

April 10, 2023

To: Christy Witters, Chris Gianfagna, and Emily Schelley
Vermont DEC Stormwater Program

From: Amy Macrellis, Stone Environmental
Jenn Callahan, Vermont Agency of Transportation

MEMO

Stone Project No. 20231008

Subject: Lake Champlain Basin Phosphorus Control Plan, Vermont Agency of Transportation –
Progress Report

On behalf of VTTrans and in accordance with *NPDES General Permit 3-9007 for Stormwater Discharges from the State Transportation Separate Storm Sewer System (TS4)* Section 9.2.D, Stone is pleased to submit this Progress Report summarizing actions taken to implement all Phosphorus Control Plan (PCP) components. This submittal includes a progress report on crediting for impervious and pervious acres managed, and BMPs implemented, through December 31, 2022 and provides updates to estimated extent of completion for remaining items and schedule as of December 31, 2022.

1. Extent of BMP implementation

In the last progress report (submitted September 28, 2022), documentation of historic and current operations, and projection of current operations through the term of the first VTTrans Phosphorus Control Implementation Plan (PCIP)¹ (submitted October 1, 2020) was updated in the implementation model to account for capital projects and maintenance activities completed through December 31, 2021. Plan review, maintenance activity review, and culvert and swale inventory review and crediting activities are in progress for reductions achieved by VTTrans between Jan. 1 and December 31, 2022 with accounting completion anticipated in September 2023.

Below, we briefly summarize activities undertaken and progress documented in July-December 2022, organized by the suite of necessary BMPs set forth in the PCIP.

1.1 Tracking and Accounting

VTTrans continued development of a tracking and accounting system, working to integrate with and build from its asset inventories and the Vermont Asset Management Information System (VAMIS). TS4 ditch inventory refinements that were field-tested in the 2021 field season, including dividing swales to correspond to road

¹ https://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/TS4/VTTrans_PC_Implementation_Plan_2020_10_01_2021_03_12.pdf

segments and to Small Culverts Inventory (SCI) cross culverts, were completed for swale assets in the Lake Champlain Basin (LCB) in May 2022. Swale asset re-inventory utilizing the refined TS4 ditch inventory for features located within the LCB commenced in the 2022 field season. All TS4 swales north of I-89 in Richmond and from Bakersfield west north to the border were re-inventoried, constituting 6,849 of 25,999 (27%) of the mapped swales in the LCB (see Attachment 1 for a map of re-inventoried swale extents).

VTrans commenced development of an automated system for tracking and accounting for structural corrections to road drainage deficiencies in July 2022. Scripting for tracking SCI asset conditions comparison and standards compliance re-calculation on a 2-week recurrence was established. Tracking system steps in development during July-December 2022 included:

- Coding for adding or subtracting culverts and establishing relationships between new culverts and road segments.
- Establishing comparisons and re-calculation of standards compliance for swales, similar to culverts.

1.2 Structural Correction of Road Drainage Deficiencies

The *VTrans Phosphorus Control Highway Drainage Management Standards (August 3, 2021)* were revised effective July 1, 2022 to integrate the VTrans Short Structures asset inventory into the existing drainage standards and phosphorus crediting framework (Attachment 2). Larger culverts, including many concrete box culverts now being installed by VTrans to replace undersized structures, are tracked in the VTrans Short Structures asset inventory instead of in the Small Culverts Inventory (SCI), which includes only culverts that are six feet in diameter or smaller.

These standards, and the menu of standard BMPs and maintenance activities that may be undertaken to bring road segments and related assets ‘up to standards’, are living documents and will be updated periodically as conditions warrant.

Analysis of phosphorus load reductions achieved through correction of road drainage deficiencies, as documented in MATS and in programmed capital projects during calendar 2022 is underway, with completion of summaries and credit accounting in the implementation model estimated by September 2023.

1.3 Structural Correction of Road Erosion Issues

Specific crediting mechanisms for stabilization and treatment of areas of localized erosion caused by roadway runoff were adopted by ANR DEC effective June 28, 2022. VTrans anticipates adopting the P crediting methodology for outlet and gully restoration BMPs as represented in ANR’s *Standard Operating Procedures for*

Tracking & Accounting of Developed Lands Regulatory Projects & Non-Regulatory Clean Water Projects² as appropriate as it accounts for road-erosion related improvements completed in calendar 2022.

Correction of minor areas of localized erosion as documented in MATS and in programmed capital projects during calendar 2022 are being summarized and credited in the implementation model, with completion of summaries and credit accounting in the implementation model estimated in September 2023.

1.4 Non-Structural Controls

Lane miles swept and drop inlets (DIs) cleaned in calendar 2022 are being summarized and credited in the implementation model, with completion estimated by September 2023.

1.5 Structural Stormwater Treatment Practices

Information about existing and planned structural stormwater treatment practices (STPs) throughout the TS4 is updated in the TS4's BMP Tracking Table and in the implementation model as practices move through design or are constructed. The current BMP Tracking Table is being submitted as part of the 2022 TS4 Annual Report. Updates to the PCP implementation model are underway for completed structural STPs following the 2022 construction season.

VTrans is presently advancing an innovative research project with the University of Vermont, evaluating the potential to enhance P removal in select stormwater treatment practices using drinking water treatment residuals (DWTRs), which are a by-product of drinking water processing³. The project began in the fall of 2022 and will continue through the 2023 field season.

1.6 Natural Resource Restoration Projects

Natural resource restoration projects, and particularly floodplain restoration projects, may be credited as stormwater treatment practices in the context of the VTrans PCP if the floodplain area to be restored is also connected to a TS4 roadway or other VTrans-controlled contributing drainage. Since the PICP submittal, VTrans has continued to complete preliminary evaluations of specific floodplain restoration projects for P reduction credit as opportunities arise.

More comprehensive evaluation of how to execute and credit floodplain reconnection will be possible through application of results from Vermont's Functioning Floodplains Initiative (FFI). The initiative is developing and applying methodologies for evaluating river reach and watershed-scale restoration of stream, riparian, wetland, and floodplain function. Public release of the web-based application is anticipated in the summer of 2023.

² [https://dec.vermont.gov/sites/dec/files/wsm/erp/docs/TrackingAccounting/Standard Operating Procedures for Tracking & Accounting of Developed Lands Regulatory Projects & Non-Regulatory Clean Water Projects.pdf](https://dec.vermont.gov/sites/dec/files/wsm/erp/docs/TrackingAccounting/Standard%20Operating%20Procedures%20for%20Tracking%20&%20Accounting%20of%20Developed%20Lands%20Regulatory%20Projects%20&%20Non-Regulatory%20Clean%20Water%20Projects.pdf)

³ <https://vtrans.vermont.gov/planning/research/projects/22-3>

Phosphorus crediting tracking and accounting methodologies for natural resource restoration projects are reflected in ANR's *Standard Operating Procedures for Tracking & Accounting of Natural Resources Restoration Projects*⁴, effective June 28, 2022. In the SOP, floodplain storage credits are proposed to be distributed between the load allocation (LA) and wasteload allocation (WLA) upstream of floodplain storage sites based on the contribution of a) regulated vs. non-regulated loads, and b) the percent sector contribution to the base load, as reported in the TMDL for each Lake Champlain subbasin by default (EPA, 2016) or by site-specific percentages of sector contributions as identified during project design (pp. 47-48 of the SOP). VTTrans is presently exploring whether and how VTTrans may apply these crediting methodologies.

2. Estimate of extent of completion for remaining items

The draft implementation schedule as presented in the October 1, 2020 PCIP remains generally accurate. Both the schedule and the implementation model are planning-level documents only and will be subject to continued adjustment as the implementation plan is executed. The base assumptions used to populate the model remain unchanged from the Generalized PCP submittal. Updates to those assumptions, particularly assumptions related to implementation costs, will continue as plan execution proceeds.

The implementation model submitted with the September 30, 2022 progress report is being updated to summarize activities completed and crediting for calendar 2022, with accounting completion estimated by September 2023. Planning for the Phase 2 PCIP is anticipated to begin in the spring of 2023, with limited field screening as necessary to adjust the suite of recommended BMPs to be completed in the 2023 field season.

3. Assessment of ability to meet remaining schedule items

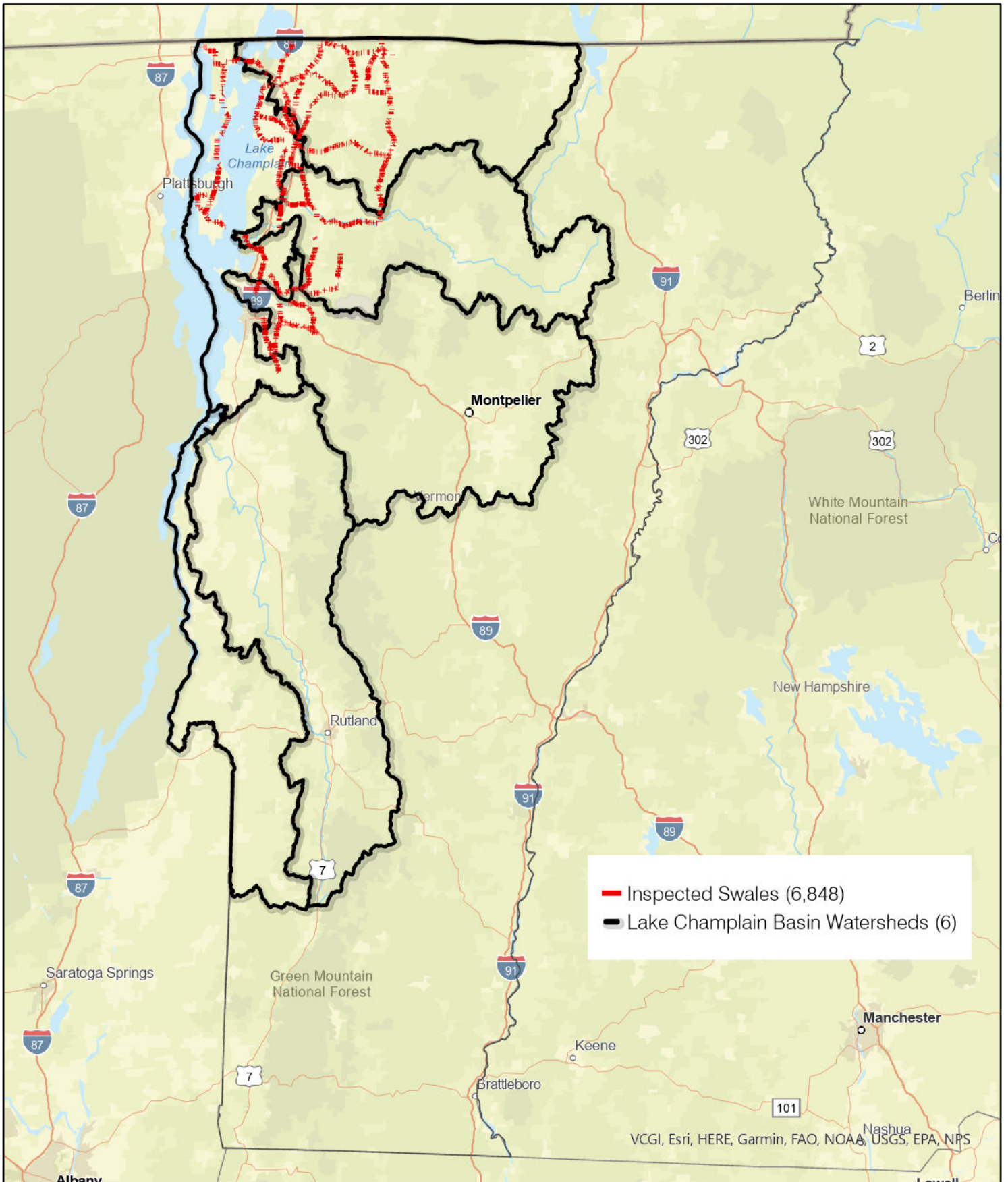
VTTrans is presently on or slightly ahead of schedule and is capable of meeting remaining schedule items. As implementation of the PCPs proceeds, if any changes in ability to meet schedule items arise, VTTrans will report on schedule adjustments as warranted.

