	70.00
Composite Area & Weighted CN	13.52		70.00

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft²)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.8	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	2	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.37	0.00	0.00
Velocity (ft/sec) :	0.05	0.00	0.00
Computed Flow Time (min) :	36.43	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	126	0.00	0.00
Slope (%) :	3.17	0.00	0.00
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.87	0.00	0.00
Computed Flow Time (min) :	0.73	0.00	0.00

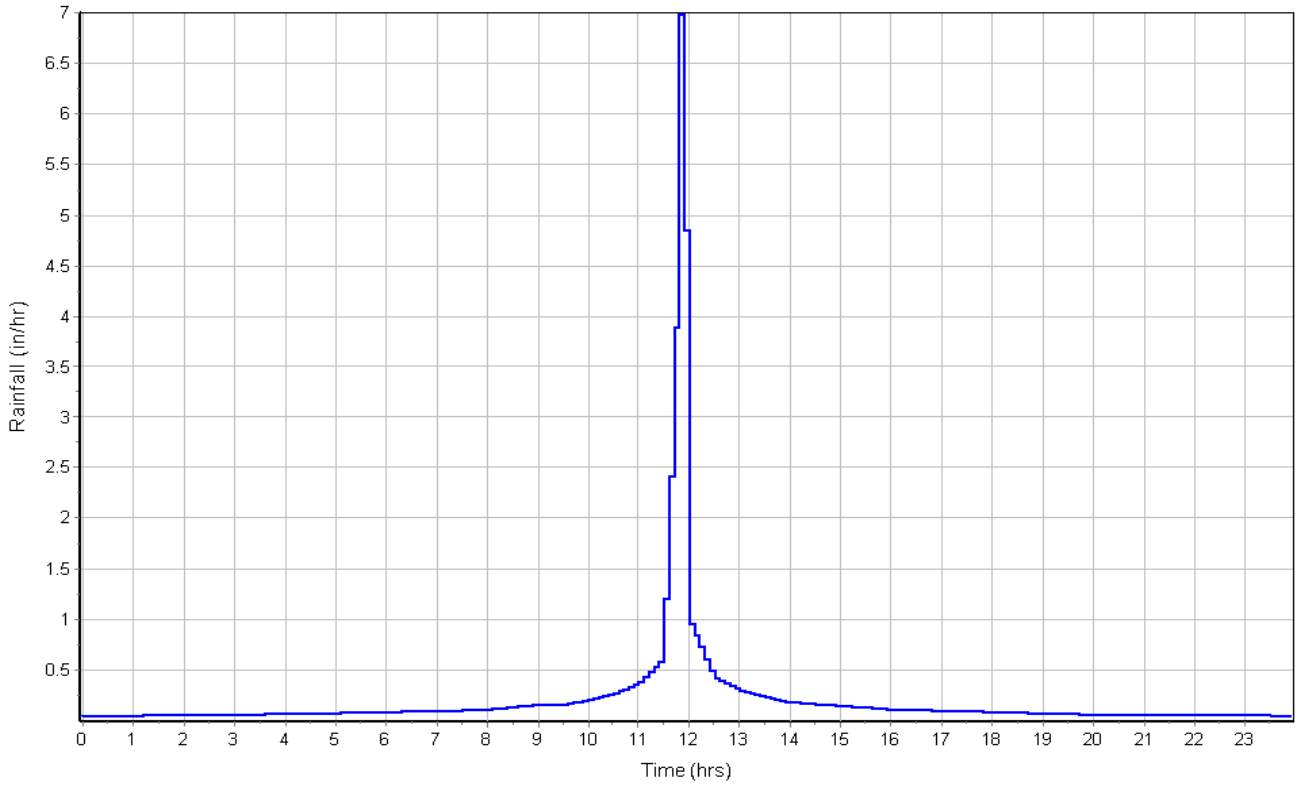
Total TOC (min) 37.16

Subbasin Runoff Results

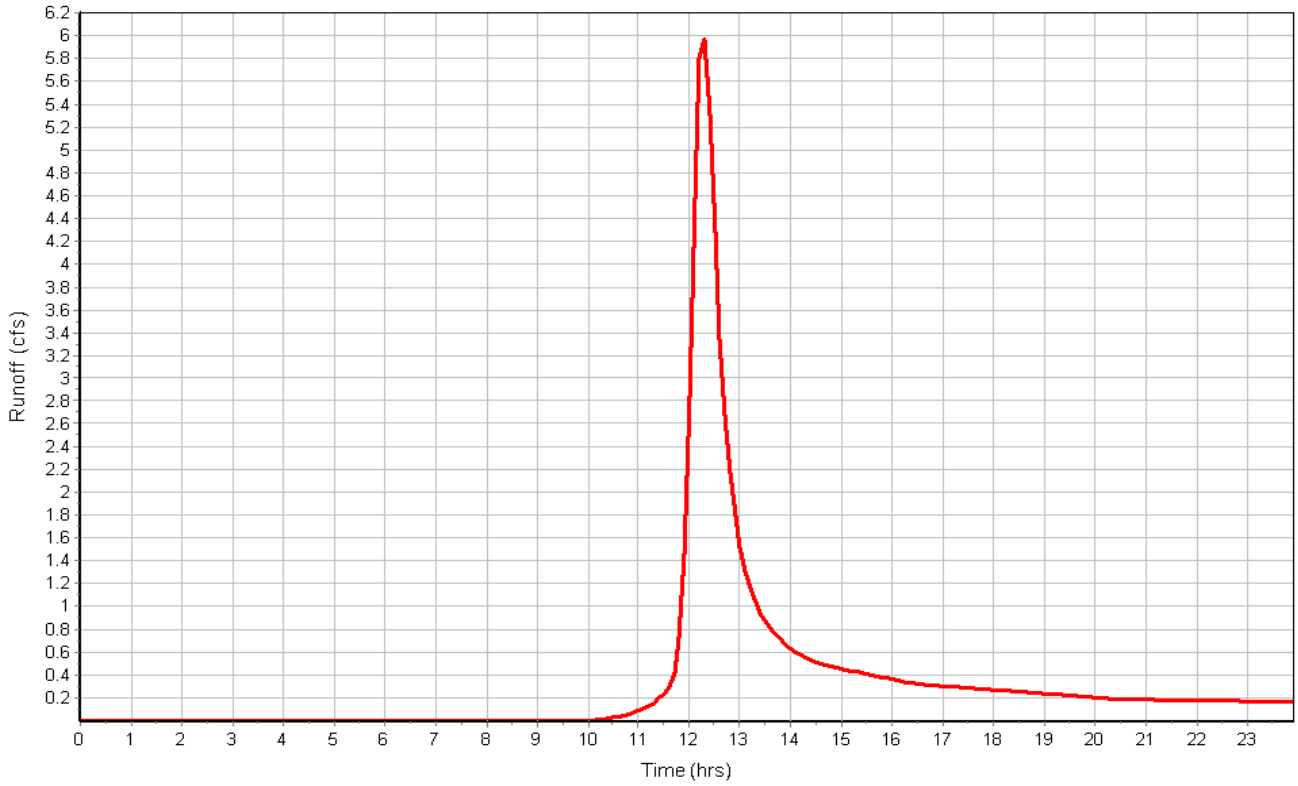
Total Rainfall (in)	5.09
Total Runoff (in)	2.10
Peak Runoff (cfs)	6.03
Weighted Curve Number	70.00
Time of Concentration (days hh:mm:ss)	0 00:37:10

Subbasin : Sub-ExPOA3

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : Sub-POA3

Input Data

Area (ac) 2.89
Weighted Curve Number 70.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods, Fair	2.89	B	70.00
Composite Area & Weighted CN	2.89		70.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.8	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	3	0.00	0.00
2 yr, 24 hr Rainfall (in) :	3.37	0.00	0.00
Velocity (ft/sec) :	0.05	0.00	0.00
Computed Flow Time (min) :	30.98	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	300	570	0.00
Slope (%) :	2.7	2	0.00
Surface Type :	Unpaved	Paved	Unpaved
Velocity (ft/sec) :	2.65	2.87	0.00
Computed Flow Time (min) :	1.89	3.31	0.00

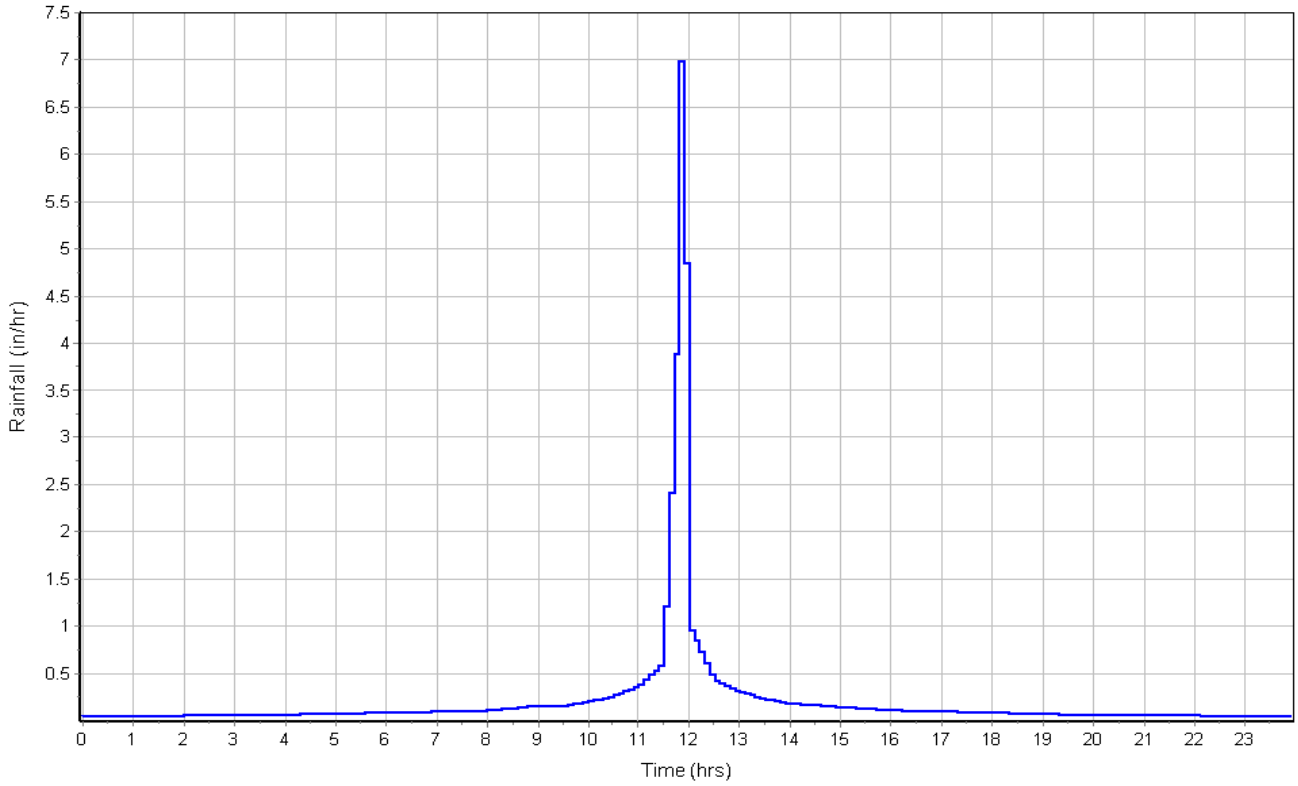
Total TOC (min) 36.18

Subbasin Runoff Results

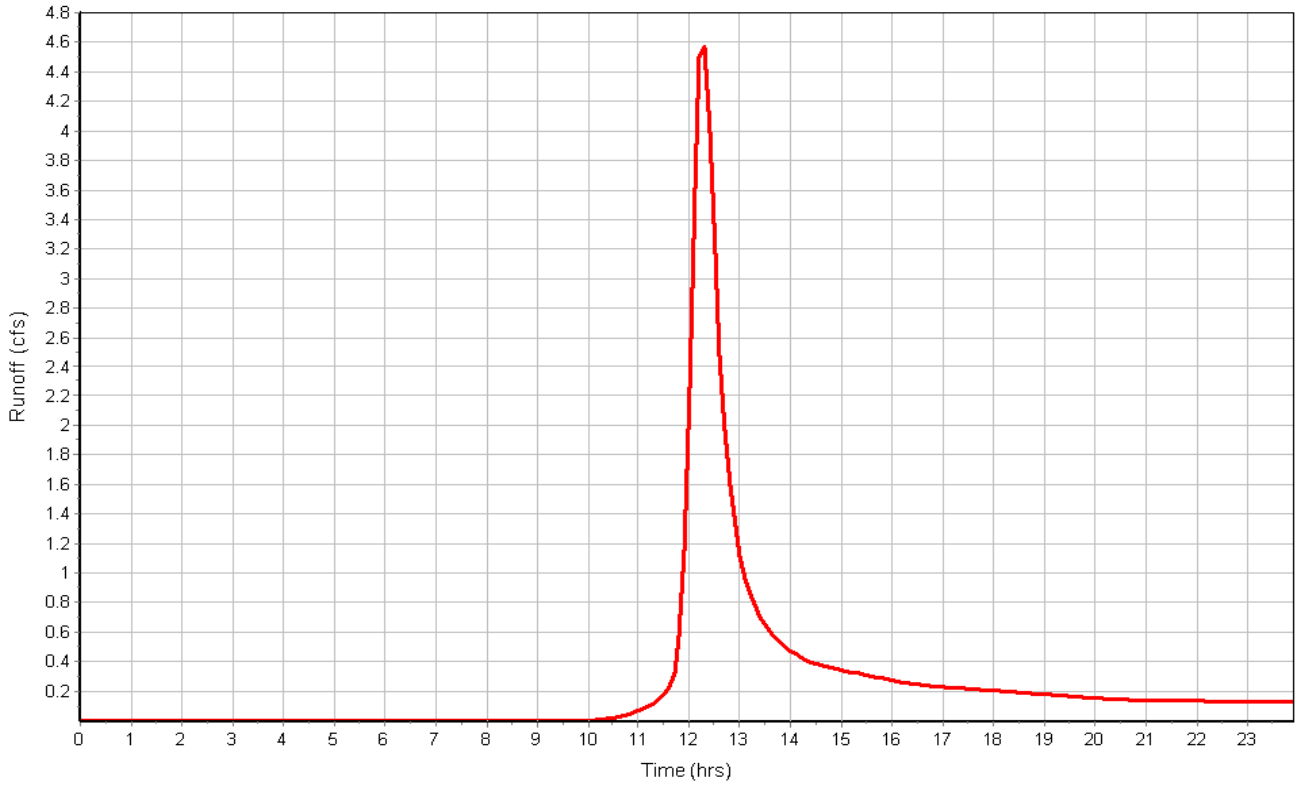
Total Rainfall (in) 5.09
Total Runoff (in) 2.10
Peak Runoff (cfs) 4.65
Weighted Curve Number 70.00
Time of Concentration (days hh:mm:ss) 0 00:36:11

Subbasin : Sub-POA3

Rainfall Intensity Graph



Runoff Hydrograph



APPENDIX F

ESC Plan and SWM Plan for Elizabeth River M&R Station

ATLANTIC COAST PIPELINE, LLC
ATLANTIC COAST PIPELINE

Stormwater Pollution Prevention Plan

APPENDIX F

Erosion and Sediment Control and Stormwater Management Plan

for

Elizabeth River M&R Station

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Attachment 2 Topographical Map

Attachment 3 Stormwater Design Specifications

Attachment 4 Letter of Availability for Nutrient Credits [Will be obtained prior to ground disturbance]

LIST OF ACRONYMS AND ABBREVIATIONS

ACP	Atlantic Coast Pipeline
BMP	best management practice
BSRF	Belted Silt Retention Fence
CBPA	Chesapeake Bay Preservation Act
DETI	Dominion Energy Transmission, Inc. (formerly Dominion Transmission, Inc.)
DTI	Dominion Transmission, Inc. (now Dominion Energy Transmission, Inc.)
EI	Environmental Inspector
ESC	erosion and sediment control
ESC Plan	Erosion and Sediment Control Plan
FERC	Federal Energy Regulatory Commission
lb/ac/yr	pounds per acre per year
MBTA	Migratory Bird Treaty Act
M&R	metering and regulating
M&R Station	Elizabeth River M&R Station
NRCS	U.S. Department of Agriculture, Natural Resources Conservation Service
NWI	National Wetlands Inventory
NWP	Nationwide Permit
PCB	polychlorinated biphenyl
STA	Seal of Testing Assurance
SWM	stormwater management
SWM Plan	Stormwater Management Plan
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VDEQ	Virginia Department of Environmental Quality
VESCH	Virginia Erosion and Sediment Control Handbook
VESCP	Virginia Erosion and Sedimentation Control Program
VRRM	Virginia Runoff Reduction Method
VSMP	Virginia Stormwater Management

1.0 INTRODUCTION

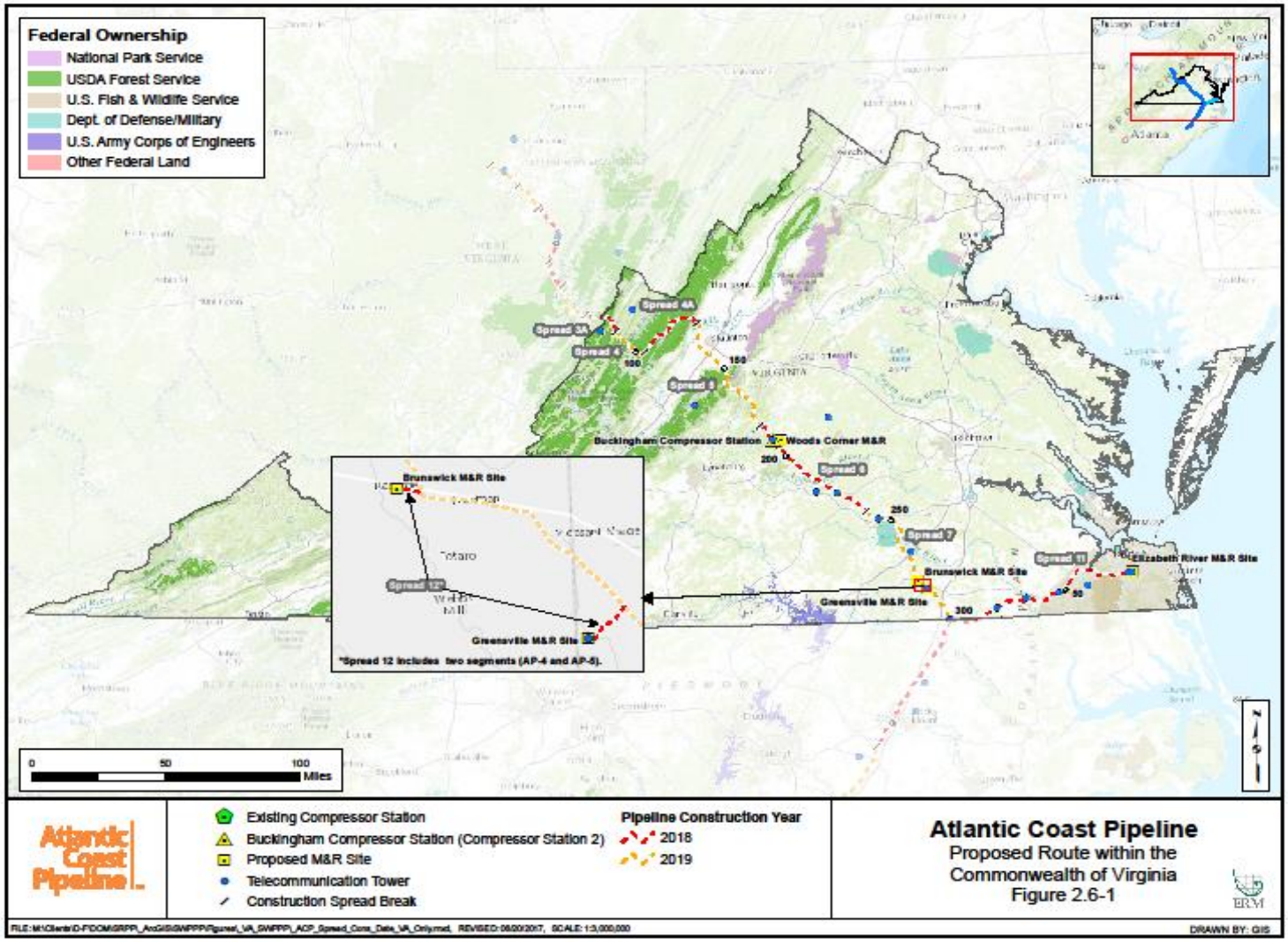
As part of the Atlantic Coast Pipeline (ACP), Dominion Energy Transmission, Inc. (DETI), formerly Dominion Transmission, Inc. (DTI), a subsidiary of Dominion, is proposing to construct an approximately 1.0-acre aboveground metering and regulating (M&R) station at 2516 South Military Highway in Chesapeake, Virginia.[1] This station, referred to as the Elizabeth River M&R Station (M&R Station), will be co-located with an existing natural gas storage and peak shaving facility.

The purpose of this Appendix is to specifically address existing site conditions; planned land-disturbing activities; construction sequence and procedures; erosion and sediment control (ESC) measures; and post-construction stormwater management (SWM) methods to be used at the M&R Station. This Appendix is intended to supplement the main body of the Stormwater Pollution Prevention Plan (SWPPP), which primarily addresses the linear portion of the Project. However, general provisions contained within the main body of the SWPPP, including pollution prevention practices and procedures; roles and responsibilities of personnel; inspection and maintenance; employee training; and notification, recordkeeping, and reporting will be followed during construction of the M&R Station, as applicable to the aboveground facility. Land-disturbing activities will conform, at a minimum, to the same regulations and guidelines listed in Section 2.0 of the SWPPP, as appropriate and applicable. In circumstances where multiple overlapping regulatory requirements and guidelines apply, DETI selected the more stringent or protective of the requirements and guidelines set forth by the Federal Energy Regulatory Commission (FERC) and the Virginia Department of Environmental Quality (VDEQ), unless otherwise agreed to in advance.

A description of the M&R Station is provided in the following sections. A Site Plan is provided in Attachment 1. Figure 1-1 below shows the location of the M&R Station in relation to the ACP.

[1] In May 2017, Dominion Transmission, Inc. (DTI) had a legal name change to Dominion Energy Transmission, Inc. (DETI).

Figure 1-1 Elizabeth River M&R Station Location



2.0 LOCATION AND DESCRIPTION

The M&R Station will be located at milepost 82.7 of the AP-3 lateral section of the ACP pipeline, within the City of Chesapeake. The approximately 1.0-acre rectangular tract of land is located along the northern property boundary of a larger parcel. The larger parcel is identified in the City of Chesapeake records as Parcel Number 0260000000340 with a property address of 2516 South Military Highway. The general vicinity around the M&R Station is a mix of commercial/industrial development to the north and west and a mix of undeveloped/residential property to the east and south.

2.1 EXISTING SITE CONDITIONS

The M&R Station is mainly undeveloped with the westernmost portion (approximately one-third of the station) consisting of a grassy area and the remaining two-thirds consisting of wooded land. An existing natural gas pipeline right-of-way crosses the proposed M&R Station along the western boundary.

A drainage ditch is located adjacent to the western boundary of the M&R Station alongside an access road leading to the M&R Station from South Military Highway. Two drainage ditches are located in the forested portion of the property running in a roughly north-south direction and another along a portion of the M&R Station's northern boundary. A wetland is located at the southeastern corner of the M&R Station as described in Section 2.11 below.

2.2 EXISTING AND PROPOSED TOPOGRAPHY

The topography at the M&R Station is characterized by flat to gently sloping terrain with an elevation of approximately ten feet above mean sea level. The proposed development will retain the existing topography of flat to gently sloping terrain with grading to direct stormwater toward vegetated filter strips planned along the eastern and western sides of the property.

Existing topography of the M&R Station can be found in the topographical map, Attachment 2. In addition, the proposed grading plan for the M&R Station is provided in Attachment 1.

2.3 PROMINENT VEGETATION

The current M&R Station site location is undeveloped with the westernmost portion (approximately one-third of the site) consisting of a grassy area and the remaining two-thirds consisting of wooded land. The M&R station will be developed with one dekatherm building (used to house equipment such as gas chromatographs, communications equipment, etc.) as well as a regulation skid, a metering skid, a microwave tower, and a small supply building surrounded by a chain-link security fence. In addition, aboveground sections of piping, gas filter/separator, meters, a tank, and regulators will be present. The ground surface around the building structures and aboveground equipment will be covered with gravel with the exception of two vegetated grass filter strips along the western and eastern sides of the property. DETI will utilize an existing road to access the M&R station from South Military Highway. Vehicles will

then enter the M&R Station using a new gravel access road. The proposed Site Plan is provided in Attachment 1.

2.4 LAND-DISTURBING ACTIVITIES AND ASSOCIATED WORK AREAS

Construction of the M&R Station will affect approximately one acre of land. The one acre of land affected will be retained for operation of the new M&R Station. The Site Plan included in Attachment 1 depicts the proposed land use with a tabulation of the percentage of surface area to be adapted to various uses, including but not limited to planned locations of utilities, structures, roads, parking areas, SWM facilities, and easements.

2.5 CONSTRUCTION SCHEDULE

Subject to receipt of the required permits and regulatory approvals, initial construction activities are expected to commence in April 2018. DETI anticipates that the M&R Station construction will be completed in the third quarter of 2019.

2.6 ADJACENT PROPERTIES

The proposed Elizabeth River M&R Station will be located in a mixed commercial/ industrial area. DETI will use a combination of management practices and control measures to limit the erosion and transport of soil to adjacent properties and waterbodies.

The following properties and associated land uses are located immediately adjacent to the M&R Station:

- Southeastern Equipment Corporation (2506 South Military Highway), a heavy equipment sales, rental, and parts facility is located to the north. According to the City of Chesapeake Real Estate website, the adjacent parcel is 8.9 acres in size and includes a 7,120-square-foot garage/storage building.

- Marine Specialty Painting (4411 Bainbridge Boulevard), a ship painting contractor, is located adjacent to the northwest corner of the site. According to the City of Chesapeake Real Estate website, a portion of the property (less than 0.1 acre) is leased for a cell phone tower. A cell tower is located in the southeast corner of the adjacent property, immediately diagonal from the subject Site. The portion of the property nearest the M&R Station appears to be primarily used for storage of trucks, trailers, land-sea containers and fill material.

- The larger parcel, within which the M&R Station will be located, is used as a propane storage and natural gas peak shaving plant. Plant operations are located immediately south and west of the M&R Station.

- The area east of the M&R Station is wooded.

2.7 OFF-SITE AREAS

This ESC and SWM Plan addresses land-disturbing activities within the M&R Station. Project plans do not include any additional off-site land-disturbing activities (such as borrow sites or disposal areas). Similar to adjacent properties, DETI will minimize any potential impact to off-site areas during the Project.

2.8 SOILS

Based on a review of the Virginia Division of Mineral Resources Geologic Map of Virginia (1993), the surficial geologic unit at the site is the Quaternary Period Lynnhaven Member of the Tabb Formation. According to the U.S. Geological Survey (USGS), the Lynnhaven Member consists of a pebbly to cobbly, fine to coarse gray sand grading upward into clayey and silty fine sand and sandy silt. Locally, at the base of the unit, medium to coarse cross-bedded sand and clayey silt containing abundant plant material fill channels cut into underlying stratigraphic units. The Lynnhaven Member is a surficial deposit of a broad swale that is traceable southward from Norfolk, and extensive low lands bounded on landward side by river-, bay-, and ocean-facing scarps having toe altitudes of 15 to 18 feet. Thickness of the unit ranges from 0 to 20 feet.

According to the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), soils beneath the wooded portion of the M&R Station are mapped as somewhat poorly drained to poorly drained (Dragston-Tomotley Complex) with depth to water table ranging from 0 to 30 inches. These soils consist of fine sand overlain by a 3 to 3.5 foot layer of fine sandy loam to a sandy clay loam. These soils stretch into the southern portion of the grassy area. The remaining portion of the grassy area is mapped in the Tomotley-Urban Land-Nimmo Complex. These soils are poorly drained with depth to water table ranging from 0 to 12 inches.

The NRCS assigns soils to one of four hydrologic soil groups based on estimates of runoff potential, as follows:

- **Group A**: Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

- **Group B**: Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

- **Group C**: Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

- **Group D**: Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell

potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter applies to drained areas and the second applies to undrained areas.

The hydrologic soil groups assigned by NRCS for the soils mapped at the M&R Station are as follows: Dragston (Group C); Tomotley (Group B/D); and Nimmo: (Group D).

2.9 RECEIVING WATERS

The M&R Station drains south toward a former sandpit which is now filled with water. Water collected within the sandpit discharges into Newton Creek, located approximately 2,000 feet south of the proposed M&R Station. Newton Creek flows west into the Southern Branch of the Elizabeth River. The M&R Station is located within the Deep Creek-Southern Branch Elizabeth River watershed identified by the USGS as hydrologic unit code 020802080203. DETI does not intend to connect to and/or discharge into a municipal separate storm sewer system (MS4).

2.10 EXEPTIONAL AND IMPAIRED WATERS

The proposed M&R Station does not impact Tier 3 exceptional waters identified in 9 VAC 25-260-30 A.

DETI reviewed the 2014 list of 305(b)/303(d) Impaired Waters for the Commonwealth of Virginia to identify waterbodies classified as impaired or for which a Total Maximum Daily Load (TMDL) wasteload allocation has been established and approved for (i) sediment or a sediment-related parameter (i.e., total suspended solids or turbidity) or (ii) nutrients (i.e., nitrogen or phosphorus) (VDEQ, 2015). The M&R Station drains to Newton Creek (a tributary of the Southern Branch of the Elizabeth River) which has been designated as impaired for dissolved oxygen, polychlorinated biphenyls (PCBs) in fish tissue, and dioxin. A dissolved oxygen TMDL has been established for Newton Creek; TMDLs are currently under development for PCBs and dioxin. Neither Newton Creek nor the Southern Branch of the Elizabeth River has a TMDL wasteload allocation for sediment or a sediment-related parameter or nutrients. However, the M&R Station will be located within the Chesapeake Bay watershed which has a wasteload allocation to reduce nitrogen, phosphorus, and sediment discharges into the Bay. The location of the Chesapeake Bay TMDL watershed is shown on Figure 2.18-1 of the main body of the SWPPP.

In accordance with the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law and their associated regulations, the following will be implemented for construction activities within the Chesapeake Bay TMDL Watershed:

- Permanent or temporary soil stabilization will be applied to denuded areas within seven days after final grade is reached on any portion of the site.

- Nutrients will be applied in accordance with manufacture's recommendations or an approved nutrient management plan and will not be applied during rainfall events.

- Inspection requirements are as follows:

    - Inspections will be conducted at a frequency of (i) at least once every four business days or (ii) at least once every five business days and no later than 48 hours following a measurable storm event (a measurable storm event is defined as a rainfall event producing 0.25 inches of rain or greater over 24 hours). In the event a measurable storm event occurs when there are more than 48 hours between business days, the inspection will be conducted on the next business day; (see Section 8.1 of the SWPPP).

    - Representative inspections used by linear construction projects will include all outfalls discharging to surface waters identified as impaired or for which a TMDL wasteload allocation has been established. **Note that inspections of the M&R Station will include all disturbed areas (i.e., representative inspections are only applicable to the linear portion of the Project – not to aboveground facilities).**

2.11 CRITICAL/SENSITIVE AREAS

Pre-construction assessments and field surveys were completed by DETI to delineate the location of critical or sensitive environmental areas within the areas of land disturbance proposed by the M&R Station.

2.11.1 Wetlands and Waterbodies

M&R stations have been sited such that impacts to wetlands will be avoided and minimized to the maximum extent practicable. During the routing phase of the ACP Project, Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) data, was used to provide a preliminary analysis of wetland resources and to assess where wetland impacts could be avoided or minimized. NWI data was also used to estimate the number, size, and locations of wetlands within the construction areas prior to conducting wetland delineations in the field.

DETI conducted field surveys during the 2015 field season to identify and delineate wetlands at the proposed Elizabeth River M&R Station. Temporary construction and operational activities at the Elizabeth River M&R station will impact approximately 0.1 acres of wetland located at the southeast corner of the M&R Station, as shown on the Site Plan in Attachment 1. Consultation with the U.S. Army Corps of Engineers (USACE) was initiated in 2015 for a Nationwide Permit (NWP) 12, and DETI is currently undergoing review and consultation with the USACE.

The portion of the wetland which extends beyond the area of land disturbance and onto the adjacent property will be protected from post-construction stormwater runoff with a vegetated filter strip, as discussed in Section 5.3 below.

2.11.2 Threatened and Endangered Species

DETI consulted with the USFWS Ecological Services Field Office in Virginia to identify federally and Commonwealth-listed endangered, threatened, and proposed species as potentially occurring in the ACP Project area. Field surveys and consultations with the USFWS regarding these species are ongoing. Virginia has separate laws protecting threatened and endangered species. DETI requested and received data on known occurrences of Commonwealth-listed species in Virginia from the Virginia Department of Conservation and Recreation Natural Heritage Program. DETI additionally has consulted and continues to consult with the Virginia Department of Game and Inland Fisheries and Virginia Department of Conservation and Recreation regarding impacts on Commonwealth-listed threatened and endangered species.

There are no endangered, threatened, or proposed species that are known to occur at the proposed M&R Station.

2.11.3 Chesapeake Bay Protection Areas

The Chesapeake Bay Preservation Act (CBPA) was enacted to protect, preserve, and improve the waters of the Chesapeake Bay and its tributaries. The CBPA is implemented through the Chesapeake Bay Preservation Area Designation and Management Regulations (9 VAC 25-830 et seq.) which requires localities within Tidewater Virginia[2] to enact ordinances to implement and enforce the requirements of the CBPA. In addition, any locality not included within Tidewater Virginia may elect to incorporate CBPA requirements into its local ordinances. The M&R Station is located within the City of Chesapeake which has a local CBPA ordinance.

In accordance with 9 VAC 25-830-150.B.1, DETI is compliant with the Chesapeake Bay Preservation Area Designation and Management Regulation by constructing, installing, operating, and maintaining the M&R Station in accordance with (i) regulations promulgated pursuant to the Erosion and Sediment Control Law and the Virginia Stormwater Management Act, (ii) an Erosion and Sediment Control Plan (ESC Plan) and a Stormwater Management Plan (SWM Plan) approved by the VDEQ, or (iii) local water quality protection criteria at least as stringent as the above Commonwealth requirements.

DETI will construct, install, operate, and maintain the M&R Station in accordance with VDEQ-approved Standards and Specifications which are consistent with the requirements of the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law and their associated regulations, where applicable. As such, the M&R Station will be compliant with the Chesapeake Bay Preservation Area Designation and Management Regulation. The ESC and SWM Plans contained in this SWPPP were prepared to ensure compliance with the Standards and Specifications as well as other federal regulations.

[2] In accordance with §62.1-44.15:68 of the CBPA, "Tidewater Virginia" means the following jurisdictions: The Counties of Accomack, Arlington, Caroline, Charles City, Chesterfield, Essex, Fairfax, Gloucester, Hanover, Henrico, Isle of Wight, James City, King and Queen, King George, King William, Lancaster, Mathews, Middlesex, New Kent, Northampton, Northumberland, Prince George, Prince William, Richmond, Spotsylvania, Stafford, Surry, Westmoreland, and York, and the Cities of Alexandria, Chesapeake, Colonial Heights, Fairfax, Falls Church, Fredericksburg, Hampton, Hopewell, Newport News, Norfolk, Petersburg, Poquoson, Portsmouth, Richmond, Suffolk, Virginia Beach, and Williamsburg.

3.0 EROSION AND SEDIMENT CONTROL

All ESC measures to be undertaken as part of this Project will be done in accordance with the VDEQ-approved DETI Standards and Specifications. These standards and specifications will be met through the implementation of the FERC's Upland Erosion Control, Revegetation, and Maintenance Plan and Wetland and Waterbody Construction and Mitigation Procedures, Minimum Standards of the Virginia Erosion and Sedimentation Control Regulations (9 VAC 25-840-40), by the design, construction and maintenance of the Erosion and Sedimentation Controls in accordance with the Virginia Erosion and Sediment Control Handbook (VESCH) (1992, 3rd Edition), and the application of environmental site design principles.

3.1 GENERAL M&R STATION CONSTRUCTION

M&R Station construction stages and the ESC measures to be installed for each of these stages are described below. The ESC drawings for the M&R Station, including typical drawings of general ESC measures, are provided in Attachment 1.

During construction, the effectiveness of temporary erosion control devices will be monitored by DETI's Environmental Inspectors (EIs). The effectiveness of permanent erosion control measures will be monitored for the life of the project by DETI operating personnel during the long-term operation and maintenance of the M&R Station.

Site Preparation

- Survey and flag the construction site and mark environmentally-sensitive areas (i.e., boundary of wetland and vegetated filter strip).
- Only vehicular traffic used for vegetated filter strip construction will be allowed within ten feet of the vegetated filter strip boundary.
- Install temporary construction entrance.
- Install safety fences prior to ESC installation.
- Conduct initial clearing, limited to that necessary to install temporary sediment barriers.
- Install all perimeter ESCs prior to any bulk earth-moving activity (road grading, log skidding, grubbing, etc.) ESC measures will be inspected and maintained throughout construction.
- Construction runoff will be directed away from the proposed vegetated filter strips with silt fence.
- Clear and grub site.
- Segregate topsoil where necessary.

M&R Station Construction

- Begin site bulk grading.
- Grade entrance road, laydown areas, and parking areas.
- Grade building pads and dig excavations for footings, foundations, and utilities.
- Install utilities.
- Construct buildings and pipeline metering and regulation facilities.
- Spread topsoil on disturbed areas, as needed.
- Complete finish grading.
- Install gravel base around buildings and M&R facilities.

Restoration

- Conduct site restoration and cleanup. As soon as slopes, channels, ditches, and other disturbed areas reach final grade, they must be stabilized within seven days.
- Apply soil amendments, permanent seed, mulch, and/or erosion control fabric, as necessary.
- Restore temporary access roads or any paved surfaces to original condition.
- Remove temporary sediment barriers from an area when replaced by permanent erosion control measures or when the area has been successfully restored to uniform perennial vegetation. Temporary erosion control best management practices (BMPs) will not be removed until inspection by the EI to confirm site stabilization.

Vegetated Filter Strip Construction

- Construction of gravel diaphragm will not commence until the contributing drainage area has been stabilized and perimeter ESCs have been removed and cleaned out.
- Minimize soil compaction by lightly grading vegetated filter strips with tracked vehicles to achieve desired elevations and slopes.
- Spread topsoil and compost amendments across the filter strip areas, seed, and protect with mulch.
- Stormwater will not be diverted into the filter strip until turf cover is dense and well established.

3.1.1 Survey and Flagging

- The limits of the approved work areas, boundaries of the delineated wetland, boundaries of the vegetated filter strips, and the location of the underground utilities must be marked in the field prior to the start of mechanized activities.
- Orange plastic fencing may be more useful than flagging to assure that equipment operators stay out of critical areas. Only unavoidable work will take place within critical areas and their buffers.
- Per VESCH **Std. & Spec. 3.01 (Safety Fence)**, safety fencing will be installed as needed during grading at public access points or around open unattended excavations to warn pedestrians of possible hazards. Stakes will be installed to the maximum extent of 18" as practical in the field to ensure the functionality of the safety fence. In areas where adequate embedment depth cannot be achieved, due to terrain/substrate constraints; additional measures including but not limited to sandbags, mounded earth, etc. will be utilized to secure the fence. In addition, lights, signs and other warnings are required at road entrances and road crossings (see Virginia Department of Transportation (VDOT) permits and regulations).
- Flagging or marking will be maintained throughout construction.
- Trees to be protected will be flagged by the EIs and if determined necessary, protected with fencing or armoring prior to clearing.
- Per VESCH **Std. & Spec. 3.38 (Tree Preservation and Protection)**, at a minimum the limits of clearing will be located outside the drip line of any tree to be retained and, in no case, closer than five feet to the trunk of any tree to be retained. In addition, heavy equipment, vehicular traffic, or stockpiles will not be permitted within the drip line of any tree to be retained.

3.1.2 Construction Entrance

In accordance with VESCH **Std. & Spec 3.02 (Stone Construction Entrance)**, a construction entrance will be constructed at any point where construction equipment leaves the right-of-way and enters a paved public road or other paved surface. Typically, a construction entrance is comprised of filter fabric overlain by six inches of coarse aggregate (Virginia Department of Transportation #1) extending a minimum of 70 feet from the edge of the pavement. The area of the entrance must be excavated three inches prior to laying the filter fabric underliner. The entrance must extend the full width of the vehicular ingress and egress area and have a minimum 12-foot width. Conveyance of surface water through culverts under the entrance will be provided, as necessary. If such as conveyance is impossible, the construction of a "mountable" berm with 5:1 slopes will be permitted.

The construction entrance must function to remove mud from vehicles and equipment leaving the site. As mud accumulates on the entrance, clean stone must be added or the tire mats lifted and shaken to remove mud. Any mud that is carried onto the pavement must be thoroughly removed by the end of the day by shoveling or sweeping. The mud will be returned to the site.

The use of water to remove sediment tracked onto roadways is permitted only after sediment is removed as stated above.

If the majority of the mud is not removed by the vehicles traveling over the stone, then tires of the vehicles must be washed before entering the public road. A wash rack may be used to make washing more convenient and effective. Wash water must be carried away from the entrance to a settling area to remove sediment before discharge.

Maintenance of the construction entrance may require periodic top dressing with additional stone and cleanout of any structures used to trap sediment. If inadvertent sediment tracking occurs on the public roadway, the road will be cleaned thoroughly by the end of each day.

3.1.3 Wind Erosion Control

Consistent with VESCH **Std. & Spec. 3.39 (Wind Erosion Control)**, the following temporary sediment controls will be used, as applicable, to minimize the surface and air movement of dust during land disturbing and construction activities:

- In areas with little or no construction traffic, a vegetatively stabilized surface will reduce dust emissions.
- Mulch will be used in areas without heavy traffic pathways.
- Tillage will be used only in an emergency situation before wind erosion begins. Plowing on the windward side of the site with chisel-type plows spaced approximately 12 inches apart.
- The contractors will have one or more water trucks available per spread that will load water from approved permitted sources to spray areas for dust control.
- Use of spray-on adhesives may be used on mineral soils only.
- Use crushed stone or course gravel to stabilize roads and other areas during construction.
- A board fence, wind fence, or sediment fence may be used to control air currents and blowing soil. Place barriers perpendicular to prevailing air currents at intervals of about 15 times the barrier height.
- Calcium chloride may be applied by a mechanical spreader as loose, dry granules or flakes at a rate that keeps the surface moist but not so high as to cause water pollution or plant damage.

3.1.4 Silt Fencing

Silt Fencing constructed of synthetic filter fabric stretched across and attached to supporting posts, and in some cases a wire support fence, will be placed across or at the toe of a slope or in a minor drainage way to intercept and detain sediment and decrease flow velocities from drainage areas of limited size. Silt fencing is applicable where sheet and rill erosion or

small concentrated flows may be a problem. In accordance with VESCH **Std. & Spec 3.05 (Silt Fence),** DETI will adhere to the following general construction and maintenance specifications if congruent with the manufacturer's recommended installation and use. In the event of conflicting specifications, DETI will always follow the manufacturer's recommendations on proper installation and use of a product.

- Silt fencing will be used where the size of the drainage area is not more than one quarter acre per 100 feet of silt fence length; the maximum slope length behind the barrier is 100 feet; and the maximum gradient behind the barrier is 50 percent (2:1).

- Silt fencing can be used in minor swales or ditches where the maximum contributing drainage area is no greater than 1 acre and flow is no greater than one cubic feet per second. In ditches or swales where higher velocity flow is expected, rock check dams will be used in place of silt fence.

- Silt fencing will not be used in areas where rock or some other hard surface prevents the full and uniform depth anchoring of the barrier.

- If wooden stakes are utilized for silt fence construction, they must have a diameter of two inches when oak is used and four inches when pine is used. Wooden stakes must have a minimum length of five feet. Fabric will not be stapled to existing trees.

- If steel posts are utilized, they must have a minimum weight of 1.33 pounds per linear foot and have a minimum length of five feet. Posts will be placed a maximum of six feet apart.

- The height of the fence will be a minimum of 16 inches above grade and will not exceed 34 inches above ground elevation.

- Filter cloth will be spliced together only at support posts with a minimum 6-inch overlap.

- When wire support is not used, extra-strength filter fabric will be fastened to the upslope side of the posts using one inch long (minimum) heavy-duty wire staples or tie wires and eight inches of the fabric will be extended into the trench. The posts will be placed a maximum of six feet apart.

- When wire support is used, the wire mesh fence must be fastened securely to the upslope side of the posts using heavy duty wire staples at least one inch long, tire wires or hog rings. The posts will be placed a maximum of ten feet apart.

- If silt fence is to be constructed across a ditch line or swale, the measure must be of sufficient length to eliminate end flow and the configuration will resemble an arc with the ends oriented upslope. Extra-strength filter fabric must be used for ditch lines or swales with a maximum three-foot spacing of posts.

- Remove accumulated sediments when sediment reaches half the aboveground height of the fence.

- Silt fences will be removed and discarded properly after project completion. Soils will be stabilized and seeded accordingly. Permanent erosion control protective measures will be utilized if seeding alone will not stabilize the site and provide soil stability.

Belted Silt Retention Fence (BSRF)

The primary silt fence product planned for use on the ACP, including the M&R Station, is a patented Belted Silt Retention Fence (BSRF) product which is available in two designs used to address different site conditions, as follows:

- BSRF Priority 1 (green band) is a heavy-duty silt fence constructed with a 36-inch, non-woven, spun-bond fabric with an internal scrim incorporated into the fabric for additional strength and durability. The system utilizes wood stakes spaced at 4-feet and a specific method of attachment. The system is functionally equivalent to wire back and metal steel post silt fence and is designed for the protection of high priority areas, including wetlands and waterbodies.

- BSRF Priority 2 (black band) is a medium-duty silt fence constructed with a 36-inch, non-woven, spun-bond fabric that is calendared on one side. The system utilizes wood stakes spaced at 6-feet and a specific method of attachment.

Drawings and specifications for BSRF are provided in Attachment 1.

3.1.5 Site Dewatering

Dewatering may be periodically conducted to remove accumulated groundwater or precipitation from the construction area, including from within excavations. The need for erosion controls as well as the type of control used will vary depending on the type and amount of sediment within the water, and volume and rate of discharge.

3.1.5.1 Geotextile Bag/Dewatering Filter Bag

DETI utilizes geotextile bags for dewatering and velocity reduction on a majority of pipeline construction projects as well as the straw bale dewatering practice illustrated in the VESCH **Std. & Spec. 3.26 (Dewatering Structure)**. The purpose, definition, conditions of application and planning considerations are identical. Design criteria and specifications vary by dewatering bag manufacturer; a variety of geotextile dewatering bag products are available on the market. The manufacturers' guidance on the use, design, sizing, maintenance, and application of the geotextile dewatering bag will be followed.

- Conduct dewatering (on or off the construction site) in such a manner that does not cause erosion and does not result in silt-laden water flowing into any waterbody, wetland, or off-site property.

- Elevate and screen the intake of each hose used to withdraw the water from the trench to minimize pumping of deposited sediments.

- A dewatering bag may not be needed if there is a well-stabilized, vegetated area on site to which water can be discharged. The area must be stabilized so that it can filter sediment and at the same time withstand the velocity of the discharged water without eroding. Per VESCH **Std. & Spec 3.26**, a minimum filtering length of 75 feet must be available in order for such a method to be feasible.

- Remove dewatering structures as soon as practicable after the completion of dewatering activities or sooner if sediment build-up prevents the bag from functioning properly. If the bag becomes half full of sediment, discard and replace with a new bag.

3.1.5.2 VESCH Standard Dewatering Structure

As warranted by site conditions, a standard dewatering structure may be used per the construction and maintenance specifications in VESCH **Std. & Spec 3.26 (Dewatering Structure)**, including the use of a portable sediment tank, filter box, or straw bale/silt fence pit. The dewatering structure must be sized (and operated) to allow pumped water to flow through the filtering device without overtopping the structure. The filtering devices must be inspected frequently and repaired or replaced once the sediment build-up prevents the structure from functioning as designed. The accumulated sediment which is removed from a dewatering device must be spread on site and stabilized or disposed of at an approved disposal site.

In some cases, DETI could use a modified dewatering structure in combination with a filter bag. The structure is similar to the straw bale/silt fence pit described in the VESCH, but the wet storage area is not excavated 3 ft. below the perimeter measures since the structures are placed off the right-of-way in well vegetated areas. The filter bag discharges into the dewatering structure for additional filtration through the straw bales. Additional energy dissipating devices may be installed downgradient of the dewatering structure, as necessary.

Installation and removal of the referenced dewatering practice does not involve ground disturbance.

3.2 SPECIAL CONSTRUCTION PROCEDURES

Sensitive areas (e.g., wetland) will be treated as separate construction entities. Sensitive areas require additional ESC procedures. Additional controls will be shown on the drawings in Attachment 1.

3.2.1 Winter Construction

DETI has developed and filed a project-specific winter construction plan with the FERC application.

The plan addresses:

- Winter construction procedures (e.g., snow handling and removal, soil handling under saturated or frozen conditions, topsoil stripping);
- Stabilization and monitoring procedures if ground conditions will delay restoration until the following spring (e.g., mulching and erosion controls, inspection and reporting, stormwater control during spring thaw conditions); and
- Where areas have been temporarily stabilized or land-disturbing activities will be suspended due to continuous frozen ground conditions and stormwater discharges are unlikely, the inspection frequency may be reduced to once per month. If weather conditions (such as above freezing temperatures or rain or snow events) make discharges likely, the operator will immediately resume the regular inspection frequency.

3.2.2 Wetlands

Construction procedures are to comply with the USACE, or its delegated agency, permit terms and conditions. Implement the following general requirements during planning and construction near or across wetlands, per the general conditions of the NWP:

- No activity will cause more than a minimal adverse effect on navigation.
- As required, a pre-construction notification will be obtained for discharges associated with the construction of utility line substations that result in the loss of greater than 5,000 square feet of waters of the United States.
- No activity will substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the wetland, including those species that normally migrate through the area. All permanent and temporary crossings of the wetland will be suitably culverted, bridged, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species, except within the proposed portion of the wetland that will be filled in for the M&R Station.
- Activities during spawning seasons will be avoided to the maximum extent practicable. There will be no activities that result in the physical destruction (e.g., through excavation, fill, or downstream smothering by substantial turbidity) of an important spawning area. Per the USACE NWP 12 conditions for the project, Elizabeth River M&R Station does not have time of year restrictions for waters of the U.S.
- Activities in waters of the United States that serve as breeding areas for migratory birds will be avoided to the maximum extent practicable. DETI plans to clear the M&R station outside of the migratory bird nesting season to reduce potential impacts on migratory birds and other sensitive species. In the event that clearing is necessary within the nesting season, DETI will avoid impacts to nests observed

within the construction limits of disturbance (LOD) in accordance with the Migratory Bird Treaty Act (MBTA).

- No activity will use unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.). Material used for construction or discharged will be free from toxic pollutants in toxic amounts (Section 307 of the Clean Water Act).

- No activity will occur in the proximity of a public water supply intake, unless the activity is for the repair or improvement of public water supply intake structures or adjacent bank stabilization.

- To the maximum extent practicable, the pre-construction course, condition, capacity, and location of open waters will be maintained for each activity, including stream channelization and stormwater management activities, except as provided below.

    - The activity will be constructed to withstand expected high flows, activity will not restrict or impede the passage of normal or high flows, unless the primary purpose of the activity is to impound water or manage high flows.

    - The activity may alter the pre-construction course; condition, capacity, and location of open waters if it benefits the aquatic environment (e.g., stream restoration or relocation activities).

- The activity will comply with applicable Federal Emergency Management Agency-approved state or local floodplain management requirements.

- Heavy equipment working in wetlands or mudflats will be placed on mats, or other measures will be taken to minimize soil disturbance.

- Appropriate soil ESCs will be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, will be permanently stabilized at the earliest practicable date.

- Temporary fills will be removed in their entirety and the affected areas will be returned to pre-construction elevations. The affected areas will be revegetated, as appropriate.

- Any authorized structure or fill will be properly maintained, including maintenance to ensure public safety and compliance with applicable NWP general conditions, as well as any activity-specific conditions added by the district engineer to an NWP authorization.

- The activity will be a single and complete project. The same NWP will not be used more than once for the same single and complete project.

- Grubbing shall be limited to the permanent easement for underground utility lines. Outside of the permanent easement, wetland vegetation shall be removed at or above the ground surface unless written justification is provided and the impacts are reviewed and approved by the USACE.

- Whenever possible, excavated material will be placed on an upland site. However, when this is not feasible, temporary stockpiling will be placed with the following guidelines:

    - All excavated material stockpiled in a vegetated wetland area is placed on filter cloth, mats, or some other semi-permeable surface. The material will be stabilized with straw bales, filter cloth, etc. to prevent reentry into the waterway.

4.0 EROSION AND SEDIMENT CONTROL MINIMUM STANDARDS

The Virginia ESC regulations specify minimum standards that must be followed for all regulated land-disturbing activities, where applicable to a specific project. Modifying or waiving any of the ESC regulations, including the 19 minimum standards, on a project-specific basis, requires a written variance request to VDEQ for review and approval. DETI will construct the M&R Station in accordance with the following criteria, techniques, and methods per minimum standards set forth in 9 VAC 25-840-40, as applicable.

Minimum Standard 1 – Permanent or temporary soil stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site. Temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain dormant for longer than 14 days. Permanent stabilization shall be applied to areas that are to be left dormant for more than one year.

Minimum Standard 2 – During construction of the project, soil stock piles and borrow areas shall be stabilized or protected with sediment trapping measures. The applicant is responsible for the temporary protection and permanent stabilization of all soil stockpiles on site as well as borrow areas and soil intentionally transported from the project site.

Minimum Standard 3 – A permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized. Permanent vegetation shall not be considered established until a ground cover is achieved that is uniform, mature enough to survive and will inhibit erosion.

Minimum Standard 4 – Sediment basins and traps, perimeter dikes, sediment barriers and other measures intended to trap sediment shall be constructed as a first step in any land-disturbing activity and shall be made functional before upslope land disturbance takes place.

Minimum Standard 5 – Stabilization measures shall be applied to earthen structures such as dams, dikes, and diversions immediately after installation.

