MGS Memos and DEP Permits

Brunswick, Miller Point

Brunswick, Bunganuc Bluff

Lubec, Shoreline Restoration

INTERDEPARTMENTAL MEMORANDUM

MAINE GEOLOGICAL SURVEY, DEPARTMENT OF ACF
93 STATE HOUSE STATION, AUGUSTA, ME 04333-0093, (207) 287-2801

DATE: 6/19/15

TO: DAVID CHERRY, ENVIRONMENTAL SPECIALIST, DEP BUREAU OF LAND AND WATER QUALITY, DIVISION OF LAND RESOURCE REGULATION

CC: JOE LeBLANC, CONSULTANT; PETER A. SLOVINSKY, MGS; DENIS-MARC NAULT, DMR, BRAD ZITSKE AND JOHN PERRY, IF&W

FROM: STEPHEN M. DICKSON, PH.D., MARINE GEOLOGIST

RE: NRPA REVIEW COMMENTS, L-26631-4D-A-N, KING BLUFF STABILIZATION, MILLER POINT, BRUNSWICK, MAINE

After a thorough review of the above report, as presented to us, and consideration of our agency's standards, programs and responsibilities, the following comments are submitted to the Department of Environmental Protection.

The Maine Geological Survey met with officials from the Town of Brunswick and representatives for the applicant on April 29, 2015 and made a site visit that day. As a result of suggestions by MGS, the initial project design was modified to:

a) minimize the impact of shoreline stabilization engineering on the intertidal zone,
b) provide sediment from the coastal bluff to the upper intertidal zone to maintain the local sediment ("mud") budget, and
c) create a fringing salt marsh seaward of the proposed riprap to minimize wave reflection and scour from the structure.

On May 12, 2015 MGS met on the site with staff from DEP, IF&W, Joe LeBlanc of LeBlanc Associates, Inc. (project engineer), and Lance Linkel of Linkel Construction. The outcome of these discussions was a revised hybrid engineering design that incorporates on-site sediment and trees that are destined to fall into the intertidal zone due to landslides and slumps (Figures 1 and 2; Bryant *et al*., 2002; Dickson, 2001).

This design, to the maximum extent practicable, mimics the transfer of soil from land to the sea over what we estimate to be the next one to two decades. Without any shoreline stabilization, natural slope failures at this site will result in the injection of large volumes of muddy sediment (the Presumpscot Formation; Weddle, 2000) into the upper intertidal zone. This sediment is often colonized by salt marsh vegetation resulting in a fringing marsh at the toe of the coastal bluff that helps protect the bluff from further erosion (Figure 3; Kelley *et al*., 1988).

Along the shore of Miller Point in Middle Bay, there are patches of fringing salt marsh. The fringing marsh is visible in air photographs (Figure 2), topographic relief (Figure 4) and has been mapped (Timson, 1976). These marshes, along with the one proposed for construction in this

project, are not permanent and subject to erosion by tides, storms, and currents. Both sediment from slumps and sediment beneath the fringing marshes are released by erosion to the intertidal mud flats and subtidal environments of inner Casco Bay. Existing marshes are eroding (Figures 1, 3, 5, and 6) and have relief of similar dimensions to that proposed for sediment impoundment to be built with logs and posts.

Over time this injection of fine-grained sediment and organic matter will help maintain the flats that otherwise would be submerging due to erosion and gradual sea level rise of about an inch per decade. Thus, this hybrid project design is consistent with natural processes helps minimize wave reflection caused from a hard stabilization structure that can negatively impact adjacent intertidal flats.

While this "green infrastructure" design is novel for Maine, there are many similar initiatives and guidance documents available. The use of natural or "nature-based" features is described by the USACE (2015). The use of drift logs in Puget Sound is common (Zelo *et al.*, 2000) and this project is consistent with the physical setting of a muddy sheltered bay (VIMS, 2015). The use of hybrid engineering has both hazard reduction and ecosystem benefits (RAE, 2015; Spalding *et al.*, 2013). There may be minor ecological tradeoffs with the creation of a stabilized marsh (Bilkovic and Mitchell, 2013) versus a mud flat. As described above, this high intertidal zone is one of episodic disturbance from landslides and slumps so the impact of this project may not be significantly different than that expected from natural processes over time at this site.

References

Bilkovic, D.M. and Mitchell, M.M., 2013, Ecological tradeoffs of stabilized salt marshes as a shoreline protection strategy: Effects of artificial structures on macrobenthic assemblages, Ecological Engineering, 61: 469-481, DOI: 10.1016/j.ecoleng.2013.10.011.