4. Written designer statements

Subpart 9.2.D.4 of the TS4 General Permit requires submittal of *a written statement signed by a designer acceptable to the Secretary that any structural BMP build or implemented within the preceding 6 month period was constructed in compliance with the approved plans*. No structural BMPs requiring written designer statements were completed explicitly for the VTTrans PCP within the preceding 6-month period.

O:\PROJ-18\WRM\18-008-D-E VTTrans PCP Implementation Support\Reports\Interim reports\PCP Progress Report 2023 03 27\VTTrans PCP Progress Report 2023 04 10.docx

⁴ <https://dec.vermont.gov/sites/dec/files/wsm/erp/docs/TrackingAccounting/Standard Operating Procedures for Tracking & Accounting of Natural Resources Restoration Projects.pdf>



2022 Swale Inventory Inspection in the Vermont Lake Champlain Basin

VTrans Phosphorus Control Plan Progress Report July-December 2022

VTRANS PHOSPHORUS CONTROL HIGHWAY DRAINAGE MANAGEMENT STANDARDS (July 1, 2022)

1.0 Applicability

- A. The standards listed below constitute minimum performance expectations applicable to “hydrologically-connected” VTrans roads in the Lake Champlain Basin portion of VTrans’ Transportation Separate Storm Sewer System (TS4)-permitted area. Road segments where associated culverts, swales, and/or closed drainage systems do not meet the standards outlined below, as detailed in the VTrans Generalized Phosphorus Control Plan, may be improved in order to meet the standards, restore function, and improve water quality. When road drainage asset conditions are improved to meet these standards, the improvements result in reduced sediment and phosphorus loading to surface waters and to Lake Champlain, and thus may be credited towards achievement of VTrans’ target phosphorus load reductions under the Vermont Lake Champlain Phosphorus TMDLs.

2.0 Feasibility

- A. VTrans may implement these standards to the extent feasible as one component of the overall Phosphorus Control Plan implementation strategy. In determining feasibility, VTrans may consider that the implementation of a standard or BMP listed in this document shall not require:
 - i. acquisition of additional state or federal permits or noncompliance with such permits;
 - ii. noncompliance with any other state or federal law;
 - iii. acquisition or condemnation of real property;
 - iv. impacts to significant environmental and historic resources, including historic stone walls, historic structures, historic landscapes, or vegetation within 250 feet of a lakeshore;
 - v. impacts to utilities; or
 - vi. excessive ledge removal.
- B. VTrans may document in an Implementation Table, or other data management and tracking system, each instance where feasibility constraints affect implementation of the standards.

3.0 Standards for Construction and Soil Disturbing Activities

- A. Following soil disturbance on a hydrologically-connected road segment, all bare or unvegetated areas shall be revegetated with seed and mulch, hydroseeded, or stone lined within 48 hours of reaching final grade. Activities shall follow the current version of the VTrans Erosion Prevention and Sediment Control (EPSC) Protocol,¹ as specified in the VTrans SWMP².

¹ <https://vtrans.vermont.gov/working/enviro/erosion-prevent>

² [https://anrweb.vt.gov/PubDocs/DEC/Stormwater/PublicNotice/7892-9007/VTrans_Final_SWMP - December 5 2017.pdf](https://anrweb.vt.gov/PubDocs/DEC/Stormwater/PublicNotice/7892-9007/VTrans_Final_SWMP_-_December_5_2017.pdf)

4.0 Standards for Travel Lanes, Shoulders, and Guardrails

A. Roadway Crown, Cross-slope, and Superelevation

- i. Roads shall be designed and constructed with appropriate crown, cross-slope, and superelevation during new construction, redevelopment, or repaving where repaving involves removal of the existing paving. Recommended cross slope is average 2%³⁴.

B. Roadway Shoulders

- i. Roadway runoff shall flow in a distributed manner to a vegetated or forested area.
- ii. There shall be no shoulder berms, except where installed to prevent slope failure or direct runoff away from steep slopes. Shoulder berms may be removed to allow precipitation to shed from the travel lane to a vegetated or forested area or into a road drainage system.
- iii. There shall be no evidence of a “secondary ditch”, or other erosion of the road shoulder. Where shoulder erosion is identified, it may be corrected to meet standards by implementing repairs including but not limited to those illustrated in the following standard details and related resources:
 - a. LE-5: Riprap Slope Protection
 - b. LE-6: Armored Shoulder Protection
 - c. District Maintenance and Fleet Division Work Activity Guidelines⁵:
 - a. 4570, Protecting Banks and Slopes (ton)
 - b. 4180, Maintaining Gravel Surfaces (lane miles)
 - c. 4360, Ditching (lin. foot)

C. Guardrails

- i. Where guardrails without curb board are present, the standards for Roadway Shoulders shall apply (Section 4.B).
- ii. Where guardrails with curbing, curb board, and/or drop inlets are present, the standards for Roadway Shoulders (Section 4.B), Culverts (Section 6.0), and Outlets and Turnouts (Section 7.0) shall apply as appropriate.
- iii. Guardrails shall be evaluated during the development process for VTrans construction projects, and curb removed if feasible per the following references:
 - a. Vermont Stormwater Management Manual Figure 6-1, Curb Removal (Detail)⁶
 - b. District Maintenance and Fleet Division Work Activity Guidelines for Activity 4480, Eliminating Guardrail (lin. foot)

³ https://vtrans.vermont.gov/sites/aot/files/highway/documents/publications/VTrans_Roadway_Design_Manual.zip

⁴ <https://vtrans.vermont.gov/sites/aot/files/highway/documents/publications/VermontStateDesignStandards.pdf>

⁵ MATS Complete Activity Book / Work Activity Guidelines document, updated September 2019; available via internal VTrans network or by request.

⁶ https://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/Permitinformation/2017_VSMM_Rule_and_Design_Guidance_04172017.pdf

- iv. If curb board is removed, the adjacent shoulder and slope must have adequate stabilization measures to handle the flows. In some cases, larger stone may be needed. Following curb board removal, the roadway draining to the guardrail and the downslope right-of-way area may be tracked and managed as a disconnection structural stormwater treatment practice.

5.0 Standards for Ditches

- A. If it is not possible for runoff to flow from the roadway in a distributed manner, runoff may enter a drainage ditch.
- B. Ditches adjacent to hydrologically connected road segments shall be constructed and maintained consistent with the standards and guidance provided in the VTrans Hydraulics Manual⁷ and the VTrans Highway System Ditching Best Management Practices (BMPs)⁸.
- C. Ditches identified in the TS4 Swales Inventory⁹ as being in “Critical” or “Poor” condition, or otherwise exhibiting bare soil, erosion, sediment accumulation, or substantial deficiencies in geometry (trapezoidal or parabolic cross section with mild side slopes of two feet horizontal per one foot vertical or flatter, 2-foot minimum ditch bottom width, and 2 foot ditch depth) do not meet standards.
- D. Best management practices that may be utilized to improve ditches to meet standards include but are not limited to those listed in Table 1.
- E. The listed BMPs may be supplemented with or replaced with armored shoulders, step pool conveyances, or sub-surface drainage practices as warranted. The following standard details and related references may also be utilized:
 - i. DD-3: Plunge Pool
 - ii. DD-4: Outlet Protection (No Defined Channel)
 - iii. DD-7: Rock Step and Riffle
 - iv. LE-1: Seed and Mulch Guidelines
 - v. LE-2: Stone Check Dam
 - vi. LE-3: Stone-Lined Ditch
 - vii. LE-4: Grass-Lined Ditch
 - viii. LE-7: Clearing Debris/Clogging
 - ix. District Maintenance and Fleet Division Work Activity Guidelines¹⁰:
 - a. 4360, Ditching (lin. ft.)

⁷ https://vtrans.vermont.gov/sites/aot/files/highway/documents/structures/VTrans_Hydraulics_Manual.pdf

⁸ https://vtrans.vermont.gov/sites/aot/files/DitchingBMP_FINAL_SIGNED_1_12_21.pdf

⁹ https://www.arcgis.com/home/webmap/viewer.html?url=https%3A%2F%2Fmaps.vtrans.vermont.gov%2Farcgis%2Frest%2Fservices%2FHWY%2FMOB_EPWQ_TS4_Inventory%2FFeatureServer&source=sd

¹⁰ MATS Complete Activity Book / Work Activity Guidelines document, updated September 2019; available via internal VTrans network or by request.

Table 1. Summary of Ditch and Outlet Protection Treatments

Ditch or Outlet Slope	Acceptable Treatments						
	Seed & Mulch*	Hydro-seeding*	Rolled Erosion Control Product Type I (Natural) Matting & Seed	Rolled Erosion Control Product Type II (Permanent)	Stone Check Dam	Type I Stone	Type II Stone
0 - 2.5%	X	X	X				
2.5 - 5%	X	X	X	X			
5 - 10%	X	X	X	X	X	X	
> 10%		X	X	X	X		X

* Treatment not recommended for application in areas of concentrated flow

6.0 Standards for Culverts (Ultra Short and some Short Structures)

- A. If it is not possible for runoff to flow from the roadway in a distributed manner, runoff may enter and flow through a culvert.
- B. VTrans cross culverts or lateral culverts adjacent to hydrologically connected road segments shall be constructed and maintained consistent with the standards and guidance provided in the VTrans Hydraulics Manual or other applicable design guidance.
- C. VTrans culverts identified in the AMB Small Culverts Inventory (Ultra-Short Structures) as exhibiting one or more of the following asset conditions, or otherwise exhibiting bare soil, erosion, sediment accumulation, or other substantial deficiencies that may impact water quality, do not meet standards:
 - i. Culvert condition = critical or poor
 - ii. Culvert erosion = severe or moderate
 - iii. Culvert sediment = plugged or heavy
 - iv. Culvert sink hole = severe or major
 - v. Road settling = grade
- D. VTrans culverts identified in the AMB Short Structures Inventory as exhibiting one or more of the following asset conditions, or otherwise exhibiting bare soil, erosion, sediment accumulation, or other substantial deficiencies that may impact water quality, do not meet standards:
 - i. Channel and Channel Protection = condition rating of 5 or lower
 - ii. Culverts = condition rating of 5 or lower
 - iii. Culvert Wing/Header Rating = condition rating of 5 or lower
- E. Best management practices that may be utilized to improve VTrans culverts to meet standards include but are not limited to:
 - i. Culvert end treatment or headwall, if erosion is due to absence of these structures and the treatment can be installed while maintaining the safety of the traveling public (standard detail DD-1 Dry Laid Field Stone Header)
 - ii. Stabilize outlet such that there will be no scour erosion (standard details DD-3 Plunge Pool, DD-4 Outlet Protection, DD-7 Rock Step and Riffle) . Stone aprons

or plunge pools required for new construction on slopes 5% or greater per the VTrans Hydraulics Manual¹¹

- iii. Upgrade to 18” culvert (minimum) if erosion is due to inadequate size or absence of structure (standard details DD-2 Culvert Replacement, DD-5 Upsize Culvert, DD-6 Partial Culvert Replacement)
 - iv. District Maintenance and Fleet Division Work Activity Guidelines¹²:
 - a. 4610, Maintaining Culverts (culvert)
 - b. 4620, Installing Culverts (lin. foot)
 - c. 4640, Stormwater/Drainage Work (each)
 - d. 5130, Repairing Structures (each)
 - e. 5150, Repairing Culvert Headwalls (each)
 - f. 5170, Small Structures Culvert Liners (lin. foot)
 - g. 5171, Small Structures Culvert Invert (lin. foot)
 - h. 5172, Small Structures Replacement (lin. foot)
 - i. 4640, Maintaining Drainage Structures (each)
 - v. Where feasible, culverts shall be installed, repaired, or replaced with minimal slope (1%) to reduce outlet velocity and outlet erosion.
- F. In some instances, intermittent streams enter the VTrans road drainage network. In these cases, culvert sizing may be based on the VTrans Hydraulics Manual¹¹. VTrans culverts conveying perennial waters are not subject to the DEC Stream Alteration General Permit, and instead are subject to Title 19 consultation¹³ if alterations are considered.
- G. An underdrain (also called a French Drain) sub-surface drainage practice may be substituted for a VTrans lateral culvert.
- H. Driveway Culverts within the VTrans ROW
- i. All driveway culverts, and their construction and maintenance within the VTrans ROW, are the responsibility of the property owner. Driveway culverts and other aspects of residential and commercial access to the VTrans ROW are permitted through the VTrans State Highway Access and Work Permit¹⁴, and as specified in the VTrans TS4 SWMP .
 - ii. Access to a state highway shall be constructed and maintained by property owners consistent with minimum VTrans standards for driveway access (Standard B-71a¹⁵ or B-71b¹⁶)
 - iii. VTrans may consider the following recommended BMPs as permit conditions

¹¹ https://vtrans.vermont.gov/sites/aot/files/highway/documents/structures/VTrans_Hydraulics_Manual.pdf

¹² MATS Complete Activity Book / Work Activity Guidelines document, updated September 2019; available via internal VTrans network or by request.