Minimum Standard 6 – Sediment traps and sediment basins shall be designed and constructed based upon the total drainage area to be served by the trap or basin.

6.a. The minimum storage capacity of a sediment trap shall be 134 cubic yards per acre of drainage area and the trap shall only control drainage areas less than 3 acres.

6.b. Surface runoff from disturbed areas that is comprised of flow from drainage areas greater than or equal to 3 acres shall be controlled by a sediment basin. The minimum storage capacity of a sediment basin shall be 134 cubic yards per acre of drainage area. The outfall system shall, at a minimum, maintain the structural integrity of the basin during a 25-year storm of 24-hour duration. Runoff coefficients used in runoff calculations shall correspond to a bare earth condition or those conditions expected to exist while the sediment basin is utilized.

Minimum Standard 7 – Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion. Slopes that are found to be eroding excessively within one year of permanent stabilization shall be provided with additional slope stabilizing measures until the problem is corrected.

Minimum Standard 8 – Concentrated runoff shall not flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, flume, or slope drain structure.

Minimum Standard 9 – Whenever water seeps from a slope face, adequate drainage or other protection shall be provided.

Minimum Standard 10 – All storm sewer inlets that are made operable during construction shall be protected so that sediment-laden water cannot enter the conveyance system without first being filtered or otherwise treated to remove sediment.

Minimum Standard 11 – Before newly constructed stormwater conveyance channels or pipes are made operational, adequate outlet protection and any required temporary or permanent channel lining shall be installed in both the conveyance channel and receiving channel.

Minimum Standard 12 – When work in a live watercourse is performed, precautions shall be taken to minimize encroachment, control sediment transport, and stabilize the work area to the greatest extent possible during construction. Nonerodible material shall be used for the construction of causeways and cofferdams. Earthen fill may be used for these structures if armored by nonerodible cover materials.

Minimum Standard 13 – When a live watercourse must be crossed by construction vehicles more than twice in any six-month period, a temporary vehicular stream crossing constructed of nonerodible material shall be provided.

Minimum Standard 14 – All applicable federal, state, and local requirements pertaining to working in or crossing live watercourses shall be met.

Minimum Standard 15 – The bed and banks of a watercourse shall be stabilized immediately after work in the watercourse is completed.

Minimum Standard 16 – Underground utility lines shall be installed in accordance with the following standards in addition to other applicable criteria:

16.a. No more than 500 linear feet of trench may be opened at one time.

16.b. Excavated material shall be placed on the uphill side of trenches.

16.c. Effluent from dewatering operations shall be filtered or passed through an approved sediment trapping device, or both, and discharged in a manner that does not adversely affect flowing streams or off-site property.

16.d. Material used for backfilling trenches shall be properly compacted in order to minimize erosion and promote stabilization.

16.e. Restabilization shall be accomplished in accordance with this chapter.

16.f. Applicable safety requirements shall be complied with.

Minimum Standard 17 – Where construction vehicle access routes intersect paved or public roads, provisions shall be made to minimize the transport of sediment by vehicular tracking onto the paved surface. Where sediment is transported onto a paved or public road surface, the road surface shall be cleaned thoroughly at the end of each day. Sediment shall be removed from the roads by shoveling or sweeping and transported to a sediment control disposal area. Street washing shall be allowed only after sediment is removed in this manner. This provision shall apply to individual development lots as well as to larger land-disturbing activities.

Minimum Standard 18 – All temporary ESC measures shall be removed within 30 days after final site stabilization or after the temporary measures are no longer needed, unless otherwise authorized by the Virginia Erosion and Sedimentation Control Program (VESCP) authority. Trapped sediment and the disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion and sedimentation.

Minimum Standard 19 – Properties and waterways downstream from development sites shall be protected from sediment deposition, erosion, and damage due to increases in volume, velocity, and peak flow rate of stormwater runoff for the stated frequency storm of 24-hour duration in accordance with the following standards and criteria. Stream restoration and relocation projects that incorporate natural channel design concepts are not man-made channels and shall be exempt from any flow rate capacity and velocity requirements for natural or man-made channels:

19.a. Concentrated stormwater runoff leaving a development site shall be discharged directly into an adequate natural or man-made receiving channel, pipe, or storm sewer system. For those sites where runoff is discharged into a pipe or pipe system, downstream stability analyses at the outfall of the pipe or pipe system shall be performed.

19.b. Adequacy of all channels and pipes shall be verified in the following manner:

19.b.(1) The applicant shall demonstrate that the total drainage area to the point of analysis within the channel is one hundred times greater than the contributing drainage area of the project in question; or

19.b.(2)(a) Natural channels shall be analyzed by the use of a two-year storm to verify that stormwater will not overtop channel banks nor cause erosion of channel bed or banks.

19.b.(2)(b) All previously constructed man-made channels shall be analyzed by the use of a 10-year storm to verify that stormwater will not overtop its banks and by the use of a two-year storm to demonstrate that stormwater will not cause erosion of channel bed or banks; and

19.b.(2)(c) Pipes and storm sewer systems shall be analyzed by the use of a 10-year storm to verify that stormwater will be contained within the pipe or system.

19.c. If existing natural receiving channels or previously constructed man-made channels or pipes are not adequate, the applicant shall:

19.c.(1) Improve the channels to a condition where a 10-year storm will not overtop the banks and a two-year storm will not cause erosion to the channel, the bed, or the banks; or

19.c.(2) Improve the pipe or pipe system to a condition where the 10-year storm is contained within the appurtenances;

19.c.(3) Develop a site design that will not cause the pre-development peak runoff rate from a two-year storm to increase when runoff outfalls into a natural channel or will not cause the pre-development peak runoff rate from a 10-year storm to increase when runoff outfalls into a man-made channel; or

19.c.(4) Provide a combination of channel improvement, stormwater detention or other measures which is satisfactory to the VESCP authority to prevent downstream erosion.

19.d. The applicant shall provide evidence of permission to make the improvements.

19.e. All hydrologic analyses shall be based on the existing watershed characteristics and the ultimate development condition of the subject project.

19.f. If the applicant chooses an option that includes stormwater detention, he shall obtain approval from the VESCP of a plan for maintenance of the detention facilities. The plan shall set forth the maintenance requirements of the facility and the person responsible for performing the maintenance.

19.g. Outfall from a detention facility shall be discharged to a receiving channel, and energy dissipators shall be placed at the outfall of all detention facilities as necessary to provide a stabilized transition from the facility to the receiving channel.

19.h. All on-site channels must be verified to be adequate.

19.i. Increased volumes of sheet flows that may cause erosion or sedimentation on adjacent property shall be diverted to a stable outlet, adequate channel, pipe or pipe system, or to a detention facility.

19.j. In applying these SWM criteria, individual lots or parcels in a residential, commercial, or industrial development shall not be considered to be separate development projects. Instead, the development, as a whole, shall be considered to be a single development project. Hydrologic parameters that reflect the ultimate development condition shall be used in all engineering calculations.

19.k. All measures used to protect properties and waterways shall be employed in a manner which minimizes impacts on the physical, chemical, and biological integrity of rivers, streams and other waters of the state.

19.l. Any plan approved prior to July 1, 2014, that provides for SWM that addresses any flow rate capacity and velocity requirements for natural or man-made channels shall satisfy the flow rate capacity and velocity requirements for natural or man-made channels if the practices are designed to (i) detain the water quality volume and to release it over 48 hours; (ii) detain and release over a 24-hour period the expected rainfall resulting from the one year, 24-hour storm; and (iii) reduce the allowable peak flow rate resulting from the 1.5-, 2-, and 10-year, 24-hour storms to a level that is less than or equal to the peak flow rate from the site assuming it was in a good forested condition, achieved through multiplication of the forested peak flow rate by a reduction factor that is equal to the runoff volume from the site when it was in a good forested condition divided by the runoff volume from the site in its proposed condition, and shall be exempt from any flow rate capacity and velocity requirements for natural or man-made channels as defined in any regulations promulgated pursuant to §62.1-44.15:54 or 62.1-44.15:65 of the Act.

19.m. For plans approved on and after July 1, 2014, the flow rate capacity and velocity requirements of §62.1-44.15:52 A of the Act and this subsection shall be satisfied by compliance with water quantity requirements in the Stormwater Management Act (§62.1-44.15:24 et seq. of the Code of Virginia) and attendant regulations, unless such land-disturbing activities are in accordance with 9 VAC 25-870-48 of the Virginia Stormwater Management Program (VSMP) Regulation or are exempt pursuant to subdivision C 7 of §62.1-44.15:34 of the Act.

19.n. Compliance with the water quantity minimum standards set out in 9 VAC 25-870-66 of the VSMP Regulation shall be deemed to satisfy the requirements of this subdivision 19.

5.0 POST-CONSTRUCTION STORMWATER MANAGEMENT

Where pre-development land cover conditions are changed significantly, triggering post-construction stormwater quality and quantity, post-construction BMPs may be required to comply with water quality and water quantity criteria of the Stormwater Management Regulations and Minimum Standard 19 of the Erosion and Sediment Control Regulations.

The M&R Station, surfaced with gravel and designated to remain a post-construction impervious surface, potentially results in increases in nutrient loading, runoff volume and peak flow rate. At this location, the need for post-construction SWM BMPs was evaluated as discussed below.

5.1 PRE-DEVELOPMENT AND POST-DEVELOPMENT DRAINAGE AREAS

As noted in Sections 2.1 and 2.2, the pre-development conditions at the M&R Station are primarily characterized as undeveloped with the westernmost portion (approximately one-third of the M&R Station site) consisting of a grassy area and the remaining two-thirds consisting of wooded land. An existing drainage ditch is located adjacent to the western boundary of the site and two drainage ditches are located in the forested portion of the property to the east. The existing topography is characterized by flat to gently sloping terrain with an elevation of approximately 10 feet above mean sea level.

In the post-development condition approximately 0.6 acres of the M&R Station site will be surfaced with gravel to create a suitable foundation for the required structures and equipment. The proposed M&R Station structures will occupy approximately 0.02 acres. Additionally, minor grading will occur to direct stormwater runoff toward a vegetated filter strip that will be constructed within the existing vegetated area to the west of the gravel pad and toward a proposed vegetated filter strip and conserved open space to the east of the gravel pad.

Delineation of the drainage watersheds and proposed management practices are shown on the SWM drawings and supporting calculations in Attachment 1. The drawings depict the proposed land uses at the site, and a tabulation of the percentage of surface area to be adapted to various uses, including but not limited to planned locations of utilities, roads, and parking lots. The drawings also show the final drainage patterns and flow paths of the stormwater, in addition to the relationship of the site to upstream and downstream properties and drainage systems. The M&R Station is located within a 500-year Federal Emergency Management Agency floodplain.

Stormwater quality and quantity calculations were performed for pre- and post-development conditions and are described in Section 5.2 below.

5.2 PRE-DEVELOPMENT AND POST-DEVELOPMENT STORMWATER CALCULATIONS

5.2.1 Water Quantity

A hydrologic analysis for the existing (pre-development) and for the proposed (post-development) conditions, including runoff rates, volumes, and velocities, identifying the methodologies used and supporting calculations are presented in this section.

Channel protection and flood protection will be addressed in accordance with the minimum standards set forth in 9 VAC 25-870-66, which are established pursuant to the requirements of § 62.1-44.15:28 of the Code of Virginia. Compliance with the minimum standards set out in this section will be deemed to also satisfy the requirements of Minimum Standard 19 of 9 VAC 25-840-40 (Minimum standards; Virginia Erosion and Sediment Control Regulations, Section 4.0).

Channel Protection

Runoff from the western side of the site sheet flows to a ditch on the western boundary and the runoff from the eastern side of the site sheet flows to a forested area and wetland. Since stormwater flow from the M&R Station will be released into a natural stormwater conveyance system, the maximum peak flow rate from the one-year, 24-hour storm following the land-disturbing activity was calculated. The supporting calculations are provided in Attachment 1.

Flood Protection

Concentrated stormwater flow will be released into a stormwater conveyance system and will meet one of the following criteria as demonstrated by use of acceptable hydrologic and hydraulic methodologies:

1. Concentrated stormwater flow to stormwater conveyance systems that currently do not experience localized flooding during the 10-year, 24-hour storm event: The point of discharge releases stormwater into a stormwater conveyance system that, following the land-disturbing activity, confines the post-development peak flow rate from the 10-year, 24-hour storm event within the stormwater conveyance system. Detention of stormwater or downstream improvements may be incorporated into the approved land-disturbing activity to meet this criterion, at the discretion of the VSMP authority.

2. Concentrated stormwater flow to stormwater conveyance systems that currently experience localized flooding during the 10-year, 24-hour storm event: The point of discharge either:

    a. Confines the post-development peak flow rate from the 10-year, 24-hour storm event within the stormwater conveyance system to avoid the localized flooding. Detention of stormwater or downstream improvements

may be incorporated into the approved land disturbing activity to meet this criterion, at the discretion of the VSMP authority; or

b. Releases a post-development peak flow rate for the 10-year, 24-hour storm event that is less than the predevelopment peak flow rate from the 10-year, 24-hour storm event. Downstream stormwater conveyance systems do not require any additional analysis to show compliance with flood protection criteria if this option is utilized.

3. Limits of analysis. Unless the methodology identified in 2b above is utilized to comply with the flood protection criteria, stormwater conveyance systems will be analyzed for compliance with flood protection criteria to a point where:

a. The site's contributing drainage area is less than or equal to 1.0 percent of the total watershed area draining to a point of analysis in the downstream stormwater conveyance system;

b. Based on peak flow rate, the site's peak flow rate from the 10-year, 24-hour storm event is less than or equal to 1.0 percent of the existing peak flow rate from the 10-year, 24-hour storm event prior to the implementation of any stormwater quantity control measures; or

c. The stormwater conveyance system enters a mapped floodplain or other flood-prone area, adopted by ordinance, of any locality.

The supporting calculations are provided in Attachment 1.

5.2.2 Water Quality

In order to protect the quality of Commonwealth waters and to control the discharge of stormwater pollutants from regulated activities, the following minimum design criteria and statewide standards for SWM will be applied to the site in accordance with 9 VAC 25-870-63.

1. New development. The total phosphorus load of new development projects will not exceed 0.41 pounds per acre per year (lb/ac/yr), as calculated pursuant to 9 VAC 25-870-65.

The VSMP regulations suggest the use of the Virginia Runoff Reduction Method (VRRM) for compliance with the water quality criteria in accordance with 9 VAC 25-870-65. The VRRM New Development spreadsheet was utilized to calculate the runoff reduction and pollutant removal capabilities of the selected post-construction stormwater BMPs based on the proposed land cover characteristics.

The approximate one-acre M&R station will have the following land cover characteristics:

- 0.26 acres of Forest/Open Space – This total is inclusive of the preserved wetland and conserved open space on the eastern side of the site, the proposed vegetated

filter strip on the eastern side of the site and the proposed vegetated filter strip on the western side of the site.

- 0.00 acres of Managed Turf – This is inclusive of the disturbed and graded side slopes of the M&R station pad.

- 0.74 acres of Impervious Cover – This is inclusive of the M&R station pad, the equipment areas, and the paved access road.

Based on the land cover characteristics, the post-development treatment volume for the M&R station was calculated to be 2,599 cubic feet and the total phosphorus produced from the site was 1.63 lb/ac/yr. With a required phosphorus load of 0.41 lb/ac/yr for new development, the phosphorus load is required to be reduced by 1.22 lb/ac/yr.

Post-Development Project (Treatment Volume and Loads)

Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals
Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land				0.26	0.26 *
Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed					0.00
Impervious Cover (acres)				0.74	0.74
** Forest/Open Space areas must be protected in accordance with the Virginia Runoff Reduction Method*					1.00

Constants

Annual Rainfall (inches)	43
Target Rainfall Event (inches)	1.00
Total Phosphorus (TP) EMC (mg/L)	0.26
Total Nitrogen (TN) EMC (mg/L)	1.86
Target TP Load (lb/acre/yr)	0.41
Pj (unitless correction factor)	0.90

Runoff Coefficients (Rv)

	A Soils	B Soils	C Soils	D Soils
Forest/Open Space	0.02	0.03	0.04	0.05
Managed Turf	0.15	0.20	0.22	0.25
Impervious Cover	0.95	0.95	0.95	0.95

Post-Development Requirement for Site Area

TP Load Reduction Required (lb/yr)	1.22

The site is proposed to be graded in a way that a portion of the site and the access road sheet flows to the vegetated filter strip on the western side of the M&R Station site. The eastern portion of the site sheet flows to the vegetated filter strip and the conserved open space on the eastern side of the M&R Station site. Based on the grading and location of the BMPs, the contributing drainage areas in acres were entered into the appropriate rows in the VRRM spreadsheet for the selected BMPs. The selected BMPs were able to reduce the phosphorus load by 0.80 lb/ac/yr with 0.42 lb/ac/yr remaining and required to be reduced.

Total Phosphorus

FINAL POST-DEVELOPMENT TP LOAD (lb/yr)	1.63
TP LOAD REDUCTION REQUIRED (lb/yr)	1.22
TP LOAD REDUCTION ACHIEVED (lb/yr)	0.80
TP LOAD REMAINING (lb/yr):	0.83
REMAINING TP LOAD REDUCTION REQUIRED (lb/yr):	0.42

The supporting calculations are provided in Attachment 1.

5.2.3 Nutrient Trading Program

Pollutant load compliance calculations were performed using the VRRM worksheet for New Development requiring the post-development phosphorus loading to be reduced to 0.41 lb/ac/yr. After completing the water quality analysis for the M&R station, approximately 0.42 lb/ac/yr of phosphorus remains to be removed. This phosphorus removal requirement will be offset with the purchase of nutrient credits in accordance with the requirements below.

For that portion of a site's compliance with stormwater nonpoint nutrient runoff water quality criteria being obtained through nutrient credits, DETI will (i) comply with a 1:1 ratio of the nutrient credits to the site's remaining post-development nonpoint nutrient runoff compliance requirement being met by credit use and will (ii) use credits certified as perpetual credits pursuant to Article 4.02 (§ 62.1-44.19:12 et seq.).

Nutrient credits will be acquired in the same tributary as the M&R Station by identifying credits generated within the same or adjacent eight-digit hydrologic unit code as defined by the USGS. Nutrient credits outside the same or adjacent eight-digit hydrologic unit code may only be used if it is determined that no credits are available within the same or adjacent eight-digit hydrologic unit code. In such cases, credits available within the same tributary may be used. However, in no case will credits from another tributary be used.

Documentation of DETI's acquisition of nutrient credits will be provided to the VDEQ prior to the commencement of land-disturbing activities at the M&R Station in a certification from the credit provider documenting the number of phosphorus nutrient credits acquired at the credit-generating entity (see Attachment 4). Until the effective date of regulations establishing application fees in accordance with § 62.1-44.19:20, the credit provider will pay the VDEQ a water quality enhancement fee equal to six percent of the amount paid by DETI for the credits. Such fee will be deposited into the Virginia Stormwater Management Fund established by § 62.1-44.15:29.

5.3 POST-CONSTRUCTION/PERMANENT STORMWATER BMPS

5.3.1 Vegetated Filter Strip

In accordance with VDEQ Stormwater Design Specification No. 2 (**Sheet Flow to a Vegetated Filter Strip or Conserved Open Space**) as provided in Attachment 3**,** DETI will adhere to the following general construction and maintenance specifications at the M&R Station to treat sheet flow delivered from adjacent impervious and managed turf areas by slowing runoff velocities and allowing sediment and attached pollutants to settle and/or be filtered by the vegetation. Vegetated filter strips will be constructed on the western and eastern portions of the M&R Station. The vegetated filter strip on the eastern portion of the M&R Station site will drain to the adjacent wetland or tree line southeast of the site, as shown on the SWM drawings in Attachment 1.

By using the minimum design criteria specified in Table 5.3.1-1, the vegetated filter strips at the Elizabeth River M&R Station can achieve 50 percent reduction in runoff volume, total phosphorus load, and total nitrogen load. In addition, peak discharge rates are reduced.

TABLE 5.3.1-1

Filter Strip Design Criteria

Design Issue	Vegetated Filter Strip
Soil and vegetative cover	Amended soil and dense turf cover or landscaped with herbaceous cover, shrubs, and trees
Overall slope and width (perpendicular to the flow)	1%[a] to 4% slope – minimum 35 ft. width
Sheet flow	Maximum flow length of 150 ft. from adjacent pervious areas; Maximum flow length of 75 ft. from adjacent impervious areas
Concentrated flow	Not applicable – only sheet flow at Elizabeth River M&R Station
Construction stage	Prevent soil compaction by heavy equipment
Typical applications	Treat small areas of impervious cover (e.g., 5,000 sf)
Compost amendments	Yes (B, C, and D soils)
Boundary spreader	Gravel diaphragm at top of filter Permeable berm at toe of filter

[a] A minimum of 1% is recommended to ensure positive drainage.

In addition, the following constraints will be observed during design and construction:

- Vegetated filter strips are not appropriate for fill soils.
- Vegetated filter strips will not receive hotspot runoff, since the infiltrated runoff could cause groundwater contamination.
- Underground pipes and conduits that cross the vegetated filter strip are acceptable.
- Before site work begins, vegetated filter strip boundaries will be clearly marked.
- Only vehicular traffic used for filter strip construction will be allowed within 10 feet of the filter strip boundary.
- If existing topsoil is stripped during grading, it will be stockpiled for later use.
- Construction runoff will be directed away from the proposed filter strip site, using perimeter silt fence or, preferably, a diversion dike.
- Construction of the gravel diaphragm or engineered level spreader will not commence until the contributing drainage area has been stabilized and perimeter ESCs have been removed and cleaned out.
- Vegetated filter strips require light grading to achieve desired elevations and slopes. This will be done with tracked vehicles to prevent compaction. Topsoil and or compost amendments will be incorporated evenly across the filter strip area, stabilized with seed, and protected by biodegradable erosion control matting or blankets.
- Stormwater will not be diverted into the filter strip until the turf cover is dense and well established.

- Vegetated filter strips will be planted at such a density to achieve a 90 percent grass/herbaceous cover after the second growing season. Filter strips will be seeded, not sodded. Seeding establishes deeper roots, and sod may have muck soil that is not conducive to infiltration. The filter strip vegetation may consist of turf grasses, meadow grasses, other herbaceous plants, shrubs, and trees, as long as the primary goal of at least 90 percent coverage with grasses and/or other herbaceous plants is achieved. Vegetation at the toe of the filter, where temporary ponding may occur behind the permeable berm, will be able to withstand both wet and dry periods. The planting areas can be divided into zones to account for differences in inundation and slope.

- **Compost Soil Amendments** Compost soil amendments will enhance the runoff reduction capability of a vegetated filter strip when located on hydrologic soil groups B, C, and D, subject to the following design requirements:

    - The compost amendments will extend over the full length and width of the filter strip.

    - Depth of compost amendment is based on the relationship of the surface area of the soil amendment to the contributing areas of impervious cover that it receives. VDEQ Stormwater Design Specification No. 4 (**Soil Compost Amendment**) Table 4.3, as provided in Attachment 3, provides general guidance for determining the required depth to which compost must be incorporated. In practice, it is expected that the depth to which compost is incorporated will be limited by the shallow depth to groundwater at the M&R Station site.

    - The projected quantity of approved compost material needed for the Elizabeth River M&R Station, calculated based on VDEQ Stormwater Design Specification No. 4 (see Attachment 3), is 5,700 cubic yards. The actual quantity will be dictated by the depth at which groundwater is encountered during construction.

    - Compost will be derived from plant material and meet the general criteria set forth by the U.S. Composting Seal of Testing Assurance (STA) program.

    - The compost will be the result of the biological degradation and transformation of plant derived materials under conditions that promote anaerobic decomposition. The material will be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost will have a moisture content that has no visible free water or dust produced when handling the material. It will meet the following criteria, as reported by the U.S. Composting Council STA Compost Technical Data Sheet provided by the vendor:

        a. 100 percent of the material must pass through a half inch screen;

b. The pH of the material will be between six and eight;

c. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) will be less than 0 percent by weight;

d. The organic matter content will be between 35 and 65 percent;

e. Soluble salt content will be less than 6.0 milliMhos per centimeter;

f. Maturity will be greater than 80 percent;

g. Stability will be seven or less;

h. Carbon/nitrogen ratio will be less than 25:1;

i. Trace metal test result = "pass"; and

j. The compost will have a dry bulk density ranging from 40 to 50 pounds per cubic foot.

- Soil tests are required during two stages of the compost amendment process. An Initial test is used to determine soil properties to a depth one foot below the proposed amendment area, which will be conducted every 5,000 square feet, and used to characterize potential drainage problems and determine if any further soil amendments are needed. The second soil test is taken at least one week after the compost has been incorporated into the soils and used to determine whether any further nutritional requirements, pH adjustment, and organic matter adjustments are necessary.

- Prior to construction, area will be deep tilled to a depth of two to three feet, creating rips perpendicular to the direction of flow, if applicable.

- A 2nd deep tilling to a depth of 12 to 18 inches will be conducted after final grading.

- Apply compost during dry conditions.

- An acceptable compost mix is then incorporated into the soil using a roto-tiller or similar equipment at the volumetric rate of one part compost to two parts soil.

- The amended area will be raked to achieve the most level slope possible without using heavy construction equipment, and it will be stabilized rapidly with perennial grass and/or herbaceous species.

- If slopes exceed three percent, a protective biodegradable fabric or matting (e.g., EC-2) will be installed to stabilize the site prior to runoff discharge.

The slopes at the Elizabeth River M&R Station are less than 3 percent; therefore, mulching methods other than biodegradable fabric or matting can be used.

- Compost amendments will not be incorporated until the gravel diaphragm and/or engineered level spreader are installed

- **Gravel Diaphragms:** A pea gravel (#8 or ASTM equivalent) diaphragm at the top of the slope is required for vegetated filter strips that receive sheetflow. The pea gravel diaphragm is created by excavating a two-foot wide and one-foot deep trench that runs on the same contour at the top of the filter strip. The diaphragm serves two purposes. First, it acts as a pretreatment device, settling out sediment particles before they reach the practice. Second, it acts as a level spreader, maintaining sheet flow as runoff flows over the filter strip.

    - The flow will travel over the impervious area and to the practice as sheet flow and then drop at least three inches onto the gravel diaphragm. The drop helps to prevent runoff from running laterally along the pavement edge, where grit and debris tend to build up (thus allowing by-pass of the filter strip).

    - A layer of filter fabric will be placed between the gravel and the underlying soil trench.

- **Permeable Berm:** Vegetated filter strips will be designed with a permeable berm at the toe of the filter strip to create a shallow ponding area. Runoff ponds behind the berm and gradually flows through outlet pipes in the berm or through a gravel lens in the berm with a perforated pipe. During larger storms, runoff may overtop the berm. The permeable berm will have the following properties:

    - A wide and shallow trench, 6 to 12 inches deep, will be excavated at the upstream toe of the berm, parallel with the contours.

    - Media for the berm will consist of 40 percent excavated soil, 40 percent sand, and 20 percent pea gravel.

    - The berm 6 to 12 inches high will be located downgradient of the excavated depression and will have gentle side slopes to promote easy mowing.

    - Stone may be needed to armor the top of berm to handle extreme storm events.

    - A permeable berm is not needed when vegetated filter strips are used as pretreatment to another stormwater practice.

5.3.2 Conserved Open Space

In accordance with VDEQ Stormwater Design Specification No. 2 (**Sheet Flow to a Vegetated Filter Strip or Conserved Open Space**) as provided in Attachment 3**,** DETI will adhere to the following general construction and maintenance specifications at the M&R Station to treat sheet flow delivered from adjacent impervious and managed turf areas by slowing runoff velocities and allowing sediment and attached pollutants to settle and/or be filtered by the vegetation. The vegetated area in the northeast corner of the property will be utilized as conserved open space, as depicted on the SWM drawings in Attachment 1.

By using the minimum design criteria specified in Table 5.3.2-1, the conserved open space area at the Elizabeth River M&R Station can achieve a 50 to 75 percent reduction in runoff volume, total phosphorus load, and total nitrogen load. In addition, peak discharge rates are reduced.

TABLE 5.3.2-1

Conserved Open Space Design Criteria

Design Issue	Conserved Open Space
Soil and Vegetative Cover	Undisturbed soil and native vegetation
Overall Slope and Width (perpendicular to the flow)	0.5% to 3% slope – minimum 35 ft. width
Sheet Flow	Maximum flow length of 150 ft. from adjacent pervious areas; Maximum flow of 75 ft. from adjacent impervious areas
Concentrated Flow	Not applicable – only sheet flow at Elizabeth River M&R Station
Construction Stage	Located outside the limits of disturbance and protected by ESCs
Typical Applications	Adjacent to stream or wetland buffer or forest conservation area
Compost Amendments	No
Boundary Spreader	Gravel diaphragm at top of filter

In addition, the following constraints will be observed during design and construction:

- No clearing, grading or heavy equipment is allowed except temporary disturbances associated with incidental utility construction, restoration operations or management of nuisance vegetation.
- The perimeter of the conserved open space will be protected by super silt fence, chain link fence, orange safety fence or other measure to prevent sediment discharge.
- The limits of disturbance will be clearly shown on all construction drawings and identified and protected in the field by acceptable signage, silt fence, snow fence or other protective barrier.
- Construction of the gravel diaphragm or engineered level spreader will not commence until the contributing drainage area has been stabilized and perimeter ESCs have been removed and cleaned out.

- A long-term vegetation management plan must be prepared to maintain the conserved open space in a natural vegetative condition. A specific plan will be developed to manage the unintended consequences of passive recreation, control invasive species, provide for tree and understory maintenance, etc.

- The conserved open space must be protected by a perpetual easement or deed restriction that assigns the responsible party to ensure that no future development, disturbance, or clearing may occur within the area.

5.4 LONG-TERM MAINTENANCE

In accordance with DETI's Standards and Specifications, long-term maintenance of structural SWM facilities must be conducted in accordance with 9 VAC 25-870-112. To be consistent with the provisions of 9 VAC 25-870-112, maintenance plans for the stormwater facilities is provided below in Section 5.5 and 5.6 must be submitted to DETI for formal review and approval prior to initiating the land disturbing activity, made available to VDEQ upon request, and must provide for inspections and maintenance and the submission of inspection and maintenance reports to the VDEQ. DETI transmission easements over land under which permanent SWM facilities will be placed must further assure the following:

- Be stated to run with the land;

- Provide for all necessary access to the property for purposes of maintenance and regulatory inspections; and

- Be enforceable by all appropriate governmental parties.

According to VDEQ Stormwater Design Specification No. 2 (**Sheet Flow to a Vegetated Filter Strip or Conserved Open Space**), vegetated filter strips must be covered by a drainage easement to allow inspection and maintenance. Conserved open space areas must be protected by a perpetual easement or deed restriction that assigns the responsible party to ensure that no future development, disturbance, or clearing may occur within the area.

5.5 MAINTENANCE INSPECTIONS

Annual inspections are used to trigger maintenance operations such as sediment removal and spot revegetation. Ideally, inspections will be conducted in the non-growing season when it easier to see the flow path.

Inspectors will check to ensure that:

- Flows through the filter strip do not short-circuit the overflow control section;
- Debris and sediment does not build up at the top of the filter strip;
- Foot or vehicular traffic does not compromise the gravel diaphragm;
- Scour and erosion do not occur within the filter strip; and
- Vegetative density exceeds a 90 percent cover in the boundary zone or grass filter.

Corrective measures must be carried out as soon as practicably feasible when needed.

5.6 ONGOING MAINTENANCE

Once established, vegetated filter strips have minimal maintenance needs outside of the spring clean-up, regular mowing, repair of check dams and other measures to maintain the hydraulic efficiency of the strip and a dense, healthy grass cover. Vegetated filter strips that consist of grass/turf cover will be mowed at least twice a year to prevent woody growth.

6.0 POLLUTION PREVENTION PRACTICES AND PROCEDURES

The same pollution prevention practices and procedures provided in Section 6.0 of the main body of the SWPPP will be used at the M&R Station, as applicable.

7.0 ROLES AND RESPONSIBILITIES

DETI will use the same qualified personnel and Responsible Land Disturber at the M&R Station as identified in Section 7.0 in the main body of the SWPPP.

8.0 INSPECTION AND MAINTENANCE

The same inspection and maintenance requirements provided in Section 8.0 in the main body of the SWPPP are applicable to the M&R Station, with the exception of representative inspections which only apply to the pipeline right-of-way.

9.0 EMPLOYEE TRAINING

The employee training program described in Section 9.0 in the main body of the SWPPP applies to the M&R Station.

10.0 NOTIFICATION, RECORDKEEPING, AND REPORTING

Refer to Section 10.0 of the main body of the SWPPP for notification, recordkeeping, and reporting requirements.

In addition, according to DETI's Standards and Specifications for projects requiring post-construction SWM BMPs, DETI must report the following annually each year to VDEQ:

- Number and types of SWM BMPs installed;
- Geographic coordinates of each BMP;
- Drainage area or watershed size served; and
- Receiving stream or hydrologic unit.

11.0 REFERENCES

Dominion Energy Transmission, Inc. 2017. Standards and Specification for Erosion and Sediment Control and Stormwater Management for Construction and Maintenance of Gas Transmission Projects in Virginia. June 2017.

LandScope America. 2014. *Mid-Atlantic Coastal Plain.* Available online at http://www.landcope.org/explore/natural_geographies/ecoregions/Mid-Atlantic%20Coastal%20Plain/. Accessed October 2014.

Soil Survey Staff. 2015a. Web Soil Survey. Natural Resources Conservation Service, U.S. Department of Agriculture. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed June 2015.

Soil Survey Staff. 2015b. Official Soil Series Descriptions. Natural Resources Conservation Service, U.S. Department of Agriculture. Available online at https://soilseries.sc.egov.usda.gov/. Accessed June 2015.

U.S. Geological Survey. 1994. Hydrological Units Maps: United States Geological Survey Water-Supply Paper 2294. Available online at http://pubs.usgs.gov/wsp/wsp2294/pdf/wsp_2294.pdf. Accessed November 2016.

Virginia Department of Environmental Quality. 1992. Virginia Erosion and Sediment Control Handbook. Available online at http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications/ESCHandbook.aspx. Accessed November 2016.

Virginia Department of Environmental Quality. 2011. *Virginia A DEQ Stormwater Design Specification No. 2* Version 1.9. Available online at Virginia Stormwater BMP Clearinghouse at http://www.vwrrc.vt.edu/swc/. Accessed December 2016

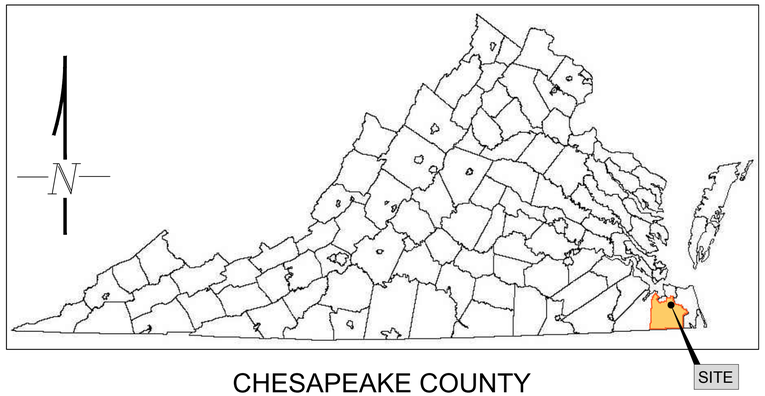
Virginia Department of Environmental Quality. 2011. *Virginia A DEQ Stormwater Design Specification No. 4* Version 1.9. Available online at Virginia Stormwater BMP Clearinghouse at http://www.vwrrc.vt.edu/swc/. Accessed December 2016

Virginia Department of Environmental Quality. 2015. Final 2014 305(b)/303(d) Water Quality Assessment Integrated Report; GIS Data. Available online at http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments/2014305(b)303(d)IntegratedReport.aspx. Accessed November 2016.

ATTACHMENT 1

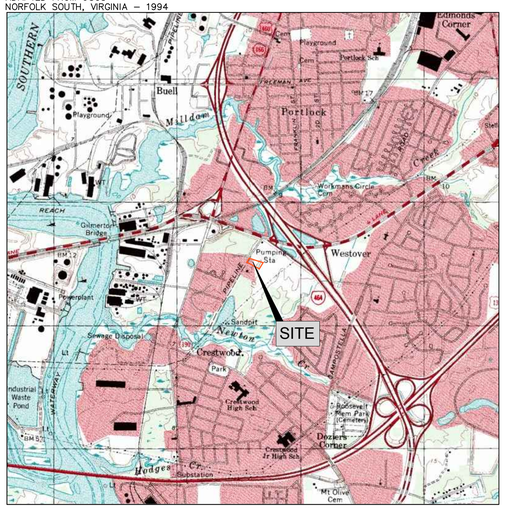
Erosion and Sediment Control and Stormwater Management Drawings and Supporting Calculations

ELIZABETH RIVER M&R STATION
EROSION AND SEDIMENT CONTROL PLAN AND
POST-CONSTRUCTION STORMWATER MANAGEMENT PLAN



CHESAPEAKE COUNTY
VIRGINIA

ADAPTED FROM USGS
NORFOLK SOUTH, VIRGINIA – 1994



36° 46' 25.87"N
76° 16' 54.34"W (NAD83)
CHESAPEAKE COUNTY, VIRGINIA

SITE LOCATION MAP

0 2000 4000
APPROXIMATE
SCALE (IN FEET)



SITE VICINITY MAP

0 300 600
APPROXIMATE
SCALE (IN FEET)

GENERAL NOTES

1. UNLESS OTHERWISE INDICATED, ALL VEGETATIVE AND STRUCTURAL EROSION AND SEDIMENT CONTROL PRACTICES WILL BE CONSTRUCTED AND MAINTAINED ACCORDING TO MINIMUM STANDARDS AND SPECIFICATIONS OF THE VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK AND VIRGINIA REGULATIONS 4VAC50–30 EROSION AND SEDIMENT CONTROL REGULATIONS.
2. THE PLAN APPROVING AUTHORITY MUST BE NOTIFIED ONE WEEK PRIOR TO THE PRE–CONSTRUCTION CONFERENCE, ONE WEEK PRIOR TO THE COMMENCEMENT OF LAND DISTURBING ACTIVITY, AND ONE WEEK PRIOR TO THE FINAL INSPECTION.
3. ALL EROSION AND SEDIMENT CONTROL MEASURES ARE TO BE PLACED PRIOR TO OR AS THE FIRST STEP IN CLEARING.
4. A COPY OF THE APPROVED EROSION AND SEDIMENT CONTROL PLAN SHALL BE MAINTAINED ON THE SITE AT ALL TIMES.
5. PRIOR TO COMMENCING LAND DISTURBING ACTIVITIES IN AREAS OTHER THAN INDICATED ON THESE PLANS (INCLUDING, BUT NOT LIMITED TO, OFF–SITE BORROW OR WASTE AREAS), THE CONTRACTOR SHALL SUBMIT A SUPPLEMENTARY EROSION CONTROL PLAN TO THE OWNER FOR REVIEW AND APPROVAL BY THE PLAN APPROVING AUTHORITY.
6. THE CONTRACTOR IS RESPONSIBLE FOR INSTALLATION OF ANY ADDITIONAL EROSION CONTROL MEASURES NECESSARY TO PREVENT EROSION AND SEDIMENTATION AS DETERMINED BY THE PLAN APPROVING AUTHORITY.
7. ALL DISTURBED AREAS ARE TO DRAIN TO APPROVED SEDIMENT CONTROL MEASURES AT ALL TIMES DURING LAND DISTURBING ACTIVITIES AND DURING SITE DEVELOPMENT UNTIL FINAL STABILIZATION IS ACHIEVED.
8. DURING DEWATERING OPERATIONS, WATER WILL BE PUMPED INTO AN APPROVED FILTERING DEVICE.
9. THE CONTRACTOR SHALL INSPECT ALL EROSION CONTROL MEASURES PERIODICALLY AND AFTER EACH RUNOFF–PRODUCING RAINFALL EVENT. ANY NECESSARY REPAIRS OR CLEANUP TO MAINTAIN THE EFFECTIVENESS OF THE EROSION CONTROL DEVICES SHALL BE MADE IMMEDIATELY.

LIST OF DRAWINGS

DRAWING NO.	TITLE
PD Z9951B	EROSION AND SEDIMENT CONTROL COVER SHEET
PD Z9951C	EROSION AND SEDIMENT CONTROL SITE PLAN
PD Z9951D	EROSION AND SEDIMENT CONTROL DETAILS
PD Z9951E	POST–CONSTRUCTION STORMWATER MANAGEMENT SITE PLAN
PD Z9951F	POST–CONSTRUCTION STORMWATER MANAGEMENT DETAILS

PROJECT NARRATIVE

PROJECT AND SITE DESCRIPTION

AS PART OF THE ATLANTIC COAST PIPELINE (ACP) PROJECT, DOMINION TRANSMISSION INC. (DTI) IS PROPOSING TO CONSTRUCT AN APPROXIMATELY 1.0–ACRE ABOVEGROUND METERING AND REGULATING STATION AT 2516 SOUTH MILITARY HIGHWAY IN CHESAPEAKE, VIRGINIA. THIS STATION, REFERRED TO AS THE ELIZABETH RIVER M&R STATION (M&R STATION), WILL BE CO–LOCATED WITH AN EXISTING NATURAL GAS STORAGE AND PEAK SHAVING FACILITY. THE M&R STATION WILL BE LOCATED AT MILEPOST 82.7 OF THE AP–3 LATERAL SECTION OF THE ACP PIPELINE, WITHIN THE CITY OF CHESAPEAKE. THE APPROXIMATELY 1.0–ACRE RECTANGULAR TRACT OF LAND IS LOCATED ALONG THE NORTHERN PROPERTY BOUNDARY OF A LARGER PARCEL. THE LARGER PARCEL IS IDENTIFIED IN THE CITY OF CHESAPEAKE RECORDS AS PARCEL NUMBER 0260000000340 WITH A PROPERTY ADDRESS OF 2516 SOUTH MILITARY HIGHWAY. THE GENERAL VICINITY AROUND THE M&R STATION IS A MIX OF COMMERCIAL/INDUSTRIAL DEVELOPMENT TO THE NORTH AND WEST AND A MIX OF UNDEVELOPED/RESIDENTIAL PROPERTY TO THE EAST AND SOUTH.

EXISTING SITE CONDITIONS

THE M&R STATION IS MAINLY UNDEVELOPED WITH THE WESTERNMOST PORTION (APPROXIMATELY ONE–THIRD OF THE STATION) CONSISTING OF A GRASSY AREA AND THE REMAINING TWO–THIRDS CONSISTING OF WOODED LAND. AN EXISTING NATURAL GAS PIPELINE RIGHT–OF–WAY (ROW) CROSSES THE PROPOSED M&R STATION ALONG THE WESTERN BOUNDARY. A DRAINAGE DITCH IS LOCATED ADJACENT TO THE WESTERN BOUNDARY OF THE M&R STATION ALONGSIDE AN ACCESS ROAD LEADING TO THE M&R STATION FROM SOUTH MILITARY HIGHWAY. TWO DRAINAGE DITCHES ARE LOCATED IN THE FORESTED PORTION OF THE PROPERTY RUNNING IN A ROUGHLY NORTH–SOUTH DIRECTION AND ANOTHER ALONG A PORTION OF THE M&R STATION'S NORTHERN BOUNDARY. A WETLAND IS LOCATED AT THE SOUTHEASTERN CORNER OF THE M&R STATION PROPERTY.

THE TOPOGRAPHY AT THE M&R STATION IS CHARACTERIZED BY FLAT TO GENTLY SLOPING TERRAIN WITH AN ELEVATION OF APPROXIMATELY 10 FEET ABOVE MEAN SEA LEVEL. THE PROPOSED DEVELOPMENT WILL RETAIN THE EXISTING TOPOGRAPHY OF FLAT TO GENTLY SLOPING TERRAIN WITH GRADING TO DIRECT STORMWATER TOWARD VEGETATED FILTER STRIPS PLANNED ALONG THE EASTERN AND WESTERN SIDES OF THE PROPERTY.

THE FULL PROJECT NARRATIVE HAS BEEN PROVIDED IN THE STORMWATER POLLUTION PREVENTION PLAN, APPENDIX F, EROSION AND SEDIMENT CONTROL AND STORMWATER MANAGEMENT PLAN FOR THE ELIZABETH RIVER M&R STATION.

NOTE:
SITE VICINITY MAP PROVIDED BY ERM USING GOOGLE EARTH PRO VERSION 7.1.5.1557. IMAGE DATED 4/23/2014.
MAP ENTITLED CIVIL EROSION AND SEDIMENT CONTROL FINAL CONDITIONS DRAINAGE AREA MAP WAS PROVIDED FOR THE VIRGINIA ELECTRIC AND POWER COMPANY BRUNSWICK COUNTY POWER STATION OVERALL STORMWATER MANAGEMENT AND EROSION AND SEDIMENT CONTROL PLANS.

SYM.	DATE	BY	REVISION INFORMATION	PROJECT/TASK	APP.
0	01/13/17	TS	ISSUED FOR REVIEW	0345197.011	SL

COMMONWEALTH OF VIRGINIA
DANIEL R. GOLDSTEIN
Lic. No. 047436
PROFESSIONAL ENGINEER

Environmental Resources Management

DRAWN:	YMT	01/11/17
CHECKED:	KC	01/13/17
APP. FOR BID:		
APP. FOR CONST.:		
SCALE:	AS NOTED	

Atlantic Coast Pipeline, LLC
925 White Oaks Blvd. Bridgeport, West Virginia 26330 / 681-842-8000

TITLE: ELIZABETH RIVER M&R STATION
EROSION AND SEDIMENT CONTROL COVER SHEET

DISTRICT:	COUNTY:	STATE:	GROUP	DWG. NO.	REV.
CHESAPEAKE	CHESAPEAKE	VA	PD	Z9951B	0

DIR/FILE: ACP\Virginia\M&R Stations\Elizabeth River\ESC

SITE LOCATION

LAT : 36°46'25.87"
LONG: 76°16'54.34"
MILE POST: 79.30 (APPROX)

20' 10' 0 20'
SCALE : 1" = 20'
CONTOUR INTERVAL: 2 FOOT
DATUM: UTM 17 NAD 83

N

SOIL TYPE 45
EXISTING ROAD
20' GATE
EXISTING 12" STEEL CULVERT
VEGETATED FILTER STRIP (POST CONSTRUCTION BMP, SEE NOTE 6)
GRAVEL DIAPHRAGM (POST CONSTRUCTION BMP, SEE NOTE 8)
SOIL TYPE 48
SOIL TYPE 20
UNPAVED PARKING
ASPHALT
TEMPORARY STONE CONSTRUCTION ENTRANCE
1
Z9951D
PROPOSED 12" STEEL CULVERT EXTENDED
SLING GATE
PROPOSED ACCESS ROAD
DUAL 15' SWING GATE
GRASS
8.5% MIN. SLOPE
MAN GATE
STANDARD FENCE
CONSERVED OPEN SPACE (POST CONSTRUCTION BMP, SEE NOTE 7)
WOODED AREA
HIGH SECURITY FENCE
DOUBLE 6' SWING GATE
EXISTING 12" STEEL CULVERT
BELTED SILT RETENTION FENCE - PRIORITY 1 (BSRF1)
2
Z9951D
EXISTING ROAD
ASPHALT
BUILDING
GRAVEL
MAIN GATE
STANDARD FENCE
VEGETATED FILTER STRIP (POST CONSTRUCTION BMP, SEE NOTE 6)
SOIL TYPE 20

LEGEND

- PROPERTY LINE
- LIMIT OF DISTURBANCE
- BELTED SILT RETENTION FENCE - PRIORITY 1 (BSRF)
- EXISTING CONTOURS
- PROPOSED CONTOURS
- DITCH
- STANDARD FENCE
- HIGH SECURITY FENCE
- SOIL LINE TYPE
- STORMWATER FLOW DIRECTION (EXISTING)
- EXISTING WETLAND
- CONSERVED OPEN SPACE (TO BE INSTALLED AS POST-CONSTRUCTION BMP)
- VEGETATED FILTER STRIP (TO BE INSTALLED AS POST-CONSTRUCTION BMP)
- GRAVEL DIAPHRAGM (TO BE INSTALLED AS POST-CONSTRUCTION BMP)

GENERAL NOTES AND COMMENTS:

1. BASE MAP PROVIDED BY I3 ENGINEERING AND CONSULTING, LLC.
2. LIMITS OF CLEARING AND GRADING IS APPROXIMATELY 0.9 ACRES WITHIN THE LIMIT OF DISTURBANCE SHOWN (FULL SITE IS 1 ACRE).
3. A DRAINAGE DITCH IS CURRENTLY LOCATED ADJACENT TO THE WESTERN BOUNDARY OF THE M&R STATION ALONGSIDE AN ACCESS ROAD LEADING TO THE M&R STATION FROM SOUTH MILITARY HIGHWAY. TWO DRAINAGE DITCHES ARE LOCATED IN THE FORESTED PORTION OF THE PROPERTY RUNNING IN A ROUGHLY NORTH-SOUTH DIRECTION AND ANOTHER ALONG A PORTION OF THE M&R STATION'S NORTHERN BOUNDARY.
4. THE M&R STATION IS LOCATED WITHIN THE DEEP CREEK-SOUTHERN BRANCH ELIZABETH RIVER WATERSHED. THE SITE DRAINS SOUTH TOWARD A FORMER SANDPIT WHICH IS NOW FILLED WITH WATER AND DISCHARGES INTO NEWTON CREEK. NEWTON CREEK FLOWS WEST INTO THE SOUTHERN BRANCH OF THE ELIZABETH RIVER.
5. FINAL CONTOURS WILL BE GRADED AS SHOWN ON THIS SITE PLAN. A PORTION OF THE SITE WILL DRAIN TOWARDS THE DRAINAGE DITCH LOCATED ON THE WESTERN SIDE OF THE PROPERTY AND THE OTHER PORTION WILL DRAIN TOWARDS THE DRAINAGE DITCH AND WETLAND ON THE EASTERN SIDE OF THE PROPERTY.
6. THE PORTION OF THE WETLAND WHICH EXTENDS BEYOND THE AREA OF LAND DISTURBANCE AND ONTO THE ADJACENT PROPERTY WILL BE PROTECTED FROM POST-CONSTRUCTION STORMWATER RUNOFF WITH A VEGETATED FILTER STRIP. A VEGETATED FILTER STRIP WILL ALSO BE LOCATED ON THE WESTERN END OF THE SITE. DETAILS AND SPECIFICATIONS FOR THE VEGETATED FILTER STRIPS ARE PROVIDED ON THE POST-CONSTRUCTION STORMWATER MANAGEMENT SITE PLAN AND DETAILS.
7. A PORTION OF THE EASTERN SIDE OF THE SITE WILL BE PRESERVED AS CONSERVED OPEN SPACE AS A PART OF THE POST-CONSTRUCTION STORMWATER MANAGEMENT REQUIREMENTS. DETAILS AND SPECIFICATIONS FOR THE CONSERVED OPEN SPACE ARE PROVIDED ON THE POST-CONSTRUCTION STORMWATER MANAGEMENT SITE PLAN AND DETAILS.
8. POST-CONSTRUCTION RUNOFF WILL SHEET FLOW TO A GRAVEL DIAPHRAGM FOR PRE-TREATMENT BEFORE ENTERING THE VEGETATED FILTERS AND CONSERVED OPEN SPACE. THE GRAVEL DIAPHRAGM WILL PROVIDE EVEN DISTRIBUTION OF THE RUNOFF FLOW SO THAT SHEET FLOW IS MAINTAINED AS THE RUNOFF ENTERS THE VEGETATED FILTERS AND CONSERVED OPEN SPACE. DETAILS AND SPECIFICATIONS FOR THE GRAVEL DIAPHRAGM ARE PROVIDED ON THE POST-CONSTRUCTION STORMWATER MANAGEMENT SITE PLAN AND DETAILS.
9. SOIL TYPES THAT ARE PRESENT AT THE M&R STATION INCLUDE DRAGSTON-TOMOTLEY COMPLEX AND TOMOTLEY-URBAN LAND-NIMMO COMPLEX.

