WRIGHT-PIERCE
Engineering a Better Environment

MEMORANDUM

TO:	Pete Clark	DATE:	September 1, 2015
FROM:	Jonathan Edgerton	PROJECT NO.:	13147A
SUBJECT:	Slope Failures – South of Town Landing		

This memorandum is intended to provide a concise summary of conceptual recommendations with respect to mitigation of current problems along the shoreline just to the south of the Falmouth Town Landing (in the vicinity of Burgess, Mason and Studley Streets).

It should be noted that the mapping exhibits within this report document show approximate limits of public rights-of-way and parcel boundaries. This information is based on the Tax Parcel Data included within the Town's Geographic Information System (GIS) and is subject to refinement based on actual boundary or right-of-way survey data. The topographic information (contours) is based on survey completed by Wright-Pierce earlier in 2015, supplemented by publicly available LiDAR data. The location of municipal infrastructure (sewers and storm drainage) is based on the Town's GIS model, with structures located by the Wright-Pierce field topographic survey.

Soil Conditions

Based on surficial geologic soils mapping and our site reconnaissance, the profile of soils along the shoreline generally consists of outwash sands overlying glaciomarine clays with sand seams. The glaciomarine clays extend out into the natural reed marsh fronting most of the shoreline and then to the mudflats. Both predominant soil types are highly erodible particularly when disturbed from wave action or when denuded of vegetation. It has been observed in many areas that groundwater seeps exiting the face of the shoreline also contribute to erosion of these soils and the gradual blocking failure that can be observed in a number of areas along the shoreline.

A number of studies have looked at the issue of coastal erosion over the years to determine the rate of soil loss and project issues that may relate to anticipated increases in sea levels. Because the rate of soil loss is highly dependent on both the nature of soil deposits and the extent the area is subject to tidal/current/wave factors, it is difficult to draw conclusions from studies based on other locations. In the present instance, the most relevant past evaluation appears to have been performed by Barry Timpson and published in 1977. Timson's effort was focused on the area of the Gilsland Farm, which appears to possess similar geology, although the erosive effects associated with wave action and currents will differ. Timson's evaluation suggested that the long-term rate of soil loss from the bluff was on the order of 0.15 meters/year, and it is reasonable to expect that the rate of loss in areas, such as this, which are subject to greater wave action, may exceed that rate.

Since future activities within the project area may be dictated to some extent by limitations imposed through both local flood hazard permitting and NEPA constraints on infrastructure projects using federally-originating funding, it is worth considering the likely ramifications of FEMA's updates to the community's Flood Insurance Rate Maps. Newly designated 100 year flood elevations are generally higher than those shown on the existing maps. It may also be worth noting that the Maine Geological Survey has been engaged in coastal erosion studies in southern Maine relating to rising sea levels predicted to occur as a result of climate change.

Observed Failure Scenario(s)

The predominant failure scenario along the shoreline appears to be related to block failures triggered by wave erosion and groundwater seepage. The cohesive characteristics of the glaciomarine clays permit these soils to stand at relatively steep slopes for a period of time before blocks break off and deposit at the toe of the slope. The deposited soil at the base of the slope creates a stabilizing berm which is subsequently eroded by wave action, thereby restarting the cycle. Groundwater seepage at the base of the slope is expected to exacerbate the situation.

It is probably appropriate to periodically monitor slopes in this area at least annually and after severe coastal storm events. Monitoring is best performed in the spring prior to foliage being established. Unfortunately, given the cohesive soils and associated mode of the slope failures in this area, as well as the presence of seeping sand lenses, it is difficult to accurately predict when and where failures will occur.

Mitigation Options

The principal mitigation option is to create stabilizing berms at the base of the slope that replicate those of the natural block failure mechanism, but are comprised of rip-rap that is resistant to erosion and keyed into the existing substrate to resist creep toward the ocean. The height of the stabilizing berms should be at least at the elevation of the design flood tide. Above the rip-rap stabilizing berms, the slope could be flattened using a granular fill material faced with a vegetated mat with salt resistant plantings. Non-woven geotextile fabrics should be installed against the existing substrate prior to installing the stabilizing berm rip-rap and slope repair materials (see attached report prepared by the project geotechnical engineer, S W Cole, including a typical section for the stabilized slope).

