Deer Brook Gully Restoration
Town of Georgia, Vermont

STONE
ENVIRONMENTAL

PROJECT NO.

17-084

REVIEWED BY:

ANM/PCL

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Deer Brook Gully Restoration, Town of Georgia, Vermont

Cover Photo: Deer Brook Gully looking upstream, during a rainstorm in November, 2017.

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1. Introduction

The Deer Brook watershed includes approximately 8.4 square miles in the towns of Georgia and Fairfax, Vermont. The majority of Deer Brook flows parallel to Rt. 89 running north to south, and then turns southeast at the I-89 Exit 18 interchange. From there it flows into Arrowhead Mountain Lake, which is part of the Lamoille River, and ultimately drains to Lake Champlain.

The elevation of the confluence with Arrowhead Mountain Lake is approximately 288 feet above sea level, and rises to approximately 793 feet above sea level at the uppermost Deer Brook tributaries. Soils in the study area are mapped predominantly as Windsor loamy fine sand, Rumney variant silt loam, and Enosburg loamy fine sand. Land use in the watershed is dominated by agriculture and light residential in the headwaters, with urbanization most prevalent in the southern portion of the watershed (NRPC, 2008).

Deer Brook is classified as sediment-impaired, from its confluence with Arrowhead Mountain Lake to 2.5 miles upstream. Various tributaries and drainage systems discharge stormwater runoff from developed lands along this lower reach, in particular the Deer Brook Gully, located approximately 1,400 feet south of I-89 at Exit 18, along Vermont Route 7. In the vicinity of the gully, the construction of I-89 and related U.S. Route 7 improvements in the 1970s, as well as subsequent addition of homes and businesses near the intersection with Route 104A, have contributed to a substantial increase in stormwater runoff discharging to the head of the gully. These stormwater flows, combined with corroding highway road culverts along Route 7 and 104A in Georgia, have caused the gully to substantially erode over time and discharge that sediment into Deer Brook.

Currently the gully is measured to be approximately 60 feet deep, measured from adjacent upland property to the toe of slope at the gully head. The gully extends approximately 480 feet from the closed drainage outfall pipe at Rt.7 and the top of the gully head, to the confluence with Deer Brook. Approximately 70% of the channel length has banks that are in adjustment and actively eroding. The gully channel bed seems to have stabilized and downcutting is thought to be negligible at this time, however that assessment is based on a longitudinal profile comparison of 2018 vs. 2006 survey data, where a datum from the 2006 survey was not provided, and estimated for comparison purposes.

1.1. Background and Project Purpose

The gully was first documented and assessed by ESPC and Stone Environmental, Inc. (Stone) in a 2007 report for the Northwest Regional Planning Commission (ESPC, 2007). Stone further evaluated the site and provided conceptual solutions to reduce flows to the Deer Brook Gully as part of a 2013 stormwater master planning project for the Friends of Northern Lake Champlain (FNLC) in Georgia, Vermont.

Following the award of an Ecosystem Restoration Program (ERP) grant from the Vermont Department of Environmental Conservation (VT DEC) in fall of 2017, FNLC hired Stone under this project to help FNLC, NRPC, and stakeholders 1) further identify, design, and eventually implement, stormwater treatment best management practices along Route 7 and 104A to address flows to the gully from impervious surfaces, as well as upland areas, and 2) identify and design remediation alternatives to stabilize the gully channel. The overall goal of the project is to reduce sediment transported from the gully to Deer Brook via a combination of stormwater treatment practices and in-channel gully stabilization measures.

This report summarizes steps taken by Stone to develop final designs for upland stormwater treatment retrofit practices in the contributing watershed as well as gully stabilization and restoration measures. The upland restoration designs include four gravel wetlands, two catch basin risers and a deep sump catch basin, with the goal of reducing stormwater runoff volume and peak flows conveyed to the gully head. The in-channel restoration designs include a drop manhole system that shifts stormwater discharges from the top of the gully to the base of the gully slope, in addition to eight in-channel step-pool structures that will incorporate downed trees and bioengineering practices, resulting in reduced flow velocities and re-stabilization of gully banks.

A series of three interim design memos and the final engineering design plans were produced by Stone for this project and submitted to FNLC, per Tasks 1 through 4 of the contract between Stone and FNLC, dated October 2017. The contents of those memos, and the drawings, were incorporated into this report with minimal revisions. The details of work and findings associated with these tasks are described further in the sections below. This report represents the deliverable for Task 5, the final deliverable by Stone for this project.

2. Site Survey and Existing Conditions

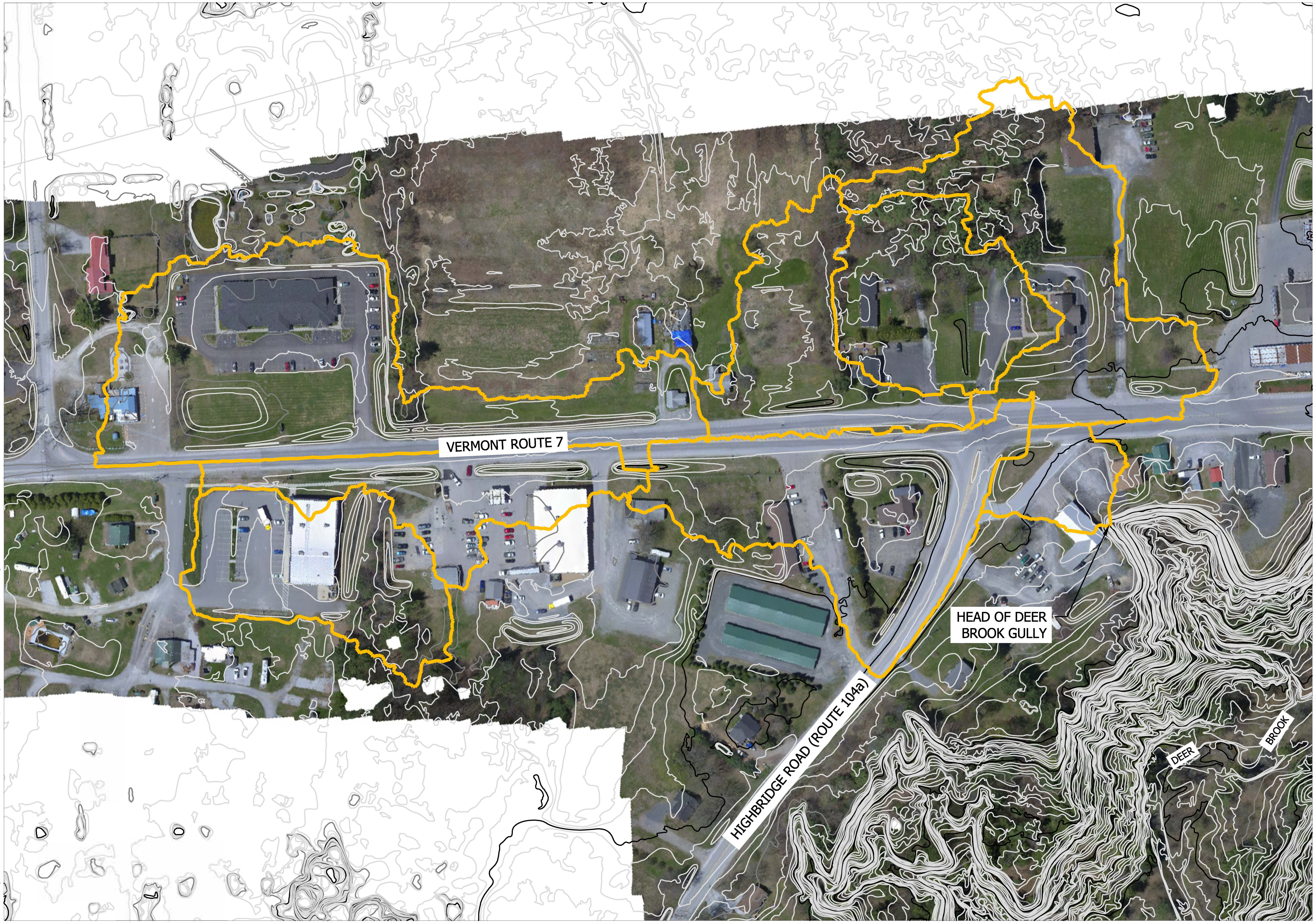
The following provides a summary of work completed by Stone under Task 1 of the project, which includes completion of a topographic survey of the project site, characterization of existing conditions, and a comparison of current conditions with those observed in the *Deer Brook Gully Remediation and Stormwater Treatment Summary Report* developed by ESPC of Williston, VT for the NRPC in February 2007 (ESPC, 2007).

2.1. Site Survey

Stone initially intended to perform the topographic survey of the gully and the associated watershed using standard topographic survey techniques. Following an inspection of the site during the project kickoff meeting on November 11, 2017, other surveying methods were considered due to expected difficulty surveying the steep slopes and degraded condition of the gully using standard methods. Stone obtained the services of AirShark of Irvine, CA to complete the topographic survey via unmanned aerial vehicle (UAV) and remote sensing techniques.

On May 8, 2018, AirShark mobilized at the site and performed a survey of the gully and watershed, utilizing a UAV drone equipped with light detection and ranging (LiDAR) equipment. AirShark set horizontal and vertical control at the site by referencing a US Geological Survey (USGS) benchmark located within the limits of the project, within the U.S. Route 7 corridor. AirShark executed a flight plan that included passes of the drone by the gully and throughout the watershed running north and south parallel to U.S. Route 7. Elevation data were collected with an accuracy equal to or less than 5 cm (~2 inches) throughout the site. Coverage of the entire gully to its confluence with Deer Brook, and of the contributing drainage area, was provided. Data deliverables included a digital terrain model (DTM), 1-foot interval contours based on the DTM, and a geo-referenced orthophoto. Figure 1 below provides a photo of AirShark's UAV system prior to takeoff. Figure 2 provides a map of the watershed that includes the 1-foot contours and geo-referenced orthophoto, along with sub-drainages.

Figure 1. AirShark's UAV drone with LiDAR components attached, prior to takeoff.



LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- SUB-CATCHMENTS

Survey Notes:

1. *Survey data shown collected by AirShark on May 8, 2018 via an aerial survey using drone technology and LiDAR equipment.*
2. *Contour interval = 1 foot. The horizontal datum refers to NAD83 (NSRS 2007) / Vermont (ft US) [EPSG: 5655]. The vertical datum refers to NAVD88.*
3. *This is not a boundary survey and does not meet the legal requirements of a boundary survey as described in 27 V.S.A. 1403.*

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DRAWING CREDITS
Drawn On: 07/02/2018
Drawn By: GMB
Checked On:
Checked By:
Project No.: 17-084

REVISIONS

#	Date	Drwn	Chk'd	App'd	Description

DRAWING SCALE
1 INCH = 40 FEET

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DEER BROOK GULLY RESTORATION

EXISTING CONDITIONS

GEORGIA VERMONT

FIGURE NO. 2

2.2. Existing Conditions

2.2.1. The Gully

Stone was able to perform a cursory inspection of the gully following the kickoff meeting in November. Stone inspected the upland area in the vicinity of the Interstate Auto parking lot, and additional areas behind properties to the north of Interstate Auto. We then entered the gully and walked to the confluence with Deer Brook. It was raining during the inspection and a significant amount of rainfall (~2 inches) had fallen within 1-2 days prior to our inspection.

Three upland buildings are located within 20-30 feet of the gully limits, with one (Interstate Auto) less than 10 feet from a failing slope. Armoring and fill along the gully edge was observed on Interstate Auto's property, and a substantial amount of fill was observed along the northern upland portion of the gully (and appeared to be failing at the toe of material placement). Trash was observed at the head of the gully and in the channel, consisting of 55-gallon drums, scrap metal, and other large items. Many trees have fallen over, likely due to bank slope failures and small landslides. Many of the downed trees were identified as eastern hemlock, with some hardwood trees also down and spanning the channel. Approximately 40-50% of the downed trees appeared to be recent falls (within the last 1-2 years), with no signs of rot or weathering.

Runoff was flowing in the gully channel during the visit and the water was gray in color. Within the lower banks and slopes of the gully, it generally appears that there are a few inches of topsoil/soil (4-8") above a soft, gray clay. The channel bed contained 6-8" of fine, gray, silt- to clay-textured sediments. The banks and slopes showed multiple slope failures and slides, and erosion of the upper soil layer with exposed gray clay in some locations. Undercut banks were observed further downstream, indicating that the channel continues to adjust its cross-sectional area to accommodate increase in flows. At the confluence of Deer Brook, a contrast between the gray colored gully discharge and brown flow in the brook was easily discernable. is a photo of the gully channel looking downstream, at an undercut bank and illustrating the sediment and debris that have collected in the channel.

Figure 3. Failing gully bank, with accumulated sediment and debris in the channel in foreground; gray- colored runoff in background.

Additionally, Figure 4 provides a plot of the longitudinal profile (along the gully channel centerline) relative to the 2018 AirShark survey, the 2014 state LiDAR data, and the profile provided in the ESPC 2007 study. The purpose of this plot is to assess the stability of the channel bed over time. A comparison between the 2018 and 2014 data shows that a portion of the channel has potentially incised, or cut down, 1-4' over that time period (understanding that the state LiDAR data most likely has an accuracy range of 0-0.5'). It should be noted that while the 2018 and 2014 data sets reference the same vertical datum (NAVD88), the ESPC profile was not collected on a datum, and is therefore not directly comparable to the other data sets. It is included in the plot for illustrative purposes only.

2.2.2. Uplands, Existing Infrastructure and BMPs

The drainage area contributing to the gully consists primarily of developed land, including buildings, lawns, parking lots/driveways, and roadways with associated rights-of-way—as well as existing drainage infrastructure and stormwater best management practices (BMPs) located on either side of U.S. Route 7, which runs from north to south and bisects the watershed. Other than BMPs constructed as part of recent development (i.e. a small wet pond associated with the Dollar General), the majority of the drainage infrastructure in the watershed consists of large swales that are hydraulically connected to the closed drainage system that discharges at the head of the gully. The system, as characterized in the 2007 study and to be verified by Stone under Task 2 (Section 3), consists of a number of catch basins (most located along the bottom of the swales), and the pipe network, which consists entirely of 12" diameter concrete pipe.

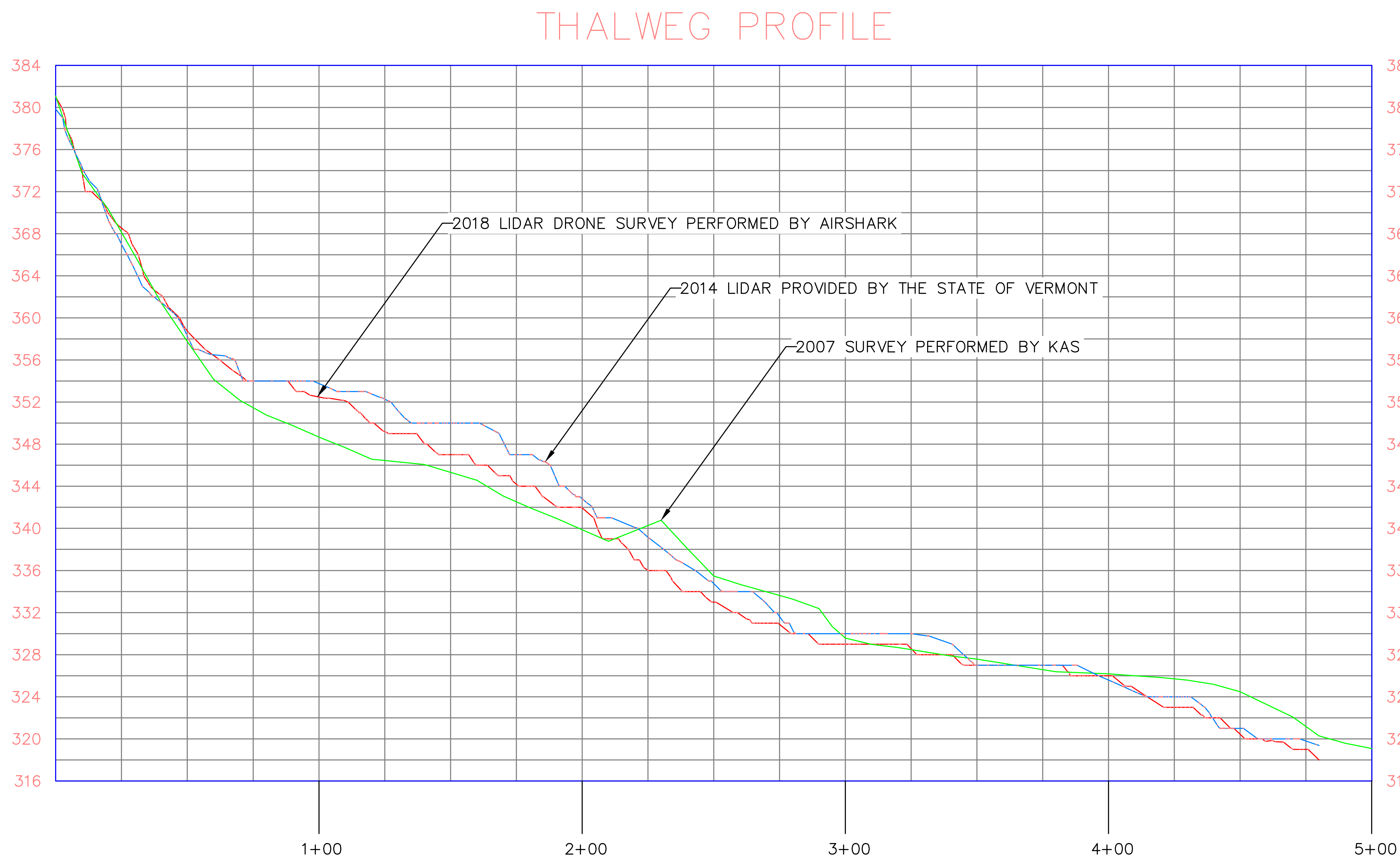
Preliminary modeling indicates that the existing piping system is undersized, which may contribute to the degraded condition observed at the gully head (discussed further in Section 2.3.2). The swales are thought to be providing significant storage capacity during large storm events. A total of six swales exist along U.S. Route 7, and the swales, pipe network, and catch basins are illustrated on Figure 5.

2.3. Evaluation of Existing Conditions

While winter weather conditions prevented early collection of site-specific topographic data, Stone initiated work under Tasks 1 and 2 (Sections 2 and 3) in the Fall of 2017 using publicly available state LiDAR data. The LiDAR data supported a preliminary evaluation of existing conditions, as well as development of a hydrologic and hydraulic (H&H) watershed model of the upland portions of the project using the EPA's Stormwater Management Model (SWMM). These initial steps facilitated progress while waiting for suitable weather to perform the UAV survey.

2.3.1. Comparisons of Drainage Area and Impervious Cover

Upon receipt of the topographic survey data in mid-May, Stone incorporated the new DTM into the SWMM model and updated results. We re-delineated the closed drainage system extents and contributing watersheds draining to the head of the gully, delineated sub-watersheds draining to each catch basin, and recalculated percent impervious cover within each sub-watershed. The existing open and closed stormwater drainage network along U.S. Route 7 was also incorporated into the SWMM model. A comparison of the total drainage areas and percent impervious values between the 2007 report, and those calculated using the 2018 survey data, is provided in Table 1 below.



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Drawn On: 07/23/2018
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REVISIONS

#	Date	Drwn	Chk'd	App'd	Description

DRAWING SCALE

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DEER BROOK GULLY REMEDIATION
FRIENDS OF NORTHERN LAKE CHAMPLAIN
GULLY THALWEG PROFILES
GEORGIA VERMONT

FIGURE NO.
4

Table 1. Comparison of Drainage Area and Percent Impervious Cover between ESPC and Stone Models

Drainage Area (catch basin ID)	ESPC (2007)			Stone (2018)		
	Area (acres)	Impervious Area (acres)	Impervious Cover (%)	Area (acres)	Impervious Area (acres)	Impervious Cover (%)
CB1	2.0	0.86	43.1	4.3	2.24	52.1
CB2	4.1	1.28	31.2	3.4	2.04	60.0
CB3	2.5	1.01	40.3	2.8	1.58	56.4
CB4	3.9	1.50	38.4	3.5	0.93	26.6
CB5	3.0	0.93	31.0	2.7	0.76	28.2
CB6	0.4	0.27	67.7	0.6	0.48	80.8
Totals	15.9	5.85	36.9	17.3	8.03	46.4

Abbreviations: CB# = catch basin
Date and Author: (05-31-2018; GMB/ANM)

Comparing the two sets of data shows that the present total drainage area is approximately 9% greater than that delineated by ESPC in 2007. Substantial changes in the drainage areas between the 2007 and 2018 delineations include:

- Extensions of the drainage areas for CB1 and CB2 to the south along US Route 7 to include areas draining to existing swales at the southern end of the watershed, including the Georgia Eye Center, as well as the Dollar General (new construction since 2007) and lands adjacent to both facilities. While the extensions of the drainage areas increased the overall length of the watershed along US Route 7, the total land area draining to CB1 and CB2 increased by only about an acre, due to tighter control on the drainage area boundaries to the east and west.
- An increase in the impervious cover within the CB3 drainage of almost half an acre; this is due to a more accurate delineation of the boundary between the CB2 and CB3 drainages rather than stemming from construction of new impervious cover.
- Redevelopment of the Maplefields gas station in drainage area CB5, though due to a shift in the drainage area boundaries, the total impervious cover in this drainage area declined slightly.

Figure 5 shows a schematic view of the drainage area delineation and existing stormwater infrastructure draining to the gully, developed by ESPC as part of the 2007 study, fitted over an image from Stone's PCSWMM model. The PCSWMM model image shows sub-drainage areas (green), the stormwater infrastructure network including conduits (yellow) and catch basins (blue dots, labeled), the gully outfall (red triangle) and the DTM surface (gray background image).

Differences in computed percent impervious cover varied for each sub-drainage area and for the watershed as a whole, where Stone accounts for 9.5% more impervious cover compared to the 2007 study (Table 1). Stone utilized a 2011 land cover data set publicly available from the Vermont Center for Geographic Information (VCGI) to facilitate quantification of impervious cover within the watershed. Stone then compared the impervious cover delineations derived from the 2011 data to the geo-referenced orthophoto collected by AirShark in May 2018 and made appropriate adjustments, to account for any impervious area additions since 2011. Differences between both studies are due primarily to the construction of additional impervious cover since 2007, changes in drainage area boundaries, and differences in the accuracy of ground cover data used for each study.

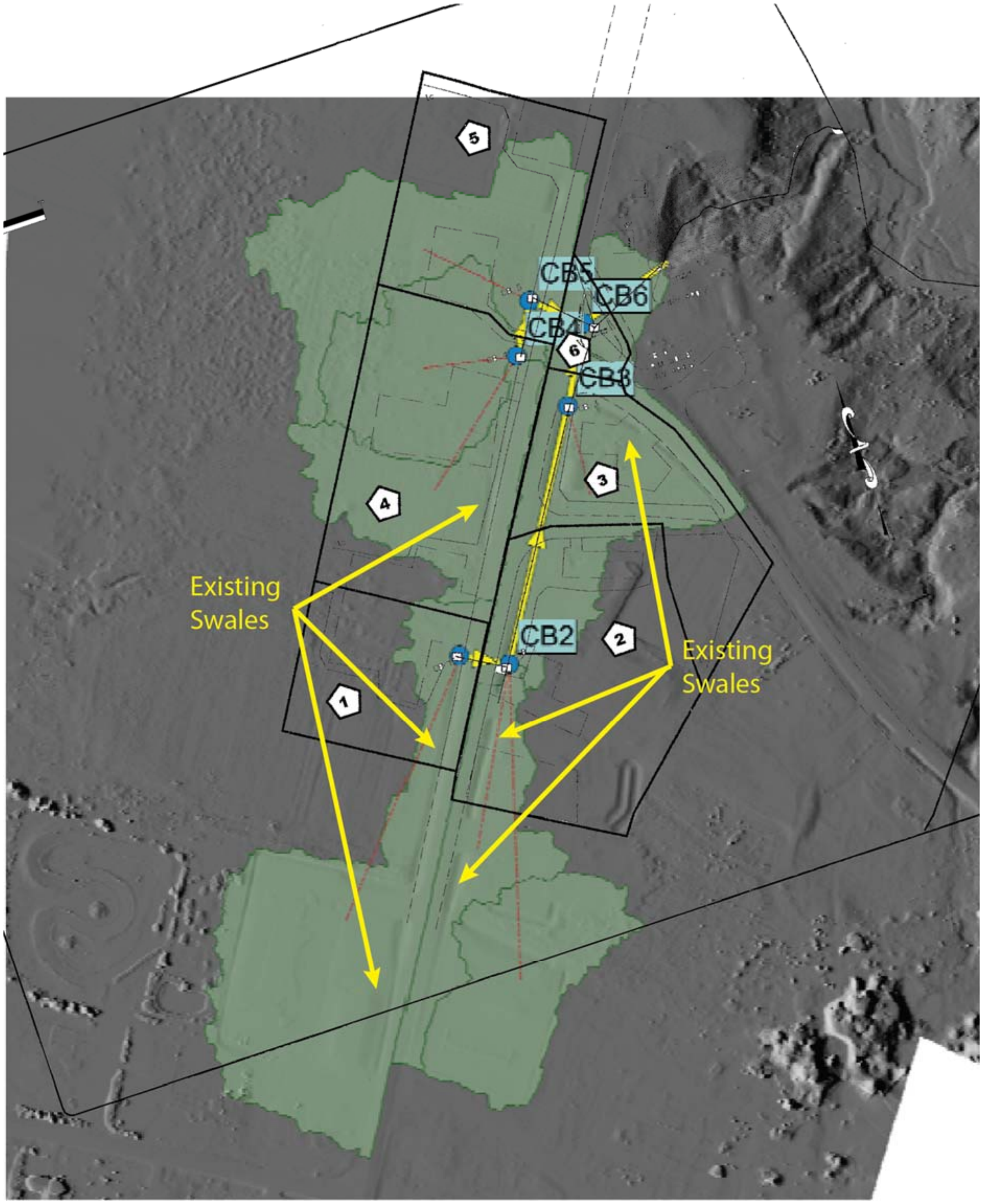

Figure 5. Gully Watershed Plan depicting drainage area delineations and existing stormwater infrastructure by ESPC, 2007, fitted over Stone's drainage area delineation based on AirShark's 2018 LiDAR topographic survey. Simulated catch basins, stormwater conduit and the gully outfall in PCSWMM model are shown. A total of 6 large swales exist throughout the watershed. Mapping by Stone via PCSWMM, 2018.

2.3.2. Comparisons of Peak Flows

Where the 2007 study utilized HydroCAD to simulate hydrology and watershed flows over land surfaces and through stormwater infrastructure leading to the gully, Stone utilizes the SWMM model for these purposes. HydroCAD is widely used for similar projects throughout Vermont, but SWMM incorporates more accurate equations to simulate closed conduit flow, includes more accurate routines to simulate pervious surface infiltration, includes routines to model BMPs, which will be a primary component to this project in later tasks, and is typically used when a higher degree of accuracy is warranted for closed conduit systems. Stone is using PCSWMM, which utilizes the SWMM engine and includes a user interface that provides numerous tools, model calibration routines, and graphical aids.

Due to the difference in impervious cover between the studies, and because Stone is using a different H&H model, peak flow estimates were re-calculated for a range of design storm events. ESPC evaluated the drainage system for the 10- and 100-year, 24-hour storm events, and Stone evaluated the 2- through 100- year design storms, in addition to the 1" Water Quality Treatment Standard storm event. Stone used the same rainfall volumes used by ESPC for the 10- and 100-year storm events, and specified a Type II SCS 24-hour rainfall distribution, as in the ESPC study. For storm events other than the 10- and 100-year design storms, Stone obtained rainfall depths from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Point Precipitation Frequency Estimates (https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html). Table 2summarizes rainfall and peak flows generated under each study. For future work, Stone will utilize the NOAA precipitation values for all design storms evaluated.

Table 2. Comparison of Peak Flows at Gully Outfall for Standard Design Storms, between ESPC and Stone Models

Design Storm	Rainfall (in.)	ESPC (2007) Q_p (cfs)	Stone (2018) Q_p (cfs)
1" WQv	1.00	-	6.36
2-Year	2.25	-	10.03
10-Year	3.10[1]	5.71	12.67
25-Year	3.85	-	14.64
50-Year	4.32	-	15.73
100-Year	5.20[1]	30.41	17.62

Abbreviations: in. = inches; Q_p = peak flow; cfs = cubic feet per second; WQv = water quality volume
Date and Author: (06-12-2018; GMB)
[1]Rainfall values are from the 2007 ESPC study and used in both models for the purposes of comparison.

The stormwater pipe network between both models is set up to be identical with respect to pipe diameter, type, slope, lengths, catch basin locations, outfall invert, and other pertinent infrastructure detail. The differences in peak flows between the studies are therefore likely due to the differences in how each model routes flow through closed drainage systems. The PCSWMM model utilizes the Dynamic Wave routing method, which we considered to be the most appropriate and accurate methodology for closed conduit systems. The method can account for conduit storage, backwater, flow reversal, and pressurized flow—conditions that are common in flooded conditions. Conversely, HydroCAD utilizes the Storage-Indication Method for most situations, which does not take into account situations specific to pressurized flow.

The existing closed drainage system that discharges to the gully is comprised entirely of 1' diameter piping. We believe that this system is undersized and prone to surcharge, while the existing drainage swale network provides significant storage, compensating somewhat for the lack of conveyance through the pipe network.

During larger storm events (i.e. 2-year design storm and above), these factors appear to result in pressurized flow in the downstream portions of the system, a backup of the flow in the upstream portion of the system, and significant ponding and storage of runoff in the swale network. Stored water in the swales drains back into the closed drainage system after peak flows have subsided. Overall, the undersized piping system is dampening peak flow values throughout the system and at the head of the gully, but exaggerating velocities at the outfall, resulting in high erosive forces that are impacting the area immediately adjacent to and downstream of the discharge.

To test the theory, Stone modified the diameter of the existing pipes, changing the diameters to 2', 3' and 5' diameters respectively, and comparing the results to the existing condition (1' diameter). This exercise confirmed that both the lowest peak flows and highest velocities at the gully for all storms are associated with the existing condition. We also found that the highest peak flows and lowest velocities were associated with the largest pipe diameter, and that peaks begin to be throttled (and velocities at the discharge tend to rise) when the modeled pipe diameter drops below 3'. The additional modeling illustrated how important a role the existing swale system plays in storing flood waters until capacity becomes available in the pipe network. Retrofits at the existing swale outlets may prove to be a good way of leveraging the storage capacity of the swales, and reducing high flow velocities discharged at the head of the gully.

Given the unique nature of the existing piping network, Stone plans to explore the installation of velocity meters at key locations and collection of velocity data during runoff events. These data can be used to further our understanding of flow characteristics in the network, and may also be used to calibrate the SWMM model and improve predictive capability.

The peak flows developed for Task 1, and the conceptual site model shared in the preceding paragraphs, have been developed to approximately the 30% design level and should be considered conceptual. Flow estimations and our understanding of the site will evolve as we progress and refine our designs. However, they are adequate for the purposes of comparison to the 2007 peak flow estimates.

3. Evaluation of Alternatives for Green Stormwater Infrastructure Stormwater Practices

The following provides a summary of work completed by Stone under Task 2 of the project, which includes a survey of the upland portions of the watershed to identify stormwater management opportunities, aimed at reducing stormwater runoff impacts to the head of the Deer Brook gully during runoff events. Per the project scope of work, Stone identified management opportunities in areas immediately adjacent to the gully (6 total) and within the VTrans US Route 7 right-of-way (11 total) (Figure 6).

The tables in this section build upon the basic problem area descriptions and documentation included in the Retrofit Summary Sheets (Appendix 1), to include documentation of drainage area characteristics, potential BMPs to be implemented, and the stormwater volume reduction and pollutant removal benefits that may be achieved by implementing the proposed improvements. A draft implementation matrix is also included, which ranks each retrofit opportunity and proposed solution relative to existing environmental concerns, overall environmental priority, constructability, and ease of operation.

3.1. Drainage Area Characteristics and Retrofit Benefits

Key characteristics and assessment results for each identified stormwater problem area or strategic retrofit opportunity within the project area are summarized in Table 3.

The following characteristics are included in Table 3 for each identified problem area or retrofit opportunity:

- Site number (with approximate treatment practice locations shown on Figure 6)
- Site name
- Drainage area characteristics:
    - Primary Hydrologic Soil Group (HSG), as derived from the Franklin County Soil Survey for the drainage area
    - Total drainage area (acres)
    - Impervious surfaces within the drainage area (acres)
    - Percent impervious cover in the drainage area
- Drainage area runoff volumes and phosphorus loading estimates
    - Estimated Water Quality Volume (WQv) (in cubic feet) for the entire area draining to the proposed BMP, based on the 2017 VSMM Water Quality Treatment Standard's required runoff capture and treatment depth of 1 inch[1]

[1] 2017 Vermont Stormwater Management Manual Rule and Design Guidance, effective July 1, 2017. Available at http://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/Permitinformation/2017%20VSMM_Rule_and_Design_Guidance_04172017.pdf

- Estimated Hydrologic Conditions Volume / Channel Protection Volume, in acre-feet and cubic feet, based on the 2017 VSMM Channel Protection Standard's requirement to provide treatment for the difference in runoff volumes between pre-development and post-development site runoff for the one-year, 24-hour storm[1]. The volumes reported in the table assume that the present condition represents the "post-development" condition.
- Estimated total phosphorus base load (lbs/year) for the WQv, calculated using the stormwater BMP performance curve approach developed by USEPA Region 1, and including base phosphorus loading rates for developed lands being applied by Vermont DEC, consistent with their online Stormwater Treatment Practice Calculator[2]. The average annual pollutant (phosphorus) concentrations provided in the guidance that were applied in Table 3 are 2.51 lb/acre-year for developed impervious, and 0.50 lb/acre-year for developed pervious. The developed impervious loading of 2.51 lb/acre-year was applied for most systems in the project area, consistent with DEC guidance for systems that include driveways, access drives, and other transportation surfaces within larger development projects (e.g., residential and commercial subdivisions).
- Estimated total phosphorus load to be removed by proposed improvements on an annual basis (lbs/year), calculated based on the estimated total phosphorus base load, annual runoff volume anticipated to be captured by proposed BMPs, and percent pollutant removal efficiencies for the proposed BMP types as calculated using the Stormwater Treatment Practice Calculator[2].

- Proposed Best Management Practices, cost estimates, and cost-benefit metrics:
  - Proposed BMP type
  - Proposed storage volume, or treatment capacity, assumed at this screening stage to be equal to treatment of the "first inch" of runoff or the Water Quality Volume (WQv). The retrofit opportunity treatment volumes were optimized by maximizing the area available for treatment while accounting for various BMP void ratio and reasonable runoff storage depths.
  - Proposed BMP implementation cost, estimated on a price per cubic foot of storage basis. Costs for implementing proposed stormwater BMPs were estimated using the cost function employed in Vermont's Best Management Practice Decision Support System (BMPDSS), as well as current installation cost estimates per cubic foot of BMP storage volume provided in 2016 guidance from U.S. EPA Region 1[3]. The costs are calculated based on the following equation:
    - total cost = installation cost (I) + land cost (L) + fixed cost (F), where

      I = BMP installation cost per cubic foot (CF) of storage volume in 2016 dollars, updated to account for inflation to the year 2018, using a 2.5% inflation rate, specific to the practice type

      L = $0 as easement or land purchase costs for individual BMPs are not known

[2] Vermont DEC, Stormwater Treatment Practice Calculator. https://anrweb.vt.gov/DEC/CleanWaterDashboard/STPCalculator.aspx

[3] 2016 EPA Memorandum: Methodology for developing cost estimates for Opti-Tool. Technical memorandum prepared by Karen Matelska, EPA Region 1, February 20, 2016. Available at https://www3.epa.gov/region1/npdes/stormwater/ma/green-infrastructure-stormwater-bmp-cost-estimation.pdf

F = project-specific estimate of design/permitting costs, estimated at 25% of construction costs.

- A cost adjustment factor was applied for each proposed BMP to account for anticipated and site-specific implementation challenges. The assumption made was that it would cost more to install a new BMP in a developed area (with more site constraints) than it would cost to install the same BMP in a previously undeveloped area. The unit-based BMP installation costs were developed using a cost adjustment factor of 1 (new BMP in undeveloped area). Proposed BMPs on private property were given an adjustment factor of 1.5; BMPs adjacent to or within the VTrans right-of-way were given a cost adjustment factor of 2.5, to account for the complexity of VTrans's project development processes.

- Phosphorus removal cost-benefit: The total implementation cost for each BMP was divided by the estimated total annual phosphorus load reduction, resulting in a cost per pound of P removed.
- Volume management cost-benefit: The total implementation cost for each BMP was divided by the proposed storage volume, resulting in a cost per cubic foot of stormwater runoff volume treated.
- Impervious treatment cost-benefit: The total implementation cost for each BMP was divided by the impervious area, resulting in a cost per impervious acre treated.

3.2. Implementation Matrix

Through the field screening, development of the problem area datasheets, and desktop evaluation to define and refine drainage areas and their respective characteristics, Stone recorded observations about each site, which were used to develop a draft "implementation score" for each opportunity (Table 4) relative to the following criteria:

- **Existing environmental concerns** – score was assigned based on the type(s) of problems present, with 1 point added for each of the following concerns presented by the site's current condition: water quality concerns; infrastructure vulnerability; localized drainage issues/flooding; gullying resulting from existing drainage systems, and directly connected impervious acreage greater than 0.25 acres. Although sites are generally anticipated to receive between 1 and 3 points, the maximum score a site can receive is 5.
- **Environmental priority –** relative environmental impact on the gully, particularly with respect to stormwater conveyed from the site and to the gully during storm events. Impacts on the gully from individual sites considered include but are not limited to upland erosion immediately adjacent to the gully; erosion, widening, or incision of the gully channel; erosion/destabilization of the gully bank; and water quality impacts associated with these processes. A score of 1 represents the smallest impact and 5 represents the greatest impact.
- **Constructability –** relative ease with which a project could be implemented, including whether the recommended practice(s) could be constructed on publicly-owned land or with a willing landowner-partner, existing access to the site, and the amount of additional assessment and engineering design work that would be required to move the project to implementation. The maximum score a site can receive is 3, indicating a project that should move quickly and easily to implementation.

- **Ease of operation –** operational considerations, including amount and frequency of maintenance likely required, and whether maintenance activities will be straightforward to complete. The maximum score a site can receive is 3, indicating a project with infrequent maintenance needs that are easily completed.
- **Phosphorus removal cost-benefit** – qualitative evaluation of the cost per pound of phosphorus removed by each proposed BMP, where a score of 3 indicates a cost-benefit of <$25,000 / lb P removed, a score of 2 indicates a cost-benefit of $25-75,000 / lb P removed, and a score of 1 indicates a cost-benefit of >$75,000 / lb P removed.
- **Volume management cost-benefit** – evaluation of the cost per cubic foot of stormwater runoff volume treated by each proposed BMP, where a score of 3 indicates a cost-benefit of <$12 / CF runoff treated, a score of 2 indicates a cost-benefit of $12-25 / CF runoff treated, and a score of 1 indicates a cost-benefit of >$25 / CF runoff treated.
- **Impervious treatment cost-benefit** – evaluation of the cost per impervious acre treated by each proposed BMP, where a score of 3 indicates a cost-benefit of <$50,000 / impervious acre treated, a score of 2 indicates a cost-benefit of $50-100,000 / impervious acre treated, and a score of 1 indicates a cost-benefit of >$100,000 / impervious acre treated.