SYM.	DATE	BY	REVISION INFORMATION	PROJECT/TASK	APP.
0	01/13/17	TS	ISSUED FOR REVIEW	0345197.011	SL

COMMONWEALTH OF VIRGINIA
DANIEL R. GOLDSTEIN
Lic. No. 047436
PROFESSIONAL ENGINEER

ERM Environmental Resources Management

DRAWN:	YMT	01/16/17
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SCALE:	AS NOTED	

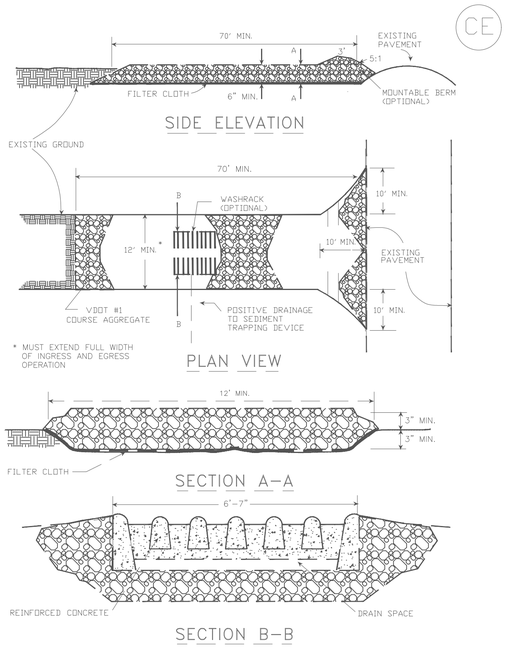
Atlantic Coast Pipeline, LLC

925 White Oaks Blvd. Bridgeport, West Virginia 26330 / 681-842-8000

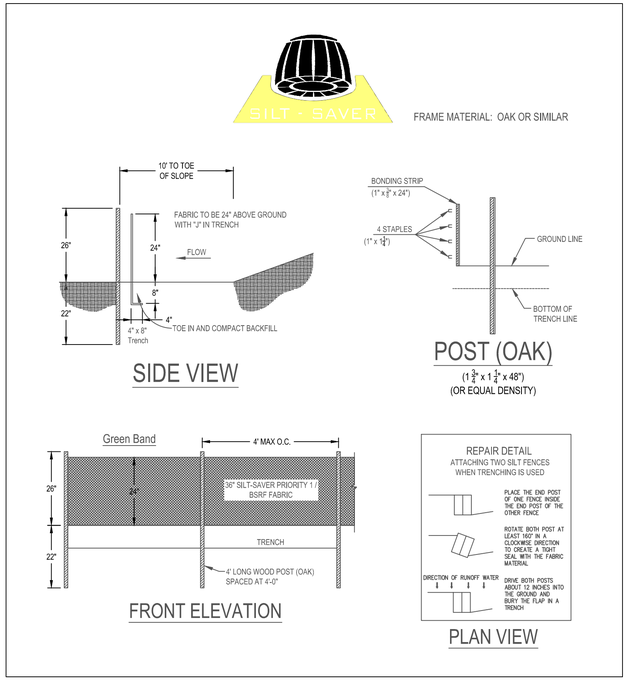
TITLE: **ELIZABETH RIVER M&R STATION**
EROSION AND SEDIMENT CONTROL SITE PLAN

DISTRICT:	COUNTY:	STATE:	GROUP	DWG. NO.	REV.
CHESAPEAKE	CHESAPEAKE	VA	PD	Z9951C	0

DIR/FILE: ACP\Virginia\M&R Stations\Elizabeth River\ESC



1 Z9951C TEMPORARY STONE CONSTRUCTION ENTRANCE
NOT TO SCALE



2 Z9951C BELTED SILT RETENTION FENCE PRIORITY 1 (BSRF1)
NOT TO SCALE

SEQUENCE OF CONSTRUCTION:

1. A PRE–CONSTRUCTION MEETING SHALL TAKE PLACE PRIOR TO START OF CONSTRUCTION ACTIVITIES.
2. INSTALL BELTED SILT RETENTION FENCE AS SHOWN ON PLANS. ALL EROSION AND SEDIMENT CONTROL MEASURES ARE TO BE PLACED PRIOR TO OR AS THE FIRST STEP IN CLEARING.
3. BEGIN CLEARING AND GRUBBING SITE AS NEEDED.
4. GRADE SITE ACCORDING TO THE CONTRACT DOCUMENTS. MAINTAIN EROSION CONTROL DEVICES AS NEEDED.
5. GRASS OR OTHERWISE STABILIZE ALL AREAS AS THEY ARE BROUGHT TO FINAL GRADES.
6. THE CONTRACTOR SHALL DILIGENTLY AND CONTINUOUSLY MAINTAIN ALL EROSION CONTROL DEVICES AND STRUCTURES TO MINIMIZE EROSION. INSPECT AND REPAIR MEASURES AFTER EACH RAINFALL AND AS NEEDED THROUGHOUT THE PROJECT.
7. CONTRACTOR TO LEAVE ALL EROSION CONTROL DEVICES IN PLACE AT THE CONCLUSION OF THIS CONTRACT. CONTRACTOR IS TO CLEAN–OUT, REPAIR AND GRASS STABILIZE ALL DENUDED AREAS. ALL AREAS WILL BE RETURNED TO THE STATE OF EXISTING CONDITIONS PRIOR TO CONTRACT AS A MINIMUM.
8. IT IS THE CONTRACTOR'S RESPONSIBILITY TO CONTAIN SEDIMENT ONSITE. ADDITIONAL EROSION CONTROL MEASURES MAY BE REQUIRED BY THE ENGINEER.
9. ALL EROSION CONTROL MEASURES SHALL BE IN ACCORDANCE WITH THE VIRGINIA EROSION AND SEDIMENTATION CONTROL HANDBOOK (VESCH) (1992, 3RD EDITION) STANDARDS AND SPECIFICATIONS.

TEMPORARY STONE CONSTRUCTION ENTRANCE NOTES

1. VDOT #1 COARSE AGGREGATE (2– TO 3–INCH STONE) SHOULD BE USED.
2. AGGREGATE LAYER SHALL BE AT LEAST 6 INCHES THICK; A MINIMUM THREE INCHES OF AGGREGATE SHALL BE PLACED IN A CUT SECTION TO GIVE THE ENTRANCE ADDED STABILITY AND TO HELP SECURE FILTER CLOTH SEPARATOR. AGGREGATE LAYER MUST EXTEND THE FULL WIDTH OF THE VEHICULAR INGRESS AND EGRESS AREA AND HAVE A MINIMUM 12–FOOT WIDTH.
3. LENGTH OF THE ENTRANCE SHALL BE AT LEAST 70 FEET.
4. ENTRANCE SHALL BE EXCAVATED A MINIMUM OF 3 INCHES AND MUST BE CLEARED OF ALL VEGETATION, ROOTS, AND OTHER OBJECTIONABLE MATERIAL BEFORE FILTER FABRIC UNDERLINER IS PLACED.
5. FILTER FABRIC UTILIZED SHALL BE A WOVEN OR NONWOVEN FABRIC CONSISTING ONLY OF CONTINUOUS CHAIN POLYMERIC FILAMENTS OR YARNS OF POLYESTER. FABRIC SHALL BE INERT TO COMMONLY ENCOUNTERED CHEMICALS AND HYDROCARBONS, BE MILDEW AND ROT RESISTANT, AND CONFORM TO THE PHYSICAL PROPERTIES NOTED IN TABLE 3.02–A OF THE VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK (VESCH) (1992, 3RD EDITION) STANDARDS AND SPECIFICATIONS.

TEMPORARY STONE CONSTRUCTION ENTRANCE MAINTENANCE NOTES

1. ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOW OF MUD ONTO PUBLIC RIGHTS–OF–WAY.
2. IF ANY INADVERTENT SEDIMENT TRACKING OCCURS ON THE PUBLIC ROADWAY, THE ROAD SHALL BE CLEANED THOROUGHLY BY THE END OF EACH DAY.
3. ENTRANCE MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE OR THE WASHING AND REWORKING OF EXISTING STONE AS CONDITIONS DEMAND AND REPAIR AND/OR CLEANOUT OF ANY STRUCTURES USED TO TRAP SEDIMENT.
4. ALL MATERIALS SPILLED, DROPPED, WASHED, OR TRACKED FROM VEHICLES ONTO ROADWAYS OR INTO STORM DRAINS MUST BE REMOVED IMMEDIATELY.
5. THE USE OF WATER TRUCKS TO REMOVE MATERIALS DROPPED, WASHED, OR TRACKED ONTO ROADWAYS WILL NOT BE PERMITTED UNDER ANY CIRCUMSTANCES.

BELTED SILT RETENTION FENCE – PRIORITY 1 NOTES

1. CONTRACTOR WILL UTILIZE THE BSRF1 MEDIUM–DUTY SILT FENCE CONSTRUCTED WITH A 36–INCH, NON–WOVEN, SPUN–BOND FABRIC WITH AN INTERNAL SCRIM INCORPORATED INTO THE FABRIC FOR ADDITIONAL STRENGTH AND DURABILITY.
2. BSRF1 SHALL BE INSTALLED IN ACCORDANCE WITH THE SPECIFICATIONS AND INSTALLATION INSTRUCTIONS PROVIDED IN THE STORMWATER POLLUTION PREVENTION PLAN, APPENDIX F, EROSION AND SEDIMENT CONTROL AND STORMWATER MANAGEMENT PLAN FOR ELIZABETH RIVER M&R STATION, APPENDIX A.

BELTED SILT RETENTION FENCE – PRIORITY 1 MAINTENANCE NOTES

1. BSRF1 SHALL BE INSPECTED AT THE END OF EACH WORK DAY AND IMMEDIATELY AFTER EACH RAINFALL EVENT. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY IN ACCORDANCE WITH THE DESIGN DETAILS AND SPECIFICATIONS.
2. ACCUMULATED SEDIMENT SHOULD BE REMOVED AFTER EACH STORM EVENT AND WHEN DEPOSITS REACH APPROXIMATELY ONE–HALF THE HEIGHT OF THE FENCE TO PREVENT FAILURES.
3. ANY DEPOSITS REMAINING IN PLACE AFTER THE FENCE IS NO LONGER REQUIRED SHALL BE DRESSED TO CONFORM WITH THE EXISTING GRADE, PREPARED AND SEEDED.

GENERAL NOTES AND COMMENTS:

SYM.	DATE	BY	REVISION INFORMATION	PROJECT/TASK	APP.
0	01/13/17	TS	ISSUED FOR REVIEW	0345197.011	SL

COMMONWEALTH OF VIRGINIA
DANIEL R. GOLDSTEIN
Lic. No. 047436
PROFESSIONAL ENGINEER

Environmental Resources Management

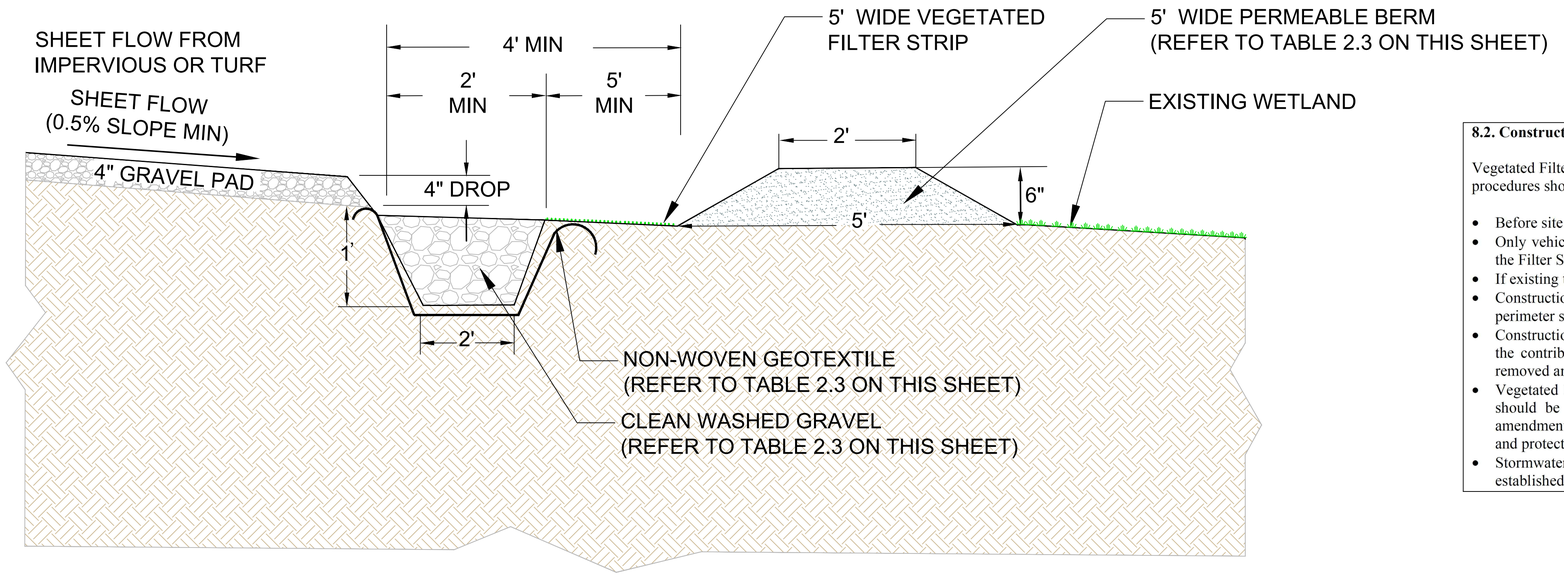
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APP. FOR BID:		
APP. FOR CONST.:		
SCALE:	AS NOTED	

Atlantic Coast Pipeline, LLC
925 White Oaks Blvd. Bridgeport, West Virginia 26330 / 681-842-8000

TITLE: **ELIZABETH RIVER M&R STATION EROSION AND SEDIMENT CONTROL DETAILS**

DISTRICT:	COUNTY:	STATE:	GROUP	DWG. NO.	REV.
CHESAPEAKE	CHESAPEAKE	VA	PD	Z9951D	0

DIR/FILE: ACP\Virginia\M&R Stations\Elizabeth River\ESC



A-A' SECTION THROUGH GRAVEL DIAPHRAGM AND VEGETATED FILTER STRIP
NOT TO SCALE

8.2. Construction Sequence for Vegetated Filter Strips

Vegetated Filter Strips can be within the limits of disturbance during construction. The following procedures should be followed during construction:

- Before site work begins, Vegetated Filter Strip boundaries should be clearly marked.
- Only vehicular traffic used for Filter Strip construction should be allowed within 10 feet of the Filter Strip boundary (City of Portland, 2004).
- If existing topsoil is stripped during grading, it shall be stockpiled for later use.
- Construction runoff should be directed away from the proposed Filter Strip site, using perimeter silt fence, or, preferably, a diversion dike.
- Construction of the gravel diaphragm or engineered level spreader shall not commence until the contributing drainage area has been stabilized and perimeter E&S controls have been removed and cleaned out.
- Vegetated Filter Strips require light grading to achieve desired elevations and slopes. This should be done with tracked vehicles to prevent compaction. Topsoil and or compost amendments should be incorporated evenly across the filter strip area, stabilized with seed, and protected by biodegradable erosion control matting or blankets.
- Stormwater should not be diverted into the Filter Strip until the turf cover is dense and well established.

Table 2.2. Filter Strip Design Criteria

Design Issue	Conserved Open Space	Vegetated Filter Strip
Soil and Vegetative Cover (Sections 6.1 and 6.2)	Undisturbed soils and native vegetation	Amended soils and dense turf cover or landscaped with herbaceous cover, shrubs, and trees
Overall Slope and Width (perpendicular to the flow) (Section 5)	0.5% to 3% Slope – Minimum 35 ft width 3% to 6% Slope – Minimum 50 ft width The first 10 ft. of filter must be 2% or less in all cases [2]	1% [1] to 4% Slope – Minimum 35 ft. width 4% to 6% Slope – Minimum 50 ft. width 6% to 8% Slope – Minimum 65 ft. width The first 10 ft. of filter must be 2% or less in all cases
Sheet Flow (Section 5)	Maximum flow length of 150 ft. from adjacent pervious areas; Maximum flow length of 75 ft. from adjacent impervious areas	
Concentrated Flow (Section 6.3)	Length of ELS [6] Lip = 13 lin. ft. per each 1 cfs of inflow if area has 90% Cover [3] Length = 40 lin. ft. per 1 cfs for forested or re-forested Areas [4] (ELS [6] length = 13 lin.ft. min; 130 lin.ft. max.)	Length of ELS [6] Lip = 13 lin.ft. per each 1 cfs of inflow (13 lin.ft. min; 130 lni.ft. max.)
Construction Stage (Section 8)	Located outside the limits of disturbance and protected by ESC controls	Prevent soil compaction by heavy equipment
Typical Applications (Section 5)	Adjacent to stream or wetland buffer or forest conservation area	Treat small areas of IC (e.g., 5,000 sf) and/or turf-intensive land uses (sports fields, golf courses) close to source
Compost Amendments (Section 6.1)	No	Yes (B, C, and D soils) [5]
Boundary Spreader (Section 6.3)	GD [6] at top of filter	GD [6] at top of filter PB [6] at toe of filter

[1] A minimum of 1% is recommended to ensure positive drainage.
[2] For Conservation Areas with a varying slope, a pro-rated length may be computed only if the first 10 ft. is 2% or less.
[3] Vegetative Cover is described in **Section 6.2**.
[4] Where the Conserved Open Space is a mixture of native grasses, herbaceous cover and forest (or re-forested area), the length of the ELS [6] Lip can be established by computing a weighted average of the lengths required for each vegetation type. Refer to **Section 6.3** for design criteria
[5] The plan approving authority may waive the requirement for compost amended soils for filter strips on B soils under certain conditions (see **Section 6.1**).
[6] ELS = Engineered Level Spreader; GD = Gravel Diaphragm; PB = Permeable Berm.

6.1. Compost Soil Amendments

Compost soil amendments will enhance the runoff reduction capability of a vegetated filter strip when located on hydrologic soil groups B, C, and D, subject to the following design requirements:

- The compost amendments should extend over the full length and width of the filter strip.
- The amount of approved compost material and the depth to which it must be incorporated is outlined in Stormwater Design Specification No. 4.
- The amended area will be raked to achieve the most level slope possible without using heavy construction equipment, and it will be stabilized rapidly with perennial grass and/or herbaceous species.
- If slopes exceed 3%, a protective biodegradable fabric or matting (e.g., EC-2) should be installed to stabilize the site prior to runoff discharge.
- Compost amendments should not be incorporated until the gravel diaphragm and/or engineered level spreader are installed (see **Section 6.3**).
- The local plan approval authority may waive the requirement for compost amendments on HSG-B soils in order to receive credit as a filter strip if (1) the designer can provide verification of the adequacy of the on-site soil type, texture, and profile to function as a filter strip, and (2) the area designated for the filter strip will not be disturbed during construction.

6.3. Diaphragms, Berms and Level Spreaders

Gravel Diaphragms: A pea gravel diaphragm at the top of the slope is required for both Conserved Open Space and Vegetated Filter Strips that receive sheetflow. The pea gravel diaphragm is created by excavating a 2-foot wide and 1-foot deep trench that runs on the same contour at the top of the filter strip. The diaphragm serves two purposes. First, it acts as a pretreatment device, settling out sediment particles before they reach the practice. Second, it acts as a level spreader, maintaining sheet flow as runoff flows over the Filter Strip. Refer to **Figure 2.5.**

- The flow should travel over the impervious area and to the practice as sheet flow and then drop at least 3 inches onto the gravel diaphragm. The drop helps to prevent runoff from running laterally along the pavement edge, where grit and debris tend to build up (thus allowing by-pass of the Filter Strip).
- A layer of filter fabric should be placed between the gravel and the underlying soil trench.
- If the contributing drainage area is steep (6% slope or greater), then larger stone (clean bank-run gravel that meets VDOT #57 grade) should be used in the diaphragm.
- If the contributing drainage area is solely turf (e.g., sports field), then the gravel diaphragm may be eliminated.

Permeable Berm: Vegetated Filter Strips should be designed with a permeable berm at the toe of the Filter Strip to create a shallow ponding area. Runoff ponds behind the berm and gradually flows through outlet pipes in the berm or through a gravel lens in the berm with a perforated pipe. During larger storms, runoff may overtop the berm (Cappiella *et al.,* 2006). The permeable berm should have the following properties:

- A wide and shallow trench, 6 to 12 inches deep, should be excavated at the upstream toe of the berm, parallel with the contours.
- Media for the berm should consist of 40% excavated soil, 40% sand, and 20% pea gravel.
- The berm 6 to 12 inches high should be located downgradient of the excavated depression and should have gentle side slopes to promote easy mowing (Cappiella *et al*., 2006).
- Stone may be needed to armor the top of berm to handle extreme storm events.
- A permeable berm is not needed when vegetated filter strips are used as pretreatment to another stormwater practice.

6.4. Filter Design Material Specifications

Table 2.3 describes materials specifications for the primary treatment within filter strips.

Table 2.3. Vegetated Filter Strip Materials Specifications

Material	Specification	Quantity
Gravel Diaphragm	Pea Gravel (#8 or ASTM equivalent) or where steep (6% +) use clean bank-run VDOT #57 or ASTM equivalent (1-inch maximum).	Diaphragm should be 2 feet wide, 1 foot deep, and at least 3 inches below the edge of pavement.
Permeable Berm	40% excavated soil, 40% sand, and 20% pea gravel to serve as the media for the berm.	
Geotextile	Needled, non-woven, polypropylene geotextile meeting the following specifications: Grab Tensile Strength (ASTM D4632): > 120 lbs. Mullen Burst Strength (ASTM D3786): > 225 lbs./sq. in. Flow Rate (ASTM D4491): > 125 gpm/sq. ft. Apparent Opening Size (ASTM D4751): US #70 or #80 sieve	
Engineered Level Spreader	Level Spreader lip should be concrete, metal, timber, or other rigid material; Reinforced channel on upstream of lip: VDOT EC-2 (or EC-3 if velocities require permanent reinforcing). See Hathaway and Hunt (2006) or Henrico County Program Manual.	
Erosion Control Fabric or Matting	Where flow velocities dictate, use woven biodegradable erosion control fabric or mats that are durable enough to last at least 2 growing seasons. (e.g., VDOT Erosion Control matting EC-2).	
Topsoil	If existing topsoil is inadequate to support dense turf growth, imported top soil (loamy sand or sandy loam texture), with less than 5% clay content, corrected pH at 6 to 7, a soluble salt content not exceeding 500 ppm, and an organic matter content of at least 2% shall be used. Topsoil shall be uniformly distributed and lightly compacted to a minimum depth of 6 to 8 inches	
Compost	Compost shall be derived from plant material and provided by a member of the U.S. Composting Seal of Testing Assurance (STA) program, as outlined in Stormwater Design Specification No. 4.	

GENERAL NOTES AND COMMENTS:
1. GUIDANCE FOR THE CONSTRUCTION AND MAINTENANCE OF THE GRAVEL DIAPHRAGM, VEGETATED FILTER STRIP AND PERMEABLE BERM IS LOCATED IN THE VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY (VDEQ) STORMWATER DESIGN SPECIFICATIONS NO. 2 (SHEET FLOW TO A VEGETATED FILTER STRIP OR CONSERVED OPEN SPACE).

SYM.	DATE	BY	REVISION INFORMATION	PROJECT/TASK	APP.
0	01/13/17	TS	ISSUED FOR REVIEW	0345197.011	SL

COMMONWEALTH OF VIRGINIA
DANIEL R. GOLDSTEIN
Lic. No. 047436
PROFESSIONAL ENGINEER

Environmental Resources Management

DRAWN:	YMT	01/17/17
CHECKED:	KC	01/13/17
APP. FOR BID:		
APP. FOR CONST.:		
SCALE:	AS NOTED	

Atlantic Coast Pipeline, LLC
925 White Oaks Blvd. Bridgeport, West Virginia 26330 / 681-842-8000

TITLE: ELIZABETH RIVER M&R STATION
POST-CONSTRUCTION STORMWATER MANAGEMENT DETAILS

DISTRICT:	COUNTY:	STATE:	GROUP	DWG. NO.	REV.
CHESAPEAKE	CHESAPEAKE	VA	PD	Z9951F	0

DIR/FILE: ACP\Virginia\M&R Stations\Elizabeth River\ESC

PURPOSE:

To demonstrate that the Elizabeth River M&R Station is compliant with the minimum standards set forth in 9VAC25-870-66 of the Virginia Administrative Code for channel and flood protection.

PROCEDURE:

Perform hydrologic analysis for the existing and proposed conditions, including runoff rates, volumes, and velocities using HydroCAD Stormwater Modeling System, Version 10 (Ref. 1) and the WinTR-55 Small Watershed Hydrology (Ref. 2) program.

The following steps will be taken:

1. Determine how many drainage areas are on site and the soil types.

2. Determine what subsection of 9VAC25-870-66-B (Channel Protection) is applicable to the site. Using WinTR-55, determine the existing and post condition peak discharge and runoff volume for the 1-year, 2-year, and 10-year frequency storm events to demonstrate compliance with that subsection.

3. Use HydroCAD to show that the velocity from the 1-year 24-hour storm in non-erosive to the stormwater conveyance channels.

4. Determine what subsection of 9VAC25-870-66-C (Flood Protection) is applicable to the site. Using HydroCAD, determine if the stormwater conveyance system contains the 10-year 24-hour storm within the channel.

1. Determine how many drainage areas are on site and soil types.

Based on the final site grading plan, the site was determined to have two drainage areas (see attached drainage map). The site was contoured so that approximately 0.24 acres drains to the western side of the site and 0.76 acres drain to the east.

Post Conditions, Drainage Area A (DA-A): Western portion of the site

- Gravel cover (including pea gravel): 0.12 acres
- Paved access road: 0.02 acres

- Vegetated Filter strip: 0.1 acres
- Total DA-A: 0.24 acres

Post Conditions, Drainage Area B (DA-B): Eastern portion of the site

- Gravel cover (including pea gravel): 0.6 acres
- Vegetated Filter strip: 0.029 acres
- Conserved Open Space: 0.068 acres
- Wetland: 0.063 acres
- Total DA-B: 0.76 acres

In order to compare exiting conditions to post conditions, it was assumed that the existing site drains in the same manner as the post conditions with 0.24 acres draining to the western ditch and 0.76 acres draining to the channel at the eastern side of the site.

Site soils are described in Appendix F of this SWPPP. According to the USDA's NRCS, soils beneath the wooded portion of the M&R Station are mapped as somewhat poorly drained to poorly drained (Dragston-Tomotley Complex) with depth to water table ranging from 0 to 30 inches. These soils consist of fine sand overlain by a 3 to 3.5 foot layer of fine sandy loam to a sandy clay loam. These soils stretch into the southern portion of the grassy area. The remaining portion of the grassy area is mapped in the Tomotley-Urban Land-Nimmo Complex. These soils are poorly drained with depth to water table ranging from 0 to 12 inches.

The hydrologic soil groups assigned by NRCS for the soils mapped at the M&R Station are as follows: Dragston (Group C); Tomotley: (Group B/D); Nimmo: (Group D). Based on this information, site soils were conservatively assumed to be Group D soils due to the high water table. Group D soils are described as such:

- Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

2. Using WinTR-55, calculate the peak discharge and runoff volume for the 1-year, 2-year, and 10-year frequency storm events to determine compliance with 9VAC25-870-66-B, Channel Protection.

Under 9VAC25-870-66-B, concentrated stormwater flow shall be released into a manmade, restored, or natural stormwater conveyance system and must meet the criteria in subdivision 1, 2, or 3. For the western portion of the site, it was determined that the existing channel is a restored stormwater conveyance system and therefore must meet the peak discharge requirements in subdivision 3 for concentrated stormwater flow to a natural system. This is due to the post-development conditions not being consistent with the pre-development conditions. The eastern portion of the site will drain to a natural conveyance system and must meet the requirements of subdivision 3 as well. Under subdivision 3, the maximum peak flow rate from the 1-year 24-hour storm shall be calculated using the following energy balance equation:

$$Q_{Developed} = I.F * (Q_{Pre-Developed} * RV_{Pre-Developed})/RV_{Developed}$$

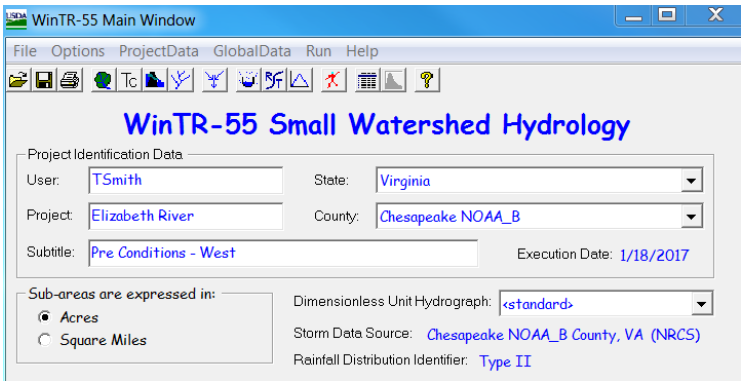
Where,

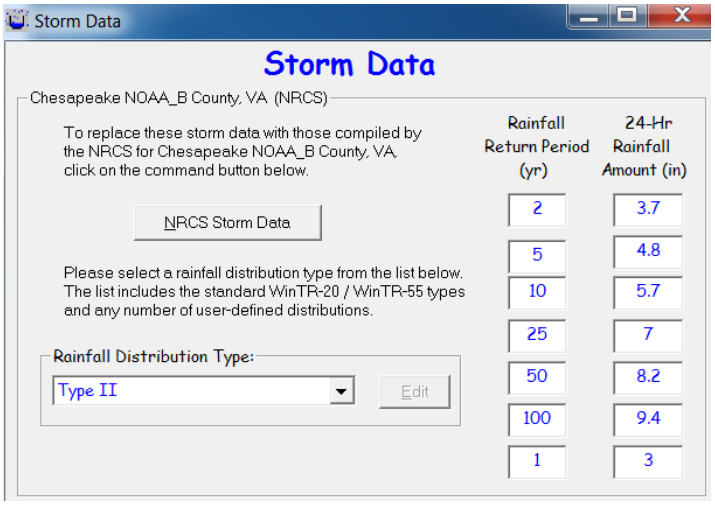
$Q_{Developed}$ = The allowable peak flow rate of runoff from the developed site
I.F. = Improvement factor, equals 0.8 for sites > 1 acre and 0.9 for sites 1 acre
$RV_{Developed}$ = The volume of runoff from the site in the developed condition
$Q_{Pre\text{-}Developed}$ = The peak flow of runoff from the site in pre-developed condition
$RV_{Pre\text{-}Developed}$ = The volume of runoff from the site in the pre-developed condition

WinTR-55 was utilized to calculate the above parameters. Inputs are shown below for the existing conditions of DA-A.

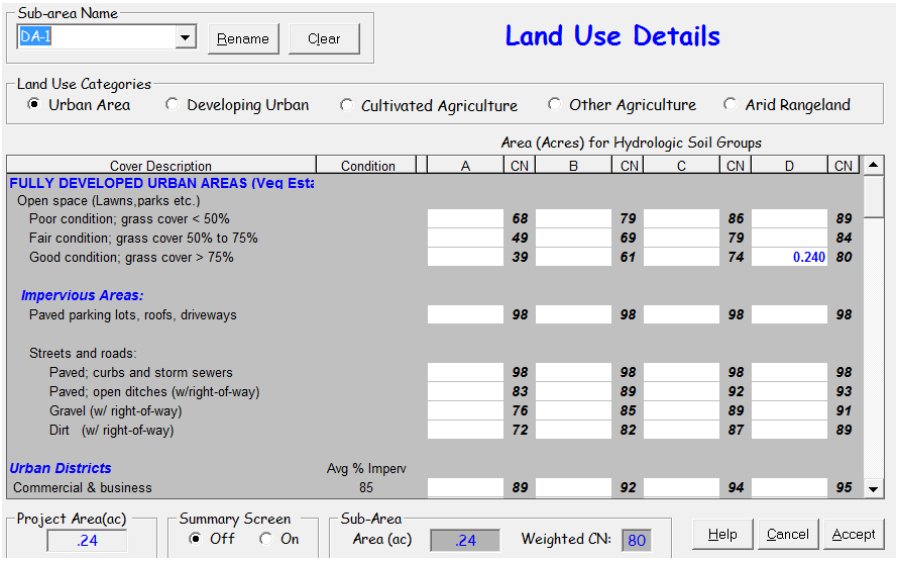
Existing Conditions, Drainage Area A (DA-A): Western portion of the site

1. The State and county was entered and the storm data was selected from the NRCS Storm Data default database for the associated county. Sub-area name, description, and where the water leaving the sub-area flows was also entered.





2. Land use details were added into the land use window. WinTR-55 calculates the weighted curve number (CN) and draingage area based on the inputs. It was assumed that the site soils are D soils and that the existing conditions are open space, good condition.



3. The time of concentration details were entered. From the point water enters DA-A to the point of discharge is approximately 100 feet. The site is assumed to have a 0.5% slope based on existing contours. The surface was selected and the time of concentration was automatically calculated.

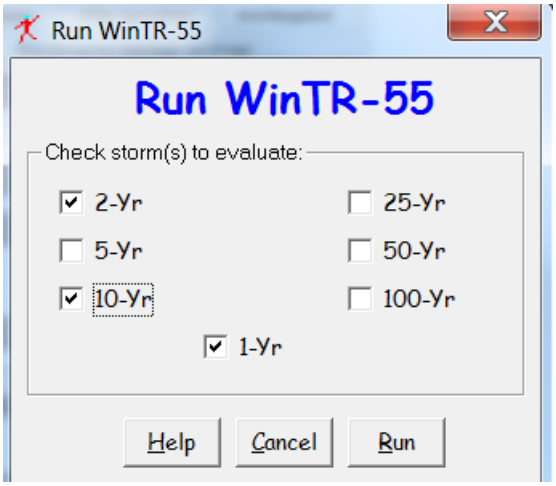
Sub-area Name: DA-1 | Rename | Clear

2-Year Rainfall (in): 3.7

Time of Concentration Details

Flow Type	Length (ft)	Slope (ft/ft)	Surface (Manning's n)	n	Area (ft²)	WP (ft)	Velocity (f/s)	Time (hr)
Sheet	100	0.0050	Grass-Range, Short (0.15)					0.264
Shallow Concentrated								
Shallow Concentrated								
Channel								
Channel								
Total	100						0.1052	0.264

4. WinTR-55 was run for the 1-year, 2-year, and 10-year 24-hour storm events. The WinTR-55 output files provide the peak runoff amounts in cfs and the WinTR-20 output files provides the peak runoff amounts in inches.



Hydrograph Peak/Peak Time Table — Close

TSmith
Elizabeth River
Pre Conditions - West
Chesapeake NOAA_B County, Virginia

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 2-Yr (cfs) (hr)	10-Yr (cfs) (hr)	1-Yr (cfs) (hr)
SUBAREAS			
DA-1	0.53 12.06	1.03 12.05	0.37 12.06
REACHES			
OUTLET	0.53	1.03	0.37

STORM 1-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DA-1	0.380E-03		0.628		12.06	0.37	966.33

STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DA-1	0.380E-03		0.998		12.06	0.53	1399.18

STORM 10-Yr

WinTR-20 Version 1.10 Page 1 02/15/2017 11:09

Elizabeth River
Pre Conditions - West

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DA-1	0.380E-03		2.343		12.05	1.03	2720.15

The same steps were performed for the pre and post conditions of DA-A and DA-B. Runoff volume was determined by converting the runoff amount to feet, dividing that by the drainage area and converting the acre-feet to cubic feet. A summary of the runoff and volume amounts are provided in the table below. All output files are provided as an attachemnt.

Drainage Area A (DA-A): Western portion of the site

TR-55 Discharge and Volume Calculations

	Discharge (cfs)			Volume (cf)		
	Pre	Post	Increase	Pre	Post	Increase
1 year storm	0.37	0.76	0.39	547.11	1006.24	459.12
2 year storm	0.53	0.99	0.46	869.46	1445.32	575.86
10 year storm	1.03	1.65	0.62	2041.22	2809.62	768.40

Drainage Area B (DA-B): Eastern portion of the site

TR-55 Discharge and Volume Calculations

	Discharge (cfs)			Volume (cf)		
	Pre	Post	Increase	Pre	Post	Increase
1 year storm	0.6	2.64	2.04	2005.65	5156.20	3150.55
2 year storm	0.92	3.35	2.43	3332.63	7175.64	3843.01
10 year storm	1.92	5.37	3.45	8030.87	13214.65	5183.79

Based on the information provided by WinTR-55, the maximum peak flow rate from the 1-year 24-hour storm can be calculated using the energy balance equations provided in 9VAC25-870-66 subsection B, subdivision 3.

Drainage Area A (DA-A): Western portion of the site

$$Q_{Developed} = I.F * (Q_{Pre-Developed} * RV_{Pre-Developed}) / RV_{Developed}$$

$Q_{Developed}$ = 0.76
I.F. = 0.9
$RV_{Developed}$ = 1006.24
$Q_{Pre-Developed}$ = 0.37
$RV_{Pre-Developed}$ = 547.11

0.76 = 0.9 * (0.37 * 547.11) / 1006.24

0.76 <> 0.18

Drainage Area B (DA-B): Eastern portion of the site

$$Q_{Developed} = I.F * (Q_{Pre-Developed} * RV_{Pre-Developed}) / RV_{Developed}$$

$Q_{Developed}$ = 2.64
I.F. = 0.9
$RV_{Developed}$ = 5156.20
$Q_{Pre-Developed}$ = 0.6
$RV_{Pre-Developed}$ = 2002.65

2.64 = 0.9 * (0.6 * 2002.65) / 5156.20

2.64 <> 0.21

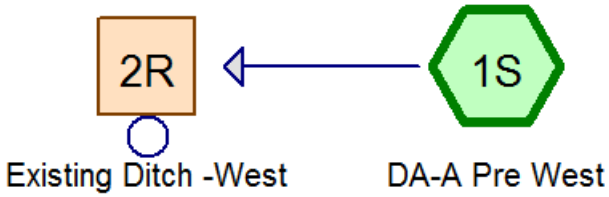
Based on the energy balance, DA-A and DA-B does not comply with 9VAC25-870-66 subsection B. The velocity of runoff from the 1-year 24-hour storm has to be calculated to show that the velocity is non-erosive to the channel.

3. Determine the velocity of runoff from the 1-year 24-hour storm to show that it is non-erosive to the stormwater conveyance system.

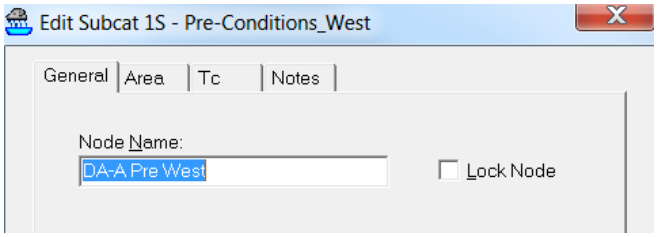
HydroCAD was utilized to calculate the velocity of runoff from the 1-year 24-hour storm event. Inputs are shown below for the existing conditions of DA-A.

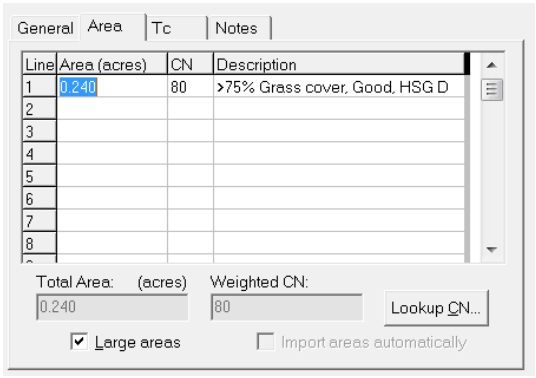
Existing Conditions, Drainage Area A (DA-A): Western portion of the site

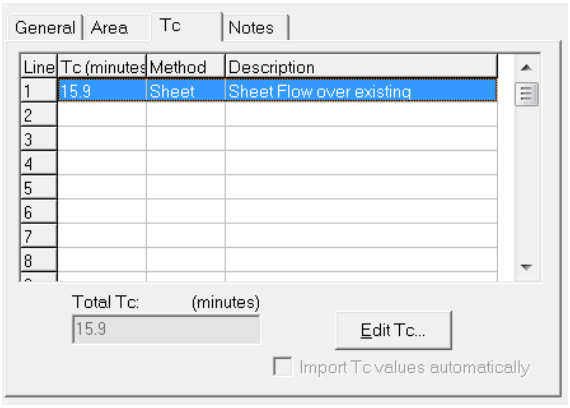
1. Construct the routing diagram to show the functional components that make up DA-A.

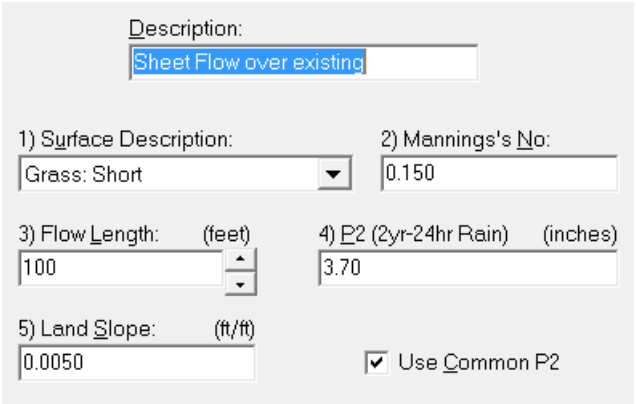


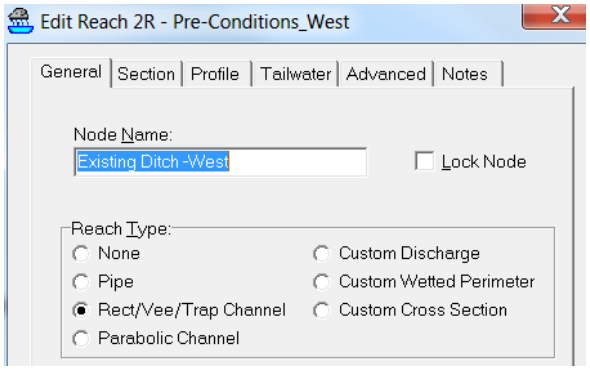
2. Describe each component or node in detail so that HydroCAD can calculate the outflow from the inflow inputs. For subcatchment 1S (DA-A), land use details and associated CN were selected and time of concentration was determined using the same parameters as shown in the WinTR-55 calculations. HydroCAD requires an input for the 2-year 24-hour storm to calculate the time of concentration. This is provided in the look up tables embedded into the program. Rainfall data was selected based on state and county (shown in step 3). For reach 2R (western channel), it was assumed that the channel was trapezoidal with a bottom width of 1 foot, depth of 1 foot, left/right slope of 0.5, and a manning's number of 0.022 for earth, clean and straight. For the purpose of these calculations, the inlet invert was set as 8 feet and the outlet invert at 7 feet with a profile length of 100 feet.

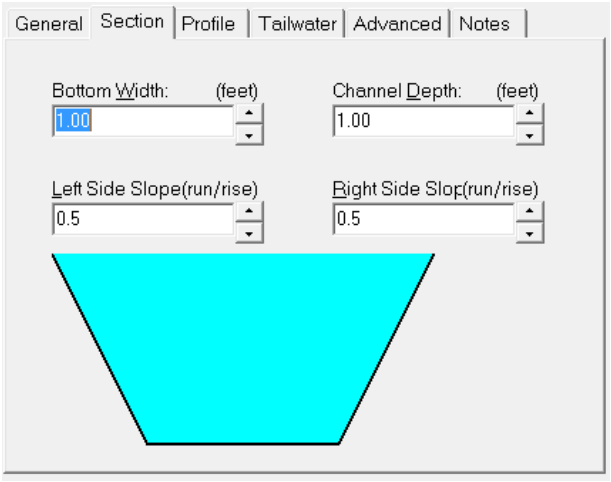

Edit Subcat 1S - Pre-Conditions_West
General
Area
Tc
Notes
Node Name:
DA-A Pre West
Lock Node

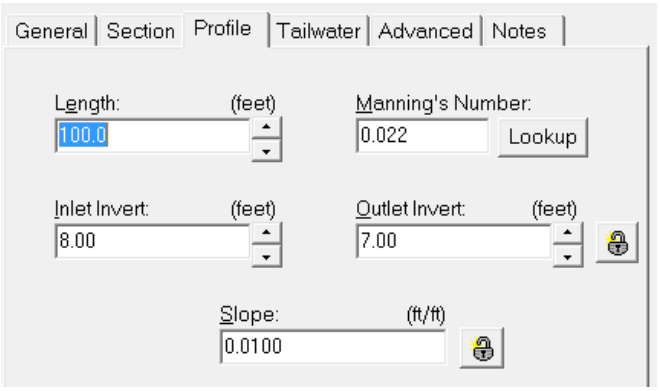

General
Area
Tc
Notes
Line
Area (acres)
CN
Description
1
0.240
80
>75% Grass cover, Good, HSG D
Total Area: (acres)
Weighted CN:
0.240
80
Lookup CN...
Large areas
Import areas automatically


General
Area
Tc
Notes
Line
Tc (minutes
Method
Description
1
15.9
Sheet
Sheet Flow over existing
Total Tc: (minutes)
15.9
Edit Tc...
Import Tc values automatically

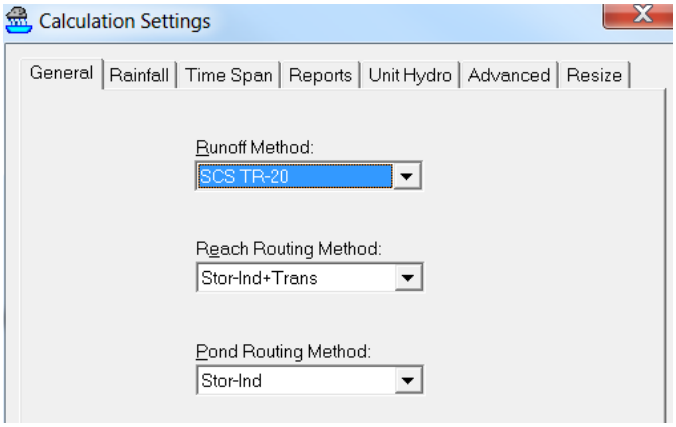

Description:
Sheet Flow over existing
1) Surface Description:
Grass: Short
2) Mannings's No:
0.150
3) Flow Length: (feet)
100
4) P2 (2yr-24hr Rain) (inches)
3.70
5) Land Slope: (ft/ft)
0.0050
Use Common P2

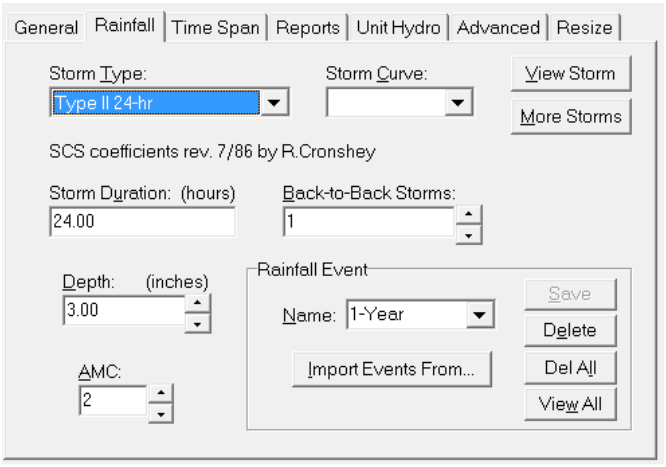


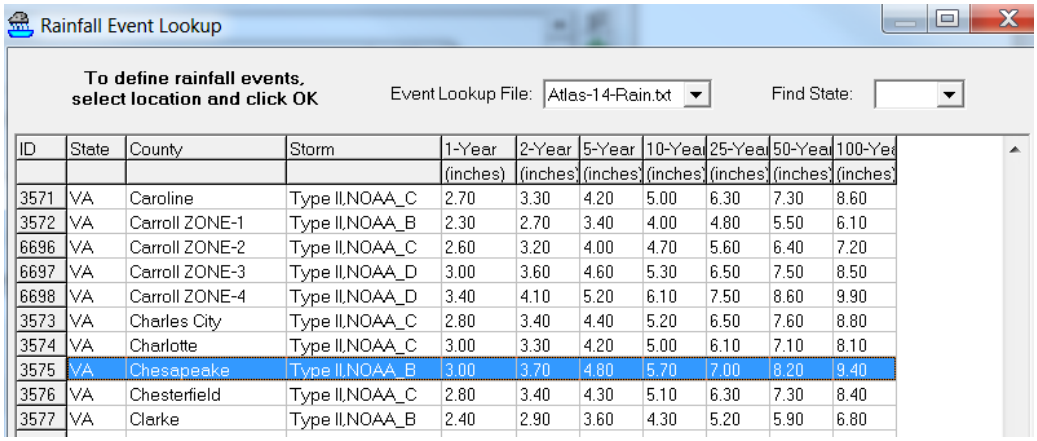




3. Rainfall data and calculations options were entered for runoff and routing calculations to be performed by HyrdoCAD. General runoff method and rainfall data were entered while all other parameters were left on default.

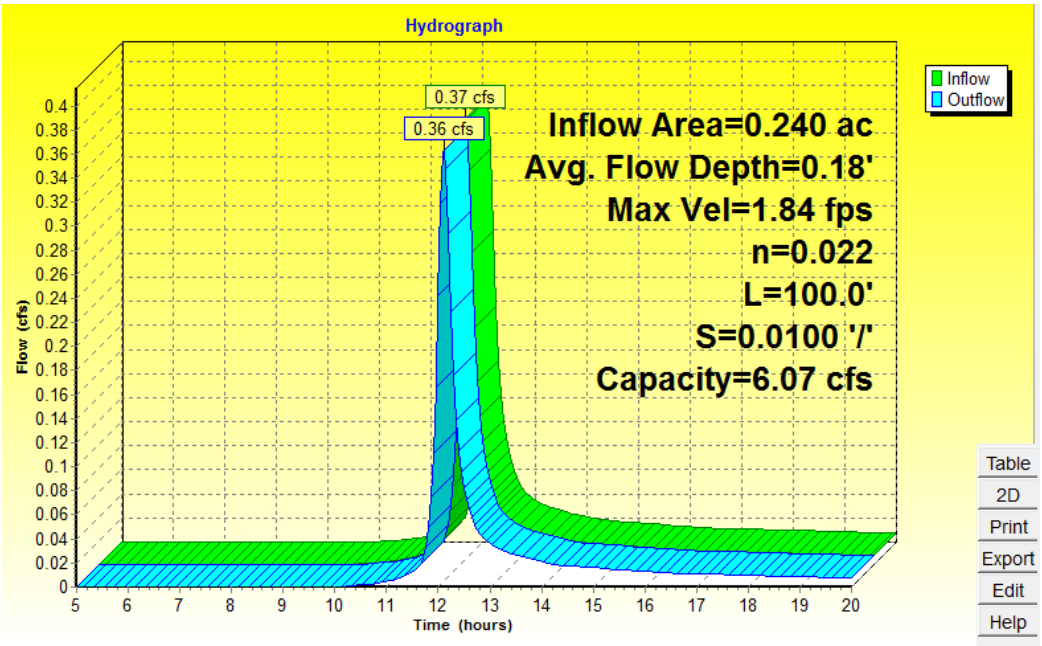






ID	State	County	Storm	1-Year (inches)	2-Year (inches)	5-Year (inches)	10-Year (inches)	25-Year (inches)	50-Year (inches)	100-Year (inches)
3571	VA	Caroline	Type II,NOAA_C	2.70	3.30	4.20	5.00	6.30	7.30	8.60
3572	VA	Carroll ZONE-1	Type II,NOAA_B	2.30	2.70	3.40	4.00	4.80	5.50	6.10
6696	VA	Carroll ZONE-2	Type II,NOAA_C	2.60	3.20	4.00	4.70	5.60	6.40	7.20
6697	VA	Carroll ZONE-3	Type II,NOAA_D	3.00	3.60	4.60	5.30	6.50	7.50	8.50
6698	VA	Carroll ZONE-4	Type II,NOAA_D	3.40	4.10	5.20	6.10	7.50	8.60	9.90
3573	VA	Charles City	Type II,NOAA_C	2.80	3.40	4.40	5.20	6.50	7.60	8.80
3574	VA	Charlotte	Type II,NOAA_C	3.00	3.30	4.20	5.00	6.10	7.10	8.10
3575	VA	Chesapeake	Type II,NOAA_B	3.00	3.70	4.80	5.70	7.00	8.20	9.40
3576	VA	Chesterfield	Type II,NOAA_C	2.80	3.40	4.30	5.10	6.30	7.30	8.40
3577	VA	Clarke	Type II,NOAA_B	2.40	2.90	3.60	4.30	5.20	5.90	6.80

4. HyrdoCAD was run calculating the inflow and outflow of the channel for the 1-year 24-hour storm. HydroCAD outputs reports for each node and includes a hydrograph, inflow and out flow volumes and velocities, and channel storage.

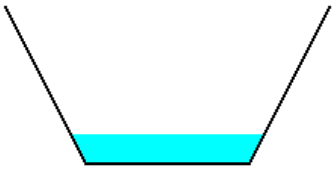


Inflow Area = 0.240 ac, 0.00% Impervious, Inflow Depth > 1.14" for 1-Year event
Inflow = 0.37 cfs @ 12.09 hrs, Volume= 0.023 af
Outflow = 0.36 cfs @ 12.11 hrs, Volume= 0.023 af, Atten= 2%, Lag= 1.5 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.84 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 0.60 fps, Avg. Travel Time= 2.8 min

Peak Storage= 20 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.18'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



The same steps were performed for the pre and post conditions of DA-A and DA-B. All output files are provided as an attachemnt. For the purpose of determining compliance with 9VAC25-870-66 subsection B, the maximum velocities for the pre and post conditions were compared to determine if the velocities were non-erosive to the channel. A summary of the velocities are provided in the table below.

HyrdoCAD Velocity Calculations

	Max Velocity (ft/s)		
	Pre	Post	Increase
DA-A	1.84	2.18	0.34
DA-B	1.17	2.1	0.93

The calculated velocities were compared to the Maximum non-scouring velocities for open channels provided in the table below (Ref. X). Based on the site soils described in Appendix F of this SWPPP, channel soils for the existing ditch for DA-A was assumed to be sandy soil with medium grass cover and the existing channel for DA-B was assumed to be sandy soil with medium grass cover. The 2.18 ft/s maximum velocity for DA-A and the 2.1 ft/s maximum velocity for DA-B for the 1-year 24-hour storm is non-erosive. Therefore, it was determined that the M&R station is compliant with the channel protection standards set forth in 9VAC25-870-66.

Maximum non-scouring velocities for open channels

Material	Maximum permissible velocities on established cover (ft/s)		
	Bare Soil	Medium grass cover	Good grass cover
Light silty sand	1.0	2.5	4.5
Light loose sand	1.5	3.0	5.0
Coarse sand	2.5	4.0	5.5
Sandy soil	2.5	4.5	6.5
Firm clay loam	3.5	5.5	7.5
Stiff clay or stiff gravelly soil	4.5	6.0	8.0
Coarse gravels	5.0	6.0	-
Shale, hardpan, soft rock	6.0	7.0	-
Hard cemented comglomerates	8.0	-	-

4. Using HydroCAD, calculate the volume of runoff contained within the conveyance system for the 10-year 24-hour storm to determine compliance with 9VAC25-870-66-C, Flood Protection.

Under 9VAC25-870-66-C, concentrated stormwater flow shall be released into a stormwater conveyance system and must meet the criteria in subdivision 1, 2, or 3. For the eastern and western portion of the site, it was conservatively assumed that the existing channels experience localized flooding. Based on this assumption, the

site must be compliant with subdivision 2 and confine the post-development peak flow from the 10-year 24-hour storm within the channel to avoid localized flooding.

Compliance was illustrated using HydroCAD. Using the inputs from Step 3 above, HydroCAD was run to model the 10-year 24-hour storm event.