Since the properties requiring stabilization are private, it is possible that stabilization would occur one property at a time, which is feasible so long as the repairs follow the same scheme, as they may eventually integrate into larger sections of shoreline. In our opinion, the conditions in the field may warrant a piecemeal approach to repair, as areas are determined to be "at risk" over a period of years, rather than a global repair. It may be possible to realize some economy of scale

by addressing multiple locations under the same construction contract, where the costs could be proportioned based upon length of shoreline stabilized and surface area of slope repaired.

Regulatory Considerations

Work within 75 feet of the high water mark will require regulatory approval from the Maine DEP. Work below the high water mark is likely to require separate approval from the Corps of Engineers.

Use of the expedited "permit by rule" process to obtain state-level regulatory approval for the work is likely not available. Areas below the level of the Highest Annual Tide (HAT) are considered coastal wetlands by the Maine DEP. This corresponds to approximately elevation 11.9.

Cost Implications

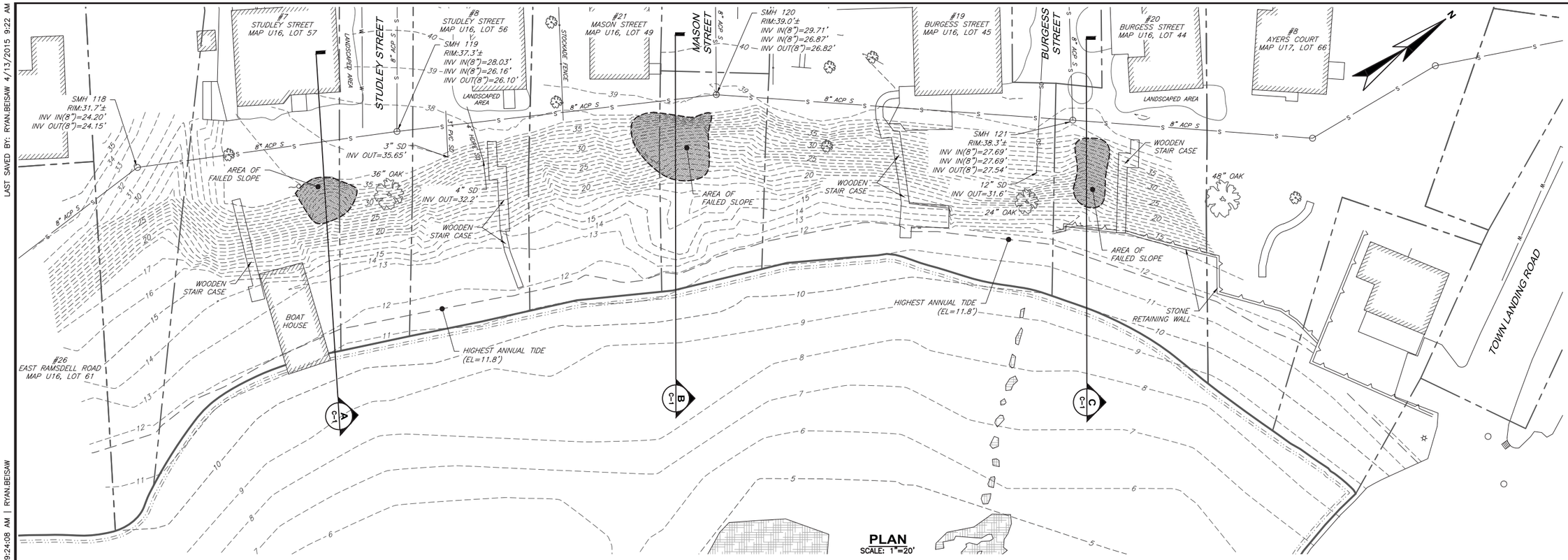
For planning purposes, we suggest budgeting approximately $55,000 - $75,000 for a section of approximately 100 feet in length. As noted above, one can expect some economy of scale. Increasing the magnitude of the stabilization effort will tend to reduce the unit price for completing the work.