The type of ownership of each project location, an initial indication of project cost, and the amount of additional engineering that will be needed for implementation are also presented in the matrix. These measures are not included currently in the score tabulated for each potential project, but are qualitatively scored as follows:

Project Type "key":

Private Private property

State State property or right-of-way

Town Public property (town-owned land or right-of-way)

Hybrid Hybrid; part public land, part private land

Estimated Implementation Cost "key":

L less than $25,000

M $25-$100,000

MH $100-$500,000

H more than $500,000

Need for Additional Engineering "key":

L Project can be implemented without formal engineering

M Project requires some amount of engineering design to ensure proper sizing

H Project requires full engineering

3.2.1. Results

Prioritization results, provided in Table 4, indicate that the highest ranked projects (i.e. implementation scores ranging from 18-19 in Table 4) include the majority of projects proposed within the US Route 7 right-of-way. Retrofit opportunities at sites 10 and 12-16 are comprised of existing grass swales coupled with either undersized or non-existent closed conduit piping systems, which, during large storm events, are expected to cause backwatering in the swales and associated infrastructure vulnerabilities. Directly connected impervious surfaces within these drainage areas contribute to the potential for flooding and exacerbate issues related to the undersized closed conduit system.

Current conditions at sites 12-16 also have a direct and significant impact on the gully. As discussed in the Task 1 memo (Section 2), the existing closed conduit system that underlies the swales throttles the amount of flow entering the conduits and dampens discharges to the gully. The undersized conduits result in exaggerated discharge velocities at the gully head, likely contributing substantially to gully erosion and instability. At the same time, the existing grass swales contain significant storage capacity, constituting a major and positive retrofit opportunity. Retrofit opportunities identified in areas immediately adjacent to the gully (1, 3, 4-6) are in closer proximity than the existing swales, but when comparing these projects to the existing open and closed drainage networks on a runoff volume basis, the existing drainage system plays a much larger role in terms of impacts to the gully.

Stone initially recommended moving forward and pursuing implementation of projects 10, and 12-16, consistent with the results in Table 4. Although only at the conceptual phase in this phase of the project, our proposed designs for projects 12-16 consist of the installation of risers at applicable basins, which would increase storage in the swale system and reduce the head throughout the system during storm events, reducing the discharge velocities at the gully head. We'll also look into replacing the outfall pipe with a properly sized pipe, which would also help to reduce discharge velocities. A storage and/or water quality practice is currently proposed for project 10 as well. All of these design details will be further refined in Task 4 (Section 6).

Note that recommendations in the preceding paragraph were those provided at the end of Task 2 in October 2018, and that final projects were refined and selected following work executed as part of Task 4, as discussed in Sections 5 and 6.

General Notes:

1. Orthophoto collected by AirShark on May 8, 2018 during an aerial survey using drone technology.
2. Existing rim/invert elevations and representation of stormwater infrastructure are from a survey executed by Gabe Bolin, PE and Branden Martin, EI of Stone Environmental Inc., and David Cavagnaro of Friends of Northern Lake Champlain, on August 15, 2018, using a Geomax Zoom 30 Total Station and are for the purposes of this plan only.
3. Horizontal coordinates refer to the North American Datum of 1983 (NAD83). The vertical datum refers to the North American Vertical Datum of 1988 (NAVD88).
4. Gully channel delineation based on LiDAR contours provided by AirShark. LiDAR contours not shown for clarity.
5. Parcel boundary lines are from shapefiles provided by the State. They do not represent a boundary survey and should be considered approximate.

Legend

- Parcel boundaries
- Existing storm drain pipe, catch basin & flow direction
- Existing culvert
- Existing swale
- Gully channel
- 1 Proposed practice location and ID #
- Proposed practice sub-catchment
- VTrans Right of Way

File: O:\PROJ-17\WRM\17-084 FNLC Deer Brook Gully Designs\CAD\Task_2_Map.dwg

DRAWING CREDITS	
Drawn On:	10/10/2018
Drawn By:	GMB
Checked On:	
Checked By:	
Project No.:	17-084

REVISIONS

#	Date	Drwn	Chk'd	App'd	Description

DRAWING SCALE

0 150 300 FEET

1 INCH = 150 FEET

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DEER BROOK GULLY RESTORATION

PROPOSED GSI STORMWATER PRACTICES

GEORGIA VERMONT

FIGURE NO.
6

Table 3
Drainage Area Assessment Summary and Cost-Benefit Screening
Deer Brook Gully Restoration

Site ID	Site Name	Drainage Area Characteristics					Drainage Area Runoff Volumes and Phosphorus Loading Estimates							Proposed BMPs, Implementation Costs, and Cost-Benefit									
		Primary Soil HSG	Drainage Area (acres)	Impervious Area (acres)	Pervious Area (acres)	% Impervious	Estimated WQv (acre-feet)	Estimated HCv / CPv (acre-feet)	Estimated WQv (CF)	Estimated HCv / CPv (CF)	Estimated Total Base P Load (lbs/year)	Estimated Total P Load Post Treatment (lbs/year)	Estimated Total P Load Reduction (lbs/year)	Proposed BMP Type	Proposed Storage Volume (CF)	BMP Construction Cost Estimate (2018 $)	BMP Design / Permitting Costs (2018 $)	Cost Adjustment Factor	Total Implementation Cost (2018 $)	Phophorus Removal Cost-Benefit ($/lb P removed)	Volume Management Cost-Benefit ($/CF runoff treated)	Impervious Treatment Cost-Benefit ($/impervious acre managed)
1	Interstate Auto Parking Disconnection	A/D	0.72	0.40	0.32	56	0.033	0.034	1,440	1,480	1.17	0.50	0.67	Gravel Wetland	1,440	$9,000	$2,250	1.5	$16,875	$33,800	$11.72	$42,000
2	Rte 7 - 104A Intersection Island	A/D	16.90	7.60	9.30	45	0.63	0.827	27,610	36,020	23.75	13.99	9.76	Bioretention	16,864	$179,000	$44,750	2.5	$559,375	$40,000	$33.17	$73,600
3	Interstate Auto Rain Garden	A/D	0.04	0.04	0.00	100	0.003	0.0020	140	90	0.11	0.05	0.06	Bioretention	140	$2,000	$500	1.5	$3,750	$75,000	$26.79	$89,400
4	Office Roof Disconnection #1	A/D	0.02	0.02	0.00	100	0.002	0.0010	80	40	0.06	0.03	0.03	Bioretention	80	$1,000	$250	1.5	$1,875	$62,500	$23.44	$78,800
5	Office Roof Disconnection #2	A/D	0.02	0.02	0.00	100	0.002	0.0010	80	40	0.06	0.03	0.03	Bioretention	80	$1,000	$250	1.5	$1,875	$62,500	$23.44	$81,700
6	Roof Runoff and Sump Disconnection	A/D	0.03	0.03	0.00	100	0.003	0.0020	120	90	0.09	0.04	0.05	Bioretention	120	$2,000	$500	1.5	$3,750	$93,800	$31.25	$107,700
7	1193 Rte 7 Detention	A	0.78	0.74	0.04	95	0.059	0.043	2,580	1,870	1.88	0.75	1.13	Gravel Wetland	1,290	$8,000	$2,000	2.5	$25,000	$33,300	$19.38	$33,700
8	1193 Rte 7 Alternate Retrofit	C/D	0.78	0.74	0.04	95	0.059	0.043	2,580	1,870	1.88	1.41	0.47	Deep Sump Catch Basin	2,580	$6,000	$1,500	2.5	$18,750	$13,300	$7.27	$25,300
9	Blake's Auto Service Retrofit	A/D	0.39	0.10	0.30	25	0.009	0.018	380	780	0.39	0.18	0.21	Gravel Wetland	380	$3,000	$750	1.5	$5,625	$31,300	$14.80	$58,200
10	Peoples Trust Company Storage & WQ Retrofit	A/D	2.78	0.80	1.98	29	0.072	0.131	3,130	5,710	3.01	1.37	1.64	Gravel Wetland	3,130	$19,000	$4,750	2.5	$59,375	$43,300	$18.97	$74,000
11	Hair Designs Swale Improvements	A/D	1.82	0.55	1.26	30	0.05	0.09	2,110	3,700	2.02	0.92	1.10	Gravel Wetland	1,055	$7,000	$1,750	2.5	$21,875	$23,800	$20.73	$39,600
12	Rte 7 Retrofit #1	A/D	1.73	0.40	1.33	23	0.037	0.09	1,630	3,920	1.67	0.78	0.89	Gravel Wetland	1,630	$10,000	$2,500	2.5	$31,250	$40,100	$19.17	$78,000
13	Rte 7 Retrofit #2	A	4.27	2.21	2.07	52	0.1817	0.209	7,910	9,100	6.57	2.81	3.76	Gravel Wetland	7,910	$48,000	$12,000	2.5	$150,000	$53,400	$18.96	$68,000
14	Rte 7 Retrofit #3	A	0.53	0.25	0.28	47	0.02	0.03	900	1,130	0.77	0.33	0.44	Gravel Wetland	900	$6,000	$1,500	2.5	$18,750	$56,800	$20.83	$75,300
15	Rte 7 Retrofit #4	A	0.77	0.72	0.05	94	0.06	0.043	2,490	1,870	1.84	0.74	1.10	Gravel Wetland	2,490	$15,000	$3,750	2.5	$46,875	$63,300	$18.83	$64,900
16	Rte 7 Retrofit #5 - Swale Near Kitchens By Design	A	0.91	0.32	0.59	35	0.027	0.038	1,180	1,660	1.09	0.49	0.60	Gravel Wetland	1,180	$8,000	$2,000	2.5	$25,000	$51,000	$21.19	$79,400
17	Rte 7 Retrofit #6	A/D	1.98	1.24	0.74	63	0.101	0.104	4,390	4,530	3.49	1.77	1.72	Bioretention	3,293	$35,000	$8,750	2.5	$109,375	$61,800	$33.22	$88,000

Table 4
Upland Alternatives Evaulation Matrix
Deer Brook Gully Restoration

Site ID	Site Name	Need	Proposed Approach	Web Soil Survey Mapped HSG	Existing Environmental Concerns (scale 1-5)	Environmental Priority (scale 1-5)	Constructability (scale 1-3)	Ease of Operation (scale 1-3)	P Removal Cost Effectiveness (Scale 1-3)	Volume Mgmt. Cost Effectiveness (Scale 1-3)	Imp. Treatment Cost Effectiveness (Scale 1-3)	Implementation Score	Project Type	Estimated Implementation Cost	Green Infrastructure Opportunity (Y or N)	Need for Additional Engineering
1	Interstate Auto Parking Disconnection	Retrofit opportunity	With minor regrading, the gravel parking lot south of Interstate Auto building could be made to drain to a gravel wetland or other stormwater practice.	A/D	1	2	2	2	2	3	3	15	Private	L	Y	M
2	Rte 7 - 104A Intersection Island	Retrofit opportunity	Use existing green space to capture runoff from closed drainage system in water quality/storage retrofit. Green space may be expanded towards Interstate Auto as a result of intersection upgrade. Pavement in front of Interstate Auto may also be removed.	A/D	2	4	1	2	2	1	2	14	State	H	Y	H
3	Interstate Auto Rain Garden	Retrofit opportunity	Capture rooftop runoff from portions of Interstate Auto building in a small rain garden. A small portion of the gravel driveway may also be made to drain to this practice.	A/D	1	2	3	3	2	1	2	14	Private	L	Y	M
4	Office Roof Disconnection #1	Retrofit opportunity	Direct existing gutter and downspout to dry well or expanded rain garden.	A/D	2	2	2	3	2	2	2	15	Private	L	Y	M
5	Office Roof Disconnection #2	Retrofit opportunity	Confirm outlet of existing downspout to roof leader. If it currently outlets to gully, propose disconnection via overland flow, rain garden, or dry well.	A/D	2	2	2	3	2	2	2	15	Private	L	Y	M
6	Roof Runoff and Sump Disconnection	Retrofit opportunity	Roof runoff from majority of residences, and line from sump pump, drain through the backyard to head of gully. Opportunity to redirect runoff to a small rain garden in backyard.	A/D	1	2	3	3	1	1	1	12	Private	L	Y	M
7	1193 Rte 7 Detention	Retrofit opportunity	Create a detention basin, subsurface gravel wetland, or other combination water quality and storage retrofit either in a green space or where trees are at head of contributing channel to gully.	A	2	3	2	2	2	2	3	16	Private	M	Y	H
8	1193 Rte 7 Alternate Retrofit	Retrofit opportunity	As part of intersection upgrade, consider installing a catch basin with offline water quality treatment instead of upgrade proposed as retrofit number seven.	C/D	2	3	2	2	3	3	3	18	State	L	Y	H
9	Blake's Auto Service Retrofit	Retrofit existing BMP	Consider a small gravel wetland or bioretention practice in deep swale next to Route 7.	A/D	1	2	2	3	2	2	2	14	State	L	Y	H
10	Peoples Trust Company Storage & WQ Retrofit	Retrofit opportunity	Daylight culvert between catch basin and manhole and implement a storage and/or water quality practice in ROW.	A/D	3	4	2	3	2	2	2	18	State	M	Y	H
11	Hair Designs Swale Improvements	Retrofit existing BMP	Increase swale geometry to store runoff and improve water quality. Drainage from bank parking lot and grass lawn is conveyed to this swale. Owner mentioned flooding issues at CB4 during large events. Consider bioretention or gravel wetland.	A/D	3	1	2	3	3	2	3	17	State	L	Y	H
12	Rte 7 Retrofit #1	Retrofit existing BMP	Implement gravel wetlands or storage retrofit in existing swale next to Route 7.	A/D	3	5	2	3	2	2	2	19	State	M	Y	H
13	Rte 7 Retrofit #2	Retrofit existing BMP	Create potential gravel wetland in swale. Moderate head anticipated along length of basin. Captures flow from road and field.	A	3	5	2	3	2	2	2	19	State	MH	Y	H
14	Rte 7 Retrofit #3	Retrofit existing BMP	Potentially retrofit existing swale outlet pipe at Georgia Market entrance with stand pipe that has low flow channel and high flow discharge, to create more volume storage. Upsize existing culvert.	A	3	5	2	3	2	2	2	19	State	L	Y	H
15	Rte 7 Retrofit #4	Retrofit existing BMP	Retrofit existing swale at Georgia Market to increase storage and water quality treatment. Also right size driveway culverts at north and south ends of swale. Culvert inlet at driveway on north end is crushed.	A	3	5	2	3	2	2	2	19	State	M	Y	H
16	Rte 7 Retrofit #5 - Swale Near Kitchens By Design	Retrofit existing BMP	Stormwater flows overland via drain pipe from the south, and overland via sheet flow from the north. Construct gravel wetlands, install an outlet structure at the catch basin inlet. Create 2 to 3 feet of ponding as well as 2 to 3 feet of media storage.	A	3	5	2	3	2	2	2	19	State	M	Y	H
17	Rte 7 Retrofit #6	Retrofit existing BMP	Install measures in swale that will pond up water here to provide additional storage volume and possible water quality treatment.	A/D	3	5	1	3	2	1	2	17	State	MH	Y	H

4. Gully Remediation Alternatives

The following provides a summary of work completed by Stone under Task 3 of the project, which consisted of an analysis of alternatives for remediation of the gully. Stone reviewed the 2007 Deer Brook Remediation and Stormwater Treatment Summary Report (ESPC, 2007) prepared for the NRPC, and prepared an updated analysis of alternatives, the details of which are described in this section.

The updated analysis included elimination of alternatives from the 2007 study deemed inapplicable with respect to current gully conditions, and inclusion of alternatives anticipated to be effective components of gully remediation (Section 4.1). Feasible alternatives were adjusted as needed, and paired with additional alternatives developed by Stone for varying aspects of the project (Section 4.2). The final set of alternatives evaluated is provided in the top portion of the Summary of Alternatives Matrix (Table 5). A group of alternatives was chosen to produce a selected remedy, aimed at providing for complete restoration of the gully (Section 4.3). Finally, next steps for the project, with respect to review by project stakeholders, and the 'bigger picture' steps that may be required as we approach final design, are included (Section 4.4).

4.1. Review of the 2007 Analysis of Alternatives

The 2007 study alternatives are included in Table 5, along the bottom half of the matrix. Alternatives that were eliminated are crossed out with red lines. Many of the 2007 study alternatives were incorporated into Stone's alternatives, often with additional detail or small revisions. The final set of alternatives available for development of the selected alternative are provided on the top half of Table 5, and discussed in detail in Section 4.2. The analysis of alternatives table that was included in the 2007 study is provided as Appendix 2 for reference.

Stone reviewed the analysis of alternatives provided in the 2007 study, and evaluated each alternative with respect to the following criteria:

1. Anticipated effectiveness relative to existing conditions in the gully
2. Constructability
3. Anticipated performance compared to alternatives within the same restoration category, as listed in Table 5.

Alternatives eliminated, along with justification for their removal, are summarized in Table 6.

Table 5
Deer Brook Gully Restoration Project
Summary of Alternatives

Restoration Category

Main Channel

Bed

Rock lined channel
Line entire channel cross section, w/ step-pool system (up to 100-year storm)

Modified rock lined channel
Line channel up to top of banks, w/ step-pool system (up to 2-year storm)

Floodplains/Banks

Seed/vegetate floodplain/banks
With erosion control fabric, use willow/ alder stakes, live fascines, native shrubs, etc.

Vegetation/ stabilization Option 1
Plant floodplains (as above), Install rootwad revetment to stabilize bank toe and slopes as needed (wood can serve as nursing logs in future)

Vegetation/ stabilization Option 2
Plant floodplains (as above), install block gravity wall, live crib walls, etc. to stabilize bank toe and slopes

Poor Soils

Crushed stone addition
Install dense graded crushed stone to adequate bearing capacity where required under channel bed

Tributary Channels

Armoring
Adequate armoring installed to stone angle of repose

Redirection of Residential Discharges/ Perimeter drain
Redirect drains or install drain around Gully head to prevent formation of tributary channels

Outfall Pipe

Structure/pipe modifications
Locate missing MH; install larger/deeper MH & larger pipe to gully; drop inlet elevation of pipe

Drop manhole system
Install drop MH and piping system, bypassing steepest Gully section

Pipe extension
Extend ~50' from proposed outlet w/ flexible or concrete pipe, bypassing steepest Gully section; consider installing pipe in steel casing

Outfall diffuser
Install at outfall pipe to reduce discharge velocity

Gully Head Stabilization

Filling the Gully
Fill head to upland elevations, for ~400 LF along Gully perimeter (included to provide upper range of restoration costs)

Wall and stabilization stone
Block wall -or-
Sheet pile -or-
Vertical I-bean w/ log wall -or-
Mechanically stabilized earth (MSE) wall
to Elev. 365'; fill with stabilization stone at 1:1 slope

Stone at Gully head
Install along head slope as necessary to stabilize slope

Check dam
Install at start of restored channel/end of Gully head

Source Control

Stone Task 2
See deliverable regarding upland BMPs

Flow diversions
Divert portion of flows out of watershed, potentially via flexible pipe to Deer Brook

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Deer Brook Gully Remediation and Stormwater Treatment Alternatives
ESPC, 2007

Bed:

- Rock-lined channel
- Stepped pools
- ~~Gabion/boulder check dam~~
- Log weir
- Live stakes/ plantings along banks

Floodplains/Banks:

Failure Type: Wet/ Active Slumping
- Live cribbing
- Gravity wall
- ~~Vegetated riprap~~

Failure Type: GW Seepage/Wet Unstable Soil
- Live staking
- Live fascines

Failure Type: Slides/ Slope Failures
- ~~Vegetated riprap~~
- Live fascines

Poor Soils:

- Layer of geotextile fabric with choking stone under rock channel

Tributary Channels:

- Diversion channels
- Slope down drains

Source Control:

Including Velocity Reduction
- ~~Detention pond @ gully head~~
- ~~Detention pond at Route 7/104A triangle~~
- Rock outlet protection
- Upland BMPs (Check dams in swales, roof drains, bioretention)

Table 6. Summary of Eliminated Alternatives from the 2007 Study

Alternative Eliminated	Justification
Gabion check dam	Anticipated effectiveness relative to existing gully conditions is low; anticipated performance compared to alternatives within the same restoration category is low; Stone staff have observed gabion wire deteriorating and baskets losing structural stability over time.
Vegetated riprap	Constructability/installation of vegetation in the thickness of stone anticipated may be difficult; anticipated performance compared to alternatives within the same restoration category is low; vegetation not expected to root well in the thickness of stone anticipated.
Detention pond at gully head	Constructability would be difficult due to presence of soils with inadequate bearing capacity; anticipated performance compared to alternatives within the same restoration category is low; other alternatives that reduce flow velocities (i.e. step pools) exist.
Detention pond at Rt. 7/104A triangle	Constructability of a pond may be difficult, due to regulatory requirements, and to limited surface area and proximity to major roadways. This alternative is not eliminated, as other stormwater practices have been considered at this location. See Task 2 (Section 3) deliverable.

Date and Author: (10-12-2018), G. Bolin

4.2. Updates to the Analysis of Alternatives

This section summarizes the alternatives developed by Stone, as listed in the top portion of Table 5. A total of 7 restoration categories are listed along the top of the matrix (i.e. Main Channel Bed, Tributary Channels, Outfall Pipe, etc.) and alternatives for restoration within each category are provided below the headings. Alternatives from the 2007 study are also organized under the restoration categories along the bottom portion of the matrix. Conceptual level construction costs for each alternative are provided following each alternative summary. Construction costs were developed using the Vermont Agency of Transportation (VTrans) 5-year average unit prices, ranging from July 2012 to June 2017 (http://vtrans.vermont.gov/sites/aot/files/estimating/documents/5YearEnglishAveragedPriceList11.pdf), as adjusted based on recent construction projects managed by Stone staff. Conceptual engineering drawings that illustrate selected details of the alternatives are included in Appendix 3.

4.2.1. Main Channel Bed

Stabilization of the main channel bed is the first step in remediating the gully. Continued downcutting of the bed contributes to 1) undermining of the toe of slope at the gully head, leading to head mass failures and landslides, and 2) an increase in bank slope in the main channel over time, resulting in bank instability and slope failure. Stormwater runoff moving through the channel during rainfall and snowmelt events also contributes to bank erosion, as the channel adjusts its cross-sectional area to accommodate flow increases resulting from impervious cover additions. The alternatives considered include a conventional rock lined channel (including rock lined low-flow channel, floodplains and banks) sized to accommodate up to the 100-year storm, and a combined approach where the low-flow channel is rock-lined, with options for incorporating vegetation and bioengineered slope stability measures in floodplains and banks.

- **Rock lined channel** – Under this alternative, the entire main channel will be regraded to stabilize banks, shaped to include a low-flow channel that will contain up to the 1.5 to 2-year storm event, and sized to accommodate the 100-year storm event. The channel will be lined with stone to an elevation above the 100-year water surface elevation, and stone in the channel bed will be installed to incorporate riffle-step-pool sequences, where energy will be dissipated in the pools.

Riffles will not exceed slopes of 2%, and steps will not exceed drops of 3'. The channel profile on Sheet 3 provides an illustration of the riffle-step-pool sequences.

- Advantages –
  - Protects bare soils throughout entire cross section
  - Potentially easier to construct
- Disadvantages –
  - Does not incorporate vegetation, and if failure occurs, there are no other stability measures present
  - Site soils are unconsolidated, wet and erodible; plant root penetration may be the best means of stabilization, which is not provided by this alternative.
- Costs - $90,000

- **Modified rock lined channel** – Similar to the rock-lined channel described above, the channel will be lined with stone, but only up to the top of banks of the low-flow channel. Floodplains and banks, however, will be stabilized using natural materials, (Section 4.2.2).
  - Advantages –
    - Protects bare soils throughout the low-flow channel
    - Incorporates vegetation in floodplains and banks, adding redundancy to soil stability measures
    - Provides root penetration, which may be the best means of stabilizing site soils.
  - Disadvantages –
    - Incorporation of other stabilization measures adds complexity to construction and may increase construction time and cost
    - Vegetation will take time to establish, and success and survival of seed and plants is not guaranteed
    - Plant selection may be limited due to unique soil characteristics.
  - Costs - $30,000

4.2.2. Main Channel Floodplains and Banks

We recommend that the following alternatives for floodplains and banks be incorporated only into the Modified Rock Lined Channel alternative above. Our experience has been that attempts to incorporate vegetation in completely rock lined channels are not sustainable over the long term.

- **Seed/vegetate floodplains and banks –** Under this alternative, seeding followed by erosion control fabric and planting of native vegetation will occur on all exposed floodplains and banks. Seed will consist of a conservation or wetland mix; erosion control fabric will consist of woven organic materials; and vegetation will include but not be limited to willow and alder stakes, native shrubs, live fascines, trees, etc.
  - Advantages –
    - Provides root penetration into soils, which may be the best means of stabilizing site soils
    - Erosion fabric will provide 1-2 years of soil stability, allowing time for vegetation to root and establish
    - Live stakes will grow quickly and develop thickets that will stabilize soil by binding particles together, and will utilize excess moisture in soils
    - Fascines will protect slope from shallow slides (1 to 2 foot depth)

- Shrubs and trees will grow deep roots into stable soils on shallow slopes, extracting moisture from soils over the long term.
- Disadvantages –
  - Vegetation will take time to establish, and success and survival of seed and plants is not guaranteed
  - Plant selection may be limited due to unique soil characteristics.
- Costs - $70,000

- **Vegetation/stabilization Option 1** – With this alternative, floodplains will be planted as described above, but rootwad revetments will be installed where the bank toe and bank slopes require stabilization. Revetments could consist of existing tree fall already in the channel and gully. Placed wood could serve as nursing logs and support future growth in the years following construction (Marcot 2017). See Sheet 2 in Appendix 3 for rootwad revetment detail.
- **Vegetation/stabilization Option 2** – This alternative has the same purpose as Option 1, but a block gravity wall, or live crib wall will be installed in place of trees. See Sheet 2 in Appendix 3 for gravity and live crib wall details.
  - Advantages –
    - All options protect bare soils at the bank toe and along bank slopes, and provide long-term structural stability
    - Wood option makes use of fallen trees and will serve as nursing logs over the long-term
    - Wood and live crib walls provide additional surface area for plantings, in an offset configuration
    - Block walls are relatively easy to construct.
  - Disadvantages –
    - Wood and crib walls may take additional time to construct
    - Block gravity walls will be made of concrete and are not a 'natural' material
    - Some contractors may view these methods as complex, and construction may be more expensive than similar alternatives.
  - Costs - $60,000 (Option 1), $40,000 (Option 2)

4.2.3. Unstable Soils in the Main Channel

Surficial soils across much of the gully and its contributing channels and side slopes are finely textured, easily erodible, and massively structured. These properties have resulted in a variety of different types of ground conditions and slope instabilities including slumping, seepage, cutting, recession and erosion, as observed in the 2007 study and continuing to present. The gray silty clay underlying the topsoil and shallow sandier soils is of particular concern for the design and construction of stone-based stabilization structures. This material constitutes a poor footing for many of the remedial measures proposed in this memo. The alternative below provides a reliable means of improving bearing capacity for relatively small areas (<100 SF).

- **Crushed stone addition** – Where materials with poor bearing capacity have been identified during the design phase or are encountered during construction, a dense graded crushed stone will be installed and compacted to adequate bearing capacity, to serve as a proper foundation for the channel bed. Once bearing capacity is achieved, as determined by the Engineer, channel construction (Section 2.1) will proceed.
  - Advantages –

    - An inexpensive means for providing adequate bearing capacity and improving success for rock placement during construction (however costs can vary, see below)
    - Demonstrated record of success on past projects.
  - Disadvantages –
    - Typically applicable over small to moderate work areas
    - Depending on soil conditions, may require placement of a significant volume of stone at depth (however this method is still anticipated to be the most affordable means of achieving adequate bearing capacity)
  - Costs - $10,000

4.2.4. Tributary Channels

Three tributary channels were identified in the 2007 study – one behind Interstate Auto and two others on the opposite bank, on the Dusty Trail Realty parcel. The AirShark surveys and recent field inspections confirm that the channel behind Interstate Auto still exists. A large volume of white stone was placed along the gully head slope on the Dusty Trail Realty parcel, in the area of the two remaining previously identified tributary channels. Although the Dusty Trail Realty owners likely placed this material to remediate the channels, a new tributary channel is forming through the placed stone, indicating partial failure of the remedy. The following alternatives offer some basic approaches for dealing with tributary flow and downcutting.

- **Armoring** – an adequate layer of armoring will be installed over the surface area of the tributary channel, to a depth determined via hydraulic analysis. Stone will be placed at a reasonable angle of repose relative to the dominant stone particle size.
  - Advantages –
    - A relatively straightforward way to address tributary channels.
  - Disadvantages –
    - Construction may be difficult, if occurring on steep slopes
    - Does not address the source of flow/erosion
    - Can become costly if tributary channel area is large
    - May only be applicable up to a certain slope, and other means may be required.
  - Costs - $12,000
- **Redirection of residential discharges** and/or perimeter drain– A 4" PVC pipe, suspected to be a foundation drain or sump pump pipe, is visible and discharging at the gully head. Removal or redirection of the discharge to a location of milder slopes and stable soils is suggested. An armored outlet could also be incorporated into the design. Additionally, Sheet 1 of the 2007 study shows a sump pipe leading to the largest tributary channel shown on the plan; this is at the western edge of the area of tributary channels remediated by the Dusty Trail Realty owners. Currently, tributary cutting is present within the perimeter of the stone fill. The presence of the sump pump pipe is unconfirmed, and it may now be buried in the placed stone. Further investigation is warranted and will be performed under Task 4 (Section 6). If still present and discharging, removal or redirection of the flow is suggested as part of this alternative. Another option would be to install a perimeter drain in the uplands adjacent to the commercial and/or residential properties north of the outfall, collect flow from one or more residential drains, and discharge to a location of milder slopes and stable soils, and potentially incorporate an armored outlet.
  - Advantages –

        - If residential drain discharge is a major factor in creation of the tributary channel along the northern bank, redirection could be a relatively easy fix.
        - The perimeter drain would be relatively simple to construct.
        - Both options offer a reasonable cost of construction.
    - Disadvantages –
        - Removal of the pipe may require excavation of the stone fill, potentially leading to slope instability and loss of material into the gully.
        - Due to unstable soils at the gully head, installation of the perimeter drain would likely be done by hand or with very small equipment.
        - Residential drain and sump pump discharges are a relatively small-volume contributor to the overall flows into the gully.
    - Costs - $8,000

4.2.5. Outfall Pipe

The existing outfall pipe discharges at the gully head, which is the steepest portion of the gully (Segments 6 and 7 as shown on the channel profile, Sheet 3 in Appendix 3). The combination of steep slope, unconsolidated and unstable soils, and soil saturation makes this slope highly unstable. Mass failures and slides have occurred in the recent past, and the edge of the gully has migrated close to the adjacent residential and commercial structures. Tension cracks are visible behind the Interstate Auto property, as well as behind 1151 US Rte. 7 (north of Interstate Auto). Without improvements, it is likely that slope instability will continue to threaten these structures, as the outfall continues to discharge the high velocity flows that result in erosive conditions.

Unlike a gully associated with a stream or river, it is possible to move the outfall—in this case, the water source causing the erosion--away from the head of the gully. The goals of the following alternatives are therefore to move the outfall discharge point away from the gully head and closer to the main channel where the potential for stabilization of the channel bed, floodplains, and banks is high, and/or to reduce velocity at the outfall pipe, minimizing erosive conditions.

The first drainage structure upstream of the gully outfall, in the parking lot to the north of Interstate Auto, is covered with pavement (Drawing 1, appendix 3). The exact location of the structure is not known. For alternatives below that include modifications or upgrades to the structure, it was assumed that structure location will be performed prior to the completion of Task 4 (Section 6; via metal detectors, cameras, etc.), and that those costs are not included as part of the alternative.

- **Structure/pipe modifications** – the upstream drainage structure will be located, removed, and replaced with a larger, deeper structure (i.e. catch basin). The size of the pipe discharging to the gully will also be increased, and the pipe invert will be set to a deeper elevation. The increased pipe size will result in lower discharge velocities, and the discharge will occur at a lower elevation along the steep slope. The elevation drop will depend on conditions of the buried structure, incoming pipes, soil conditions, etc., and will most likely be no greater than 10 feet.
    - Advantages –
        - Results in lower discharge velocities
        - Discharge will occur at a lower elevation along the head slope.
    - Disadvantages –

        - Unknown location of structure may prolong construction of this alternative, and result in increased construction costs.
    - Costs - $60,000
- **Drop manholes and piping system extension –** a series of drop manholes and associated piping will be installed in the gully along the head slope. The proposed outfall will discharge into the top of the first drop manhole. Water will fall the depth of the structure (~10 feet), be conveyed to the next drop manhole, drop a similar depth, and then be conveyed to the head of the restored channel via a short length of 36" pipe. The two drop manholes will provide for contained energy dissipation inside the mahole structures. The manholes will have to be buried at a reasonable depth to retain structural integrity. Additional structural support via bracing or tie-backs may be required. A total of 2 10' deep drop manholes and 36 LF of 36" diameter pipe is required.
    - Advantages –
        - Discharge will occur at a lower elevation along the head slope.
        - System provides for energy dissipation in a contained system.
    - Disadvantages –
        - Installation and excavation required to install the manholes may be challenging, due to soil conditions and slopes.
        - Stabilizing and anchoring the structure may prove difficult/expensive.
    - Costs - $90,000
- **Pipe extension –** the outfall pipe will be extended 53' from the proposed outlet location, with a concrete pipe or material of similar strength. An extension of this length would bypass the steepest section of the gully and discharge at the head of the restored main channel (Section 4.2.1). Additional measures to protect the pipe in the event of a slide or tree fall could be considered, including installation of the pipe in a steel casing.
    - Advantages –
        - Moves the outfall discharge away from the steepest slope, which is arguably the most vulnerable and unstable section of the gully.
    - Disadvantages –
        - Pipe could be vulnerable over time, if head slope materials move or shift
        - Flow could gain velocity and energy as it travels through the pipe down the slope, introducing additional energy at the head of the main channel
        - Additional protection measures would be costly
        - Pipe will be difficult to construct.
    - Costs - $45,000
- **Outfall diffuser –** A diffuser will be installed at the end of the outfall pipe that will distribute flow over a wider area and reduce discharge velocities.
    - Advantages –
        - Flow velocity and energy reduction would help to solve soil erosion issues through channel
        - Low relative cost.
    - Disadvantages –
        - May need a large area to dissipate flows
        - May need to modify the design of the upstream end of the main channel to accept wide flow array from the diffuser.
    - Costs - $25,000

4.2.6. Gully Head Stabilization

Stabilizing the main channel bed will allow the gully head's toe of slope to cease adjusting vertically. Stabilization of the head slope face is also necessary to protect abutting structures. Alternatives include filling vertically along the slope face, as well as placing material along or on top of the slope face. The depth and width of the gully is substantial, and so these alternatives will likely be the most costly component of restoration work.

- **Filling the gully –** With this option, the gully will be filled to an elevation even with the uplands immediately behind the residential and commercial buildings along the gully perimeter. Fill will be placed for approximately 400' along the perimeter of the gully head. Although this alternative is likely infeasible, it is included to define the upper range of potential restoration costs.
  - Advantages –
    - Solves the most significant bank instability issues at and near the gully head, with high confidence
    - Provides long term protection of adjacent buildings.
  - Disadvantages –
    - Likely infeasible due to high cost
    - Would require significant amount of fill
    - Ground stabilization measures may need to be implemented to accommodate machines dumping material over edge of gully, or an alternate access way would be required.
  - Costs - $375,000
- **Wall and stabilization stone** – Under this alternative, a structural wall will be installed to elevation 365', at an offset approximately 60' from the gully perimeter. The type of wall could range from a retaining wall comprised of large blocks, sheet pile, a combined I-beam and log wall, or a mechanically stabilized earth (MSE) wall. Stone fill will then be placed from the top of the wall up to the upland elevation, at a slope of 1:1, or an angle of repose consistent with the median stone size of the fill.
  - Advantages –
    - Would remediate many bank instability issues at the gully head
    - Would provide increased protection to adjacent buildings.
    - Placement of the wall, and of stabilization fill behind the wall, would return beneficial use of the portion of properties abutting the gully head to the abutting owners.
  - Disadvantages –
    - Likely infeasible due to high cost
    - Would require significant fill
    - Would require significant engineering design
    - Sheet pile and I-beam options may not be feasible due to large boulders at bottom of gully, preventing penetration of bottom soils.
    - Design of these types of walls and stabilization systems is outside the scope of the current contract for stormwater retrofit and gully channel stabilization improvements.
  - Costs - $175,000 - $250,000

- **Stone at gully head** – stone will be placed along the head slope face of the gully, from the uplands adjacent to the buildings down to the toe of the slope, at a gradation and thickness determined by hydraulic and geotechnical analysis (currently set to 3'). This will occur along the gully perimeter, as shown on Sheet 1 (Appendix 3). The intent of this alternative is to stabilize the slope, reduce instability and reduce the chance of mass failures and slides.
  - Advantages –
    - Would mitigate bank instability issues at the gully head
    - Would provide protection of adjacent buildings, but not to the extent of the first two options
    - Cost would be reasonable compared to first two options.
  - Disadvantages –
    - Requires substantial stone fill
    - Land lost to property owners at the gully head would not be reclaimed for use
    - Remedy may conflict with future municipal plans that incentivize compact development near the US Route 7/VT Route 104 intersection.
  - Costs - $140,000
- **Check dam** – a check dam will be installed at the head of the restored main channel (Section 2.1), which also coincides with the downstream end of the steepest section of the gully. This alternative will serve to stabilize the gully head toe of slope near the restored main channel.
  - Advantages –
    - Costs are reasonable compared to other options.
  - Disadvantages –
    - Stabilizes toe of slope in area of main channel, but nowhere else.
  - Costs - $40,000

4.2.7. Flow Source Control

Most alternatives related to flow source control were provided in Stone's October 10, 2018 Task 2 technical memo (Section 3). That effort included a survey of the upland portions of the watershed to identify stormwater management opportunities, aimed at reducing stormwater runoff impacts to the head of the gully. The flow diversion alternative discussed below was not included in that deliverable.

- **Flow diversion** – the intent of this alternative is to divert stormwater flows that originate on the western side of Route 7 to the north, out of the watershed. Taking advantage of the narrow width of the drainage area towards its northern end, flow would be routed through the open space between the Maplefields (Mobil) gas station and the I-89 northbound off ramp at Exit 18 via a stormwater piping system. However, a review of the VTrans Small Culvert Inventory webmap (https://www.arcgis.com/home/webmap/viewer.html?webmap=c1c6135f1c0a468c8758882160ef0950) indicates that existing infrastructure sends flows from this area east (rather than west) under Route 7 via a degraded 18" cross culvert and back into Deer Brook, slightly north of the gully drainage area. In addition to the severe lack of capacity of the existing cross culvert, a significant concern regarding this alternative is the potential to create a new source of erosion at the diversion discharge outlet, which would be located east of Route 7 and just upstream of our existing gully.
  - Advantages –
    - Reduces flow through gully, which is the root cause of erosion.

- Disadvantages –
    - Existing infrastructure to the immediate north and under Route 7 is not conducive to the addition of flows.
    - The potential to create a new source of erosion in the sub-drainage area just north of the gully is high.
    - May be infeasible due to cost, difficulty of construction and regulatory restrictions.