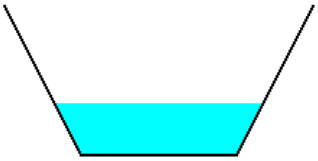
Existing Conditions, Drainage Area A (DA-A): Western portion of the site

Inflow Area = 0.240 ac, 0.00% Impervious, Inflow Depth > 3.25" for 10-Year event
Inflow = 1.05 cfs @ 12.08 hrs, Volume= 0.065 af
Outflow = 1.03 cfs @ 12.10 hrs, Volume= 0.065 af, Atten= 1%, Lag= 1.1 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.54 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 0.76 fps, Avg. Travel Time= 2.2 min

Peak Storage= 41 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



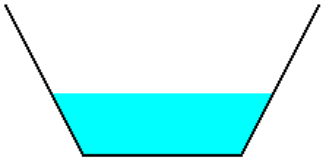
Post Conditions, Drainage Area A (DA-A): Western portion of the site

Inflow Area = 0.240 ac, 58.33% Impervious, Inflow Depth > 4.37" for 10-Year event
Inflow = 1.38 cfs @ 12.06 hrs, Volume= 0.087 af
Outflow = 1.36 cfs @ 12.07 hrs, Volume= 0.087 af, Atten= 2%, Lag= 1.1 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.75 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 0.83 fps, Avg. Travel Time= 2.0 min

Peak Storage= 50 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Existing Conditions, Drainage Area B (DA-B): Eastern portion of the site

Inflow Area = 0.760 ac, 0.00% Impervious, Inflow Depth > 0.96" for 1-Year event
Inflow = 0.58 cfs @ 12.35 hrs, Volume= 0.061 af
Outflow = 0.58 cfs @ 12.39 hrs, Volume= 0.060 af, Atten= 1%, Lag= 2.4 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.17 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 0.47 fps, Avg. Travel Time= 3.6 min

Peak Storage= 50 cf @ 12.36 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 '/' Top Width= 5.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Post Conditions, Drainage Area B (DA-B): Eastern portion of the site

Inflow Area = 0.760 ac, 78.95% Impervious, Inflow Depth > 2.21" for 1-Year event
Inflow = 3.15 cfs @ 11.94 hrs, Volume= 0.140 af
Outflow = 2.97 cfs @ 11.95 hrs, Volume= 0.140 af, Atten= 6%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.10 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 0.47 fps, Avg. Travel Time= 3.5 min

Peak Storage= 147 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.43'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 '/' Top Width= 5.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



For DA-A, the existing site's peak discharge from the 10-year 24-hour storm has a peak storage of 41 cf and an average depth at peak storage of 0.35 feet. The post conditions peak discharge from the 10-year 24-hour storm has a peak storage of 50 cf and an average depth at peak storage of 0.42 feet. DA-B existing conditions have a

peak storage of 50 cf and an average depth at peak storage of 0.16 feet and the post conditions have a peak storage of 147 cf and an average depth at peak storage of 0.43 feet. Since the existing channel on the western edge and the natural channel on the eastern edge of the property both have a bank full depth of 1 foot, the HydroCAD modeling demonstrates that the peak discharge from the 10-yer 24-hour storm for the post conditions is confined within the channels during this storm event. The M&R station is compliant with the flood protection standards set forth in 9VAC25-870-66.

REFERENCES:

1)

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
Elizabeth River
Pre Conditions - East

SUB-AREA:
DA-2 Outlet .00119 77. .608

STREAM REACH:

STORM ANALYSIS:
2-Yr 3.7 Type II 2
10-Yr 5.7 Type II 2
1-Yr 3.0 Type II 2

STRUCTURE RATING:

GLOBAL OUTPUT:
2 0.05 YYYYN YYYYNN

WinTR-20 Printed Page File End of Input Data List

Elizabeth River
Pre Conditions - East

Name of printed page file:
TR20.out

STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DA-2	0.001		1.208		12.26	0.92	773.20

Line Start Time (hr)	Flow Values @ time increment of 0.038 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.641	0.05	0.06	0.07	0.09	0.11	0.14	0.19
11.909	0.25	0.32	0.41	0.51	0.61	0.71	0.80
12.178	0.87	0.91	0.92	0.91	0.88	0.84	0.78
12.447	0.72	0.66	0.60	0.54	0.49	0.45	0.41
12.716	0.38	0.35	0.32	0.30	0.28	0.26	0.24
12.985	0.23	0.21	0.20	0.19	0.18	0.17	0.17
13.253	0.16	0.15	0.15	0.14	0.14	0.13	0.13
13.522	0.12	0.12	0.12	0.11	0.11	0.11	0.11
13.791	0.10	0.10	0.10	0.10	0.10	0.09	0.09
14.060	0.09	0.09	0.09	0.09	0.08	0.08	0.08
14.329	0.08	0.08	0.08	0.08	0.08	0.07	0.07
14.597	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.866	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.135	0.07	0.06	0.06	0.06	0.06	0.06	0.06
15.404	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.673	0.06	0.06	0.06	0.06	0.06	0.06	0.05
15.941	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.210	0.05	0.05					

Area or	Drainage	Rain Gage	Runoff	Peak Flow

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - East

STORM 2-Yr

SUB-AREA:

DA-2	Outlet	.00119	77.	.608	

STREAM REACH:

Reach Identifier	Area (sq mi)	ID or Location	Amount (in)	Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
OUTLET	0.001		1.208		12.26	0.92	773.20

Line Start Time (hr)	Flow Values @ time increment of 0.038 hr (cfs)						
11.641	0.05	0.06	0.07	0.09	0.11	0.14	0.19
11.909	0.25	0.32	0.41	0.51	0.61	0.71	0.80
12.178	0.87	0.91	0.92	0.91	0.88	0.84	0.78
12.447	0.72	0.66	0.60	0.54	0.49	0.45	0.41
12.716	0.38	0.35	0.32	0.30	0.28	0.26	0.24
12.985	0.23	0.21	0.20	0.19	0.18	0.17	0.17
13.253	0.16	0.15	0.15	0.14	0.14	0.13	0.13
13.522	0.12	0.12	0.12	0.11	0.11	0.11	0.11
13.791	0.10	0.10	0.10	0.10	0.10	0.09	0.09
14.060	0.09	0.09	0.09	0.09	0.08	0.08	0.08
14.329	0.08	0.08	0.08	0.08	0.08	0.07	0.07

Elizabeth River
Pre Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.038 hr (cfs)						
14.597	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.866	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.135	0.07	0.06	0.06	0.06	0.06	0.06	0.06
15.404	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - East

STORM 2-Yr

SUB-AREA:
DA-2 Outlet .00119 77. .608

STREAM REACH:

15.673	0.06	0.06	0.06	0.06	0.06	0.06	0.05
15.941	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.210	0.05	0.05					

STORM 10-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DA-2	0.001		2.911		12.24	1.92	1611.61

Line Start Time (hr)	Flow Values @ time increment of 0.038 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
10.665	0.05	0.05	0.06	0.06	0.06	0.06	0.06
10.934	0.07	0.07	0.07	0.08	0.08	0.08	0.09
11.203	0.09	0.09	0.10	0.10	0.11	0.11	0.12
11.472	0.12	0.13	0.14	0.15	0.16	0.18	0.20
11.741	0.24	0.28	0.35	0.44	0.55	0.70	0.87
12.009	1.07	1.28	1.48	1.66	1.80	1.89	1.92
12.278	1.90	1.84	1.75	1.63	1.50	1.37	1.24
12.547	1.12	1.01	0.92	0.84	0.77	0.71	0.65
12.816	0.60	0.55	0.51	0.48	0.45	0.42	0.39
13.085	0.37	0.35	0.33	0.32	0.30	0.29	0.28
13.353	0.27	0.26	0.25	0.24	0.23	0.23	0.22
13.622	0.21	0.21	0.20	0.20	0.19	0.19	0.18
13.891	0.18	0.18	0.17	0.17	0.17	0.16	0.16
14.160	0.16	0.15	0.15	0.15	0.15	0.14	0.14
14.429	0.14	0.14	0.14	0.14	0.13	0.13	0.13
14.697	0.13	0.13	0.13	0.13	0.13	0.12	0.12
14.966	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.235	0.12	0.11	0.11	0.11	0.11	0.11	0.11

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - East

STORM 10-Yr

SUB-AREA:

DA-2	Outlet	.00119	77.	.608		

STREAM REACH:

15.504	0.11	0.11	0.11	0.11	0.10	0.10	0.10
15.773	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.041	0.10	0.09	0.09	0.09	0.09	0.09	0.09
16.310	0.09	0.09	0.09	0.09	0.09	0.09	0.08
16.579	0.08	0.08	0.08	0.08	0.08	0.08	0.08
16.848	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.117	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.385	0.08	0.08	0.08	0.08	0.08	0.07	0.07
17.654	0.07	0.07	0.07	0.07	0.07	0.07	0.07
17.923	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.192	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.461	0.07	0.07	0.07	0.07	0.07	0.07	0.06
18.729	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Elizabeth River
Pre Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.038 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
18.998	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.267	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.536	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.805	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.073	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.342	0.05						

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 77. .608

STREAM REACH:
OUTLET 0.001 2.911 12.24 1.92 1611.61

Line Start Time (hr)	Flow Values @ time increment of 0.038 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
10.665	0.05	0.05	0.06	0.06	0.06	0.06	0.06
10.934	0.07	0.07	0.07	0.08	0.08	0.08	0.09
11.203	0.09	0.09	0.10	0.10	0.11	0.11	0.12
11.472	0.12	0.13	0.14	0.15	0.16	0.18	0.20
11.741	0.24	0.28	0.35	0.44	0.55	0.70	0.87
12.009	1.07	1.28	1.48	1.66	1.80	1.89	1.92
12.278	1.90	1.84	1.75	1.63	1.50	1.37	1.24
12.547	1.12	1.01	0.92	0.84	0.77	0.71	0.65
12.816	0.60	0.55	0.51	0.48	0.45	0.42	0.39
13.085	0.37	0.35	0.33	0.32	0.30	0.29	0.28
13.353	0.27	0.26	0.25	0.24	0.23	0.23	0.22
13.622	0.21	0.21	0.20	0.20	0.19	0.19	0.18
13.891	0.18	0.18	0.17	0.17	0.17	0.16	0.16
14.160	0.16	0.15	0.15	0.15	0.15	0.14	0.14
14.429	0.14	0.14	0.14	0.14	0.13	0.13	0.13
14.697	0.13	0.13	0.13	0.13	0.13	0.12	0.12
14.966	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.235	0.12	0.11	0.11	0.11	0.11	0.11	0.11
15.504	0.11	0.11	0.11	0.11	0.10	0.10	0.10
15.773	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.041	0.10	0.09	0.09	0.09	0.09	0.09	0.09
16.310	0.09	0.09	0.09	0.09	0.09	0.09	0.08
16.579	0.08	0.08	0.08	0.08	0.08	0.08	0.08
16.848	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.117	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.385	0.08	0.08	0.08	0.08	0.08	0.07	0.07
17.654	0.07	0.07	0.07	0.07	0.07	0.07	0.07
17.923	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 77. .608

STREAM REACH:

18.192	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.461	0.07	0.07	0.07	0.07	0.07	0.07	0.06
18.729	0.06	0.06	0.06	0.06	0.06	0.06	0.06
18.998	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.267	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.536	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Elizabeth River
Pre Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.038 hr (cfs)						
19.805	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.073	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.342	0.05						

STORM 1-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DA-2	0.001		0.727		12.25	0.60	507.04

Line Start Time (hr)	Flow Values @ time increment of 0.038 hr (cfs)						
11.787	0.05	0.07	0.10	0.13	0.18	0.23	0.30
12.055	0.37	0.44	0.50	0.55	0.59	0.60	0.60

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - East

STORM 1-Yr

SUB-AREA:
DA-2 Outlet .00119 77. .608

STREAM REACH:

12.324	0.59	0.56	0.53	0.49	0.45	0.41	0.37
12.593	0.34	0.31	0.29	0.26	0.24	0.23	0.21
12.862	0.20	0.18	0.17	0.16	0.15	0.14	0.14
13.131	0.13	0.12	0.12	0.11	0.11	0.11	0.10
13.399	0.10	0.10	0.09	0.09	0.09	0.08	0.08
13.668	0.08	0.08	0.08	0.07	0.07	0.07	0.07
13.937	0.07	0.07	0.07	0.07	0.06	0.06	0.06
14.206	0.06	0.06	0.06	0.06	0.06	0.06	0.06
14.475	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.743	0.05	0.05	0.05				

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
OUTLET	0.001		0.727		12.25	0.60	507.04

Line Start Time (hr)	Flow Values @ time increment of 0.038 hr (cfs)						
11.787	0.05	0.07	0.10	0.13	0.18	0.23	0.30
12.055	0.37	0.44	0.50	0.55	0.59	0.60	0.60
12.324	0.59	0.56	0.53	0.49	0.45	0.41	0.37
12.593	0.34	0.31	0.29	0.26	0.24	0.23	0.21
12.862	0.20	0.18	0.17	0.16	0.15	0.14	0.14
13.131	0.13	0.12	0.12	0.11	0.11	0.11	0.10
13.399	0.10	0.10	0.09	0.09	0.09	0.08	0.08
13.668	0.08	0.08	0.08	0.07	0.07	0.07	0.07
13.937	0.07	0.07	0.07	0.07	0.06	0.06	0.06
14.206	0.06	0.06	0.06	0.06	0.06	0.06	0.06
14.475	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.743	0.05	0.05	0.05				

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - East

STORM 1-Yr

SUB-AREA:
DA-2 Outlet .00119 77. .608

STREAM REACH:

Elizabeth River
Pre Conditions - East

Area or Reach Identifier	Drainage Area (sq mi)	Alternate	Peak Flow by Storm 2-Yr (cfs)	10-Yr (cfs)	1-Yr (cfs)	(cfs)	(cfs)
DA-2	0.001		0.92	1.92	0.60		
OUTLET	0.001		0.92	1.92	0.60		

WinTR-20 Printed Page File TR20.inp Beginning of Input Data List

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - East
STORM 1-Yr

SUB-AREA:

	DA-2	Outlet	.00119	77.	.608

STREAM REACH:

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

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WinTR-20: Version 1.10                  0         0         0.05
Elizabeth River
Pre Conditions - West

SUB-AREA:
          DA-1      Outlet              .00038    80.       .264

STREAM REACH:

STORM ANALYSIS:
          2-Yr                          3.7       Type II   2
          10-Yr                         5.7       Type II   2
          1-Yr                          3.0       Type II   2

STRUCTURE RATING:


GLOBAL OUTPUT:
          2         0.05                YYYYN     YYYYNN
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WinTR-20 Printed Page File End of Input Data List

Elizabeth River
Pre Conditions - West

Name of printed page file:
TR20.out

STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DA-1	0.380E-03		0.998		12.06	0.53	1399.18

Line Start Time (hr)	Flow Values @ time increment of 0.017 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.673	0.06	0.06	0.07	0.08	0.09	0.10	0.12
11.789	0.13	0.15	0.17	0.19	0.21	0.24	0.27
11.906	0.30	0.34	0.38	0.41	0.45	0.47	0.50
12.023	0.52	0.53	0.53	0.53	0.51	0.49	0.47
12.140	0.43	0.40	0.37	0.33	0.30	0.28	0.25
12.256	0.23	0.21	0.19	0.18	0.17	0.16	0.15
12.373	0.14	0.13	0.12	0.12	0.11	0.11	0.10
12.490	0.10	0.09	0.09	0.09	0.08	0.08	0.08
12.606	0.08	0.07	0.07	0.07	0.07	0.06	0.06
12.723	0.06	0.06	0.06	0.06	0.06	0.06	0.05
12.840	0.05	0.05	0.05	0.05	0.05	0.05	

Area or	Drainage	Rain Gage	Runoff	Peak Flow

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - West

STORM 2-Yr

SUB-AREA:

DA-1	Outlet	.00038	80.	.264	

STREAM REACH:

Reach Identifier	Area (sq mi)	ID or Location	Amount (in)	Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
OUTLET	0.380E-03		0.998		12.06	0.53	1399.18

Line Start Time (hr)	Flow Values @ time increment of 0.017 hr (cfs)						
11.673	0.06	0.06	0.07	0.08	0.09	0.10	0.12
11.789	0.13	0.15	0.17	0.19	0.21	0.24	0.27
11.906	0.30	0.34	0.38	0.41	0.45	0.47	0.50
12.023	0.52	0.53	0.53	0.53	0.51	0.49	0.47
12.140	0.43	0.40	0.37	0.33	0.30	0.28	0.25
12.256	0.23	0.21	0.19	0.18	0.17	0.16	0.15
12.373	0.14	0.13	0.12	0.12	0.11	0.11	0.10
12.490	0.10	0.09	0.09	0.09	0.08	0.08	0.08
12.606	0.08	0.07	0.07	0.07	0.07	0.06	0.06
12.723	0.06	0.06	0.06	0.06	0.06	0.06	0.05
12.840	0.05	0.05	0.05	0.05	0.05	0.05	

STORM 10-Yr

Elizabeth River
Pre Conditions - West

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DA-1	0.380E-03		2.343		12.05	1.03	2720.15

Line Start Time (hr)	Flow Values @ time increment of 0.017 hr (cfs)						
11.271	0.05	0.05	0.05	0.05	0.05	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - West

STORM 10-Yr

SUB-AREA:
DA-1 Outlet .00038 80. .264

STREAM REACH:

11.388	0.06	0.06	0.06	0.06	0.06	0.07	0.07
11.504	0.07	0.07	0.07	0.08	0.08	0.08	0.09
11.621	0.10	0.11	0.12	0.13	0.15	0.17	0.19
11.738	0.21	0.24	0.26	0.29	0.33	0.36	0.41
11.855	0.45	0.50	0.56	0.63	0.70	0.76	0.83
11.971	0.89	0.94	0.99	1.02	1.03	1.03	1.02
12.088	0.99	0.95	0.89	0.83	0.76	0.70	0.64
12.205	0.58	0.52	0.47	0.43	0.39	0.36	0.33
12.321	0.31	0.29	0.27	0.26	0.24	0.23	0.22
12.438	0.21	0.20	0.19	0.18	0.17	0.17	0.16
12.555	0.15	0.15	0.14	0.14	0.13	0.13	0.12
12.672	0.12	0.12	0.11	0.11	0.11	0.11	0.10
12.788	0.10	0.10	0.10	0.10	0.10	0.09	0.09
12.905	0.09	0.09	0.09	0.09	0.09	0.09	0.08
13.022	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.139	0.08	0.08	0.08	0.07	0.07	0.07	0.07
13.255	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.372	0.07	0.07	0.07	0.07	0.06	0.06	0.06
13.489	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.605	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.722	0.06	0.06	0.06	0.05	0.05	0.05	0.05
13.839	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.956	0.05						

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
OUTLET	0.380E-03		2.343		12.05	1.03	2720.15

Line Start Time (hr)	Flow Values @ time increment of 0.017 hr (cfs)						
11.271	0.05	0.05	0.05	0.05	0.05	0.06	0.06
11.388	0.06	0.06	0.06	0.06	0.06	0.07	0.07
11.504	0.07	0.07	0.07	0.08	0.08	0.08	0.09
11.621	0.10	0.11	0.12	0.13	0.15	0.17	0.19
11.738	0.21	0.24	0.26	0.29	0.33	0.36	0.41
11.855	0.45	0.50	0.56	0.63	0.70	0.76	0.83
11.971	0.89	0.94	0.99	1.02	1.03	1.03	1.02
12.088	0.99	0.95	0.89	0.83	0.76	0.70	0.64
12.205	0.58	0.52	0.47	0.43	0.39	0.36	0.33
12.321	0.31	0.29	0.27	0.26	0.24	0.23	0.22

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - West

STORM 10-Yr

SUB-AREA:
DA-1 Outlet .00038 80. .264

STREAM REACH:

Elizabeth River
Pre Conditions - West

Line Start Time (hr)	Flow Values @ time increment of 0.017 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.438	0.21	0.20	0.19	0.18	0.17	0.17	0.16
12.555	0.15	0.15	0.14	0.14	0.13	0.13	0.12
12.672	0.12	0.12	0.11	0.11	0.11	0.11	0.10
12.788	0.10	0.10	0.10	0.10	0.10	0.09	0.09
12.905	0.09	0.09	0.09	0.09	0.09	0.09	0.08
13.022	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.139	0.08	0.08	0.08	0.07	0.07	0.07	0.07
13.255	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.372	0.07	0.07	0.07	0.07	0.06	0.06	0.06
13.489	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.605	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.722	0.06	0.06	0.06	0.05	0.05	0.05	0.05
13.839	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.956	0.05						

STORM 1-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
DA-1	0.380E-03		0.628		12.06	0.37	966.33

Line Start Time (hr)	Flow Values @ time increment of 0.017 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.745	0.06	0.06	0.07	0.08	0.10	0.11	0.12
11.862	0.14	0.16	0.18	0.21	0.23	0.26	0.28
11.979	0.31	0.33	0.35	0.36	0.37	0.37	0.36
12.096	0.35	0.34	0.32	0.30	0.27	0.25	0.23
12.212	0.21	0.19	0.17	0.16	0.14	0.13	0.12
12.329	0.12	0.11	0.10	0.10	0.09	0.09	0.08
12.446	0.08	0.08	0.07	0.07	0.07	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - West

STORM 1-Yr

SUB-AREA:
DA-1 Outlet .00038 80. .264

STREAM REACH:
12.562 0.06 0.06 0.06 0.05 0.05 0.05

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
OUTLET	0.380E-03		0.628		12.06	0.37	966.33

Line Start Time (hr)	Flow Values @ time increment of 0.017 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.745	0.06	0.06	0.07	0.08	0.10	0.11	0.12
11.862	0.14	0.16	0.18	0.21	0.23	0.26	0.28
11.979	0.31	0.33	0.35	0.36	0.37	0.37	0.36
12.096	0.35	0.34	0.32	0.30	0.27	0.25	0.23
12.212	0.21	0.19	0.17	0.16	0.14	0.13	0.12

Line Start Time (hr)	Flow Values @ time increment of 0.017 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.329	0.12	0.11	0.10	0.10	0.09	0.09	0.08
12.446	0.08	0.08	0.07	0.07	0.07	0.06	0.06
12.562	0.06	0.06	0.06	0.05	0.05	0.05	

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TR20.inp

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - West

STORM 1-Yr

SUB-AREA:
DA-1 Outlet .00038 80. .264

STREAM REACH:

Elizabeth River
Pre Conditions - West

Area or Reach Identifier	Drainage Area (sq mi)	Alternate	Peak Flow by Storm 2-Yr (cfs)	10-Yr (cfs)	1-Yr (cfs)	(cfs)	(cfs)

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - West

STORM 1-Yr

SUB-AREA:

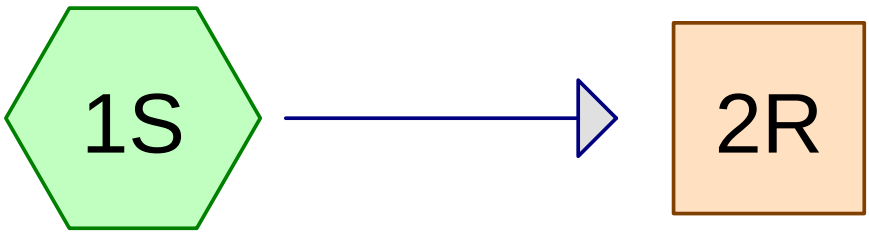
	DA-1	Outlet	.00038	80.	.264

STREAM REACH:

DA-1	0.380E-03	0.53	1.03	0.37
OUTLET	0.380E-03	0.53	1.03	0.37

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Pre Conditions - West
STORM 1-Yr
SUB-AREA:
DA-1 Outlet .00038 80. .264

STREAM REACH:



DA-B East

Channel - East

Subcat Reach Pond Link

Routing Diagram for Pre-Conditions_East
Prepared by ERM, Printed 2/1/2017
HydroCAD® 10.00-18 s/n 09594 © 2016 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.080	80	>75% Grass cover, Good, HSG D (1S)
0.680	77	Woods, Good, HSG D (1S)
0.760	**77**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.760	HSG D	1S
0.000	Other	
0.760		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.080	0.000	0.080	>75% Grass cover, Good	1S
0.000	0.000	0.000	0.680	0.000	0.680	Woods, Good	1S
0.000	**0.000**	**0.000**	**0.760**	**0.000**	**0.760**	**TOTAL AREA**	

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-B East Runoff Area=0.760 ac 0.00% Impervious Runoff Depth>0.96"
Flow Length=215' Slope=0.0050 '/' Tc=36.5 min CN=77 Runoff=0.58 cfs 0.061 af

Reach 2R: Channel - East Avg. Flow Depth=0.16' Max Vel=1.17 fps Inflow=0.58 cfs 0.061 af
n=0.035 L=100.0' S=0.0100 '/' Capacity=13.21 cfs Outflow=0.58 cfs 0.060 af

Total Runoff Area = 0.760 ac Runoff Volume = 0.061 af Average Runoff Depth = 0.96"
100.00% Pervious = 0.760 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: DA-B East

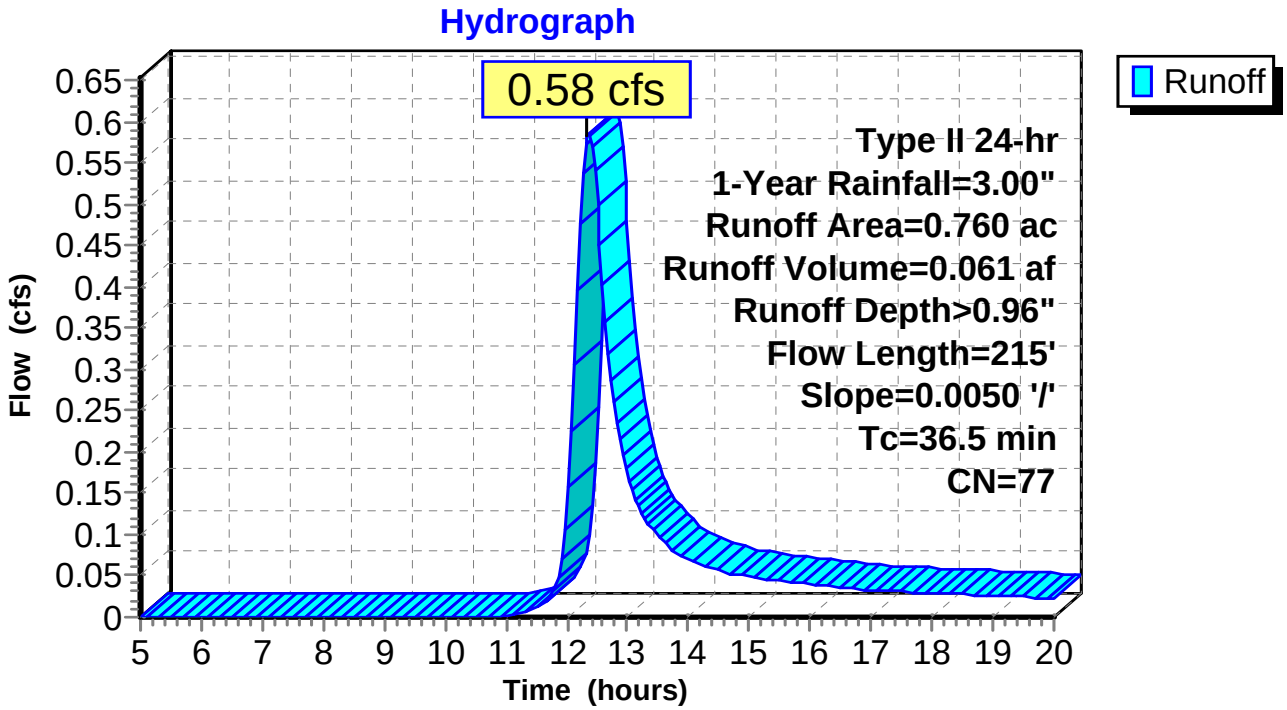
Runoff = 0.58 cfs @ 12.35 hrs, Volume= 0.061 af, Depth> 0.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-Year Rainfall=3.00"

Area (ac)	CN	Description
0.680	77	Woods, Good, HSG D
0.080	80	>75% Grass cover, Good, HSG D
0.760	77	Weighted Average
0.760		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.8	100	0.0050	0.05		**Sheet Flow, Sheet Flow grass/woods** Woods: Light underbrush n= 0.400 P2= 3.70"
1.7	115	0.0050	1.14		**Shallow Concentrated Flow, Shallow Conc. Flow woods** Unpaved Kv= 16.1 fps
36.5	215	Total			

Subcatchment 1S: DA-B East



Summary for Reach 2R: Channel - East

Inflow Area = 0.760 ac, 0.00% Impervious, Inflow Depth > 0.96" for 1-Year event
Inflow = 0.58 cfs @ 12.35 hrs, Volume= 0.061 af
Outflow = 0.58 cfs @ 12.39 hrs, Volume= 0.060 af, Atten= 1%, Lag= 2.4 min

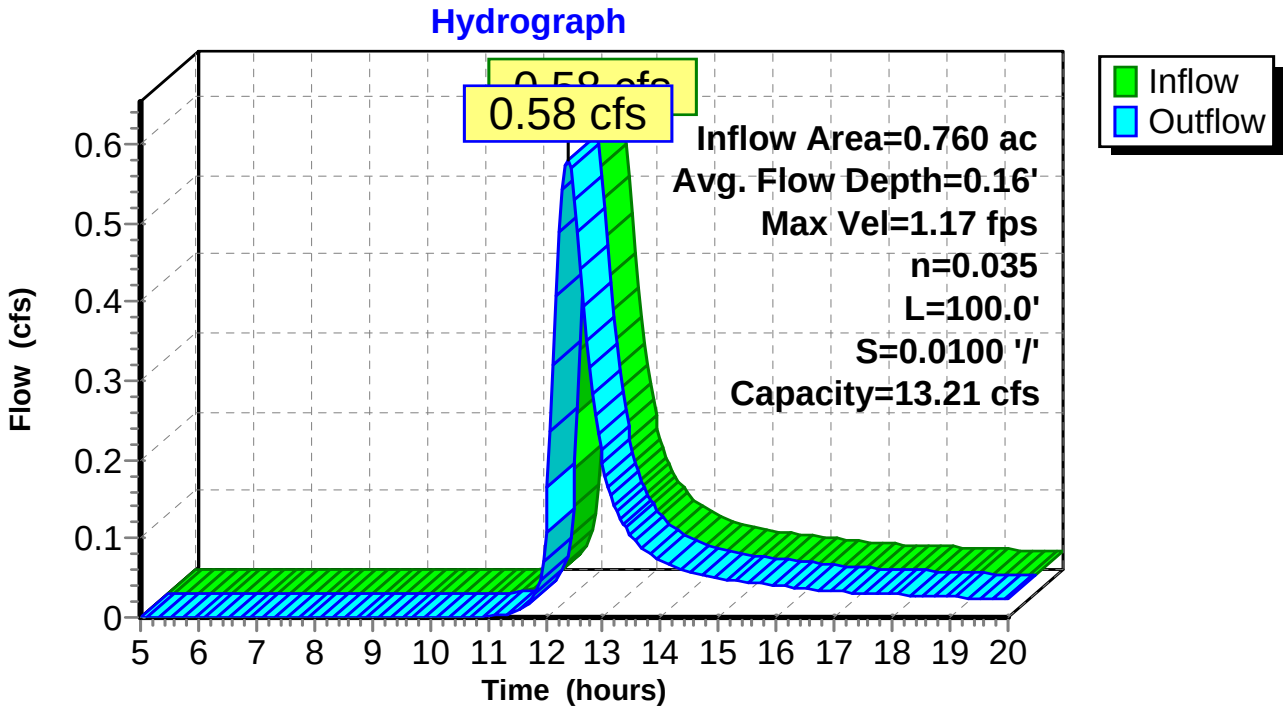
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.17 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 0.47 fps, Avg. Travel Time= 3.6 min

Peak Storage= 50 cf @ 12.36 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 '/' Top Width= 5.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Channel - East



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-B East Runoff Area=0.760 ac 0.00% Impervious Runoff Depth>1.43"
Flow Length=215' Slope=0.0050 '/' Tc=36.5 min CN=77 Runoff=0.89 cfs 0.090 af

Reach 2R: Channel - East Avg. Flow Depth=0.20' Max Vel=1.36 fps Inflow=0.89 cfs 0.090 af
n=0.035 L=100.0' S=0.0100 '/' Capacity=13.21 cfs Outflow=0.89 cfs 0.090 af

Total Runoff Area = 0.760 ac Runoff Volume = 0.090 af Average Runoff Depth = 1.43"
100.00% Pervious = 0.760 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: DA-B East

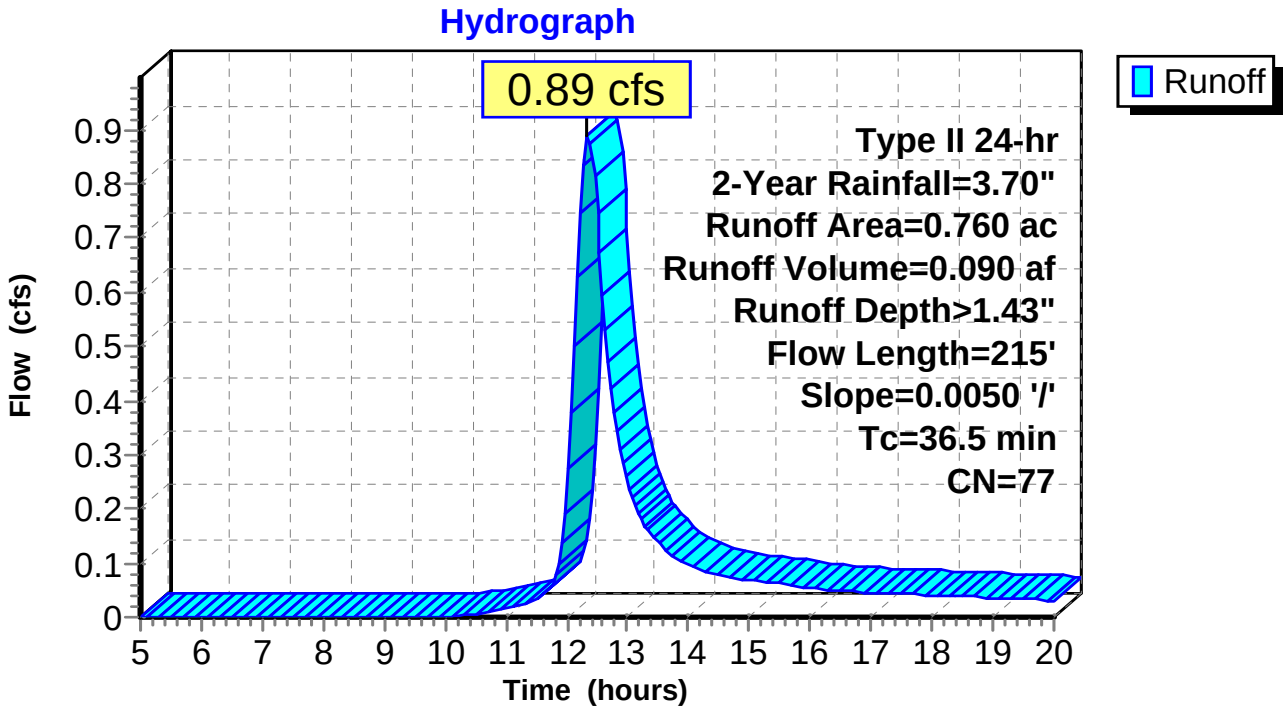
Runoff = 0.89 cfs @ 12.34 hrs, Volume= 0.090 af, Depth> 1.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.70"

Area (ac)	CN	Description
0.680	77	Woods, Good, HSG D
0.080	80	>75% Grass cover, Good, HSG D
0.760	77	Weighted Average
0.760		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.8	100	0.0050	0.05		**Sheet Flow, Sheet Flow grass/woods** Woods: Light underbrush n= 0.400 P2= 3.70"
1.7	115	0.0050	1.14		**Shallow Concentrated Flow, Shallow Conc. Flow woods** Unpaved Kv= 16.1 fps
36.5	215	Total			

Subcatchment 1S: DA-B East



Summary for Reach 2R: Channel - East

Inflow Area = 0.760 ac, 0.00% Impervious, Inflow Depth > 1.43" for 2-Year event
Inflow = 0.89 cfs @ 12.34 hrs, Volume= 0.090 af
Outflow = 0.89 cfs @ 12.37 hrs, Volume= 0.090 af, Atten= 1%, Lag= 2.1 min

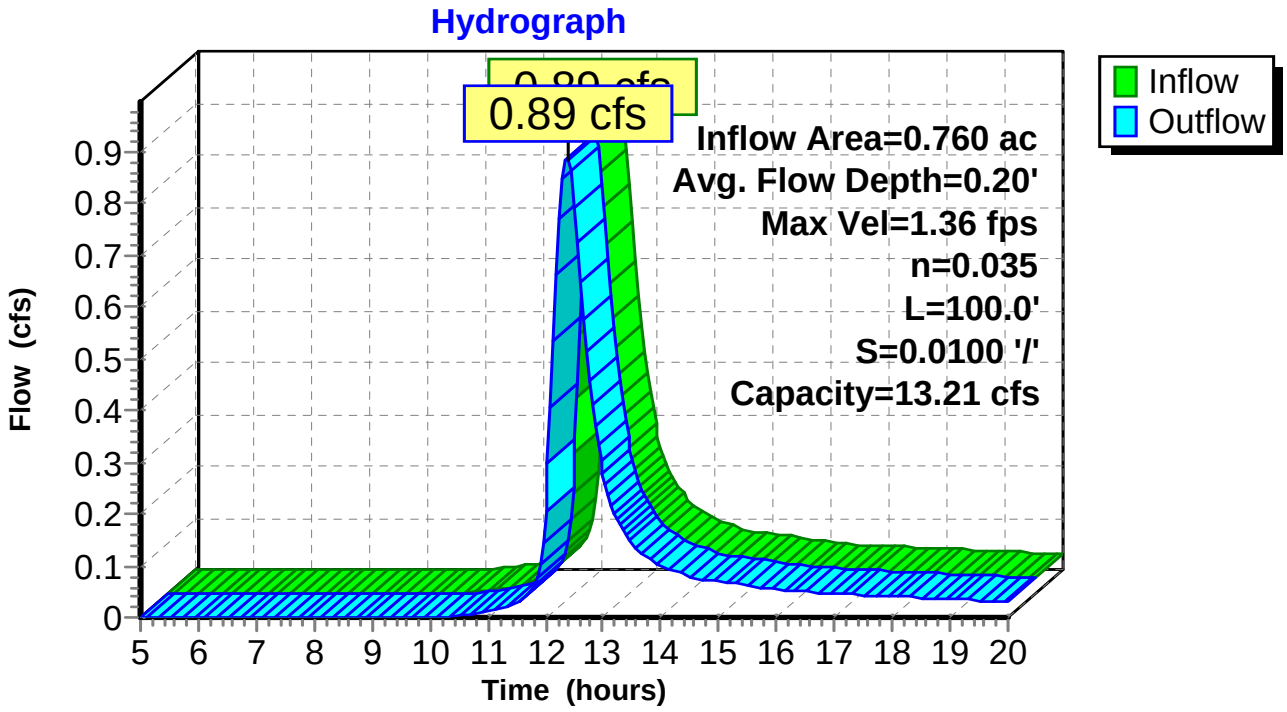
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.36 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 0.51 fps, Avg. Travel Time= 3.3 min

Peak Storage= 65 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.20'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 '/' Top Width= 5.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Channel - East



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-B East Runoff Area=0.760 ac 0.00% Impervious Runoff Depth>2.95"
Flow Length=215' Slope=0.0050 '/' Tc=36.5 min CN=77 Runoff=1.86 cfs 0.187 af

Reach 2R: Channel - East Avg. Flow Depth=0.32' Max Vel=1.77 fps Inflow=1.86 cfs 0.187 af
n=0.035 L=100.0' S=0.0100 '/' Capacity=13.21 cfs Outflow=1.85 cfs 0.186 af

Total Runoff Area = 0.760 ac Runoff Volume = 0.187 af Average Runoff Depth = 2.95"
100.00% Pervious = 0.760 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: DA-B East

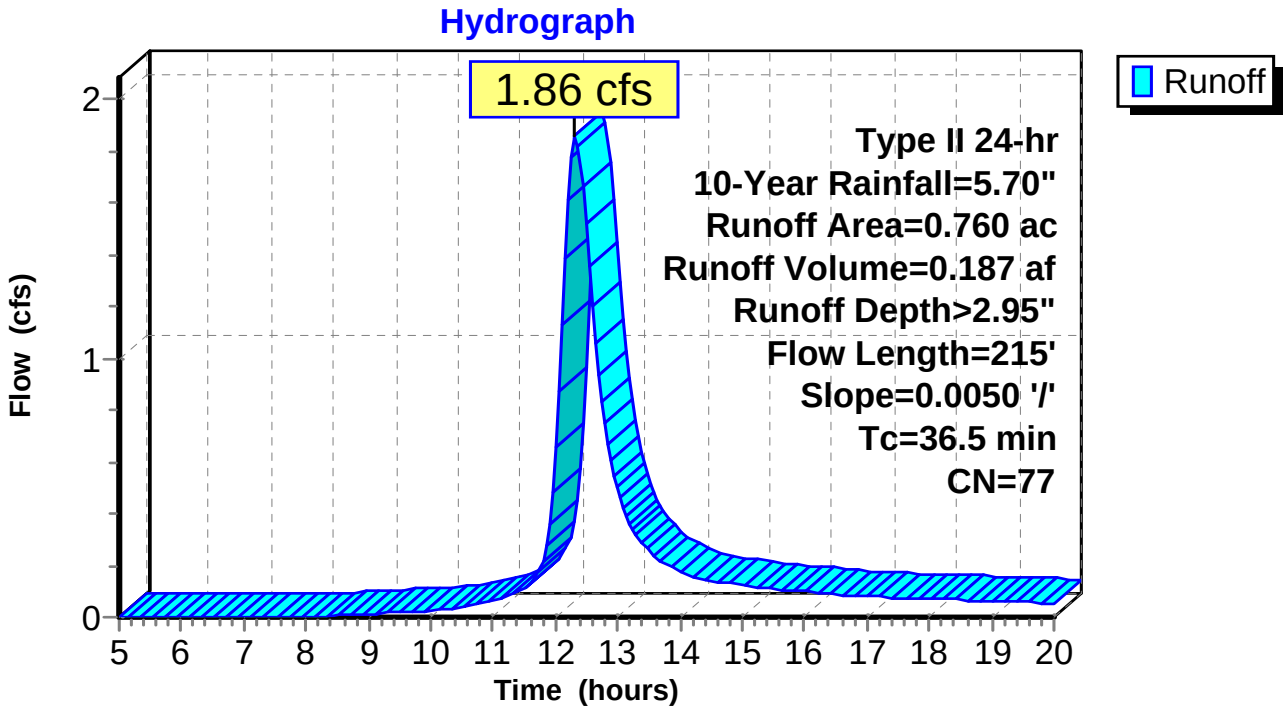
Runoff = 1.86 cfs @ 12.32 hrs, Volume= 0.187 af, Depth> 2.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.70"

Area (ac)	CN	Description
0.680	77	Woods, Good, HSG D
0.080	80	>75% Grass cover, Good, HSG D
0.760	77	Weighted Average
0.760		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.8	100	0.0050	0.05		**Sheet Flow, Sheet Flow grass/woods** Woods: Light underbrush n= 0.400 P2= 3.70"
1.7	115	0.0050	1.14		**Shallow Concentrated Flow, Shallow Conc. Flow woods** Unpaved Kv= 16.1 fps
36.5	215	Total			

Subcatchment 1S: DA-B East



Summary for Reach 2R: Channel - East

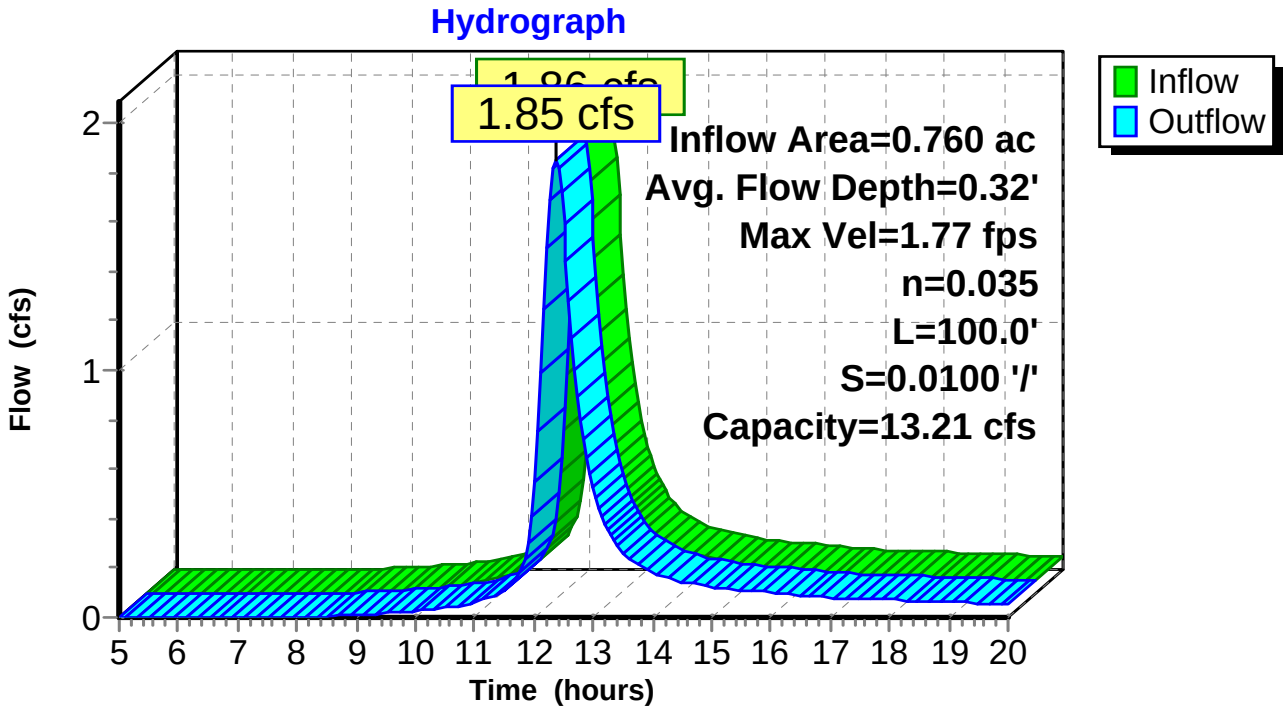
Inflow Area = 0.760 ac, 0.00% Impervious, Inflow Depth > 2.95" for 10-Year event
Inflow = 1.86 cfs @ 12.32 hrs, Volume= 0.187 af
Outflow = 1.85 cfs @ 12.35 hrs, Volume= 0.186 af, Atten= 1%, Lag= 1.7 min

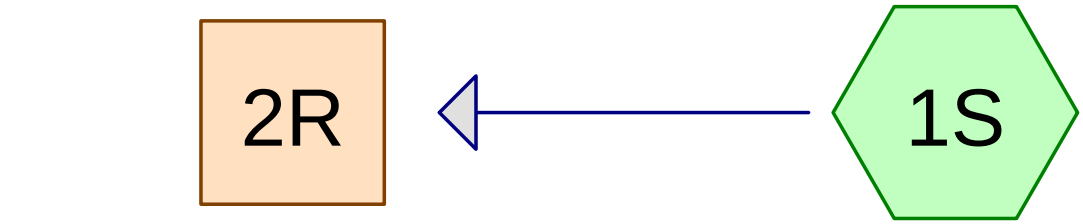
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.77 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 0.60 fps, Avg. Travel Time= 2.8 min

Peak Storage= 105 cf @ 12.33 hrs
Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 '/' Top Width= 5.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'







Existing Ditch -West

DA-A Pre West

Subcat Reach Pond Link

Routing Diagram for Pre-Conditions_West
Prepared by ERM, Printed 2/1/2017
HydroCAD® 10.00-18 s/n 09594 © 2016 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.240	80	>75% Grass cover, Good, HSG D (1S)
0.240	**80**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.240	HSG D	1S
0.000	Other	
0.240		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.240	0.000	0.240	>75% Grass cover, Good	1S
0.000	**0.000**	**0.000**	**0.240**	**0.000**	**0.240**	**TOTAL AREA**	

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-A Pre West Runoff Area=0.240 ac 0.00% Impervious Runoff Depth>1.14"
Flow Length=100' Slope=0.0050 '/' Tc=15.9 min CN=80 Runoff=0.37 cfs 0.023 af

Reach 2R: Existing Ditch -West Avg. Flow Depth=0.18' Max Vel=1.84 fps Inflow=0.37 cfs 0.023 af
n=0.022 L=100.0' S=0.0100 '/' Capacity=6.07 cfs Outflow=0.36 cfs 0.023 af

Total Runoff Area = 0.240 ac Runoff Volume = 0.023 af Average Runoff Depth = 1.14"
100.00% Pervious = 0.240 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: DA-A Pre West

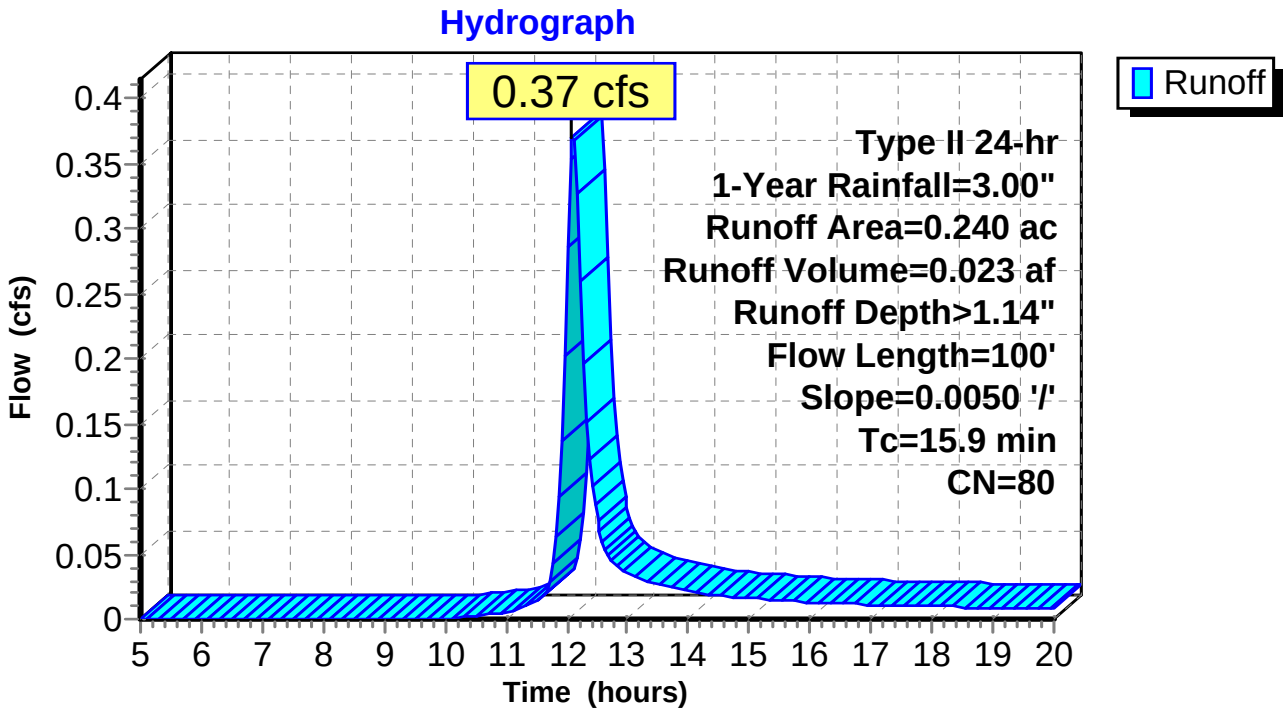
Runoff = 0.37 cfs @ 12.09 hrs, Volume= 0.023 af, Depth> 1.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-Year Rainfall=3.00"

Area (ac)	CN	Description
0.240	80	>75% Grass cover, Good, HSG D
0.240		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.9	100	0.0050	0.11		**Sheet Flow, Sheet Flow over existing** Grass: Short n= 0.150 P2= 3.70"

Subcatchment 1S: DA-A Pre West



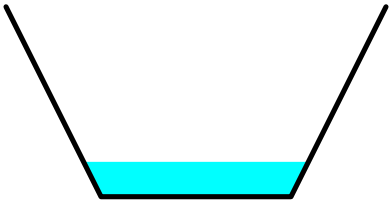
Summary for Reach 2R: Existing Ditch -West

Inflow Area = 0.240 ac, 0.00% Impervious, Inflow Depth > 1.14" for 1-Year event
Inflow = 0.37 cfs @ 12.09 hrs, Volume= 0.023 af
Outflow = 0.36 cfs @ 12.11 hrs, Volume= 0.023 af, Atten= 2%, Lag= 1.5 min

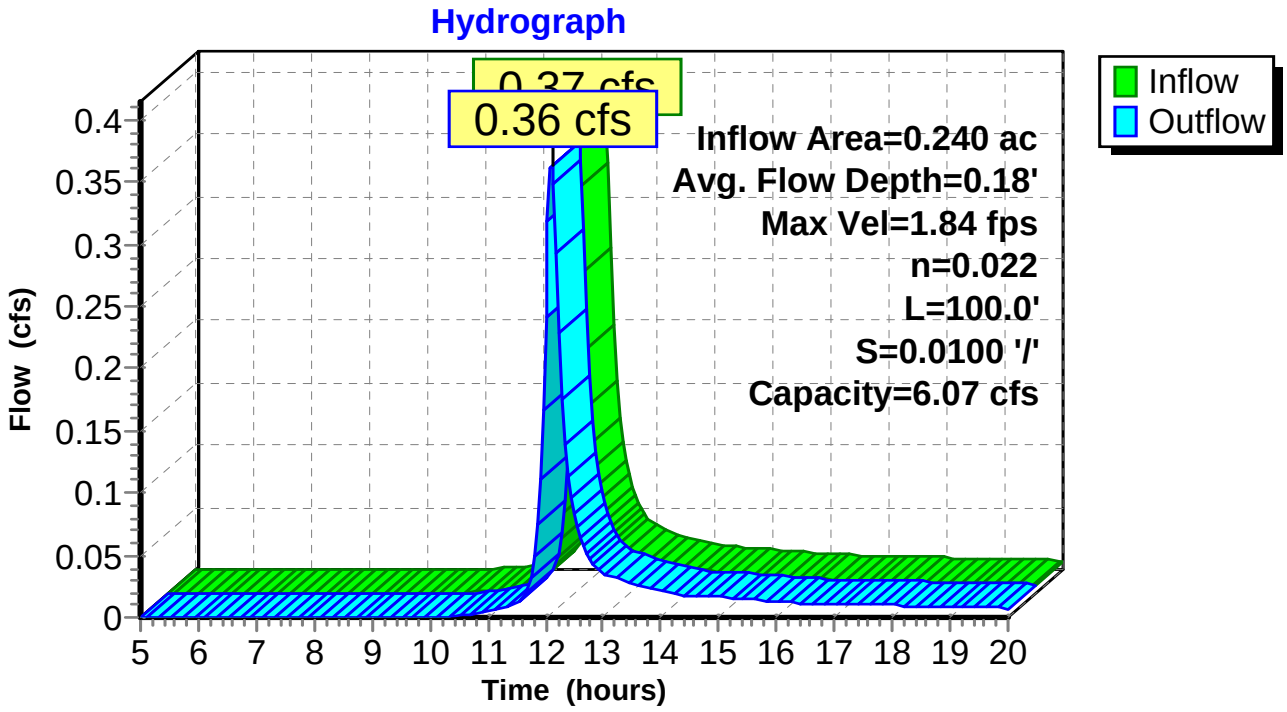
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.84 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 0.60 fps, Avg. Travel Time= 2.8 min