Bryant, M., Barnhardt, W.A., Dickson, S.M., and Kelley, J.T., 2002, Coastal bluffs in the Orrs Island quadrangle, Maine (PDF 16.8Mb): Maine Geological Survey, Open-File Map 02-201, map, scale 1:24,000.

Dickson, S.M., 2001, Coastal landslide hazards in the Orrs Island quadrangle, Maine (PDF 9.0Mb): Maine Geological Survey, Open-File Map 01-530, map, scale 1:24,000.

Kelley, J.T., Belknap, D.F., Jacobson, G.L., Jr., and Jacobson, H.A., 1988, The morphology and origin of salt marshes along the glaciated coastline of Maine, USA; Journal of Coastal Research, v. 4, no. 4, p. 649-666.

RAE, 2015, Living Shorelines: From Barriers to Opportunities, Restore America's Estuaries, Arlington, Virginia, 54 p., accessed June 19, 2015.

Spalding, M.D., Ruffo, S., Lacambra, C., Meliane, I., Zeitlin Hale, L., Shepard, C.C., and Beck, M.W., 2013, The role of ecosystems in coastal protection: Adaptation to climate change and coastal hazards, Ocean & Coastal Management, 90: 50-57, DOI: 10.1016/j.ocecoaman.2013.09.007.

Timson, B.S., 1976, Coastal marine geologic environments of the Orrs Island quadrangle, Maine; Maine Geological Survey (Department of Conservation), Open-File Map 76-116 (scale 1:24,000).

USACE, 2015, U.S. Army Corps of Engineers, Northeast Comprehensive Report, accessed online June 19, 2015.

VIMS, 2015, Decision Tree Tool, Virginia Institute of Marine Sciences, Center for Coastal Resources Management, accessed June 19, 2015.

Weddle, T.K., 2000, A general introduction to the Presumpscot Formation, Maine's "Blue Clay," Maine Geological Survey, Web Site, October 2000.

Zelo, I., Shipman, H., and Brennan, J., 2000, Alternative bank protection methods for Puget Sound shorelines, Washington State, Ecology Publication 00-06-012.

Figure 1. This photograph shows the Miller Point shoreline in the vicinity of the project area. Unstable slopes (Bryant *et al.*, 2002) of Presumpscot Formation mud experience slope failures that lead to drift logs on the upper intertidal profile and sediment platforms that become colonized with salt marsh vegetation. Fringing marshes exist in the foreground (lower left) and distance. These marsh segments are experiencing erosion as part of a natural cycle. Eroded sediment is contributed to the adjacent mud flats. MGS file photo by S. M. Dickson, April 29, 2015.