4.3. Preferred Alternative

As stated in the 2007 report, storm flows from the culvert at the head of the gully, and concentrated runoff flowing down the sides of the gully (tributary channels), are the root causes of erosion. The nature of the site soils also plays a large role in the erodibility and structural integrity of the channel bed, banks, and the gully head slope.

The key objectives of the selected remedy are to:

- Arrest and stabilize channel downcutting in the main channel (establishing grade control at the toe of the gully head slopes);
- Relocate the discharge point of the closed drainage system outfall; and
- Stabilize the gully head slope via a feasible alternative at reasonable cost.

The preferred alternative consists of a modified rock channel with banks stabilized via a combination of vegetative and structural means; modifications to the gully outfall and upstream drainage structure; a drop manhole and piping system that extends the gully to the start of the restored main channel and bypasses the steepest areas of the gully; and placement of stone along the gully head and on tributary channels. The selected alternatives that comprise our preferred remedy are indicated on Table 5, and are bordered in red boxes. They are described in further detail below, and the order in which they are discussed roughly follows the anticipated construction sequence. A summary of costs for the preferred remedy are provided following the discussion. Conceptual engineering drawings that illustrate the selected alternative are included in Appendix 3.

The preferred alternative includes a modified rock lined channel, lined only to the top of banks of the low-flow channel. Within the channel, stones will be placed to create riffle-step-pool sequences per the profile on Sheet 3 of the design plans. Riffles will be set at a 2% slope, much milder than the range of slopes throughout the existing channel (3.6% – 16.9%), as illustrated in the channel profile, Sheet 3. The maximum drop from a step to pool will not exceed 3’, so that the steps and pools are constructible, and energy dissipation in the pools is limited, ensuring maintenance of pool structural integrity over the long term. Pool tail crests will be constructed as grade controls, and material made to construct the steps, pools and grade controls will be sized to be immobile past the 100-year storm event.

Floodplains and banks will be built following Vegetation/Stabilization Option 1 or 2, depending on the condition of the bank soils. Floodplains immediately adjacent to channel top of banks will be seeded, erosion control fabric made of organic fibers will be placed over bare soils and seed, and live stakes (willow, alder, etc.), native shrubs, trees and live fascines will be planted via small slits in the fabric. Depending on the condition of the bank toe and slope (i.e. stable, slumping, wet soil/seepage, slides/slope failures, etc.) wood logs, live crib walls or block gravity walls will be placed as needed to stabilize the bank toe and slopes.

Where unstable soils have been identified, and in the event that the contractor encounters unsuitable soils during bed and bank stabilization construction, dense graded crushed stone will be placed until adequate bearing capacity is achieved, as determined by the Engineer.

Tributary channels conveying flow from the uplands will receive an appropriate layer of stone, placed at an angle of repose that matches the dominant particle size in the stone gradation. Additionally, any existing sump pump or foundation drains that are known to flow to tributary channels will be redirected to a perimeter drain, which will lead to a stabilized channel on a milder slope, with outlet protection.

Next steps include locating the drainage structure that is currently buried under pavement, in the parking lot just north of the Interstate Auto building. The structure will be exposed, and a trench will be dug above the gully discharge pipe. Both the structure and the pipe will be removed, and replaced with a minimum 10' deep catch basin, and a 36" reinforced concrete pipe (RCP), respectively. Connections of incoming pipes will be reestablished in the new catch basin, and the invert of the new outfall pipe, will enter the limits of the gully a minimum 5' lower than the existing invert. The new catch basin will have a standard grate and accept runoff from the paved parking lot.

The new pipe (which will be 2 times the diameter of the existing pipe), will discharge into a drop manhole at the gully head, and convey flow via 36" pipe to another drop manhole roughly halfway down the gully head slope. The drop manhole and piping system will provide a means for flow conveyance to the restored stream channel and bypass the steepest section of the gully (Segments 5 – 7 as shown on the channel profile, Sheet 3, Appendix 3). Pipe between the manholes will be installed on a bed of 1-1/2" gravel that will run down the slope face. Pipe joints will be mortared tongue and groove to ensure structural integrity and eliminate potential for exfiltration.

Installation of the pipe will be followed by placement of stone riprap placed over the entire head slope and as necessary for complete stabilization. Preliminary stone thickness is roughly 3', or to the top of the pipe extension discussed. Table 7 provides a summary of probable construction costs for the selected remedy.

Table 7. Conceptual Level Opinion of Probable Construction Costs for the Preferred Remedy

ITEM #	ITEM	AMOUNT		UNIT COST	TOTAL
1	CONSTRUCT ACCESS	1	LS	$20,000.00	$20,000
2	CLEARING AND GRUBBING	1	LS	$10,000.00	$10,000
3	DEBRIS REMOVAL	1	LS	$10,000.00	$10,000
4	PROCESS AND STOCKPILE DOWN TREES	1	LS	$5,000.00	$5,000
5	MODIFIED ROCK LINED CHANNEL	1	LS	$30,000.00	$30,000
6	SEED/VEGETATE FLOODPLAIN AND BANKS	1	LS	$70,000	$70,000
7	VEGETATION/STABILIZATION OPTIONS (COMBINATION OF 1 & 2)	1	LS	$50,000	$50,000
8	CRUSH STONE ADDITION	1	LS	$10,000	$10,000
9	TRIBUTARY CHANNEL ARMORING	1	LS	$12,000	$12,000
10	OUTFALL STRUCTURE/PIPE MODIFICATIONS	1	LS	$60,000	$60,000
11	DROP MANHOLES AND PIPING SYSTEM EXTENSION	1	LS	$90,000	$90,000
12	STONE AT GULLY HEAD	1	LS	$140,000	$140,000
13	DEWATERING/FLOW BYPASS	1	LS	$10,000.00	$10,000
14	EROSION PROTECTION AND SEDIMENT CONTROL	1	LS	$4,000	$4,000
15	RESTORE ACCESS TO EXISTING CONDITIONS	1	LS	$2,000	$2,000
				CONSTRUCTION TOTAL	***$523,000***
				PERMITTING (5%)	***$26,150***
				STAKE OUT (1%)	***$5,230***
				MOBILIZATION / DEMOBILIZATION (5%)	***$26,150***
				CONSTRUCTION OVERSIGHT (5%)	***$26,150***
				CONTINGENCY (25%)	***$130,750***
				TOTAL (ROUNDED TO NEAREST $100)	***$737,500***

5. Stakeholder & Landowner Coordination

The following provides a summary of work completed by Stone in preparation of Task 4. The majority of this work was beyond the contract scope of work, but was required in order to determine which projects had landowner buy-in and therefore the best potential for implementation.

During the months of December 2018 and January 2019, a series of coordination and outreach meetings were convened to discuss and advance the conceptual design deliverables developed by Stone for improved stormwater management in upland areas draining to the gully at the intersection of US Route 7 and VT Route 104A (Task 2, Section 3), and for restoration of the gully (Task 3, Section 4) – as well as for coordination with other active municipal planning work in the project area. Brief summaries of those meetings, as well as follow-up actions, are included below.

5.1. Georgia South Village Transportation Master Plan - Stormwater Coordination Meeting: 12/6/2018

This meeting was convened by NRPC, VHB, FNLC, and Stone in order to coordinate the efforts of the Georgia South Village Transportation Master Plan and Stone's stormwater planning and design efforts in the Deer Brook Gully. Attendees included:

- Amanda Holland and Taylor Newton, NRPC
- David Saladino, Erica Quallen, and Lucy Thayer, VHB
- Kent Henderson and Patrick Daunais, FNLC
- Gabe Bolin and Amy Macrellis, Stone
- Michael McCarthy, Georgia Town Administrator

The Georgia South Village Transportation Master Plan (TMP) covers that village area's zoning district, centered along US Route 7 from Ballard Road at the south end to north of I-89 Exit 18. The goal of the plan is to build development density in a traditional village center pattern while improving efficiency of movement for the traveling public. Major recommendations of the plan include improvements to the US Route 7 streetscape (which is a generous 4-5 rod right-of-way), reclaiming existing pavement for green space and/or green stormwater infrastructure, improvements at the US Route 7-VT Route 104A intersection (to include either a turning lane/slip lanes or a roundabout), and implementation of a form-based code for the zoning district that includes grid streets connecting to US Route 7, limits on building footprint size (20,000 SF), and a three-story maximum building height. Public input received on the draft TMP indicates that maintaining sustained through traffic on US Route 7 is preferred. The plan requires substantial infrastructure improvements (wastewater, water supply, and stormwater) for successful implementation. If wastewater treatment capacity can be secured, implementation of next steps for this plan could proceed in the 10- to 20-year time frame, but realistically, it may take 40 years or more for substantial progress to occur.

Stone reviewed the preferred options for upland stormwater improvements, emphasizing that the highest-priority concept designs rely on existing swales in the US Route 7 right-of-way as essential elements. The proposed TMP concept plan converts these swales to tree-planted green space. Stone and VHB discussed means by which stormwater treatment and storage could be integrated into typical sections for the treelawn in the final TMP (such as tree trenches, structural soils/Silva Cells, and underground chamber storage).

The team members discussed overall project timing: Stone's design work will be complete in the spring of 2019, pending further coordination with VTrans, and construction of improvements in the upland areas is anticipated in the next 3 years. It is estimated that VTrans may take 12-15 years to advance design and construction of any improvements to the US Route 7/VT Route 104A intersection. Overall, if Stone prioritizes and advances upland improvements in the VTrans right-of-way along US Route 7 outside of the intersection area, these improvements should last 20-30 years or more. Thus, by the time major reconstruction in the US Route 7 right-of-way might be moving forward associated with TMP implementation, stormwater management practices installed in the next 3 years may be reaching the end of their design life.

Also discussed was an opportunity to design any new drainage systems in the TMP area south of I-89 to drain to the southwest and ultimately across Ballard Road, to tunnels and recently-improved drainage passing beneath I-89 through an area of substantially lower slope and risk, compared to the existing closed drainage system and outlet into the Deer Brook Gully.

5.2. Task 2-3 Deliverables Review and Project Coordination with VT DEC and VTrans: 1/3/2019

A meeting between FNLC, NRPC, Stone, and VT DEC and VTrans project stakeholders was convened to discuss the Deer Brook stormwater projects, walk through each of the priority projects, and to choose those projects that should receive a final design. Attendees included:

- Tyler Hanson, VTrans Maintenance and Operations Bureau
- Jim Pease and Danielle Owczarski, Vermont DEC Watershed Management Division
- Staci Pomeroy, Vermont DEC Rivers Program
- Amanda Holland, NRPC
- Kent Henderson and Patrick Daunais, FNLC
- Gabe Bolin and Amy Macrellis, Stone

Stone first presented the results of Task 2 (Section 3) and the upland priorities for stormwater management and water quality treatment improvements. Priorities in the upland are to slow velocities and provide water quality treatment; given the soil conditions across much of the project area, infiltration should be anticipated to be minimal.

The highest-priority upland improvements are overwhelmingly located within the VTrans right-of-way along US Route 7. Tyler stated that VTrans is not opposed to the proposed improvements and would be willing to take over ownership and maintenance of the best management practices after construction. VTrans will not have funding to construct improvements in the short term due to the ongoing phosphorus control planning process. VTrans is unwilling to allow direct stormline connections from private property to stormwater BMPs within the VTrans ROW. Overland or drainage ditch flow, such as currently exists from the Georgia Eye Center to Area 13, is acceptable but not optimal if VTrans BMPs are thus providing substantial water quality treatment benefits for private run-on.

Vermont DEC project partners were generally supportive of the high-priority projects within the US Route 7 right of way but questioned whether additional projects on private property could be advanced such that those owners also managed their "fair share" of runoff and/or run-on into the VTrans ROW. Suggestions included management of runoff from the western portion of the Georgia Market property to divert runoff from the parking lot draining to US Route 7 to the existing BMP at the eastern edge of the parking area, or improvements at the Georgia Eye Center.

Priority projects in the upland area to advance to final design include:

- Tier 1 priority: Areas 12, 14, and 16, pending confirmation by VTrans
- Tier 2 priority: Areas 17 and 2 (catch-basin risers only)
- Tier 3 priority (private property improvements): Area 15 (configuration of flow out of the VTrans ROW), Area 1, and Areas 7 or 8 if property owner commitment can be secured.

Follow-up actions include:

- Forward Task 2 and Task 3 deliverables to Tyler
- Send detailed breakdown of VTrans and private impervious cover by drainage area, as well as details of possible phosphorus removal credit, to Tyler
- Check VTrans district office plans for additional details about outfall / outlet pipe from the US Route 7 drainage system
- Determine whether an operational stormwater permit exists for the Georgia Eye Center

Stone next presented the preferred alternative for gully restoration. Priorities in the gully are to protect water quality in Deer Brook, and to stabilize the gully channel and sideslopes.

Vermont DEC Rivers Program staff were not supportive of the preferred alternative for gully restoration. Comments presented at the meeting included:

- A construction road would be needed to move material out, rock in
- Disturbance footprint is substantial
- Woody materials-based stabilization preferred
- Clay and sand in existing channel will “eat” the placed stone
- Some small areas in the gully are making benches, is the design able to accommodate this trapping?
- Focus more on upstream/upland improvements, give more opportunity for sediment trapping in channel

VT DEC Watershed Management Division staff were not supportive of the use of large stone to stabilize gully side slopes in the highly unstable areas at the head of the gully. DEC staff concerns were related to high cost and to potential liability falling to DEC if the remedy were to fail in the future.

VT DEC Watershed Management Division staff were also initially not supportive of the proposed drop manhole concept for conveying runoff beyond the existing outfall location and to a restored channel. Stone offered staff experience observing nearby projects in the Town of Colchester where this approach has been successfully applied by others to convey runoff down steep embankments.

Follow-up actions include:

- Stone to provide photos of Colchester site (Appendix 4)
- Stone to calculate volume and peak velocity reduction anticipated through implementation of Tier 1 and Tier 2 upland concepts (at minimum); consider adjusting gully channel preferred alternative accordingly

- Stone to consider using woody materials to a larger degree in channel and bank restoration design
- FNLC and Stone to meet with private landowners surrounding the head of the gully, to confirm willingness to participate in designs and to allow BMPs to be constructed on their properties

5.3. Landowner Meeting at 1193 Ethan Allen Highway (Dusty Trail Realty): 1/11/2019

Representatives from FNLC and Stone met with the owners of 1193 Ethan Allen Highway to discuss the Deer Brook stormwater projects, and to gauge the potential interest or willingness of the landowners to host a best management practice on their property (especially the Area 7 and/or Area 8 opportunities identified in Task 2, Section 3), and to discuss potential improvements in the gully. The parcel under discussion covers both the Dusty Trail Realty building and appurtenances, and the undeveloped land along the eastern edge of the project area, including the gully itself and the wooded land extending south to the cemetery.

Attendees included:

- Gary Blake (owner of the Dusty Trail Realty business)
- Yvonne Blake (mother of Gary and owner of the 1193 Ethan Allen Highway property)
- Kent Henderson, FNLC
- Amy Macrellis, Stone

Kent presented the project purpose and progress made over the summer and fall of 2018.

Mr. Blake shared that he is familiar with the issues affecting his business property and the adjoining lot to the south, and that he has installed substantial stone over the years to stop erosion stemming from US Route 7 run-on. He favors a catch-basin or other solution that captures runoff from the VTrans right-of-way before it impacts his property.

The well sited in the current flow path for that run-on serves five properties including the gas station – interfering with the well must be avoided. Mr. Blake is not opposed to siting a best management practice in his back lot, as there are no plans for future improvement in that area. He is not willing to provide maintenance on the practice.

Mr. Blake grew up in the white house to the south, and stated that the parking lot at the head of the gully has been filled in over time. When he was a child, he could sled from the outfall to the brook – there were no trees. The parcels to the south originally also contained a gas station with pumps in front, which were removed with the widening of US Route 7 following I-89 construction. The larger, now-vacant commercial building was a store. Ownership of both parcels immediately south has changed recently, and Mr. Blake stated that the new owner may be more receptive than the previous owner to suggestions for improvements that protect his property.

Follow-up actions include:

- Stone to follow up with VTrans regarding catch-basins or other improvements to capture the run-on from US Route 7 and direct to existing outfall (similar to Area 8 concept)

5.4. Landowner Meeting at 4504 Highbridge Road (VT Route 104A) (Interstate Auto Service): 1/11/2019

Representatives from FNLC and Stone met with the owner to discuss the Deer Brook stormwater projects, and to gauge his willingness to host a best management practice on the property (especially the Area 1 opportunity identified in Task 2), and to discuss potential improvements at the head of the gully. The parcel under discussion abuts the gully head to the north, and borders on the Blakes' property to the north and east.

Attendees included:

- David Burnor (owner of Interstate Automotive)
- Kent Henderson, FNLC
- Amy Macrellis, Stone

Kent presented the project purpose and progress made over the summer and fall of 2018.

Mr. Kaynor shared that he is familiar with the issues affecting his business property and the adjoining lot to the north, and that he has installed stone over the years to stop continued slumping of his parking and access area into the gully to the north. He is willing to allow design and construction of an expanded practice, similar to that installed by a VYCC crew next to his leachfield around 8 years ago, that directs runoff into the current lawn area and provides stable overflow away from the main gully.

Mr. Kaynor cautioned that his property line is roughly at the north-eastern tree line and that the area beyond is owned by the Blakes, so any improvement that affects that property should be coordinated with them. He further noted that, while he supports the gully restoration project and is willing to do his part, his property is not the main contributor to the erosion and instability occurring in the gully.

Follow-up actions include:

- Stone to proceed with final design for Area 1 improvements as envisioned in the Task 2 deliverable (Section 3).

5.5. Landowner Meeting at 1151 Ethan Allen Highway: 1/11/2019

Representatives from FNLC and Stone met with the new owner of this property and 1161 Ethan Allen Highway (parcel to the north and abutting Dusty Trail Realty) to discuss the Deer Brook stormwater projects, and to gauge his willingness to allow design and construction of improvements in his parking lot and at the head of the gully. The parcel under discussion contains the existing outlet of the US Route 7 closed drainage system and the head of the gully.

Attendees included:

- Terry Rooney (owner)
- Kent Henderson, FNLC
- Amy Macrellis and Gabe Bolin, Stone

Kent presented the project purpose and progress made over the summer and fall of 2018.

Mr. Rooney is stated that he is generally familiar with the issues affecting his business property. He purchased both properties, one at a time, within the last two years, and is beginning to plan for their redevelopment. He is familiar with VTrans' plans to eventually upgrade the intersection adjoining his land and understands that said improvements are not imminent. He is supportive of improvements that will protect his property and is willing to work with FNLC and Stone to potentially incorporate these design ideas into his redevelopment plans.

Follow-up actions include:

- Mr. Rooney to connect Stone with his design engineering partner (Trudell Consulting Engineers) to discuss the Deer Brook Gully restoration project and means to coordinate designs as redevelopment plans come into focus.

6. Final Engineering Designs

Stone delivered final engineering plans to FNLC on April 30, 2019 per the requirements of Task 4. Following prioritization of upland stormwater practices as outlined in Section 3, an evaluation of gully remediation alternatives provided in Section 4, and discussions and input provided by FNLC, VT DEC, landowners and other stakeholders as discussed in Section 5, the following designs were developed under this task and included in the final plans:

- **Upland Stormwater Practices**
  - Gravel Wetland at Area 12 across the highway from Georgia Auto Parts
  - Gravel Wetland at Area 1 behind Interstate Auto
  - Gravel Wetland at Area 15 near Georgia Market
  - Gravel Wetland at Area 16 near Whites Bikes & Outfitters
  - Catch Basin Riser at Area 2 at the Island at Intersection of Route 7 and 104a
  - Catch Basin Riser at Area 17 near the Franklin West Supervisory Union Office
  - Deep sump catch basin at Area 8 along Route 7 (incorporated into the closed drainage system upgrades discussed below)

- **Gully Restoration/Stabilization**
  - Closed drainage system upgrades including a drop manhole system to lower the gully outfall to the gully head toe of slope
  - Total of eight (8) log steps placed strategically throughout the gully channel

A summary of each project type and relevant costs developed to the 100% design level are provided below. The engineering design plans are provided in Appendix 5.

6.1. Gravel Wetlands

Gravel wetlands are a stormwater practice that route stormwater flows through a number of media layers that provide for efficient nutrient removal via biological (i.e. microbial) and physical (i.e. filtering) processes. A gravel layer at the bottom of the practice, which is typically designed to remain saturated acts as a subsurface storage reservoir, providing an anaerobic environment hospitable to microbes which in turn, provide for a environment well suited for nutrient removal.

The four (4) gravel wetlands proposed for this project include a 24” layer of 2” diameter double washed stone at the bottom of each wetland, and a low permeability liner under the gravel. Above the 2” gravel layer is a 4” layer of pea gravel which acts as an intermediate choker layer, followed by a minimum of 8” of wetland soil. The wetland soil will be planted with wetland plants native to the surrounding landscape. A stone weir is proposed in each wetland to provide for multiple stages of treatment, a system of pipes at the bottom of each practice provides a means for cleaning and an outlet structure will control outflows and allow for overflow during high flow events at each practice.

Stormwater runoff will enter the wetlands via overland flow and a proposed forebay to trap sediment, and via pipes that make up the existing closed drainage infrastructure network, as shown on the plans. Freeboard above the wetland soil layer provides for approximately 18-24" of storage during high flow events, which is defined by side berms at slopes of 1 vertical to 2 horizontal. Sheets 4 and 5 of the engineering plans show the location and site plans for each wetland, while Sheet 9 provides details and construction notes. Dimensions of each wetland vary according to the conditions at each site, however each cell is approximately 12' wide.

The proposed designs will accommodate more than 100% of the water quality volume for a 1" storm event (approximately 3,100 cubic feet), will provide water quality treatment including sediment and phosphorous removal and provide for storage and velocity reduction of runoff during storm events.

6.2. Catch Basin Risers

Catch basin risers are based on the simple concept of raising the elevation of a catch basin grate to increase the surface water storage capacity in a swale or detention/retention pond. In this case, the purpose of the risers are to take advantage of the storage capacity of the existing swale at Area 17 and of the topography in the island at Area 2, encouraging ponding of water in both areas up to the proposed elevation of each catch basin (i.e. 383.88 at Area 17 and 384.5' at Area 2, per Sheet 6 of the engineering plans). A 6" orifice will also be included at each catch basin riser, 0.5' lower than each grate elevation, to provide for some degree of low flow conveyance prior to spillover of flow at the proposed catch basin elevations. Risers rather than more complex practices were chosen at these locations due to the presence of gas infrastructure at Area 17, and the limitation of area within the traffic island at Area 2.

Construction would typically include removing the catch basin grate and frame of the existing basin, installing a precast concrete riser and sealant on the existing structure and replacing the catch basin frame and grate. Risers can be ordered from manufacturers to fit the dimensions of existing structures and made to custom heights, typically at increments of 6".

6.3. Deep Sump Catch Basin

A deep sump catch basin (DSCB) is similar to a regular catch basin, however it usually incorporates a sump of 2-4 feet at the bottom of the structure. A sump is defined as the distance from the lowest pipe invert to the bottom of the structure, and it provides a place for sediment, solids and debris to accumulate.

A DSCB with a hooded outlet is proposed in Area 8, within the eastern shoulder of the highway and adjacent to the Blake's property. As discussed in Section 5.3, during storm events, stormwater runoff from the highway runs on to the Blake's property and is thought to be causing erosion where they've placed fill material to mitigate migration of the gully head into their property. The proposed DSCB will intercept runoff from the highway and send it into the closed drainage network that drains to the gully (discussed in Section 6.4). The sump associated with this structure will also provide a means for removal of sediment and petroleum constituents typically associated with roadways. It is anticipated that this structure will be installed during construction of the drop manhole system discussed in Section 6.4. The location of the structure can be found along the top of Sheet 7 of the engineering plans and in the left portion of the profile on the same sheet.

DSCBs with hooded outlets have recently been shown to perform at least as well as proprietary stormwater treatment devices with respect to sediment and total petroleum hydrocarbon removal (Niles and Houle, 2017). In this research, removal rates for both constituents exceeded 70% and the DSCB was determined to be the most cost-effective option. DSCBs are typically more economical as compared to proprietary devices, and the costs in Section 6.6 reflect current device costs. While the sediment, TSS, and free oil removal benefits of

DSCBs are reasonably well documented, the phosphorus— and particularly dissolved phosphorus—removal benefits of these practices is less well understood and further investigation is warranted.

6.4. Drop Manhole System

A priority project outlined in Section 4 included modifications to the gully outfall, with the goal of moving the closed drainage discharge of water from the top of the gully to the bottom of the gully, or more specifically the toe of slope of the gully head. The discharge of water, and the energy created from the fall of that water (i.e. the potential energy) is considered to be one of the primary mechanisms that drove the advance of the channel headcut up to the Route 7 road embankment, and created the gully as it currently exists. The purpose of the drop manhole system is to eliminate that potential energy, and discharge water from the closed drainage system at the bottom of the road embankment into the channel with less velocity, lower shear force and stream power.

Sheet 7 of the engineering plans provides a site plan and a profile of the proposed close drainage system improvements. Currently an existing catch basin exists in the parking lot just north of Interstate Auto, however it is not visible as it is buried under pavement. This catch basin receives flow from the existing closed drainage system running south to north along Route 7, and discharges flow to the head of the gully via an 18" HDPE pipe. To construct this project, the contractor will be required to dig up the pavement and locate the existing catch basin, and replace it with a new catch basin structure and pipe per details on Sheet 7. The contractor will also install the DSCB discussed in Section 6.3, additional catch basins and pipe, and the drop manholes per Sheet 7, and the detail on Sheet 8. For work to be performed from the bottom of the gully, it is anticipated that the contractor will use the same access used to install the wood steps (discussed in Section 6.5). The contractor will be required to provide adequate shoring for the project to ensure integrity of the head slope during construction operations.

6.5. In-Channel Wood Steps

In-channel log steps are bioengineered structures constructed of rootwads and/or logs, where the narrow end of the log is pushed into the stream bank by a small to medium sized excavator, perpendicular to the direction of flow. Typically 2-4 logs are installed in this manner, on either side of the channel to create a barrier to flow that is mostly impervious, despite small voids that may exist between each log (see details on Sheet 10 of the engineering plans, Appendix 5). The purpose of these structures is to 1) reduce the velocity of channel flow, 2) dissipate flow energy in the system and potentially mitigate erosional impacts to existing banks, and 3) trap sediment behind the logs, reducing sediment transported to Deer Brook, while potentially raising the bed of the gully channel over time.

The location of the wood steps are shown on Sheet 10 and were placed in order to create long pools throughout the system, and maximize collected sediment over time. Construction of the steps would require the mobilization of a small to medium sized excavator down to the gully channel. Minimizing impact throughout the area would be a key component of the success of this project. The contractor would be directed to use timber mats to distribute the weight of the machine, and they would also be directed to minimize impacts to live trees. Trees that have already fallen in and around the gully can be cleared out of the way and incorporated into the steps to the extent practicable.

6.6. 100% Design Opinion of Probable Costs

Detailed cost estimates for each proposed project, including considerations for access, excavation, existing structure removal, flow bypassing and dewatering, structure placement, backfilling, regrading, etc. are provided at the 100% design level. Costs have been developed based on average unit costs for particular construction items provided by VTrans, average unit costs derived from similar projects Stone staff have managed, and quantities based on the designs discussed above as calculated in AutoCAD drawings. Costs for permitting, survey layout, and contingencies are provided at the bottom of each cost table.

For the purposes of these estimates and anticipating fund application sequencing, it was assumed that the four (4) gravel wetlands and two (2) catch basin risers would be constructed under one contract, while the DSCB, closed drainage system upgrades and the in-channel log steps would be constructed under a separate contract.

Table 7: 100% Design Level Opinion of Probable Construction Costs for Gravel Wetland and Catch Basin Riser Installation

#	DESCRIPTION	UNIT	UNIT QUANTITY	UNIT COST	TOTAL COST
GRAVEL WETLANDS (4 TOTAL)					
1	Clearing and Grubbing	LS	1	$4,000	$4,000
2	Excavation, Including Haul Away	CY	520	$50	$26,000
3	Low Permeability Liner	CY	69	$50	$3,474
4	2" Double Washed Crushed Stone	CY	207	$35	$7,259
5	3/8" Double Washed Crushed Stone	CY	34	$40	$1,369
6	Wetland Soil	CY	69	$35	$2,432
7	4-6" Double Washed Crushed Stone	CY	10	$45	$447
8	Granular Backfill for Structures	CY	6	$45	$267
9	Precast Reinforced Concrete Catch Basin with Atrium Style Grate and Trash Rack	EA	4	$10,000	$40,000
10	8" Perforated PVC Pipe	LF	240	$25	$6,000
11	Erosion Control Matting	SY	249	$10	$2,489
12	Loam	CY	10	$35	$350
13	Seed	LB	5	$100	$500
14	Wetland Plantings	LS	1	$10,000	$10,000
14	Erosion Controls and Bypass Flows	LS	1	$8,000	$8,000
CATCH BASIN RISERS (2 TOTAL)					
15	Concrete Riser Section and Install	EA	2	$1,500	$3,000
16	Reset Frame and Grate	EA	2	$500	$1,000
17	Traffic Control	LS	1	$8,000	$8,000
CONSTRUCTION TOTAL					***$124,586***
PERMITTING (15%)					***$18,688***
STAKE OUT (5%)					***$6,229***
MOBILIZATION / DEMOBILIZATION (10%)					***$12,459***
CONSTRUCTION MANAGEMENT / OVERSIGHT (10%)					***$12,459***
CONTINGENCY (10%)					***$12,459***
TOTAL (ROUNDED TO NEAREST $100)					***$186,900***

Table 8: 100% Design Level Opinion of Probable Construction Costs for Closed Drainage System Upgrades and Deep Sump Catch Basin Installation

#	DESCRIPTION	UNIT	UNIT QUANTITY	UNIT COST	TOTAL COST
CLOSED DRAINAGE SYSTEM UPGRADES AND DEEP SUMP CATCH BASIN					
1	Project Demarcation Fencing	LF	600	$1	$600
2	Excavation of Surfaces and Pavements	CY	92	$25	$2,311
3	Trench Excavation	CY	955	$18	$17,195
4	Install 18" HDPE(SL)	LF	252	$45	$11,340
5	Install 36" HDPE(SL)	LF	128	$65	$8,320
6	Granular Backfill for Structures	CY	108	$45	$4,840
7	Gravel for Subbase	CY	92	$45	$4,160
8	Fine Graded Crushed Gravel for Subbase	CY	46	$42	$1,941
9	Bituminous Concrete Pavement, Type I Base Course	TON	62	$250	$15,444
11	48" Square Precast Reinforced Catch Basin with Deep Sump and Cast Iron Grate	EA	1	$6,000	$6,000
12	48" Square Precast Reinforced Catch Basin with Cast Iron Grate	EA	1	$4,500	$4,500
13	60" Round Precast Reinforced Catch Basin with Cast Iron Grate	EA	2	$5,500	$11,000
14	60" Round Precast Reinforced Catch Basin with Atrium Style Rim	EA	1	$5,500	$5,500
15	Stone Fill and Outfall Stone Apron (Stone Fill, Type II)	CY	100	$50	$5,011
16	Shoring Slopes	LS	1	$15,000	$15,000
17	Dewatering and Bypass Flows	LS	1	$5,000	$5,000
18	Loam	CY	10	$35	$350
19	Seed	LB	1	$100	$100
20	Erosion Controls	LS	1	$3,000	$3,000
21	Traffic Control	LS	1	$8,000	$8,000
IN-CHANNEL LOG STEPS					
22	Access to Channel	LS	1	$10,000	$10,000
23	Log Steps	EA	8	$2,000	$16,000
CONSTRUCTION TOTAL					***$129,612***
PERMITTING (15%)					***$19,442***
STAKE OUT (5%)					***$6,481***
MOBILIZATION / DEMOBILIZATION (10%)					***$12,961***
CONSTRUCTION MANAGEMENT / OVERSIGHT (10%)					***$12,961***
CONTINGENCY (10%)					***$12,961***
TOTAL (ROUNDED TO NEAREST $100)					***$194,500***

7. Next Steps

Following submittal of this final report to VT DEC and closeout of the current grant, next steps include the following:

- Pursuit and filing of grant applications for project implementation (VT DEC ERP and other opportunities)
- Continued coordination with VTrans and other landowners regarding the potential implementation for each project
    - Continue discussion with VTRans regarding which potential projects would be acceptable regarding connections and discharges from private drainages (Section 5.2)
- Provided grant funding is obtained and landowners are on board for a specific project, coordinate with permitting agencies regarding permit requirements. File and submit permits once complete.
- Once permits are received, pursue construction bidding and execution
    - Develop construction bid documents and advertise the project
    - Select a contractor and develop a contract
    - Layout the project(s) using conventional survey equipment
    - Construct the project and provide oversight to ensure compliance with the engineering drawings

References

ESPC. Deer Brook Gully Remediation and Stormwater Treatment, Georgia, Vermont. Summary Report. Prepared for: Northwest Regional Planning Commission. 2007.

Bruce Marcot. Ecosystems Processes Related to Wood Decay. USDA Forest Service, Pacific Northwest Research Station, PNW-RN-576. 2017. Available at: https://www.fs.fed.us/pnw/pubs/pnw_rn576.pdf

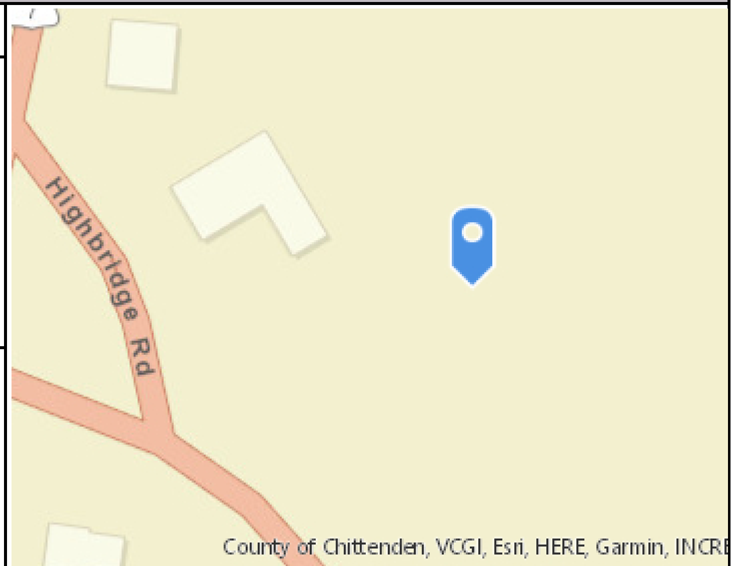
Rich Niles, James Houle, 2017. Dissecting Proprietary Stormwater Treatment BMPs to Develop Practical Solutions – Unbiased Research and Case Studies. Presented at the Maine Stormwater Conference, Portland, Maine. October 24, 2017. Online at https://maineswc.files.wordpress.com/2017/10/01-niles-andballestero.pdf

Northwest Regional Planning Commission. Fluvial Erosion Hazard Mapping and Phase 2 Assessment Report. For the Municipalities of Georgia, Highgate and St. Albans City. Prepared for: Vermont Emergency Management. 2008. Available at: https://anrweb.vt.gov/DEC/SGA/finalReports.aspx

Appendix 1 – Retrofit Summary Sheets

ID#: 1

Name: Interstate Auto Parking Disconnection



Concept Description:

With minor regrading, the gravel parking lot south of Interstate Auto building could be made to drain to a gravel wetland or other stormwater practice. LCBP installed a rain garden here some years ago – but per the installer's instruction it has not been weeded and now is full of sumac.

Notes/Feasibility:

Mound wastewater system is located adjacent to existing gravel lot. This constrains the footprint of the practice, as does steep slope just inside tree line.

GENERAL SITE INFORMATION	
Site Contact Info:	
Ownership:	Private
Land Use Type:	Commercial
Land Use Detail:	Auto repair
Existing BMP on Site?	Yes
Is site a hotspot?	Yes
Sources/pollutants:	Sediment, Nutrients
Soils:	A/D
Use in Retrofit DA:	Commercial Roof Gravel or Compacted Parking or Driveway Lawn, Low Compaction

SIZING INFORMATION	
Drainage Area (ac):	0.72
Impervious Area (ac):	0.40
Practice Area Available (ft²):	3,700
Existing Head Available?	Yes

RETROFIT DETAILS	
Project Candidate:	Yes
New BMP / Retrofit Existing:	Retrofit Existing BMP
Proposed Retrofit Practice(s):	Constructed gravel wetland
Non-Structural Controls:	
Non-Structural Other:	
Maintenance Burden:	Low

Benefits:		**Conflicts:**	
Storage:	Yes	Soils:	No
Water Quality:	Yes	Access:	No
Recharge:	Yes	Land Use:	Yes
Demonstration:	No	Utilities:	Yes
Repair:	Yes	Polluted:	No
Reuse:	No	High WT:	Yes
		Wetlands:	No
Other:		Other:	

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Assessed by: amacrellis_stone_env

ID# 1, Image 1

ID# 1, Image 2

ID# 1, Image 3

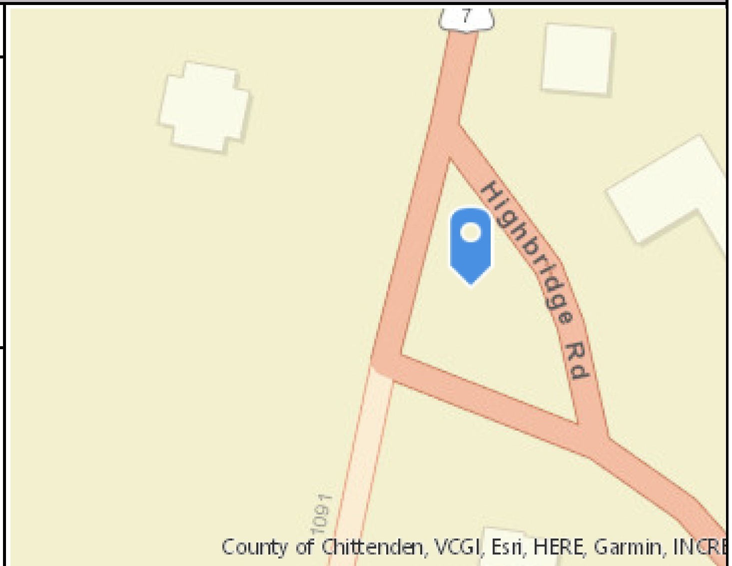
ID# 1, Image 4

ID# 1, Image 5

Project: Deer Brook Gully Restoration — Retrofit Summary Sheet

ID#: 2

Name: Rte 7 - 104A Intersection Island



Concept Description:

Use existing green space to capture runoff from closed drainage system in water quality/storage retrofit. Green space may be expanded towards Interstate Auto as a result of intersection upgrade. Pavement in front of Interstate Auto may also be removed.

Notes/Feasibility:

Within the VTrans ROW; utility conflicts include gas.

GENERAL SITE INFORMATION

Site Contact Info:	VTrans
Ownership:	Public
Land Use Type:	Commercial, Transport-Related (roadway or ROW)
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Sediment, Nutrients, Metals (Cu, Zn, Pb - transportation)
Soils:	A/D
Use in Retrofit DA:	Commercial and residential rooftops, Paved and Gravel Parking or Driveway, Paved Road, Moderate Traffic, Lawn, and ROW, Low Compaction Pervious

SIZING INFORMATION

Drainage Area (ac):	16.90
Impervious Area (ac):	7.60
Practice Area Avail. (ft²):	5,300
Existing Head Available?	Challenging; existing stormlines beneath green space; existing CB in center.