Peak Storage= 20 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.18'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Existing Ditch -West



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-A Pre West Runoff Area=0.240 ac 0.00% Impervious Runoff Depth>1.65"
Flow Length=100' Slope=0.0050 '/' Tc=15.9 min CN=80 Runoff=0.54 cfs 0.033 af

Reach 2R: Existing Ditch -West Avg. Flow Depth=0.23' Max Vel=2.07 fps Inflow=0.54 cfs 0.033 af
n=0.022 L=100.0' S=0.0100 '/' Capacity=6.07 cfs Outflow=0.53 cfs 0.033 af

Total Runoff Area = 0.240 ac Runoff Volume = 0.033 af Average Runoff Depth = 1.65"
100.00% Pervious = 0.240 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: DA-A Pre West

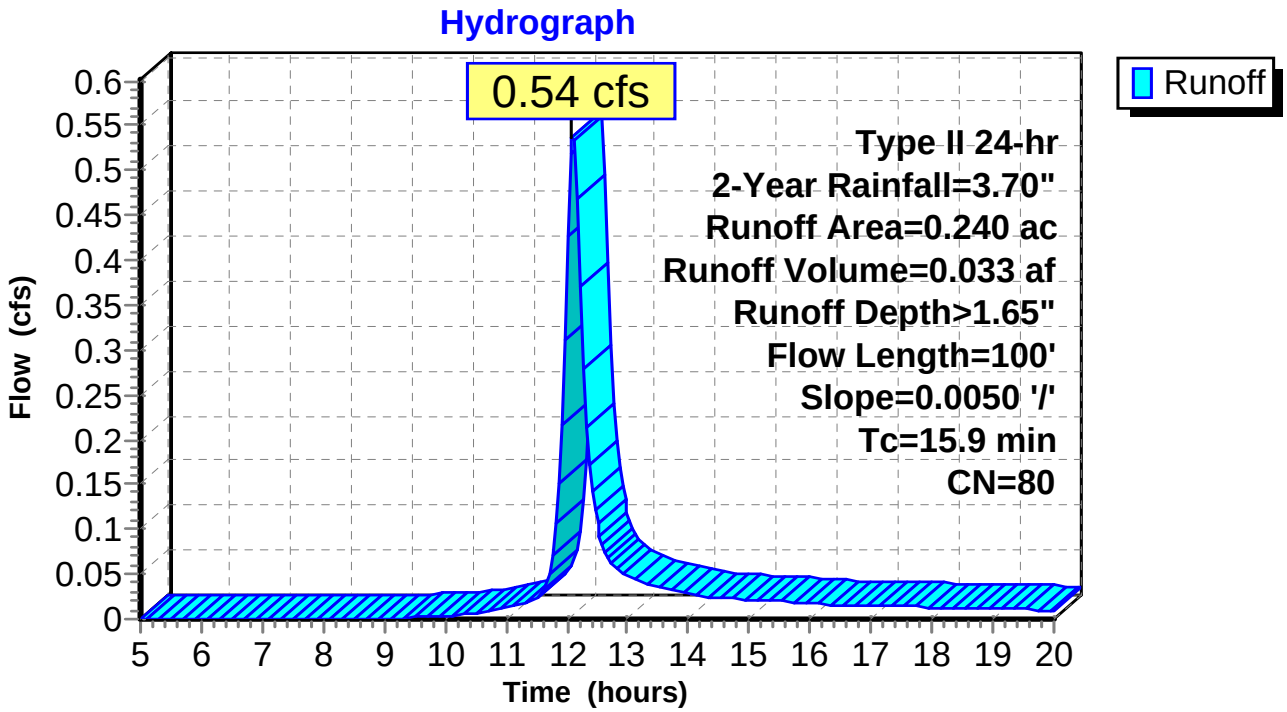
Runoff = 0.54 cfs @ 12.08 hrs, Volume= 0.033 af, Depth> 1.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.70"

Area (ac)	CN	Description
0.240	80	>75% Grass cover, Good, HSG D
0.240		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.9	100	0.0050	0.11		**Sheet Flow, Sheet Flow over existing** Grass: Short n= 0.150 P2= 3.70"

Subcatchment 1S: DA-A Pre West



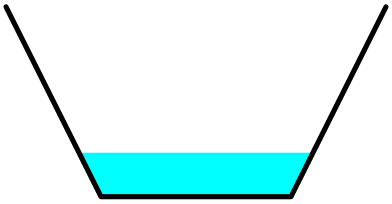
Summary for Reach 2R: Existing Ditch -West

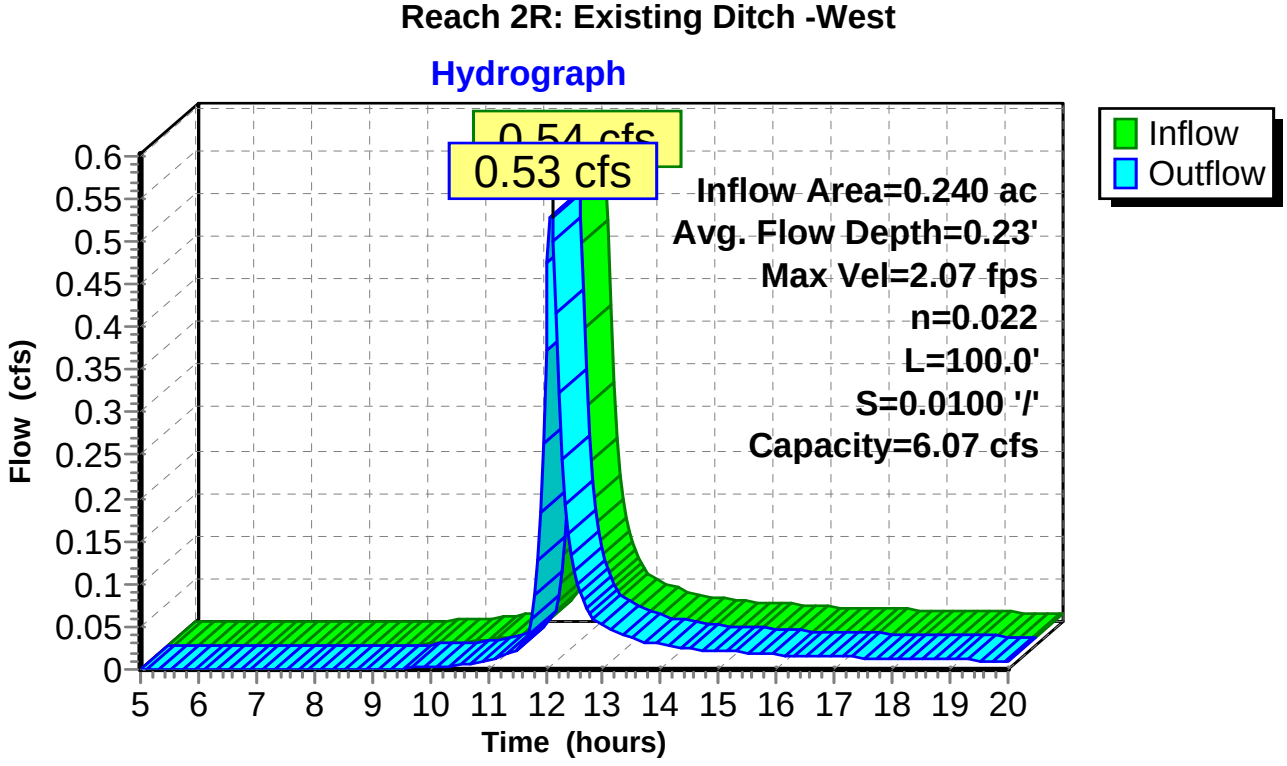
Inflow Area = 0.240 ac, 0.00% Impervious, Inflow Depth > 1.65" for 2-Year event
Inflow = 0.54 cfs @ 12.08 hrs, Volume= 0.033 af
Outflow = 0.53 cfs @ 12.11 hrs, Volume= 0.033 af, Atten= 2%, Lag= 1.4 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.07 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 0.65 fps, Avg. Travel Time= 2.5 min

Peak Storage= 26 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.23'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'





Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-A Pre West Runoff Area=0.240 ac 0.00% Impervious Runoff Depth>3.25"
Flow Length=100' Slope=0.0050 '/' Tc=15.9 min CN=80 Runoff=1.05 cfs 0.065 af

Reach 2R: Existing Ditch -West Avg. Flow Depth=0.35' Max Vel=2.54 fps Inflow=1.05 cfs 0.065 af
n=0.022 L=100.0' S=0.0100 '/' Capacity=6.07 cfs Outflow=1.03 cfs 0.065 af

Total Runoff Area = 0.240 ac Runoff Volume = 0.065 af Average Runoff Depth = 3.25"
100.00% Pervious = 0.240 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: DA-A Pre West

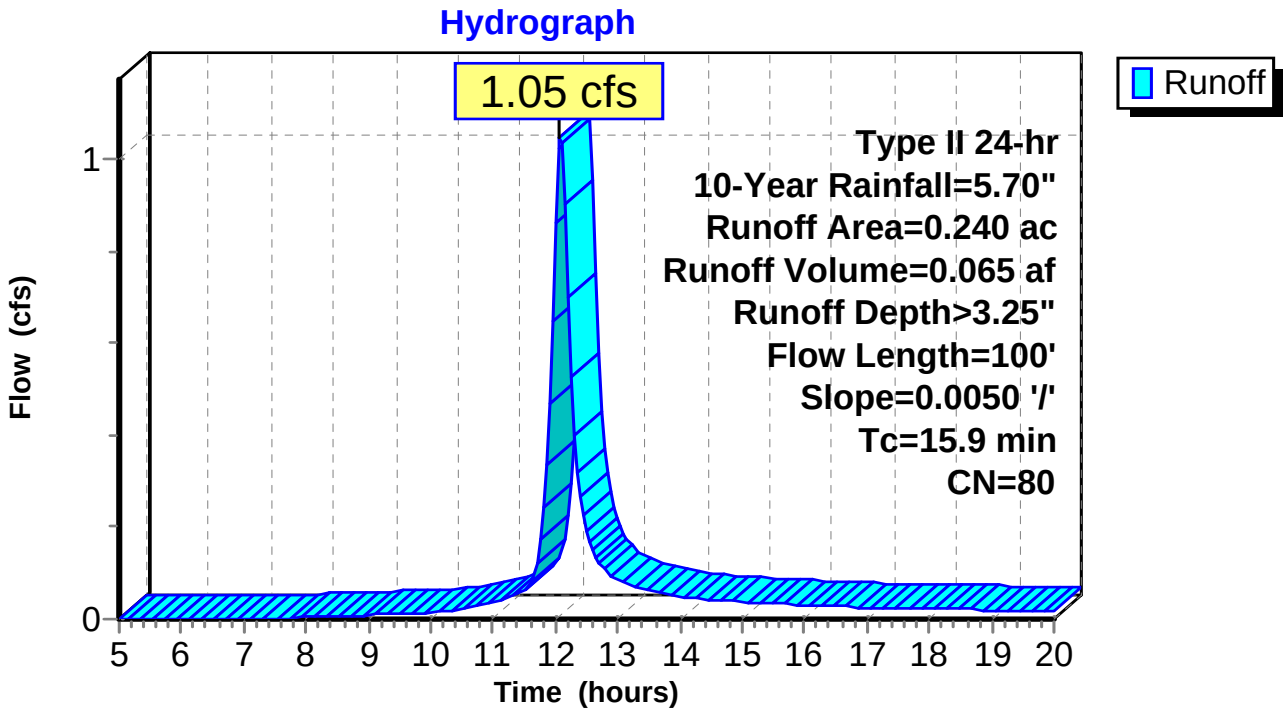
Runoff = 1.05 cfs @ 12.08 hrs, Volume= 0.065 af, Depth> 3.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.70"

Area (ac)	CN	Description
0.240	80	>75% Grass cover, Good, HSG D
0.240		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.9	100	0.0050	0.11		**Sheet Flow, Sheet Flow over existing** Grass: Short n= 0.150 P2= 3.70"

Subcatchment 1S: DA-A Pre West



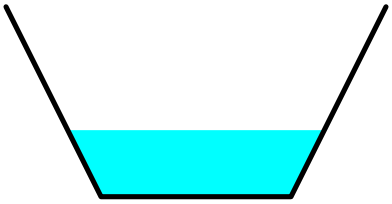
Summary for Reach 2R: Existing Ditch -West

Inflow Area = 0.240 ac, 0.00% Impervious, Inflow Depth > 3.25" for 10-Year event
Inflow = 1.05 cfs @ 12.08 hrs, Volume= 0.065 af
Outflow = 1.03 cfs @ 12.10 hrs, Volume= 0.065 af, Atten= 1%, Lag= 1.1 min

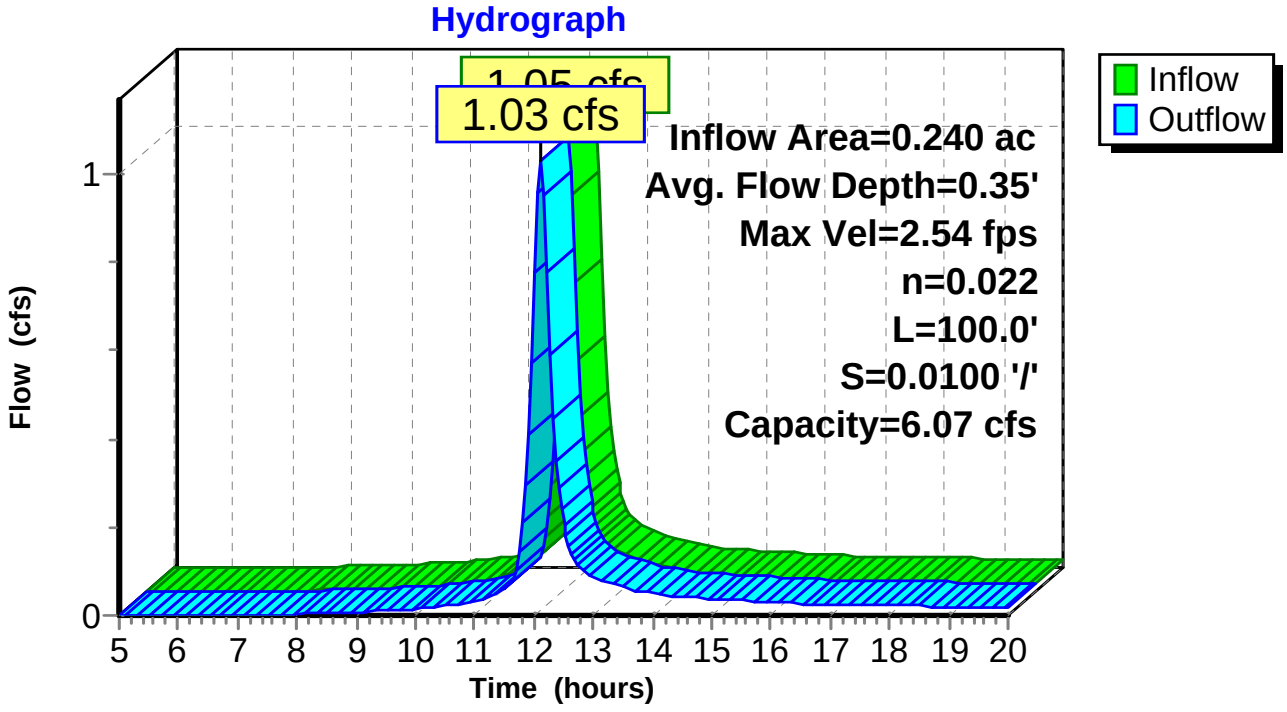
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.54 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 0.76 fps, Avg. Travel Time= 2.2 min

Peak Storage= 41 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Existing Ditch -West



WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
Elizabeth River
Post Conditions - East

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

STORM ANALYSIS:
2-Yr 3.7 Type II 2
10-Yr 5.7 Type II 2
1-Yr 3.0 Type II 2

STRUCTURE RATING:

GLOBAL OUTPUT:
2 0.05 YYYYN YYYYNN

WinTR-20 Printed Page File End of Input Data List

Elizabeth River
Post Conditions - East

Name of printed page file:
TR20.out

STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DA-2	0.001		2.601		11.92	3.35	2816.55

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
8.773	0.05	0.05	0.05	0.05	0.05	0.05	0.05
8.817	0.05	0.05	0.05	0.05	0.05	0.05	0.05
8.861	0.05	0.05	0.05	0.05	0.05	0.05	0.05
8.905	0.05	0.05	0.05	0.05	0.05	0.05	0.05
8.950	0.05	0.05	0.05	0.05	0.06	0.06	0.06
8.994	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.038	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.082	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.127	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.171	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.215	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.259	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.303	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.348	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.392	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.436	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.480	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.524	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.569	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.613	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.657	0.06	0.06	0.06	0.06	0.07	0.07	0.07
9.701	0.07	0.07	0.07	0.07	0.07	0.07	0.07
9.745	0.07	0.07	0.07	0.07	0.07	0.07	0.07
9.790	0.07	0.07	0.07	0.07	0.07	0.07	0.07
9.834	0.07	0.07	0.07	0.07	0.07	0.07	0.07
9.878	0.07	0.07	0.07	0.07	0.07	0.07	0.07
9.922	0.07	0.07	0.07	0.07	0.08	0.08	0.08
9.967	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.011	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.055	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.099	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.143	0.08	0.08	0.08	0.09	0.09	0.09	0.09
10.188	0.09	0.09	0.09	0.09	0.09	0.09	0.09

10.232	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.276	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.320	0.09	0.09	0.09	0.10	0.10	0.10	0.10
10.364	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10.409	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10.453	0.10	0.10	0.10	0.10	0.10	0.10	0.11
10.497	0.11	0.11	0.11	0.11	0.11	0.11	0.11

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
10.541	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.585	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.630	0.11	0.12	0.12	0.12	0.12	0.12	0.12
10.674	0.12	0.12	0.12	0.12	0.12	0.12	0.12
10.718	0.12	0.12	0.12	0.13	0.13	0.13	0.13
10.762	0.13	0.13	0.13	0.13	0.13	0.13	0.13
10.807	0.13	0.13	0.13	0.13	0.13	0.14	0.14
10.851	0.14	0.14	0.14	0.14	0.14	0.14	0.14
10.895	0.14	0.14	0.14	0.14	0.14	0.14	0.15
10.939	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10.983	0.15	0.15	0.15	0.15	0.15	0.15	0.15
11.028	0.16	0.16	0.16	0.16	0.16	0.16	0.16
11.072	0.16	0.16	0.17	0.17	0.17	0.17	0.17
11.116	0.17	0.17	0.17	0.17	0.18	0.18	0.18
11.160	0.18	0.18	0.18	0.19	0.19	0.19	0.19
11.204	0.19	0.19	0.19	0.19	0.20	0.20	0.20
11.249	0.20	0.20	0.20	0.21	0.21	0.21	0.21
11.293	0.21	0.21	0.22	0.22	0.22	0.22	0.22
11.337	0.22	0.22	0.23	0.23	0.23	0.23	0.23
11.381	0.23	0.24	0.24	0.24	0.24	0.24	0.24
11.425	0.24	0.24	0.25	0.25	0.25	0.25	0.25
11.470	0.26	0.26	0.26	0.26	0.26	0.26	0.27
11.514	0.27	0.28	0.28	0.30	0.31	0.33	0.35
11.558	0.37	0.40	0.42	0.44	0.46	0.47	0.49
11.602	0.50	0.52	0.53	0.55	0.57	0.60	0.64
11.647	0.68	0.72	0.77	0.82	0.86	0.90	0.94
11.691	0.98	1.01	1.03	1.06	1.08	1.11	1.15
11.735	1.19	1.24	1.30	1.36	1.42	1.49	1.54
11.779	1.60	1.65	1.70	1.73	1.77	1.81	1.85
11.823	1.90	1.97	2.06	2.17	2.29	2.41	2.54
11.868	2.67	2.79	2.91	3.01	3.11	3.18	3.25
11.912	3.30	3.33	3.35	3.35	3.33	3.29	3.24
11.956	3.18	3.12	3.05	2.98	2.92	2.87	2.82
12.000	2.78	2.74	2.70	2.65	2.58	2.49	2.37
12.044	2.24	2.08	1.92	1.76	1.60	1.45	1.32
12.089	1.19	1.09	1.00	0.92	0.86	0.81	0.76
12.133	0.72	0.69	0.65	0.63	0.60	0.58	0.56
12.177	0.55	0.53	0.52	0.51	0.50	0.49	0.48
12.221	0.48	0.47	0.47	0.46	0.45	0.45	0.44
12.265	0.43	0.43	0.42	0.42	0.41	0.41	0.41
12.310	0.40	0.40	0.40	0.40	0.39	0.39	0.38
12.354	0.38	0.37	0.37	0.36	0.36	0.35	0.35
12.398	0.35	0.34	0.34	0.34	0.34	0.33	0.33
12.442	0.32	0.32	0.31	0.31	0.30	0.30	0.30
12.487	0.29	0.29	0.28	0.28	0.28	0.28	0.28
12.531	0.27	0.27	0.27	0.26	0.26	0.26	0.25
12.575	0.25	0.25	0.24	0.24	0.24	0.24	0.24
12.619	0.24	0.24	0.23	0.23	0.23	0.23	0.23
12.663	0.23	0.23	0.22	0.22	0.22	0.22	0.22
12.708	0.22	0.22	0.22	0.22	0.22	0.22	0.21
12.752	0.21	0.21	0.21	0.21	0.21	0.21	0.21

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 2-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.796	0.21	0.21	0.21	0.20	0.20	0.20	0.20
12.840	0.20	0.20	0.20	0.20	0.20	0.20	0.19
12.884	0.19	0.19	0.19	0.19	0.19	0.19	0.19
12.929	0.19	0.19	0.19	0.19	0.18	0.18	0.18
12.973	0.18	0.18	0.18	0.18	0.18	0.18	0.18
13.017	0.18	0.18	0.18	0.17	0.17	0.17	0.17
13.061	0.17	0.17	0.17	0.17	0.17	0.17	0.17
13.105	0.17	0.17	0.16	0.16	0.16	0.16	0.16
13.150	0.16	0.16	0.16	0.16	0.16	0.16	0.16
13.194	0.16	0.16	0.16	0.16	0.16	0.16	0.16
13.238	0.16	0.15	0.15	0.15	0.15	0.15	0.15
13.282	0.15	0.15	0.15	0.15	0.15	0.15	0.15
13.327	0.15	0.15	0.15	0.15	0.15	0.15	0.15
13.371	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.415	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.459	0.14	0.14	0.14	0.14	0.14	0.14	0.13
13.503	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.548	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.592	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.636	0.13	0.13	0.13	0.12	0.12	0.12	0.12
13.680	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.724	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.769	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.813	0.12	0.12	0.12	0.12	0.12	0.11	0.11
13.857	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.901	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.945	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.990	0.11	0.11	0.11	0.11	0.11	0.11	0.10
14.034	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.078	0.10	0.10	0.10	0.10	0.10	0.10	0.10

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 2-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

14.122	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.167	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.211	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.255	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.299	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.343	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.388	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.432	0.10	0.09	0.09	0.09	0.09	0.09	0.09
14.476	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.520	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.564	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.609	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.653	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.697	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.741	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.785	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.830	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.874	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.918	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.962	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.007	0.08	0.08	0.08	0.08	0.08	0.08	0.08

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
15.051	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.095	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.139	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.183	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.228	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.272	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.316	0.08	0.08	0.08	0.08	0.08	0.08	0.08

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 2-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

15.360	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.404	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.449	0.08	0.08	0.08	0.08	0.08	0.07	0.07
15.493	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.537	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.581	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.625	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.670	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.714	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.758	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.802	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.847	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.891	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.935	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.979	0.07	0.07	0.06	0.06	0.06	0.06	0.06
16.023	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.068	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.112	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.156	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.200	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.244	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.289	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.333	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.377	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.421	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.465	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.510	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.554	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.598	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.642	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.687	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.731	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.775	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.819	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.863	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.908	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.952	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.996	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 2-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

17.040	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.084	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.129	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.173	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.217	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.261	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
17.305	0.06	0.06	0.06	0.06	0.06	0.05	0.05
17.350	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.394	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.438	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.482	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.527	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.571	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.615	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.659	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.703	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.748	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.792	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.836	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.880	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.924	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.969	0.05	0.05	0.05	0.05	0.05	0.05	0.05
18.013	0.05	0.05	0.05	0.05	0.05	0.05	

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 2-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:
OUTLET 0.001 2.601 11.92 3.35 2816.55

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
8.773	0.05	0.05	0.05	0.05	0.05	0.05	0.05
8.817	0.05	0.05	0.05	0.05	0.05	0.05	0.05
8.861	0.05	0.05	0.05	0.05	0.05	0.05	0.05
8.905	0.05	0.05	0.05	0.05	0.05	0.05	0.05
8.950	0.05	0.05	0.05	0.05	0.06	0.06	0.06
8.994	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.038	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.082	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.127	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.171	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.215	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.259	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.303	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.348	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.392	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.436	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.480	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.524	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.569	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.613	0.06	0.06	0.06	0.06	0.06	0.06	0.06
9.657	0.06	0.06	0.06	0.06	0.07	0.07	0.07
9.701	0.07	0.07	0.07	0.07	0.07	0.07	0.07
9.745	0.07	0.07	0.07	0.07	0.07	0.07	0.07

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 2-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

9.790	0.07	0.07	0.07	0.07	0.07	0.07	0.07
9.834	0.07	0.07	0.07	0.07	0.07	0.07	0.07
9.878	0.07	0.07	0.07	0.07	0.07	0.07	0.07
9.922	0.07	0.07	0.07	0.07	0.08	0.08	0.08
9.967	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.011	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.055	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.099	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.143	0.08	0.08	0.08	0.09	0.09	0.09	0.09
10.188	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.232	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.276	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.320	0.09	0.09	0.09	0.10	0.10	0.10	0.10
10.364	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10.409	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10.453	0.10	0.10	0.10	0.10	0.10	0.10	0.11
10.497	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.541	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.585	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.630	0.11	0.12	0.12	0.12	0.12	0.12	0.12
10.674	0.12	0.12	0.12	0.12	0.12	0.12	0.12
10.718	0.12	0.12	0.12	0.13	0.13	0.13	0.13
10.762	0.13	0.13	0.13	0.13	0.13	0.13	0.13
10.807	0.13	0.13	0.13	0.13	0.13	0.14	0.14
10.851	0.14	0.14	0.14	0.14	0.14	0.14	0.14
10.895	0.14	0.14	0.14	0.14	0.14	0.14	0.15
10.939	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10.983	0.15	0.15	0.15	0.15	0.15	0.15	0.15
11.028	0.16	0.16	0.16	0.16	0.16	0.16	0.16
11.072	0.16	0.16	0.17	0.17	0.17	0.17	0.17
11.116	0.17	0.17	0.17	0.17	0.18	0.18	0.18
11.160	0.18	0.18	0.18	0.19	0.19	0.19	0.19
11.204	0.19	0.19	0.19	0.19	0.20	0.20	0.20
11.249	0.20	0.20	0.20	0.21	0.21	0.21	0.21
11.293	0.21	0.21	0.22	0.22	0.22	0.22	0.22
11.337	0.22	0.22	0.23	0.23	0.23	0.23	0.23
11.381	0.23	0.24	0.24	0.24	0.24	0.24	0.24

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 2-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

11.425	0.24	0.24	0.25	0.25	0.25	0.25	0.25
11.470	0.26	0.26	0.26	0.26	0.26	0.26	0.27
11.514	0.27	0.28	0.28	0.30	0.31	0.33	0.35
11.558	0.37	0.40	0.42	0.44	0.46	0.47	0.49
11.602	0.50	0.52	0.53	0.55	0.57	0.60	0.64
11.647	0.68	0.72	0.77	0.82	0.86	0.90	0.94
11.691	0.98	1.01	1.03	1.06	1.08	1.11	1.15
11.735	1.19	1.24	1.30	1.36	1.42	1.49	1.54
11.779	1.60	1.65	1.70	1.73	1.77	1.81	1.85
11.823	1.90	1.97	2.06	2.17	2.29	2.41	2.54
11.868	2.67	2.79	2.91	3.01	3.11	3.18	3.25
11.912	3.30	3.33	3.35	3.35	3.33	3.29	3.24
11.956	3.18	3.12	3.05	2.98	2.92	2.87	2.82
12.000	2.78	2.74	2.70	2.65	2.58	2.49	2.37

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
12.044	2.24	2.08	1.92	1.76	1.60	1.45	1.32
12.089	1.19	1.09	1.00	0.92	0.86	0.81	0.76
12.133	0.72	0.69	0.65	0.63	0.60	0.58	0.56
12.177	0.55	0.53	0.52	0.51	0.50	0.49	0.48
12.221	0.48	0.47	0.47	0.46	0.45	0.45	0.44
12.265	0.43	0.43	0.42	0.42	0.41	0.41	0.41
12.310	0.40	0.40	0.40	0.40	0.39	0.39	0.38
12.354	0.38	0.37	0.37	0.36	0.36	0.35	0.35
12.398	0.35	0.34	0.34	0.34	0.34	0.33	0.33
12.442	0.32	0.32	0.31	0.31	0.30	0.30	0.30
12.487	0.29	0.29	0.28	0.28	0.28	0.28	0.28
12.531	0.27	0.27	0.27	0.26	0.26	0.26	0.25
12.575	0.25	0.25	0.24	0.24	0.24	0.24	0.24
12.619	0.24	0.24	0.23	0.23	0.23	0.23	0.23

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 2-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

12.663	0.23	0.23	0.22	0.22	0.22	0.22	0.22
12.708	0.22	0.22	0.22	0.22	0.22	0.22	0.21
12.752	0.21	0.21	0.21	0.21	0.21	0.21	0.21
12.796	0.21	0.21	0.21	0.20	0.20	0.20	0.20
12.840	0.20	0.20	0.20	0.20	0.20	0.20	0.19
12.884	0.19	0.19	0.19	0.19	0.19	0.19	0.19
12.929	0.19	0.19	0.19	0.19	0.18	0.18	0.18
12.973	0.18	0.18	0.18	0.18	0.18	0.18	0.18
13.017	0.18	0.18	0.18	0.17	0.17	0.17	0.17
13.061	0.17	0.17	0.17	0.17	0.17	0.17	0.17
13.105	0.17	0.17	0.16	0.16	0.16	0.16	0.16
13.150	0.16	0.16	0.16	0.16	0.16	0.16	0.16
13.194	0.16	0.16	0.16	0.16	0.16	0.16	0.16
13.238	0.16	0.15	0.15	0.15	0.15	0.15	0.15
13.282	0.15	0.15	0.15	0.15	0.15	0.15	0.15
13.327	0.15	0.15	0.15	0.15	0.15	0.15	0.15
13.371	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.415	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.459	0.14	0.14	0.14	0.14	0.14	0.14	0.13
13.503	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.548	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.592	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.636	0.13	0.13	0.13	0.12	0.12	0.12	0.12
13.680	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.724	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.769	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.813	0.12	0.12	0.12	0.12	0.12	0.11	0.11
13.857	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.901	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.945	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.990	0.11	0.11	0.11	0.11	0.11	0.11	0.10
14.034	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.078	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.122	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.167	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.211	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.255	0.10	0.10	0.10	0.10	0.10	0.10	0.10

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 2-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
14.299	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.343	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.388	0.10	0.10	0.10	0.10	0.10	0.10	0.10
14.432	0.10	0.09	0.09	0.09	0.09	0.09	0.09
14.476	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.520	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.564	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.609	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.653	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.697	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.741	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.785	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.830	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.874	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.918	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14.962	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.007	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.051	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.095	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.139	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.183	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.228	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.272	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.316	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.360	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.404	0.08	0.08	0.08	0.08	0.08	0.08	0.08
15.449	0.08	0.08	0.08	0.08	0.08	0.07	0.07
15.493	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.537	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 2-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

15.581	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.625	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.670	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.714	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.758	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.802	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.847	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.891	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.935	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.979	0.07	0.07	0.06	0.06	0.06	0.06	0.06
16.023	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.068	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.112	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.156	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.200	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.244	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.289	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.333	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.377	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.421	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.465	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.510	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
16.554	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.598	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.642	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.687	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.731	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.775	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 2-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

16.819	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.863	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.908	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.952	0.06	0.06	0.06	0.06	0.06	0.06	0.06
16.996	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.040	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.084	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.129	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.173	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.217	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.261	0.06	0.06	0.06	0.06	0.06	0.06	0.06
17.305	0.06	0.06	0.06	0.06	0.06	0.05	0.05
17.350	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.394	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.438	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.482	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.527	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.571	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.615	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.659	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.703	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.748	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.792	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.836	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.880	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.924	0.05	0.05	0.05	0.05	0.05	0.05	0.05
17.969	0.05	0.05	0.05	0.05	0.05	0.05	0.05
18.013	0.05	0.05	0.05	0.05	0.05	0.05	

STORM 10-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DA-2	0.001		4.790		11.93	5.37	4511.72

Line

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
6.536	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.580	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.624	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.669	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Elizabeth River
Post Conditions - East

Line

Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
6.713	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.757	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.801	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.845	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.890	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.934	0.05	0.05	0.06	0.06	0.06	0.06	0.06
6.978	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.022	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.066	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.111	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.155	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.199	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.243	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.287	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.332	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.376	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.420	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.464	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.509	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.553	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.597	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

7.641	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.685	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.730	0.06	0.06	0.06	0.06	0.06	0.06	0.07
7.774	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.818	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.862	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.906	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.951	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.995	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.039	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.083	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.127	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.172	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.216	0.07	0.07	0.07	0.07	0.07	0.08	0.08
8.260	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.304	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.349	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.393	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.437	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.481	0.08	0.08	0.08	0.09	0.09	0.09	0.09
8.525	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.570	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.614	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.658	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.702	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.746	0.09	0.10	0.10	0.10	0.10	0.10	0.10
8.791	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.835	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.879	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.923	0.10	0.10	0.10	0.10	0.10	0.10	0.10

Line
Start Time ---------- Flow Values @ time increment of 0.006 hr ----------

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

(hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
8.967	0.10	0.10	0.10	0.10	0.11	0.11	0.11
9.012	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.056	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.100	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.144	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.189	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.233	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.277	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.321	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.365	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.410	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.454	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.498	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.542	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.586	0.11	0.11	0.11	0.11	0.12	0.12	0.12
9.631	0.12	0.12	0.12	0.12	0.12	0.12	0.12
9.675	0.12	0.12	0.12	0.12	0.12	0.12	0.12
9.719	0.12	0.12	0.12	0.12	0.12	0.12	0.12
9.763	0.12	0.12	0.13	0.13	0.13	0.13	0.13
9.807	0.13	0.13	0.13	0.13	0.13	0.13	0.13
9.852	0.13	0.13	0.13	0.13	0.13	0.13	0.13
9.896	0.13	0.13	0.13	0.13	0.13	0.13	0.14
9.940	0.14	0.14	0.14	0.14	0.14	0.14	0.14
9.984	0.14	0.14	0.14	0.14	0.14	0.14	0.14
10.029	0.14	0.14	0.14	0.14	0.14	0.14	0.15
10.073	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10.117	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10.161	0.15	0.15	0.15	0.16	0.16	0.16	0.16
10.205	0.16	0.16	0.16	0.16	0.16	0.16	0.16
10.250	0.16	0.16	0.16	0.16	0.16	0.17	0.17
10.294	0.17	0.17	0.17	0.17	0.17	0.17	0.17
10.338	0.17	0.17	0.17	0.17	0.17	0.17	0.17
10.382	0.18	0.18	0.18	0.18	0.18	0.18	0.18
10.426	0.18	0.18	0.18	0.18	0.18	0.18	0.18
10.471	0.18	0.18	0.19	0.19	0.19	0.19	0.19
10.515	0.19	0.19	0.19	0.19	0.19	0.19	0.19

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

10.559	0.19	0.19	0.20	0.20	0.20	0.20	0.20
10.603	0.20	0.20	0.20	0.20	0.20	0.20	0.20
10.647	0.21	0.21	0.21	0.21	0.21	0.21	0.21
10.692	0.21	0.21	0.22	0.22	0.22	0.22	0.22
10.736	0.22	0.22	0.22	0.22	0.22	0.23	0.23
10.780	0.23	0.23	0.23	0.23	0.23	0.23	0.23
10.824	0.23	0.23	0.24	0.24	0.24	0.24	0.24
10.869	0.24	0.24	0.25	0.25	0.25	0.25	0.25
10.913	0.25	0.25	0.25	0.25	0.25	0.25	0.26
10.957	0.26	0.26	0.26	0.26	0.26	0.26	0.26
11.001	0.26	0.27	0.27	0.27	0.27	0.27	0.27
11.045	0.27	0.28	0.28	0.28	0.28	0.28	0.29
11.090	0.29	0.29	0.29	0.29	0.29	0.29	0.30
11.134	0.30	0.30	0.30	0.31	0.31	0.31	0.32
11.178	0.32	0.32	0.32	0.33	0.33	0.33	0.33

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.222	0.33	0.33	0.34	0.34	0.34	0.35	0.35
11.266	0.35	0.36	0.36	0.36	0.36	0.37	0.37
11.311	0.37	0.37	0.37	0.37	0.38	0.38	0.38
11.355	0.39	0.39	0.39	0.40	0.40	0.40	0.40
11.399	0.41	0.41	0.41	0.41	0.41	0.42	0.42
11.443	0.42	0.42	0.43	0.43	0.43	0.44	0.44
11.487	0.44	0.44	0.45	0.45	0.45	0.46	0.48
11.532	0.49	0.52	0.55	0.59	0.62	0.66	0.70
11.576	0.73	0.76	0.79	0.82	0.84	0.86	0.88
11.620	0.91	0.95	0.99	1.05	1.12	1.19	1.27
11.664	1.35	1.42	1.49	1.55	1.61	1.66	1.71
11.709	1.75	1.79	1.83	1.89	1.96	2.04	2.13
11.753	2.23	2.33	2.42	2.52	2.61	2.69	2.76

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

11.797	2.83	2.88	2.94	3.01	3.09	3.19	3.32
11.841	3.49	3.67	3.87	4.08	4.28	4.48	4.66
11.885	4.83	4.98	5.10	5.21	5.28	5.34	5.37
11.930	5.37	5.34	5.28	5.19	5.10	4.99	4.88
11.974	4.77	4.67	4.58	4.50	4.43	4.37	4.30
12.018	4.22	4.11	3.98	3.80	3.58	3.34	3.09
12.062	2.83	2.58	2.34	2.12	1.92	1.75	1.60
12.106	1.48	1.38	1.29	1.22	1.15	1.09	1.04
12.151	1.00	0.96	0.92	0.89	0.87	0.84	0.82
12.195	0.80	0.79	0.78	0.77	0.76	0.75	0.74
12.239	0.73	0.72	0.71	0.70	0.69	0.68	0.67
12.283	0.66	0.65	0.65	0.64	0.64	0.63	0.63
12.327	0.62	0.62	0.61	0.60	0.60	0.59	0.58
12.372	0.57	0.56	0.56	0.55	0.55	0.54	0.54
12.416	0.53	0.53	0.53	0.52	0.51	0.51	0.50
12.460	0.49	0.48	0.47	0.47	0.46	0.45	0.45
12.504	0.44	0.44	0.44	0.43	0.43	0.43	0.42
12.549	0.42	0.41	0.40	0.40	0.39	0.39	0.39
12.593	0.38	0.38	0.38	0.37	0.37	0.37	0.37
12.637	0.37	0.36	0.36	0.36	0.36	0.35	0.35
12.681	0.35	0.35	0.35	0.35	0.35	0.34	0.34
12.725	0.34	0.34	0.34	0.34	0.34	0.33	0.33
12.770	0.33	0.33	0.33	0.33	0.32	0.32	0.32
12.814	0.32	0.32	0.32	0.32	0.32	0.32	0.31
12.858	0.31	0.31	0.31	0.31	0.30	0.30	0.30
12.902	0.30	0.30	0.30	0.30	0.30	0.30	0.29
12.946	0.29	0.29	0.29	0.29	0.29	0.28	0.28
12.991	0.28	0.28	0.28	0.28	0.28	0.28	0.28
13.035	0.27	0.27	0.27	0.27	0.27	0.27	0.27
13.079	0.26	0.26	0.26	0.26	0.26	0.26	0.26
13.123	0.26	0.26	0.26	0.26	0.25	0.25	0.25
13.167	0.25	0.25	0.25	0.25	0.25	0.25	0.25
13.212	0.25	0.25	0.25	0.24	0.24	0.24	0.24
13.256	0.24	0.24	0.24	0.24	0.24	0.24	0.24
13.300	0.24	0.24	0.23	0.23	0.23	0.23	0.23
13.344	0.23	0.23	0.23	0.23	0.23	0.23	0.23
13.389	0.22	0.22	0.22	0.22	0.22	0.22	0.22
13.433	0.22	0.22	0.22	0.22	0.22	0.22	0.21

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
13.477	0.21	0.21	0.21	0.21	0.21	0.21	0.21
13.521	0.21	0.21	0.21	0.21	0.21	0.21	0.21
13.565	0.20	0.20	0.20	0.20	0.20	0.20	0.20
13.610	0.20	0.20	0.20	0.20	0.20	0.20	0.20
13.654	0.20	0.20	0.19	0.19	0.19	0.19	0.19
13.698	0.19	0.19	0.19	0.19	0.19	0.19	0.19
13.742	0.19	0.19	0.19	0.19	0.19	0.19	0.18
13.786	0.18	0.18	0.18	0.18	0.18	0.18	0.18
13.831	0.18	0.18	0.18	0.18	0.18	0.18	0.18
13.875	0.18	0.18	0.18	0.17	0.17	0.17	0.17
13.919	0.17	0.17	0.17	0.17	0.17	0.17	0.17
13.963	0.17	0.17	0.17	0.17	0.17	0.17	0.17
14.007	0.17	0.17	0.16	0.16	0.16	0.16	0.16
14.052	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.096	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.140	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.184	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.229	0.16	0.15	0.15	0.15	0.15	0.15	0.15
14.273	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.317	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.361	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.405	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.450	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.494	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.538	0.15	0.15	0.15	0.15	0.14	0.14	0.14
14.582	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.626	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.671	0.14	0.14	0.14	0.14	0.14	0.14	0.14

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

14.715	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.759	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.803	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.847	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.892	0.14	0.13	0.13	0.13	0.13	0.13	0.13
14.936	0.13	0.13	0.13	0.13	0.13	0.13	0.13
14.980	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.024	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.069	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.113	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.157	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.201	0.13	0.13	0.13	0.13	0.13	0.12	0.12
15.245	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.290	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.334	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.378	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.422	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.466	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.511	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.555	0.12	0.11	0.11	0.11	0.11	0.11	0.11
15.599	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.643	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.687	0.11	0.11	0.11	0.11	0.11	0.11	0.11

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
15.732	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.776	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.820	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.864	0.11	0.11	0.11	0.11	0.10	0.10	0.10
15.909	0.10	0.10	0.10	0.10	0.10	0.10	0.10

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

15.953	0.10	0.10	0.10	0.10	0.10	0.10	0.10
15.997	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.041	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.085	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.130	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.174	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.218	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.262	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.306	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.351	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.395	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.439	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.483	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.527	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.572	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.616	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.660	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.704	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.749	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.793	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.837	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.881	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.925	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.970	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.014	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.058	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.102	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.146	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.191	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.235	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.279	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.323	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.367	0.09	0.09	0.09	0.09	0.09	0.09	0.08
17.412	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.456	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.500	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.544	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.589	0.08	0.08	0.08	0.08	0.08	0.08	0.08

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

17.633	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.677	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.721	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.765	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.810	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.854	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.898	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.942	0.08	0.08	0.08	0.08	0.08	0.08	0.08

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
17.986	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.031	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.075	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.119	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.163	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.207	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.252	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.296	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.340	0.08	0.08	0.07	0.07	0.07	0.07	0.07
18.384	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.429	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.473	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.517	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.561	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.605	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.650	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.694	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.738	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.782	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.826	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

18.871	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.915	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.959	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.003	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.047	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.092	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.136	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.180	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.224	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.269	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.313	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.357	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.401	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.445	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.490	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.534	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.578	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.622	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.666	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.711	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.755	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.799	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.843	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.887	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.932	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.976	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.020	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.064	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.109	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.153	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.197	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Line

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
20.241	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.285	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.330	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.374	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.418	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.462	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.506	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.551	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.595	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.639	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.683	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.727	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.772	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.816	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.860	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.904	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.949	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.993	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.037	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.081	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.125	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.170	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.214	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.258	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.302	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.346	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.391	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.435	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.479	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.523	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.567	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.612	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.656	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.700	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.744	0.05	0.05	0.05	0.05	0.05	0.05	0.05

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

21.789	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.833	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.877	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.921	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.965	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.010	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.054	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.098	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.142	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.186	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.231	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.275	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.319	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.363	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.407	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.452	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
22.496	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.540	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.584	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.629	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.673	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.717	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.761	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.805	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.850	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.894	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.938	0.05	0.05	0.05	0.05	0.05	0.05	

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
OUTLET	0.001		4.790		11.93	5.37	4511.72

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
6.536	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.580	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.624	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.669	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.713	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.757	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.801	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.845	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.890	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6.934	0.05	0.05	0.06	0.06	0.06	0.06	0.06
6.978	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.022	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.066	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.111	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.155	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.199	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.243	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.287	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.332	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.376	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.420	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.464	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.509	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.553	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.597	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.641	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.685	0.06	0.06	0.06	0.06	0.06	0.06	0.06
7.730	0.06	0.06	0.06	0.06	0.06	0.06	0.07

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:
7.774 0.07 0.07 0.07 0.07 0.07 0.07 0.07

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
7.818	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.862	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.906	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.951	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.995	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.039	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.083	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.127	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.172	0.07	0.07	0.07	0.07	0.07	0.07	0.07
8.216	0.07	0.07	0.07	0.07	0.07	0.08	0.08
8.260	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.304	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.349	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.393	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.437	0.08	0.08	0.08	0.08	0.08	0.08	0.08
8.481	0.08	0.08	0.08	0.09	0.09	0.09	0.09
8.525	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.570	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.614	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.658	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.702	0.09	0.09	0.09	0.09	0.09	0.09	0.09
8.746	0.09	0.10	0.10	0.10	0.10	0.10	0.10
8.791	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.835	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.879	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.923	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8.967	0.10	0.10	0.10	0.10	0.11	0.11	0.11

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

9.012	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.056	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.100	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.144	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.189	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.233	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.277	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.321	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.365	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.410	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.454	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.498	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.542	0.11	0.11	0.11	0.11	0.11	0.11	0.11
9.586	0.11	0.11	0.11	0.11	0.12	0.12	0.12
9.631	0.12	0.12	0.12	0.12	0.12	0.12	0.12
9.675	0.12	0.12	0.12	0.12	0.12	0.12	0.12
9.719	0.12	0.12	0.12	0.12	0.12	0.12	0.12
9.763	0.12	0.12	0.13	0.13	0.13	0.13	0.13
9.807	0.13	0.13	0.13	0.13	0.13	0.13	0.13
9.852	0.13	0.13	0.13	0.13	0.13	0.13	0.13
9.896	0.13	0.13	0.13	0.13	0.13	0.13	0.14
9.940	0.14	0.14	0.14	0.14	0.14	0.14	0.14
9.984	0.14	0.14	0.14	0.14	0.14	0.14	0.14
10.029	0.14	0.14	0.14	0.14	0.14	0.14	0.15

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
10.073	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10.117	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10.161	0.15	0.15	0.15	0.16	0.16	0.16	0.16
10.205	0.16	0.16	0.16	0.16	0.16	0.16	0.16

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

10.250	0.16	0.16	0.16	0.16	0.16	0.17	0.17
10.294	0.17	0.17	0.17	0.17	0.17	0.17	0.17
10.338	0.17	0.17	0.17	0.17	0.17	0.17	0.17
10.382	0.18	0.18	0.18	0.18	0.18	0.18	0.18
10.426	0.18	0.18	0.18	0.18	0.18	0.18	0.18
10.471	0.18	0.18	0.19	0.19	0.19	0.19	0.19
10.515	0.19	0.19	0.19	0.19	0.19	0.19	0.19
10.559	0.19	0.19	0.20	0.20	0.20	0.20	0.20
10.603	0.20	0.20	0.20	0.20	0.20	0.20	0.20
10.647	0.21	0.21	0.21	0.21	0.21	0.21	0.21
10.692	0.21	0.21	0.22	0.22	0.22	0.22	0.22
10.736	0.22	0.22	0.22	0.22	0.22	0.23	0.23
10.780	0.23	0.23	0.23	0.23	0.23	0.23	0.23
10.824	0.23	0.23	0.24	0.24	0.24	0.24	0.24
10.869	0.24	0.24	0.25	0.25	0.25	0.25	0.25
10.913	0.25	0.25	0.25	0.25	0.25	0.25	0.26
10.957	0.26	0.26	0.26	0.26	0.26	0.26	0.26
11.001	0.26	0.27	0.27	0.27	0.27	0.27	0.27
11.045	0.27	0.28	0.28	0.28	0.28	0.28	0.29
11.090	0.29	0.29	0.29	0.29	0.29	0.29	0.30
11.134	0.30	0.30	0.30	0.31	0.31	0.31	0.32
11.178	0.32	0.32	0.32	0.33	0.33	0.33	0.33
11.222	0.33	0.33	0.34	0.34	0.34	0.35	0.35
11.266	0.35	0.36	0.36	0.36	0.36	0.37	0.37
11.311	0.37	0.37	0.37	0.37	0.38	0.38	0.38
11.355	0.39	0.39	0.39	0.40	0.40	0.40	0.40
11.399	0.41	0.41	0.41	0.41	0.41	0.42	0.42
11.443	0.42	0.42	0.43	0.43	0.43	0.44	0.44
11.487	0.44	0.44	0.45	0.45	0.45	0.46	0.48
11.532	0.49	0.52	0.55	0.59	0.62	0.66	0.70
11.576	0.73	0.76	0.79	0.82	0.84	0.86	0.88
11.620	0.91	0.95	0.99	1.05	1.12	1.19	1.27
11.664	1.35	1.42	1.49	1.55	1.61	1.66	1.71
11.709	1.75	1.79	1.83	1.89	1.96	2.04	2.13
11.753	2.23	2.33	2.42	2.52	2.61	2.69	2.76
11.797	2.83	2.88	2.94	3.01	3.09	3.19	3.32
11.841	3.49	3.67	3.87	4.08	4.28	4.48	4.66
11.885	4.83	4.98	5.10	5.21	5.28	5.34	5.37

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

11.930	5.37	5.34	5.28	5.19	5.10	4.99	4.88
11.974	4.77	4.67	4.58	4.50	4.43	4.37	4.30
12.018	4.22	4.11	3.98	3.80	3.58	3.34	3.09
12.062	2.83	2.58	2.34	2.12	1.92	1.75	1.60
12.106	1.48	1.38	1.29	1.22	1.15	1.09	1.04
12.151	1.00	0.96	0.92	0.89	0.87	0.84	0.82
12.195	0.80	0.79	0.78	0.77	0.76	0.75	0.74
12.239	0.73	0.72	0.71	0.70	0.69	0.68	0.67
12.283	0.66	0.65	0.65	0.64	0.64	0.63	0.63

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.327	0.62	0.62	0.61	0.60	0.60	0.59	0.58
12.372	0.57	0.56	0.56	0.55	0.55	0.54	0.54
12.416	0.53	0.53	0.53	0.52	0.51	0.51	0.50
12.460	0.49	0.48	0.47	0.47	0.46	0.45	0.45
12.504	0.44	0.44	0.44	0.43	0.43	0.43	0.42
12.549	0.42	0.41	0.40	0.40	0.39	0.39	0.39
12.593	0.38	0.38	0.38	0.37	0.37	0.37	0.37
12.637	0.37	0.36	0.36	0.36	0.36	0.35	0.35
12.681	0.35	0.35	0.35	0.35	0.35	0.34	0.34
12.725	0.34	0.34	0.34	0.34	0.34	0.33	0.33
12.770	0.33	0.33	0.33	0.33	0.32	0.32	0.32
12.814	0.32	0.32	0.32	0.32	0.32	0.32	0.31
12.858	0.31	0.31	0.31	0.31	0.30	0.30	0.30
12.902	0.30	0.30	0.30	0.30	0.30	0.30	0.29
12.946	0.29	0.29	0.29	0.29	0.29	0.28	0.28
12.991	0.28	0.28	0.28	0.28	0.28	0.28	0.28
13.035	0.27	0.27	0.27	0.27	0.27	0.27	0.27
13.079	0.26	0.26	0.26	0.26	0.26	0.26	0.26
13.123	0.26	0.26	0.26	0.26	0.25	0.25	0.25

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

13.167	0.25	0.25	0.25	0.25	0.25	0.25	0.25
13.212	0.25	0.25	0.25	0.24	0.24	0.24	0.24
13.256	0.24	0.24	0.24	0.24	0.24	0.24	0.24
13.300	0.24	0.24	0.23	0.23	0.23	0.23	0.23
13.344	0.23	0.23	0.23	0.23	0.23	0.23	0.23
13.389	0.22	0.22	0.22	0.22	0.22	0.22	0.22
13.433	0.22	0.22	0.22	0.22	0.22	0.22	0.21
13.477	0.21	0.21	0.21	0.21	0.21	0.21	0.21
13.521	0.21	0.21	0.21	0.21	0.21	0.21	0.21
13.565	0.20	0.20	0.20	0.20	0.20	0.20	0.20
13.610	0.20	0.20	0.20	0.20	0.20	0.20	0.20
13.654	0.20	0.20	0.19	0.19	0.19	0.19	0.19
13.698	0.19	0.19	0.19	0.19	0.19	0.19	0.19
13.742	0.19	0.19	0.19	0.19	0.19	0.19	0.18
13.786	0.18	0.18	0.18	0.18	0.18	0.18	0.18
13.831	0.18	0.18	0.18	0.18	0.18	0.18	0.18
13.875	0.18	0.18	0.18	0.17	0.17	0.17	0.17
13.919	0.17	0.17	0.17	0.17	0.17	0.17	0.17
13.963	0.17	0.17	0.17	0.17	0.17	0.17	0.17
14.007	0.17	0.17	0.16	0.16	0.16	0.16	0.16
14.052	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.096	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.140	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.184	0.16	0.16	0.16	0.16	0.16	0.16	0.16
14.229	0.16	0.15	0.15	0.15	0.15	0.15	0.15
14.273	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.317	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.361	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.405	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.450	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.494	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14.538	0.15	0.15	0.15	0.15	0.14	0.14	0.14