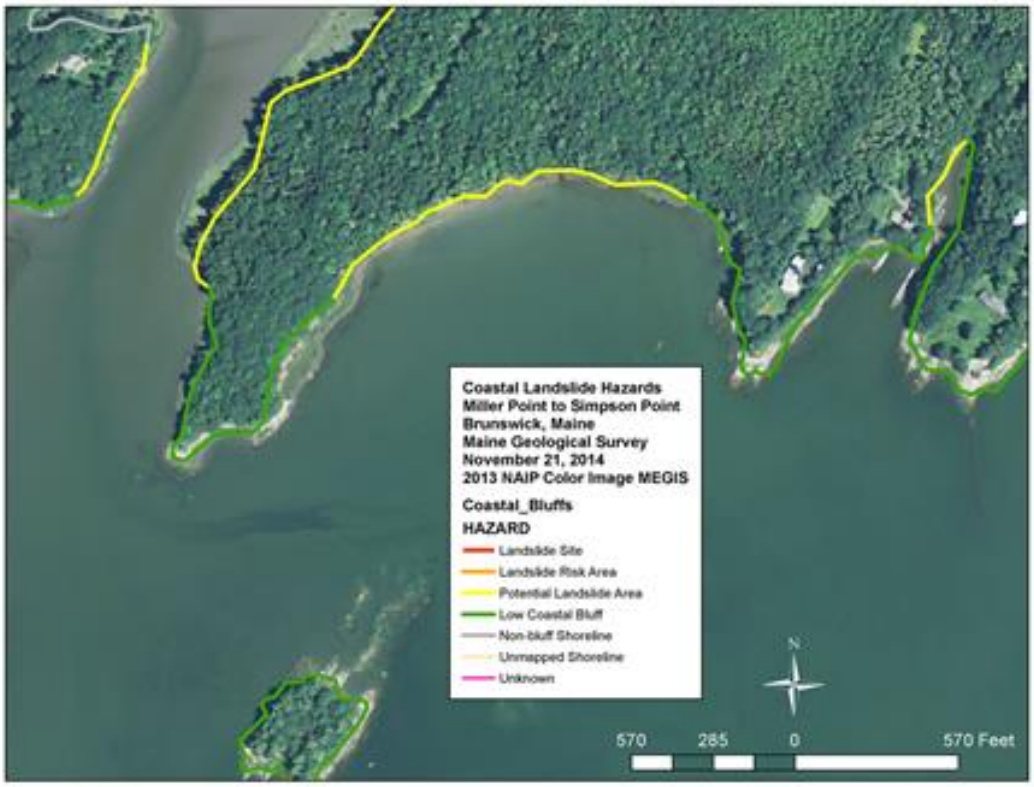

Figure 2. A portion of the MGS Coastal Landslide Hazards Map for Miller Point, Brunswick, Maine. For a full explanation of the map units and processes see Dickson (2001). The proposed hybrid shoreline stabilization project is in the Potential Landslide Area above the legend. Also visible are fringing salt marshes along the Low Coastal Bluff near both bedrock peninsulas framing the cove. Within the project area there are intermittent patches of fringing salt marsh. The tide in this image is close to high. Most of the cove (above the legend box) becomes subaerial at low tide. The engineering footprint is approximately twice the yellow line width. Map by S.M. Dickson, November 21, 2014.

Figure 3. This image shows the top of an eroding coastal bluff at Miller Point in Brunswick, Maine. This bluff is also prone to episodic landslides that deposit sediment in the high intertidal zone and become colonized with salt marsh (upper part of photo with drift log). Based on historical air photos, the large drift log has been on the marsh for at least a decade. Note how the edge of the fringing marsh is eroding with a relief of 2-3 feet. MGS file photo by S. M. Dickson, April 29, 2015.

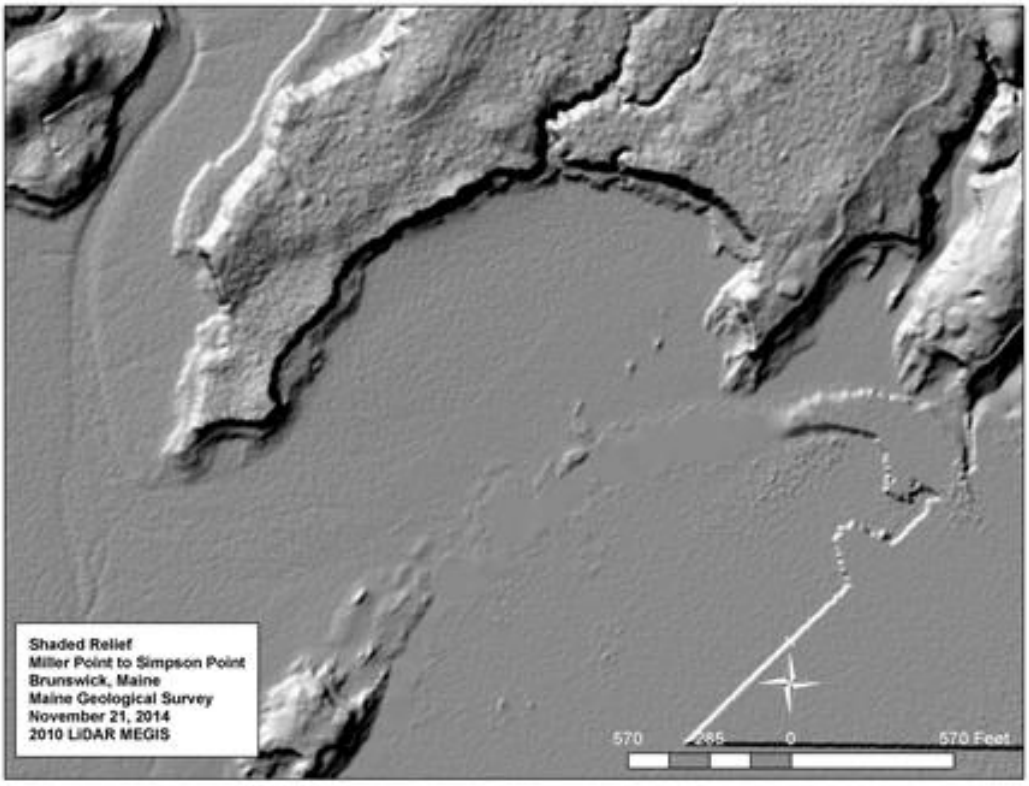

Figure 4. This map shows shaded relief along the Miller Point shoreline. The eroding bluff is cast in shadow. Along the north shore of the cove (and partially masked in shadow) are patches of fringing salt marsh seen as terraces. The marsh is more continuous along the east and west shore of the cove. The proposed project would create a more continuous fringing marsh along the shoreline. The linear discontinuity near the north arrow is an artifact of different tide levels. Topography collected by Light Detection and Ranging (LiDAR) from an aircraft. Metadata is available at the Maine Office of GIS web site. Map by S.M. Dickson, November 21, 2014.