¹³ <https://vtrans.vermont.gov/environmental-manual/permitting/wetlands/stream-alteration>

¹⁴ <https://vtrans.vermont.gov/planning/permitting>

¹⁵ <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdb71a.pdf>

¹⁶ <https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/English/PDF/stdb71b.pdf>

during review of VSA Title 19 Section 1111 Permit applications for alterations to existing access points:

- a. Culvert end treatment recommended for areas with slopes of 5% or greater if erosion is due to absence of these structures.
 - b. Stabilize outlet such that there will be no scour erosion if erosion is due to absence or inadequacy of outlet stabilization.
 - c. Upgrade to minimum 15” culvert, if erosion is due to inadequate size or absence of structure.
- iv. VTrans may review issued VSA Title 19 Section 1111 Permits during VTrans project development¹⁷. If a driveway culvert in the VTrans ROW has not been issued an 1111 Permit, the property owner may be required to obtain the appropriate permit for access and to make improvements consistent with permit conditions. Otherwise, the access may be considered abandoned and be eliminated during the project’s construction phase.

7.0 Standards for Outlets and Turnouts

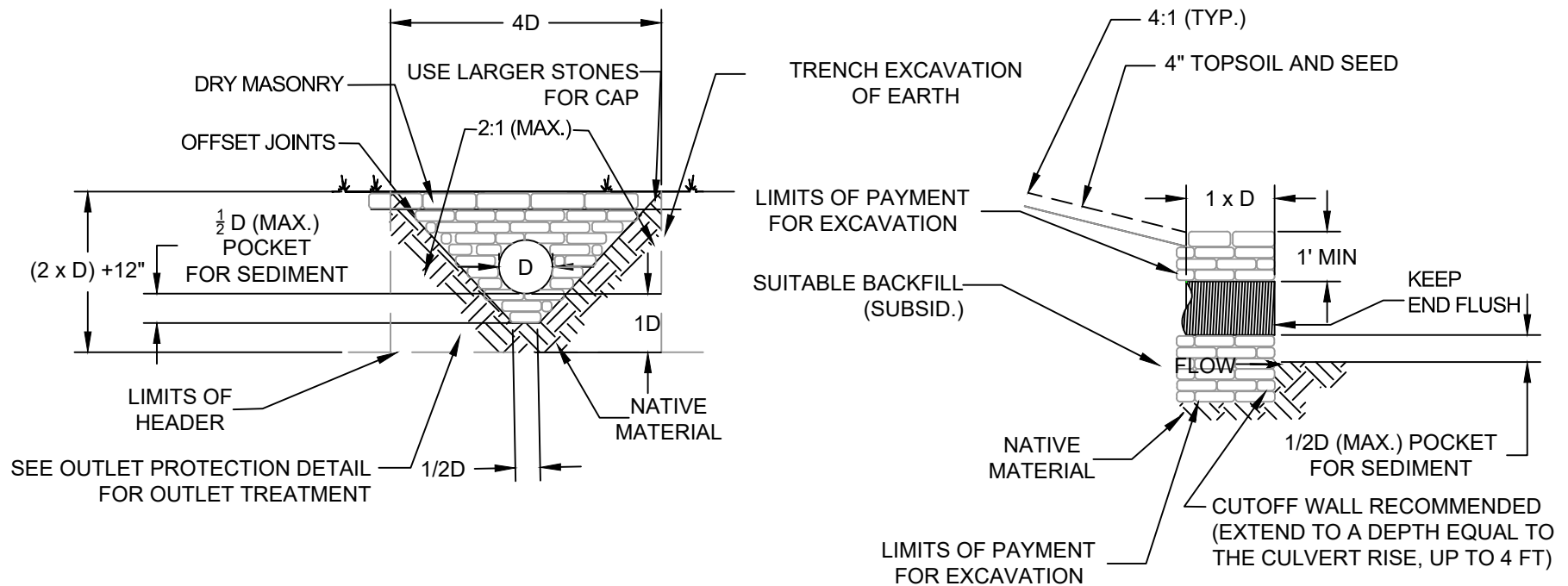
- A. Roadway drainage shall be disconnected from or turned out to avoid direct outlet to waterbodies and defined channels where feasible. Hydrologically-connected drop inlet and closed drainage system outlets, culvert and ditch outlets, turnouts, and conveyance areas shall be constructed and maintained consistent with the standards and guidance provided in the VTrans Hydraulics Manual¹⁸ or other applicable design guidance.
- B. Adequate outlet protection must be provided at the outlet or turnout, consistent with slope ranges provided in Table 1. Outlet and turnout slopes shall be measured on the bank where the practice is located.
- C. Closed drainage or culvert outlets, ditch outlets, or turnouts exhibiting bare soil, erosion, or sediment accumulation do not meet standards. Best management practices that may be utilized to meet standards include but are not limited to those listed for ditches in Table 1. The listed BMPs may be supplemented with or replaced with level spreaders, plunge pools (standard detail DD-3), step pool conveyances (standard detail DD-7) or other BMPs as warranted.

¹⁷ <https://vtrans.vermont.gov/sites/aot/files/highway/documents/publications/PDManual.pdf>

¹⁸ [https://vtrans.vermont.gov/sites/aot/files/highway/documents/structures/VTrans Hydraulics Manual.pdf](https://vtrans.vermont.gov/sites/aot/files/highway/documents/structures/VTrans_Hydraulics_Manual.pdf)

NOTES:

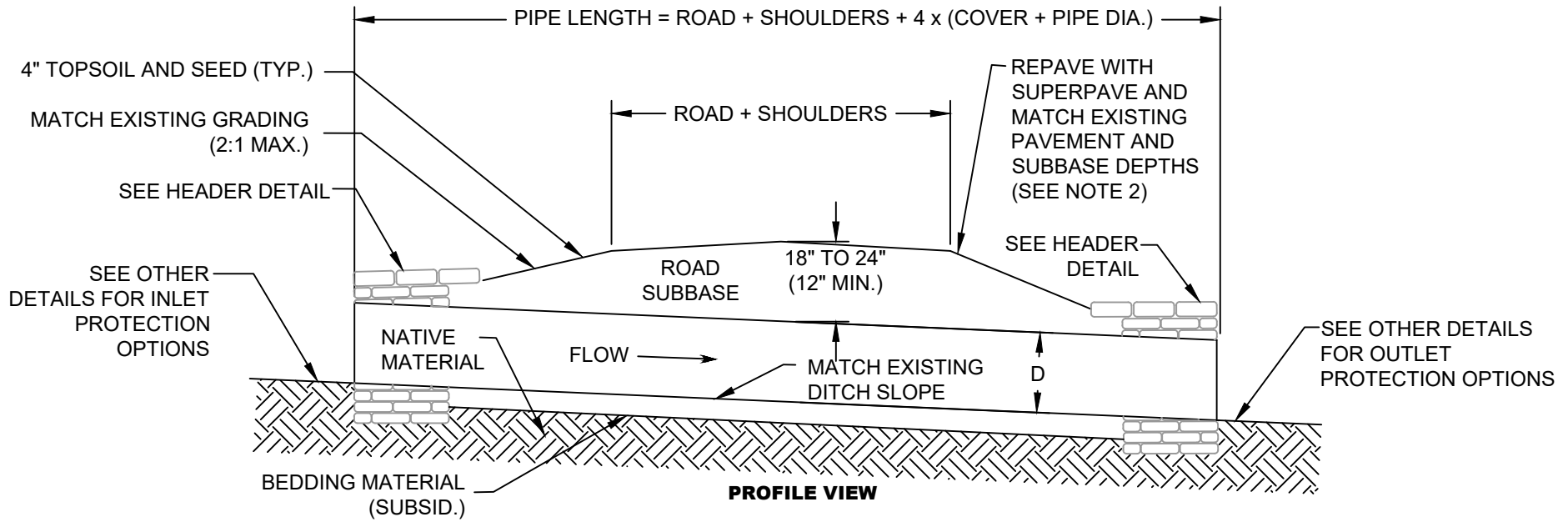
1. DRY LAID FIELD STONE HEADERS ARE RECOMMENDED. SEE VTRANS STANDARD DETAILS D-33 AND D-34 FOR REINFORCED CONCRETE HEADWALL OPTIONS.
2. PRIOR TO INSTALLATION OF A HEADER TO A CULVERT END, DESIGNER SHALL REVIEW THE VTRANS HYDRAULICS MANUAL SECTION 6.4.3.5 TO DETERMINE PROPER PIPE END TREATMENT.
3. EXISTING NATIVE MATERIAL SHALL BE USED AS BACKFILL UNLESS UNSUITABLE MATERIAL IS DISCOVERED DURING EXCAVATION AND PLACEMENT OF HEADER. UNSUITABLE MATERIAL SHALL BE REMOVED AND REPLACED WITH APPROVED MATERIAL PER VTRANS STANDARD SPECIFICATIONS.



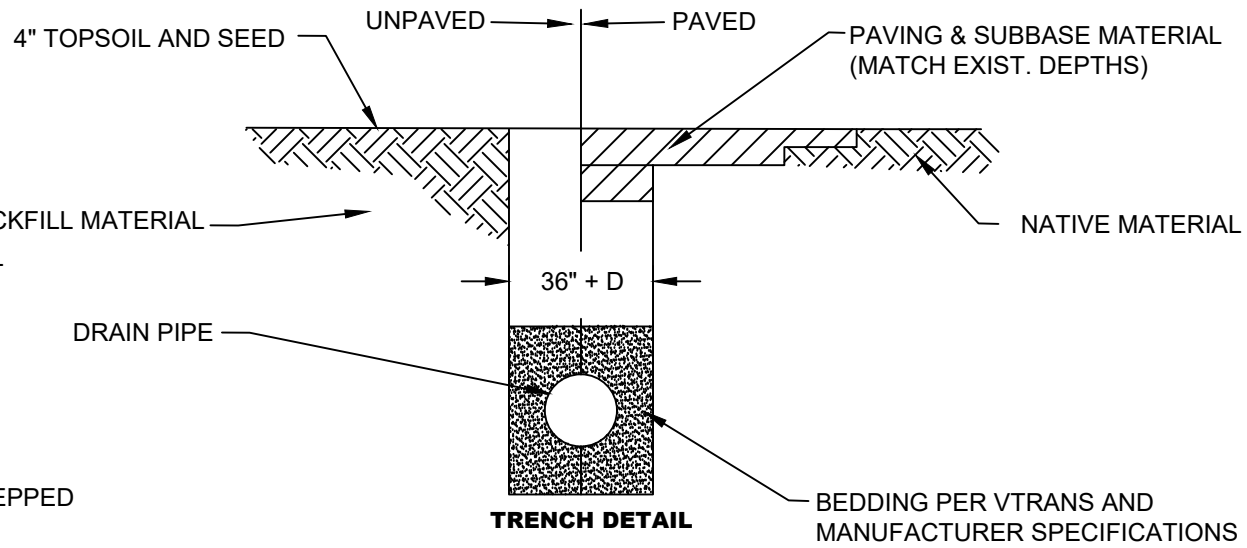
DRY LAID FIELD STONE HEADER DETAIL

Not To Scale





PROFILE VIEW



TRENCH DETAIL

NOTES:

1. EXISTING NATIVE MATERIAL SHALL BE USED AS BACKFILL UNLESS UNSUITABLE MATERIAL IS DISCOVERED DURING EXCAVATION AND PLACEMENT OF HEADER. UNSUITABLE MATERIAL SHALL BE REMOVED AND REPLACED WITH APPROVED MATERIAL PER VTRANS STANDARD SPECIFICATIONS.
2. SUPERPAVE SHALL BE UTILIZED MATCHING EXISTING PAVEMENT DEPTHS. PAVEMENT COURSES SHALL BE STEPPED TO AVOID A SINGLE PAVEMENT JOINT AND EMULSIFIED ASPHALT SHALL BE USED PER VTRANS STANDARD SPECIFICATIONS.