RETROFIT DETAILS

Project Candidate:	Yes, high-priority
New BMP / Retrofit Existing:	New BMP
Proposed Retrofit Practice(s):	Bioretention or constructed gravel wetland
Non-Structural Other:	
Maintenance Burden:	Low

Benefits:		**Conflicts:**	
Storage:	Yes	Soils:	No
Water Quality:	Yes	Access:	No
Recharge:	No	Land Use:	No
Demonstration:	Yes	Utilities:	Yes
Repair:		Polluted:	No
Reuse:	No	High WT:	No
		Wetlands:	No
Other:		Other:	VTrans ROW

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Assessed by: amacrellis_stone_env

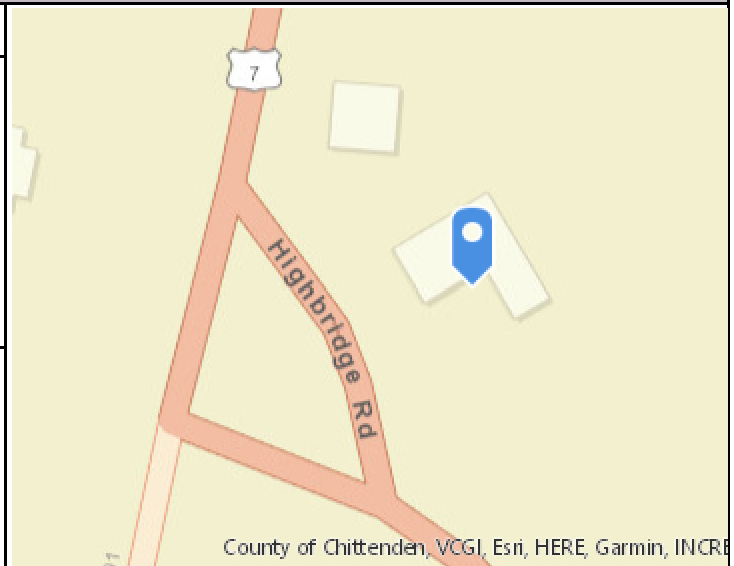
ID# 2, Image 1

ID# 2, Image 2

Project: Deer Brook Gully Restoration — Retrofit Summary Sheet

ID#: 3

Name: Interstate Auto Rain Garden



Concept Description:

Capture rooftop runoff from portions of Interstate Auto building in a small rain garden. A small portion of the gravel driveway may also be made to drain to this practice.

Notes/Feasibility:

Utility conflicts may include gas and electric.

GENERAL SITE INFORMATION

Site Contact Info:	
Ownership:	Private
Land Use Type:	Commercial
Land Use Detail:	
Existing BMP on Site?	No
Is site a hotspot?	Yes
Sources/pollutants:	Sediment, Nutrients, Metals (Cu, Zn, Pb, e.g., transportation)
Soils:	A/D
Use in Retrofit DA:	Commercial Roof, Gravel or Compacted Parking or Driveway, Lawn, Compacted

SIZING INFORMATION

Drainage Area (ac):	0.04
Impervious Area (ac):	0.04
Practice Area Available (ft^2):	200
Existing Head Available?	Yes

RETROFIT DETAILS

Project Candidate:	Ok
New BMP / Retrofit Existing:	New BMP
Proposed Retrofit Practice(s):	Rain garden
Non-Structural Controls:	
Non-Structural Other:	
Maintenance Burden:	Medium

Benefits:		**Conflicts:**	
Storage:	No	Soils:	No
Water Quality:	Yes	Access:	No
Recharge:	Yes	Land Use:	Yes
Demonstration:	No	Utilities:	Yes
Repair:		Polluted:	No
Reuse:	No	High WT:	Yes
		Wetlands:	No
Other:		Other:	

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Assessed by: amacrellis_stone_env

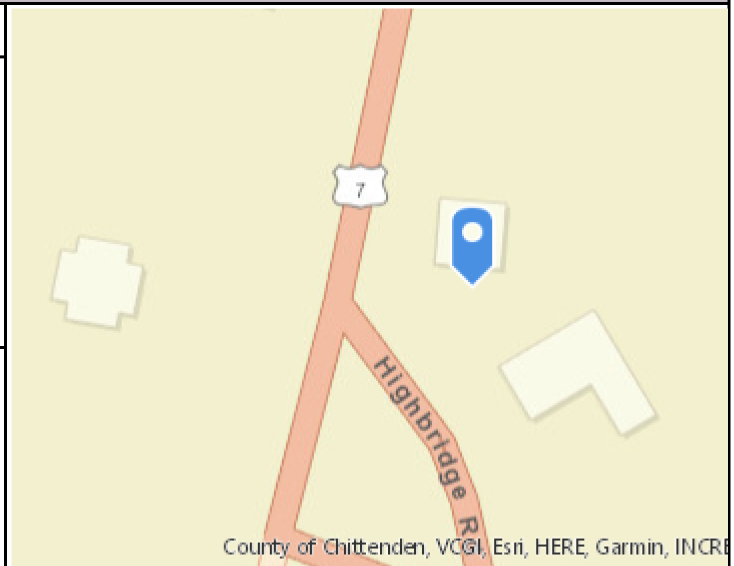
ID# 3, Image 1

ID# 3, Image 2

Project: Deer Brook Gully Restoration — Retrofit Summary Sheet

ID#: 4

Name: Office Roof Disconnection #1



Concept Description:

Direct existing gutter and downspout to dry well or expanded rain garden to manage runoff from half of the pitched roof.

Notes/Feasibility:

Existing septic drywell in backyard, and limited pervious area, substantially constrain this opportunity. Property is currently vacant.

GENERAL SITE INFORMATION	
Site Contact Info:	
Ownership:	Private
Land Use Type:	Commercial
Land Use Detail:	Office and apartment
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Sediment, Nutrients
Soils:	A/D
Use in Retrofit DA:	Commercial Roof

SIZING INFORMATION	
Drainage Area (ac):	0.02
Impervious Area (ac):	0.02
Practice Area Available (ft²):	100 or less
Existing Head Available?	

RETROFIT DETAILS	
Project Candidate:	Ok
New BMP / Retrofit Existing:	New BMP
Proposed Retrofit Practice(s):	Rain garden, dry well
Non-Structural Controls:	
Non-Structural Other:	
Maintenance Burden:	Low

Benefits:		**Conflicts:**	
Storage:	No	Soils:	No
Water Quality:	Yes	Access:	No
Recharge:	Yes	Land Use:	No
Demonstration:	No	Utilities:	No
Repair:		Polluted:	No
Reuse:	No	High WT:	Yes
		Wetlands:	No
Other:		Other:	

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Assessed by: amacrellis_stone_env

ID# 4, Image 1

ID# 4, Image 2

Project: Deer Brook Gully Restoration

Retrofit Summary Sheet

ID#: 5

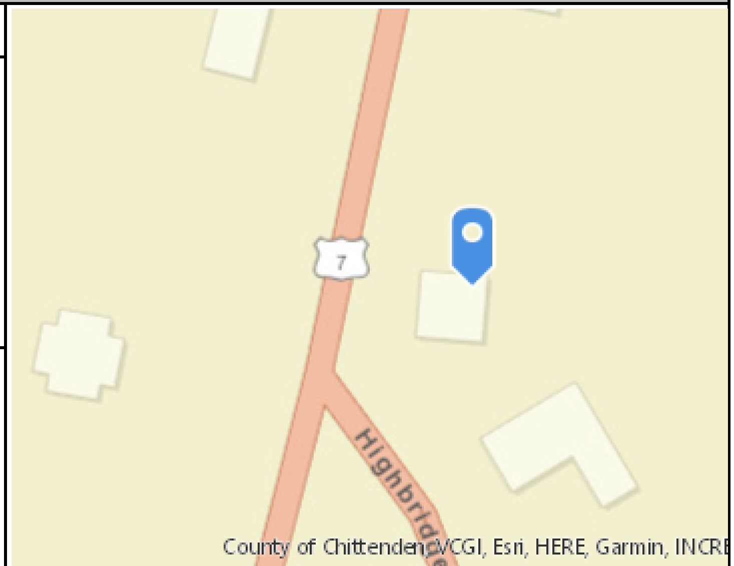
Name: Office Roof Disconnection #2

Concept Description:

Confirm outlet of existing downspout to roof leader. If it currently outlets to gully, propose disconnection via overland flow, rain garden, or dry well.

Notes/Feasibility:

Existing septic dry well in backyard significantly constrains opportunity and available space.



GENERAL SITE INFORMATION

Site Contact Info:	
Ownership:	Private
Land Use Type:	Commercial
Land Use Detail:	
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Sediment, Nutrients
Soils:	A/D
Use in Retrofit DA:	Commercial Roof, Lawn, Low Compaction

SIZING INFORMATION

Drainage Area (ac):	0.02
Impervious Area (ac):	0.02
Practice Area Available (ft²):	100 or less
Existing Head Available?	Yes

RETROFIT DETAILS

Project Candidate:	Ok
New BMP / Retrofit Existing:	New BMP
Proposed Retrofit Practice(s):	Rain garden, dry well
Non-Structural Controls:	
Non-Structural Other:	
Maintenance Burden:	Low

Benefits:		**Conflicts:**	
Storage:	No	Soils:	Yes
Water Quality:	Yes	Access:	No
Recharge:	Yes	Land Use:	No
Demonstration:	No	Utilities:	Yes
Repair:		Polluted:	No
Reuse:	No	High WT:	Yes
		Wetlands:	No
Other:		Other:	Steep slope at back of lot

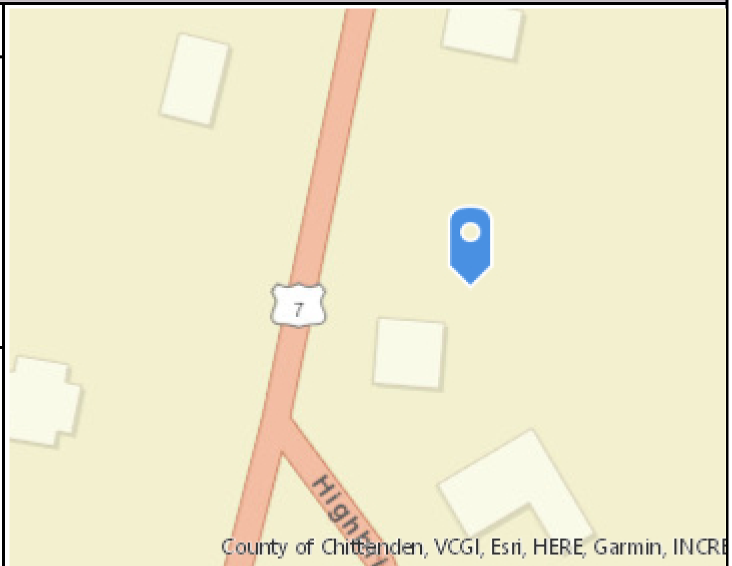
Date: 08/15/2018 09:48 PM

Assessed by: amacrellis_stone_env

ID# 5, Image 1

ID#: 6

Name: Roof Runoff and Sump Disconnection



Concept Description:

Roof runoff from majority of abutting residences, and line from sump pump, drain through the backyard to head of gully. Opportunity to redirect runoff to a small rain garden in backyard.

Notes/Feasibility:

Location of septic system unknown. Overhead electric may further constrain available space. Sump drainage currently runs through 6 inch corrugated plastic pipe to gully rim.

GENERAL SITE INFORMATION	
Site Contact Info:	
Ownership:	Private
Land Use Type:	Single Family Residential (<1 ac. lots)
Land Use Detail:	Single family homes
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Sediment, Nutrients
Soils:	A/D
Use in Retrofit DA:	Pitched Residential Roof, Lawn, Low Compaction

SIZING INFORMATION	
Drainage Area (ac):	0.04
Impervious Area (ac):	0.04
Practice Area Available (ft²):	250
Existing Head Available?	Yes

RETROFIT DETAILS	
Project Candidate:	Ok
New BMP / Retrofit Existing:	New BMP
Proposed Retrofit Practice(s):	Rain garden
Non-Structural Controls:	
Non-Structural Other:	
Maintenance Burden:	Medium

Benefits:		**Conflicts:**	
Storage:	No	Soils:	Yes
Water Quality:	Yes	Access:	No
Recharge:	Yes	Land Use:	No
Demonstration:	No	Utilities:	Yes
Repair:		Polluted:	No
Reuse:	No	High WT:	Yes
		Wetlands:	No
Other:		Other: septic system location unknown	

Date: 08/15/2018 09:55 PM

Assessed by: amacrellis_stone_env

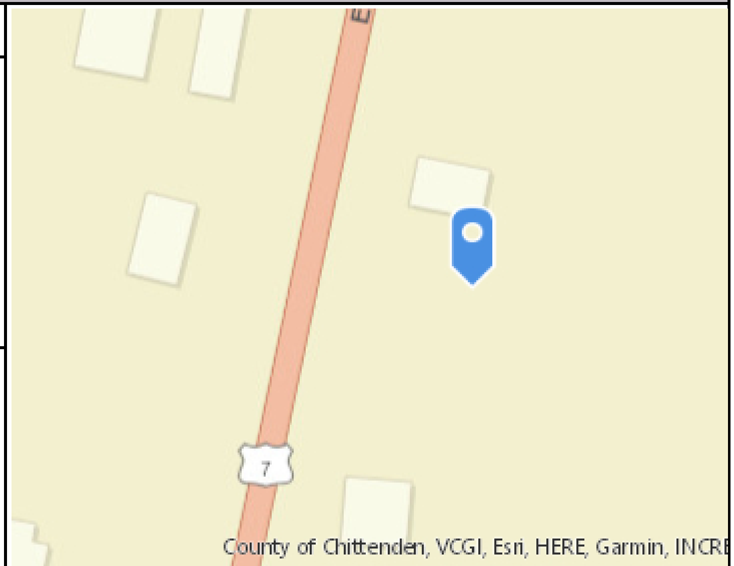
ID# 6, Image 1

ID# 6, Image 2

Project: Deer Brook Gully Restoration **Retrofit Summary Sheet**

ID#: 7

Name: 1193 Rte 7 Detention



Concept Description:

Create a detention basin, subsurface gravel wetland, or other combination water quality and storage retrofit either in narrow green space or where trees are at head of contributing channel to gully. Immediately west of major, recent slope repair by private owner.

Notes/Feasibility:

Existing drilled well is right next to stone lined channel leading to gully. Overhead electric also a possible conflict. There may be an opportunity to redirect runoff to flat former parking area in back of building. Septic system location unknown.

GENERAL SITE INFORMATION

Site Contact Info:	
Ownership:	Private
Land Use Type:	Commercial
Land Use Detail:	Office and parking; road
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Sediment, Nutrients, Metals (Cu, Zn, Pb, e.g., transportation)
Soils:	A
Use in Retrofit DA:	Commercial Roof, Paved Parking or Driveway, Paved Road, Moderate Traffic, Lawn, Compacted

SIZING INFORMATION

Drainage Area (ac):	0.78
Impervious Area (ac):	0.74
Practice Area Available (ft^2):	2,250
Existing Head Available?	Yes

RETROFIT DETAILS

Project Candidate:	Yes
New BMP / Retrofit Existing:	New BMP
Proposed Retrofit Practice(s):	Constructed gravel wetland
Non-Structural Controls:	
Non-Structural Other:	
Maintenance Burden:	Low

Benefits:		**Conflicts:**	
Storage:	Yes	Soils:	No
Water Quality:	Yes	Access:	No
Recharge:	No	Land Use:	No
Demonstration:	No	Utilities:	Yes
Repair:		Polluted:	No
Reuse:	No	High WT:	No
		Wetlands:	No
Other:		Other: Geotech conflict with adjacent steep slope and slope failure	

Date: 08/15/2018 10:09 PM

Assessed by: amacrellis_stone_env

ID# 7, Image 1

ID# 7, Image 2

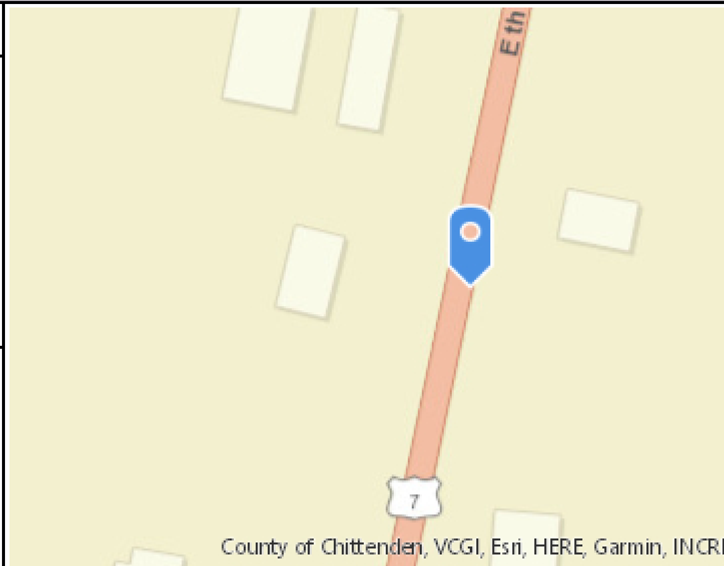
ID# 7, Image 3

ID# 7, Image 4

Project: Deer Brook Gully Restoration — Retrofit Summary Sheet

ID#: 8

Name: 1193 Rte 7 Alternate Retrofit



Concept Description:

As part of intersection upgrade, consider installing a catch basin with offline water quality treatment – or deep sump catch basin at minimum – and connect to site 2 or at least to closed drainage, instead of upgrade proposed at site #7.

Notes/Feasibility:

Utility conflicts include overhead electric and telecom. Connection of this area to the closed drainage would at minimum mitigate erosion and instability immediately west of recent private slope stabilization work. Additional water quality or volume management could occur at #2 location.

GENERAL SITE INFORMATION

Site Contact Info:	VTrans
Ownership:	Public
Land Use Type:	Commercial, Transport-Related (roadway or ROW)
Land Use Detail:	Roadway
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Sediment, Nutrients, Metals (Cu, Zn, Pb, e.g., transportation)
Soils:	C/D
Use in Retrofit DA:	Commercial Roof, Paved Parking or Driveway, paved Road, Moderate Traffic, Pervious, road right-of-way, low compaction

SIZING INFORMATION

Drainage Area (ac):	0.78
Impervious Area (ac):	0.74
Practice Area Available (ft²):	n/a
Existing Head Available?	

RETROFIT DETAILS

Project Candidate:	Yes
New BMP / Retrofit Existing:	New BMP
Proposed Retrofit Practice(s):	Deep sump catch basin, Vault
Non-Structural Controls:	
Non-Structural Other:	
Maintenance Burden:	Medium

Benefits:		**Conflicts:**	
Storage:	Yes	Soils:	No
Water Quality:	Yes	Access:	No
Recharge:	No	Land Use:	No
Demonstration:	No	Utilities:	Yes
Repair:		Polluted:	No
Reuse:	No	High WT:	No
		Wetlands:	No
Other:		Other:	

Date: 08/15/2018 10:19 PM

Assessed by: amacrellis_stone_env

ID# 8, Image 1

ID#: 9

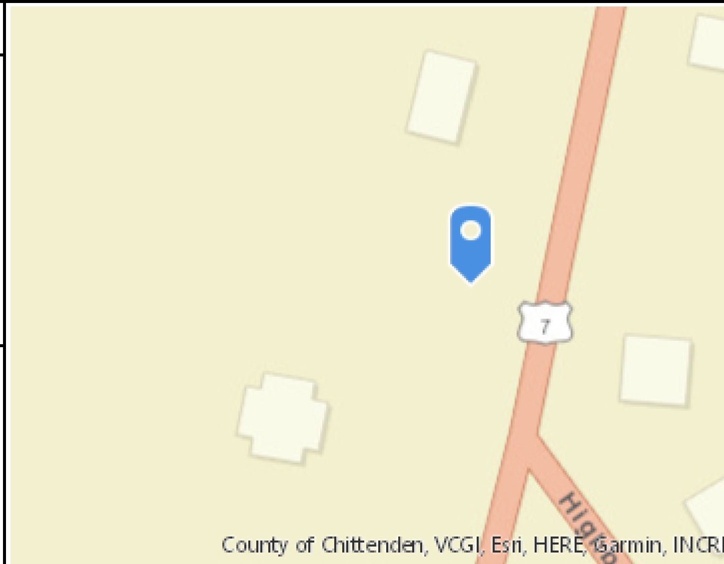
Name: Blake's Auto Service Retrofit

Concept Description:

Consider a small gravel wetland or bioretention practice in deep swale next to Route 7. Generally low-priority.

Notes/Feasibility:

Very small drainage area and little contributing impervious.



GENERAL SITE INFORMATION	
Site Contact Info:	VTrans
Ownership:	Public
Land Use Type:	Commercial, Transport-Related (roadway or ROW)
Land Use Detail:	
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Sediment, Nutrients, Metals (Cu, Zn, Pb, e.g., transportation)
Soils:	A/D
Use in Retrofit DA:	Gravel or Compacted Parking or Driveway, Paved Road, Moderate Traffic, Pervious, road right-of-way, low compaction

SIZING INFORMATION	
Drainage Area (ac):	0.39
Impervious Area (ac):	0.10
Practice Area Available (ft²):	300
Existing Head Available?	Yes

RETROFIT DETAILS	
Project Candidate:	Ok
New BMP / Retrofit Existing:	New BMP
Proposed Retrofit Practice(s):	Constructed gravel wetland
Non-Structural Controls:	
Non-Structural Other:	
Maintenance Burden:	Medium

Benefits:		**Conflicts:**	
Storage:	Yes	Soils:	No
Water Quality:	Yes	Access:	No
Recharge:	No	Land Use:	No
Demonstration:	No	Utilities:	Yes
Repair:		Polluted:	No
Reuse:	No	High WT:	No
		Wetlands:	No
Other:		Other:	

Date: 08/15/2018 10:35 PM

Assessed by: amacrellis_stone_env

ID# 9, Image 1

ID# 9, Image 2

ID#: 10

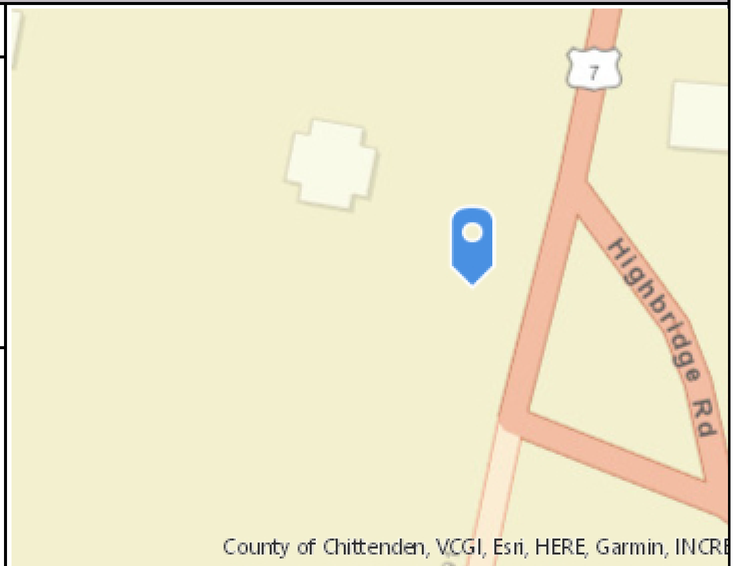
Name: Peoples Trust Company Storage & WQ Retrofit

Concept Description:

Daylight culvert between catch basin and manhole and implement a storage and/or water quality practice in ROW. Sufficient area likely exists to manage more than the Water Quality Volume, providing relief at gully head/system outlet.

Notes/Feasibility:

Ample green space in the ROW; historically it is likely a swale existed here. Electric and telecom are overhead; gas lateral is a likely conflict. Not clear whether intersection improvements would reduce available ROW space for stormwater management.



GENERAL SITE INFORMATION	
Site Contact Info:	VTrans
Ownership:	Public
Land Use Type:	Commercial, Transport-Related (roadway or ROW)
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Sediment, Nutrients, Metals (Cu, Zn, Pb, e.g., transportation)
Soils:	A/D
Use in Retrofit DA:	Commercial Roof, Paved Parking or Driveway, Paved Road, Moderate Traffic, Lawn, Low Compaction, Pervious, road right-of-way, low compaction

SIZING INFORMATION	
Drainage Area (ac):	2.78
Impervious Area (ac):	0.80
Practice Area Available (ft²):	1,600
Existing Head Available?	

RETROFIT DETAILS	
Project Candidate:	Yes
New BMP / Retrofit Existing:	New BMP
Proposed Retrofit Practice(s):	Constructed gravel wetland
Non-Structural Other:	
Maintenance Burden:	Low

Benefits:		**Conflicts:**	
Storage:	Yes	Soils:	No
Water Quality:	Yes	Access:	No
Recharge:	No	Land Use:	No
Demonstration:	No	Utilities:	Yes
Repair:		Polluted:	No
Reuse:	No	High WT:	Yes
		Wetlands:	No
Other: Volume storage above WQv		Other:	

Date: 08/15/2018 11:05 PM

Assessed by: amacrellis_stone_env

ID# 10, Image 1

ID# 10, Image 2

ID#: 11

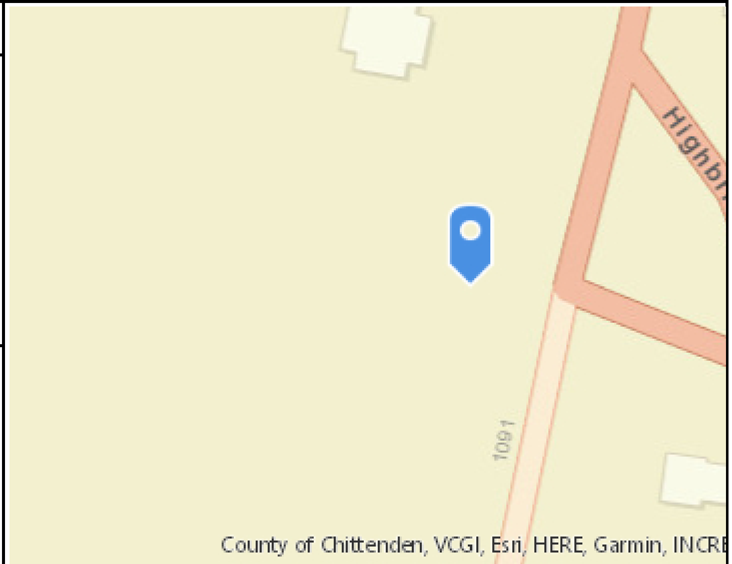
Name: Hair Designs Swale Improvements

Concept Description:

Increase swale geometry to store runoff and improve water quality. Drainage from bank parking lot and grass lawn is conveyed to this swale. Owner reported flooding issues at CB4 during large events. Consider bioretention or gravel wetland. Owner also potentially open to low-maintenance practice in roadway swale.

Notes/Feasibility:

6" CMP not visible in CB4, suspected to be buried via accumulated sediment in catch basin. Yard floods, limited infiltration. Septic replacment area between parking lot and fence. Tenants well is visible from CB4. Another well exists in woods.



GENERAL SITE INFORMATION	
Site Contact Info:	
Ownership:	Private
Land Use Type:	Commercial, Single Family Residential (<1 ac. lots)
Land Use Detail:	
Existing BMP on Site?	Yes
Is site a hotspot?	No
Sources/pollutants:	Sediment, Nutrients
Soils:	A/D
Use in Retrofit DA:	Commercial Roof, Commercial/Industrial Parking, Lawn, Compacted

SIZING INFORMATION	
Drainage Area (ac):	1.82
Impervious Area (ac):	0.55
Practice Area Available (ft^2):	1,300
Existing Head Available?	

RETROFIT DETAILS	
Project Candidate:	Yes
New BMP / Retrofit Existing:	Existing BMP
Proposed Retrofit Practice(s):	Constructed gravel wetland
Non-Structural Controls:	
Non-Structural Other:	
Maintenance Burden:	Low

Benefits:		**Conflicts:**	
Storage:	Yes	Soils:	
Water Quality:	Yes	Access:	No
Recharge:		Land Use:	
Demonstration:		Utilities:	Yes
Repair:		Polluted:	No
Reuse:		High WT:	
		Wetlands:	
Other:		Other: replacement leachfield area	

Date: 08/15/2018 11:56 PM

Assessed by: gbolin_stone_env

ID# 11, Image 1

ID# 11, Image 2

ID# 11, Image 3

ID#: 12

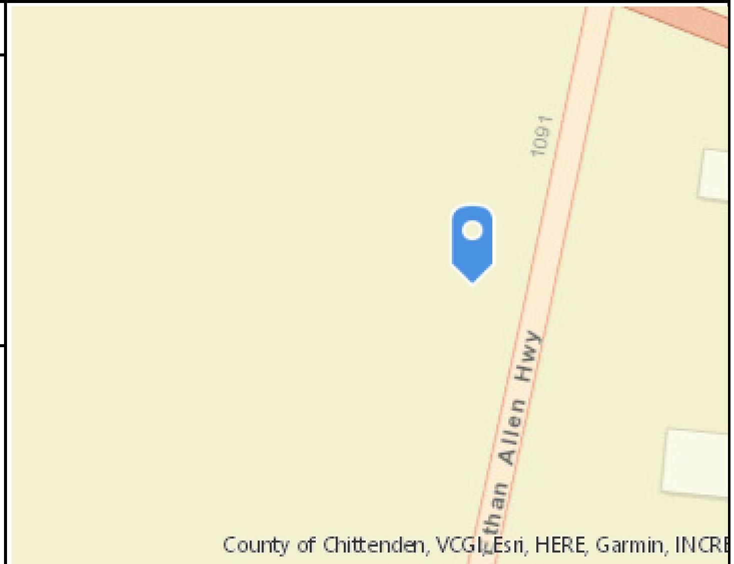
Name: Rte 7 Retrofit #1

Concept Description:

Implement gravel wetlands or storage retrofit in existing swale next to Route 7. Sufficient area is available to manage more than the WQv, and potentially above the HCv/CPv, providing peak flow reduction benefit as well as water quality treatment.

Notes/Feasibility:

No apparent utility conflicts. The west side of US Rte 7 in this area drains to this swale.



GENERAL SITE INFORMATION	
Site Contact Info:	VTrans
Ownership:	Public and private
Land Use Type:	Single Family Residential, Commercial, Roadway/ROW
Land Use Detail:	
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Sediment, Nutrients, Metals (Cu, Zn, Pb, e.g., transportation)
Soils:	A/D
Use in Retrofit DA:	Commercial Roof, Paved Parking or Driveway, Paved Road, Moderate Traffic, Pervious, road right-of-way, low compaction

SIZING INFORMATION	
Drainage Area (ac):	1.73
Impervious Area (ac):	0.40
Practice Area Available (ft²):	1,700
Existing Head Available?	Yes

RETROFIT DETAILS	
Project Candidate:	Yes, high-priority
New BMP / Retrofit Existing:	New BMP
Proposed Retrofit Practice(s):	Constructed gravel wetland
Non-Structural Controls:	
Non-Structural Other:	
Maintenance Burden:	Low

Benefits:		**Conflicts:**	
Storage:	Yes	Soils:	No
Water Quality:	Yes	Access:	No
Recharge:	No	Land Use:	No
Demonstration:	No	Utilities:	No
Repair:		Polluted:	No
Reuse:	No	High WT:	Yes
		Wetlands:	No
Other:		Other:	

Date: 08/15/2018 11:41 PM

Assessed by: amacrellis_stone_env

ID# 12, Image 1

ID# 12, Image 2

Project: Deer Brook Gully Restoration — Retrofit Summary Sheet

ID#: 13

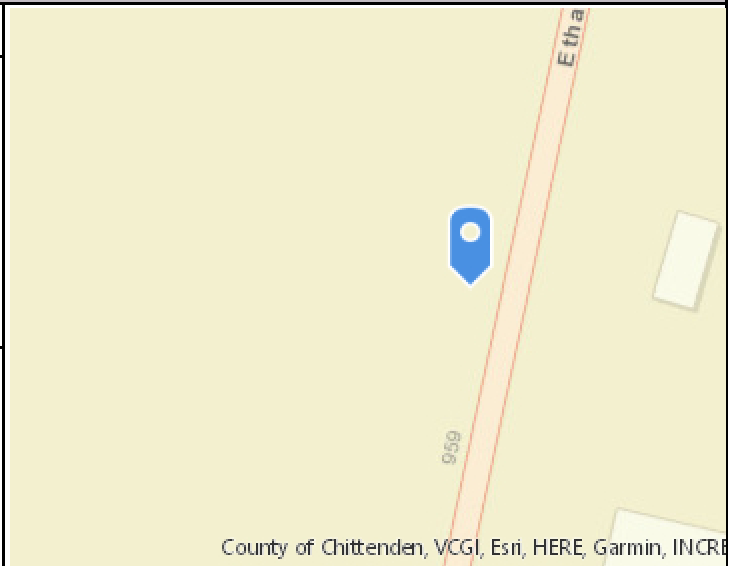
Name: Rte 7 Retrofit #2

Concept Description:

Potential gravel wetland in swale. Moderate head anticipated along length of basin. Captures flow from road and field. Sufficient area exists to manage well more than the WQv from contributing impervious, and potentially more than CPv, providing peak flow reduction benefits at system outfall/head of gully.

Notes/Feasibility:

This swale is also connected to swale system at Georgia Eye Center (which has substantial connected impervious with almost no space for treatment on site). Despite HSG A in soil survey, conditions observed during site visit indicate limited to no infiltration should be expected.



GENERAL SITE INFORMATION	
Site Contact Info:	VTrans
Ownership:	
Land Use Type:	Single Family Residential (>1 ac. lots), Commercial, Agricultural
Land Use Detail:	
Existing BMP on Site?	Yes
Is site a hotspot?	No
Sources/pollutants:	Sediment, Nutrients, Metals
Soils:	A
Use in Retrofit DA:	Commercial Roof, Lawn, Compacted

SIZING INFORMATION	
Drainage Area (ac):	4.28
Impervious Area (ac):	2.21
Practice Area Available (ft^2):	5,000+
Existing Head Available?	~2-3'

RETROFIT DETAILS	
Project Candidate:	Yes
New BMP / Retrofit Existing:	Existing BMP
Proposed Retrofit Practice(s):	Constructed gravel wetland
Non-Structural Controls:	
Non-Structural Other:	
Maintenance Burden:	Low

Benefits:		**Conflicts:**	
Storage:	Yes	Soils:	No
Water Quality:	Yes	Access:	No
Recharge:	No	Land Use:	No
Demonstration:	No	Utilities:	No
Repair:		Polluted:	No
Reuse:	No	High WT:	Yes
		Wetlands:	No
Other:		Other:	

Date: 08/15/2018 11:56 PM

Assessed by: gbolin_stone_env

ID# 13, Image 1

ID# 13, Image 2

ID# 13, Image 3

ID#: 14

Name: Rte 7 Retrofit #3

Concept Description:

Potentially retrofit existing swale outlet pipe at Georgia Market entrance with stand pipe that has low flow channel and high flow discharge, to create more volume storage. Upsize existing driveway culvert. Sufficient area exists to manage substantially more than the WQv and CPv, providing peak flow attenuation in addition to water quality treatment.

Notes/Feasibility:

Existing pipe under entrance is 12” CMP that is half burried by sediment at both ends. Entrance has caved in and compromised pipe on downstream end.

GENERAL SITE INFORMATION	
Site Contact Info:	VTrans
Ownership:	
Land Use Type:	Commercial
Land Use Detail:	
Existing BMP on Site?	Yes
Is site a hotspot?	No
Sources/pollutants:	Sediment, Nutrients
Soils:	A
Use in Retrofit DA:	Commercial Roof, Paved Road, Moderate Traffic, Paved Parking or Driveway

SIZING INFORMATION	
Drainage Area (ac):	0.53
Impervious Area (ac):	0.25
Practice Area Available (ft²):	800
Existing Head Available?	~1’

RETROFIT DETAILS	
Project Candidate:	Yes
New BMP / Retrofit Existing:	Existing BMP
Proposed Retrofit Practice(s):	Bioswale, gravel wetland, culvert repair or replacement
Non-Structural Controls:	
Non-Structural Other:	
Maintenance Burden:	Low

Benefits:		**Conflicts:**	
Storage:	Yes	Soils:	No
Water Quality:	Yes	Access:	No
Recharge:	No	Land Use:	No
Demonstration:	No	Utilities:	Yes
Repair:	Yes	Polluted:	No
Reuse:	No	High WT:	No
		Wetlands:	No
Other:		Other:	

Date: 08/16/2018 12:18 AM **Assessed by:** gbolin_stone_env

ID# 14, Image 1

ID# 14, Image 2

ID# 14, Image 3

ID# 14, Image 4


GEORGIA MARKET
UNITED STATES POST OFFICE
Car Wash
Food Mart

ID#: 15

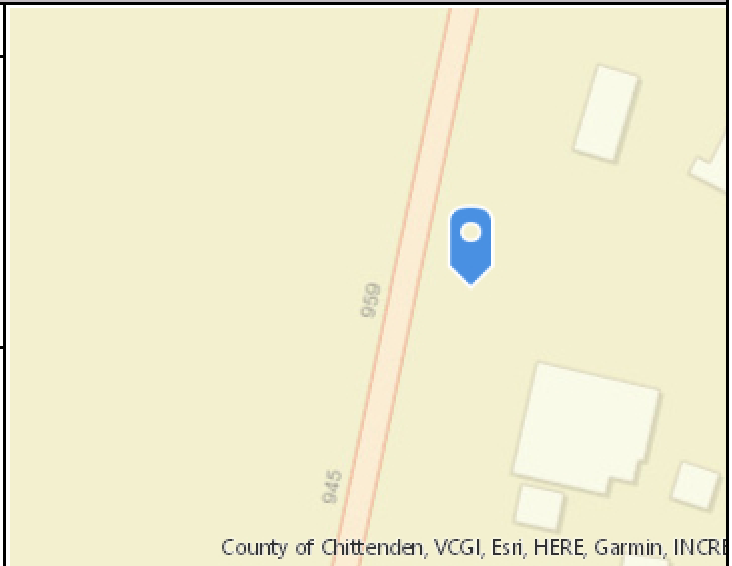
Name: Rte 7 Retrofit #4

Concept Description:

Retrofit existing swale at Georgia Market to increase storage and water quality treatment. Also right size driveway culverts at north and south ends of swale. Culvert inlet at driveway on north end is crushed. More than the WQv may be managed here, and possibly more than CPv – except hotspot land use adjacent.

Notes/Feasibility:

Utility conflicts include overhead electric, telecom. Gas at east edge of right of way. Georgia Market has gas pumps.