Attachments

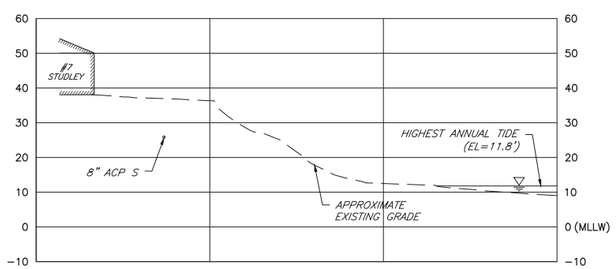
Attachment 1 – Topographic Plan
Attachment 2 – Aerial Photograph showing Sewers
Attachment 3 – S. W. Cole Report

ATTACHMENT 1

Topographic Plan



PLAN
SCALE: 1"=20'



SECTION A C-1
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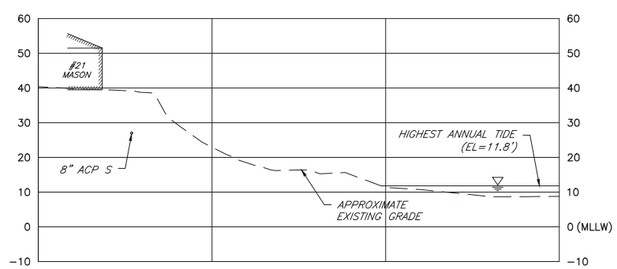

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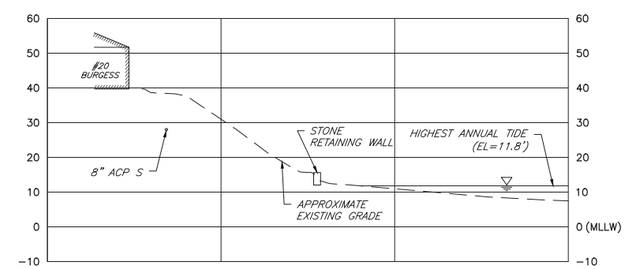

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NOTE:
EXISTING CONDITIONS TOPOGRAPHIC INFORMATION IS BASED UPON A TOPOGRAPHIC SURVEY PERFORMED BY WRIGHT-PIERCE IN APRIL 2015. VERTICAL DATUM IS REFERENCED TO MEAN LOWER LOW WATER (MLLW).

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
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4			

DESIGNED BY: MDM
CAD CO/RD: RPB
CAD: RPB
CHECKED BY: MDM
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TOWN OF FALMOUTH
COASTAL SHORELINE STABILITY
AT TOWN LANDING
FALMOUTH, MAINE

EXISTING CONDITIONS PLAN & SECTIONS

DRAWING
C-1

ATTACHMENT 2

Aerial Photograph showing Sewers

Mariner Ln
Town Landing Rd
Pitt St
Wescott St
Ayers Ct
Burgess St
Mason St
Studley St
Birch Dr
Ramsdell Rd
Dale St
E Ramsdell Rd
Maiden Ln
Old Powerhouse Rd

Sewer Manhole
Catch Basin
Inlet
Manhole
Outfall
Sewer Gravity Main
Collector
Culvert

N

0 25 50 100 Feet

C:\M_W\GIS_Development\Projects\MEIF-falmouth\MTB14_TownLanding\MXDs\TownLandingRd_24x36L.mxd

Town of Falmouth, Maine

Town Landing Road

PROJ NO:	DATE:	FIGURE:
MTB14	11/11/2014	1

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Engineering a Better Environment

ATTACHMENT 3

S. W. Cole Report

15-0141

May 6, 2015

Wright-Pierce
Attn: Jonathan Edgerton, P.E.
99 Main Street
Topsham, ME 04086

Subject: Site Reconnaissance and Preliminary Geotechnical Services
Coastal Shoreline Stability
Falmouth Town Landing
Burgess, Mason and Studley Streets
Falmouth, Maine

Dear Jon:

In accordance with our Agreement, dated March 16, 2015, we made site reconnaissance visits and completed preliminary geotechnical services for the subject project. This report summarizes our findings and geotechnical recommendations and its contents are subject to the limitations set forth in Attachment A.

INTRODUCTION

Based on the information provided, we understand the Town of Falmouth is in the process of reviewing existing coastal shoreline conditions south of the Town Landing. We understand portions of a ±300-foot long section of shoreline located generally between Burgess Street and Studley Street has slumped and eroded. We understand an underground sewer line is located at the head of slope in this area and a stormwater outfall is located off the end of Burgess Street.

The purpose of our services was to observe visible conditions and develop cross-sections of the shoreline area in order to evaluate conceptual slope repair options. Our scope of services included two site reconnaissance visits, a preliminary geotechnical analysis of the observed conditions and preparation of this letter.

SURFACE OBSERVATIONS

S. W. Cole Engineering, Inc. (S.W.COLE) made site reconnaissance visits on March 11 and May 5, 2015 to observe and sketch slumped areas, identify areas of potential groundwater seepage, and develop schematic cross-sections for use in slope stability evaluation.