CULVERT REPLACEMENT DETAIL

Not To Scale

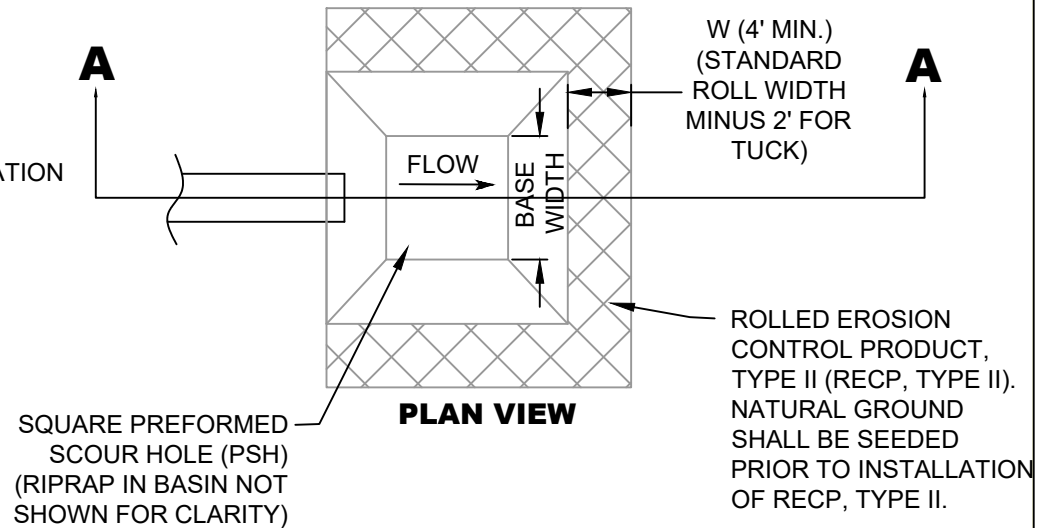
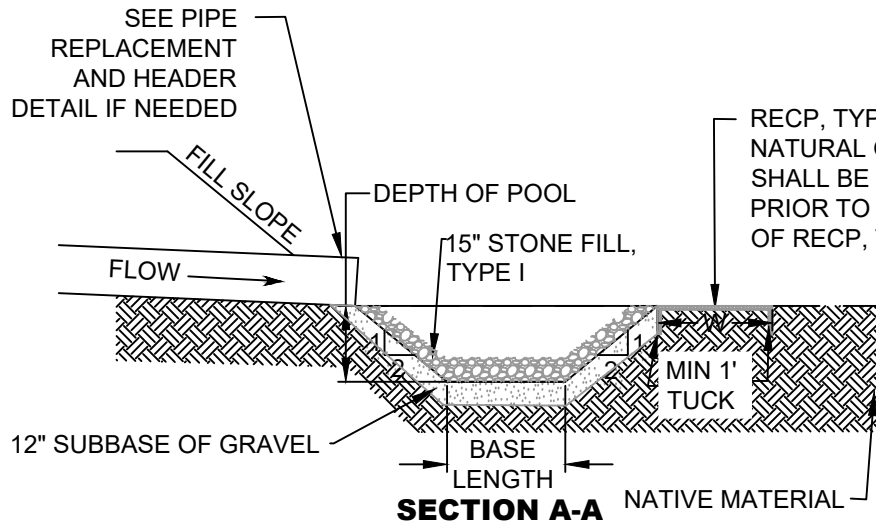
TABLE 1

PIPE SIZE/FLOW	BASE WIDTH (W) (FT)	BASE LENGTH (L) (FT)	DEPTH OF POOL (FT)	L:W RATIO
PIPE <= 18" DIA AND FLOWS <= 9 CFS	3 x D	3 x D	1' MIN/3' MAX	1:1
PIPE > 18" DIA AND FLOWS > 9 CFS	SEE TABLE 2	SEE TABLE 2	3' MIN/5' MAX	2:1 MIN/6:1 MAX

TABLE 2

PIPE SIZE/FLOW	IMPERVIOUS AREA (SF)	CALCULATED VOLUME (CF)	BASE WIDTH (W) (FT)	BASE LENGTH (L) (FT)	DEPTH OF POOL (FT)	ACTUAL VOLUME (CF)
PIPE > 18" DIA AND FLOWS > 9 CFS	LESS THAN 60,000	500	4	8	3	512
	BETWEEN 60,000 AND 110,000	917	4	8	4	939
	BETWEEN 110,000 AND 180,000	1500	4	8	5	1547

IMPERVIOUS AREA DRAINING TO PRACTICE.
 SIZE IS BASED ON VOLUME ASSOCIATED WITH 0.1 IN OF RUNOFF FOR THE IMPERVIOUS AREA WITHIN THE CONTRIBUTING DRAINAGE AREA



NOTES:

- EXISTING NATIVE MATERIAL SHALL BE USED AS BACKFILL UNLESS UNSUITABLE MATERIAL IS DISCOVERED DURING EXCAVATION AND PLACEMENT OF PLUNGE POOL. UNSUITABLE MATERIAL SHALL BE REMOVED AND REPLACED WITH APPROVED MATERIAL PER VTRANS STANDARD SPECIFICATIONS.
- PLUNGE POOLS SHALL BE LIMITED TO AREAS WITH <10% SLOPE.
- THE GRAVEL LAYER SHALL BE REPLACED WITH FILTER FABRIC IN CLAY AND SILT SOILS.
- PLUNGE POOLS SHALL BE INSTALLED WHERE EXISTING STORMWATER HAS ERODED A HOLE IN THE NATIVE MATERIAL AT THE PIPE OUTLET. PLUNGE POOLS CAN NOT BE INSTALLED ON SLOPES.
- PLUNGE POOLS SHALL BE CONSTRUCTED IN UNDISTURBED SOILS INSTEAD OF IN FILL MATERIAL.
- PLUNGE POOLS SHALL BE CONSTRUCTED OUTSIDE OF CLEAR RECOVERY ZONES AND ENVIRONMENTALLY SENSITIVE AREAS AND SHALL BE DESIGNED PER THE VERMONT STORMWATER TREATMENT STANDARDS.

PLUNGE POOL DETAIL

Not To Scale

FIGURE NO.

3

STONE ENVIRONMENTAL

535 Stone Cutters Way / Montpelier / VT / 05602 / USA
 802.229.4541 / info@stone-env.com / www.stone-env.com

Hoyle, Tanner & Associates, Inc.

125 College Street, 4th Floor
 Burlington, Vermont 05401
 802-860-1331
 802-860-6499 fax
 www.hoyletanner.com

VERMONT

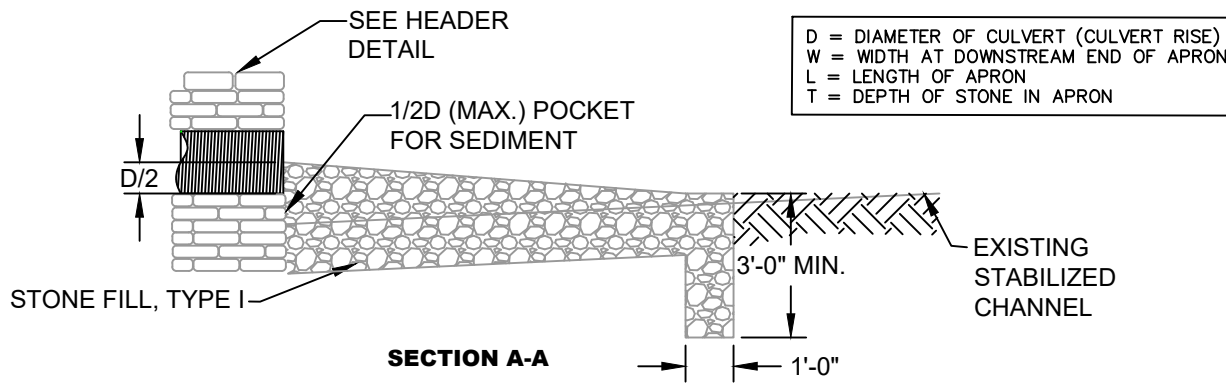
AGENCY OF TRANSPORTATION

DRAINAGE DEFICIENCIES
 PLUNGE POOL DETAIL
 PCP IMPLEMENTATION PLAN

VERMONT

DRAWING CREDITS

Drawn On:	8/19/2020
Drawn By:	MMI
Checked On:	8/19/2020
Checked By:	AGB
Project No.:	18-008-C



D = DIAMETER OF CULVERT (CULVERT RISE)
 W = WIDTH AT DOWNSTREAM END OF APRON
 L = LENGTH OF APRON
 T = DEPTH OF STONE IN APRON

TABLE 1: STONE FILL TYPE REQUIRED AT CULVERT OUTLETS

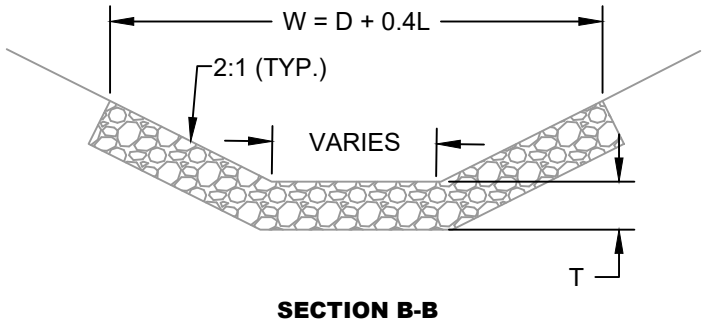
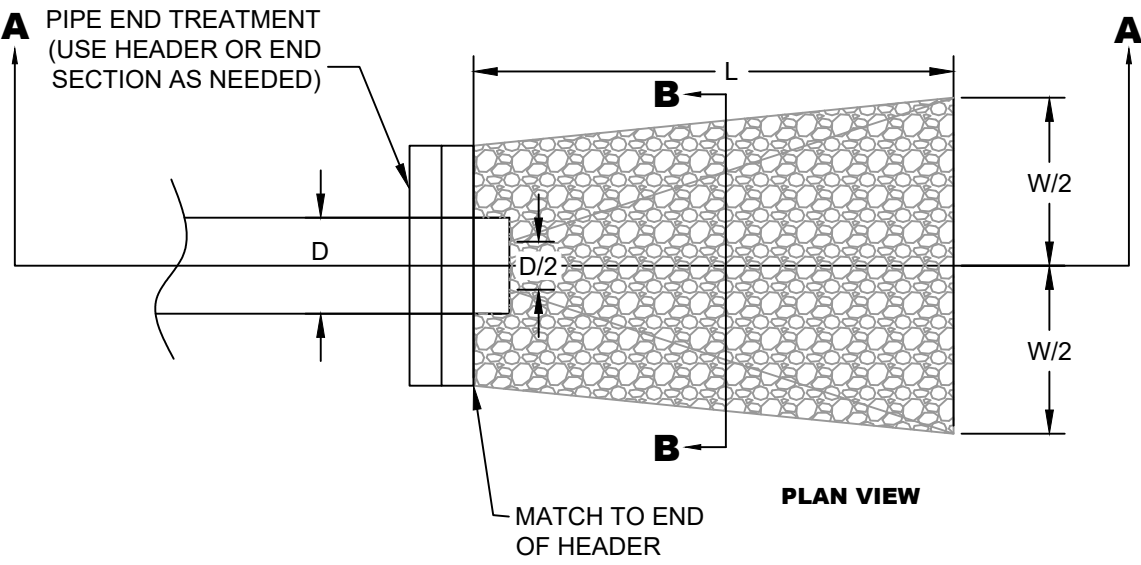
CULVERT RISE (FT)	DESIGN DISCHARGE (CFS)			
	10	20	30	40
2	I	II	II	IV
3	I	I	II	II
4	I	I	I	I

SEE VTRANS HYDRAULICS MANUAL FOR ADDITIONAL PIPE SIZE AND DISCHARGE OPTIONS (TABLE 6-4)