Figure 5. This photo shows an eroding fringing marsh with a seaward embankment of 2-4 feet of relief. The proposed project would create an embankment of drift logs of similar relief to help a marsh get established. Over time the engineered marsh and drift logs are expected to decay and time-release sediment to the intertidal zone in a manner somewhat analogous to the existing process. MGS file photo by S. M. Dickson, April 29, 2015.

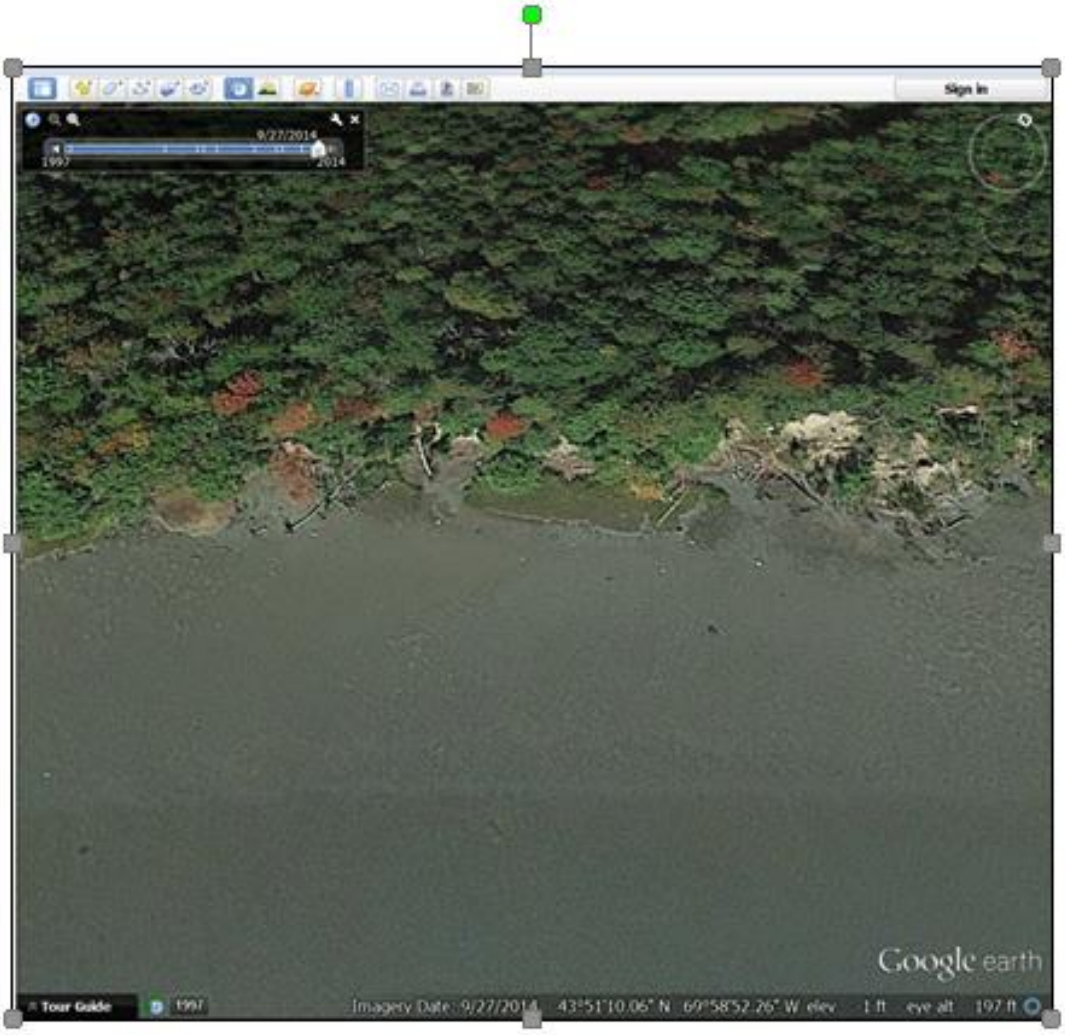

Figure 6. This image shows the project area in a vertical air photograph taken September 27, 2014. Fringing salt marshes occur in patches and have indentations that will be infilled with sediment and planted with native vegetation in the proposed project. Along the right (east) edge of the image is a landslide area with exposed Presumpscot Formation above the slump block. Image courtesy of Google Earth.