Initial Visit: We made our initial reconnaissance visit on March 11, 2015 to observe the shoreline slope area. At the time of our visit, the slope area was generally snow covered; however, we were able to observe:

- Mason Street: A recently slumped area with an approximate 4-foot vertical, headscarp and moderate groundwater seepage was observed off the end of Mason Street. The exposed soils in the headscarp consisted of saturated fine sands and silts. The head of slope was observed to be about 15 feet from a residential structure on Lot 49 and close proximity to several other residential structures.
- Burgess Street: A relic failed area was observed off the end of Burgess Street. This relic failed area was obscured by vegetation. A stormwater outfall was observed near the head of slope and a large deciduous tree on the slope below the outfall.

Follow-up Visit: We made a follow-up reconnaissance visit on May 5, 2015, to observe slope areas obscured by snow during our visit in March 2015. During our follow-up visit, we made the following additional observations:

- Studley Street: A slumped area near the head of the slope off the end of Studley Street about 15 to 20 feet wide and extended about 10 to 15 feet down the face of the slope. This area is about 30 feet from a residential structure on Lot 57.
- Mason Street: In addition to observations on March 11, 2015, we observed material slumped off the slope was deposited at the toe of the slope.
- Burgess Street: In addition to the observations on March 11, 2015, we observed the relic failed area was covered with established vegetation. The head of slope is about 25 feet from the residential structure on Lot 44.

Mapped site features are shown on the attached Existing Conditions Plan and Sections. Photographs of the slope areas are attached.

EVALUATION AND RECOMMENDATIONS

Based on the available information and our experience, we offer the following:

- Studley Street: The eroded area appears to be the result of surface erosion. We recommend stabilizing and re-vegetating the bare, exposed soil. This area should be periodically monitored following repair to assess the need for reconstruction.

- Mason Street: The slumped area appears to be the result of toe erosion. We recommend reconstructing the slope according to the conceptual repair option provided by Wright-Pierce with additional recommendations from S.W.COLE as shown on the attached sketch. Additionally, we recommend the gravity sewer pipe bedding be drained and outlet to the toe of the repaired slope area by means of an underdrain and pipe.

- Burgess Street: The slope face is covered with established vegetation and therefore, we currently do not recommend additional stabilization measures in this area. This area should be periodically monitored to assess the need for reconstruction.

SLOPE STABILITY

Preliminary slope stability evaluations were made using a two-dimensional stability model and SLOPE/W computer software. Initial stability results indicated a safety factor against global failure of approximately 1.26. Safety factors of 1.5 are considering acceptable for slopes supporting embankments and uninhabited structures. Therefore, we recommend raising the top elevation of the 3-foot diameter riprap approximately 2 feet to elevation 10 feet (project datum) to improve the safety factor against a global slope failure to approximately 1.5. Additionally, we recommend an initial 1 to 2 foot layer of free-draining Structural Fill be installed against the slope prior to filling in order to provide positive drainage relief.. We recommend keying in the new fills where the slope is steeper than 3H:1V. Our preliminary stability analysis are illustrated on the attached graphics.

A safety factor of at least 2.0 is considered minimal for slopes supporting buildings. The nearest residential structure and other structures are within the H/3 setback requirement for buildings on top of the slopes and therefore at-risk.

CLOSURE

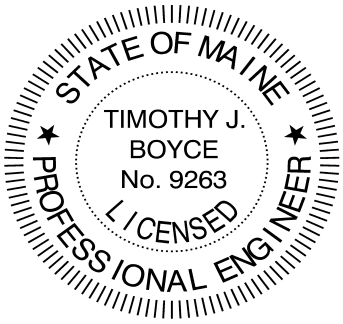
The analyses performed for this report are based on surface observations made by S.W.COLE at the site and assumed subsurface conditions. The recommendations presented in this report are confirmation dependent and will require test boring explorations at the site.

It has been a pleasure to be of assistance to you with this phase of your project. We look forward to working with you during the exploration and design phase of the project.