TABLE 2: STONE APRON DIMENSIONS AT CULVERT OUTLETS WITH COMMERCIAL END SECTIONS

STONE FILL TYPE	D ₅₀	APRON LENGTH	APRON DEPTH
	(IN)	(L) (FT)	(T) (FT)
TYPE I	4	4 x D	1.2
TYPE II	12	5.5 x D	2.3
TYPE III	16	6.5 x D	2.8
TYPE IV	20	7 x D	3.3

NOTE: FOR CULVERTS WITHOUT COMMERCIAL END SECTIONS, ADD AN ADDITIONAL 3 FT ONTO THE APRON LENGTH
 REFERENCE: VTRANS HYDRAULICS MANUAL

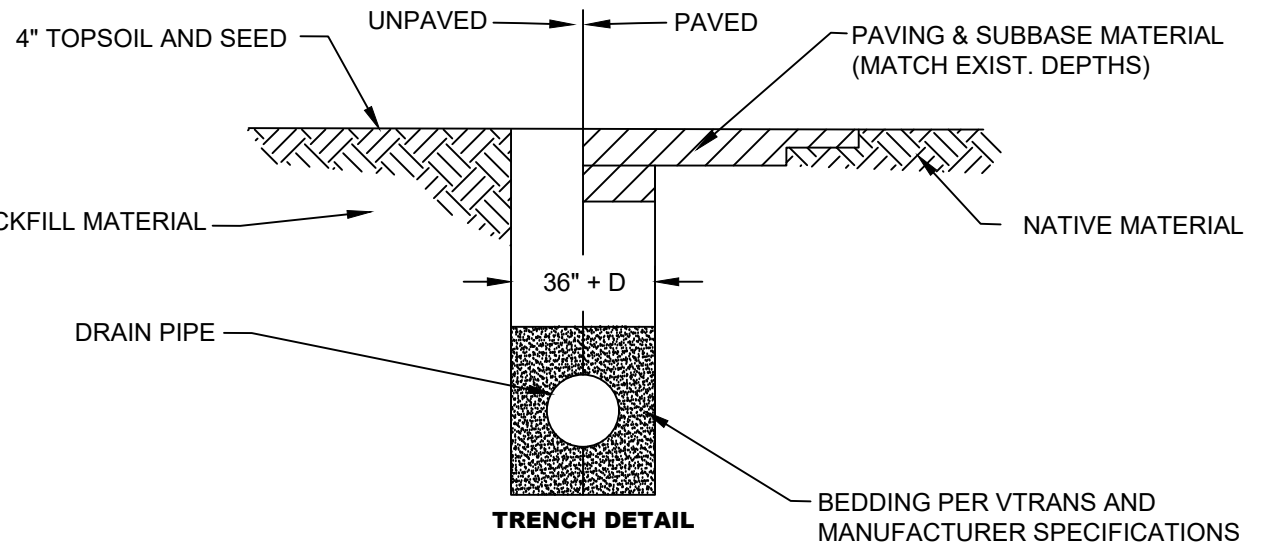
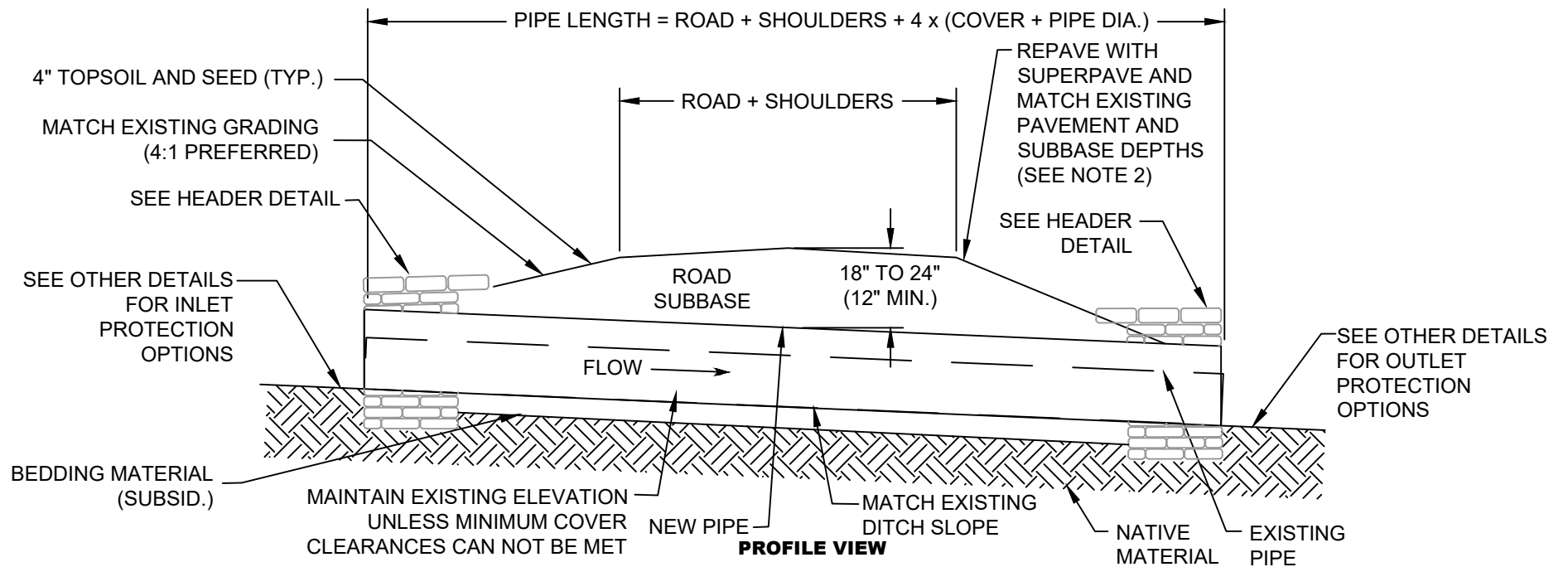


OUTLET PROTECTION DETAIL (NO DEFINED CHANNEL)

Not To Scale

- NOTES:
1. MINIMUM LENGTH (L) SHALL BE A DISTANCE EQUAL TO THE CULVERT RISE UPSTREAM OR DOWNSTREAM.
 2. ENERGY DISSIPATORS SHALL BE UTILIZED IF EXISTING OUTLET HAS EROSION OF AN EXISTING STONE OUTLET PROTECTION AREA. SEE VTRANS STANDARD DETAIL D-16 FOR ADDITIONAL INFORMATION ON ENERGY DISSIPATORS FOR CULVERTS.
 3. IF FLOW THROUGH CULVERT IS CAUSING EROSION TO AN EXISTING ENERGY DISSIPATER AS DESIGNED BY VTRANS STANDARD DETAIL D-16, REVISED OUTLET PROTECTION AND ENERGY DISSIPATERS SHALL BE DESIGNED IN ACCORDANCE WITH THE DESIGN GUIDELINES PUBLISHED IN FHWA'S HEC-14, "HYDRAULIC DESIGN OF ENERGY DISSIPATERS FOR CULVERTS AND CHANNELS."

4	<p>STONE ENVIRONMENTAL</p> <p>535 Stone Cutters Way / Montpelier / VT / 05602 / USA 802.229.4541 / info@stone-env.com / www.stone-env.com</p>	<p>Hoyle, Tanner & Associates, Inc.</p> <p>125 College Street, 4th Floor Burlington, Vermont 05401 802-860-1331 802-860-6499 fax www.hoyletanner.com</p>	<p>VERMONT AGENCY OF TRANSPORTATION</p>	<p>DRAINAGE DEFICIENCIES OUTLET PROTECTION DETAIL PCP IMPLEMENTATION PLAN</p> <p>VERMONT</p>	<p style="writing-mode: vertical-rl; transform: rotate(180deg);">DRAWING CREDITS</p>	<p>Drawn On: 8/19/2020 Drawn By: MMI Checked On: 8/19/2020 Checked By: AGB Project No.: 18-008-C</p>
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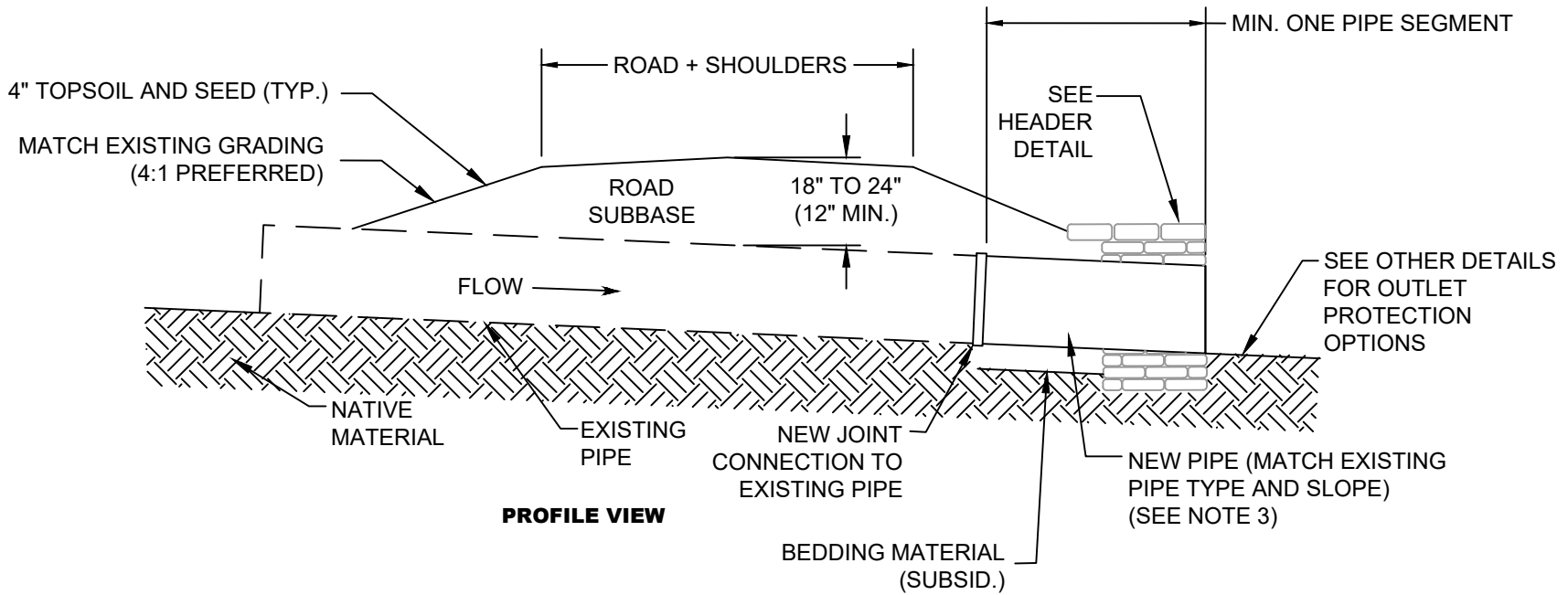


NOTES:

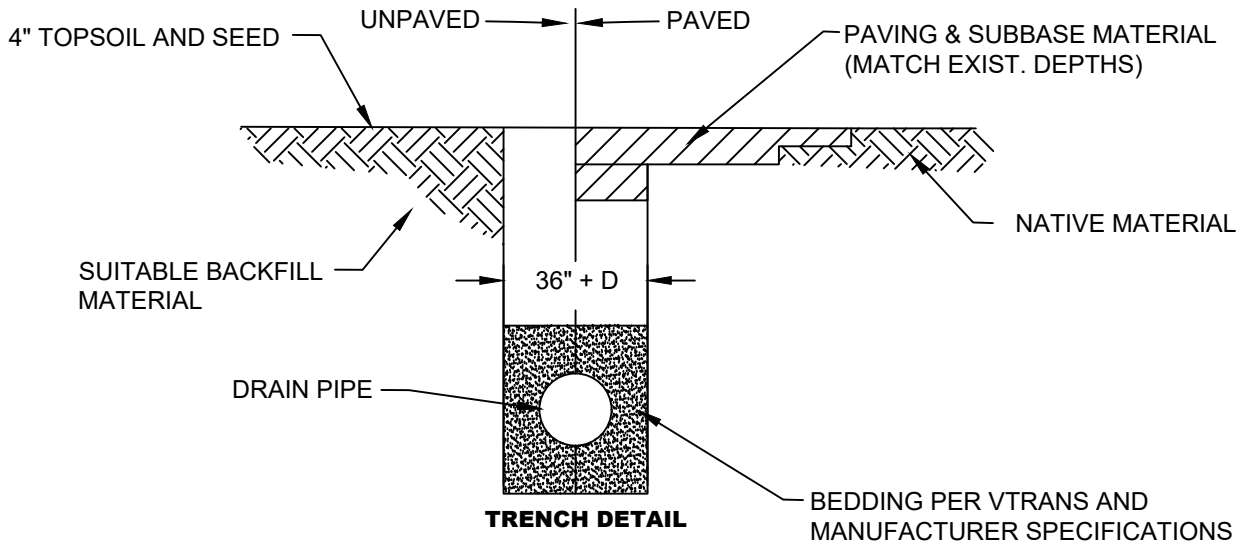
1. EXISTING NATIVE MATERIAL SHALL BE USED AS BACKFILL UNLESS UNSUITABLE MATERIAL IS DISCOVERED DURING EXCAVATION AND PLACEMENT OF PIPE. UNSUITABLE MATERIAL SHALL BE REMOVED AND REPLACED WITH APPROVED MATERIAL PER VTRANS STANDARD SPECIFICATIONS.
2. SUPERPAVE SHALL BE UTILIZED MATCHING EXISTING PAVEMENT DEPTHS. PAVEMENT COURSES SHALL BE STEPPED TO AVOID A SINGLE PAVEMENT JOINT AND EMULSIFIED ASPHALT SHALL BE USED PER VTRANS SPECIFICATIONS.