GENERAL SITE INFORMATION	
Site Contact Info:	VTrans
Ownership:	Public
Land Use Type:	Commercial, Transport-Related (roadway or ROW)
Land Use Detail:	
Existing BMP on Site?	No
Is site a hotspot?	Yes
Sources/pollutants:	Sediment, Metals (Cu, Zn, Pb, e.g., transportation), Nutrients
Soils:	A
Use in Retrofit DA:	Commercial Roof, Commercial/Industrial Parking, Paved Road, Moderate Traffic

SIZING INFORMATION	
Drainage Area (ac):	0.77
Impervious Area (ac):	0.72
Practice Area Available (ft²):	1,800
Existing Head Available?	Yes

RETROFIT DETAILS	
Project Candidate:	Yes
New BMP / Retrofit Existing:	New BMP
Proposed Retrofit Practice(s):	Constructed gravel wetland, culvert repair or replacement
Non-Structural Controls:	
Non-Structural Other:	
Maintenance Burden:	Medium

Benefits:		**Conflicts:**	
Storage:	Yes	Soils:	No
Water Quality:	Yes	Access:	No
Recharge:	No	Land Use:	Yes
Demonstration:	No	Utilities:	Yes
Repair:		Polluted:	No
Reuse:	No	High WT:	No
		Wetlands:	No
Other:		Other:	

Date: 08/16/2018 12:19 AM

Assessed by: amacrellis_stone_env

ID# 15, Image 1

ID# 15, Image 2

ID# 15, Image 3

ID#: 16

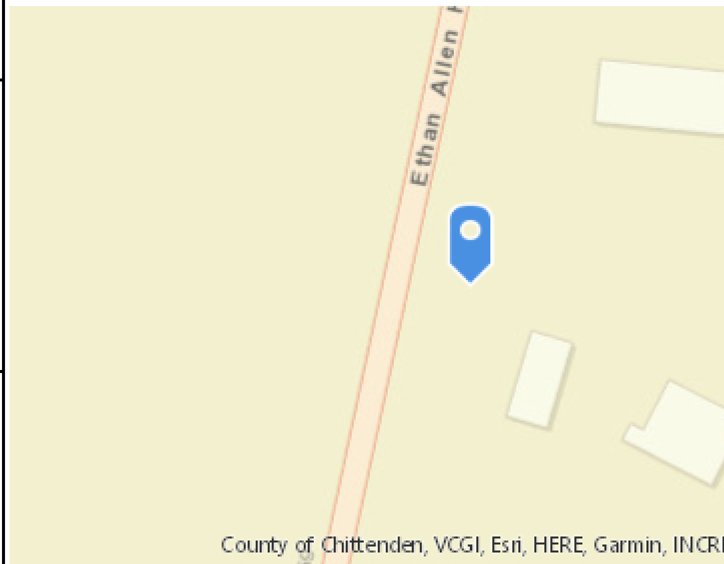
Name: Rte 7 Retrofit #5 - Swale Near Kitchens By Design

Concept Description:

Stormwater flows overland via drain pipe from the south, and overland via sheet flow from the north. Construct gravel wetlands, install an outlet structure at the catch basin inlet. Create 2 to 3 feet of ponding as well as 2 to 3 feet of media storage. Substantial storage volume and peak flow attenuation possible here.

Notes/Feasibility:

Seasonal high groundwater may become an issue; gas runs along the east.



GENERAL SITE INFORMATION	
Site Contact Info:	VTrans
Ownership:	Public
Land Use Type:	Commercial
Land Use Detail:	
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Sediment, Nutrients
Soils:	A
Use in Retrofit DA:	Commercial Roof, Paved Parking or Driveway, Paved Road, High Traffic, Lawn, Urbanized, Lawn, Low Compaction, Pervious, road right-of-way, compacted

SIZING INFORMATION	
Drainage Area (ac):	0.91
Impervious Area (ac):	0.32
Practice Area Available (ft^2):	
Existing Head Available?	

RETROFIT DETAILS	
Project Candidate:	Yes, high-priority
New BMP / Retrofit Existing:	New BMP
Proposed Retrofit Practice(s):	Constructed gravel wetland
Non-Structural Controls:	
Non-Structural Other:	
Maintenance Burden:	Low

Benefits:		**Conflicts:**	
Storage:	Yes	Soils:	Yes
Water Quality:	Yes	Access:	Yes
Recharge:	No	Land Use:	No
Demonstration:	No	Utilities:	No
Repair:		Polluted:	
Reuse:	No	High WT:	
		Wetlands:	No
Other:		Other:	

Date: 08/16/2018 12:26 AM

Assessed by: bmartin_stone_env

ID# 16, Image 1

ID# 16, Image 2

ID# 16, Image 3

ID#: 17

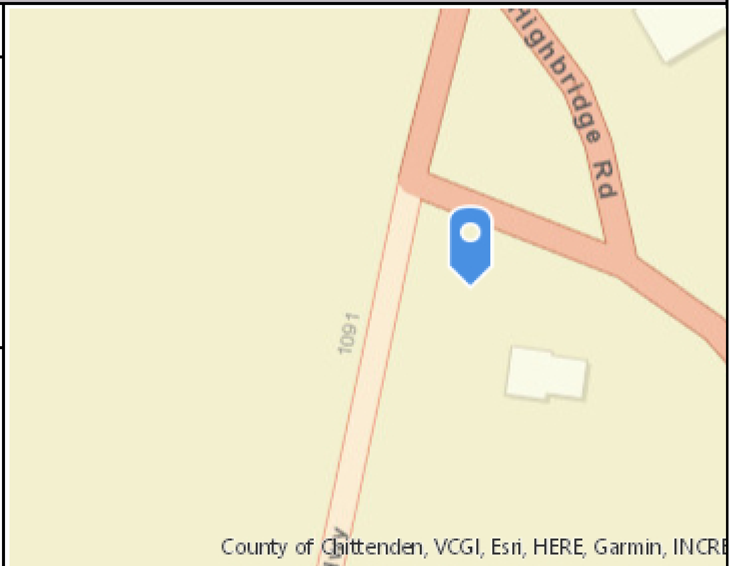
Name: Rte 7 Retrofit #6

Concept Description:

Install measures in swale that will pond up water here to provide additional storage volume and possible water quality treatment. Utility constraints mean excavation likely prohibitive, but building up from existing grade is a possibility, swale is quite deep.

Notes/Feasibility:

Overhead electric and telecom; mound septic system immediately outside of ROW; numerous gas conflicts, making excavation in this area very challenging.



GENERAL SITE INFORMATION	
Site Contact Info:	VTrans
Ownership:	Public
Land Use Type:	Commercial, Transport-Related (roadway or ROW)
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Sediment, Nutrients, Metals (Cu, Zn, Pb, e.g., transportation)
Soils:	A/D
Use in Retrofit DA:	Commercial Roof, Paved Parking or Driveway, Paved Road, Moderate Traffic, Lawn, Low Compaction, Pervious, road right-of-way, low compaction

SIZING INFORMATION	
Drainage Area (ac):	1.98
Impervious Area (ac):	1.24
Practice Area Available (ft^2):	
Existing Head Available?	Yes

RETROFIT DETAILS	
Project Candidate:	Yes
New BMP / Retrofit Existing:	New BMP
Proposed Retrofit Practice(s):	Constructed gravel wetland, dry detention pond
Non-Structural Other:	
Maintenance Burden:	Low

Benefits:		**Conflicts:**	
Storage:	Yes	Soils:	No
Water Quality:	Yes	Access:	No
Recharge:	No	Land Use:	Yes
Demonstration:	No	Utilities:	Yes
Repair:		Polluted:	No
Reuse:	No	High WT:	No
		Wetlands:	No
Other:		Other:	

Date: 08/16/2018 12:38 AM

Assessed by: amacrellis_stone_env

ID# 17, Image 1

ID# 17, Image 2

ID# 17, Image 3

ID# 17, Image 4

ID# 17, Image 5

Appendix 2 – Analysis of Alternatives Table

PROBLEM AREA / ISSUE	PROBLEM DESCRIPTION	ALTERNATIVES	ADVANTAGES	DISADVANTAGES	CONST. ESTIMATE
I. Source Flow Reduction and / or Velocity Reduction	Storm flows from the culvert at the head of the gully and concentrated runoff flowing down the sides of the gully are the root cause of the erosion. They must be controlled to prevent continued or future erosion.	**1 –** Stormwater detention pond at the head of the gully. An embankment pond would be constructed right at the existing culvert outfall. The pond would have a regulated outlet to control the flow of discharge and an emergency spillway to handle very large flows.	●Stormwater flows would be controlled and velocities reduced upon entering the gully and stormwater quality would be improved as well. ●Can take advantage of existing ground contours	●In order to construct an embankment pond capable of treating the water quality volume, it would be necessary to construct a dam that is 18 feet high ●Significant soil and site investigation would be required to ensure proper design of a dam of that size ●Steep emergency spillway ●May not be allowed by regulations ●Would be very expensive and require a significant amount of material ●Potential habitat degradation ●Could create a physical hazard ●Will require routine maintenance	$90,000 to $120,000
		2 – Stormwater detention pond at the catch basin in the triangle at the Route 7/104A intersection. An excavated pond would be constructed and the existing catch basin replaced with an outlet device. It would be necessary to measure the elevations of existing inlet pipes to determine feasibility	●Easily accessible for construction and maintenance ●Will handle flows and treat stormwater before ever entering the gully ●The existing conveyance structures could potentially be re-used.	●Adequate barriers would need to be constructed to separate traffic from the pond resulting in added danger to traffic ●Overland emergency overflow would not be an option as it would result in flooding the adjacent highways ●Would require routine maintenance ●Due to space limitations, it would not be possible to treat the full water quality volume ●It may not be feasible if the existing inlet structures are too deep	$60,000 to $80,000
		3 – Rock Outlet Protection. Install new stone or reset existing stone at the top culvert outfall to reduce the depth, velocity, and energy of water exiting the culvert.	●Will reduce the energy of flow entering the gully channel. ●Relatively easy to construct. May be possible to use existing materials.	●Will provide limited control of flow entering the channel.	$1,000
II. Wet active slumping adjacent to main stream (Upper areas A on map)	50-130 feet downstream of the culvert outfall, primarily on the left side, significant bank erosion from stream flow and slumping at groundwater seeps. The failures at the stream edge have resulted in major slope failures all the way up to the top edge of the gully. It is now in a very advanced stage of failure.	**1 –** Live cribbing. Install live crib walls throughout this section on the left side of the stream, at the bottom of the slope. (Can also consider live gabions). Live crib walls are untreated timber box cribbing filled with stone at the bottom and soil with live branch cuttings.	●Can provide immediate structural support to the slope ●Provides vertical structure in relatively small area ●The cribbing material will help drain adjacent soil and plantings will further transpire moisture ●Natural appearance and habitat provider ●As plantings grow they will provide added structural integrity and will continue to stabilize the slope after the cribbing rots away	●Complex to construct (labor intensive). ●Expensive to construct. ●High failure rate for vegetation	$25,000 to $35,000 (assume 100 lineal feet of cribbing)
		2 – Gravity wall retaining structure. Construct a gabion or solid stone or block retaining wall at the toe of the slope along the channel edge to control the mass slumping along the steep slopes of the gully sides.	●Will provide immediate structural support to the slope ●Will provide vertical structure in a relatively small area allowing the top slope to be reduced at the immediate top of the wall structure (improving it's ability to retain the soil. ●Relatively easy and fast to construct once base is	●Will not provide enhanced drainage of soil behind the wall unless a drain is constructed or a gabion with highly porous media is used. ●In order to construct properly it will be necessary to excavate down to the existing channel depth away from the channel edge in order to prepare the foundation for the structure.	

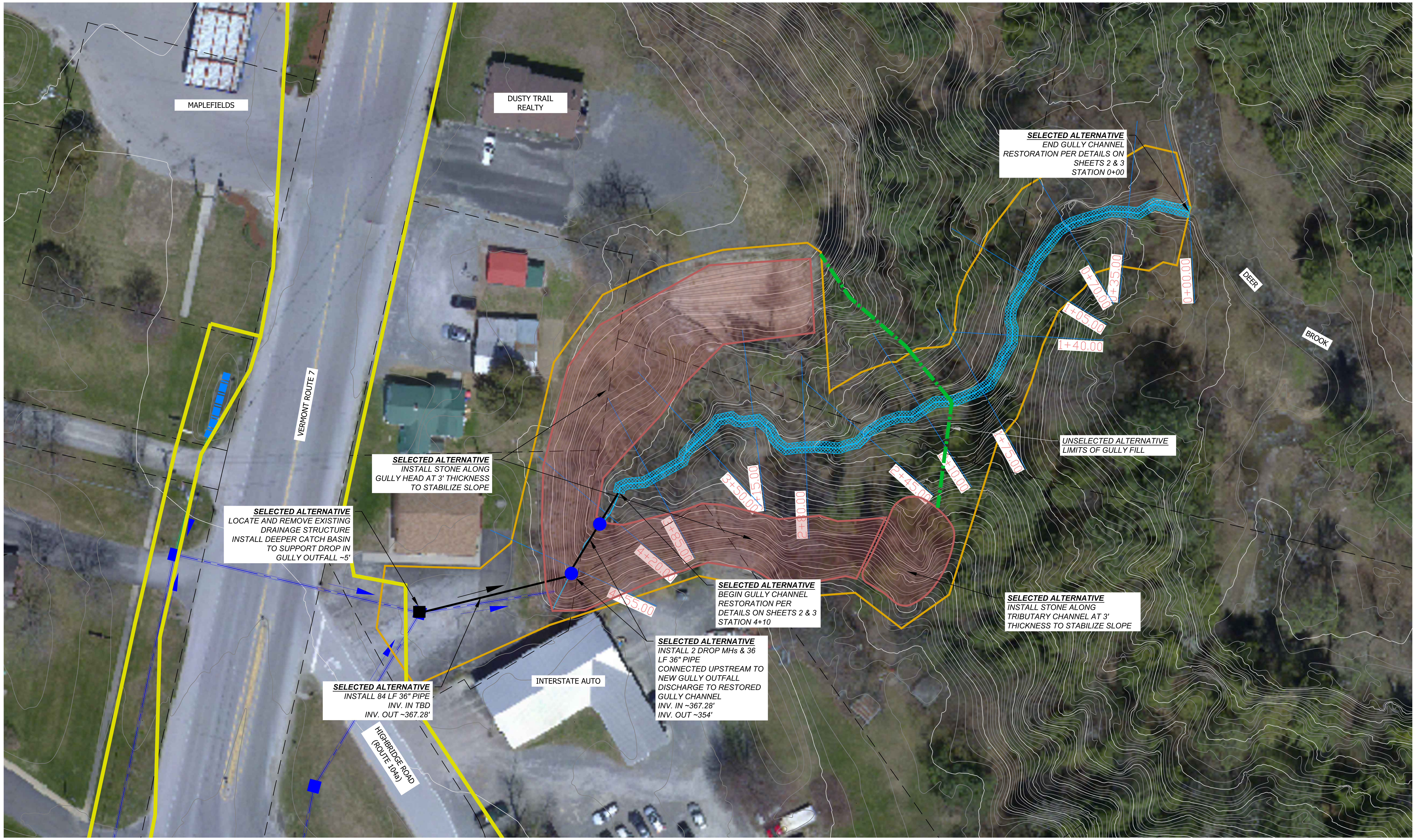
PROBLEM AREA / ISSUE	*PROBLEM DESCRIPTION*	*ALTERNATIVES*	*ADVANTAGES*	*DISADVANTAGES*	*CONST. ESTIMATE*
			prepared.	●Will require machinery and will be labor intensive. If large stone or block it used, it will be complicated to get the materials in place to to the difficult maneuverability in the gully.	
		3 – Vegetated rip rap. Continue the existing rip rap on both sides of the stream down to approximately 130 feet downstream of the culvert outfall. Live stakes would then be tamped through openings in the stone.	●Rip rap will provide immediate support and stabilization to the slope ●Vegetation will anchor the stone over time adding and will bind soil particles creating additional stabilization ●Live stake roots will improve soil drainage by removing moisture	●Will require a significant amount of large sized rip rap to properly stabilize such a high and steep slope ●Construction access will be very difficult as the areas directly upslope of the problem areas are the backyards of homes and businesses and buildings are very close to the top of the embankment ●It may be difficult to establish vegetation due to the quantity and size of stone	$30,000 to $35,000
III. Groundwater seepage / wet unstable soil (Areas B on map)	Several areas along the mid to upper side slopes are wet with apparent groundwater seepage. Failure is minimal, but these areas are very vulnerable to slope failure. There is very low vegetation in these and other areas.	**1 –** Live Staking. Live staking is the insertion and tamping of live rootable vegetative cuttings (e.g. willow, cottonwood, and red-osier dogwood).	●Will enhance conditions for natural invasion and the establishment of other plants from the surrounding plant community. ●Over time a living root mat will develop soil by reinforcing and binding soil particles together and by extracting excess soil moisture. ●Appropriate technique for repair of small earth slips and slumps that usually have moist soils.	●Should not be used where structural integrity is required nor to resist large, lateral earth pressures. ●Does not solve existing erosion problems (excluding benefits from associated mulch). ●Not a short-term solution to slope instability.	$8,000 to $10,000 for approx. 9,600 square feet
		2 – Live Fascines. Also referred to as contour or willow wattling, are long bundles of branch cuttings bound together into sausage like structures. When cut from appropriate species and properly installed with live and dead stout stakes, they will root and immediately begin to stabilize slopes	●Will protect slopes from shallow slides (1 to 2 foot depth). ●Immediately reduces surface erosion or rilling. Capable of trapping and holding soil on the face of the slope, thus reducing a long slope into a series of shorter slopes. ●Enhances vegetative establishment by creating a microclimate conducive to plant growth. ●When installed by a trained crew, causes little site disturbance.	●Slopes should be 1:1 or flatter. ●On steep or long slope lengths, high runoff velocities can undermine live fascines near drainage channels. ●Significant quantity of plant material is required and can dry out if not properly installed.	$12,000 to $15,000 for 9,600 square feet
IV. Tributary Channel Cutting (Areas C on map)	Concentrated surface runoff from the top edges of the gully have cut channels leading down to the main stream. These are steep narrow channels that are actively cutting deeply into the soil.	**1 –** Diversion (Tributary Channels). This would involve diverting the surface flow at the top of the gully to a stabilized channel on a less aggressive slope, and/or dispersing the flow over a greater area.	●Can minimize direct impact to specific areas and will re-direct excess runoff to trickle down into the gully. ●Will slow the flow of stormwater to the main channel	●Will require machinery to re-grade the tops of the embankments ●If not done correctly, it can cause other problem areas ●Diversion channels will need to be constructed with machinery in area that is not easily accessible	$15,000 to $20,000
		2- Slope Down-drains (Tributary Channels). Install a wide culvert inlet device at the top of the gully to capture concentrated surface runoff and divert it to a flexible aboveground or buried culvert and deliver it directly to the	●Relatively simple to construct ●Very inexpensive ●Would not require large machinery	●Could result in delivering stormwater to the stream faster than existing conditions ●Could result in greater erosion at the main stream channel ●Possible freezing issues	$2,000 to $3,000

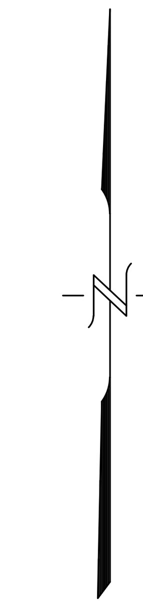
PROBLEM AREA / ISSUE	*PROBLEM DESCRIPTION*	*ALTERNATIVES*	*ADVANTAGES*	*DISADVANTAGES*	*CONST. ESTIMATE*
		main stream. Would require a tee or other energy dissipating device at the outlet.			
V. Discrete slide / slope failure along edge of main stream channel (Areas D on the map)	Discrete slides are present directly adjacent to the main stream, particularly on the right side at approximately 90' and 200' downstream of the culvert outfall. These areas are wet and have virtually no vegetation.	**1** – Vegetated Rip Rap. This involves tamping live stakes into joints or open spaces in rocks that have been placed on a slope.	●Live stake roots will improve soil drainage by removing moisture. ●Will provide immediate protection ●If extended down into the streambed, it can dissipate hydraulic energy along the bank.	●Rip rap would need to be brought in and placed onto the slope (very labor intensive if no machinery)	$6,000 to $8,000
		2 – Live Fascines (refer to Area B Alternative)	●Same advantages as for Area 'B' ●Would be easier construction than vegetated rip rap in these locations	●Same disadvantages as for Area 'B' ●Will not be effective if these areas are actively failing	$1,500 to $3,000
VI. Main stream bank erosion and deep channel down-cutting (Areas E on map)	Several areas along the main stream channel, beginning at approximately 100 feet downstream of the culvert outfall. Bank erosion from high flow and water velocity in main stream and down-cutting. Solutions offered to slow the flow quantity and velocity of the stream will benefit these areas also.	**1** – Rock Lined Channel. Re-grade the existing channel to a low flat channel bottom, designed with a cross section that can handle the 100-year storm. Beneath the stone native soils would be protected by a layer of geo-textile fabric and choking stone.	●Stream flows would no longer be in direct contact with the highly erosive soils along the stream channel sides and bottom. ●Irregular placement of large stones can assist in reducing the velocity of the stream and encouraging sediments to drop out of the water.	●Armor approach. Does not achieve the underlying goal to promote more natural practices. ●Will require machinery to reshape the channel and stone placement. Can also be very labor intensive.	
		2 – Stepped pools. Several low-height stone/boulder drops would be constructed connected by a low-gradient channel. Due to the very steep gradient at the top of the main channel, pools could not begin until approximately 70 feet down-gradient of the culvert outfall. Woody plantings (live stakes) could be incorporated along the edges of the channel.	●Mimics the natural formation of steep-gradient perennial streams ●Relatively simple construction. Could be accomplished with minimal use of equipment if intensive labor is available. ●If extended to the confluence with tributary gullies, it would provide flow control for those added flows as well.	●Will require monitoring and possible maintenance at least for the first few storms for gauging its performance. ●Stones and boulders are not native to the gully, they would need to be imported.	$85,000 to $100,000
		3 – Stone gabion and boulder check dam / weir and re-grading the bank along the channel with live staking and other plantings. Placement of a weir would be particularly effective where the channel now narrows.	●Would effectively disperse energy and trap sediment ●If routinely maintained, the trapped sediment could be used to refill surrounding banks ●Would enhance the habitat of the gully ●If regular maintenance were not performed, the trapped sediment would provide a low gradient channel at the approach ●If placed correctly it would minimize the direct impact to the stream bed where tributaries flow into the main stream	●Construction would be very labor intensive if constructed without significant machinery. ●Stone would need to be imported ●May require regular maintenance	$4,500 to $6,000
		4 – Log weir and re-grading the bank along the channel with live staking and other plantings. Similar to a stone check dam, except constructed with logs	●Could use some of the many fallen logs already in the gully for the materials of the weir ●Many of the same other benefits as a stone check dam ●Due to its relative impermeability, the formation of a pool behind it would be more likely.	●The log weirs, not being porous, could become barriers during low flows ●Log weirs could rot over time ●May require routine maintenance	$2,000 to $4,000
VII. Upgradient Stormwater BMPs	A stormwater collection system is present that extends	**1** – Ditch check dams. All catch basins are located in the bottom of grass-lined ditches	●Relatively easy access for construction ●Would slow flows and assist in early sediment	●Will require routine maintenance ●Will impact the look of existing front lawns of	$2,000 to $3,000

PROBLEM AREA / ISSUE	PROBLEM DESCRIPTION	ALTERNATIVES	ADVANTAGES	DISADVANTAGES	CONST. ESTIMATE
	several hundred feet to the south of the gully, on both sides of Route 7. Opportunities are present upgradient of the outfall to further reduce volume and treat stormwater flows.	off of the edge of Route 7. Small stone check dams in the ditches would assist in slowing the travel time to the catch basins.	removal ●Will promote more infiltration by detaining flows.	properties (all ditches are currently grass, most are maintained)	
		2 – Divert roof drains. Roof drains of buildings discharge mostly to the ground, where it creates a concentrated runoff, particularly in the immediate vicinity of the edge of the gully. Roof drains would be dispersed on a pervious surface or diverted to a drywell.	●Would result in greater infiltration and dispersion of flows, thereby reducing runoff quantity.	●Infiltration at the top of the gully could exacerbate existing groundwater seeps.	$1,000 to $5,000
		3 – Bioretention. Construction of bioretention areas or rain gardens in the existing ditch system. Bioretention involves filtration of stormwater through a porous organic filter media. Underdrains would divert stormwater to existing catch basins.	●Would provide significant added treatment of the stormwater flows, particularly in the removal of phosphorous.	●In order to determine the feasibility of this option it will be necessary to measure the depth of existing structures to ensure there is adequate vertical distance between existing grade and pipe inverts. ●Required annual maintenance (replacement of mulch)	$4,000 to $6,000

Notes:
Directions (left – right) are to be taken as facing downstream.
Any of the live recommendations will require removal of some of the larger trees to increase the amount of sunlight that reaches the gully.

Appendix 3 – Conceptual Engineering Drawings





General Notes:

1. Orthophoto collected by AirShark on May 8, 2018 during an aerial survey using drone technology.
2. Existing representation of closed drainage system are from a survey executed by Gabe Bolin, PE and Branden Martin, EI of Stone Environmental Inc., and David Cavagnaro of Friends of Northern Lake Champlain, on August 15, 2018, using a Geomax Zoom 30 Total Station and are for the purposes of this plan only.
3. Horizontal coordinates refer to the North American Datum of 1983 (NAD83). The vertical datum refers to the North American Vertical Datum of 1988 (NAVD88).
4. Gully channel delineation based on LiDAR contours provided by AirShark.
5. Parcel boundaries were obtained from the Vermont Center for Geographic Information (VCGI), do not represent a boundary survey and should be considered approximate.
6. VTrans right of way delineation obtained from VTrans and should be considered approximate.
7. Delineation of proposed stone at Gully head, along tributary channels and proposed catch basin and storm pipe have been designed to the conceptual level and should be considered approximate.

Legend

- Major Contour
- Minor Contour
- VTrans right ofway limits
- Existing storm drain pipe, catch basin & flow direction
- Existing culvert
- Existing swale
- Gully channel
- Proposed limits of disturbance
- Proposed storm drain pipe, catch basin & flow direction

REDUCED SIZED PLANS NOT TO SCALE

CONCEPTUAL DESIGNS NOT FOR CONSTRUCTION

FILE:

DRAWING CREDITS

DRAWN ON: 10/17/2018
DRAWN BY: GMB
CHECKED ON:
CHECKED BY:
PROJECT NO: 17-084

REVISIONS

#	DATE	DRWN	CHK'D	APP'D	DESCRIPTION

DRAWING SCALE

1 inch = 30 feet
(1 : 360)

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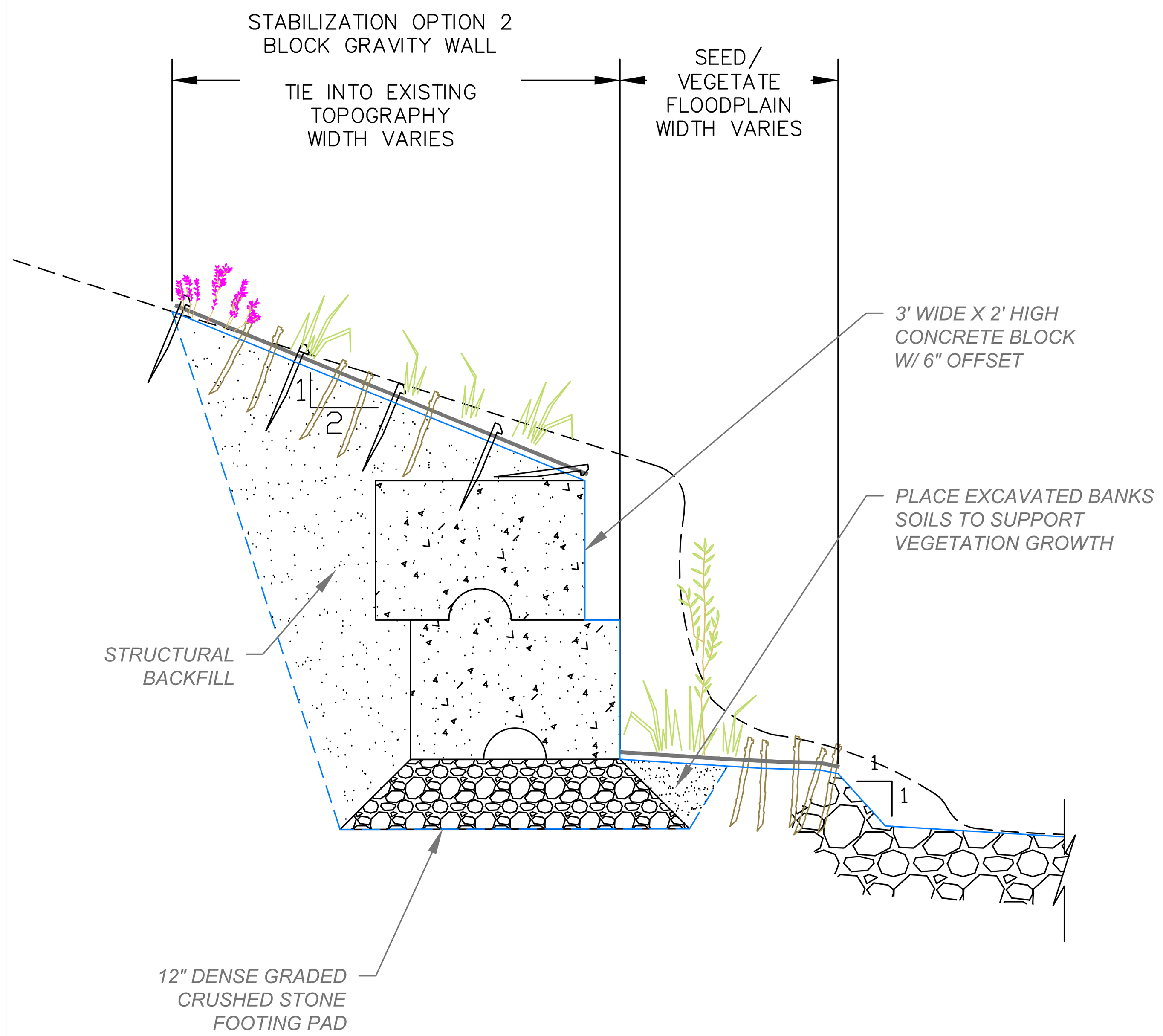
DEER BROOK GULLY RESTORATION
GULLY REMEDIATION ALTERNATIVES ANALYSIS
SITE PLAN

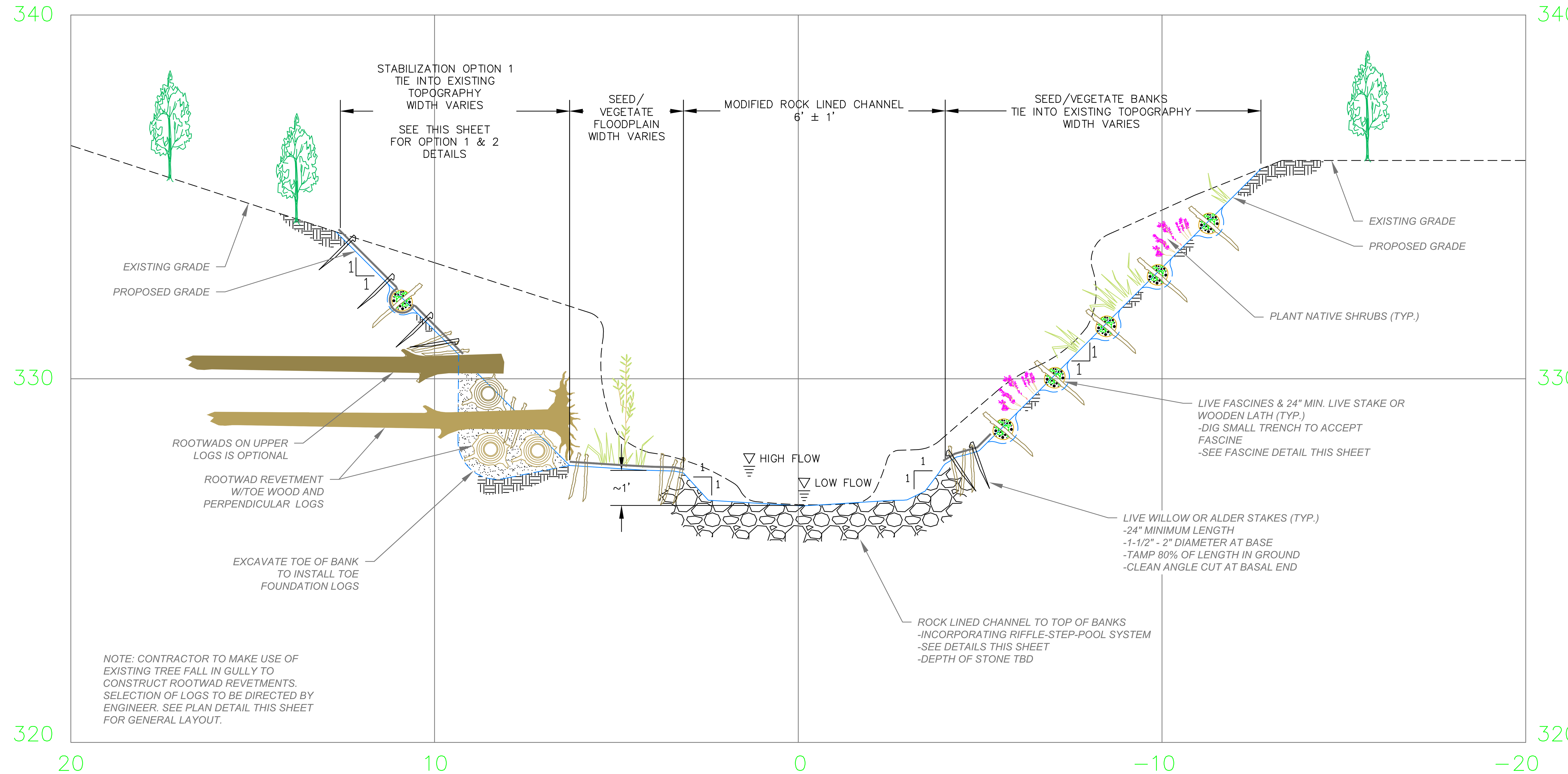
GEORGIA VERMONT

FIGURE NO.