Sincerely,

S. W. Cole Engineering, Inc.

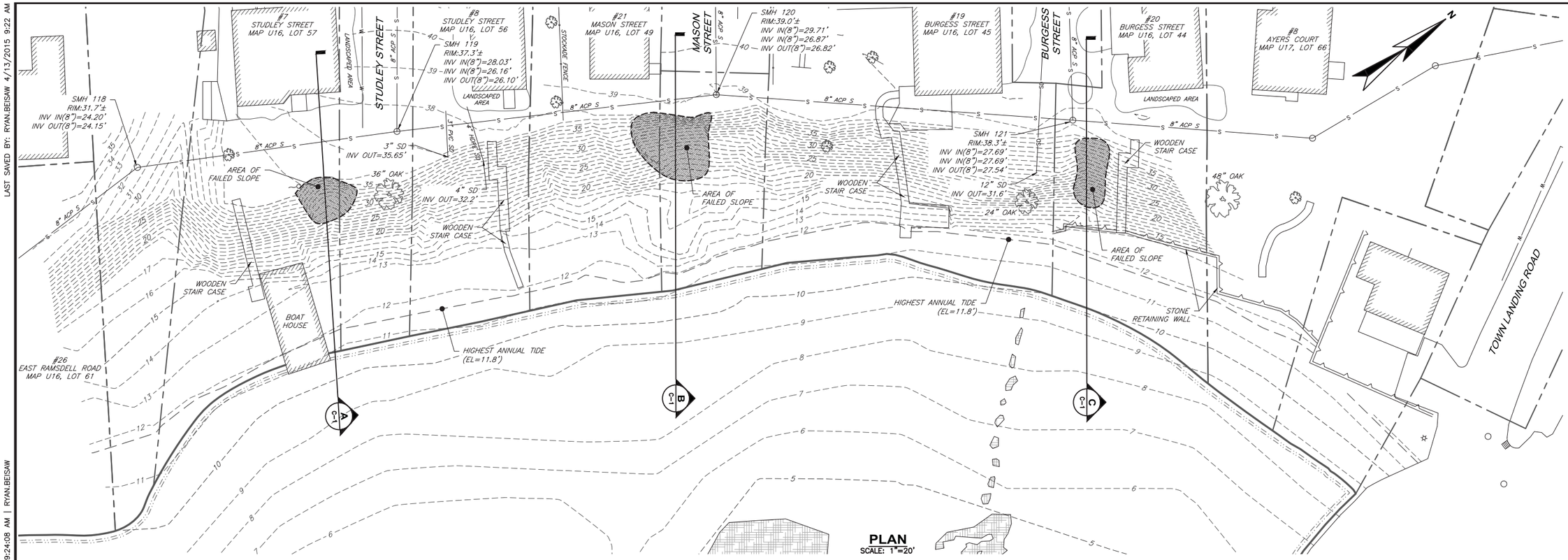
Michael A. St. Pierre, P.E.
Geotechnical Engineer



Timothy J. Boyce, P.E.
Senior Geotechnical Engineer

MAS:tjb

Enc: (4)



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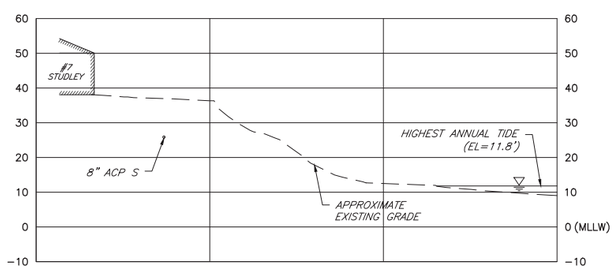

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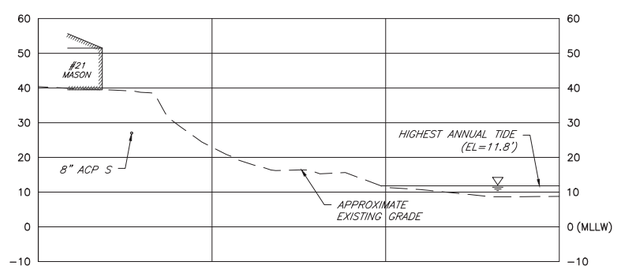

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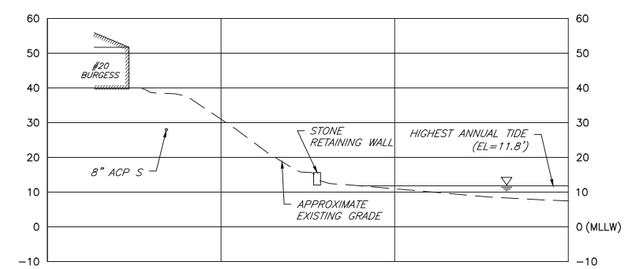

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EXISTING CONDITIONS PLAN & SECTIONS