UPSIE CULVERT DETAIL
Not To Scale





PROFILE VIEW



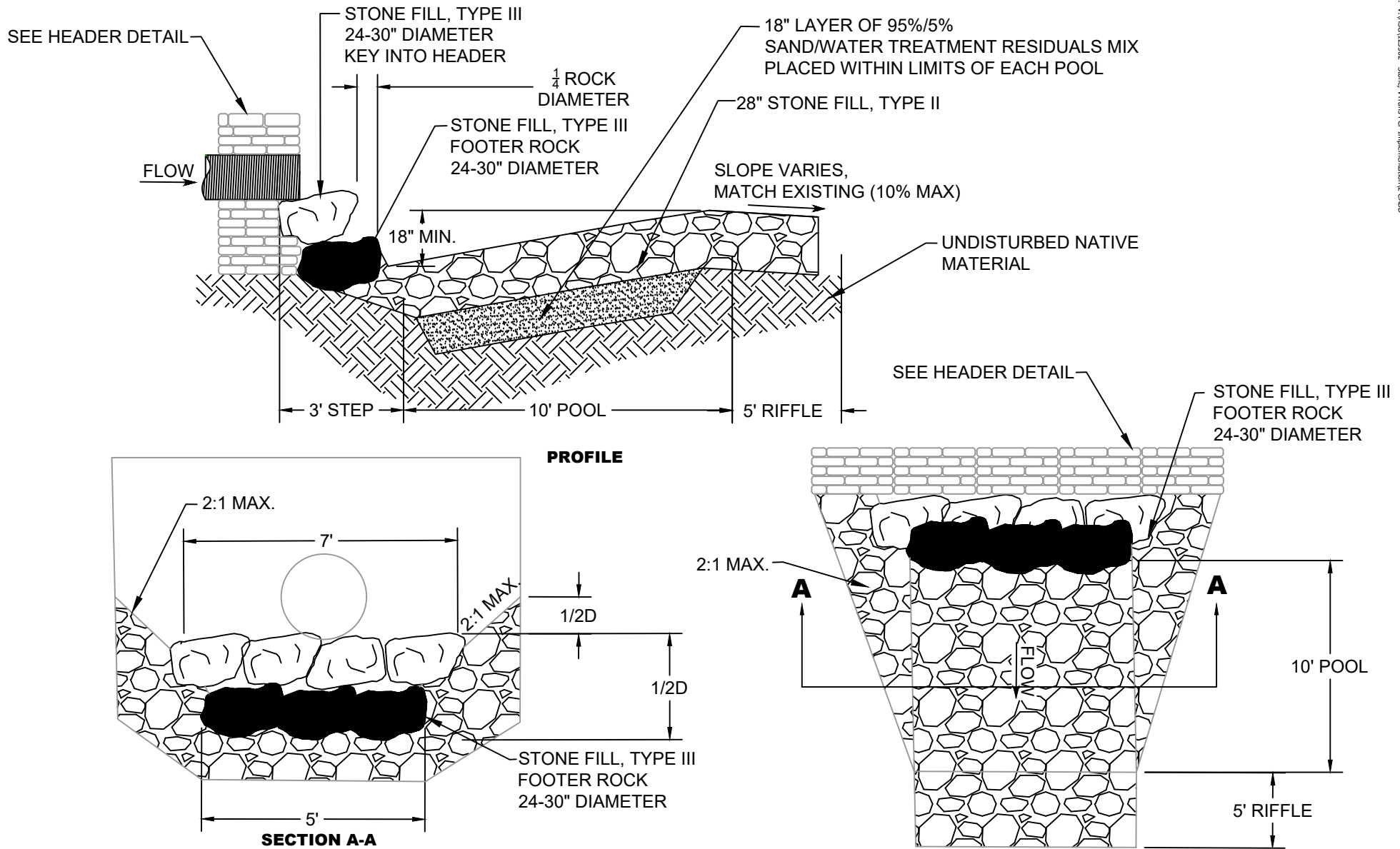
TRENCH DETAIL

- NOTES:
1. EXISTING NATIVE MATERIAL SHALL BE USED AS BACKFILL UNLESS UNSUITABLE MATERIAL IS DISCOVERED DURING EXCAVATION AND PLACEMENT OF PIPE. UNSUITABLE MATERIAL SHALL BE REMOVED AND REPLACED WITH APPROVED MATERIAL PER VTRANS STANDARD SPECIFICATIONS.
 2. SUPERPAVE SHALL BE UTILIZED MATCHING EXISTING PAVEMENT DEPTHS. PAVEMENT COURSES SHALL BE STEPPED TO AVOID A SINGLE PAVEMENT JOINT AND EMULSIFIED ASPHALT SHALL BE USED PER VTRANS SPECIFICATIONS.
 3. PARTIAL CULVERT REPLACEMENTS SHALL ONLY BE USED FOR PLASTIC OR RC PIPES. CORRUGATED METAL PIPES SHOULD BE FULLY REPLACED.

PARTIAL CULVERT REPLACEMENT DETAIL

Not To Scale

<p style="writing-mode: vertical-rl; transform: rotate(180deg);">FIGURE NO.</p> <h1 style="font-size: 48px; margin: 0;">9</h1>	<p>STONE ENVIRONMENTAL</p> <p style="font-size: 8px;">535 Stone Cutters Way / Montpelier / VT / 05602 / USA 802.229.4541 / info@stone-env.com / www.stone-env.com</p>	<p>Hoyle, Tanner & Associates, Inc.</p> <p style="font-size: 8px;">125 College Street, 4th Floor Burlington, Vermont 05401 802-860-1331 802-860-6499 fax www.hoyletanner.com</p>	<p>VERMONT AGENCY OF TRANSPORTATION</p>	<p>DRAINAGE DEFICIENCIES PARTIAL REPLACEMENT DETAIL PCP IMPLEMENTATION PLAN</p> <p>VERMONT</p>	<p style="writing-mode: vertical-rl; transform: rotate(180deg);">DRAWING CREDITS</p> <table border="1" style="width: 100%; border-collapse: collapse; font-size: 8px;"> <tr><td>Drawn On: 8/19/2020</td></tr> <tr><td>Drawn By: MMI</td></tr> <tr><td>Checked On: 8/19/2020</td></tr> <tr><td>Checked By: AGB</td></tr> <tr><td>Project No.: 18-008-C</td></tr> </table>	Drawn On: 8/19/2020	Drawn By: MMI	Checked On: 8/19/2020	Checked By: AGB	Project No.: 18-008-C
Drawn On: 8/19/2020										
Drawn By: MMI										
Checked On: 8/19/2020										
Checked By: AGB										
Project No.: 18-008-C										



NOTES:

1. DETAIL CAN BE USED IN SUCCESSION AS NEEDED.

ROCK STEP AND RIFFLE DETAIL

Not To Scale



DITCH GUIDELINES

LONGITUDINAL SLOPE (S) RANGE	APPROPRIATE DITCH TREATMENTS
0% < S < 5%	GRASS-LINED DITCH
5% ≤ S < 8%	GRASS-LINED DITCH WITH STONE CHECK DAMS
	GRASS-LINED DITCH WITH DISCONNECTION PRACTICES
	STONE-LINED DITCH
8% ≤ S < 10%	STONE-LINED DITCH (6" TO 8" MINUS STONE)
10% ≤ S	STONE-LINED DITCH (12" MINUS STONE)

NOTES:

1. GRASS-LINED DITCHES SHALL BE INSTALLED WHENEVER POSSIBLE AND WHENEVER GRASS CAN BE ESTABLISHED NO MATTER THE SLOPE.
2. IF GRASS CANNOT BE ESTABLISHED ON SLOPES LESS THAN 5%, STONE-LINED DITCHES SHALL BE INSTALLED.
3. FOR ADDITIONAL SEEDING INFORMATION SEE VTRANS EPSC TURF ESTABLISHMENT DETAIL.

CULVERT GUIDELINES

NOTES:

1. REPLACE CULVERTS WITH THE SAME SIZE PIPE IF IT IS HANDLING THE FLOW ADEQUATELY.
2. INCREASE CULVERT SIZE AS DEVELOPMENT ALONG A ROAD INCREASES OR IF THE CULVERT IS MORE THAN HALF FULL DURING HIGH FLOWS.

SEED MIXTURES

MIXTURES	'RATE PER ACRE (LBS)	RATE PER 1,000 SF (LBS)
A. BIRDSFOOT TREFOIL OR LADINO CLOVER*	8	0.20
TALL FESCUE OR SMOOTH BROMEGRASS	20	0.45
REDTOP**	2	0.05
	<hr/> 30	<hr/> 0.70
OR		
B. KENTUCKY BLUEGRASS***	25	0.60
CREEPING RED FESCUE	20	0.50
PERENNIAL RYEGRASS	10	0.20
	<hr/> 55	<hr/> 1.30

REFERENCE: THE VERMONT STANDARDS AND SPECIFICATIONS FOR EROSION PREVENTION & SEDIMENT CONTROL 2019.

- * INOCULATE WITH APPROPRIATE INOCULUM IMMEDIATELY PRIOR TO SEEDING. LADINO OR COMMON WHITE CLOVER MAY BE SUBSTITUTED FOR BIRDSFOOT TREFOIL AND SEEDED AT THE SAME RATE.
- ** PERENNIAL RYEGRASS MAY BE SUBSTITUTED FOR THE REDTOP BUT INCREASE SEEDING RATE TO 5 LBS/ACRE (0.1 LB/1,000 SF).
- *** USE THIS MIXTURE IN AREAS WHICH ARE MOWED FREQUENTLY. COMMON WHITE CLOVER MAY BE ADDED IF DESIRED AND SEEDED AT 8 LBS/ACRE (0.2 LB/1,000 SF).