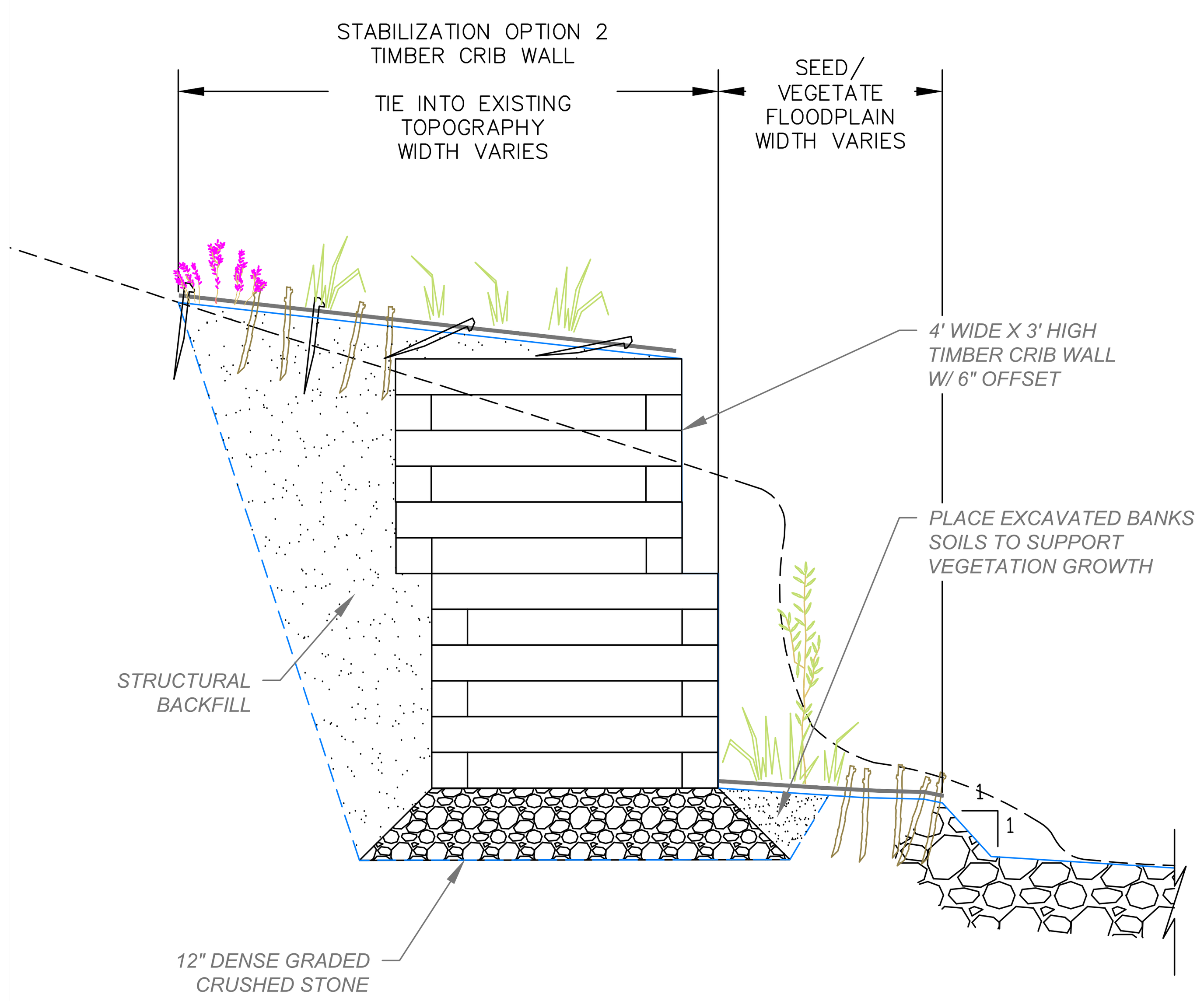
1



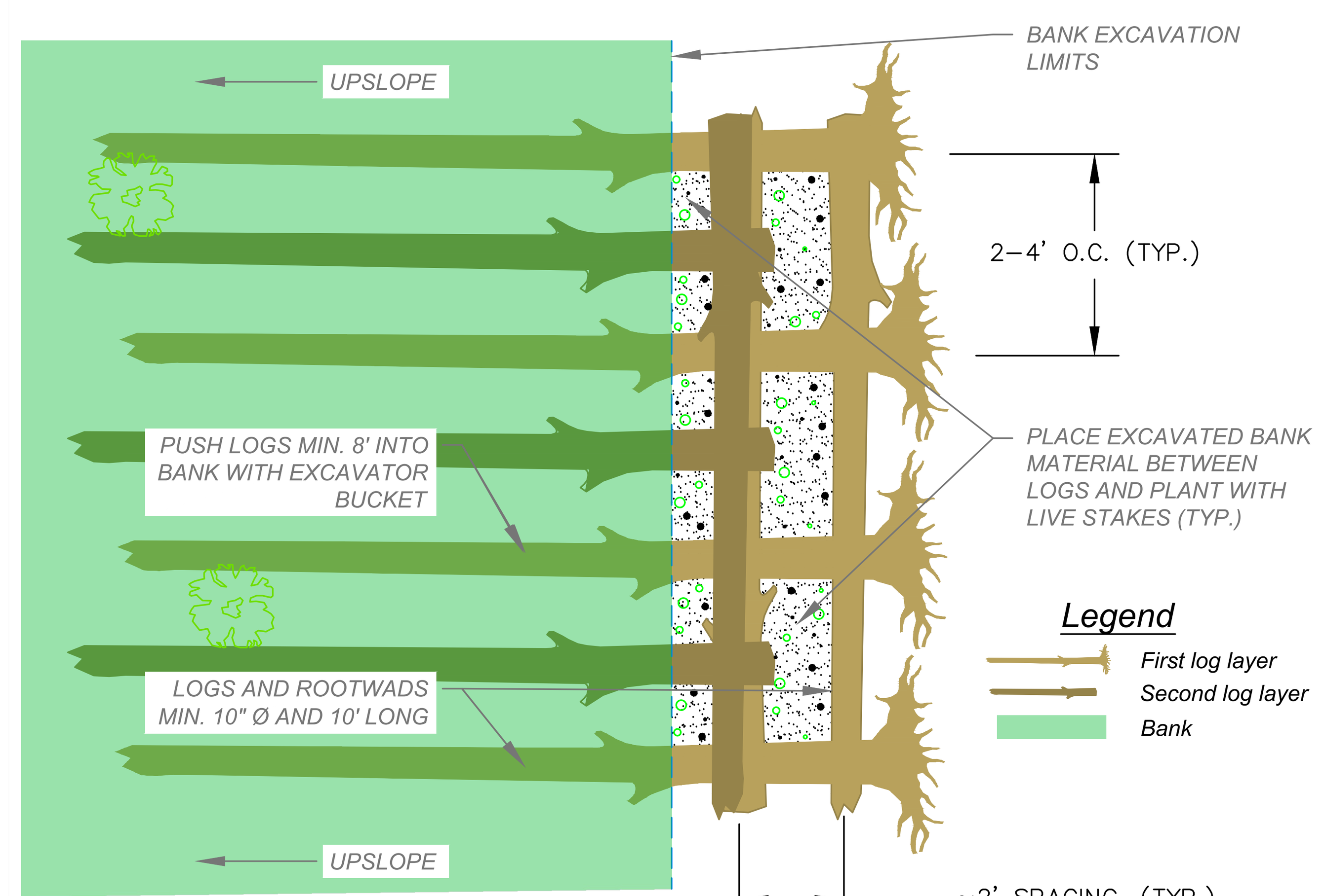
Bank Stabilization Option 2 - Block Gravity Wall
Scale: 1" = 2'-0"



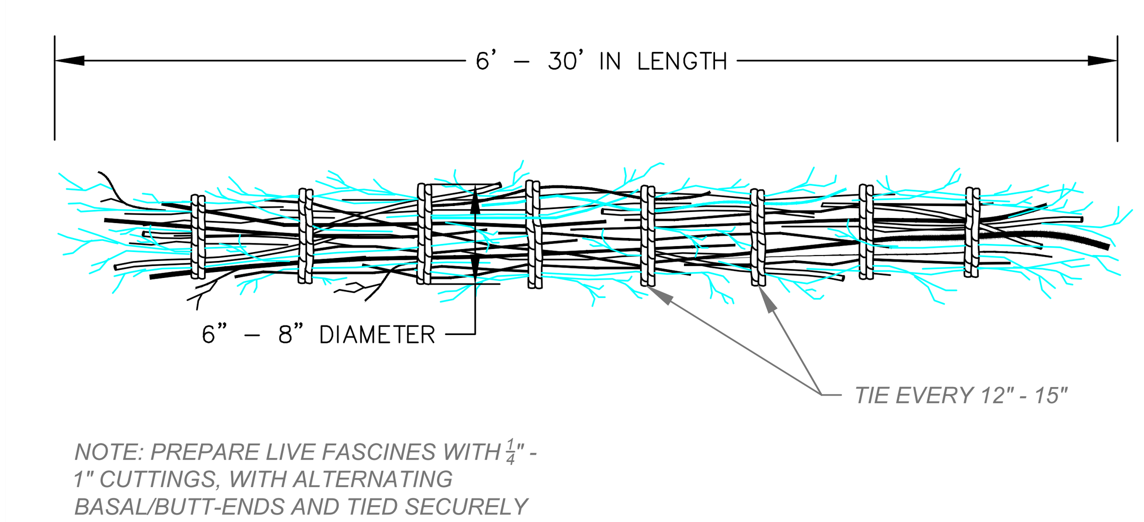
Typical Channel Restoration Section - Station 1+40
Scale: 1" = 2'-0"



Bank Stabilization Option 2 - Live Crib Wall
Scale: 1" = 2'-0"



Rootwad Revetment - Plan
Scale: 1" = 2'-0"



Live Fascine Detail
Scale: 1" = 1'-0"

REDUCED SIZED PLANS
NOT TO SCALE

CONCEPTUAL DESIGNS
NOT FOR CONSTRUCTION

FILE:

DRAWING CREDITS

DRAWN ON:	10/17/2018
DRAWN BY:	GMB
CHECKED ON:	
CHECKED BY:	
PROJECT NO:	17-084

REVISIONS

#	DATE	DRWN	CHK'D	APP'D	DESCRIPTION

DRAWING SCALE

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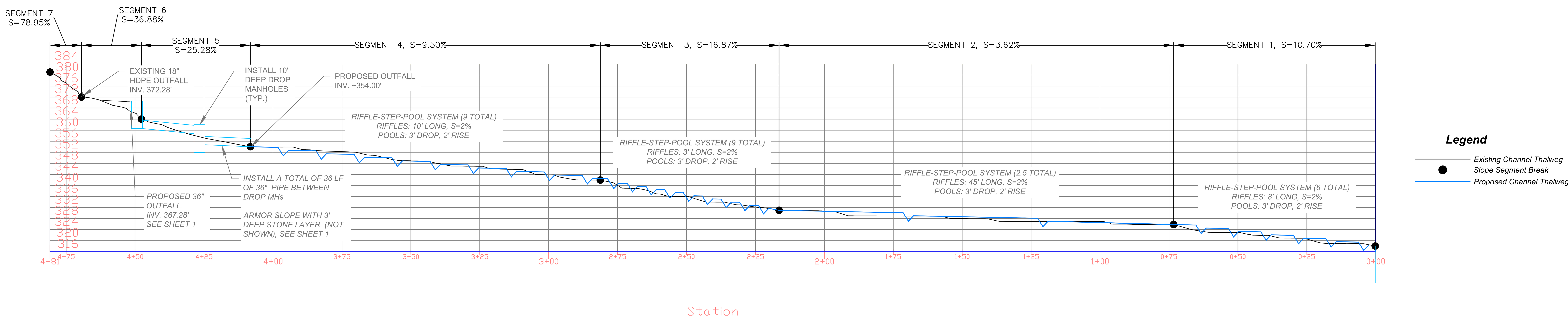
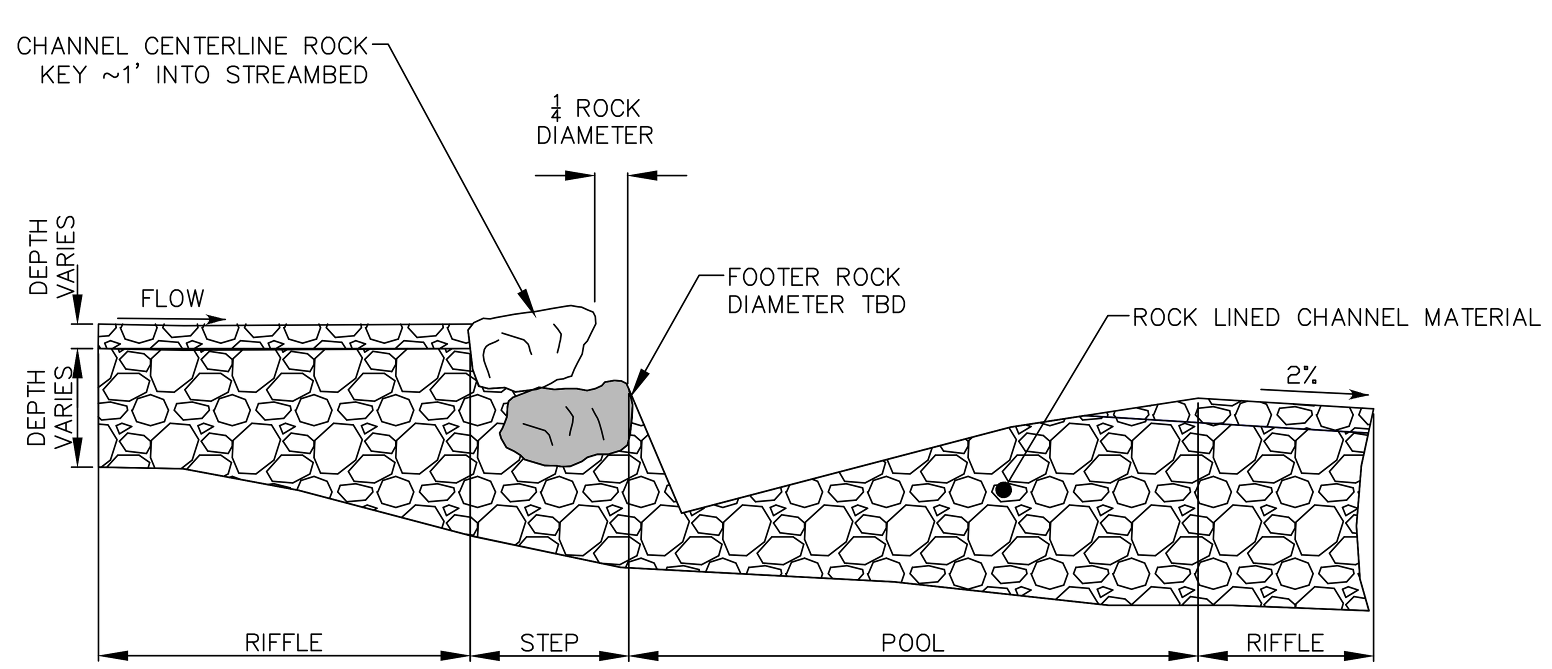
DEER BROOK GULLY RESTORATION
GULLY REMEDIATION ALTERNATIVES ANALYSIS
FLOODPLAIN AND BANK RESTORATION DETAILS
GEORGIA VERMONT

FIGURE NO.
2



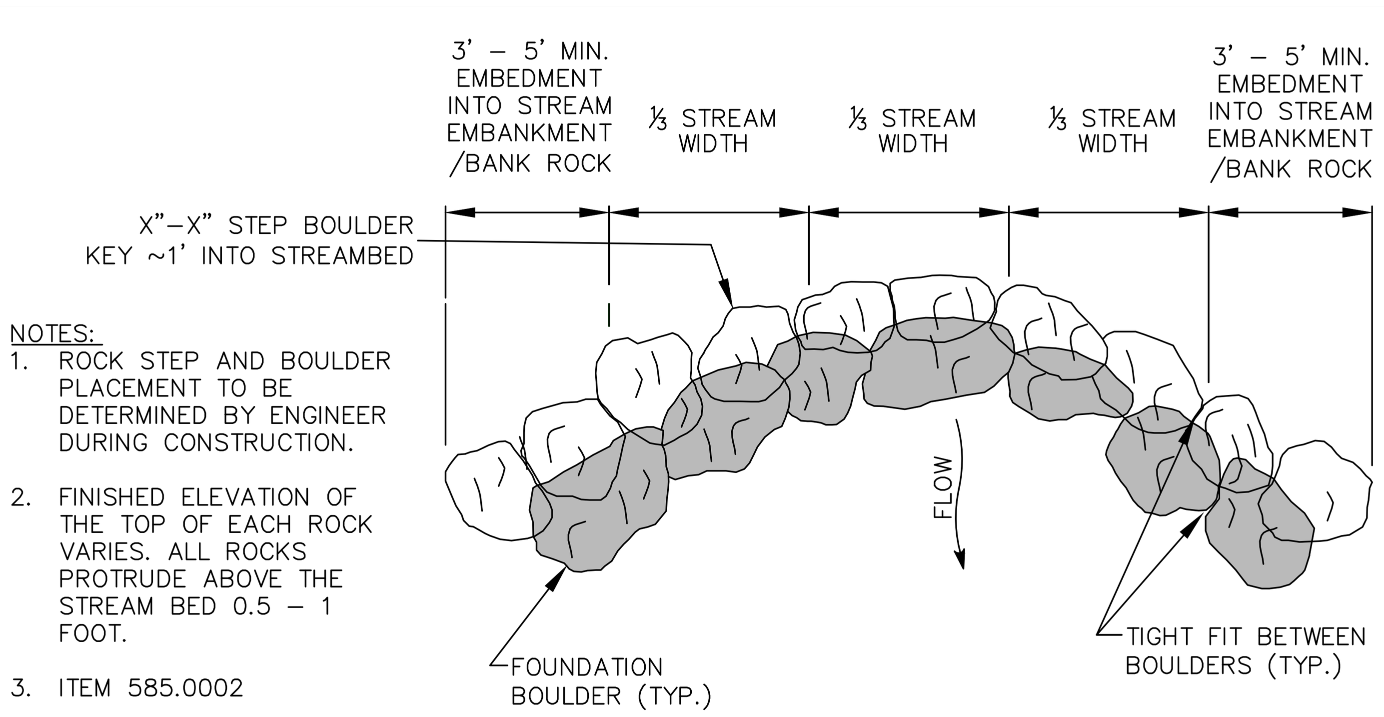
Existing and Proposed Longitudinal Profile

Horizontal Scale: 1" = 20'
Vertical Scale: 1" = 20'



Rock Step and Riffle - Typical Section

Scale: ¼" = 1'-0"



NOTES:
1. ROCK STEP AND BOULDER PLACEMENT TO BE DETERMINED BY ENGINEER DURING CONSTRUCTION.
2. FINISHED ELEVATION OF THE TOP OF EACH ROCK VARIES. ALL ROCKS PROTRUDE ABOVE THE STREAM BED 0.5 - 1 FOOT.
3. ITEM 585.0002

Rock Step - Plan View

Scale: NTS

REDUCED SIZED PLANS NOT TO SCALE

CONCEPTUAL DESIGNS NOT FOR CONSTRUCTION

FILE:

DRAWING CREDITS
DRAWN ON: 10/17/2018
DRAWN BY: GMB
CHECKED ON:
CHECKED BY:
PROJECT NO: 17-084

REVISIONS

#	DATE	DRWN	CHK'D	APP'D	DESCRIPTION

DRAWING SCALE

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DEER BROOK GULLY RESTORATION
GULLY REMEDIATION ALTERNATIVES ANALYSIS
CHANNEL RESTORATION PROFILE & DETAILS
GEORGIA VERMONT

FIGURE NO. 3

Appendix 4 – Colchester Drop Manhole Photos

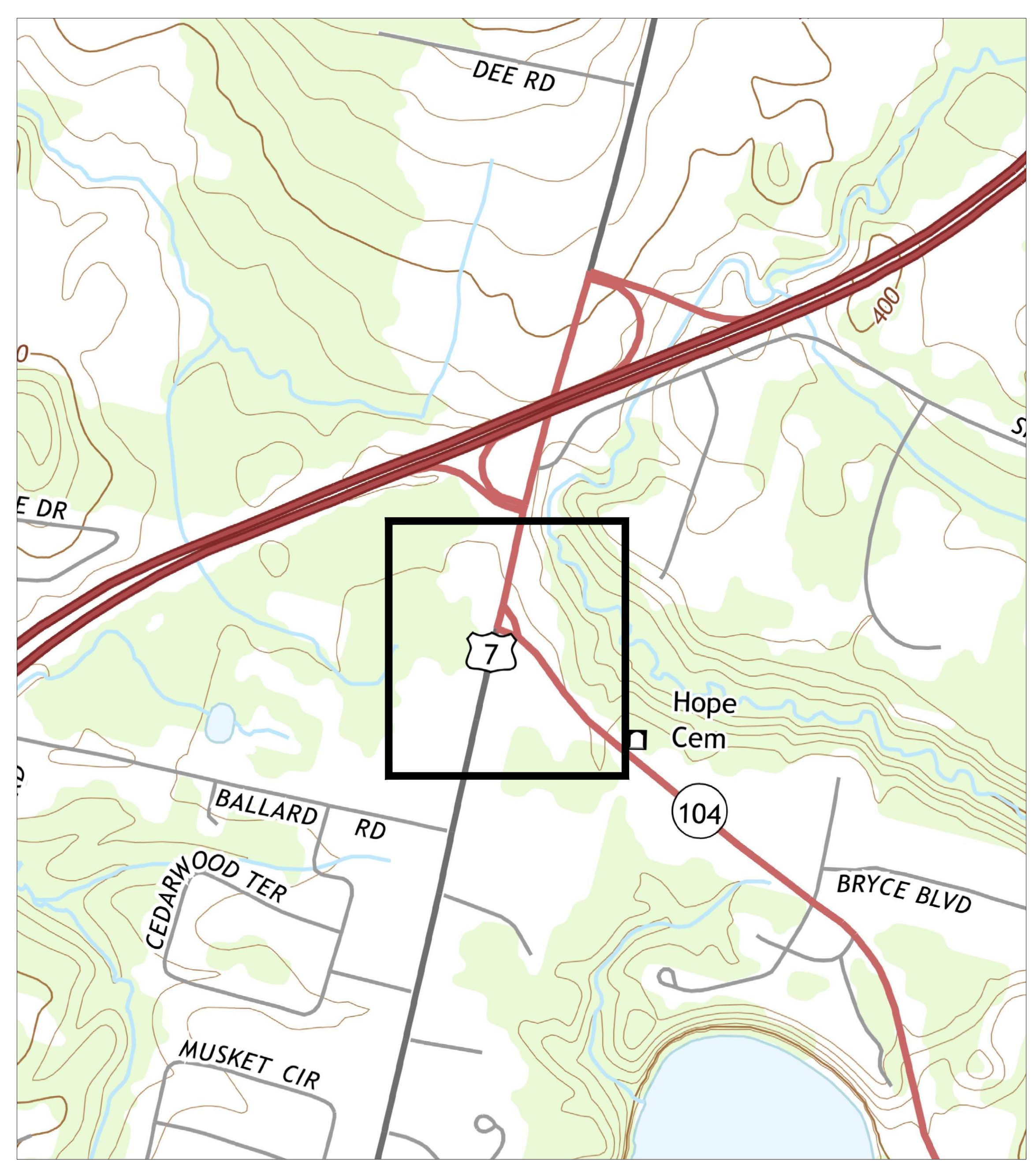
Drop Manhole Application – East Lakeshore Drive, Colchester (January 2018)

Appendix 5 – Final 100% Engineering Plans

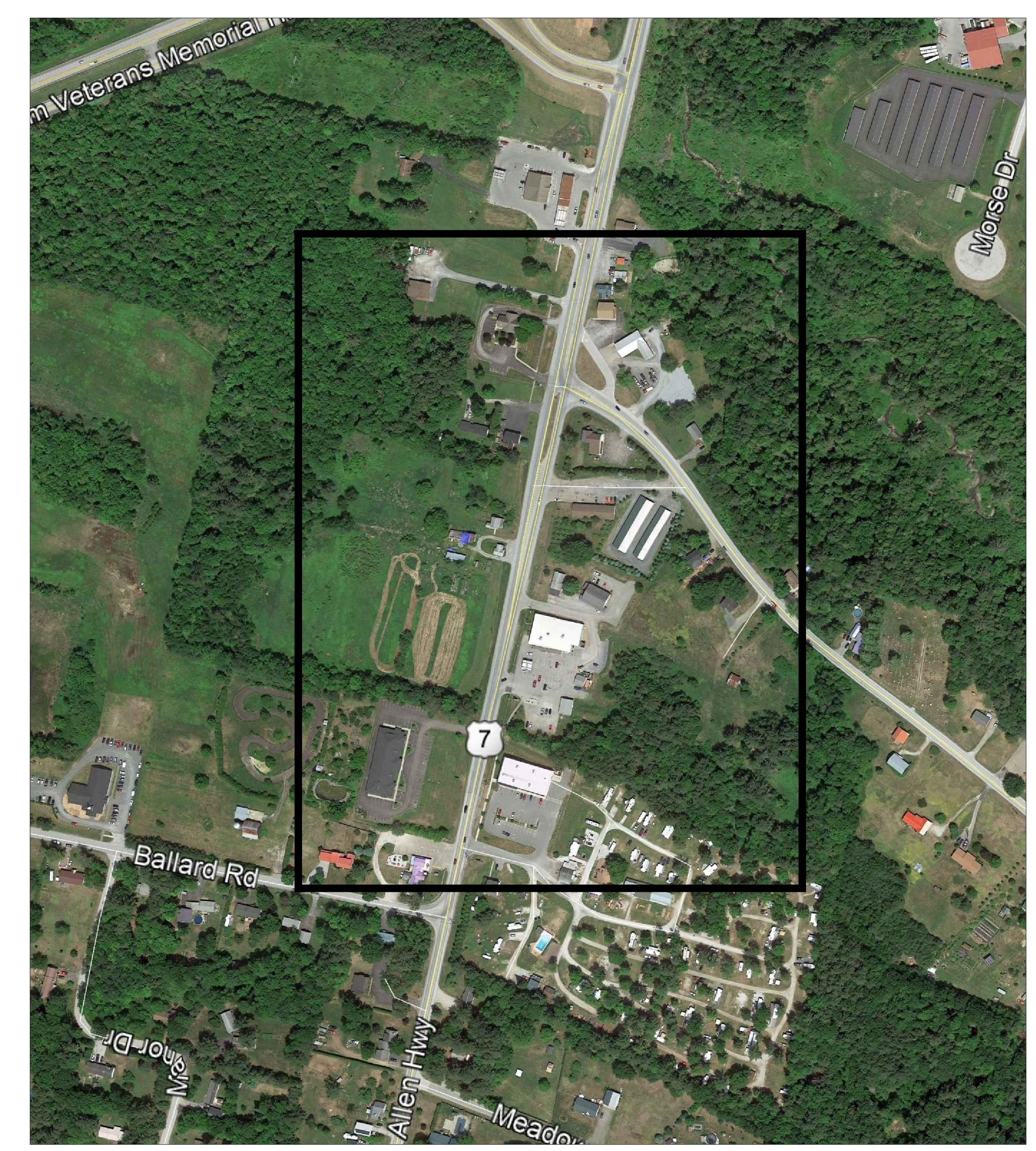
DEER BROOK GULLY RESTORATION
TOWN OF GEORGIA, VERMONT

PREPARED FOR:
FRIENDS OF NORTHERN LAKE CHAMPLAIN

PREPARED BY:
STONE ENVIRONMENTAL, INC.



Project Vicinity
1" = 1000'



Project Location
Scale: NTS

DRAWING INDEX:

SHEET	TITLE
1	COVER SHEET
2	GENERAL NOTES & LEGEND
3	OVERALL SITE PLAN
4-6	STORMWATER RETROFIT SITE PLANS
7	CLOSED DRAINAGE UPGRADE PLAN
8	DETAILS
9	GRAVEL WETLAND DETAILS
10	CHANNEL RESTORATION PROFILE AND DETAILS
11	EROSION PREVENTION & SEDIMENT CONTROL DETAILS

NOT FOR CONSTRUCTION

FILE:

DRAWING CREDITS
DRAWN ON: 04/10/2019
DRAWN BY: BAM
CHECKED ON: 04/29/2019
CHECKED BY: PCL/GMB
PROJECT NO: 17-084

REVISIONS

#	DATE	DRWN	CHK'D	APP'D	DESCRIPTION

DRAWING SCALE

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DEER BROOK
GULLY RESTORATION
COVER SHEET

GEORGIA VERMONT

FIGURE NO. 1

General Notes:

1. Specifications for design, materials and construction shall meet or exceed the following:
   - 1.1. VTrans - Vermont Agency of Transportation "Standard Specifications for Construction", 2018, with current standard plans and supplemental specifications.
   - 1.2. This plan set and all conditions, specifications and supplements to standard specifications contained within the contract documents.
2. Final resolution to conflicts within the specifications or any substitutions shall be determined by the Engineer.
3. Utilities:
   - 3.1. The Contractor shall be responsible for determining the location of all utilities prior to any construction procedure. There are numerous utilities in the vicinity of the projects. The Contractor is advised that extreme caution will be required in the operation of equipment. Contact DIG-SAFE at 1-888-DIG-SAFE.
   - 3.2. Temporary relocation of utilities, if necessary, during construction is the responsibility of the Contractor.
   - 3.3. Damage to any utility by the Contractor shall be reported to the utility company. Repair of the utility shall be paid for by the Contractor.
4. The Contractor shall not disturb any existing property corner, monument, survey marker, or benchmark without first making provisions for its replacement or relocation.

General Construction Notes:

1. Note that permits have not yet been received for this project, and will be acquired prior to construction by the Owner's representatives. Work can not proceed until permits are acquired.
2. See Sheet 11 for notes on erosion prevention and sediment control.
3. All items shall be constructed to the dimensions shown on the drawings. Any changes require approval by the Engineer.
4. The Engineer shall be notified prior to the start of construction.
5. It shall be the Contractor's responsibility to notify the Engineer immediately if problems or unforeseen circumstances arise during construction.
6. All testing shall be ordered by the Engineer and coordinated by the Contractor in accordance with VTrans and project specifications. Contractor shall give the Engineer 24 hours advance notice prior to placing materials requiring testing. Testing costs are subsidiary and shall be included in the item unit price.
7. Determination of maximum densities for sand and gravels are the responsibility of the Contractor. Proctor tests ordered by the Engineer shall be sampled and performed by an independent testing laboratory and paid for by the Contractor. Include all costs in the item unit price.
8. Areas outside the limits of proposed work disturbed by the Contractor's operations shall be restored by the Contractor to their original condition at the Contractor's expense.
9. All soil moving equipment shall be thoroughly cleaned to make it free of soil, non-native invasive species or other debris that could contain or hold seeds prior to being delivered to the project site. Equipment shall be considered free of non-native or invasive species and other such debris when a visual inspection by the Engineer, completed prior to the equipment being moved to the site, does not disclose such material present.
10. Where relevant, topsoil shall be stripped and stockpiled to be used to restore disturbed areas.
11. The Contractor is responsible for providing any required traffic control including, but not limited to, jersey barriers, or other barricades, signage and flaggers.
12. Contractor shall protect existing facilities and utility lines from all damage. Noted and/or observable subsurface improvements such as utilities, water lines, and culverts shall be avoided and repaired and/or replaced as needed. Repair of unforeseen subsurface improvements will be negotiated.
13. Job-site safety conditions, including but not limited to, mobilization/demobilization, excavation, stockpiling, pipe and material installation, etc. shall be the Contractor's responsibility.
14. Legally dispose of excess material off site.
15. Control dust with water as needed.
16. Basic construction standards for storage of materials, safety protection, protection of neighboring properties, and reclamation of disturbed areas shall be followed. All landscaping must be returned to the original condition or as modified per these plans.
17. Contractor shall construct appropriate fences and barriers around all construction sites, storage sites, and excavations to safe guard the public from the construction site.
18. Details shown on any drawings are to be considered typical for all similar conditions, unless otherwise noted.
19. Prior to beginning construction the following people shall be notified:
    - A. Dig-Safe
    - B. Friends of Northern Lake Champlain
    - C. Site Owner
    - D. Project Engineer
    - E. Town of Georgia
    - F. Vermont Agency of Transportation

    If work is delayed for a significant period, the same individuals shall be contacted again prior to restart.
20. Investigate above surface site conditions prior to beginning work. Disturbed and damaged property must be replaced and/or repaired to the satisfaction of the Owner, Town and Engineer.
21. All excavation and backfilling shall be completed as soon as possible. Open trenches shall be properly barricaded and warned for pedestrians and vehicles.

General Construction Notes (Continued):

22. Granular backfill for structures shall consist of satisfactorily graded, free draining granular material reasonably free from loam, silt, clay and organic material in accordance with Section 704.08 of the VT Agency of Transportation Standard Specifications for Construction.

Shop Drawing Approval Process:

1. The following process will be followed regarding the submission and approval of shop drawings.
   - 1.a. Contractor submits shop drawing to Engineer for review and comment.
   - 1.b. Following review, the Engineer sends comments back to the Contractor.
   - 1.c. Contractor submits revised shop drawings (if necessary) to Engineer; Engineer ensures comments are incorporated into the revised shop drawings.
   - 1.d. If comments are addressed appropriately, Engineer will provide shop drawing approval stamp, distribute copies to applicable parties, and store approved documents in project files.
   - 1.e. If comments are not addressed, repeat steps 1a through 1c.
2. Engineer review and approval does not relieve the Contractor of full responsibility for any negligence in the construction of the project resulting from shop drawings. Engineer review and approval of shop drawings is not a warranty of the adequacy and correctness of shop drawings; the Contractor is responsible for the correctness of shop drawings and all associated calculations.

Pipe Work Notes:

1. The contractor shall make provisions for maintaining flow through existing force mains, sewer lines, water lines, storm drains and channels which must be interrupted during the work. Once work is complete, all flows shall be restored and temporary flow diversions and associated piping shall be removed from the site.
2. The contractor is required to manage any groundwater encountered and maintain stable slopes during excavation.
3. Existing water mains are under pressure. Contractor is advised to take precautions while excavating around existing infrastructure. Temporary sheeting and/or bracing may be required.
4. The contractor shall install mechanical plugs in the end of all pipe work at the completion of each work day to seal it from water and soil.

Survey Notes:

1. Orthophoto collected by AirShark on May 8, 2018 during an aerial survey using drone technology.
2. Existing representation of closed drainage system are from a survey executed by Gabe Bolin, PE and Branden Martin, EI of Stone Environmental Inc., and David Cavagnaro of Friends of Northern Lake Champlain, on August 15, 2018, using a Geomax Zoom 30 Total Station and are for the purposes of this plan only.
3. Horizontal coordinates refer to the North American Datum of 1983 (NAD83). The vertical datum refers to the North American Vertical Datum of 1988 (NAVD88).
4. Gully channel delineation based on LiDAR contours provided by AirShark.
5. Parcel boundaries were obtained from the Vermont Center for Geographic Information (VCGI) , do not represent a boundary survey and should be considered approximate.
6. VTrans right of way delineation obtained from VTrans and should be considered approximate.

Legend

- Major Contour
- Minor Contour
- Edge of Pavement
- Parcel Boundaries
- Drainage Area
- VTrans Right of Way Limits
- Existing Storm Drain Pipe, Catch Basin & Flow Direction
- Existing Swale
- Gully Channel
- OHU — Overhead Utility
- UGT — Underground Telecom
- UGE — Underground Electric
- W — Water Main
- GAS — Gas Line
- S — Sanitary System
- Utility Pole
- Proposed limits of disturbance
- Proposed storm drain pipe, catch basin & flow direction

FILE:

DRAWING CREDITS

DRAWN ON: 04/10/2019
DRAWN BY: BAM
CHECKED ON: 04/29/2019
CHECKED BY: PCL/GMB
PROJECT NO: 17-084

REVISIONS

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DRAWING SCALE

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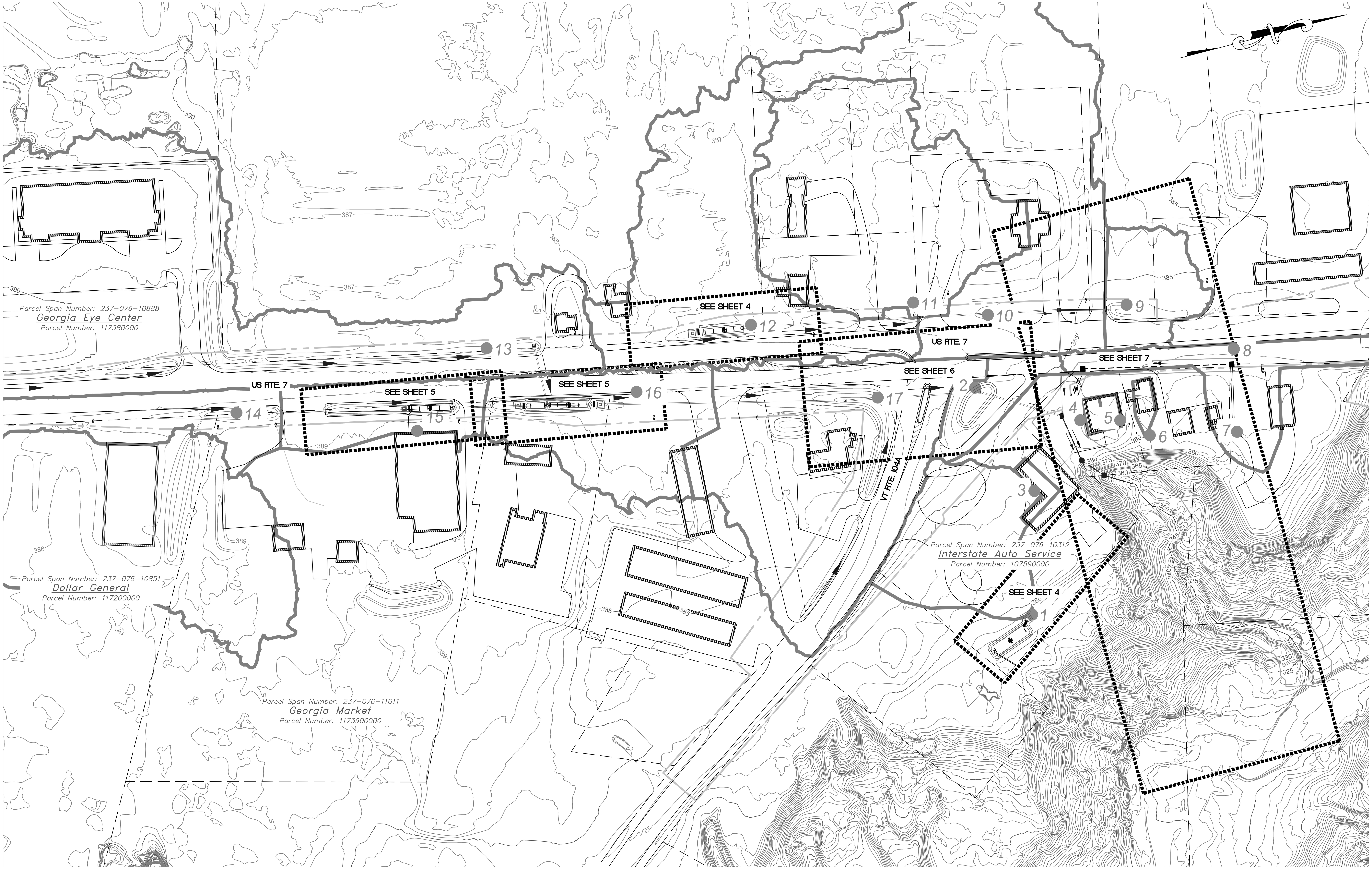
DEER BROOK
GULLY RESTORATION
GENERAL NOTES & LEGEND

GEORGIA VERMONT

FIGURE NO. 2



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CHECKED BY: PCL/GMB
PROJECT NO: 17-084

REVISIONS

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DRAWING SCALE

DRAWINGS ARE HALF SCALE WHEN PRINTED ON 11x17

60 0 60 120 240 ft

12 0 30 60 m

1 inch = 60 feet

(1 : 720)

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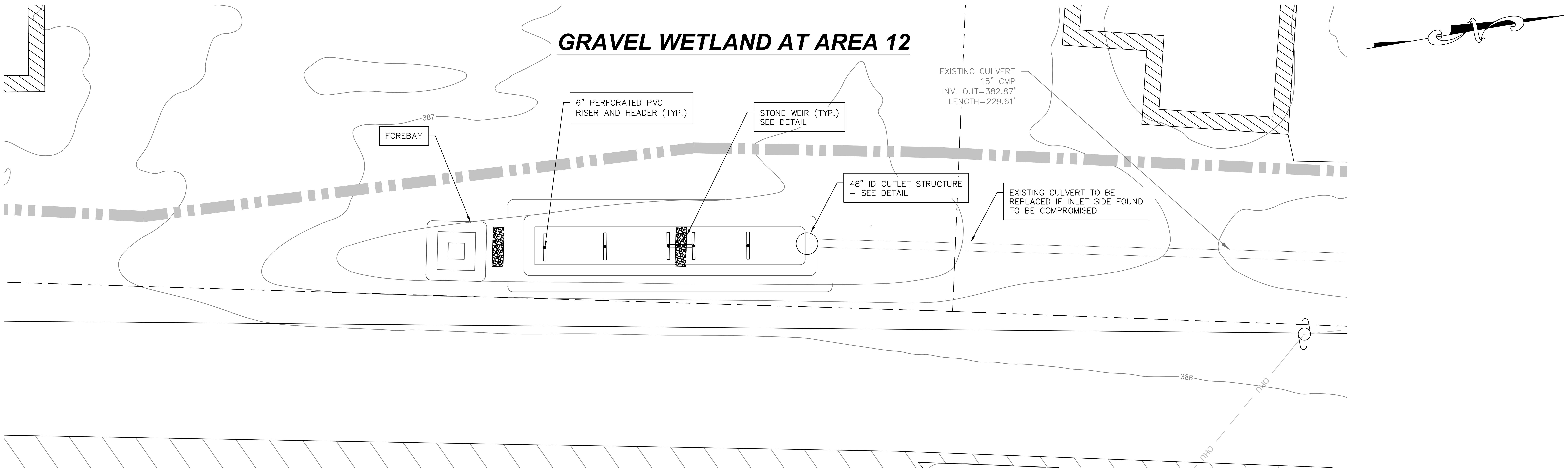
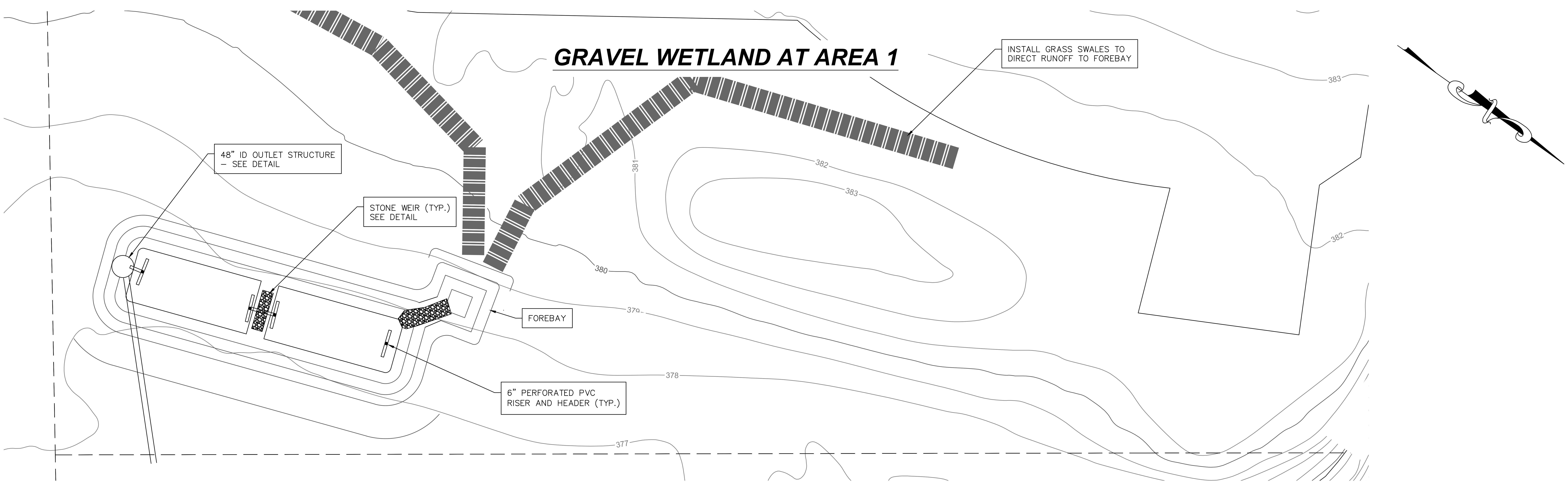
DEER BROOK
GULLY RESTORATION
OVERALL SITE PLAN

GEORGIA VERMONT

FIGURE NO. 3





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PROJECT NO: 17-084

REVISIONS

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DRAWING SCALE

DRAWINGS ARE HALF SCALE WHEN PRINTED ON 11x17

1 inch = 10 feet
(1 : 120)

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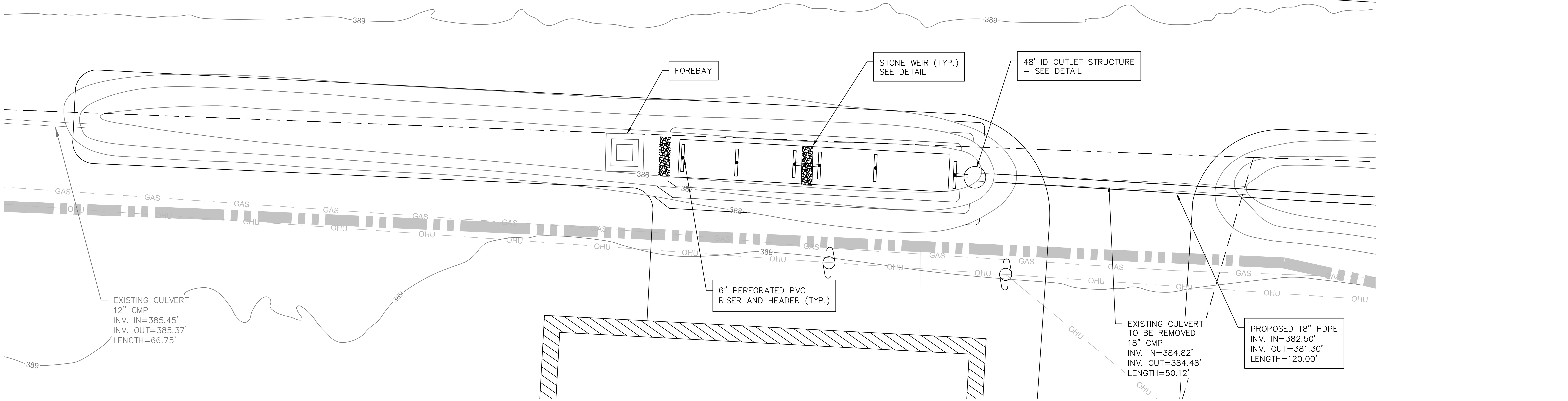
DEER BROOK
GULLY RESTORATION
STORMWATER RETROFIT SITE PLANS

GEORGIA VERMONT

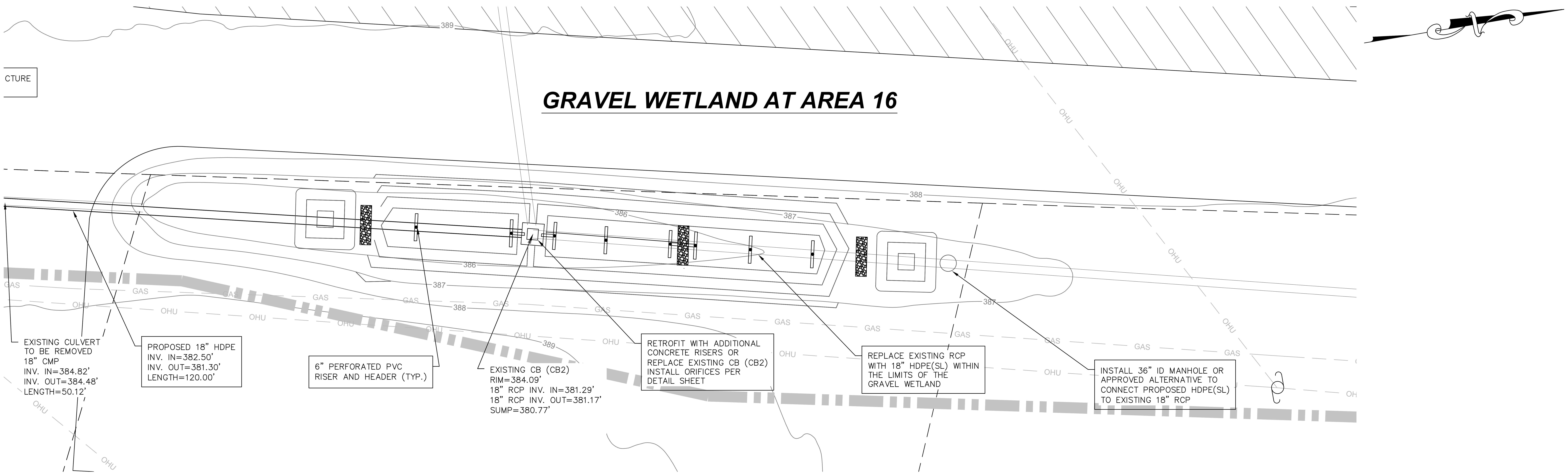
FIGURE NO.