DRAWING
C-1

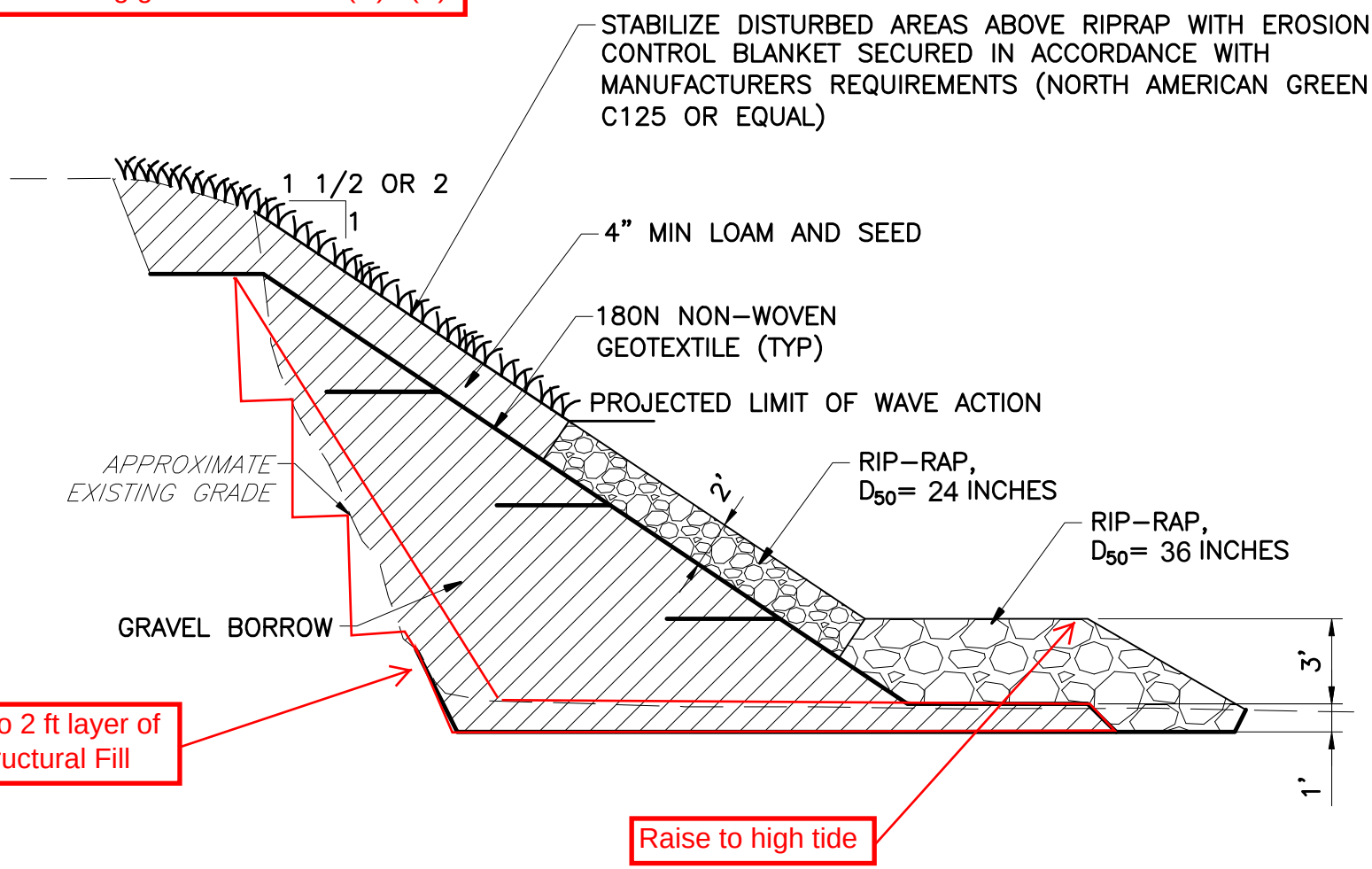
PHOTO 1
Slope erosion with Lot 57 at head of slope.

PHOTO 2
Slumped area with Lot 49 at head of slope

PHOTO 3
Relic slumped and bulging area with Lots 45 and 44 at head of slope.

PHOTO 4
Close up of tree within bulging area.

New fills should be keyed/benched where existing grades exceed 3(H):1(V)



1 to 2 ft layer of Structural Fill

Raise to high tide

TOWN OF FALMOUTH
FALMOUTH, MAINE

PROJ NO:	DATE:	FIGURE:
11545A	OCT. 2010	2A

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