GUIDELINES, SEED AND MULCH DETAIL

Not To Scale

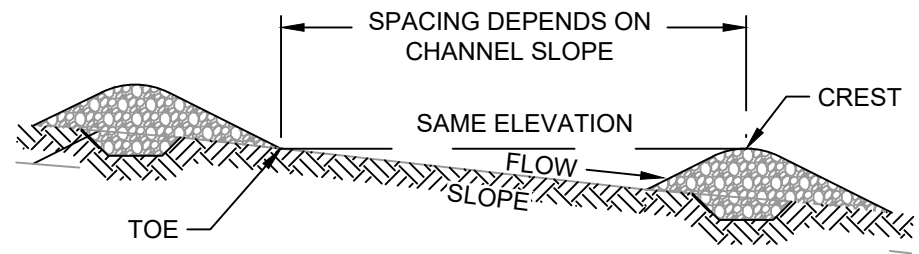
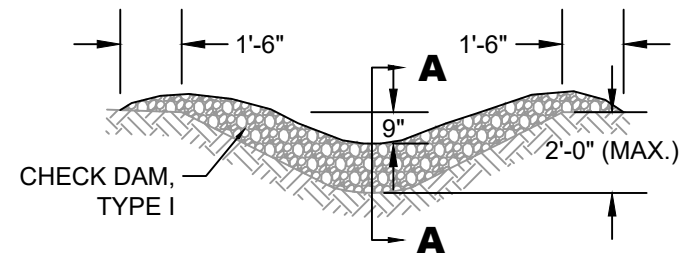
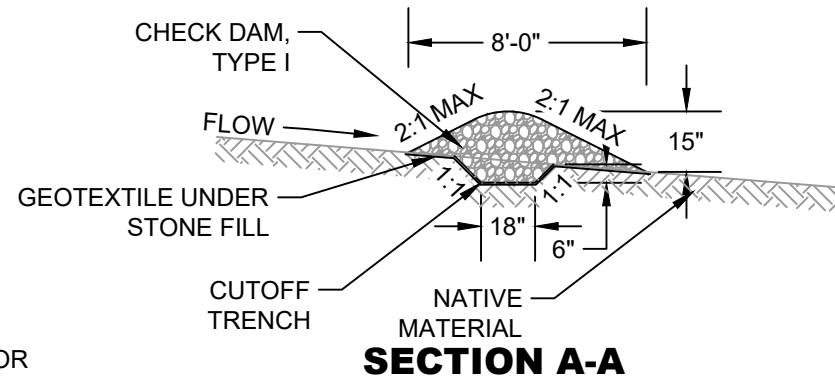


NOTES:

1. STONE WILL BE PLACED ON A FILTER FABRIC FOUNDATION.
2. SET SPACING OF CHECK DAMS TO ASSUME THAT THE ELEVATIONS OF THE CREST OF THE DOWNSTREAM DAM IS AT THE SAME ELEVATION OF THE TOE OF THE UPSTREAM DAM.
3. CHECK DAMS SHALL NOT BE INSTALLED IN LIVE STREAMS OR CHANNELS.
4. EXTEND THE STONE A MINIMUM OF 1.5 FEET BEYOND THE DITCH BANKS TO PREVENT CUTTING AROUND THE DAM.
5. ENSURE THAT CHANNEL APPURTENANCES SUCH AS CULVERT ENTRANCES BELOW CHECK DAMS ARE NOT SUBJECT TO DAMAGE OR BLOCKAGE FROM DISPLACED STONE.
6. MAXIMUM DRAINAGE AREA IS 2 ACRES.

MAINTENANCE:

1. REMOVE SEDIMENT ACCUMULATED BEHIND THE DAM AS NEEDED TO ALLOW CHANNEL TO DRAIN THROUGH THE STONE CHECK DAM AND PREVENT LARGE FLOWS FROM CARRYING SEDIMENT OVER THE DAM. IF SIGNIFICANT EROSION OCCURS BETWEEN CHECK DAMS, A LINER OF STONE SHOULD BE INSTALLED.

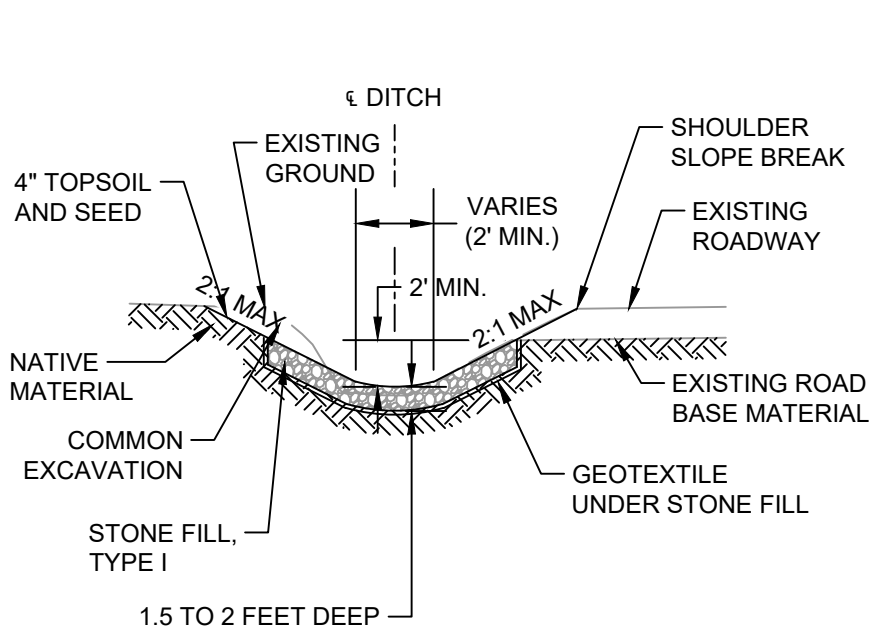


SPACING BETWEEN CHECK DAMS
STONE CHECK DAM DETAIL
Not To Scale

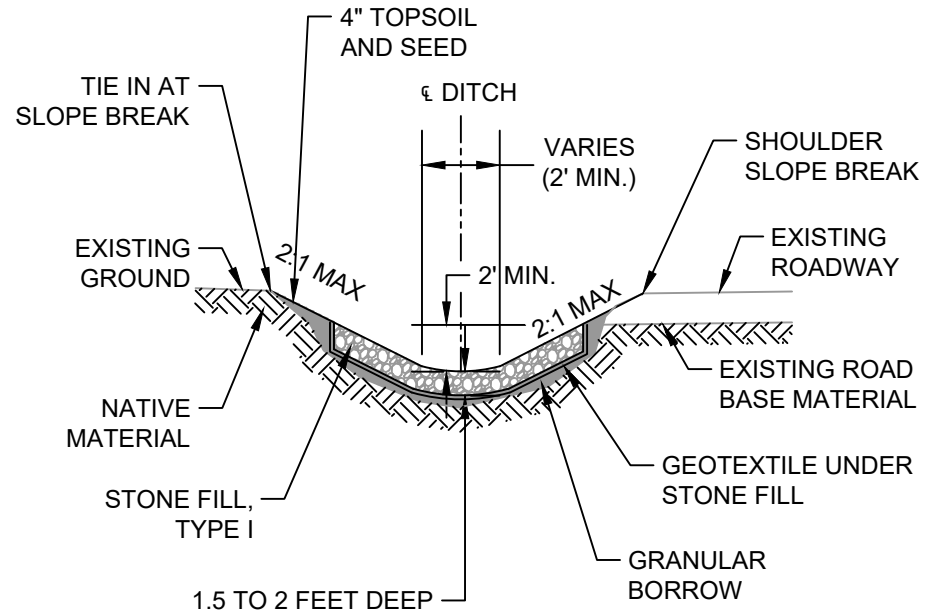
SAMPLE SPACING FOR 2' HIGH CHECK DAMS	
SLOPE	SPACING
1%	200
2%	100
5%	40
8%	25
10%	20

NOTES:

1. SEE SEED AND MULCH DETAIL FOR SEEDING MIXTURE.
2. THE MAXIMUM CAPACITY OF THE WATERWAY FLOWING AT DESIGN DEPTH SHALL NOT EXCEED 100 CUBIC FEET PER SECOND.
3. THE MINIMUM CAPACITY SHALL BE ADEQUATE TO CARRY THE PEAK RATE OF RUNOFF FROM A 10-YEAR, 24-HOUR STORM.
4. SEE THE VERMONT STANDARDS AND SPECIFICATIONS FOR EROSION PREVENTION & SEDIMENT CONTROL FOR ADDITIONAL INFORMATION.



TYPICAL CUT SECTION



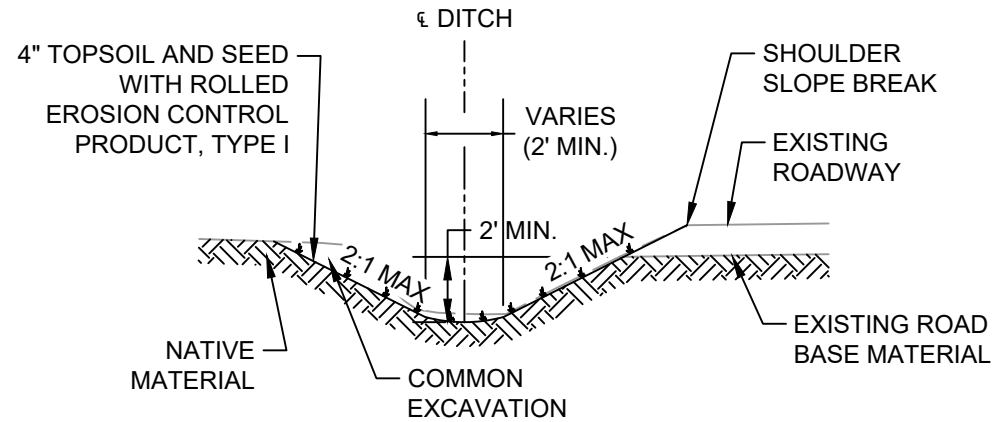
TYPICAL FILL SECTION

STONE-LINED DITCH DETAIL
Not To Scale

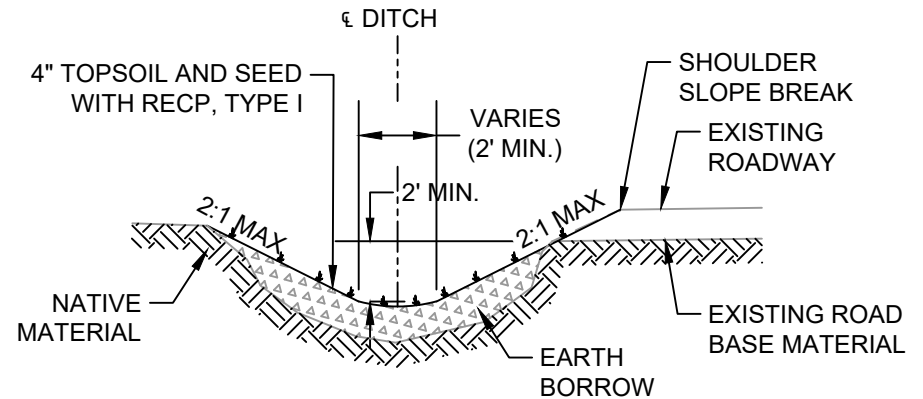


NOTES:

1. THE WATERWAY SHALL BE EXCAVATED OR SHAPED TO LINE, GRADE, AND CROSS SECTION AS REQUIRED TO MEET THE CRITERIA SPECIFIED HEREIN, AND BE FREE OF BANK PROJECTIONS OR OTHER IRREGULARITIES WHICH WILL IMPEDE NORMAL FLOW.
2. FILLS SHALL BE COMPACTED AS NEEDED TO PREVENT UNEQUAL SETTLEMENT THAT WOULD CAUSE DAMAGE IN THE COMPLETE WATERWAY.
3. ALL EARTH REMOVED AND NOT NEEDED IN CONSTRUCTION SHALL BE SPREAD OR DISPOSED OF SO THAT IT WILL NOT INTERFERE WITH THE FUNCTIONING OF THE WATERWAY.
4. STABILIZATION SHALL BE DONE ACCORDING TO THE APPROPRIATE STANDARD AND SPECIFICATIONS FOR VEGETATIVE PRACTICES.
 - 4.1. FOR DESIGN VELOCITIES OF LESS THAN 3.5 FT. PER. SEC., SEEDING AND MULCHING MAY BE USED FOR THE ESTABLISHMENT OF THE VEGETATION. IT IS RECOMMENDED THAT, WHEN CONDITIONS PERMIT, TEMPORARY WATERWAYS OR OTHER MEANS SHOULD BE USED TO PREVENT WATER FROM ENTERING THE WATERWAY DURING THE ESTABLISHMENT OF THE VEGETATION.
 - 4.2. FOR DESIGN VELOCITIES OF MORE THAN 3.5 FT. PER. SEC., THE WATERWAY SHALL BE STABILIZED WITH SOD, WITH SEEDING PROTECTED BY JUTE OR OTHER MATTING OR WITH SEEDING AND MULCHING INCLUDING TEMPORARY DIVERSION OF THE WATER UNTIL THE VEGETATION IS ESTABLISHED.
5. SEE SEED AND MULCH DETAIL FOR ADDITIONAL INFORMATION.