4

GRAVEL WETLAND AT AREA 15



GRAVEL WETLAND AT AREA 16



FILE:

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PROJECT NO: 17-084

REVISIONS

#	DATE	DRWN	CHK'D	APP'D	DESCRIPTION

DRAWING SCALE
DRAWINGS ARE HALF SCALE WHEN PRINTED ON 11x17
10 0 10 20 40 ft
2 0 5 10 m
1 inch = 10 feet
(1 : 120)

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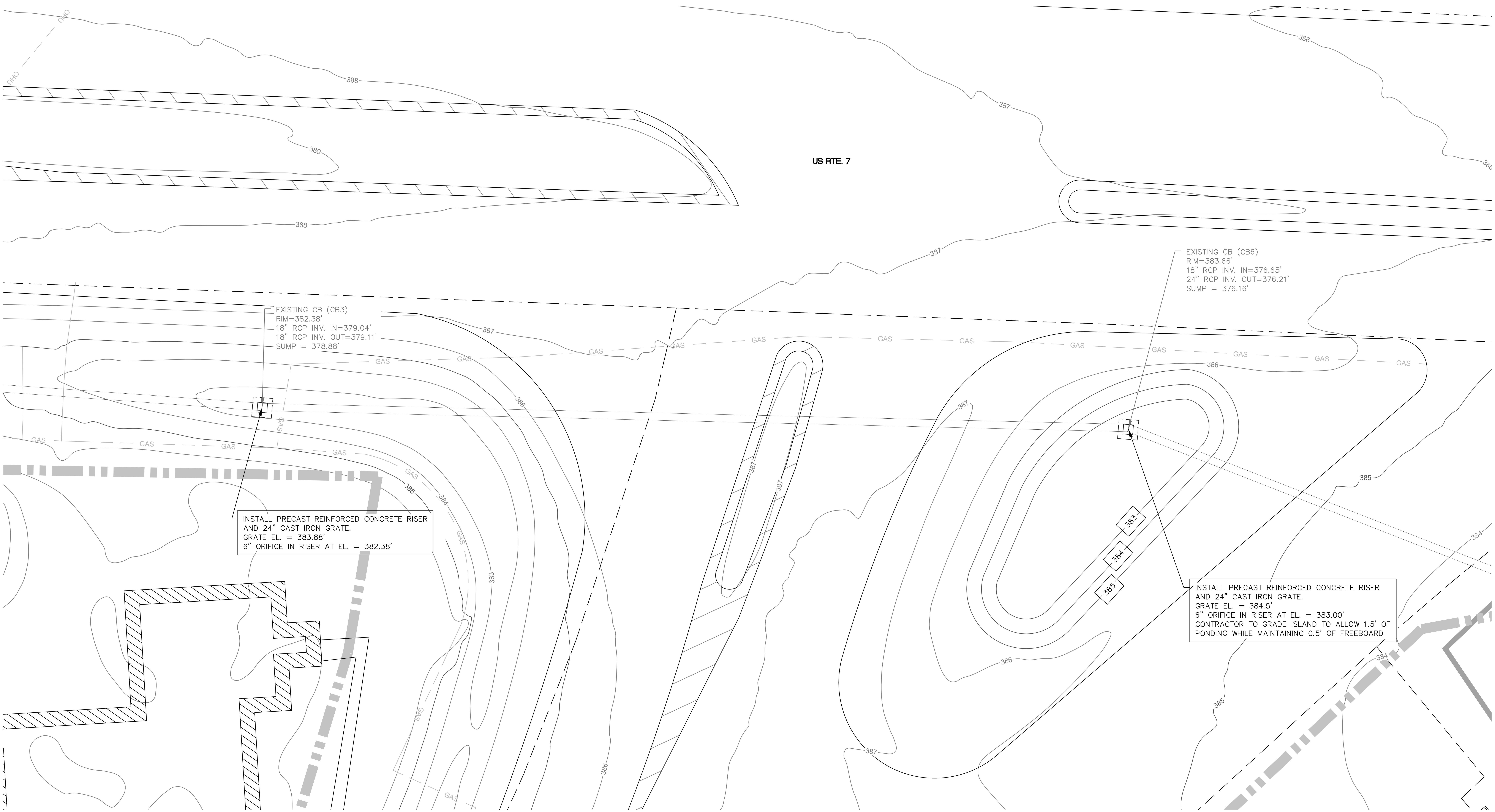
DEER BROOK
GULLY RESTORATION
STORMWATER RETROFIT SITE PLANS
GEORGIA VERMONT

FIGURE NO. 5

CATCH BASIN RISERS AT AREAS 2 & 17



FILE:

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REVISIONS

#	DATE	DRWN	CHK'D	APP'D	DESCRIPTION

DRAWING SCALE
DRAWINGS ARE HALF SCALE WHEN PRINTED ON 11x17
10 0 10 20 40 ft
2 0 5 10 m
1 inch = 10 feet
(1 : 120)

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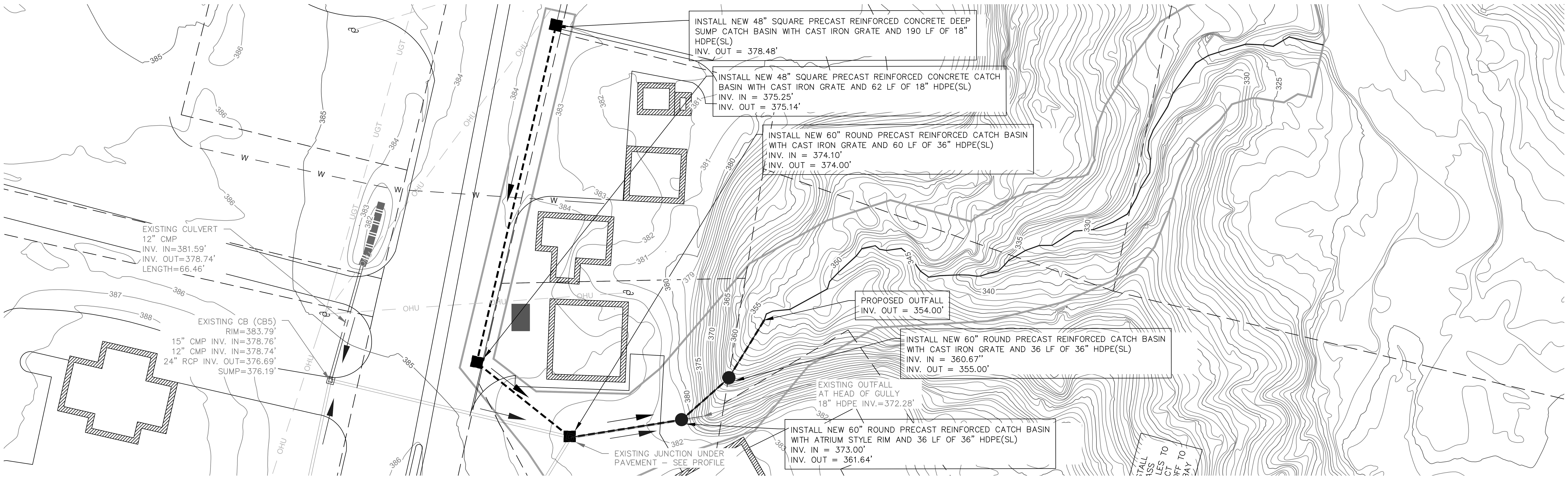
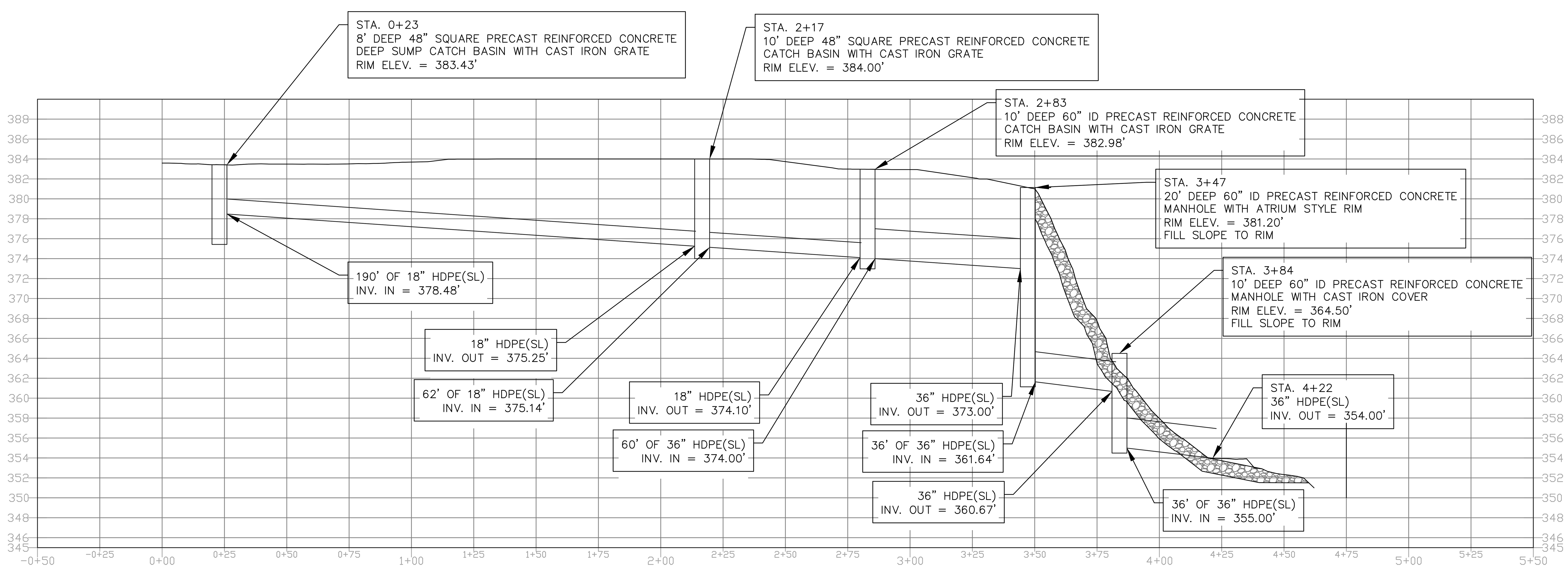
DEER BROOK
GULLY RESTORATION
STORMWATER RETROFIT SITE PLANS
GEORGIA VERMONT

FIGURE NO. 6



SITE PLAN DETAIL

SCALE: 1" = 30'



PROFILE

HORIZONTAL SCALE: 1" = 30'
VERTICAL SCALE: 1" = 7.5'

FILE:

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CHECKED BY:	PCL/GMB
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DRAWING SCALE

DRAWINGS ARE HALF SCALE WHEN PRINTED ON 11x17

1 inch = 30 feet
(1 : 360)

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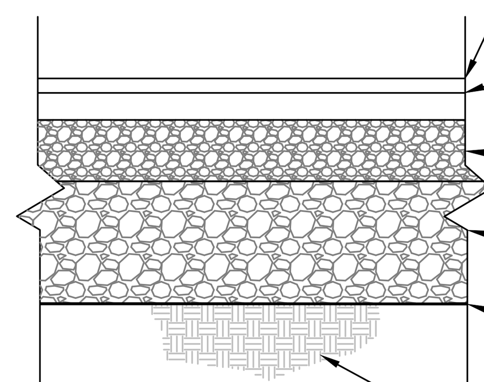
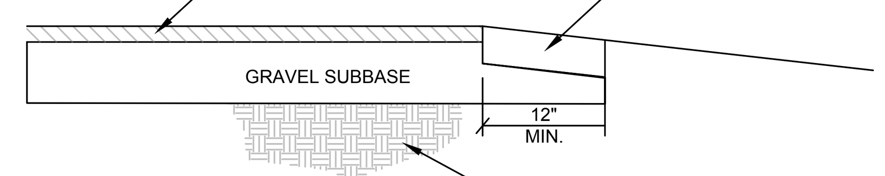
DEER BROOK
GULLY RESTORATION
CLOSED DRAINAGE UPGRADE PLAN
GEORGIA VERMONT

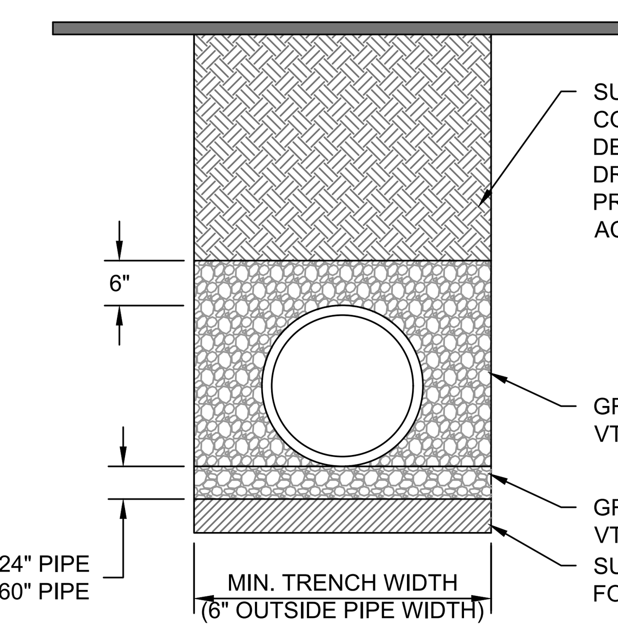
FIGURE NO. 7



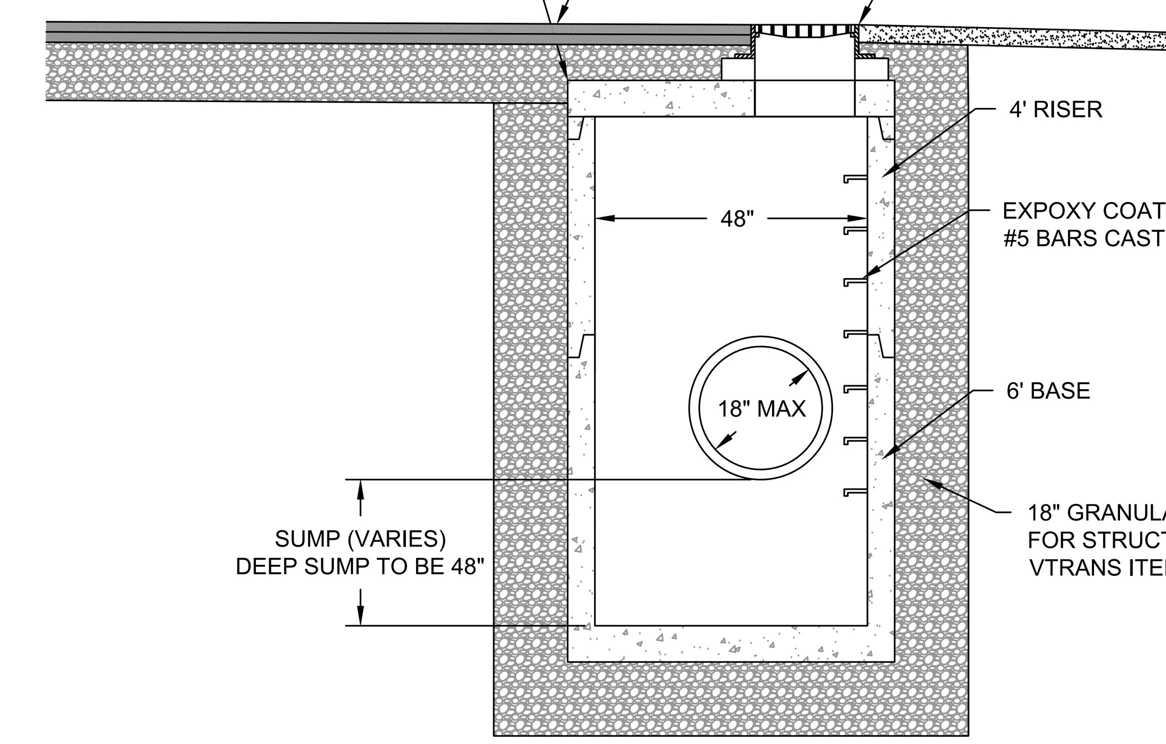
TYPICAL PAVEMENT SECTION
NOT TO SCALE



STONE SHOULDER PROTECTION
NOT TO SCALE

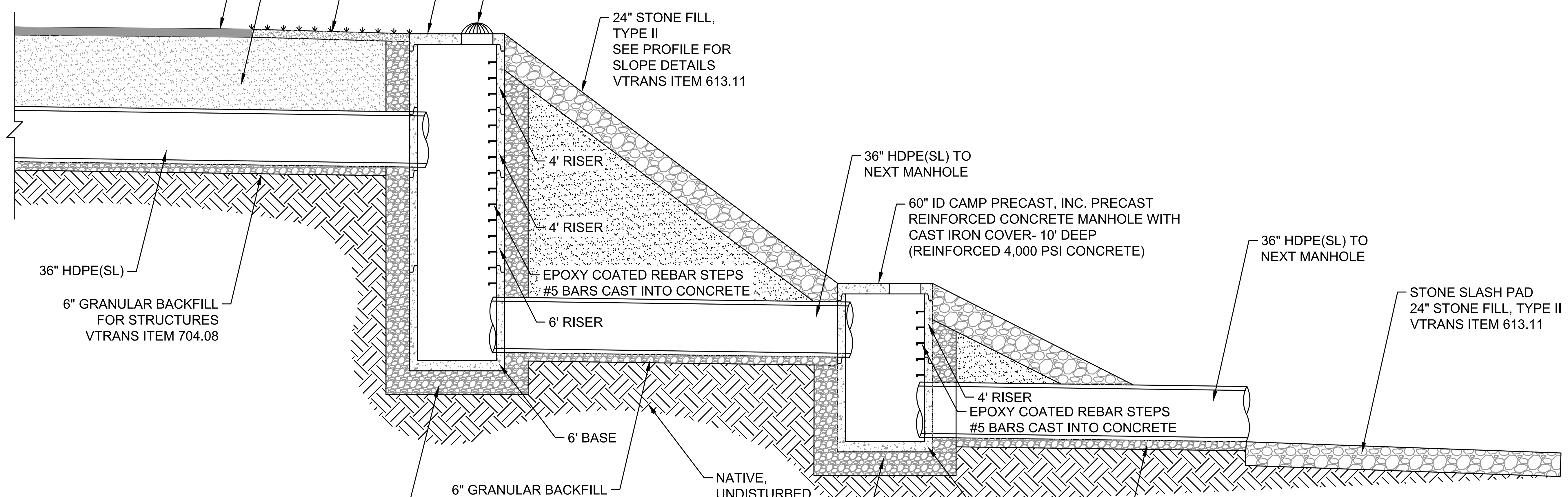


TYPICAL PIPE TRENCH DETAIL
NOT TO SCALE

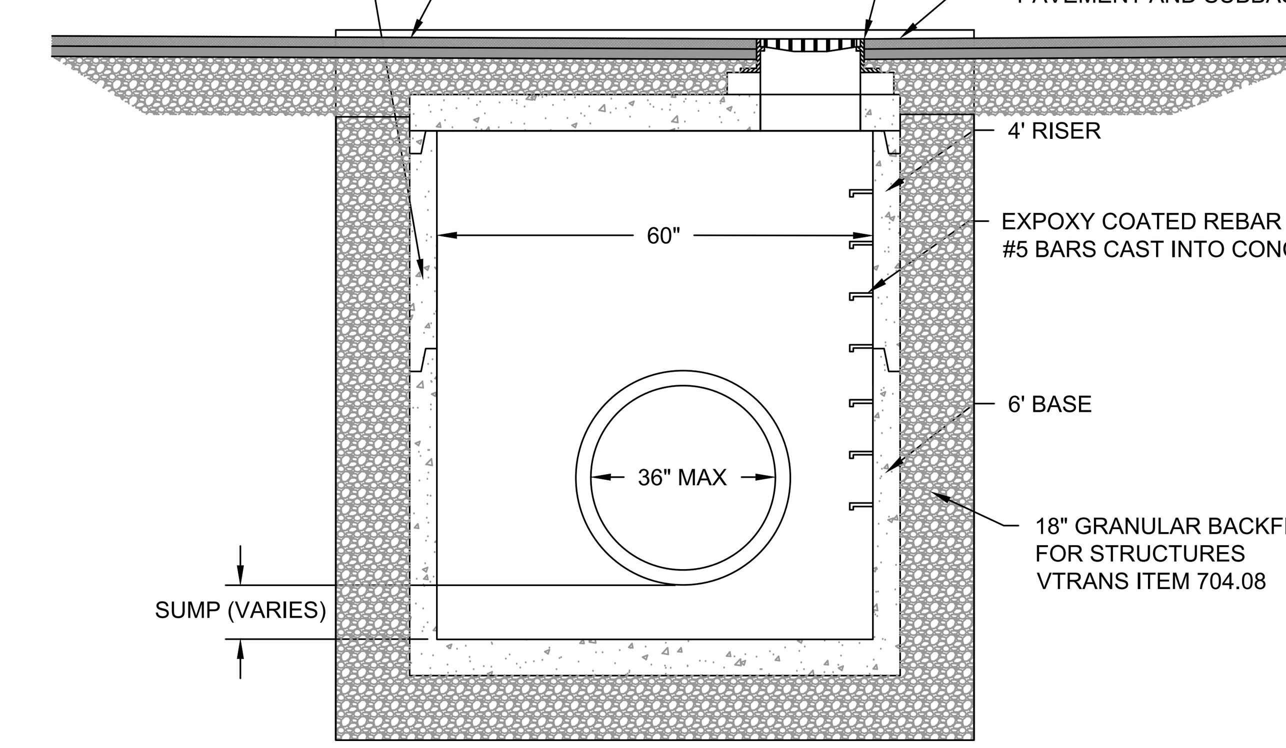


NOTES:
1. ALL BACKFILL TO BE COMPACTED IN 9" LIFTS TO A DENSITY OF 95% OF THE MAXIMUM DRY DENSITY USING STANDARD PROCTOR TEST, METHOD A, ACCORDING TO ASTM D698
2. CONTRACTOR TO REMOVE AND RESET CONCRETE CURBING WHERE NECESSARY

48" ID PRECAST REINFORCED CONCRETE CATCH BASIN
NOT TO SCALE



DROP MANHOLE DETAIL
NOT TO SCALE



NOTE:
ALL BACKFILL TO BE COMPACTED IN 9" LIFTS TO A DENSITY OF 95% OF THE MAXIMUM DRY DENSITY USING STANDARD PROCTOR TEST, METHOD A, ACCORDING TO ASTM D698

60" ID PRECAST REINFORCED CONCRETE CATCH BASIN
NOT TO SCALE

FILE:

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PROJECT NO: 17-084

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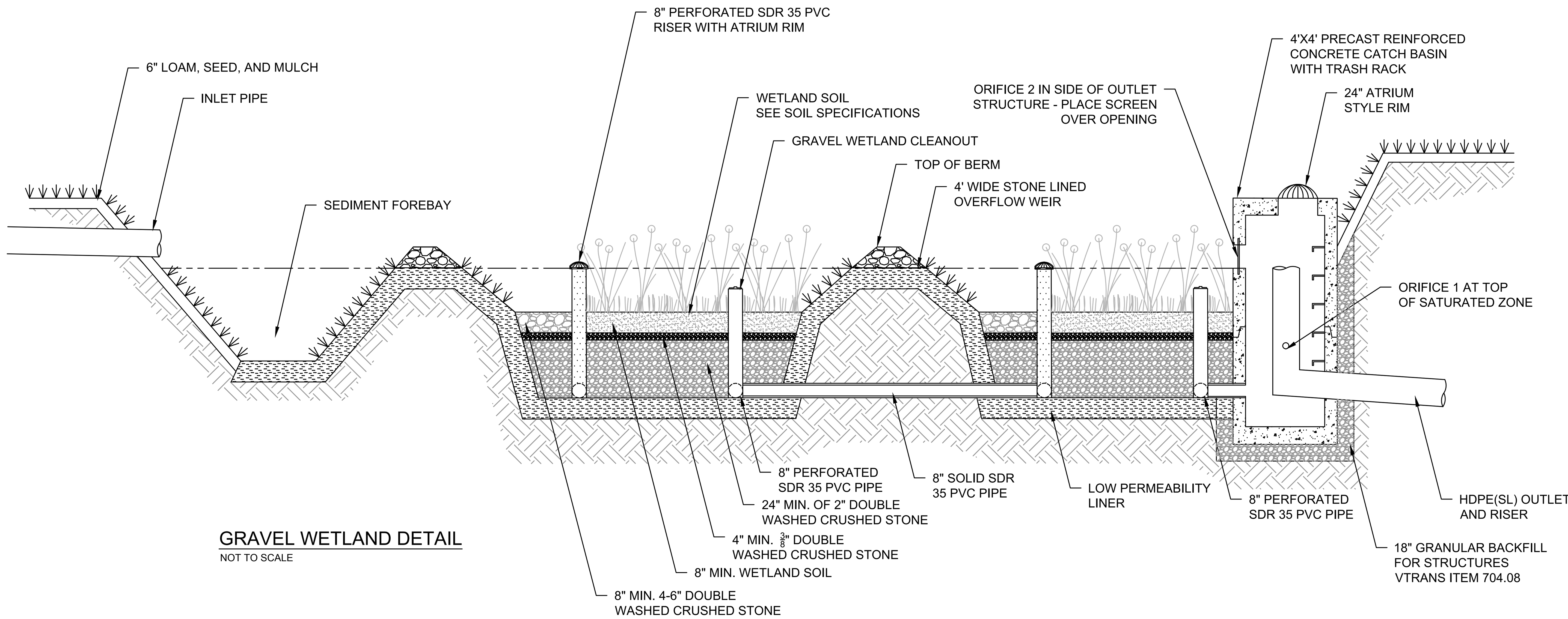
DEER BROOK
GULLY RESTORATION
DETAILS
GEORGIA VERMONT

FIGURE NO.
8



GRAVEL WETLAND DETAIL
NOT TO SCALE

Gravel Wetland Construction Notes:

1. *Wetland soil shall be a low hydraulic conductive soil (0.1-0.01 ft/day = 3.5x10^-5 cm/sec to 3.5x10^-6 cm/sec). The soil shall consist of compost, sand, and some fine soils with a 15% or greater organic matter and a maximum of 15% clay content.*

2. *Wetland soils may be prepared by amending natural topsoil with peat moss or leaf mold, at a ratio of 75% soil to 25% organic material by volume. The resulting soil mix shall have a ph range of 5.2 to 7.0 and be free of large stones, stumps, large sticks, shrubs, or other litter.*

3. *3/8-inch pea stone (crushed stone) shall be composed of durable crushed rock consisting of angular fragments, free from detrimental quantity of thin, flat, elongated pieces. The crushed stone shall be free from clay, loam, or deleterious materials. The crushed stone shall conform to the following gradation:*

sieve size	*percent passing by weight*
3/8 inch	*90-100*
no. 4	*30-50*
no. 8	*5-20*
no. 16	*0-5*

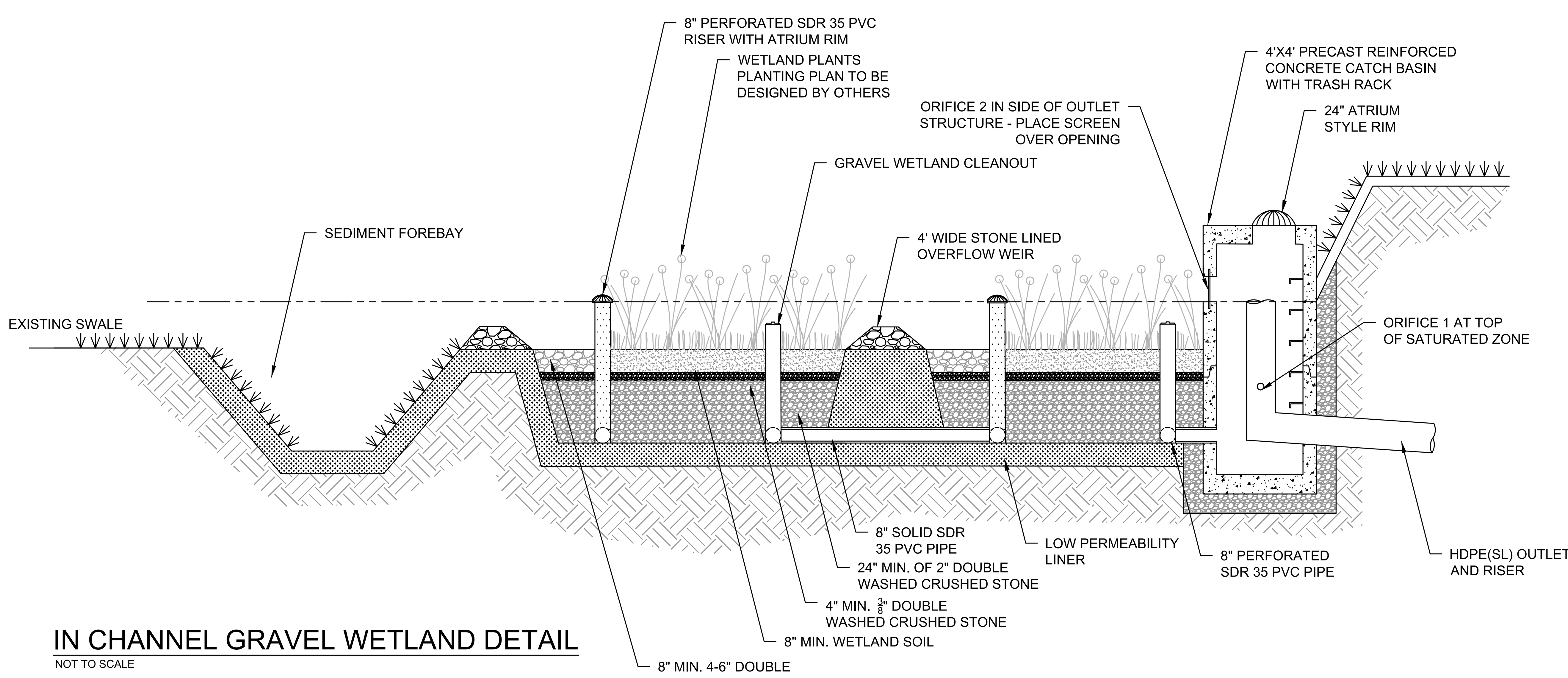
4. *2-inch crushed stone shall be composed of durable crushed rock consisting of angular fragments, free from detrimental quantity of thin, flat, elongated pieces. The crushed stone shall be free from clay, loam, or deleterious materials. The crushed stone shall conform to the following gradation:*

sieve size	*percent passing by weight*
2 inch	*90-100*
1 1/4 inch	*25-50*
3/4 inch	*0-15*
1/2 inch	*0-5*

5. *Low permeability soil shall be a clay soil with minimum 15% passing the no. 200 sieve. Soil shall have an in-situ permeability rate of not more than 1.0x10^-5 cm/sec.*

6. *The contractor shall be responsible for notifying the owner of the start of work requiring oversight by the engineer/representative. The contractor shall contact the engineer/representative at least 48 hours prior to required inspection. At a minimum the wetland shall be inspected at the following stages of construction:*

   - *a. Engineer/representative inspection and acceptance is required upon establishment of subgrade, prior to installation of low permeability soil liner.*
   - *b. Engineer/representative inspection and acceptance is required after installation of low permeability soil liner and subdrain piping, prior to placement of crushed stone and wetland soil.*
   - *c. Inspection and acceptance is required by engineer/representative after placement of crushed stone, wetland soil, berms and overflow weirs, prior to seeding and planting.*
   - *d. Contractor shall notify engineer/representative once planting and seeding of wetlands is complete and stabilized. Following final stabilization and within 24 hours of a rain storm of 0.5 inch or greater the engineer/representative shall inspect the gravel wetland for final acceptance.*
   - *e. Inspection and acceptances is required by representative after plantings are established.*



IN CHANNEL GRAVEL WETLAND DETAIL
NOT TO SCALE

GRAVEL WETLAND DETAILS

AREA	BOTTOM ELEVATION 2" DOUBLE WASHED CRUSHED STONE (FT)	BOTTOM ELEVATION 3/8" DOUBLE WASHED CRUSHED STONE (FT)	TOP ELEVATION WETLAND SOIL (FT)	ORIFICE 1 SIZE (IN)	ORIFICE 1 ELEVATION (FT)	ORIFICE 2 SIZE (IN)	ORIFICE 2 ELEVATION (FT)	OUTLET PIPE ELEVATION (FT)	ATRIUM STYLE RIM ELEVATION (FT)
1	372.00	374.00	375.00	1.00	374.30	6.00	376.00	373.00	377.00
12	381.30	383.30	384.30	1.00	384.00	6.00	385.30	384.00	386.30
15	381.75	383.75	384.75	1.00	384.50	6.00	386.00	382.50	387.00
16	381.00	383.00	384.00	2.00	383.60	6.00	385.00	381.17	387.00

FILE:

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PROJECT NO: 17-084

REVISIONS

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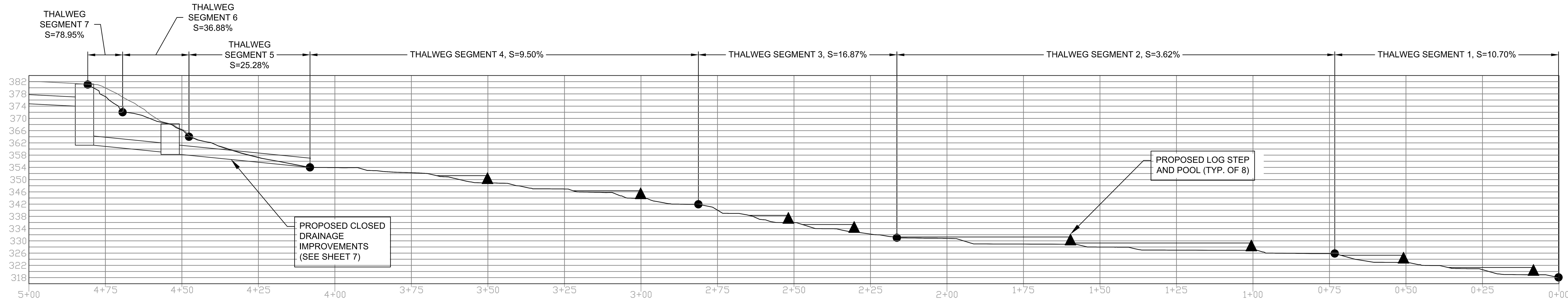
DEER BROOK
GULLY RESTORATION
GRAVEL WETLAND DETAILS