Elizabeth River
Post Conditions - East

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:
Line
Start Time ---------- Flow Values @ time increment of 0.006 hr ----------
(hr) (cfs) (cfs) (cfs) (cfs) (cfs) (cfs) (cfs)

14.582	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.626	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.671	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.715	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.759	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.803	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.847	0.14	0.14	0.14	0.14	0.14	0.14	0.14
14.892	0.14	0.13	0.13	0.13	0.13	0.13	0.13
14.936	0.13	0.13	0.13	0.13	0.13	0.13	0.13
14.980	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.024	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.069	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.113	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.157	0.13	0.13	0.13	0.13	0.13	0.13	0.13
15.201	0.13	0.13	0.13	0.13	0.13	0.12	0.12
15.245	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.290	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.334	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.378	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.422	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.466	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.511	0.12	0.12	0.12	0.12	0.12	0.12	0.12
15.555	0.12	0.11	0.11	0.11	0.11	0.11	0.11
15.599	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.643	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.687	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.732	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.776	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.820	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15.864	0.11	0.11	0.11	0.11	0.10	0.10	0.10
15.909	0.10	0.10	0.10	0.10	0.10	0.10	0.10
15.953	0.10	0.10	0.10	0.10	0.10	0.10	0.10
15.997	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.041	0.10	0.10	0.10	0.10	0.10	0.10	0.10

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

16.085	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.130	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.174	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.218	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.262	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.306	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.351	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.395	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.439	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16.483	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.527	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.572	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.616	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.660	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.704	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.749	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.793	0.09	0.09	0.09	0.09	0.09	0.09	0.09

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
16.837	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.881	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.925	0.09	0.09	0.09	0.09	0.09	0.09	0.09
16.970	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.014	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.058	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.102	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.146	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.191	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.235	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.279	0.09	0.09	0.09	0.09	0.09	0.09	0.09

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

17.323	0.09	0.09	0.09	0.09	0.09	0.09	0.09
17.367	0.09	0.09	0.09	0.09	0.09	0.09	0.08
17.412	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.456	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.500	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.544	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.589	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.633	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.677	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.721	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.765	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.810	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.854	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.898	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.942	0.08	0.08	0.08	0.08	0.08	0.08	0.08
17.986	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.031	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.075	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.119	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.163	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.207	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.252	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.296	0.08	0.08	0.08	0.08	0.08	0.08	0.08
18.340	0.08	0.08	0.07	0.07	0.07	0.07	0.07
18.384	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.429	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.473	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.517	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.561	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.605	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.650	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.694	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.738	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.782	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.826	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.871	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.915	0.07	0.07	0.07	0.07	0.07	0.07	0.07
18.959	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

19.003	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.047	0.07	0.07	0.07	0.07	0.07	0.07	0.07

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
19.092	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.136	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.180	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.224	0.07	0.07	0.07	0.07	0.07	0.07	0.07
19.269	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.313	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.357	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.401	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.445	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.490	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.534	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.578	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.622	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.666	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.711	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.755	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.799	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.843	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.887	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.932	0.06	0.06	0.06	0.06	0.06	0.06	0.06
19.976	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.020	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.064	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.109	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.153	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.197	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

20.241	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.285	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.330	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.374	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.418	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.462	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.506	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.551	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.595	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20.639	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.683	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.727	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.772	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.816	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.860	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.904	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.949	0.05	0.05	0.05	0.05	0.05	0.05	0.05
20.993	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.037	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.081	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.125	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.170	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.214	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.258	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.302	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
21.346	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.391	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.435	0.05	0.05	0.05	0.05	0.05	0.05	0.05

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 10-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

21.479	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.523	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.567	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.612	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.656	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.700	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.744	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.789	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.833	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.877	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.921	0.05	0.05	0.05	0.05	0.05	0.05	0.05
21.965	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.010	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.054	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.098	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.142	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.186	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.231	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.275	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.319	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.363	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.407	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.452	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.496	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.540	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.584	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.629	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.673	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.717	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.761	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.805	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.850	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.894	0.05	0.05	0.05	0.05	0.05	0.05	0.05
22.938	0.05	0.05	0.05	0.05	0.05	0.05	

STORM 1-Yr

Area or	Drainage	Rain Gage	Runoff	Peak Flow

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 1-Yr

SUB-AREA:

DA-2	Outlet	.00119	94.	.1	

STREAM REACH:

Reach Identifier	Area (sq mi)	ID or Location	Amount (in)	Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
DA-2	0.001		1.869		11.93	2.64	2216.42

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
9.801	0.05	0.05	0.05	0.05	0.05	0.05	0.05
9.845	0.05	0.05	0.05	0.05	0.05	0.05	0.05
9.890	0.05	0.05	0.05	0.05	0.05	0.05	0.05
9.934	0.05	0.05	0.05	0.05	0.05	0.05	0.06
9.978	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.022	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.066	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.111	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.155	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.199	0.06	0.06	0.06	0.06	0.06	0.06	0.07
10.243	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.287	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.332	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.376	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.420	0.07	0.07	0.07	0.07	0.07	0.07	0.08
10.464	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.509	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.553	0.08	0.08	0.08	0.08	0.08	0.08	0.08

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 1-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

10.597	0.08	0.08	0.08	0.08	0.08	0.08	0.09
10.641	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.685	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.730	0.09	0.09	0.09	0.09	0.09	0.09	0.10
10.774	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10.818	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10.862	0.10	0.10	0.10	0.10	0.11	0.11	0.11
10.906	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.951	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.995	0.11	0.11	0.11	0.11	0.12	0.12	0.12
11.039	0.12	0.12	0.12	0.12	0.12	0.12	0.12
11.083	0.12	0.12	0.13	0.13	0.13	0.13	0.13
11.127	0.13	0.13	0.13	0.13	0.13	0.13	0.14
11.172	0.14	0.14	0.14	0.14	0.14	0.14	0.14
11.216	0.14	0.15	0.15	0.15	0.15	0.15	0.15
11.260	0.15	0.15	0.16	0.16	0.16	0.16	0.16
11.304	0.16	0.16	0.16	0.16	0.17	0.17	0.17
11.349	0.17	0.17	0.17	0.17	0.18	0.18	0.18
11.393	0.18	0.18	0.18	0.18	0.18	0.18	0.18
11.437	0.19	0.19	0.19	0.19	0.19	0.19	0.20
11.481	0.20	0.20	0.20	0.20	0.20	0.20	0.21
11.525	0.21	0.22	0.23	0.25	0.26	0.28	0.30
11.570	0.31	0.33	0.35	0.36	0.37	0.38	0.39
11.614	0.40	0.41	0.43	0.45	0.48	0.51	0.55
11.658	0.58	0.62	0.65	0.69	0.72	0.74	0.77
11.702	0.79	0.81	0.83	0.85	0.88	0.91	0.95
11.746	0.99	1.04	1.09	1.14	1.19	1.23	1.27
11.791	1.31	1.34	1.37	1.40	1.43	1.47	1.52
11.835	1.59	1.67	1.76	1.86	1.97	2.07	2.17
11.879	2.26	2.34	2.42	2.49	2.54	2.58	2.62
11.923	2.63	2.64	2.63	2.60	2.56	2.52	2.47
11.967	2.42	2.37	2.32	2.28	2.24	2.21	2.18
12.012	2.14	2.11	2.05	1.99	1.90	1.79	1.67

Elizabeth River
Post Conditions - East

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East
STORM 1-Yr
SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.056	1.55	1.42	1.29	1.18	1.07	0.97	0.88
12.100	0.81	0.74	0.69	0.65	0.61	0.58	0.55
12.144	0.52	0.50	0.48	0.46	0.45	0.44	0.42
12.189	0.41	0.41	0.40	0.39	0.39	0.38	0.38
12.233	0.37	0.37	0.36	0.36	0.35	0.35	0.34
12.277	0.34	0.33	0.33	0.33	0.32	0.32	0.32
12.321	0.32	0.32	0.31	0.31	0.31	0.30	0.30
12.365	0.29	0.29	0.29	0.28	0.28	0.28	0.27
12.410	0.27	0.27	0.27	0.27	0.26	0.26	0.26
12.454	0.25	0.25	0.24	0.24	0.24	0.23	0.23
12.498	0.23	0.23	0.22	0.22	0.22	0.22	0.22
12.542	0.21	0.21	0.21	0.20	0.20	0.20	0.20
12.586	0.20	0.19	0.19	0.19	0.19	0.19	0.19
12.631	0.19	0.19	0.18	0.18	0.18	0.18	0.18
12.675	0.18	0.18	0.18	0.18	0.18	0.18	0.17
12.719	0.17	0.17	0.17	0.17	0.17	0.17	0.17
12.763	0.17	0.17	0.17	0.17	0.17	0.16	0.16
12.807	0.16	0.16	0.16	0.16	0.16	0.16	0.16
12.852	0.16	0.16	0.16	0.16	0.16	0.15	0.15
12.896	0.15	0.15	0.15	0.15	0.15	0.15	0.15
12.940	0.15	0.15	0.15	0.15	0.15	0.14	0.14
12.984	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.029	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.073	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.117	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.161	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.205	0.13	0.13	0.13	0.12	0.12	0.12	0.12
13.250	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.294	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.338	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.382	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.426	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.471	0.11	0.11	0.11	0.11	0.11	0.11	0.11

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 1-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

13.515	0.11	0.11	0.11	0.11	0.11	0.11	0.10
13.559	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.603	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.647	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.692	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.736	0.10	0.10	0.10	0.10	0.10	0.09	0.09
13.780	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.824	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.869	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.913	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.957	0.09	0.09	0.09	0.09	0.09	0.08	0.08
14.001	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.045	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.090	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.134	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.178	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.222	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.266	0.08	0.08	0.08	0.08	0.08	0.08	0.08

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
14.311	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.355	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.399	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.443	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.487	0.08	0.08	0.07	0.07	0.07	0.07	0.07
14.532	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.576	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.620	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.664	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.708	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 1-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

14.753	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.797	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.841	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.885	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.930	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.974	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.018	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.062	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.106	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.151	0.07	0.06	0.06	0.06	0.06	0.06	0.06
15.195	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.239	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.283	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.327	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.372	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.416	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.460	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.504	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.549	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.593	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.637	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.681	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.725	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.770	0.06	0.06	0.06	0.06	0.06	0.05	0.05
15.814	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.858	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.902	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.946	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.991	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.035	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.079	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.123	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.167	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.212	0.05	0.05	0.05				

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East
STORM 1-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

OUTLET 0.001 1.869 11.93 2.64 2216.42

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
9.801	0.05	0.05	0.05	0.05	0.05	0.05	0.05
9.845	0.05	0.05	0.05	0.05	0.05	0.05	0.05
9.890	0.05	0.05	0.05	0.05	0.05	0.05	0.05
9.934	0.05	0.05	0.05	0.05	0.05	0.05	0.06
9.978	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.022	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.066	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.111	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.155	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.199	0.06	0.06	0.06	0.06	0.06	0.06	0.07
10.243	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.287	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.332	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.376	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.420	0.07	0.07	0.07	0.07	0.07	0.07	0.08
10.464	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.509	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.553	0.08	0.08	0.08	0.08	0.08	0.08	0.08
10.597	0.08	0.08	0.08	0.08	0.08	0.08	0.09
10.641	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.685	0.09	0.09	0.09	0.09	0.09	0.09	0.09
10.730	0.09	0.09	0.09	0.09	0.09	0.09	0.10
10.774	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10.818	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10.862	0.10	0.10	0.10	0.10	0.11	0.11	0.11

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 1-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

10.906	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.951	0.11	0.11	0.11	0.11	0.11	0.11	0.11
10.995	0.11	0.11	0.11	0.11	0.12	0.12	0.12
11.039	0.12	0.12	0.12	0.12	0.12	0.12	0.12
11.083	0.12	0.12	0.13	0.13	0.13	0.13	0.13
11.127	0.13	0.13	0.13	0.13	0.13	0.13	0.14
11.172	0.14	0.14	0.14	0.14	0.14	0.14	0.14
11.216	0.14	0.15	0.15	0.15	0.15	0.15	0.15
11.260	0.15	0.15	0.16	0.16	0.16	0.16	0.16
11.304	0.16	0.16	0.16	0.16	0.17	0.17	0.17
11.349	0.17	0.17	0.17	0.17	0.18	0.18	0.18
11.393	0.18	0.18	0.18	0.18	0.18	0.18	0.18
11.437	0.19	0.19	0.19	0.19	0.19	0.19	0.20
11.481	0.20	0.20	0.20	0.20	0.20	0.20	0.21
11.525	0.21	0.22	0.23	0.25	0.26	0.28	0.30
11.570	0.31	0.33	0.35	0.36	0.37	0.38	0.39
11.614	0.40	0.41	0.43	0.45	0.48	0.51	0.55
11.658	0.58	0.62	0.65	0.69	0.72	0.74	0.77
11.702	0.79	0.81	0.83	0.85	0.88	0.91	0.95
11.746	0.99	1.04	1.09	1.14	1.19	1.23	1.27
11.791	1.31	1.34	1.37	1.40	1.43	1.47	1.52
11.835	1.59	1.67	1.76	1.86	1.97	2.07	2.17
11.879	2.26	2.34	2.42	2.49	2.54	2.58	2.62
11.923	2.63	2.64	2.63	2.60	2.56	2.52	2.47
11.967	2.42	2.37	2.32	2.28	2.24	2.21	2.18
12.012	2.14	2.11	2.05	1.99	1.90	1.79	1.67

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.056	1.55	1.42	1.29	1.18	1.07	0.97	0.88
12.100	0.81	0.74	0.69	0.65	0.61	0.58	0.55

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 1-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

12.144	0.52	0.50	0.48	0.46	0.45	0.44	0.42
12.189	0.41	0.41	0.40	0.39	0.39	0.38	0.38
12.233	0.37	0.37	0.36	0.36	0.35	0.35	0.34
12.277	0.34	0.33	0.33	0.33	0.32	0.32	0.32
12.321	0.32	0.32	0.31	0.31	0.31	0.30	0.30
12.365	0.29	0.29	0.29	0.28	0.28	0.28	0.27
12.410	0.27	0.27	0.27	0.27	0.26	0.26	0.26
12.454	0.25	0.25	0.24	0.24	0.24	0.23	0.23
12.498	0.23	0.23	0.22	0.22	0.22	0.22	0.22
12.542	0.21	0.21	0.21	0.20	0.20	0.20	0.20
12.586	0.20	0.19	0.19	0.19	0.19	0.19	0.19
12.631	0.19	0.19	0.18	0.18	0.18	0.18	0.18
12.675	0.18	0.18	0.18	0.18	0.18	0.18	0.17
12.719	0.17	0.17	0.17	0.17	0.17	0.17	0.17
12.763	0.17	0.17	0.17	0.17	0.17	0.16	0.16
12.807	0.16	0.16	0.16	0.16	0.16	0.16	0.16
12.852	0.16	0.16	0.16	0.16	0.16	0.15	0.15
12.896	0.15	0.15	0.15	0.15	0.15	0.15	0.15
12.940	0.15	0.15	0.15	0.15	0.15	0.14	0.14
12.984	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.029	0.14	0.14	0.14	0.14	0.14	0.14	0.14
13.073	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.117	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.161	0.13	0.13	0.13	0.13	0.13	0.13	0.13
13.205	0.13	0.13	0.13	0.12	0.12	0.12	0.12
13.250	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.294	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.338	0.12	0.12	0.12	0.12	0.12	0.12	0.12
13.382	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.426	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.471	0.11	0.11	0.11	0.11	0.11	0.11	0.11
13.515	0.11	0.11	0.11	0.11	0.11	0.11	0.10
13.559	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.603	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.647	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.692	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13.736	0.10	0.10	0.10	0.10	0.10	0.09	0.09
13.780	0.09	0.09	0.09	0.09	0.09	0.09	0.09

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 1-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

13.824	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.869	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.913	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.957	0.09	0.09	0.09	0.09	0.09	0.08	0.08
14.001	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.045	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.090	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.134	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.178	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.222	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.266	0.08	0.08	0.08	0.08	0.08	0.08	0.08

Elizabeth River
Post Conditions - East

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
14.311	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.355	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.399	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.443	0.08	0.08	0.08	0.08	0.08	0.08	0.08
14.487	0.08	0.08	0.07	0.07	0.07	0.07	0.07
14.532	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.576	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.620	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.664	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.708	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.753	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.797	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.841	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.885	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.930	0.07	0.07	0.07	0.07	0.07	0.07	0.07
14.974	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.018	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 1-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

15.062	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.106	0.07	0.07	0.07	0.07	0.07	0.07	0.07
15.151	0.07	0.06	0.06	0.06	0.06	0.06	0.06
15.195	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.239	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.283	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.327	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.372	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.416	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.460	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.504	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.549	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.593	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.637	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.681	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.725	0.06	0.06	0.06	0.06	0.06	0.06	0.06
15.770	0.06	0.06	0.06	0.06	0.06	0.05	0.05
15.814	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.858	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.902	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.946	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15.991	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.035	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.079	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.123	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.167	0.05	0.05	0.05	0.05	0.05	0.05	0.05
16.212	0.05	0.05	0.05				

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East

STORM 1-Yr

SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

Post Conditions - East

Area or Reach Identifier	Drainage Area (sq mi)	Alternate	Peak Flow by Storm 2-Yr (cfs)	10-Yr (cfs)	1-Yr (cfs)	(cfs)	(cfs)
DA-2	0.001		3.35	5.37	2.64		
OUTLET	0.001		3.35	5.37	2.64		

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - East
STORM 1-Yr
SUB-AREA:
DA-2 Outlet .00119 94. .1

STREAM REACH:

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
Elizabeth River
Post Conditions - West

SUB-AREA:
DA-1 Outlet .00038 91. .1

STREAM REACH:

STORM ANALYSIS:
2-Yr 3.7 Type II 2
10-Yr 5.7 Type II 2
1-Yr 3.0 Type II 2

STRUCTURE RATING:

GLOBAL OUTPUT:
2 0.05 YYYYN YYYYNN

WinTR-20 Printed Page File End of Input Data List

Elizabeth River
Post Conditions - West

Name of printed page file:
TR20.out

STORM 2-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DA-1	0.380E-03		1.659		11.93	0.99	2614.35

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.194	0.05	0.05	0.05	0.05	0.05	0.05	0.05
11.239	0.05	0.05	0.05	0.05	0.05	0.06	0.06
11.283	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.327	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.371	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.415	0.07	0.07	0.07	0.07	0.07	0.07	0.07
11.460	0.07	0.07	0.07	0.07	0.07	0.07	0.07
11.504	0.07	0.07	0.07	0.08	0.08	0.08	0.09
11.548	0.09	0.10	0.10	0.11	0.12	0.12	0.13
11.592	0.13	0.14	0.14	0.14	0.15	0.15	0.16
11.636	0.17	0.18	0.19	0.21	0.22	0.23	0.24
11.681	0.26	0.27	0.28	0.28	0.29	0.30	0.31
11.725	0.32	0.33	0.34	0.36	0.37	0.39	0.41
11.769	0.43	0.45	0.46	0.48	0.49	0.50	0.51
11.813	0.52	0.54	0.56	0.58	0.61	0.64	0.68
11.857	0.72	0.76	0.79	0.83	0.86	0.90	0.92
11.902	0.95	0.96	0.98	0.99	0.99	0.99	0.99
11.946	0.97	0.96	0.94	0.92	0.90	0.89	0.87
11.990	0.85	0.84	0.83	0.82	0.81	0.79	0.77
12.034	0.74	0.70	0.66	0.61	0.56	0.51	0.47
12.079	0.42	0.38	0.35	0.32	0.29	0.27	0.25
12.123	0.24	0.23	0.21	0.20	0.20	0.19	0.18
12.167	0.17	0.17	0.16	0.16	0.16	0.15	0.15
12.211	0.15	0.15	0.14	0.14	0.14	0.14	0.14
12.255	0.14	0.13	0.13	0.13	0.13	0.13	0.13
12.300	0.12	0.12	0.12	0.12	0.12	0.12	0.12
12.344	0.12	0.12	0.11	0.11	0.11	0.11	0.11
12.388	0.11	0.11	0.11	0.10	0.10	0.10	0.10
12.432	0.10	0.10	0.10	0.10	0.10	0.09	0.09
12.476	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.521	0.08	0.08	0.08	0.08	0.08	0.08	0.08
12.565	0.08	0.08	0.08	0.08	0.07	0.07	0.07
12.609	0.07	0.07	0.07	0.07	0.07	0.07	0.07

12.653	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.697	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.742	0.07	0.07	0.07	0.06	0.06	0.06	0.06
12.786	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.830	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.874	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.919	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Elizabeth River
Post Conditions - West

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.963	0.06	0.06	0.06	0.06	0.05	0.05	0.05
13.007	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.051	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.095	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.140	0.05						

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
OUTLET	0.380E-03		1.659		11.93	0.99	2614.35

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.194	0.05	0.05	0.05	0.05	0.05	0.05	0.05
11.239	0.05	0.05	0.05	0.05	0.05	0.06	0.06
11.283	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.327	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.371	0.06	0.06	0.06	0.06	0.06	0.06	0.06
11.415	0.07	0.07	0.07	0.07	0.07	0.07	0.07
11.460	0.07	0.07	0.07	0.07	0.07	0.07	0.07
11.504	0.07	0.07	0.07	0.08	0.08	0.08	0.09
11.548	0.09	0.10	0.10	0.11	0.12	0.12	0.13
11.592	0.13	0.14	0.14	0.14	0.15	0.15	0.16
11.636	0.17	0.18	0.19	0.21	0.22	0.23	0.24
11.681	0.26	0.27	0.28	0.28	0.29	0.30	0.31
11.725	0.32	0.33	0.34	0.36	0.37	0.39	0.41
11.769	0.43	0.45	0.46	0.48	0.49	0.50	0.51
11.813	0.52	0.54	0.56	0.58	0.61	0.64	0.68
11.857	0.72	0.76	0.79	0.83	0.86	0.90	0.92
11.902	0.95	0.96	0.98	0.99	0.99	0.99	0.99
11.946	0.97	0.96	0.94	0.92	0.90	0.89	0.87
11.990	0.85	0.84	0.83	0.82	0.81	0.79	0.77
12.034	0.74	0.70	0.66	0.61	0.56	0.51	0.47
12.079	0.42	0.38	0.35	0.32	0.29	0.27	0.25
12.123	0.24	0.23	0.21	0.20	0.20	0.19	0.18
12.167	0.17	0.17	0.16	0.16	0.16	0.15	0.15
12.211	0.15	0.15	0.14	0.14	0.14	0.14	0.14
12.255	0.14	0.13	0.13	0.13	0.13	0.13	0.13
12.300	0.12	0.12	0.12	0.12	0.12	0.12	0.12
12.344	0.12	0.12	0.11	0.11	0.11	0.11	0.11
12.388	0.11	0.11	0.11	0.10	0.10	0.10	0.10
12.432	0.10	0.10	0.10	0.10	0.10	0.09	0.09
12.476	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.521	0.08	0.08	0.08	0.08	0.08	0.08	0.08
12.565	0.08	0.08	0.08	0.08	0.07	0.07	0.07
12.609	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.653	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.697	0.07	0.07	0.07	0.07	0.07	0.07	0.07

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - West

STORM 2-Yr

SUB-AREA:
DA-1 Outlet .00038 91. .1

STREAM REACH:

Elizabeth River
Post Conditions - West

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
12.742	0.07	0.07	0.07	0.06	0.06	0.06	0.06
12.786	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.830	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.874	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.919	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.963	0.06	0.06	0.06	0.06	0.05	0.05	0.05
13.007	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.051	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.095	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.140	0.05						

STORM 10-Yr

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
DA-1	0.380E-03		3.225		11.93	1.65	4338.34

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
10.449	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.493	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.538	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.582	0.05	0.06	0.06	0.06	0.06	0.06	0.06
10.626	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.670	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.714	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - West

STORM 10-Yr

SUB-AREA:
DA-1 Outlet .00038 91. .1

STREAM REACH:

10.759	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.803	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.847	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.891	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.935	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.980	0.07	0.07	0.07	0.07	0.08	0.08	0.08
11.024	0.08	0.08	0.08	0.08	0.08	0.08	0.08
11.068	0.08	0.08	0.08	0.08	0.08	0.08	0.08
11.112	0.08	0.08	0.08	0.08	0.09	0.09	0.09
11.156	0.09	0.09	0.09	0.09	0.09	0.09	0.09
11.201	0.09	0.09	0.09	0.09	0.10	0.10	0.10
11.245	0.10	0.10	0.10	0.10	0.10	0.10	0.10
11.289	0.10	0.10	0.11	0.11	0.11	0.11	0.11
11.333	0.11	0.11	0.11	0.11	0.11	0.11	0.11
11.378	0.11	0.12	0.12	0.12	0.12	0.12	0.12
11.422	0.12	0.12	0.12	0.12	0.12	0.12	0.12
11.466	0.13	0.13	0.13	0.13	0.13	0.13	0.13
11.510	0.13	0.13	0.14	0.14	0.15	0.16	0.17
11.554	0.18	0.19	0.20	0.21	0.22	0.23	0.24
11.599	0.24	0.25	0.26	0.26	0.27	0.29	0.30
11.643	0.32	0.34	0.36	0.39	0.41	0.43	0.45

Elizabeth River
Post Conditions - West

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
11.687	0.47	0.49	0.50	0.51	0.52	0.54	0.55
11.731	0.57	0.60	0.62	0.65	0.68	0.71	0.74
11.775	0.77	0.80	0.82	0.84	0.86	0.88	0.90
11.820	0.92	0.95	0.99	1.03	1.09	1.15	1.21
11.864	1.28	1.34	1.40	1.45	1.50	1.54	1.58
11.908	1.61	1.63	1.64	1.65	1.64	1.63	1.61
11.952	1.58	1.55	1.52	1.49	1.45	1.43	1.40

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - West

STORM 10-Yr

SUB-AREA:
DA-1 Outlet .00038 91. .1

STREAM REACH:

11.996	1.38	1.36	1.34	1.32	1.29	1.25	1.20
12.041	1.14	1.07	0.99	0.91	0.83	0.76	0.69
12.085	0.62	0.57	0.52	0.48	0.44	0.41	0.39
12.129	0.37	0.35	0.33	0.32	0.30	0.29	0.28
12.173	0.27	0.27	0.26	0.25	0.25	0.24	0.24
12.218	0.24	0.23	0.23	0.23	0.22	0.22	0.22
12.262	0.21	0.21	0.21	0.21	0.20	0.20	0.20
12.306	0.20	0.20	0.20	0.20	0.19	0.19	0.19
12.350	0.19	0.18	0.18	0.18	0.18	0.17	0.17
12.394	0.17	0.17	0.17	0.17	0.17	0.16	0.16
12.439	0.16	0.16	0.16	0.15	0.15	0.15	0.15
12.483	0.14	0.14	0.14	0.14	0.14	0.14	0.14
12.527	0.13	0.13	0.13	0.13	0.13	0.13	0.13
12.571	0.12	0.12	0.12	0.12	0.12	0.12	0.12
12.615	0.12	0.12	0.12	0.11	0.11	0.11	0.11
12.660	0.11	0.11	0.11	0.11	0.11	0.11	0.11
12.704	0.11	0.11	0.11	0.11	0.11	0.11	0.11
12.748	0.11	0.10	0.10	0.10	0.10	0.10	0.10
12.792	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.836	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.881	0.10	0.10	0.09	0.09	0.09	0.09	0.09
12.925	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.969	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.013	0.09	0.09	0.09	0.09	0.09	0.09	0.08
13.058	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.102	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.146	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.190	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.234	0.08	0.08	0.08	0.08	0.08	0.08	0.07
13.279	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.323	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.367	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.411	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.455	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.500	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.544	0.07	0.06	0.06	0.06	0.06	0.06	0.06
13.588	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.632	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - West

STORM 10-Yr

SUB-AREA:
DA-1 Outlet .00038 91. .1

STREAM REACH:

13.676	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.721	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.765	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.809	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.853	0.06	0.06	0.06	0.06	0.06	0.06	0.05
13.898	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Elizabeth River
Post Conditions - West

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
13.942	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.986	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.030	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.074	0.05	0.05	0.05	0.05	0.05	0.05	

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Time (hr)	Rate (cfs)	Rate (csm)
OUTLET	0.380E-03		3.225		11.93	1.65	4338.34

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
10.449	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.493	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.538	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10.582	0.05	0.06	0.06	0.06	0.06	0.06	0.06
10.626	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.670	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.714	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - West

STORM 10-Yr

SUB-AREA:
DA-1 Outlet .00038 91. .1

STREAM REACH:

10.759	0.06	0.06	0.06	0.06	0.06	0.06	0.06
10.803	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.847	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.891	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.935	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.980	0.07	0.07	0.07	0.07	0.08	0.08	0.08
11.024	0.08	0.08	0.08	0.08	0.08	0.08	0.08
11.068	0.08	0.08	0.08	0.08	0.08	0.08	0.08
11.112	0.08	0.08	0.08	0.08	0.09	0.09	0.09
11.156	0.09	0.09	0.09	0.09	0.09	0.09	0.09
11.201	0.09	0.09	0.09	0.09	0.10	0.10	0.10
11.245	0.10	0.10	0.10	0.10	0.10	0.10	0.10
11.289	0.10	0.10	0.11	0.11	0.11	0.11	0.11
11.333	0.11	0.11	0.11	0.11	0.11	0.11	0.11
11.378	0.11	0.12	0.12	0.12	0.12	0.12	0.12
11.422	0.12	0.12	0.12	0.12	0.12	0.12	0.12
11.466	0.13	0.13	0.13	0.13	0.13	0.13	0.13
11.510	0.13	0.13	0.14	0.14	0.15	0.16	0.17
11.554	0.18	0.19	0.20	0.21	0.22	0.23	0.24
11.599	0.24	0.25	0.26	0.26	0.27	0.29	0.30
11.643	0.32	0.34	0.36	0.39	0.41	0.43	0.45
11.687	0.47	0.49	0.50	0.51	0.52	0.54	0.55
11.731	0.57	0.60	0.62	0.65	0.68	0.71	0.74
11.775	0.77	0.80	0.82	0.84	0.86	0.88	0.90
11.820	0.92	0.95	0.99	1.03	1.09	1.15	1.21
11.864	1.28	1.34	1.40	1.45	1.50	1.54	1.58
11.908	1.61	1.63	1.64	1.65	1.64	1.63	1.61
11.952	1.58	1.55	1.52	1.49	1.45	1.43	1.40
11.996	1.38	1.36	1.34	1.32	1.29	1.25	1.20

Elizabeth River
Post Conditions - West

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - West

STORM 10-Yr

SUB-AREA:
DA-1 Outlet .00038 91. .1

STREAM REACH:

12.041	1.14	1.07	0.99	0.91	0.83	0.76	0.69
12.085	0.62	0.57	0.52	0.48	0.44	0.41	0.39
12.129	0.37	0.35	0.33	0.32	0.30	0.29	0.28
12.173	0.27	0.27	0.26	0.25	0.25	0.24	0.24
12.218	0.24	0.23	0.23	0.23	0.22	0.22	0.22
12.262	0.21	0.21	0.21	0.21	0.20	0.20	0.20
12.306	0.20	0.20	0.20	0.20	0.19	0.19	0.19
12.350	0.19	0.18	0.18	0.18	0.18	0.17	0.17
12.394	0.17	0.17	0.17	0.17	0.17	0.16	0.16
12.439	0.16	0.16	0.16	0.15	0.15	0.15	0.15
12.483	0.14	0.14	0.14	0.14	0.14	0.14	0.14
12.527	0.13	0.13	0.13	0.13	0.13	0.13	0.13
12.571	0.12	0.12	0.12	0.12	0.12	0.12	0.12
12.615	0.12	0.12	0.12	0.11	0.11	0.11	0.11
12.660	0.11	0.11	0.11	0.11	0.11	0.11	0.11
12.704	0.11	0.11	0.11	0.11	0.11	0.11	0.11
12.748	0.11	0.10	0.10	0.10	0.10	0.10	0.10
12.792	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.836	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.881	0.10	0.10	0.09	0.09	0.09	0.09	0.09
12.925	0.09	0.09	0.09	0.09	0.09	0.09	0.09
12.969	0.09	0.09	0.09	0.09	0.09	0.09	0.09
13.013	0.09	0.09	0.09	0.09	0.09	0.09	0.08
13.058	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.102	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.146	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.190	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13.234	0.08	0.08	0.08	0.08	0.08	0.08	0.07
13.279	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.323	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.367	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.411	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.455	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.500	0.07	0.07	0.07	0.07	0.07	0.07	0.07
13.544	0.07	0.06	0.06	0.06	0.06	0.06	0.06
13.588	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.632	0.06	0.06	0.06	0.06	0.06	0.06	0.06

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - West

STORM 10-Yr

SUB-AREA:
DA-1 Outlet .00038 91. .1

STREAM REACH:

13.676	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.721	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.765	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.809	0.06	0.06	0.06	0.06	0.06	0.06	0.06
13.853	0.06	0.06	0.06	0.06	0.06	0.06	0.05
13.898	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.942	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13.986	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.030	0.05	0.05	0.05	0.05	0.05	0.05	0.05
14.074	0.05	0.05	0.05	0.05	0.05	0.05	

STORM 1-Yr

Elizabeth River
Post Conditions - West

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
DA-1	0.380E-03		1.155		11.93	0.76	2006.82

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
11.472	0.05	0.05	0.05	0.05	0.05	0.05	0.05
11.516	0.05	0.05	0.06	0.06	0.06	0.07	0.07
11.560	0.08	0.08	0.08	0.09	0.09	0.10	0.10
11.604	0.10	0.10	0.11	0.11	0.12	0.12	0.13
11.649	0.14	0.15	0.16	0.17	0.18	0.19	0.20
11.693	0.20	0.21	0.21	0.22	0.23	0.23	0.24
11.737	0.25	0.26	0.28	0.29	0.30	0.32	0.33
11.781	0.34	0.36	0.37	0.37	0.38	0.39	0.40

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - West

STORM 1-Yr

SUB-AREA:
DA-1 Outlet .00038 91. .1

STREAM REACH:

11.825	0.42	0.43	0.46	0.48	0.51	0.54	0.57
11.870	0.60	0.63	0.66	0.68	0.70	0.72	0.74
11.914	0.75	0.76	0.76	0.76	0.76	0.75	0.74
11.958	0.73	0.71	0.70	0.68	0.67	0.66	0.65
12.002	0.64	0.64	0.63	0.61	0.60	0.57	0.55
12.046	0.51	0.48	0.44	0.40	0.37	0.33	0.30
12.091	0.27	0.25	0.23	0.21	0.20	0.19	0.18
12.135	0.17	0.16	0.15	0.15	0.14	0.14	0.13
12.179	0.13	0.13	0.12	0.12	0.12	0.12	0.11
12.223	0.11	0.11	0.11	0.11	0.11	0.11	0.10
12.268	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.312	0.10	0.10	0.09	0.09	0.09	0.09	0.09
12.356	0.09	0.09	0.09	0.09	0.09	0.08	0.08
12.400	0.08	0.08	0.08	0.08	0.08	0.08	0.08
12.444	0.08	0.08	0.07	0.07	0.07	0.07	0.07
12.489	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.533	0.07	0.06	0.06	0.06	0.06	0.06	0.06
12.577	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.621	0.06	0.06	0.06	0.06	0.06	0.06	0.05
12.665	0.05	0.05	0.05	0.05	0.05	0.05	0.05
12.710	0.05	0.05	0.05	0.05	0.05	0.05	0.05
12.754	0.05	0.05	0.05	0.05	0.05		

Area or Reach Identifier	Drainage Area (sq mi)	Rain Gage ID or Location	Runoff Amount (in)	Peak Flow Elevation (ft)	Peak Flow Time (hr)	Peak Flow Rate (cfs)	Peak Flow Rate (csm)
OUTLET	0.380E-03		1.155		11.93	0.76	2006.82

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)						
11.472	0.05	0.05	0.05	0.05	0.05	0.05	0.05
11.516	0.05	0.05	0.06	0.06	0.06	0.07	0.07
11.560	0.08	0.08	0.08	0.09	0.09	0.10	0.10
11.604	0.10	0.10	0.11	0.11	0.12	0.12	0.13

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - West

STORM 1-Yr

SUB-AREA:
DA-1 Outlet .00038 91. .1

STREAM REACH:

Elizabeth River
Post Conditions - West

Line Start Time (hr)	Flow Values @ time increment of 0.006 hr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
11.649	0.14	0.15	0.16	0.17	0.18	0.19	0.20
11.693	0.20	0.21	0.21	0.22	0.23	0.23	0.24
11.737	0.25	0.26	0.28	0.29	0.30	0.32	0.33
11.781	0.34	0.36	0.37	0.37	0.38	0.39	0.40
11.825	0.42	0.43	0.46	0.48	0.51	0.54	0.57
11.870	0.60	0.63	0.66	0.68	0.70	0.72	0.74
11.914	0.75	0.76	0.76	0.76	0.76	0.75	0.74
11.958	0.73	0.71	0.70	0.68	0.67	0.66	0.65
12.002	0.64	0.64	0.63	0.61	0.60	0.57	0.55
12.046	0.51	0.48	0.44	0.40	0.37	0.33	0.30
12.091	0.27	0.25	0.23	0.21	0.20	0.19	0.18
12.135	0.17	0.16	0.15	0.15	0.14	0.14	0.13
12.179	0.13	0.13	0.12	0.12	0.12	0.12	0.11
12.223	0.11	0.11	0.11	0.11	0.11	0.11	0.10
12.268	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12.312	0.10	0.10	0.09	0.09	0.09	0.09	0.09
12.356	0.09	0.09	0.09	0.09	0.09	0.08	0.08
12.400	0.08	0.08	0.08	0.08	0.08	0.08	0.08
12.444	0.08	0.08	0.07	0.07	0.07	0.07	0.07
12.489	0.07	0.07	0.07	0.07	0.07	0.07	0.07
12.533	0.07	0.06	0.06	0.06	0.06	0.06	0.06
12.577	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12.621	0.06	0.06	0.06	0.06	0.06	0.06	0.05
12.665	0.05	0.05	0.05	0.05	0.05	0.05	0.05
12.710	0.05	0.05	0.05	0.05	0.05	0.05	0.05
12.754	0.05	0.05	0.05	0.05	0.05		

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - West
STORM 1-Yr
SUB-AREA:
DA-1 Outlet .00038 91. .1

STREAM REACH:

Elizabeth River
Post Conditions - West

Area or Reach Identifier	Drainage Area (sq mi)	Alternate	Peak Flow by Storm 2-Yr (cfs)	10-Yr (cfs)	1-Yr (cfs)	(cfs)	(cfs)
DA-1	0.380E-03		0.99	1.65	0.76		
OUTLET	0.380E-03		0.99	1.65	0.76		

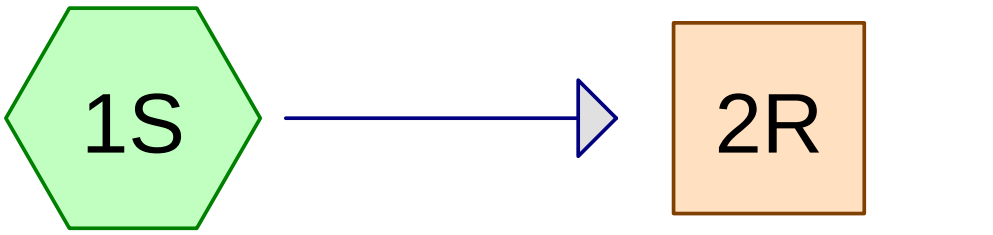
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beth River (continued)
Post Conditions - West
STORM 1-Yr
SUB-AREA:
DA-1 Outlet .00038 91. .1

STREAM REACH:

WinTR-20 Printed Page File Beginning of Input Data List
TR20.inp

WinTR-20: Version 1.10 0 0 0.05
beth River (continued)
Post Conditions - West
STORM 1-Yr
SUB-AREA:
DA-1 Outlet .00038 91. .1

STREAM REACH:



DA-B East Post

Channel - West

Subcat Reach Pond Link

Routing Diagram for Post-Conditions_East
Prepared by ERM, Printed 2/1/2017
HydroCAD® 10.00-18 s/n 09594 © 2016 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.029	80	>75% Grass cover, Good, HSG D (1S)
0.600	98	Paved roads w/curbs & sewers, HSG D (1S)
0.131	77	Woods, Good, HSG D (1S)
0.760	**94**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.760	HSG D	1S
0.000	Other	
0.760		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.029	0.000	0.029	>75% Grass cover, Good	1S
0.000	0.000	0.000	0.600	0.000	0.600	Paved roads w/curbs & sewers	1S
0.000	0.000	0.000	0.131	0.000	0.131	Woods, Good	1S
0.000	**0.000**	**0.000**	**0.760**	**0.000**	**0.760**	**TOTAL AREA**	

Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-B East Post Runoff Area=0.760 ac 78.95% Impervious Runoff Depth>2.21"
Flow Length=215' Slope=0.0050 '/' Tc=3.4 min CN=94 Runoff=3.15 cfs 0.140 af

Reach 2R: Channel - West Avg. Flow Depth=0.43' Max Vel=2.10 fps Inflow=3.15 cfs 0.140 af
n=0.035 L=100.0' S=0.0100 '/' Capacity=13.21 cfs Outflow=2.97 cfs 0.140 af

Total Runoff Area = 0.760 ac Runoff Volume = 0.140 af Average Runoff Depth = 2.21"
21.05% Pervious = 0.160 ac 78.95% Impervious = 0.600 ac

Summary for Subcatchment 1S: DA-B East Post

[49] Hint: Tc<2dt may require smaller dt

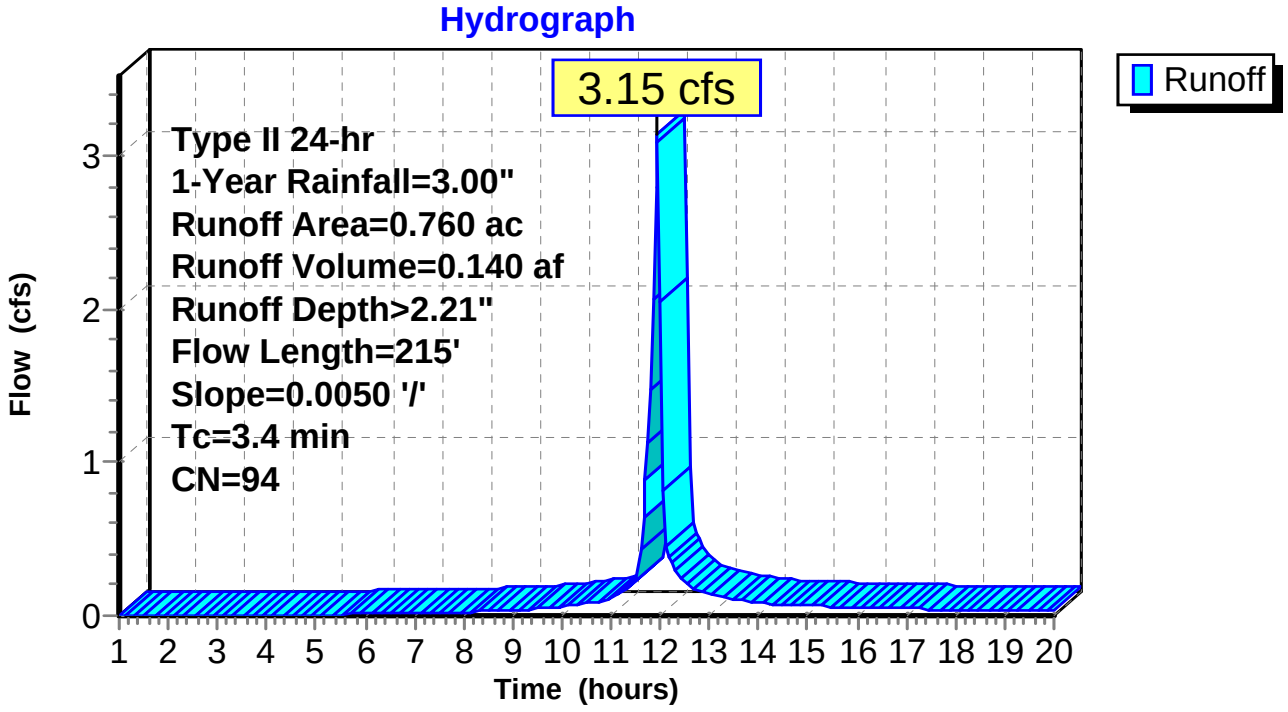
Runoff = 3.15 cfs @ 11.94 hrs, Volume= 0.140 af, Depth> 2.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-Year Rainfall=3.00"

Area (ac)	CN	Description
0.131	77	Woods, Good, HSG D
0.029	80	>75% Grass cover, Good, HSG D
0.600	98	Paved roads w/curbs & sewers, HSG D
0.760	94	Weighted Average
0.160		21.05% Pervious Area
0.600		78.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	100	0.0050	0.85		**Sheet Flow, Sheet Flow gravel** Smooth surfaces n= 0.011 P2= 3.70"
1.0	90	0.0050	1.44		**Shallow Concentrated Flow, Shallow Conc. gravel** Paved Kv= 20.3 fps
0.4	25	0.0050	1.14		**Shallow Concentrated Flow, Shallow Conc. VF/Open Space** Unpaved Kv= 16.1 fps
3.4	215	Total			

Subcatchment 1S: DA-B East Post



Summary for Reach 2R: Channel - West

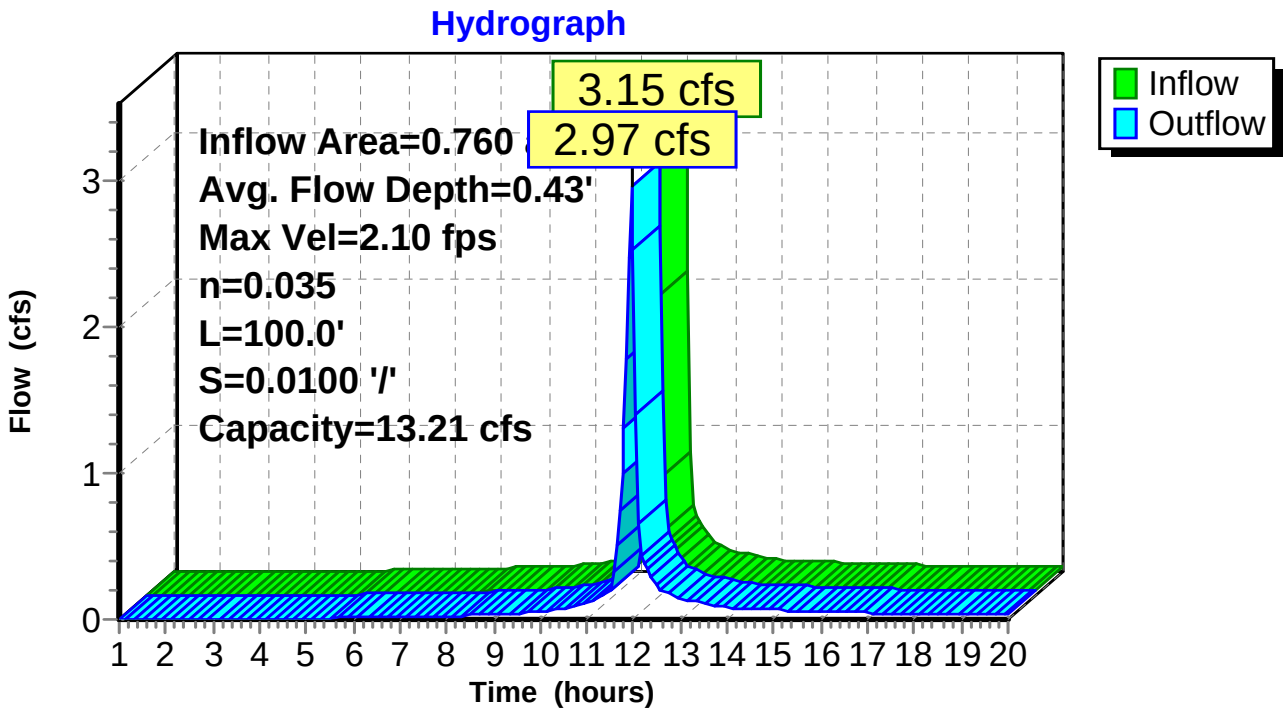
Inflow Area = 0.760 ac, 78.95% Impervious, Inflow Depth > 2.21" for 1-Year event
Inflow = 3.15 cfs @ 11.94 hrs, Volume= 0.140 af
Outflow = 2.97 cfs @ 11.95 hrs, Volume= 0.140 af, Atten= 6%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.10 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 0.47 fps, Avg. Travel Time= 3.5 min

Peak Storage= 147 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.43'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 '/' Top Width= 5.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'





Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-B East Post Runoff Area=0.760 ac 78.95% Impervious Runoff Depth>2.86"
Flow Length=215' Slope=0.0050 '/' Tc=3.4 min CN=94 Runoff=3.99 cfs 0.181 af

Reach 2R: Channel - West Avg. Flow Depth=0.49' Max Vel=2.27 fps Inflow=3.99 cfs 0.181 af
n=0.035 L=100.0' S=0.0100 '/' Capacity=13.21 cfs Outflow=3.78 cfs 0.181 af

Total Runoff Area = 0.760 ac Runoff Volume = 0.181 af Average Runoff Depth = 2.86"
21.05% Pervious = 0.160 ac 78.95% Impervious = 0.600 ac

Summary for Subcatchment 1S: DA-B East Post

[49] Hint: Tc<2dt may require smaller dt

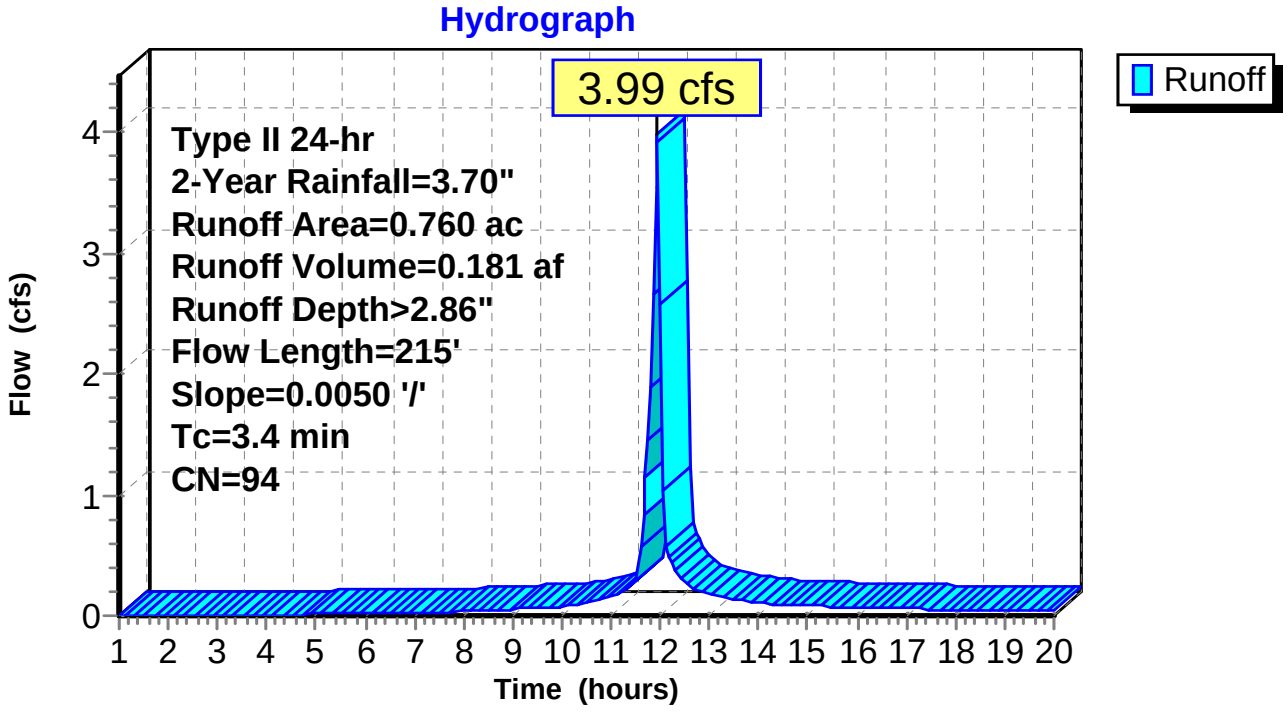
Runoff = 3.99 cfs @ 11.94 hrs, Volume= 0.181 af, Depth> 2.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.70"

Area (ac)	CN	Description
0.131	77	Woods, Good, HSG D
0.029	80	>75% Grass cover, Good, HSG D
0.600	98	Paved roads w/curbs & sewers, HSG D
0.760	94	Weighted Average
0.160		21.05% Pervious Area
0.600		78.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	100	0.0050	0.85		**Sheet Flow, Sheet Flow gravel** Smooth surfaces n= 0.011 P2= 3.70"
1.0	90	0.0050	1.44		**Shallow Concentrated Flow, Shallow Conc. gravel** Paved Kv= 20.3 fps
0.4	25	0.0050	1.14		**Shallow Concentrated Flow, Shallow Conc. VF/Open Space** Unpaved Kv= 16.1 fps
3.4	215	Total			