TYPICAL CUT SECTION



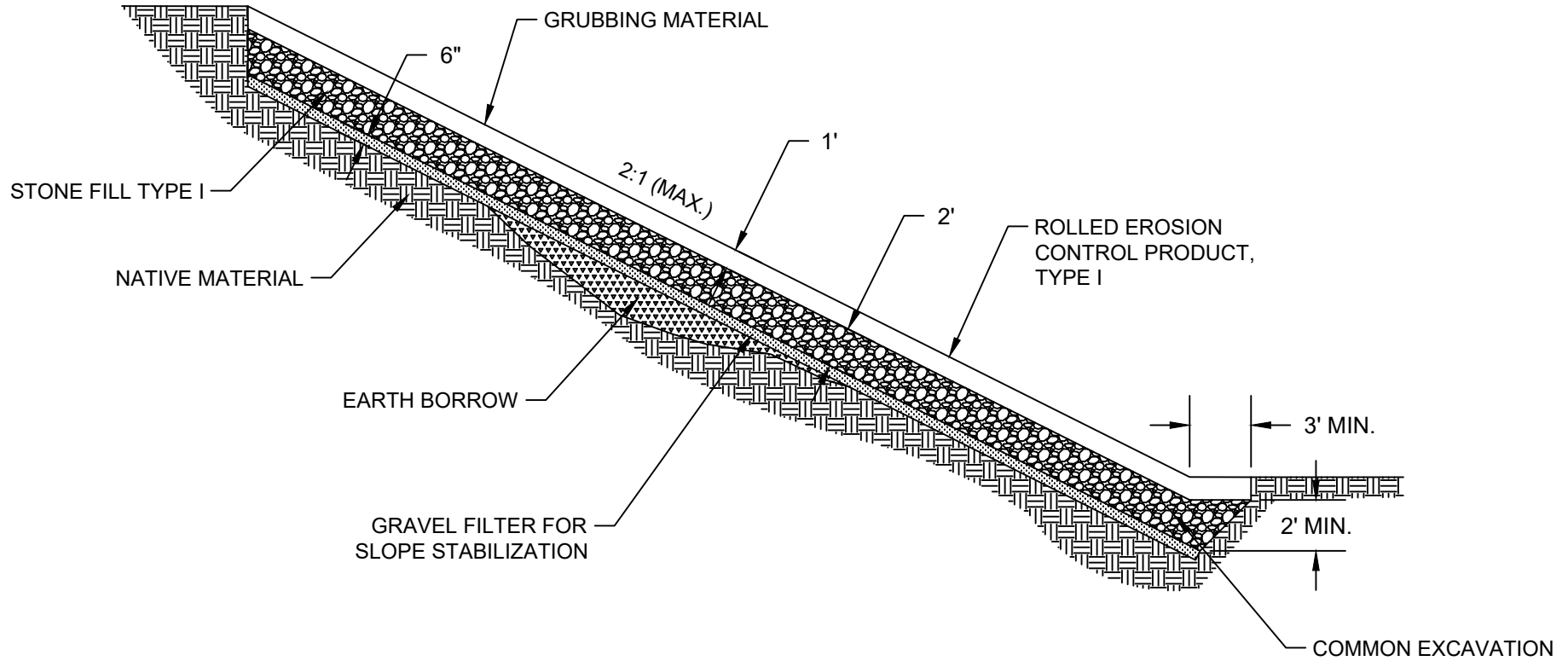
TYPICAL FILL SECTION

GRASS-LINED DITCH DETAIL
Not To Scale



NOTES:

1. THE FINISHED SLOPE SHOULD BE FREE OF POCKETS OF SMALL STONE OR CLUSTERS OF LARGER STONES.
2. HAND PLACING MAY BE NECESSARY TO ACHIEVE PROPER DISTRIBUTION OF STONE SIZES TO PRODUCE A RELATIVELY SMOOTH, UNIFORM SURFACE.

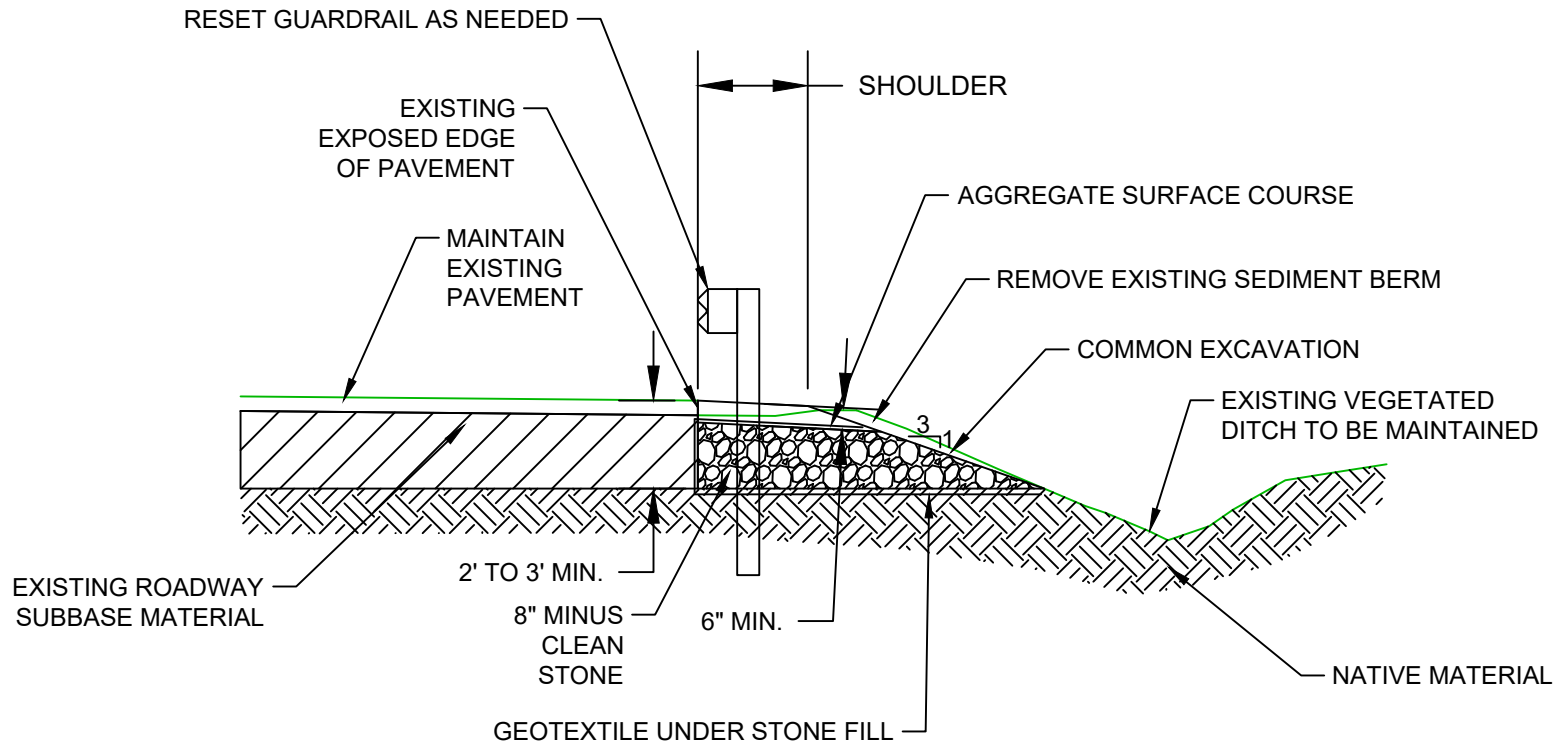


RIPRAP SLOPE PROTECTION DETAIL
Not To Scale



NOTES:

1. FOR GRAVEL ROADS, SHOULDER GRADES SHOULD BE 6-8% TO ENSURE QUICK RUNOFF AND VISUAL BREAK BETWEEN TRAVEL LAND AND SHOULDER.
2. THE SHOULDER NEEDS TO BE ADEQUATELY COMPACTED TO SUPPORT COMMERCIAL AND AGRICULTURAL VEHICLES.



ARMORED SHOULDER PROTECTION DETAIL
Not To Scale



NOTES:

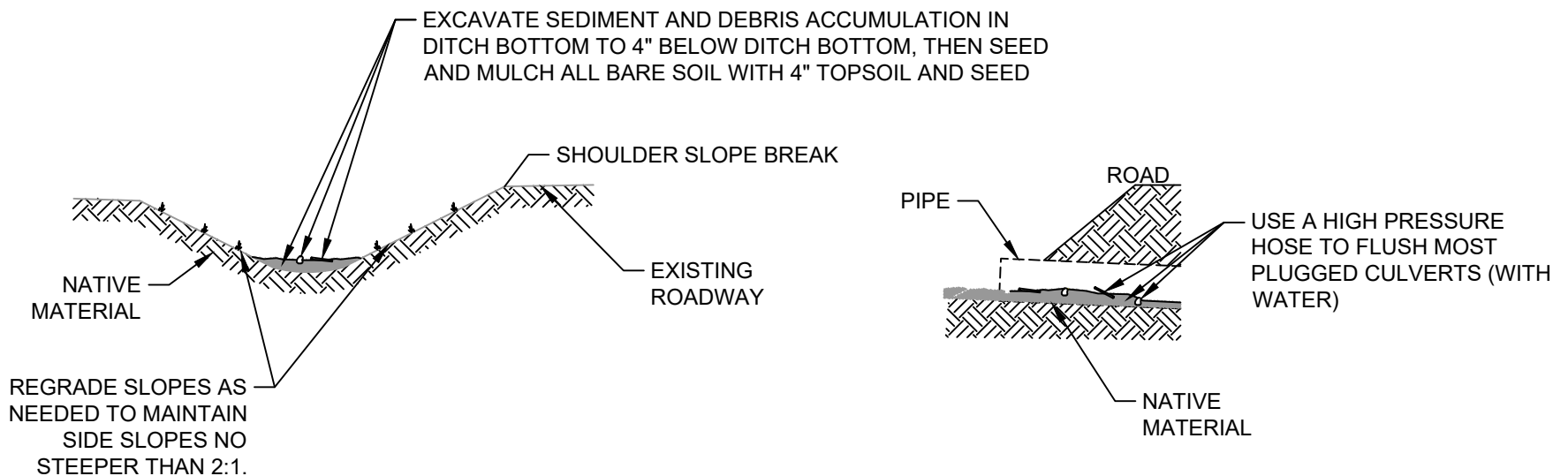
1. ALL TREES, BRUSH, STUMPS, OBSTRUCTIONS, AND OTHER OBJECTIONABLE MATERIAL SHALL BE REMOVED AND DISPOSED OF SO AS NOT TO INTERFERE WITH THE PROPER FUNCTIONING OF THE WATERWAY.
2. SEE SEED AND MULCH DETAIL FOR ADDITIONAL INFORMATION.

CULVERT CLEANING & MAINTENANCE:

1. INSPECT CULVERTS AS OFTEN AS POSSIBLE, BUT AT LEAST IN THE SPRING, FALL AND AFTER MAJOR STORMS.
2. CULVERTS SHOULD BE FLUSHED FROM THE OUTLET END.
3. THE OUTLET DITCH SHOULD BE CLEANED AFTER CULVERT FLUSHING.

DITCH CLEANING & MAINTENANCE:

1. CLEAN DITCHES WHEN THEY BECOME CLOGGED WITH SEDIMENTS OR DEBRIS TO PREVENT OVERFLOWS AND WASHOUTS.
2. CHECK DITCHES AFTER MAJOR STORM EVENTS AS THEY MAY HAVE OBSTRUCTIONS, EROSION, OR COLLAPSED BANKS.
3. REGRADE DITCHES ONLY WHEN ABSOLUTELY NECESSARY AND LINE WITH VEGETATION AS SOON AS POSSIBLE.
4. PREVENTING EROSION FROM UPHILL OR ON BACKSLOPES CAN LENGTHEN THE TIME NEEDED BETWEEN DITCH CLEANINGS.



CLEARING DEBRIS/CLOGGING DETAIL
Not To Scale