GEORGIA VERMONT

FIGURE NO. 9



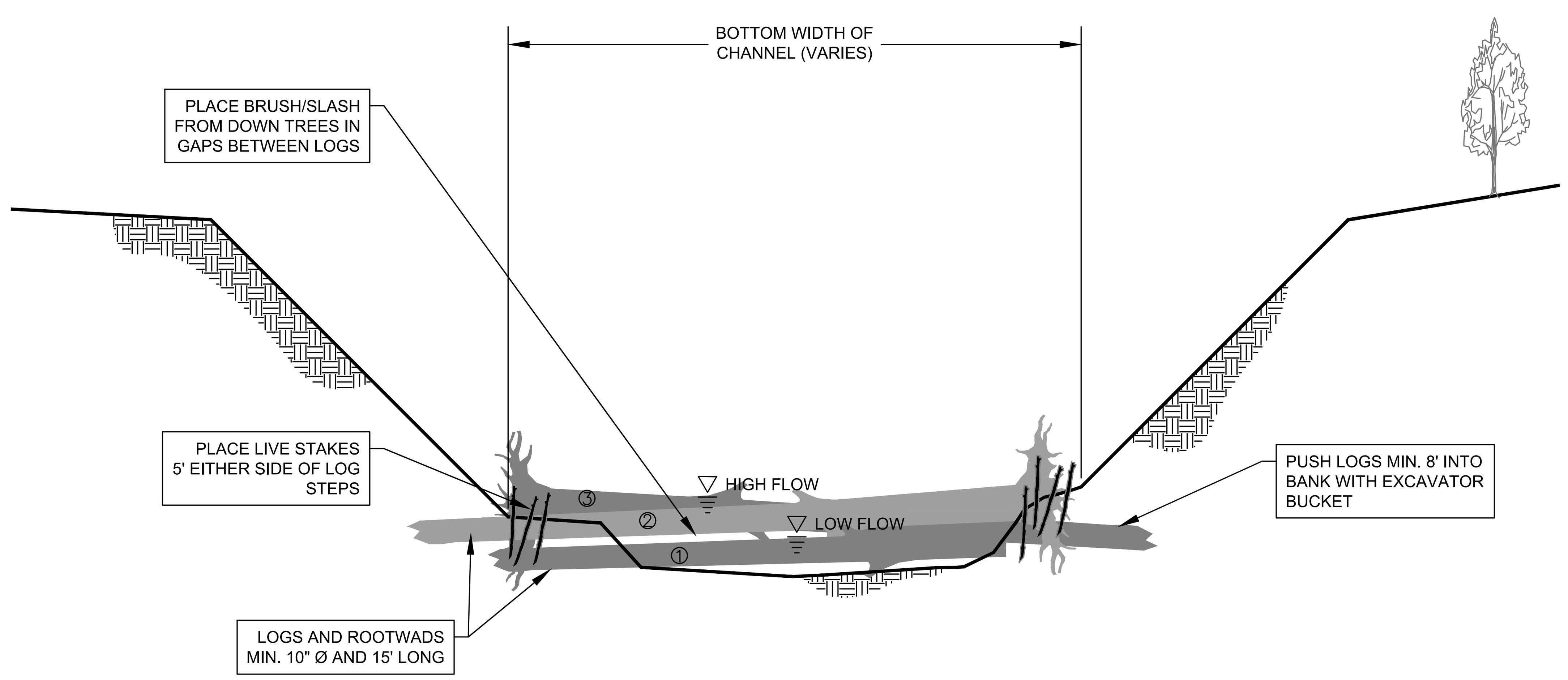
Legend

- Existing Channel Thalweg
- Slope Segment Break
- Proposed Wood Step

WOOD STEP LOCATIONS - PROFILE

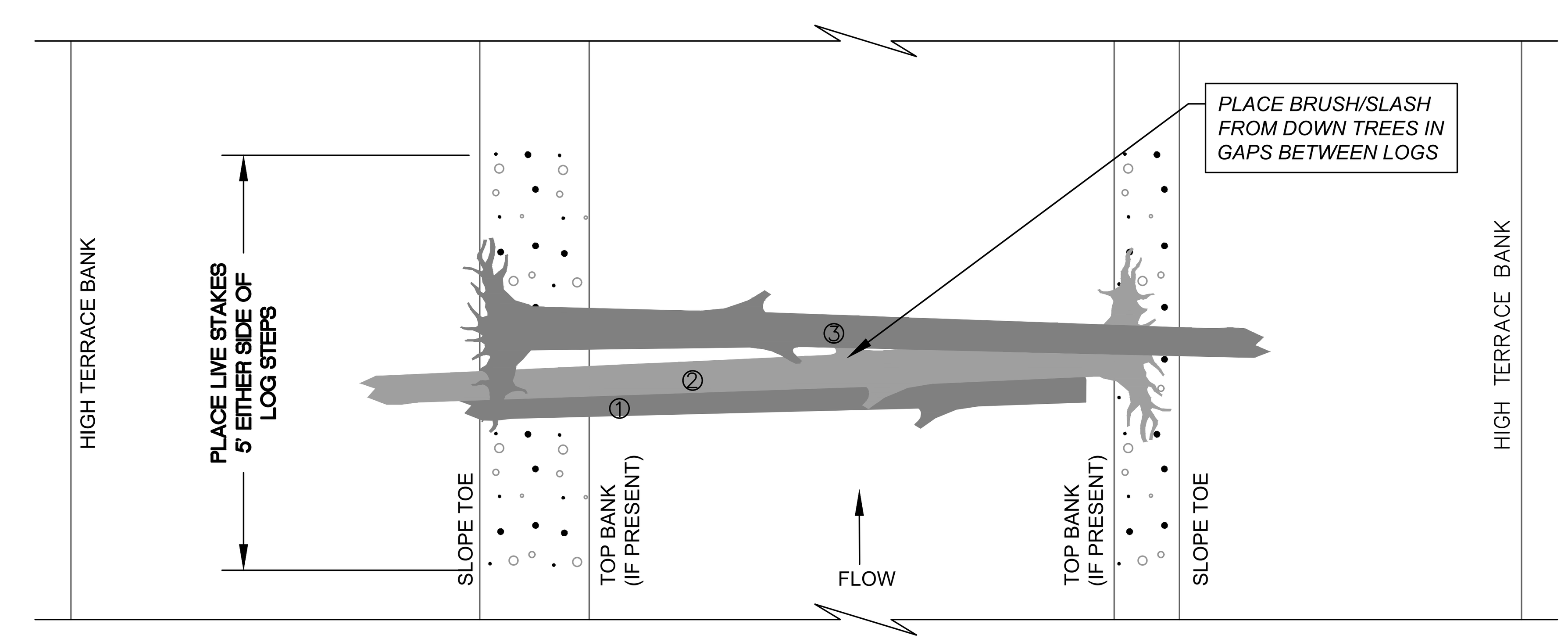
HORIZONTAL SCALE: 1" = 20'

VERTICAL SCALE: 1" = 20'



TYPICAL WOOD STEP DETAIL - SECTION VIEW

SCALE: 1" = 2'



TYPICAL WOOD STEP DETAIL - PLAN VIEW

SCALE: 1" = 2'

GENERAL NOTES:

1. CONTRACTOR TO MAKE USE OF EXISTING TREE FALL IN GULLY TO CONSTRUCT LOG STEPS. SELECTION OF LOGS TO BE DIRECTED BY THE ENGINEER. SEE PROFILE ON THIS SHEET FOR GENERAL LOCATIONS.
2. PLACE MINIMUM THREE LOGS AT EACH STEP LOCATION: 1) FIRST LOG WITHOUT ROOT BALL IN BOTTOM SECTION OF CHANNEL; 2) SECOND LOG ON TOP OF FIRST, NARROW END PENCIL-POINTED INTO BANK; 3) THIRD LOG PLACED DOWNSTREAM OF FIRST TWO LOGS, NARROW END PENCIL-POINTED INTO BANK. SEE NUMBERED LOGS ON EACH DETAIL ON THIS SHEET.
3. LIVE STAKES SHALL BE 24" MINIMUM IN LENGTH, 1-½" - 2" DIAMETER AT BASE, TAMPED 80% OF LENGTH INTO GROUND, WITH A CLEAN ANGLE CUT AT BASAL END.

FILE:

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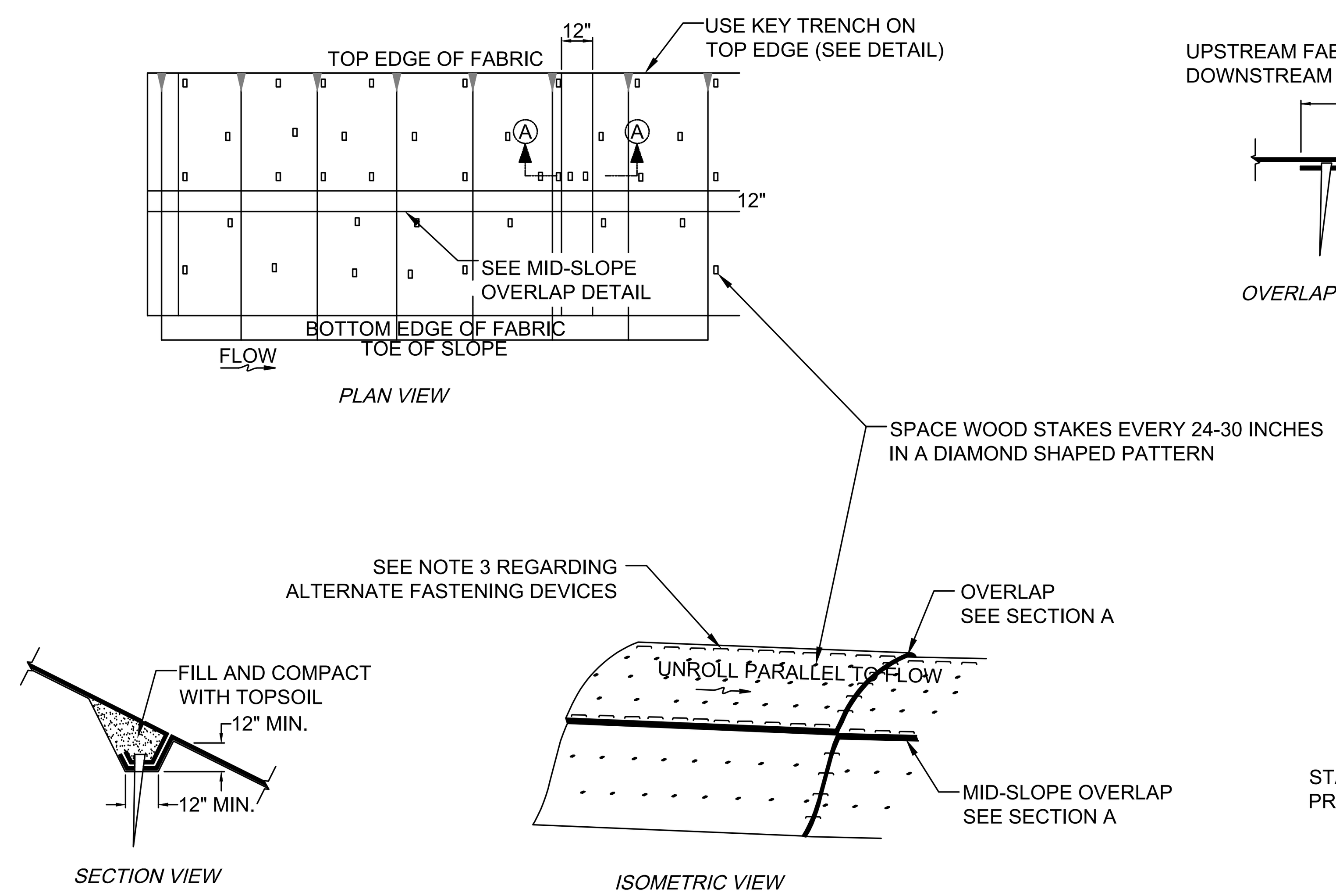
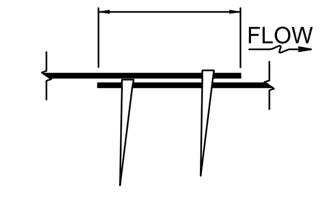
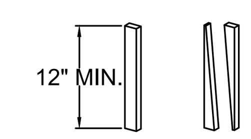
DEER BROOK
GULLY RESTORATION
CHANNEL RESTORATION PROFILE AND DETAILS

GEORGIA VERMONT

FIGURE NO. 10

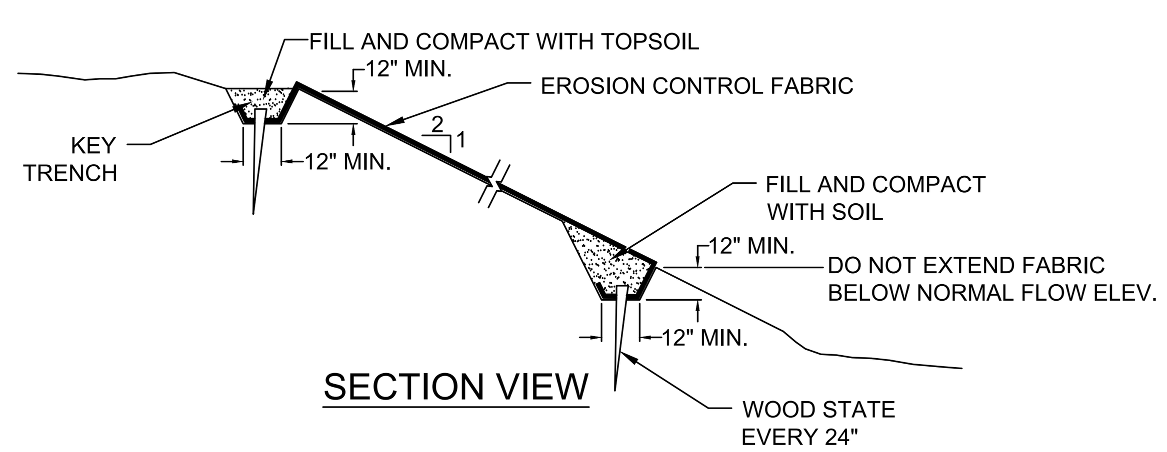






STAKES MAY BE MADE BY SAWING A 2 x 4 DIAGONALLY TO PRODUCE 2 DEAD STOUT STAKES.

WOOD STAKES



SECTION VIEW

NOTES:

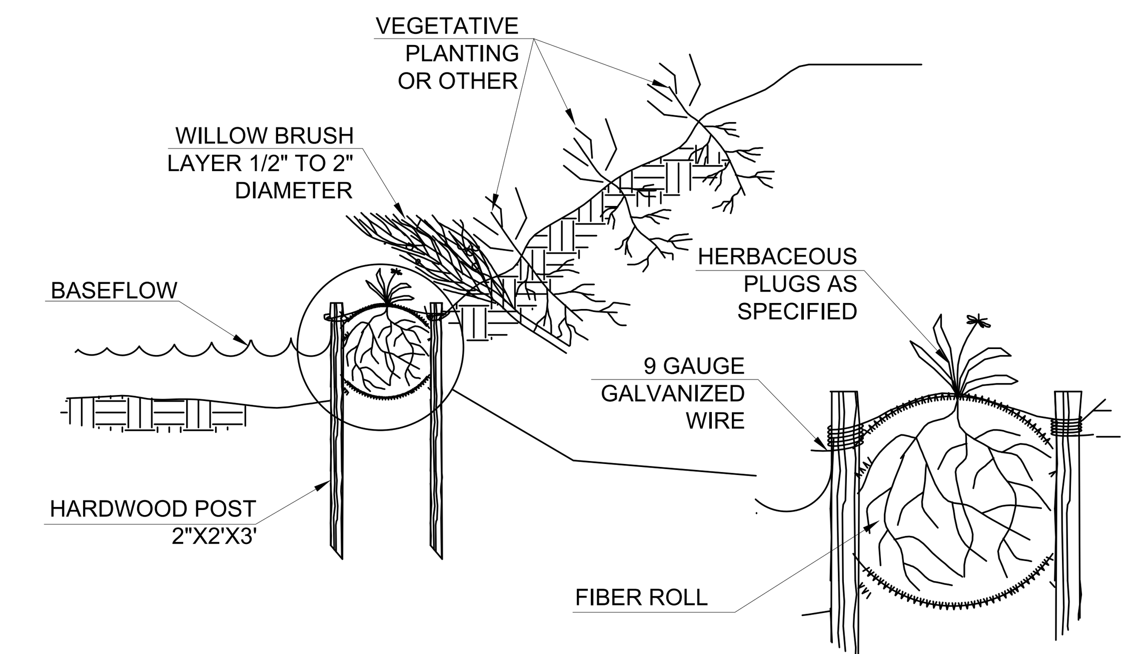
1. PREPARE SOIL SURFACE AND INSTALL ACCORDING TO THIS DETAIL AND SPECIFICATIONS.

2. EROSION CONTROL FABRIC MUST BE MADE OF NATURAL, BIODEGRADABLE FIBERS, AND SHOULD NOT INCLUDE MATERIALS OR WELDED PLASTIC OR 'BIODEGRDABLE PLASTIC' NETTING OR THREAD.

3. ALTERNATE FASTENING DEVICES REQUIRE ENGINEER'S APPROVAL BEFORE USE. ALL FASTENERS MUST BE MADE OF WOOD PRODUCTS; PLASTIC OR BIODEGRADABLE COMPOSITE PRODUCTS WILL NOT BE ACCEPTED.

EROSION CONTROL FABRIC DETAIL

NOT TO SCALE



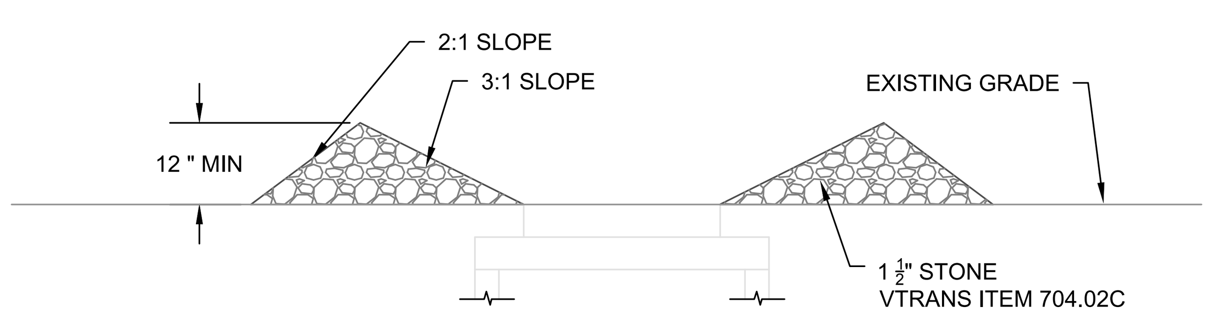
FIBER ROLL DETAIL

NOT TO SCALE

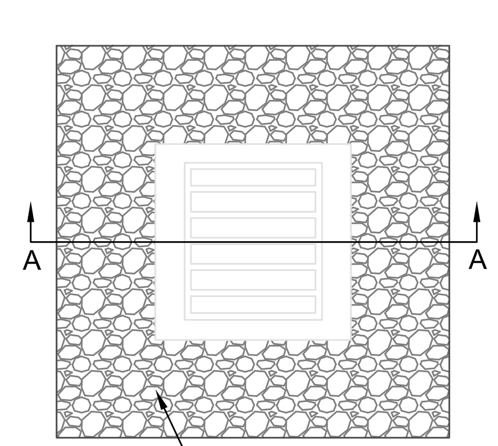
CONSTRUCTION SPECIFICATIONS

1. EXCAVATE A SHALLOW TRENCH SLIGHTLY BELOW BASEFLOW OR A 4" TRENCH ON SLOPE CONTOURS.
2. PLACE THE ROLL IN THE TRENCH AND ANCHOR WITH 2"X2" POSTS PLACED ON BOTH SIDES FOR THE ROLL AND SPACED LATERALLY ON 2' TO 4' CENTERS. TRIM THE TOP OF THE POSTS EVEN WITH THE EDGE OF THE ROLL, IF NECESSARY.
3. NOTCH THE POSTS AND TIE TOGETHER, ACROSS THE ROLL, WITH 9 GAUGE GALVANIZED WIRE OR 1/8" DIAMETER BRAIDED NYLON ROPE.
4. PLACE SOIL EXCAVATED FROM THE TRENCH BEHIND THE ROLL AND HAND TAMP PLANT WITH SUITABLE HERBACEOUS OR WOODY VEGETATION AS SPECIFIED ELSEWHERE IN THE CONTRACT DOCUMENTS. VEGETATION SHALL BE PLACED IMMEDIATELY ADJACENT TO THE ROLL TO PROMOTE ROOT GROWTH INTO THE FIBER. HERBACEOUS VEGETATION, IF SPECIFIED, SHALL BE PLANTED INTO THE FIBER ROLL.

NOTES:
1. REFER TO "THE VERMONT STANDARDS & SPECIFICATIONS FOR EROSION PREVENTION & SEDIMENT CONTROL -2006- " FROM THE VT AGENCY OF NATURAL RESOURCES FOR ADDITIONAL GUIDANCE.
2. THIS WORK SHALL BE PERFORMED IN ACCORDANCE WITH SECTION 653 FOR EROSION LOG (PAY ITEM 653.60)

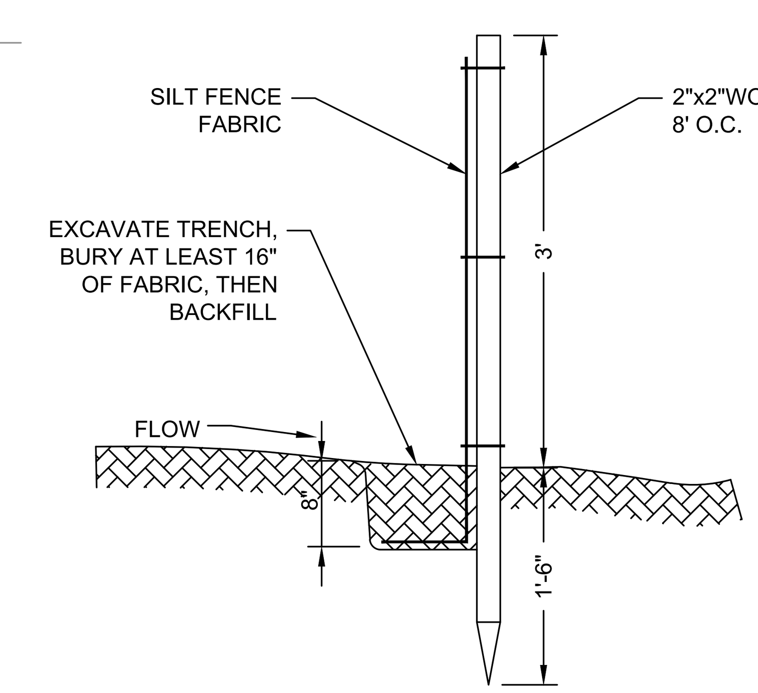


SECTION A-A



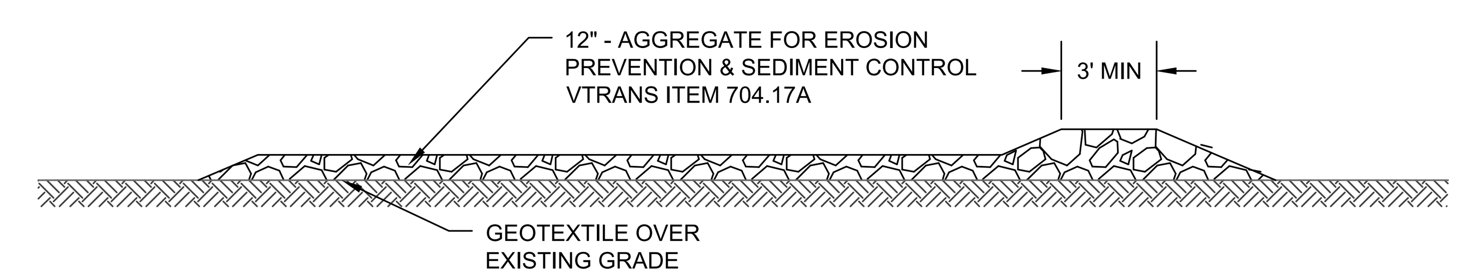
STONE INLET PROTECTION

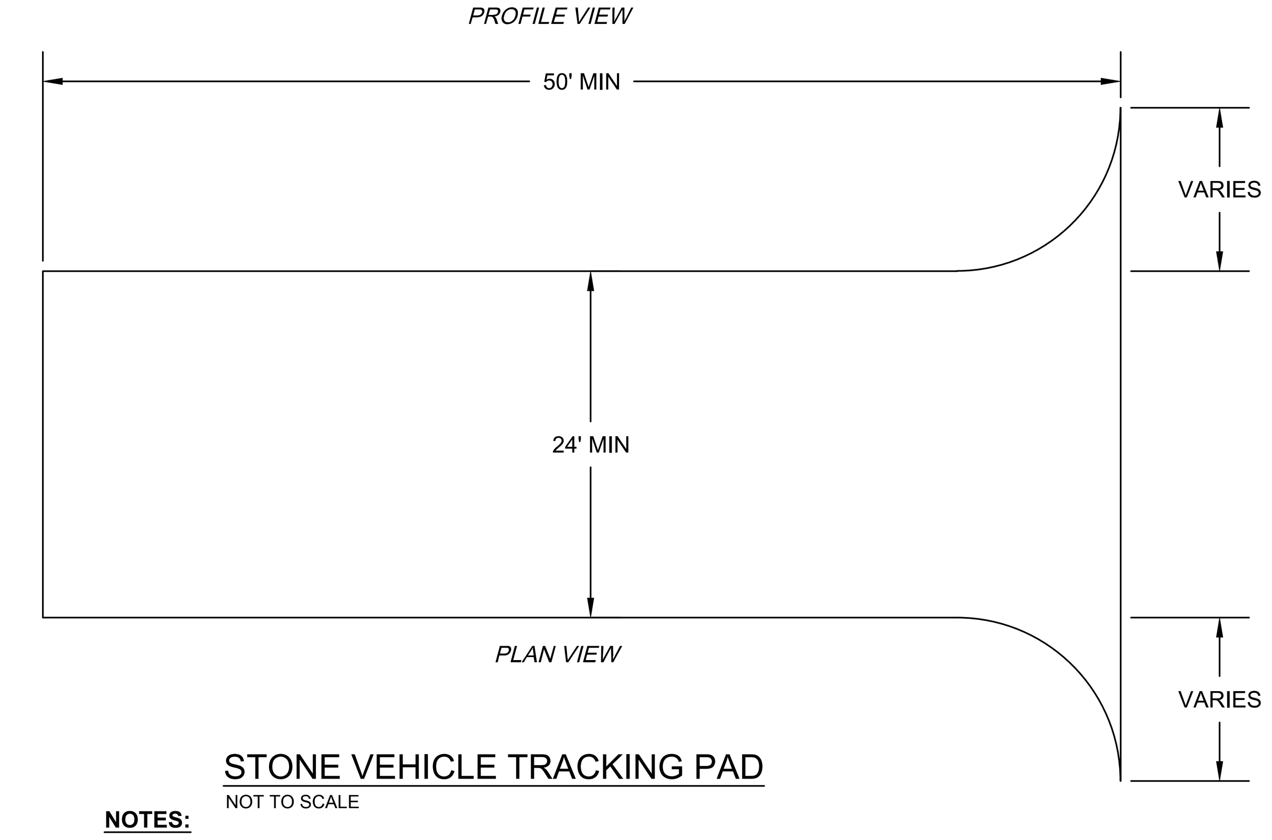
NOT TO SCALE



SILT FENCE DETAIL

NOT TO SCALE





STONE VEHICLE TRACKING PAD

NOT TO SCALE

NOTES:

1. TRACKING PAD SHALL BE INSTALLED PRIOR TO SITE DISTURBANCE.
2. TRACKING PADS WILL REQUIRE PERIODIC CLEANING TO MAINTAIN EFFECTIVENESS, WHICH MAY INCLUDE REMOVAL AND RE-INSTALLATION OF STONE.
3. STONE SHALL BE REPLACED WHEN STONE BECOMES BURIED OR SEDIMENT IS NOT BEING REMOVED EFFECTIVELY FROM TIRES.
4. SEDIMENT TRACKED INTO ROADWAYS SHALL BE REMOVED IMMEDIATELY.

EROSION CONTROL DURING CONSTRUCTION

1. BEFORE ANY CLEARING, GRUBBING, OR DEMOLITION OF THE SITE IS INITIATED, AND DURING ALL EARTHWORK PHASES, EROSION CONTROL MEASURES SHALL BE CONSTRUCTED AND MAINTAINED AT THE INLET OF ANY STORM DRAINS, SWALES, AND DITCHES RECEIVING WATER FROM THE PROJECT. SEE TYPICAL DETAILS AND PLANS FOR TYPES AND LOCATIONS.
2. SILT FENCE SHALL BE PLACED DOWN GRADIENT OF ALL DISTURBED AREAS. IF THE DISTURBED AREA IS 100' OR LESS FROM THE WATERS OF THE STATE THE SILT FENCE SHALL BE WIRE MESH REINFORCED.
3. ALL STOCKPILED SOIL SHALL BE ENCIRCLED WITH SILT FENCE, UNLESS AN EXISTING BARRIER WILL ENTRAP ALL EROSION FROM SUCH A STOCKPILE OR THE STOCKPILE IS COMPLETELY COVERED WITH VEGETATION THAT PREVENTS EROSION.
4. NO MORE THAN 500 FEET OF TRENCH SHALL BE OPEN AT ONE TIME AND EXCAVATED MATERIAL TO BE USED FOR BACKFILL SHALL BE PLACED ON THE UPHILL SIDE OF THE TRENCH. ALL OTHER EXCAVATED MATERIAL SHALL BE DISPOSED OF OFF-SITE AT AN APPROVED LOCATION.
5. BEFORE AND AFTER EVERY STORM ALL STRUCTURAL EROSION CONTROL MEASURES SHALL BE INSPECTED FOR FAILURES OR CLOGGING, AND ANY FAILURE OR CLOGGING SHALL BE RECTIFIED. DURING THE WINTER CONSTRUCTION SEASON SPECIAL ATTENTION SHALL BE PAID TO THE CHANGES IN WEATHER THAT COULD CAUSE SIGNIFICANT SNOW MELT AND RUNOFF.
6. STONE CHECK DAMS SHALL BE PLACED IN NEWLY CONSTRUCTED SWALES, DITCHES, OR OTHER WATERWAYS DURING THE CONSTRUCTION PERIOD. STONE INLET PROTECTION OR SEDIMENT CATCH BASIN INSERTS SHALL BE PLACED IN ALL NEW AND EXISTING CATCH BASIN WHICH RECEIVED RUNOFF FROM DISTURBED AREAS. THE PLACING OF THESE TRAPS AND DAMS SHALL BE AS SHOWN ON THE PLANS. MAINTENANCE SHALL BE AS IN #5 ABOVE.
7. EROSION CONTROL MEASURES INDICATED ON THE PLANS ARE THE MINIMUM NUMBER REQUIRED. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO USE ADDITIONAL BARRIERS AS FIELD CONDITIONS DICTATE AND TO INSURE THAT ANY EROSION CREATED BY THIS PROJECT DOES NOT REACH THE STATE'S WATERWAYS OR LEAVE THE SITE.
8. NEW SWALES AND DITCHES (AND ANY OTHER AREA SUBJECT TO CONCENTRATED STORM RUNOFF) SHALL BE FERTILIZED AND SEEDED WITH THE FOLLOWING MIXTURE TO AT LEAST TWO (2) FEET ABOVE THE CHANNEL BOTTOM:

SEED	LBS/ACRE
CREEPING RED FESCUE	20
REDTOP	2
SMOOTH BROMEGRASS	20

AND SHALL HAVE MULCH APPLIED AT THE RATE OF 2 TONS PER ACRE.

9. IN ALL NEW SWALES AND DITCHES, AND WHERE SLOPE GRADE EXCEEDS 25 PERCENT (1 ON 4 SLOPE), JUTE MATTING SECURELY ATTACHED TO THE GROUND SHALL BE PLACED OVER MULCH AND MAINTAINED UNTIL A PERMANENT GRASS COVER IS ESTABLISHED.
10. ALL DISTURBED TERRAIN AT FINAL GRADE SHALL BE SEEDED AND MULCHED WITHIN 48 HOURS OF COMPLETION, AND BY SEPTEMBER 15TH AT THE LATEST. BEFORE APPLYING FINAL SEEDING FOUR (4) INCH AVERAGE DEPTH OF TOPSOIL SHALL BE PLACED IN ALL DISTURBED AREAS TO BE SEEDED. FERTILIZER SHALL BE APPLIED TO THE TOP 2-INCHES OF TOPSOIL AT A RATE OF 500 LBS/ACRE. SEED MIXTURES SHALL BE ONE AS SPECIFIED ON LANDSCAPING PLAN. IF NO SEED MIXTURE IS SPECIFIED IT SHALL BE ONE OF THE FOLLOWING, AS APPROPRIATE.

EMBANKMENT/SLOPING GROUND	LBS/ACRE
MIXTURE#1	
CREEPING RED FESCUE	20
REDTOP	2
BIRDSFOOT TREFOIL	8
OR CROWNVETCH	15
MIXTURE#2	
TALL FESCUE	10
REDTOP	2
FLAT PEA (LATHCO)	30
MIXTURE#3	
CREEPING RED FESCUE	15
FLAT PEA (LATHCO)	30

FLAT/LEVEL GROUND	LBS/ACRE
MIXTURE#1	
KENTUCKY BLUE GRASS	20
CREEPING RED FESCUE	20
RYE (PERENNIAL), OR REDTOP	5
MIXTURE#2	
CREEPING RED FESCUE	20
REDTOP	2
TALL FESCUE	20

11. ALL NEWLY SEEDED AREAS SHALL BE MULCHED AT A RATE OF TWO (2) TONS PER ACRE OF HAY OR STRAW. DURING WINTER CONSTRUCTION MULCH SHALL BE APPLIED AT A RATE OF 4 TONS PER ACRE. JUTE OR OTHER EQUAL NETTING SHALL BE USED WHERE WIND OR WATER MAY ERODE NEWLY-PLACED SEED OR MULCH OR WHERE GRADE EXCEEDS 25% (1:4). ALL NETTING, WHERE USED, SHALL BE STAKED TO THE GROUND IN COMPLIANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.
12. ALL AREAS THAT REACH FINISHED GRADE DURING THE WINTER CONSTRUCTION SEASON SHALL BE MULCHED AT A RATE OF 4 TONS/ACRE AND TACKED DOWN TO PREVENT WINDTHROW WITHIN 24 HOURS OF REACHING FINAL GRADE. THESE AREAS SHALL BE SEEDED AS SPECIFIED IN NOTE 10 IN THE SPRING AS SOON AS WEATHER ALLOWS.
13. ALL HAY MULCH SHALL BE TACKED DOWN TO PREVENT WINDTHROW. JUTE MATTING OR EQUIVALENT SHALL BE USED WHERE INDICATED ON PLANS. IN ALL OTHER AREAS MULCHED SHALL BE TRACKED WITH A BULLDOZER. THE CLEATS OF THE BULLDOZER SHALL BE PARALLEL TO THE CONTOURS. DURING THE WINTER CONSTRUCTION SEASON NETTING OR JUTE MATTING SHALL BE USED TO TACK DOWN ALL MULCH.
14. ALL DISTURBED AREAS NOT AT FINAL GRADE THAT WILL NOT BE DISTURBED AGAIN FOR A PERIOD OF GREATER THAN THIRTY (30) DAYS, SHALL BE SEEDED WITH A TEMPORARY, RAPID-GROWING COVER CROP, SUCH AS RYE GRASS AND MILLET, AND SHALL BE MULCHED. NETTING SHALL ALSO BE APPLIED, AS SPECIFIED IN ITEM 13, TO STABILIZE THE MULCH AND SEED.
15. ALL DISTURBED AREAS MUST HAVE TEMPORARY OR FINAL STABILIZATION WITHIN 14 DAYS OF THE INITIAL DISTURBANCE. AFTER THIS TIME, ANY DISTURBANCE IN THE AREA MUST BE STABILIZED AT THE END OF EACH WORK DAY. THE FOLLOWING EXCEPTIONS APPLY: i) STABILIZATION IS NOT REQUIRED IF WORK IS TO CONTINUE IN THE AREA IN THE NEXT 24 HOURS AND THERE IS NO PRECIPITATION FORECAST FOR THE NEXT 24 HOURS. ii) STABILIZATION IS NOT REQUIRED IF THE WORK IS OCCURRING IN A SELF-CONTAINED EXCAVATION (I.E. NO OUTLET) WITH A DEPTH OF 2-FEET OR GREATER (E.G. FOUNDATION EXCAVATION, UTILITY TRENCHES).
16. DURING WINTER CONSTRUCTION ALL DISTURBED AREAS MUST HAVE TEMPORARY OR FINAL STABILIZATION AT THE END OF EACH WORK DAY. THE FOLLOWING EXCEPTIONS APPLY: i) STABILIZATION IS NOT REQUIRED IF WORK IS TO CONTINUE IN THE AREA IN THE NEXT 24 HOURS AND THERE IS NO PRECIPITATION FORECAST FOR THE NEXT 24 HOURS. ii) STABILIZATION IS NOT REQUIRED IF THE WORK IS OCCURRING IN A SELF-CONTAINED EXCAVATION (I.E. NO OUTLET) WITH A DEPTH OF 2-FEET OR GREATER (E.G. FOUNDATION EXCAVATION, UTILITY TRENCHES).
17. ALL TEMPORARY EROSION CONTROL MEASURES SHALL BE REMOVED WITHIN 30 DAYS OF PERMANENT STABILIZATION OF THE SITE.
18. EROSION CONTROLS SHALL BE INSPECTED WEEKLY AND AFTER ANY RAIN EVENT WHICH PRODUCES RUNOFF BY THE ON-SITE COORDINATOR, WHO WILL BE RESPONSIBLE FOR RECTIFYING ANY PROBLEMS FOUND. ALL INSPECTION FORMS SHALL BE KEPT ON-SITE AS RECORDS OF THE CONDITION OF THE EROSION CONTROL MEASURES. TEMPORARY EROSION CONTROL MEASURE SHALL BE REMOVE WITH 30 DAYS OF PERMANENT SITE STABILIZATION.
19. NO MORE THAN 1 ACRE SHALL BE DISTURBED (WITHOUT TEMPORARY OR FINAL STABILIZATION) AT ANY ONE TIME
20. SEEDING MUST BE COMPLETED BY SEPTEMBER 15.
21. CONTRACTOR SHALL APPLY DUST CONTROL MEASURES AS NECESSARY OR AS DIRECTED BY THE ENGINEER TO PREVENT THE AIR MOVEMENT OF DUST. ACCEPTABLE METHODS OF DUST CONTROL ARE VEGETATIVE COVER, MULCHING, SPRINKLING OF WATER, OR THE USE OF CALCIUM CHLORIDE.
22. AT THE COMPLETION OF THE PROJECT, ALL STORMWATER DRAINAGE FACILITIES INCLUDING DITCHES, GRASSED SWALES, CATCH BASINS, SUMPS, CULVERTS, STORM DRAINS, STORM MANHOLES, OUTLET STRUCTURES, STORM FILTERS, ETC SHALL BE CLEANED AND FREE OF SILT, SEDIMENT OR DEBRIS WHICH MIGHT IMPAIR THE PROPER OPERATION OF THE FACILITIES.

FILE:

DRAWING CREDITS	
DRAWN ON:	04/11/2019
DRAWN BY:	BAM
CHECKED ON:	04/29/2019
CHECKED BY:	PCL/GMB
PROJECT NO:	17-084

REVISIONS

#	DATE	DRWN	CHK'D	APP'D	DESCRIPTION

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