Subcatchment 1S: DA-B East Post



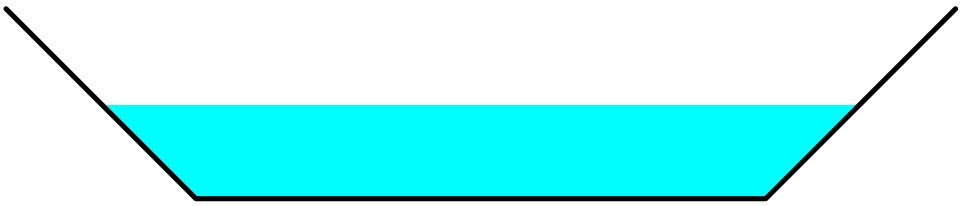
Summary for Reach 2R: Channel - West

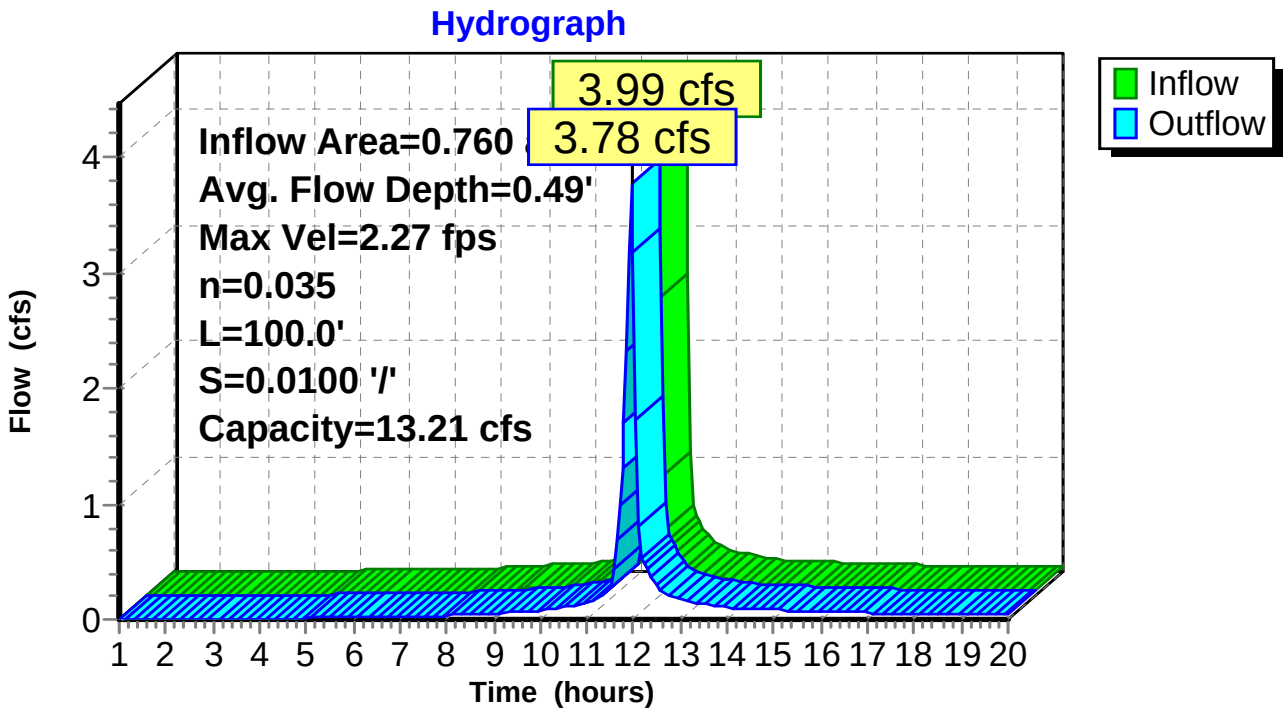
Inflow Area = 0.760 ac, 78.95% Impervious, Inflow Depth > 2.86" for 2-Year event
Inflow = 3.99 cfs @ 11.94 hrs, Volume= 0.181 af
Outflow = 3.78 cfs @ 11.95 hrs, Volume= 0.181 af, Atten= 5%, Lag= 0.8 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.27 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 0.52 fps, Avg. Travel Time= 3.2 min

Peak Storage= 172 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 '/' Top Width= 5.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'





Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-B East Post Runoff Area=0.760 ac 78.95% Impervious Runoff Depth>4.73"
Flow Length=215' Slope=0.0050 '/' Tc=3.4 min CN=94 Runoff=6.36 cfs 0.299 af

Reach 2R: Channel - West Avg. Flow Depth=0.65' Max Vel=2.64 fps Inflow=6.36 cfs 0.299 af
n=0.035 L=100.0' S=0.0100 '/' Capacity=13.21 cfs Outflow=6.07 cfs 0.299 af

Total Runoff Area = 0.760 ac Runoff Volume = 0.299 af Average Runoff Depth = 4.73"
21.05% Pervious = 0.160 ac 78.95% Impervious = 0.600 ac

Summary for Subcatchment 1S: DA-B East Post

[49] Hint: Tc<2dt may require smaller dt

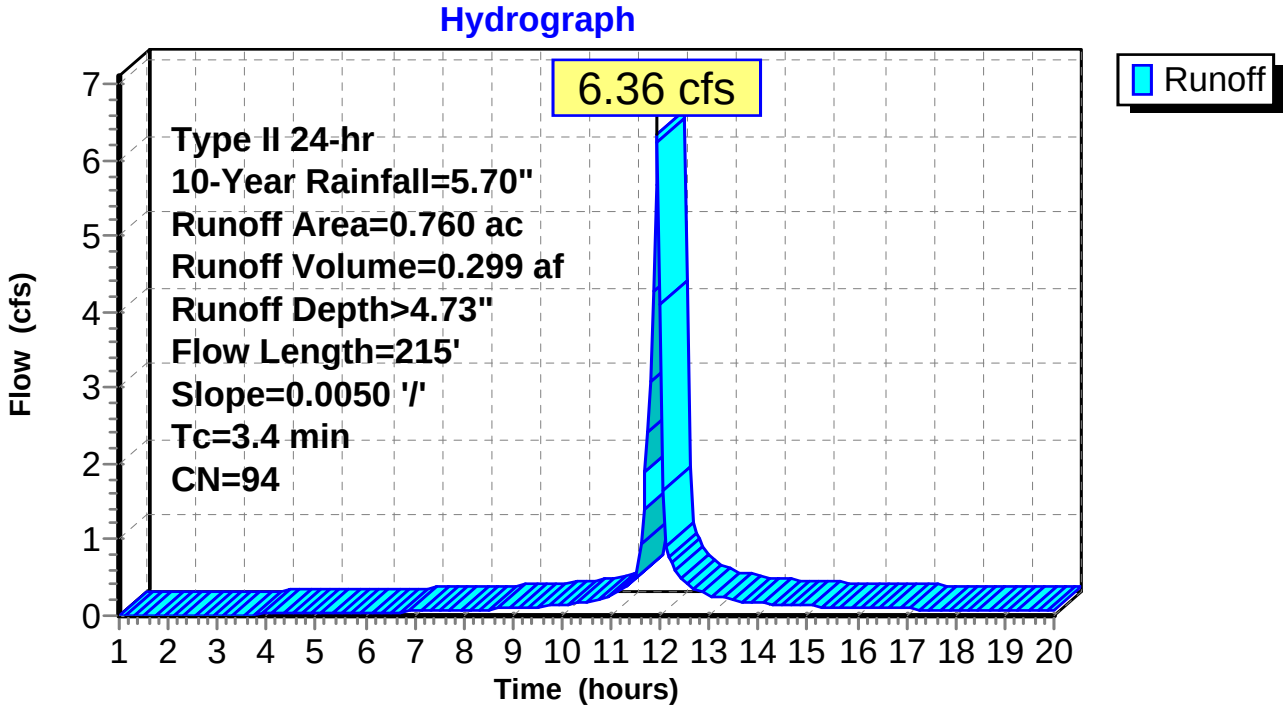
Runoff = 6.36 cfs @ 11.94 hrs, Volume= 0.299 af, Depth> 4.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.70"

Area (ac)	CN	Description
0.131	77	Woods, Good, HSG D
0.029	80	>75% Grass cover, Good, HSG D
0.600	98	Paved roads w/curbs & sewers, HSG D
0.760	94	Weighted Average
0.160		21.05% Pervious Area
0.600		78.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	100	0.0050	0.85		**Sheet Flow, Sheet Flow gravel** Smooth surfaces n= 0.011 P2= 3.70"
1.0	90	0.0050	1.44		**Shallow Concentrated Flow, Shallow Conc. gravel** Paved Kv= 20.3 fps
0.4	25	0.0050	1.14		**Shallow Concentrated Flow, Shallow Conc. VF/Open Space** Unpaved Kv= 16.1 fps
3.4	215	Total			

Subcatchment 1S: DA-B East Post



Summary for Reach 2R: Channel - West

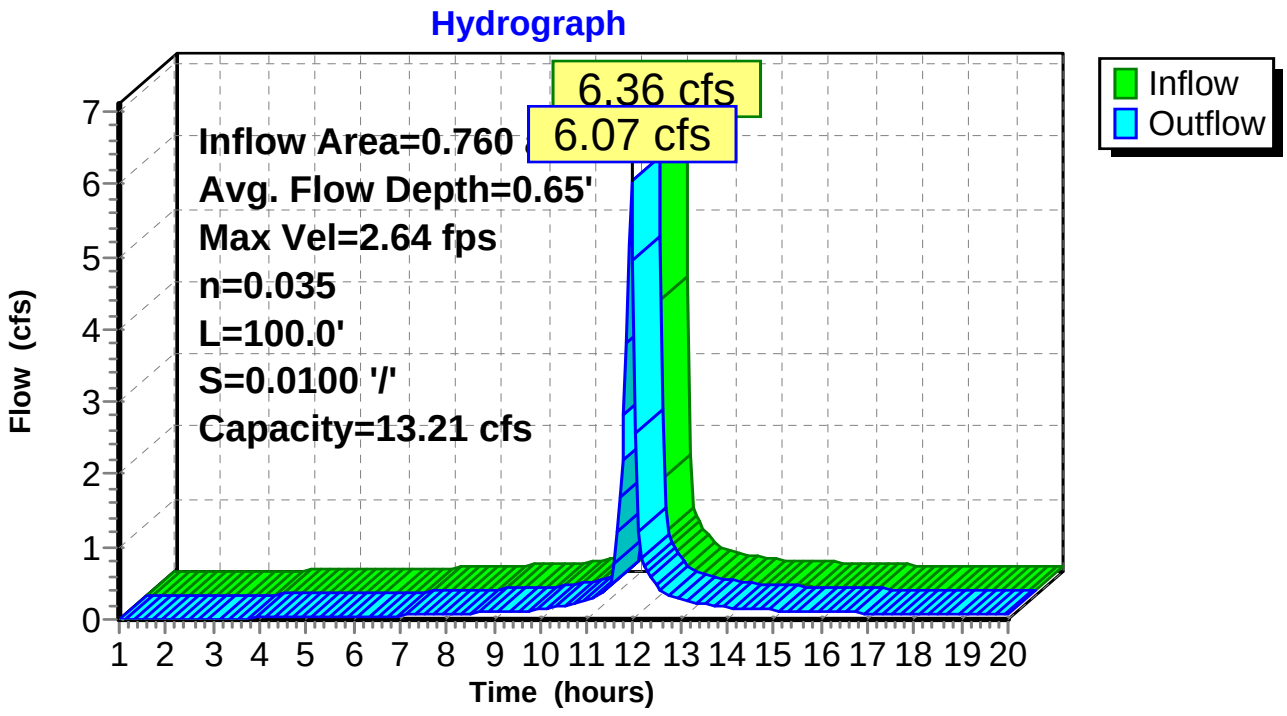
Inflow Area = 0.760 ac, 78.95% Impervious, Inflow Depth > 4.73" for 10-Year event
Inflow = 6.36 cfs @ 11.94 hrs, Volume= 0.299 af
Outflow = 6.07 cfs @ 11.95 hrs, Volume= 0.299 af, Atten= 4%, Lag= 0.7 min

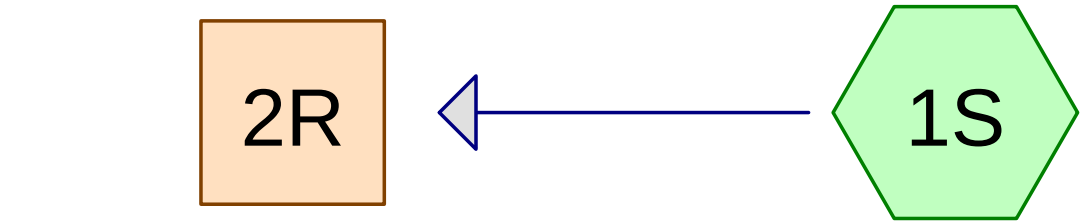
Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.64 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 0.62 fps, Avg. Travel Time= 2.7 min

Peak Storage= 237 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.65'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 13.21 cfs

3.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 1.0 '/' Top Width= 5.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'







Existing Ditch -West

DA-A Post West

Subcat Reach Pond Link

Routing Diagram for Post-Conditions_West
Prepared by ERM, Printed 2/1/2017
HydroCAD® 10.00-18 s/n 09594 © 2016 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.100	80	>75% Grass cover, Good, HSG D (1S)
0.020	98	Paved parking, HSG D (1S)
0.120	98	Paved roads w/curbs & sewers, HSG D (1S)
0.240	**91**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.240	HSG D	1S
0.000	Other	
0.240		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.100	0.000	0.100	>75% Grass cover, Good	1S
0.000	0.000	0.000	0.020	0.000	0.020	Paved parking	1S
0.000	0.000	0.000	0.120	0.000	0.120	Paved roads w/curbs & sewers	1S
0.000	**0.000**	**0.000**	**0.240**	**0.000**	**0.240**	**TOTAL AREA**	

Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-A Post West Runoff Area=0.240 ac 58.33% Impervious Runoff Depth>1.93"
Flow Length=100' Slope=0.0050 '/' Tc=14.4 min CN=91 Runoff=0.64 cfs 0.039 af

Reach 2R: Existing Ditch -West Avg. Flow Depth=0.26' Max Vel=2.18 fps Inflow=0.64 cfs 0.039 af
n=0.022 L=100.0' S=0.0100 '/' Capacity=6.07 cfs Outflow=0.63 cfs 0.039 af

Total Runoff Area = 0.240 ac Runoff Volume = 0.039 af Average Runoff Depth = 1.93"
41.67% Pervious = 0.100 ac 58.33% Impervious = 0.140 ac

Summary for Subcatchment 1S: DA-A Post West

Runoff = 0.64 cfs @ 12.06 hrs, Volume= 0.039 af, Depth> 1.93"

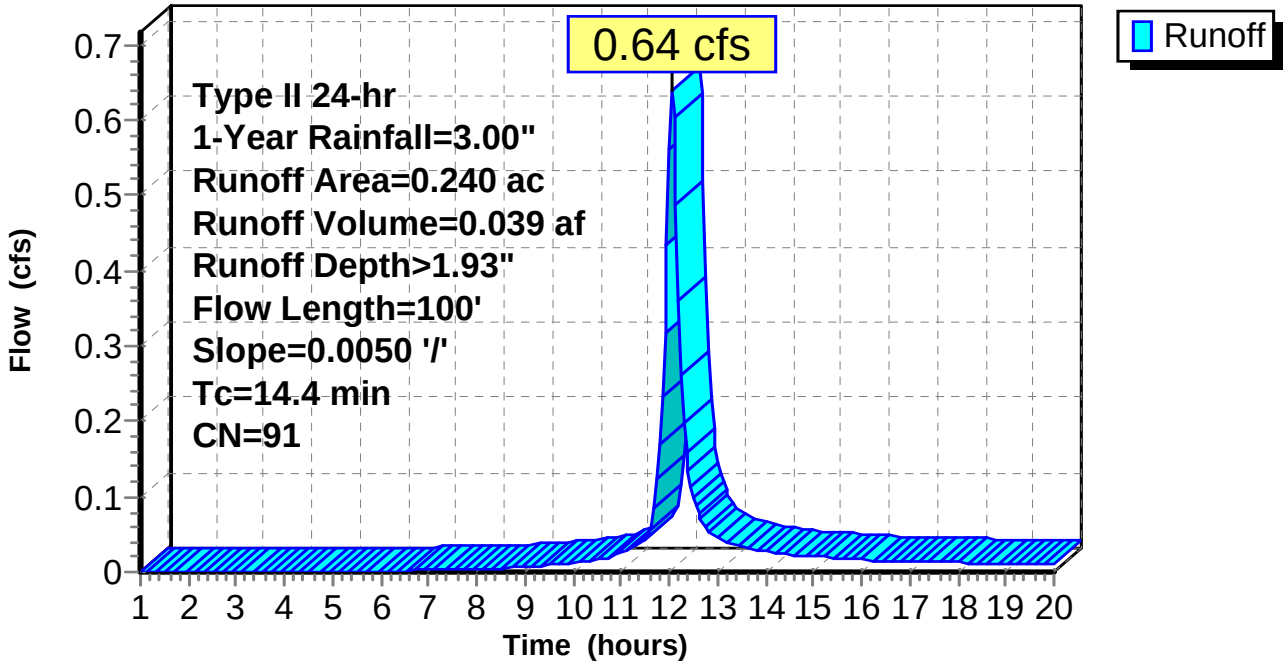
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-Year Rainfall=3.00"

Area (ac)	CN	Description
0.100	80	>75% Grass cover, Good, HSG D
0.020	98	Paved parking, HSG D
0.120	98	Paved roads w/curbs & sewers, HSG D
0.240	91	Weighted Average
0.100		41.67% Pervious Area
0.140		58.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	50	0.0050	0.74		**Sheet Flow, Sheet Flow over gravel** Smooth surfaces n= 0.011 P2= 3.70"
13.3	50	0.0050	0.06		**Sheet Flow, Sheet Flow over VF** Grass: Dense n= 0.240 P2= 3.70"
14.4	100	Total			

Subcatchment 1S: DA-A Post West

Hydrograph



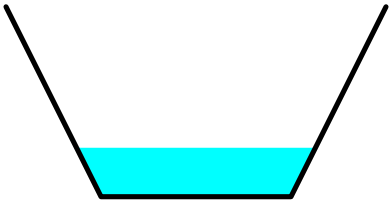
Summary for Reach 2R: Existing Ditch -West

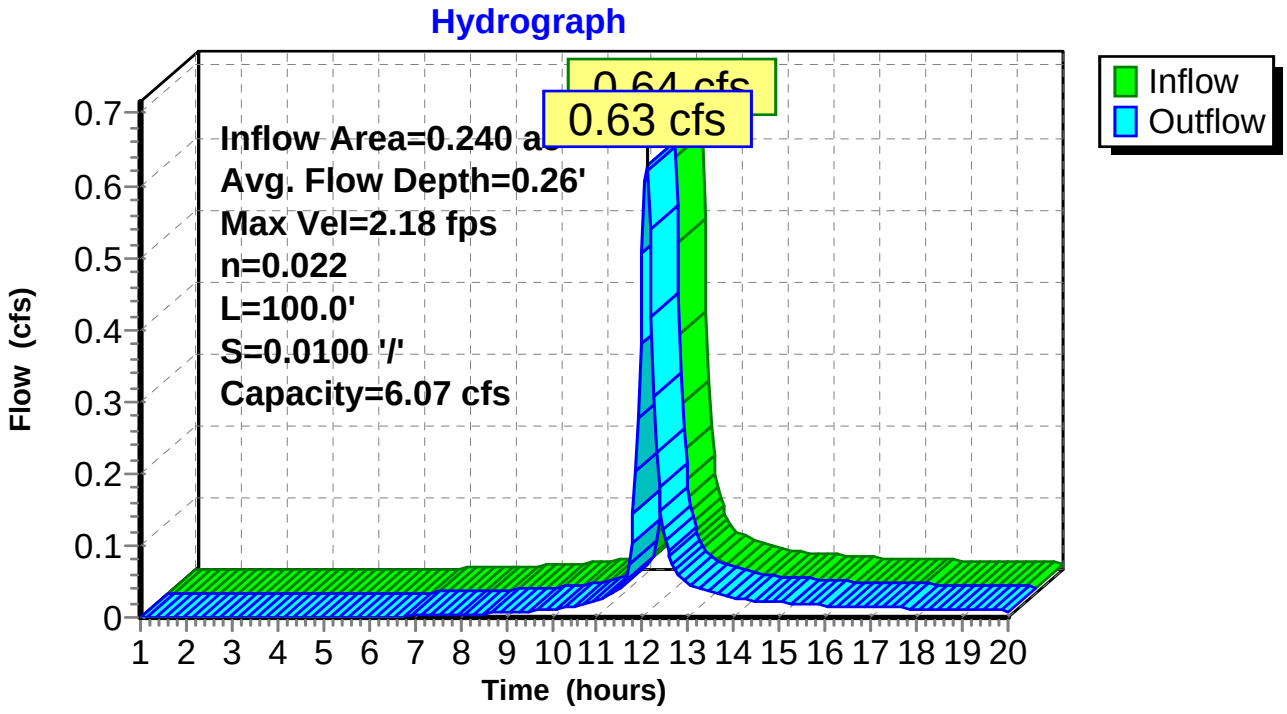
Inflow Area = 0.240 ac, 58.33% Impervious, Inflow Depth > 1.93" for 1-Year event
Inflow = 0.64 cfs @ 12.06 hrs, Volume= 0.039 af
Outflow = 0.63 cfs @ 12.08 hrs, Volume= 0.039 af, Atten= 2%, Lag= 1.4 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.18 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 0.61 fps, Avg. Travel Time= 2.7 min

Peak Storage= 29 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'





Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-A Post West Runoff Area=0.240 ac 58.33% Impervious Runoff Depth>2.55"
Flow Length=100' Slope=0.0050 '/' Tc=14.4 min CN=91 Runoff=0.83 cfs 0.051 af

Reach 2R: Existing Ditch -West Avg. Flow Depth=0.30' Max Vel=2.37 fps Inflow=0.83 cfs 0.051 af
n=0.022 L=100.0' S=0.0100 '/' Capacity=6.07 cfs Outflow=0.82 cfs 0.051 af

Total Runoff Area = 0.240 ac Runoff Volume = 0.051 af Average Runoff Depth = 2.55"
41.67% Pervious = 0.100 ac 58.33% Impervious = 0.140 ac

Summary for Subcatchment 1S: DA-A Post West

Runoff = 0.83 cfs @ 12.06 hrs, Volume= 0.051 af, Depth> 2.55"

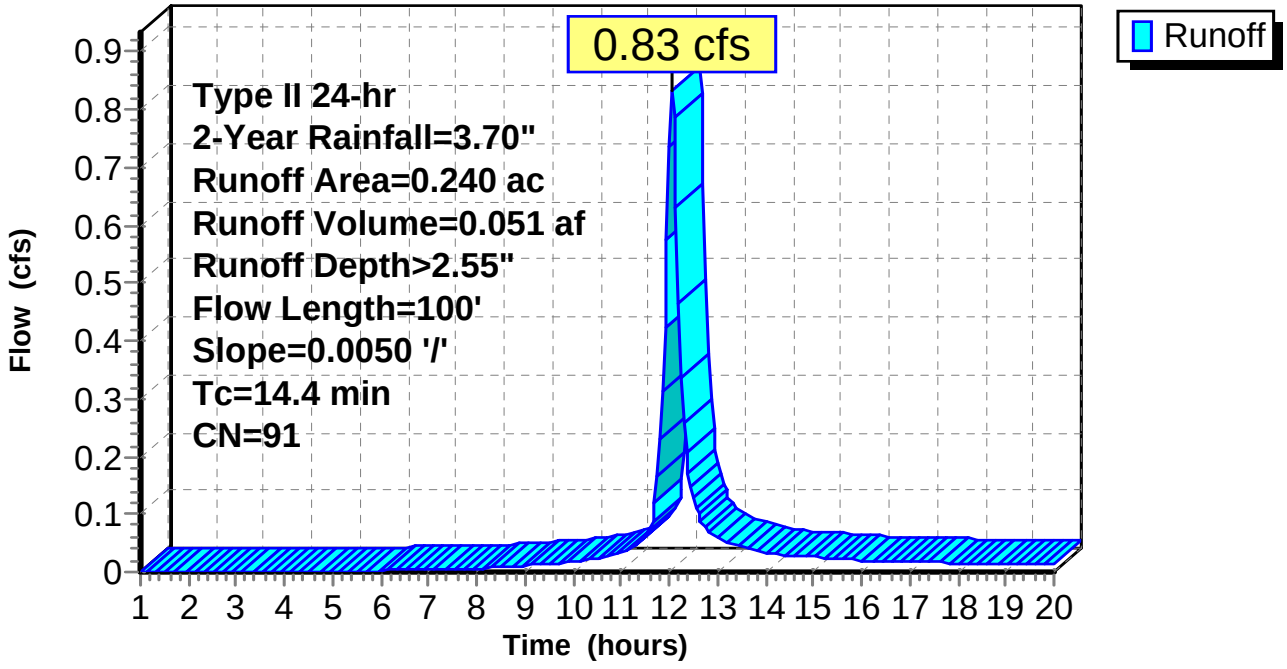
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=3.70"

Area (ac)	CN	Description
0.100	80	>75% Grass cover, Good, HSG D
0.020	98	Paved parking, HSG D
0.120	98	Paved roads w/curbs & sewers, HSG D
0.240	91	Weighted Average
0.100		41.67% Pervious Area
0.140		58.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	50	0.0050	0.74		**Sheet Flow, Sheet Flow over gravel** Smooth surfaces n= 0.011 P2= 3.70"
13.3	50	0.0050	0.06		**Sheet Flow, Sheet Flow over VF** Grass: Dense n= 0.240 P2= 3.70"
14.4	100	Total			

Subcatchment 1S: DA-A Post West

Hydrograph



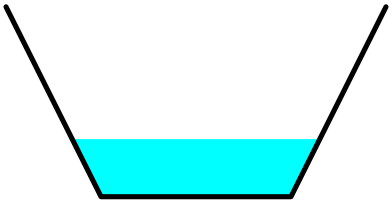
Summary for Reach 2R: Existing Ditch -West

Inflow Area = 0.240 ac, 58.33% Impervious, Inflow Depth > 2.55" for 2-Year event
Inflow = 0.83 cfs @ 12.06 hrs, Volume= 0.051 af
Outflow = 0.82 cfs @ 12.08 hrs, Volume= 0.051 af, Atten= 2%, Lag= 1.3 min

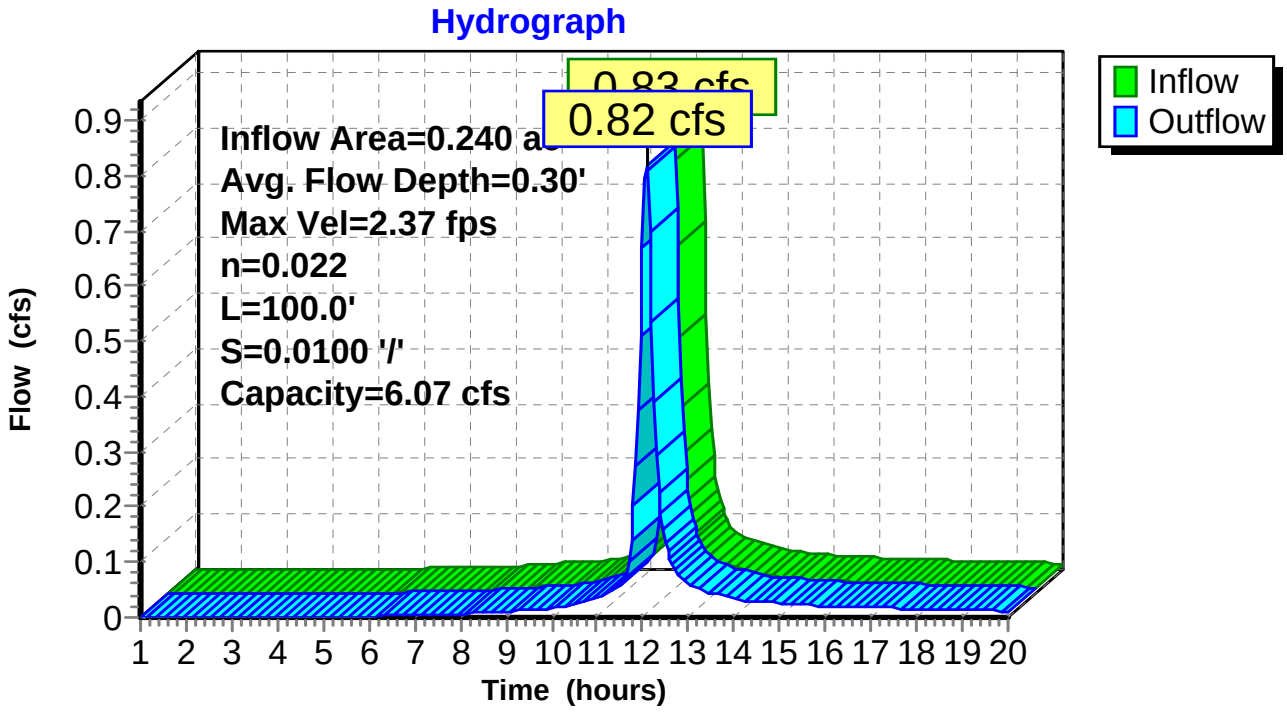
Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.37 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 0.66 fps, Avg. Travel Time= 2.5 min

Peak Storage= 35 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'



Reach 2R: Existing Ditch -West



Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-A Post West Runoff Area=0.240 ac 58.33% Impervious Runoff Depth>4.38"
Flow Length=100' Slope=0.0050 '/' Tc=14.4 min CN=91 Runoff=1.38 cfs 0.088 af

Reach 2R: Existing Ditch -West Avg. Flow Depth=0.42' Max Vel=2.75 fps Inflow=1.38 cfs 0.088 af
n=0.022 L=100.0' S=0.0100 '/' Capacity=6.07 cfs Outflow=1.36 cfs 0.088 af

Total Runoff Area = 0.240 ac Runoff Volume = 0.088 af Average Runoff Depth = 4.38"
41.67% Pervious = 0.100 ac 58.33% Impervious = 0.140 ac

Summary for Subcatchment 1S: DA-A Post West

Runoff = 1.38 cfs @ 12.06 hrs, Volume= 0.088 af, Depth> 4.38"

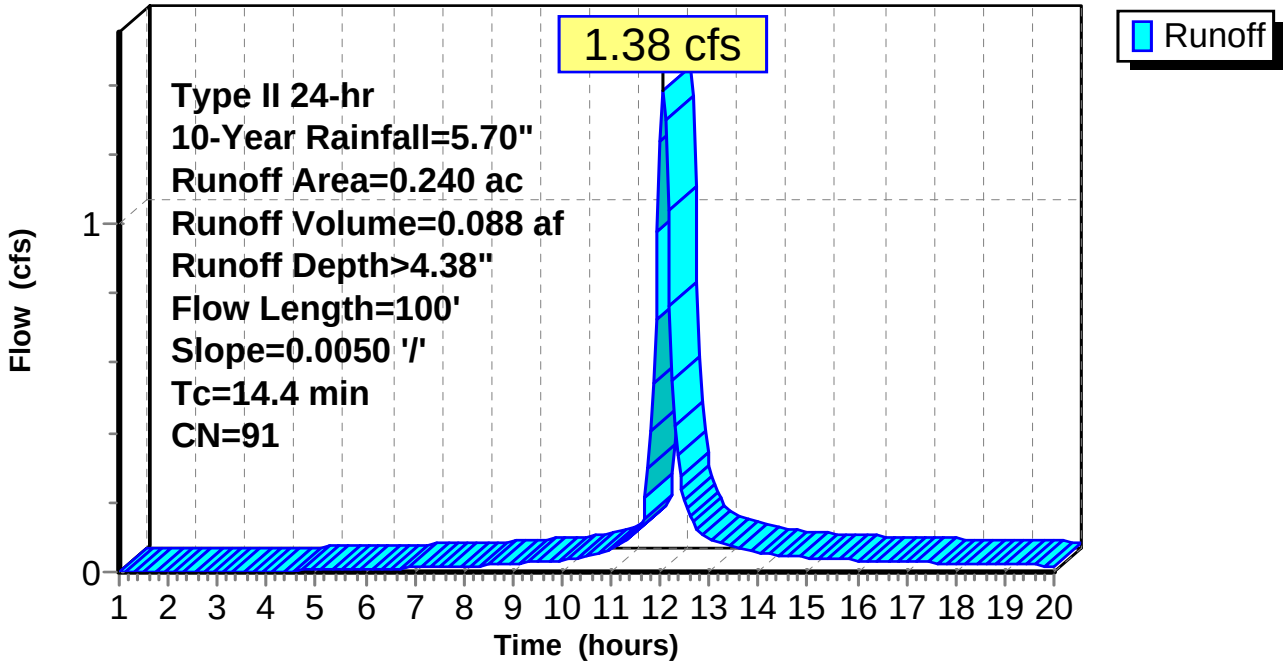
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=5.70"

Area (ac)	CN	Description
0.100	80	>75% Grass cover, Good, HSG D
0.020	98	Paved parking, HSG D
0.120	98	Paved roads w/curbs & sewers, HSG D
0.240	91	Weighted Average
0.100		41.67% Pervious Area
0.140		58.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	50	0.0050	0.74		**Sheet Flow, Sheet Flow over gravel** Smooth surfaces n= 0.011 P2= 3.70"
13.3	50	0.0050	0.06		**Sheet Flow, Sheet Flow over VF** Grass: Dense n= 0.240 P2= 3.70"
14.4	100	Total			

Subcatchment 1S: DA-A Post West

Hydrograph



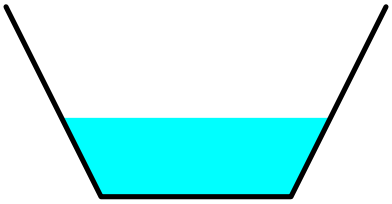
Summary for Reach 2R: Existing Ditch -West

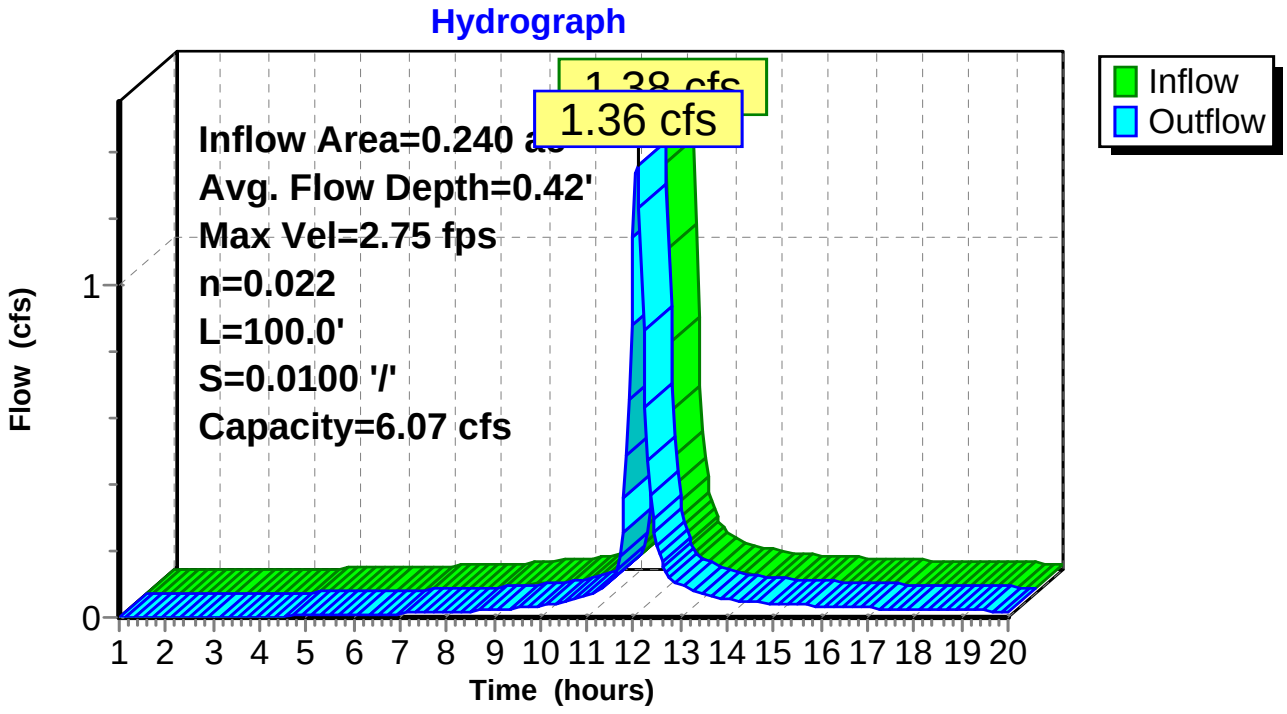
Inflow Area = 0.240 ac, 58.33% Impervious, Inflow Depth > 4.38" for 10-Year event
Inflow = 1.38 cfs @ 12.06 hrs, Volume= 0.088 af
Outflow = 1.36 cfs @ 12.07 hrs, Volume= 0.088 af, Atten= 2%, Lag= 1.1 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.75 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 0.78 fps, Avg. Travel Time= 2.1 min

Peak Storage= 50 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 1.00' Flow Area= 1.5 sf, Capacity= 6.07 cfs

1.00' x 1.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 0.5 '/' Top Width= 2.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 8.00', Outlet Invert= 7.00'





ATTACHMENT 2

Topo Map



Atlantic Coast Pipeline

- Milepost
- Proposed Route
- Elizabeth River M and R Site
- NHD Waterbodies

Atlantic Coast Pipeline

Elizabeth River M and R Site
USGS Topo Overview

ERM

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ATTACHMENT 3

Stormwater Design Criteria

VIRGINIA DEQ STORMWATER DESIGN SPECIFICATION No. 2

SHEET FLOW TO A VEGETATED FILTER STRIP OR CONSERVED OPEN SPACE

VERSION 1.9
March 1, 2011





SECTION 1. DESCRIPTION

Filter strips are vegetated areas that treat sheet flow delivered from adjacent impervious and managed turf areas by slowing runoff velocities and allowing sediment and attached pollutants to settle and/or be filtered by the vegetation. The two design variants of filter strips are (1) *Conserved Open Space* and (2) designed *Vegetated Filter Strips*. The design, installation, and management of these design variants are quite different, as outlined in this specification.

In both instances, stormwater must enter the filter strip or conserved open space as sheet flow. If the inflow is from a pipe or channel, an engineered level spreader must be designed in accordance with the criteria contained herein to convert the concentrated flow to sheet flow.

SECTION 2. PERFORMANCE

With proper design and maintenance, these practices can provide relatively high runoff reduction as shown in **Table 2.1**.

Table 2.1: Summary of Stormwater Functions Provided by Filter Strips [1]

Stormwater Function	Conservation Area		Vegetated Filter Strip	
	HSG Soils A and B	HSG Soils C and D	HSG Soils A	HSG Soils B [4], C and D
	Assume no CA [2] in Conservation Area		No CA [3]	With CA [2]
Annual Runoff Vol. Reduction (RR)	75%	50%	50%	50%
Total Phosphorus (TP) EMC Reduction[5] by BMP Treatment Process	0		0	
Total Phosphorus (TP) Mass Load Removal	75%	50%	50%	50%
Total Nitrogen (TN) EMC Reduction by BMP Treatment Process	0		0	
Total Nitrogen (TN) Mass Load Removal	75%	50%	50%	50%
Channel Protection and Flood Mitigation	**Partial.** Designers can use the RRM spreadsheet to adjust curve number for each design storm for the contributing drainage area; *and* designers can account for a lengthened Time-of-Concentration flow path in computing peak discharge.			

[1] CWP and CSN (2008); CWP (2007)
[2] CA = Compost Amended Soils (see Design Specification No. 4)
[3] Compost amendments are generally not applicable for undisturbed A soils, although it may be advisable to incorporate them on mass-graded A or B soils and/or filter strips on B soils, in order to maintain runoff reduction rates.
[4] The plan approving authority may waive the requirement for compost amended soils for filter strips on B soils under certain conditions (see Section 6.2 below)
[5] There is insufficient monitoring data to assign a nutrient removal rate for filter strips at this time.

SECTION 3. DESIGN TABLE

Conserved Open Space and Vegetated Filter Strips do not have two levels of design. Instead, each must meet the appropriate minimum criteria outlined in **Table 2.2** (next page) and **Section 6** (below) to qualify for the indicated level of runoff reduction. In addition, designers must conduct a site reconnaissance prior to design to confirm topography and soil conditions.

SECTION 4. TYPICAL DETAILS

Figure 1 shows a typical approach for sheetflow to a Conserved Open Space (Cappiella *et al*., 2006). **Figures 2 and 3** provide standard details for an engineered level spreader developed by North Carolina State University (Hathaway and Hunt, 2006). An alternative design for an "energy dissipater" can be found in Henrico County's *Environmental Program Manual* (Chapter 9, Minimum Design Standard 9.01) at: http://www.co.henrico.va.us/works/eesd/

Table 2.2. Filter Strip Design Criteria

Design Issue	Conserved Open Space	Vegetated Filter Strip
Soil and Vegetative Cover (Sections 6.1 and 6.2)	Undisturbed soils and native vegetation	Amended soils and dense turf cover or landscaped with herbaceous cover, shrubs, and trees
Overall Slope and Width (perpendicular to the flow) (Section 5)	0.5% to 3% Slope – Minimum 35 ft width 3% to 6% Slope – Minimum 50 ft width The first 10 ft. of filter must be 2% or less in all cases [2]	1% [1] to 4% Slope – Minimum 35 ft. width 4% to 6% Slope – Minimum 50 ft. width 6% to 8% Slope – Minimum 65 ft. width The first 10 ft. of filter must be 2% or less in all cases
Sheet Flow (Section 5)	Maximum flow length of 150 ft. from adjacent pervious areas; Maximum flow length of 75 ft. from adjacent impervious areas	
Concentrated Flow (Section 6.3)	Length of ELS [6] Lip = 13 lin. ft. per each 1 cfs of inflow if area has 90% Cover [3] Length = 40 lin. ft. per 1 cfs for forested or re-forested Areas [4] (ELS [6] length = 13 lin.ft. min; 130 lin.ft. max.)	Length of ELS [6] Lip = 13 lin.ft. per each 1 cfs of inflow (13 lin.ft. min; 130 lni.ft. max.)
Construction Stage (Section 8)	Located outside the limits of disturbance and protected by ESC controls	Prevent soil compaction by heavy equipment
Typical Applications (Section 5)	Adjacent to stream or wetland buffer or forest conservation area	Treat small areas of IC (e.g., 5,000 sf) and/or turf-intensive land uses (sports fields, golf courses) close to source
Compost Amendments (Section 6.1)	No	Yes (B, C, and D soils) [5]
Boundary Spreader (Section 6.3)	GD [6] at top of filter	GD [6] at top of filter PB [6] at toe of filter

[1] A minimum of 1% is recommended to ensure positive drainage.
[2] For Conservation Areas with a varying slope, a pro-rated length may be computed only if the first 10 ft. is 2% or less.
[3] Vegetative Cover is described in **Section 6.2**.
[4] Where the Conserved Open Space is a mixture of native grasses, herbaceous cover and forest (or re-forested area), the length of the ELS [6] Lip can be established by computing a weighted average of the lengths required for each vegetation type. Refer to **Section 6.3** for design criteria
[5] The plan approving authority may waive the requirement for compost amended soils for filter strips on B soils under certain conditions (see **Section 6.1**).
[6] ELS = Engineered Level Spreader; GD = Gravel Diaphragm; PB = Permeable Berm.

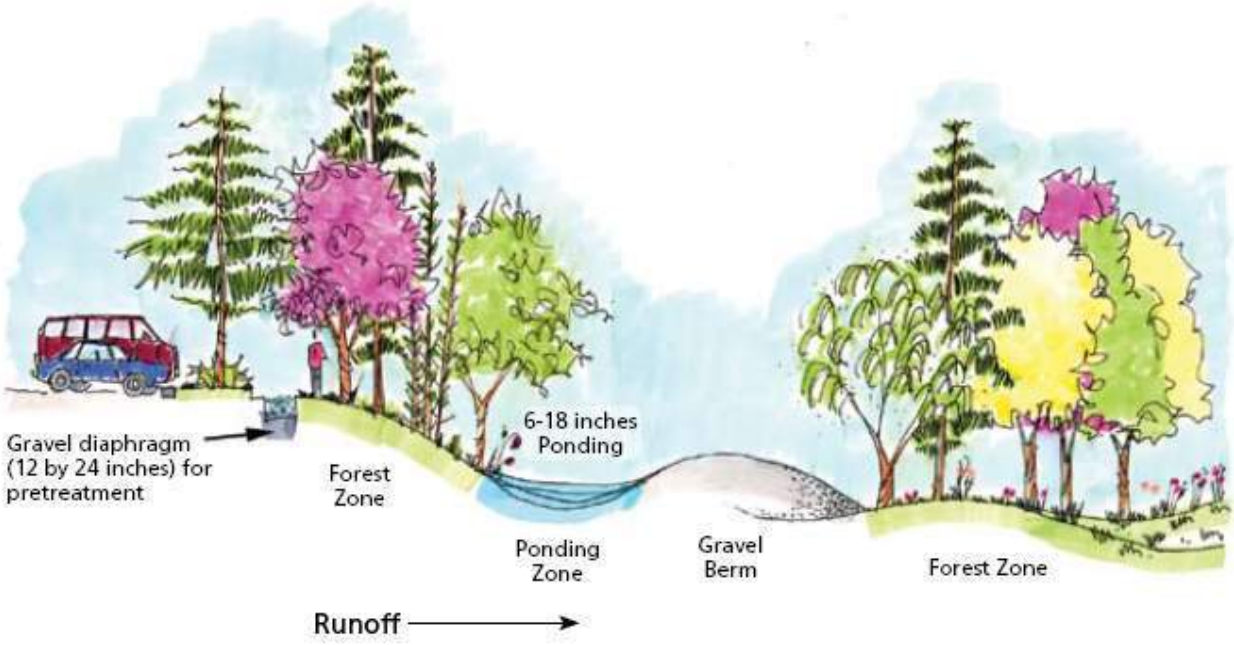


Figure 2.1. Typical Sheetflow to Conserved Open Space

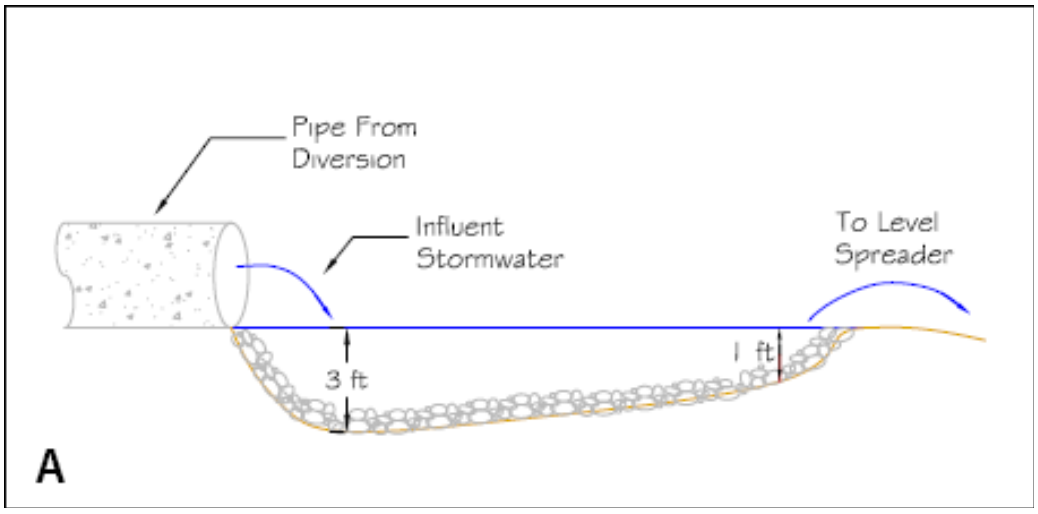


Figure 2.2. Level Spreader Forebay (Hathaway and Hunt 2006)

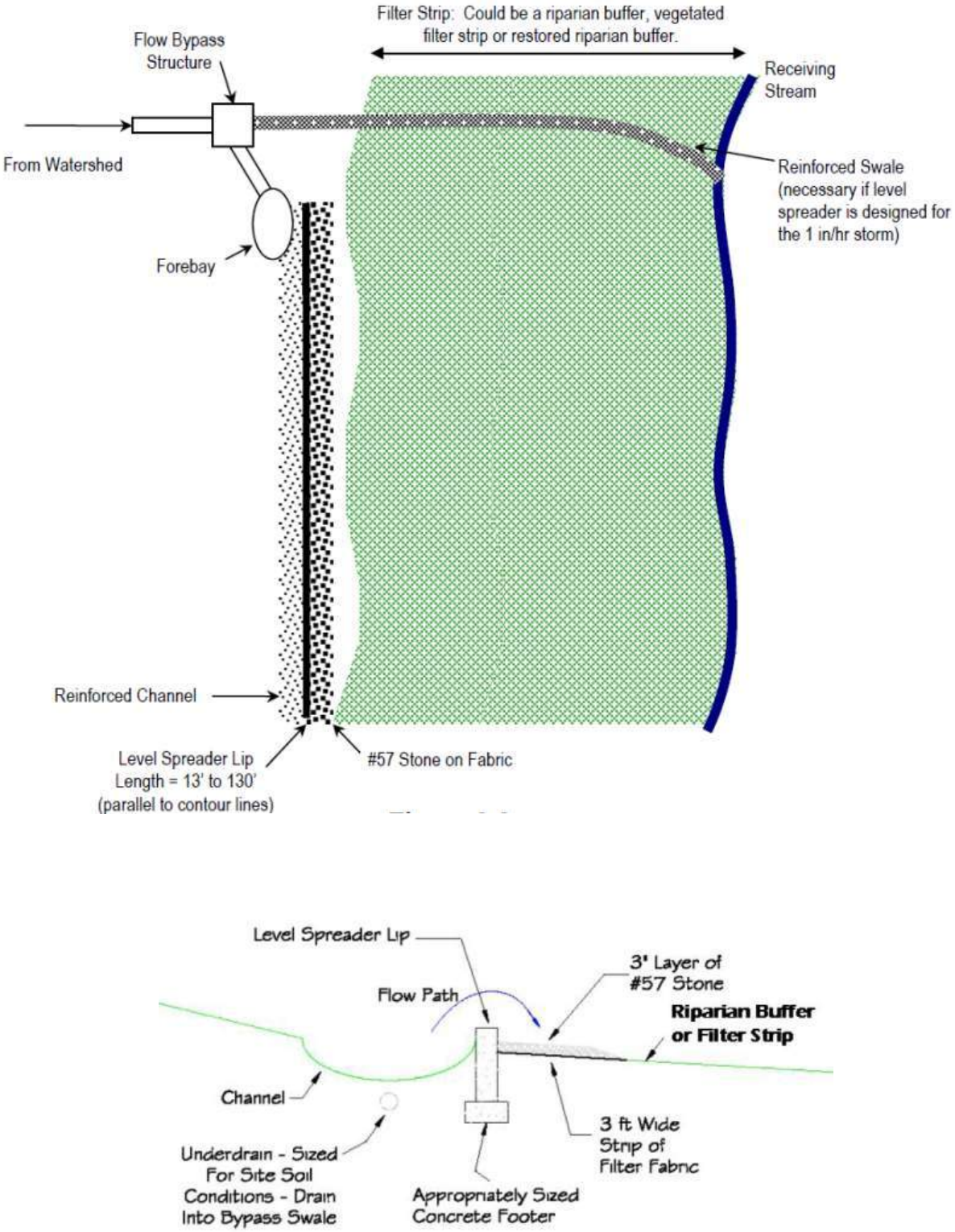


Figure 2.3: Plan and Cross Section of Engineered Level Spreader (ELS) (Hathaway 2006)

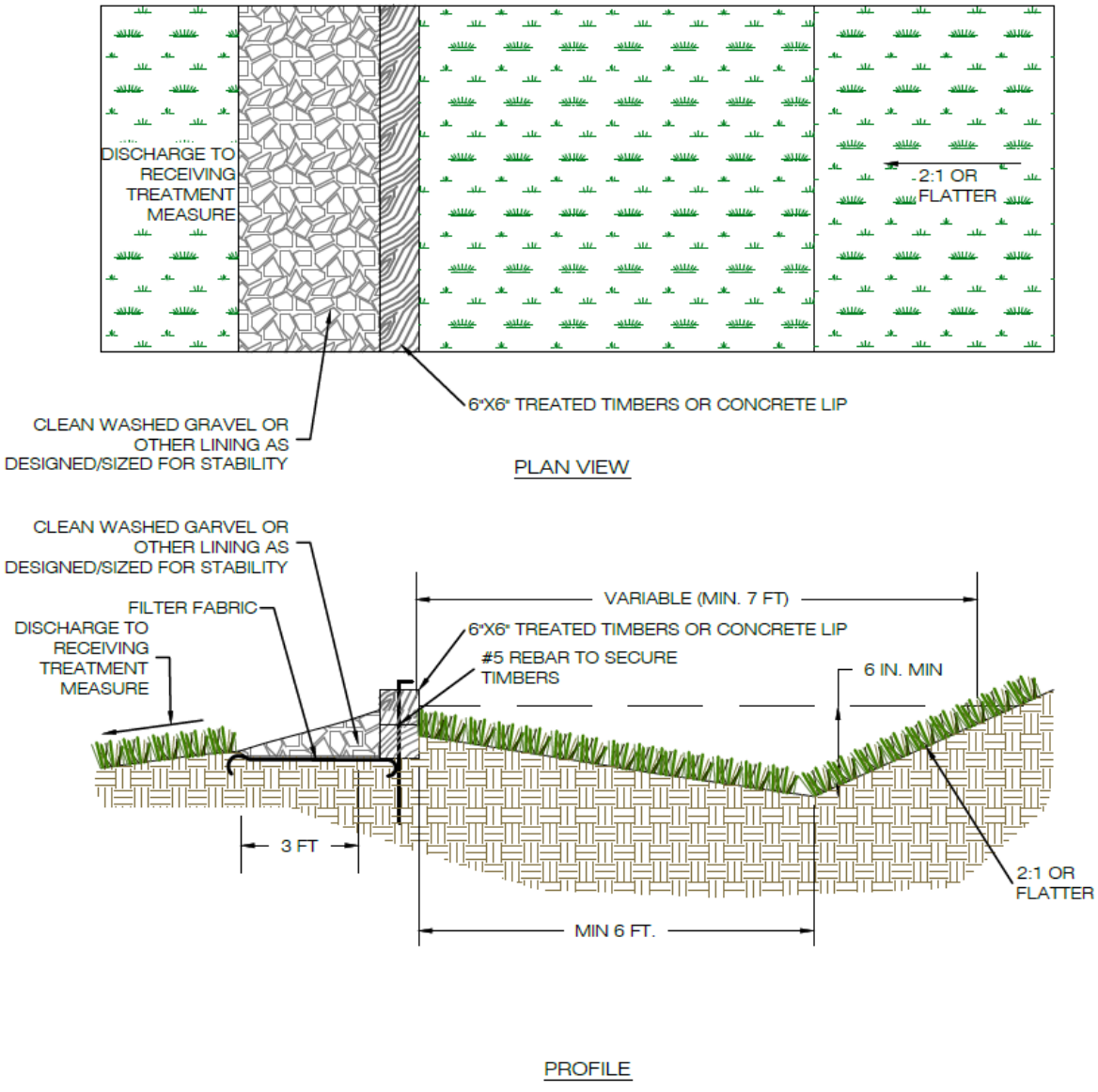


Figure 2.4A: Section - Level Spreader with Rigid Lip

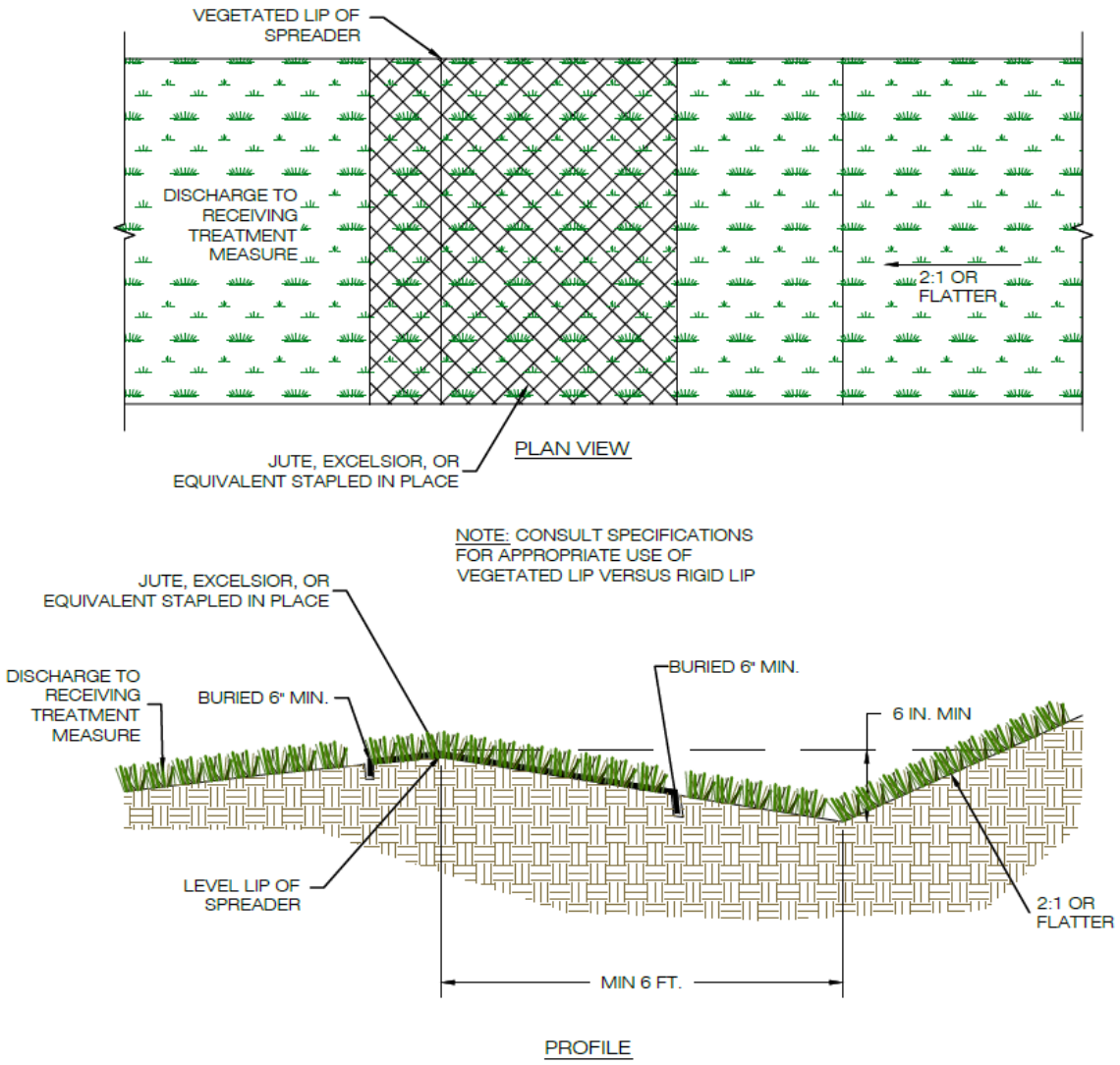


Figure 2.4B: Section - Alternative Level Spreader with Vegetated Lip

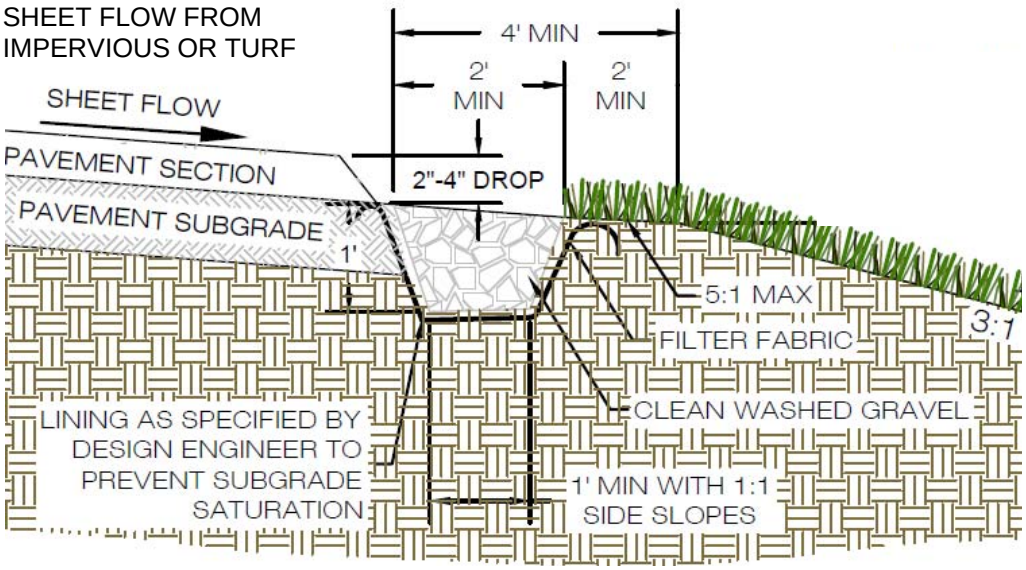


Figure 2.5 – Gravel Diaphragm – Sheet Flow Pre-treatment

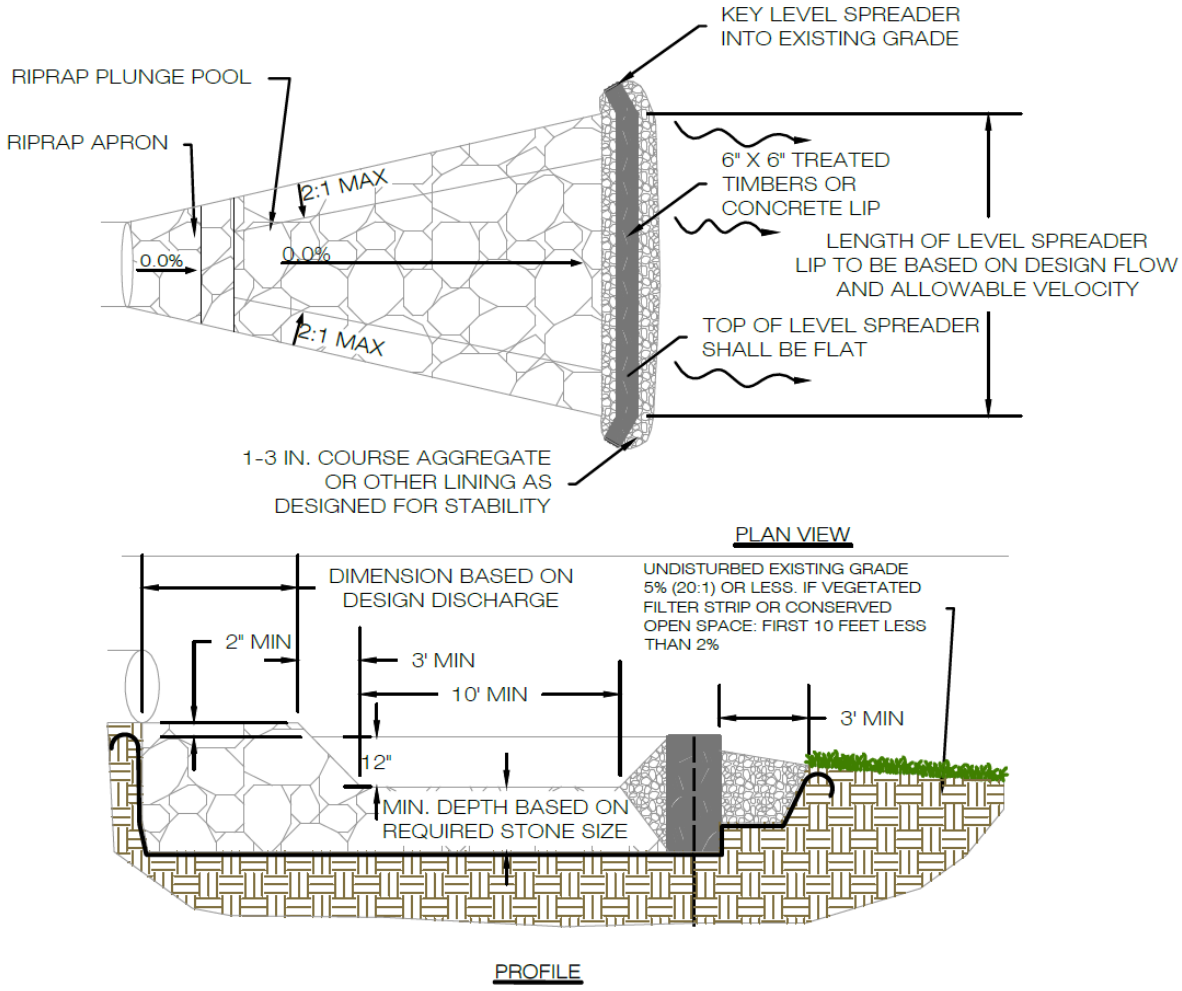


Figure 2.6: Level Spreader: Pipe or Channel Flow to Filter Strip or Preserved Open Space

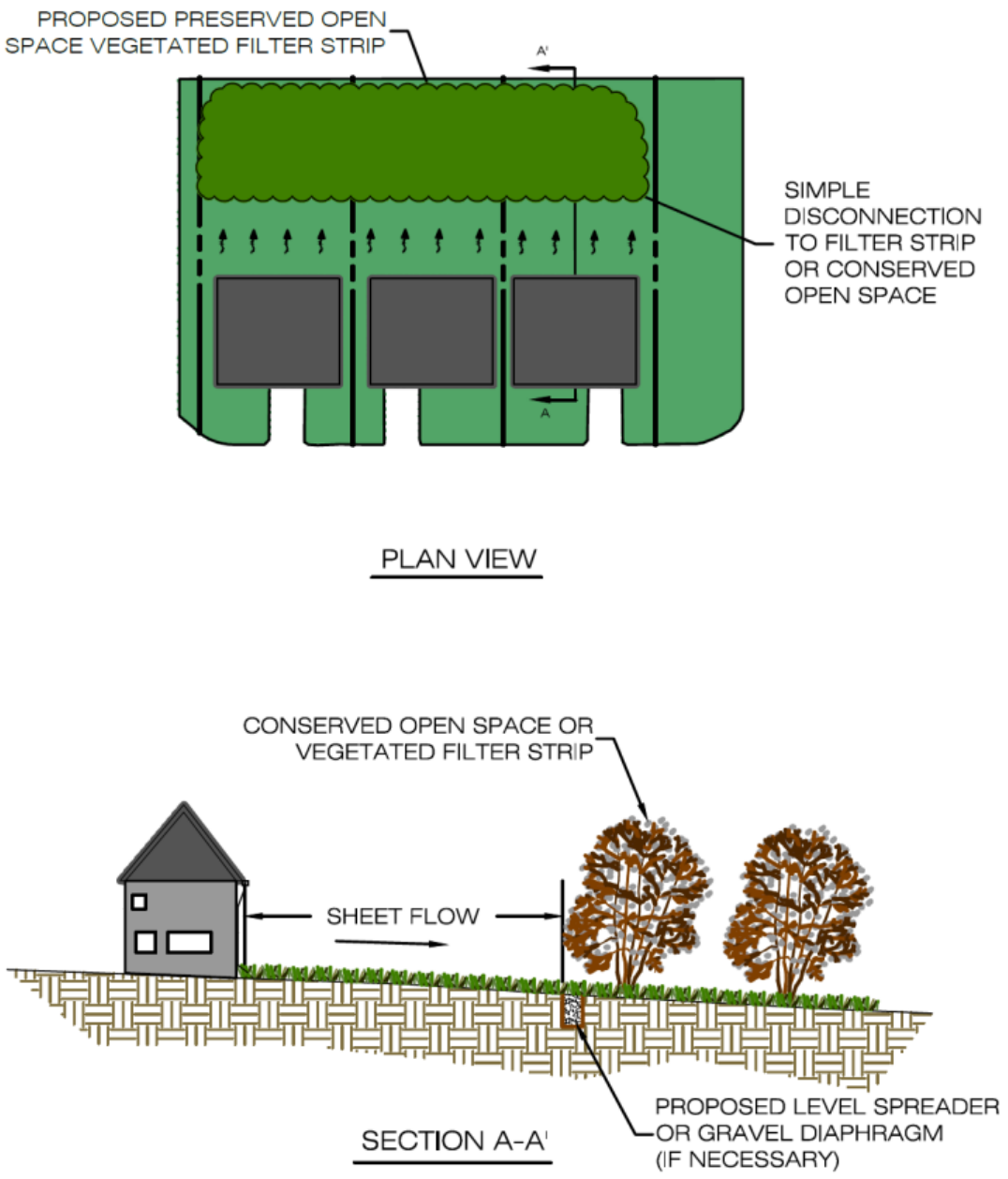


Figure 2.7: Simple Disconnection to downstream Preserved Open Space or Vegetated Filter Strip

SECTION 5. PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

5.1 Conserved Open Space

The most common design applications of Conserved Open Space are on sites that are hydrologically connected to a protected stream buffer, wetland buffer, floodplain, forest conservation area, or other protected lands. Conserved open space is an ideal component of the "outer zone" of a stream buffer, such as a Resource Protection Area (as is required in some parts of the state), which normally receives runoff as sheetflow. Care should be taken to locate all energy dissipaters or flow spreading devices outside of the protected area.

Designers may apply a runoff reduction credit to any impervious or managed turf cover that is hydrologically connected and effectively treated by a protected Conserved Open Space that meets the following eligibility criteria:

- The goal of establishing Conserved Open Space is to protect a vegetated area contiguous to a receiving system, such as a stream or natural channel, for treating stormwater runoff. Establishing isolated Conserved Open Space pockets on a development site may not achieve this goal unless they effectively serve to connect the surface runoff to the receiving system. Therefore, a locality may choose to establish goals for minimum acreage to be conserved (in terms of total acreage or percentage of the total project site), and the physical location (adjacent to a stream, or other criteria) in order for the cumulative conserved open space to qualify for the RRM credit.
- No major disturbance may occur within the conserved open space during or after construction (i.e., no clearing or grading is allowed except temporary disturbances associated with incidental utility construction, restoration operations, or management of nuisance vegetation). The Conserved Open Space area shall not be stripped of topsoil. Some light grading may be needed at the boundary using tracked vehicles to prevent compaction.
- The limits of disturbance should be clearly shown on all construction drawings and protected by acceptable signage and erosion control measures.
- A long term vegetation management plan must be prepared to maintain the Conserved Open Space in a natural vegetative condition. Generally, Conserved Open Space management plans do not encourage or even allow any active management. However, a specific plan should be developed to manage the unintended consequences of passive recreation, control invasive species, provide for tree and understory maintenance, etc. Managed turf is not considered an acceptable form of vegetative management, and only the passive recreation areas of dedicated parkland are eligible for the practice (e.g., the actively used portions of ball fields and golf courses are not eligible), although conservation areas can be ideal treatment practices at the edges of turf-intensive land uses.
- The Conserved Open Space must be protected by a perpetual easement or deed restriction that assigns the responsible party to ensure that no future development, disturbance, or clearing may occur within the area.
- The practice does *not* apply to jurisdictional wetlands that are sensitive to increased inputs of stormwater runoff (e.g., bogs and fens).

5.2 Vegetated Filter Strips

Vegetated Filter Strips are best suited to treat runoff from small segments of impervious cover (usually less than 5,000 sq. ft.) adjacent to road shoulders, small parking lots and rooftops. Vegetated Filter Strips may also be used as pretreatment for another stormwater practice such as a dry swale, bioretention, or infiltration areas. If sufficient pervious area is available at the site, larger areas of impervious cover can be treated by vegetated filter strips, using an engineered level spreader to recreate sheet flow. Vegetated Filter Strips are also well suited to treat runoff from turf-intensive land uses, such as the managed turf areas of sports fields, golf courses, and parkland.

Conserved Open Space and Vegetated Filter Strips can be used in a variety of situations; however there are several constraints to their use:

- ***Filter Slopes and Widths.*** Maximum slopes for Conserved Open Space and Vegetated Filter Strips are 6% and 8% respectively, in order to maintain sheet flow through the practice. In addition, the overall contributing drainage area must likewise be relatively flat to ensure sheet flow draining into the filter. Where this is not possible, alternative measures, such as an engineered level spreader, can be used. Minimum widths (flow path) for Conserved Open Space and Vegetated Filter Strips are dependent on slope, as specified in **Table 2.2** above.

- ***Soils.*** Vegetated Filter Strips are appropriate for all soil types, except fill soils. The runoff reduction rate, however, is dependent on the underlying Hydrologic Soil Groups (see **Table 2.1** above) and whether soils receive compost amendments.

- ***Contributing Flow Path to Filter.*** Vegetated Filter Strips are used to treat very small drainage areas of a few acres or less. The limiting design factor is the length of flow directed to the filter. As a rule, flow tends to concentrate after 75 feet of flow length for impervious surfaces, and 150 feet for pervious surfaces (Claytor, 1996). When flow concentrates, it moves too rapidly to be effectively treated by a Vegetated Filter Strip, unless an engineered level spreader is used. When the existing flow at a site is concentrated, a vegetated swale should be used instead of a Vegetated Filter Strip (Lantin and Barrett, 2005).

- ***Hotspot Land Uses.*** Vegetated Filter Strips should not receive hotspot runoff, since the infiltrated runoff could cause groundwater contamination.

- ***Turf-Intensive Land Uses.*** Both Conserved Open Space and Vegetated Filter Strips are appropriate to treat managed turf and the actively-used areas of sports fields, golf courses, parkland, and other turf-intensive land uses.

- ***Proximity of Underground Utilities.*** Underground pipes and conduits that cross the Vegetated Filter Strip are acceptable.

SECTION 6. DESIGN CRITERIA

6.1. Compost Soil Amendments

Compost soil amendments will enhance the runoff reduction capability of a vegetated filter strip when located on hydrologic soil groups B, C, and D, subject to the following design requirements:

- The compost amendments should extend over the full length and width of the filter strip.
- The amount of approved compost material and the depth to which it must be incorporated is outlined in Stormwater Design Specification No. 4.
- The amended area will be raked to achieve the most level slope possible without using heavy construction equipment, and it will be stabilized rapidly with perennial grass and/or herbaceous species.
- If slopes exceed 3%, a protective biodegradable fabric or matting (e.g., EC-2) should be installed to stabilize the site prior to runoff discharge.
- Compost amendments should not be incorporated until the gravel diaphragm and/or engineered level spreader are installed (see **Section 6.3**).
- The local plan approval authority may waive the requirement for compost amendments on HSG-B soils in order to receive credit as a filter strip if (1) the designer can provide verification of the adequacy of the on-site soil type, texture, and profile to function as a filter strip, and (2) the area designated for the filter strip will not be disturbed during construction.

6.2. Planting and Vegetation Management

Conserved Open Space . No grading or clearing of native vegetation is allowed within the Conserved Open Space. An invasive species management plan should be developed and approved by the local plan approval authority.

Reforested Conserved Open Space. At some sites, the proposed stream buffer or Conserved Open Space may be in turf or meadow cover, or overrun with invasive plants and vines. In these situations, a landscape architect or horticulturalist should prepare a reforestation or restoration plan for the Conserved Open Space. The entire area can be planted with native trees and shrubs or planted to achieve a gradual transition from turf to meadow to shrub and forest. Trees and shrubs with deep rooting capabilities are recommended for planting to maximize soil infiltration capacity (PWD, 2007). Over-plant with seedlings for fast establishment and to account for mortality. Plant larger stock at desired spacing intervals (25 to 40 feet for large trees) using random spacing (Cappiella *et al*., 2006). Plant ground cover or a herbaceous layer to ensure rapid vegetative cover of the surface area.

Vegetated Filter Strips. Vegetated Filter Strips should be planted at such a density to achieve a 90% grass/herbaceous cover after the second growing season. Filter strips should be seeded, not sodded. Seeding establishes deeper roots, and sod may have muck soil that is not conducive to infiltration (Wisconsin DNR, 2007). The filter strip vegetation may consist of turf grasses, meadow grasses, other herbaceous plants, shrubs, and trees, as long as the primary goal of at least 90% coverage with grasses and/or other herbaceous plants is achieved. Designers should

choose vegetation that stabilizes the soil and is salt tolerant. Vegetation at the toe of the filter, where temporary ponding may occur behind the permeable berm, should be able to withstand both wet and dry periods. The planting areas can be divided into zones to account for differences in inundation and slope.

6.3. Diaphragms, Berms and Level Spreaders

Gravel Diaphragms: A pea gravel diaphragm at the top of the slope is required for both Conserved Open Space and Vegetated Filter Strips that receive sheetflow. The pea gravel diaphragm is created by excavating a 2-foot wide and 1-foot deep trench that runs on the same contour at the top of the filter strip. The diaphragm serves two purposes. First, it acts as a pretreatment device, settling out sediment particles before they reach the practice. Second, it acts as a level spreader, maintaining sheet flow as runoff flows over the Filter Strip. Refer to **Figure 2.5.**

- The flow should travel over the impervious area and to the practice as sheet flow and then drop at least 3 inches onto the gravel diaphragm. The drop helps to prevent runoff from running laterally along the pavement edge, where grit and debris tend to build up (thus allowing by-pass of the Filter Strip).
- A layer of filter fabric should be placed between the gravel and the underlying soil trench.
- If the contributing drainage area is steep (6% slope or greater), then larger stone (clean bank-run gravel that meets VDOT #57 grade) should be used in the diaphragm.
- If the contributing drainage area is solely turf (e.g., sports field), then the gravel diaphragm may be eliminated.

Permeable Berm: Vegetated Filter Strips should be designed with a permeable berm at the toe of the Filter Strip to create a shallow ponding area. Runoff ponds behind the berm and gradually flows through outlet pipes in the berm or through a gravel lens in the berm with a perforated pipe. During larger storms, runoff may overtop the berm (Cappiella *et al.,* 2006). The permeable berm should have the following properties:

- A wide and shallow trench, 6 to 12 inches deep, should be excavated at the upstream toe of the berm, parallel with the contours.
- Media for the berm should consist of 40% excavated soil, 40% sand, and 20% pea gravel.
- The berm 6 to 12 inches high should be located downgradient of the excavated depression and should have gentle side slopes to promote easy mowing (Cappiella *et al*., 2006).
- Stone may be needed to armor the top of berm to handle extreme storm events.
- A permeable berm is not needed when vegetated filter strips are used as pretreatment to another stormwater practice.

Engineered Level Spreaders. The design of engineered level spreaders should conform to the following design criteria based on recommendations of Hathaway and Hunt (2006), or a locally approved standard that meets the intent of these criteria, in order to ensure non-erosive sheet flow into the vegetated buffer area. **Figure 2.3** above represents a configuration that includes a bypass structure that diverts the design storm to the level spreader, and bypasses the larger storm events around the Conserved Open Space or Vegetated Filter Strip through an improved channel.

An alternative approach is that utilized by Henrico County, where pipe or channels discharge at the landward edge of a floodplain or stream (Resource Protection Area or RPA) buffer. The entire flow is directed through a stilling basin energy dissipater and then a level spreader such that the entire design storm for the conveyance system (typically a 10-year frequency storm) is discharged as sheet flow through the buffer. (Refer to Henrico County's *Environmental Program Manual;* Chapter 9, Minimum Design Standard 9.01 "Energy Dissipator": http://www.co.henrico.va.us/works/eesd/ .)

Key design elements of the engineered level spreader, as provided in **Figures 2 and 3**, include the following:

- High Flow Bypass provides safe passage for larger design storms through the filter strip. The bypass channel should accommodate all peak flows greater than the water quality design flow.
- A Forebay should have a maximum depth of 3 feet and gradually transition to a depth of 1 foot at the level spreader lip (**Figure 2**). The forebay is sized such that the surface area is 0.2% of the contributing impervious area. (A forebay is not necessary if the concentrated flow is from the outlet of an extended detention basin or similar practice).
- The length of the level spreader should be determined by the type of filter area and the design flow:
  - 13 feet of level spreader length per every 1 cubic foot per second (cfs) of inflow for discharges to a Vegetated Filter Strip or Conserved Open Space consisting of native grasses or thick ground cover;
  - 40 feet of level spreader length per every 1 cfs of inflow when the spreader discharges to a Conserved Open Space consisting of forested or reforested buffer (Hathaway and Hunt, 2006).
  - Where the Conserved Open Space is a mix of grass and forest (or re-forested), establish the level spreader length by computing a weighted average of the lengths required for each vegetation type.
  - The minimum level spreader length is 13 feet and the maximum is 130 feet.
  - For the purposes of determining the Level Spreader length, the peak discharge shall be determined using the Rational Equation with an intensity of 1-inch/hour.

- The level spreader lip should be concrete, wood or pre-fabricated metal, with a well-anchored footer, or other accepted rigid, non-erodible material.
- The ends of the level spreader section should be tied back into the slope to avoid scouring around the ends of the level spreader; otherwise, short-circuiting of the facility could create erosion.
- The width of the level spreader channel on the up-stream side of the level lip should be three times the diameter of the inflow pipe, and the depth should be 9 inches or one-half the culvert diameter, whichever is greater.
- The level spreader should be placed 3 to 6 inches above the downstream natural grade elevation to avoid turf buildup. In order to prevent grade drops that re-concentrate the flows, a 3-foot long section of VDOT # 3 stone, underlain by filter fabric, should be installed just below the spreader to transition from the level spreader to natural grade.

- Vegetated receiving areas down-gradient from the level spreader must be able to withstand the force of the flow coming over the lip of the device. It may be necessary to stabilize this area with temporary (VDOT EC-2) or permanent (VDOT EC-3) materials in accordance with the calculated velocity (on-line system peak, or diverted off-line peak) and material specifications, along with seeding and stabilization in conformance with the Virginia Erosion and Sediment Control Handbook.

6.4. Filter Design Material Specifications

Table 2.3 describes materials specifications for the primary treatment within filter strips.

Table 2.3. Vegetated Filter Strip Materials Specifications

Material	Specification	Quantity
Gravel Diaphragm	Pea Gravel (#8 or ASTM equivalent) or where steep (6% +) use clean bank-run VDOT #57 or ASTM equivalent (1-inch maximum).	Diaphragm should be 2 feet wide, 1 foot deep, and at least 3 inches below the edge of pavement.
Permeable Berm	40% excavated soil, 40% sand, and 20% pea gravel to serve as the media for the berm.	
Geotextile	Needled, non-woven, polypropylene geotextile meeting the following specifications: Grab Tensile Strength (ASTM D4632): > 120 lbs. Mullen Burst Strength (ASTM D3786): > 225 lbs./sq. in. Flow Rate (ASTM D4491): > 125 gpm/sq. ft. Apparent Opening Size (ASTM D4751): US #70 or #80 sieve	
Engineered Level Spreader	Level Spreader lip should be concrete, metal, timber, or other rigid material; Reinforced channel on upstream of lip: VDOT EC-2 (or EC-3 if velocities require permanent reinforcing). See Hathaway and Hunt (2006) or Henrico County Program Manual.	
Erosion Control Fabric or Matting	Where flow velocities dictate, use woven biodegradable erosion control fabric or mats that are durable enough to last at least 2 growing seasons. (e.g., VDOT Erosion Control matting EC-2).	
Topsoil	If existing topsoil is inadequate to support dense turf growth, imported top soil (loamy sand or sandy loam texture), with less than 5% clay content, corrected pH at 6 to 7, a soluble salt content not exceeding 500 ppm, and an organic matter content of at least 2% shall be used. Topsoil shall be uniformly distributed and lightly compacted to a minimum depth of 6 to 8 inches	
Compost	Compost shall be derived from plant material and provided by a member of the U.S. Composting Seal of Testing Assurance (STA) program, as outlined in Stormwater Design Specification No. 4.	

SECTION 7: REGIONAL & SPECIAL CASE DESIGN ADAPTATIONS

7.1. Karst Terrain

Conserved Open Space areas are highly recommended in karst terrain, particularly when storm flow discharges to the outer boundary of a karst protection area (see CSN, 2009).

Vegetated Filter Strips can also be used to treat runoff from small areas of impervious cover (e.g., less than 5,000 square feet). Some communities use wide grass filter strips to treat runoff from the roadway shoulder.

In no case should the use of a Conserved Open Space or Vegetated Filter Strip be considered as a replacement for an adequate receiving system for developed-condition stormwater discharges, unless the adequacy of the design has been demonstrated consistent with the the Virginia Stormwater Management Handbook.

7.2. Coastal Plain

The use of Conserved Open Space areas and Vegetated Filter Strips are highly recommended in the coastal plain, particularly when sheetflow (or concentrated flow with an appropriately-sized level spreader) discharges to the outer boundary of a shoreline, stream or wetland buffer. Vegetated Filter Strips can also be used to treat runoff from small areas of impervious cover (e.g., less than 5,000 square feet). In both cases, however, the designer must consider the depth to the water table. In general, shallow water tables may inhibit the function of Vegetated Filter Strips.

7.3. Linear Highway Sites

Vegetated Filter Strips are highly recommended to treat highway runoff if the median and/or road shoulder is wide enough to provide an adequate flow path.

SECTION 8: CONSTRUCTION

8.1. Construction Sequence for Conserved Open Space Areas

The Conserved Open Space must be fully protected during the construction stage of development and kept outside the limits of disturbance on the Erosion and Sediment (E&S) Control Plan.

- No clearing, grading or heavy equipment access is allowed except temporary disturbances associated with incidental utility construction, restoration operations or management of nuisance vegetation.
- The perimeter of the Conserved Open Space shall be protected by super silt fence, chain link fence, orange safety fence, or other measures to prevent sediment discharge.
- The limits of disturbance should be clearly shown on all construction drawings and identified and protected in the field by acceptable signage, silt fence, snow fence or other protective barrier.

- Construction of the gravel diaphragm or engineered level spreader shall not commence until the contributing drainage area has been stabilized and perimeter E&S controls have been removed and cleaned out.
- Some light grading may be needed at the Filter Strip boundary; this should be done with tracked vehicles to prevent compaction.
- Stormwater should not be diverted into the Vegetated Filter Strip until the gravel diaphragm and/or level spreader are installed and stabilized.

8.2. Construction Sequence for Vegetated Filter Strips

Vegetated Filter Strips can be within the limits of disturbance during construction. The following procedures should be followed during construction:

- Before site work begins, Vegetated Filter Strip boundaries should be clearly marked.
- Only vehicular traffic used for Filter Strip construction should be allowed within 10 feet of the Filter Strip boundary (City of Portland, 2004).
- If existing topsoil is stripped during grading, it shall be stockpiled for later use.
- Construction runoff should be directed away from the proposed Filter Strip site, using perimeter silt fence, or, preferably, a diversion dike.
- Construction of the gravel diaphragm or engineered level spreader shall not commence until the contributing drainage area has been stabilized and perimeter E&S controls have been removed and cleaned out.
- Vegetated Filter Strips require light grading to achieve desired elevations and slopes. This should be done with tracked vehicles to prevent compaction. Topsoil and or compost amendments should be incorporated evenly across the filter strip area, stabilized with seed, and protected by biodegradable erosion control matting or blankets.
- Stormwater should not be diverted into the Filter Strip until the turf cover is dense and well established.

8.3. Construction Inspection

Construction inspection is critical to obtain adequate spot elevations, to ensure the gravel diaphragm or ELS is completely level, on the same contour, and constructed to the correct design elevation. As-built surveys should be required to ensure compliance with design standards. Inspectors should evaluate the performance of the Filter Strip after the first big storm to look for evidence of gullies, outflanking, undercutting or sparse vegetative cover. Spot repairs should be made, as needed.

An example construction phase inspection checklist for Sheet Flow to a Filter Strip or Conserved Open Space can be found on the Center for Watershed Protection website at:

http://www.cwp.org/Resource_Library/Controlling_Runoff_and_Discharges/sm.htm
(scroll to Tool6: Plan Review, BMP Construction, and Maintenance Checklists)

SECTION 9. MAINTENANCE

9.1. Maintenance Agreements

Section 4 VAC 50-60-124 of the regulations specifies the circumstances under which a maintenance agreement must be executed between the owner and the local program. This section sets forth inspection requirements, compliance procedures if maintenance is neglected, notification of the local program upon transfer of ownership, and right-of-entry for local program personnel.

All Vegetated Filter Strips must be covered by a drainage easement to allow inspection and maintenance. If the filter area is a natural Conserved Open Space, it must be protected by a perpetual easement or deed restriction that assigns the responsible party to ensure that no future development, disturbance or clearing may occur within the area, except as stipulated in the vegetation maintenance plan.

If the Vegetated Filter Strip is located on a residential private lot, the existence and purpose of the Filter Strip shall be noted on the deed of record. Homeowners will need to be provided a simple document that explains the purpose of the Filter Strip and routine maintenance needs. A deed restriction or other mechanism enforceable by the qualifying local program must be in place to help ensure that Filter Strips are maintained and Conserved Open Space Areas are not converted or disturbed. The mechanism should, if possible, grant authority for local agencies to access the property for inspection or corrective action.

9.2. Maintenance Inspections

Annual inspections are used to trigger maintenance operations such as sediment removal, spot re-vegetation and level spreader repair. Ideally, inspections should be conducted in the non-growing season when it easier to see the flow path. Example maintenance inspection checklists for Sheet Flow to a Filter Strip or Conserved Open Space areas can be accessed in Appendix C of Chapter 9 of the Virginia Stormwater Management Handbook or at the Center for Watershed Protection's website at:

http://www.cwp.org/Resource_Library/Controlling_Runoff_and_Discharges/sm.htm
(scroll to Tool6: Plan Review, BMP Construction, and Maintenance Checklists)

Inspectors should check to ensure that:

- Flows through the Filter Strip do not short-circuit the overflow control section;
- Debris and sediment does not build up at the top of the Filter Strip;
- Foot or vehicular traffic does not compromise the gravel diaphragm;
- Scour and erosion do not occur within the Filter Strip;
- Sediments are cleaned out of Level Spreader forebays and flow splitters; and
- Vegetative density exceeds a 90% cover in the boundary zone or grass filter.

9.3. Ongoing Maintenance

Once established, Vegetated Filter Strips have minimal maintenance needs outside of the spring clean up, regular mowing, repair of check dams and other measures to maintain the hydraulic efficiency of the strip and a dense, healthy grass cover. Vegetated Filter Strips that consist of grass/turf cover should be mowed at least twice a year to prevent woody growth.

SECTION 10. REFERENCES

Cappiella, K., T. Schueler, and T. Wright. 2006. *Urban Watershed Forestry Manual, Part 2. Conserving and Planting Trees at Development Sites*. Center for Watershed Protection. Prepared for United States Department of Agriculture, Forest Service.

City of Portland, Environmental Services. 2004. *Portland Stormwater Management Manual*. Portland, OR. Available online at: http://www.portlandonline.com/bes/index.cfm?c=dfbbh

Claytor, R. and T. Schueler. 1996. *Design of Stormwater Filtering Systems*. Center for Watershed Protection. Ellicott City, MD.

CWP. 2007. *National Pollutant Removal Performance Database Version 3.0*. Center for Watershed Protection, Ellicott City, MD.

Hathaway, J. and B. Hunt. 2006. *Level Spreaders: Overview, Design, and Maintenance*. Department of Biological and Agricultural Engineering. NC State University. Raliegh, NC. http://www.bae.ncsu.edu/stormwater/PublicationFiles/LevelSpreaders2006.pdf.

Henrico County, Virginia. *Henrico County Environmental Program Manual*. Available online at: http://www.co.henrico.va.us/works/eesd/

North Carolina State University. *Level Spreader Design Worksheet*. Available online at: http://www.bae.ncsu.edu/cont_ed/main/handouts/lsworksheet.pdf

North Carolina Department of Environment and Natural Resources, Division of Water Quality. "Level Spreader Design Guidelines." January 2007. Available online at: http://h2o.enr.state.nc.us/su/Manuals_Factsheets.htm

Northern Virginia Regional Commission. 2007. *Low Impact Development Supplement to the Northern Virginia BMP Handbook*. Fairfax, Virginia.

Philadelphia Stormwater Management Guidance Manual. Available online at: http://www.phillyriverinfo.org/Programs/SubprogramMain.aspx?Id=StormwaterManual

Schueler, T., D. Hirschman, M. Novotney and J. Zielinski. 2007. *Urban Stormwater Retrofit Practices*. Manual 3 in the Urban Subwatershed Restoration Manual Series. Center for Watershed Protection, Ellicott City, MD.

Schueler, T. 2008. Technical Support for the Baywide Runoff Reduction Method. Chesapeake Stormwater Network. Baltimore, MD. www.chesapeakestormwater.net

Virginia Stormwater Management Handbook. 1999. *Volumes 1 and 2*. Richmond, VA.

VIRGINIA DEQ STORMWATER DESIGN SPECIFICATION No. 4

SOIL COMPOST AMENDMENT

VERSION 1.9
March 1, 2011
Amended November 28, 2016



SECTION 1: DESCRIPTION

Soil restoration is an Environmental Site Design (ESD) practice applied after construction, to deeply till compacted soils and restore their porosity by amending them with compost. These soil amendments can reduce the generation of runoff from compacted urban lawns and may also be used to enhance the runoff reduction performance of downspout disconnections, grass channels, and filter strips (**Table 4.1**).

SECTION 2: PERFORMANCE

Table 4.1: Stormwater Functions of Soil Compost Amendments [1]

Stormwater Function	HSG Soils A and B		HSG Soils C and D	
	No CA [2]	With CA	No CA	With CA
Annual Runoff Volume Reduction (RR)				
Simple Rooftop Disconnection	**50%**	**NA** [3]	**25%**	**50%**
Filter Strip	**50%**	**NA** [3]	**NA** [4]	**50%**
Grass Channel	**20%**	**NA** [3]	**10%**	**30%**
Total Phosphorus (TP) EMC Reduction[4] by BMP Treatment Practice	**0**		**0**	
Total Phosphorus (TP) Mass Load Removal	**Same as for RR (above)**		**Same as for RR (above)**	
Total Nitrogen (TN) EMC Reduction by BMP Treatment Practice	**0**		**0**	
Total Nitrogen (TN) Mass Load Removal	**Same as for RR (above)**		**Same as for RR (above)**	
Channel Protection & Flood Mitigation	**Partial.** Designers can use the RRM spreadsheet to adjust the curve number for each design storm for the contributing drainage area, based on annual runoff volume reduction achieved.			

[1] CWP and CSN (2008), CWP (2007)

[2] CA = Compost Amended Soils, see Stormwater Design Specification No. 4.

[3] Compost amendments are generally not applicable for A and B soils, although it may be advisable to incorporate them on mass-graded B soils to maintain runoff reduction rates.

[4] Filter strips in HSG C and D should use composted amended soils to enhance runoff reduction capabilities. See Stormwater Design Specification No. 2: Sheetflow to Vegetated Filter Strip or Conserved Open Space.

SECTION 3: DESIGN TABLE

Not applicable.

SECTION 4: TYPICAL DETAILS

Not applicable.

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

Compost amended soils are suitable for any pervious area where soils have been or will be compacted by the grading and construction process. They are particularly well suited when existing soils have low infiltration rates (HSG C and D) and when the pervious area will be used to filter runoff (downspout disconnections and grass channels). The area or strip of amended soils should be hydraulically connected to the stormwater conveyance system. Soil restoration is recommended for sites that will experience mass grading of more than a foot of cut and fill across the site.

Compost amendments are not recommended where:

- Existing soils have high infiltration rates (e.g., HSG A and B), although compost amendments may be needed at mass-graded B soils in order to maintain runoff reduction rates.
- The water table or bedrock is located within 1.5 feet of the soil surface.
- Slopes exceed 10%.
- Existing soils are saturated or seasonally wet.
- They would harm roots of existing trees (keep amendments outside the tree drip line).
- The downhill slope runs toward an existing or proposed building foundation.
- The contributing impervious surface area exceeds the surface area of the amended soils.

Compost amendments can be applied to the entire pervious area of a development or be applied only to select areas of the site to enhance the performance of runoff reduction practices. Some common design applications include:

- Reduce runoff from compacted lawns.
- Enhance rooftop disconnections on poor soils.
- Increase runoff reduction within a grass channel.
- Increase runoff reduction within a vegetated filter strip.
- Increase the runoff reduction function of a tree cluster or reforested area of the site.

SECTION 6: DESIGN CRITERIA

6.1. Performance When Used in Conjunction With Other Practices

As referenced in several of the other specifications, soil compost amendments can be used to enhance the runoff reduction capabilities of allied practices. The specifications for each of these practices contain design criteria for how compost amendments can be incorporated into those designs:

- Rooftop (impervious) Disconnection – see Stormwater Design Specification No. 1, Section 3.2.
- Vegetated Filter Strips – see Stormwater Design Specification No. 2, Section 6.1.
- Grass Channels – see Stormwater Design Specification No. 3, Section 6.5.
- Site Reforestation – see Appendix A of this design specification.

6.2. Soil Testing

Soil tests are required during two stages of the compost amendment process. The first testing is done to ascertain pre-construction soil properties at proposed amendment areas. The initial testing is used to determine soil properties to a depth 1 foot below the proposed amendment area, with respect to bulk density, pH, salts, and soil nutrients. These tests should be conducted every 5000 square feet, and are used to characterize potential drainage problems and determine what, if any, further soil amendments are needed.

The second soil test is taken at least one week after the compost has been incorporated into the soils. This soil analysis should be conducted by a reputable laboratory to determine whether any further nutritional requirements, pH adjustment, and organic matter adjustments are necessary for plant growth. This soil analysis should be done in conjunction with the final construction inspection to ensure tilling or subsoiling has achieved design depths.

6.3. Runoff Volume Reduction

The runoff volume reduction achieved by soil restoration depends on the site application and the pre-construction hydrologic soil group. When compost amendments are used simply to reduce runoff volume from compacted lawns, the lower runoff coefficients shown in **Table 4.2** can be used to lower the total treatment volume for the site as a whole. If the soil restoration area accepts runoff from adjacent impervious areas, the higher runoff reduction rates outlined in **Table 4.1** above may be used for the indicated practices.

Table 4.2. Runoff Coefficients for Use for Different Pervious Areas

Hydrologic Soil Group	Undisturbed Soils [1]	Disturbed Soils [2]	Restored and Reforested [3]
A	0.02	0.15	0.02
B	0.03	0.20	0.03
C	0.04	0.22	0.04
D	0.05	0.25	0.05

Notes:
[1] Portions of a new development site, outside the limits of disturbance, which are not graded and do not receive construction traffic.
[2] Previously developed sites, and any site area inside the limits of disturbance as shown on the E&S Control plan.
[3] Areas with restored soils that are also reforested to achieve a minimum 75% forest canopy

6.4. Determining Depth of Compost Incorporation

The depth of compost amendment is based on the relationship of the surface area of the soil amendment to the contributing area of impervious cover that it receives. **Table 4.3** presents some general guidance derived from soil modeling by Holman-Dodds (2004) that evaluates the required depth to which compost must be incorporated. Some adjustments to the recommended incorporation depth were made to reflect alternative recommendations of Roa Espinosa (2006), Balousek (2003), Chollak and Rosenfeld (1998) and others.

Table 4.3. Short-Cut Method to Determine Compost and Incorporation Depths

	Contributing Impervious Cover to Soil Amendment Area Ratio [1]			
	IC/SA = 0 [2]	IC/SA = 0.5	IC/SA = 0.75	IC/SA = 1.0 [3]
Compost (in) [4]	2 to 4 [5]	3 to 6 [5]	4 to 8 [5]	6 to 10 [5]
Incorporation Depth (in)	6 to 10 [5]	8 to 12 [5]	15 to 18 [5]	18 to 24 [5]
Incorporation Method	Rototiller	Tiller	Subsoiler	Subsoiler

Notes:
[1] IC = contrib. impervious cover (sq. ft.) and SA = surface area of compost amendment (sq. ft.)
[2] For amendment of compacted lawns that do not receive off-site runoff
[3] In general, IC/SA ratios greater than 1 should be avoided
[4] Average depth of compost added
[5] Lower end for B soils, higher end for C/D soils

Once the area and depth of the compost amendments are known, the designer can estimate the total amount of compost needed, using an estimator developed by TCC, (1997):

$$C = A * D * 0.0031$$

Where: C = compost needed (cu. yds.)
A = area of soil amended (sq. ft.)
D = depth of compost added (in.)

6.5. Compost Specifications

The basic material specifications for compost amendments are outlined below:

- Compost shall be derived from plant material and meet the general criteria set forth by the U.S. Composting Seal of Testing Assurance (STA) program. See www.compostingcouncil.org for a list of local providers.

- The compost shall be the result of the biological degradation and transformation of plant-derived materials under conditions that promote anaerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have a moisture content that has no visible free water or dust produced when handling the material. It shall meet the following criteria, as reported by the U.S. Composting Council STA Compost Technical Data Sheet provided by the vendor:

  a. 100% of the material must pass through a half inch screen
  b. The pH of the material shall be between 6 and 8
  c. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0% by weight
  d. The organic matter content shall be between 35% and 65%
  e. Soluble salt content shall be less than 6.0 mmhos/cm
  f. Maturity should be greater than 80%
  g. Stability shall be 7 or less

h. Carbon/nitrogen ratio shall be less than 25:1
i. Trace metal test result = "pass"
j. The compost must have a dry bulk density ranging from 40 to 50 lbs./cu. ft^3.

SECTION 7: REGIONAL & SPECIAL CASE DESIGN ADAPTATIONS

7.1. Karst Terrain

No special adaptations are needed in karst terrain, but the designer should take soil tests to ensure that soil pH is adjusted to conform to pre-existing soil conditions found in limestone dominated areas.

7.2. Coastal Plain

Designers should evaluate drainage and water table elevations to ensure the entire depth of soil amendment will not become saturated (i.e., a minimum separation depth of 2 feet from groundwater). Compost amendments are most cost effective when used to boost the runoff reduction capability of grass vegetated filter strips, grass channels and rooftop disconnections.

7.3. Steep Terrain

Compost amendments are ineffective when longitudinal slopes exceed 5%, so some terracing may be needed on steeper slopes.

7.4. Cold Climate and Winter Performance

Soil restoration is not recommended for areas that will be used for snow storage.

7.5. Linear Highway Sites

Soil amendments can improve the runoff reduction of drainage swales in open section rights-of-way and highway medians.

SECTION 8: CONSTRUCTION

8.1. Construction Sequence

The construction sequence for compost amendments differs depending whether the practice will be applied to a large area or a narrow filter strip, such as in a rooftop disconnection or grass channel. For larger areas, a typical construction sequence is as follows:

Step 1. Prior to building, the proposed area should be deep tilled to a depth of 2 to 3 feet using a tractor and sub-soiler with two deep shanks (curved metal bars) to create rips perpendicular to the direction of flow. (This step is usually omitted when compost is used for narrower filter strips.)

Step 2. A second deep tilling to a depth of 12 to 18 inches is needed after final building lots have been graded.

Step 3. It is important to have dry conditions at the site prior to incorporating compost.

Step 4. An acceptable compost mix is then incorporated into the soil using a roto-tiller or similar equipment at the volumetric rate of 1 part compost to 2 parts soil.

Step 5. The site should be leveled and seeds or sod used to establish a vigorous grass cover. Lime or irrigation may initially be needed to help the grass grow quickly.

Step 6. Areas of compost amendments exceeding 2500 square feet should employ simple erosion control measures, such as silt fence, to reduce the potential for erosion and trap sediment.

8.2. Construction Inspection

Construction inspection involves digging a test pit to verify the depth of mulch, amended soil and scarification. A rod penetrometer should be used to establish the depth of uncompacted soil at one location per 10,000 square feet.

SECTION 9: MAINTENANCE

9.1. Maintenance Agreements

When soil compost amendments are applied on private residential lots, homeowners will need to be educated on their routine maintenance needs, understand the long-term maintenance plan, and be subject to a deed restriction or other mechanism enforceable by the qualifying local program to ensure that infiltrating areas are not converted or disturbed. The mechanism should, ideally, grant authority for local agencies to access the property for inspection or corrective action. In addition, the GPS coordinates for all amended areas should be provided upon facility acceptance to ensure long term tracking.

A simple maintenance agreement should be provided if soil restoration is associated with more than 10,000 square feet of reforestation. A conservation easement or deed restriction, which also identifies a responsible party, may be required to make sure the newly developing forest cannot be cleared or developed management is accomplished (i.e., thinning, invasive plant removal, etc.). Soil compost amendments within a filter strip or grass channel should be located in a public right-of-way, or within a dedicated stormwater or drainage easement.

9.2. First Year Maintenance Operations

In order to ensure the success of soil compost amendments, the following tasks must be undertaken in the first year following soil restoration:

Initial inspections. For the first six months following the incorporation of soil amendments, the site should be inspected at least once after each storm event that exceeds 1/2-inch of rainfall.

Spot Reseeding. Inspectors should look for bare or eroding areas in the contributing drainage area or around the soil restoration area and make sure they are immediately stabilized with grass cover.

Fertilization. Depending on the amended soils test, a one-time, spot fertilization may be needed in the fall after the first growing season to increase plant vigor.

Watering. Water once every three days for the first month, and then weekly during the first year (April-October), depending on rainfall.

9.3. Ongoing Maintenance

There are no major on-going maintenance needs associated with soil compost amendments, although the owners may want to de-thatch the turf every few years to increase permeability. The owner should also be aware that there are maintenance tasks needed for filter strips, grass channels, and reforestation areas. An example maintenance inspection checklist for an area of Soil Compost Amendments can be accessed in Appendix C of Chapter 9 of the *Virginia Stormwater Management Handbook* (2010).

SECTION 10. COMMUNITY & ENVIRONMENTAL CONCERNS

Not applicable.

SECTION 11: REFERENCES

Balusek. 2003. *Quantifying decreases in stormwater runoff from deep-tilling, chisel-planting and compost amendments*. Dane County Land Conservation Department. Madison, Wisconsin.

Chollak, T. and P. Rosenfeld. 1998. *Guidelines for Landscaping with Compost-Amended Soils*. City of Redmond Public Works. Redmond, WA. Available online at: http://www.ci.redmond.wa.us/insidecityhall/publicworks/environment/pdfs/compostamendedsoils.pdf

City of Portland. 2008. "Soil Specification for Vegetated Stormwater Facilities." *Portland Stormwater Management Manual*. Portland, Oregon.

Composting Council (TCC). 1997. *Development of a Landscape Architect Specification for Compost Utilization*. Alexandria, VA. http://www.cwc.org/organics/org972rpt.pdf

Holman-Dodds, L. 2004. *Chapter 6. Assessing Infiltration-Based Stormwater Practices*. PhD Dissertation. Department of Hydroscience and Engineering. University of Iowa. Iowa City, IA.

Lenhart, J. 2007. "Compost as a Soil Amendment for Water Quality Treatment Facilities." *Proceedings: 2007 LID Conference*. Wilmington, NC.

Low Impact Development Center. *Guideline for Soil Amendments*. Available online at:

http://www.lowimpactdevelopment.org/epa03/soilamend.htm

Roa-Espinosa. 2006. *An Introduction to Soil Compaction and the Subsoiling Practice. Technical Note.* Dane County Land Conservation Department. Madison,Wisconsin.

Soils for Salmon. 2003. *Soil Restoration and Compost Amendments.* Available online at: http://www.soilsforsalmon.org/pdf/SoilsforSalmonLIDrev9-16-04.pdf

APPENDIX 4-A

INITIAL MINIMUM DESIGN CRITERIA FOR REFORESTATION, DISCONNECTION, FILTER STRIPS AND GRASS CHANNELS

SECTION 4-A.1: SITE REFORESTATION

Several design criteria apply when compost amendments are used to enhance the performance of reforested areas. Site reforestation involves planting trees on existing turf or barren ground at a development site with the explicit goal of establishing a mature forest canopy that will intercept rainfall, increase evapotranspiration rates, and enhance soil infiltration rates. Reforestation areas at larger development sites (and individual trees at smaller development sites) are eligible under the following qualifying conditions.

- The minimum contiguous area of reforestation must be greater than 5,000 square feet.
- A long term vegetation management plan must be prepared and filed with the local review authority in order to maintain the reforestation area in a natural forest condition.
- The reforestation area must be protected by a perpetual stormwater easement or deed restriction which stipulates that no future development or disturbance may occur within the area.
- Reforestation methods must achieve 75% forest canopy within ten years.
- The planting plan must be approved by the appropriate local forestry or conservation authority, including any special site preparation needs.
- The construction contract should contain a care and replacement warranty extending at least 3 growing seasons, to ensure adequate growth and survival of the plant community.
- The reforestation area shall be shown on all construction drawings and E&S Control plans during construction.

SECTION 4-A.2: SIMPLE DOWNSPOUT DISCONNECTION

See VA DEQ Stormwater Design Specification No. 1.

SECTION 4-A.3: FILTER STRIP

See VA DEQ Stormwater Design Specification No. 2.

SECTION 4-A.4: GRASS CHANNEL

See VA DEQ Stormwater Design Specification No. 3.

ATTACHMENT 4

Letter of Availability for Nutrient Credits

[Will Be Provided Prior to Land Disturbance Activities]