INTERDEPARTMENTAL MEMORANDUM

MAINE GEOLOGICAL SURVEY, DEPARTMENT OF ACF
93 STATE HOUSE STATION, AUGUSTA, ME 04333-0093, (207) 287-2801

DATE: 8/17/15

TO: DAVID CHERRY, ENVIRONMENTAL SPECIALIST, DEP BUREAU OF LAND AND WATER QUALITY, DIVISION OF LAND RESOURCE REGULATION

CC: PETER A. SLOVINSKY, MGS

FROM: STEPHEN M. DICKSON, PH.D., MARINE GEOLOGIST

RE: NRPA REVIEW COMMENTS, L-26631-4D-A-N, KING BLUFF STABILIZATION, MILLER POINT, BRUNSWICK, MAINE

After a thorough review of the above report, as presented to us, and consideration of our agency's standards, programs and responsibilities, the following comments are submitted to the Department of Environmental Protection.

The Maine Geological Survey reviewed Revision 3 dated 7/28/15 illustrating the HAT on a cross-section drawing of a revised engineering design. This new design maintains a 1:1 slope of rip rap that is covered by sediment removed from the site in the process of creating the more gradual slope. The illustration suggests a sediment and vegetative cover to the rip rap that is about one to two feet in thickness.

It is not clear to MGS whether or not this sediment overlay will remain stable over the rip rap or be released to supply sediment to the toe of the slope. The existing slope is obviously unstable and much steeper than that proposed. However, a stable slope (angle of repose) for mud may be 1:2 to 1:3 (Merriman, 1916; Figure 1). An example of a 1:1 slope that did become established with vegetation is shown in Figure 2 (from Washington State; Zelo et al., 2000) although we do not know how long the slope has remained vegetated. We recommend DEP seek additional information from others with more expertise in slope stabilization in Maine to better understand the fate of sediment placed over the rip rap at a 1:1 slope.

We favor the on-site beneficial use of bluff sediment. If sediment does move down slope over the rip rap, that sediment will contribute to at least some beneficial deposition in the intertidal zone.

References

Merriman, M., (ed.), 1916, *American Civil Engineers' Pocket Book*, London, John Wiley & Sons, p. 580.

Zelo, I., Shipman, H., and Brennan, J., 2000, Alternative bank protection methods for Puget Sound shorelines, Washington State, Ecology Publication 00-06-012.

Slopes of Repose and Weights for Loose Earth

Kind of earth	Slope of repose	Angle of repose	Weight Lb per cu ft
Sand, clean	1.5 to 1	33° 41′	90
Sand and clay	1.33 to 1	36 53	100
Clay, dry	1.33 to 1	36 53	100
Clay, damp, plastic	2 to 1	26 34	100
Gravel, clean	1.33 to 1	36 53	100
Gravel and clay	1.33 to 1	36 53	100
Gravel, sand and clay	1.33 to 1	36 53	100
Soil	1.33 to 1	36 53	100
Soft rotten rock	1.33 to 1	36 53	110
Hard rotten rock	1 to 1	45 00	100
Bituminous cinders	1 to 1	45 00	45
Anthracite ashes	1 to 1	45 00	30

The Angle of Repose given in the third column of this table is the angle ϕ which the sloping face of a bank of loose earth makes with the horizontal (Fig. 1). The cotangent of this angle is the slope ratio given in the second column; thus, 1.5 is the cotangent of 33° 41′. In general, if s is the slope of repose, or the ratio of horizontal to vertical projection, and ϕ the angle of repose, then $s = \cot \phi$. The term "natural slope" is sometimes used as synonymous with "slope of repose." The tangent of this angle is the coefficient of friction for earth upon earth, or $f = \tan \phi$ (Art. 3).

Material Excavated by a wet or a dry process, and dumped into water, as at the back of a sea wall, has weights and slopes approximated as follows:

Kind of material	Slope of repose	Angle of repose	Weight. Lb per cu ft
Sand, clean	2 to 1	26° 34′	60
Sand and clay	3 to 1	18 26	65
Clay	3½ to 1	15 57	80
Gravel, clean	2 to 1	26 34	60
Gravel and clay	3 to 1	18 26	65
Gravel, sand and clay	3 to 1	18 26	65
Soil	3½ to 1	15 57	70
Soft rotten rock	1 to 1	45 00	65
Hard rock, riprap	1 to 1	45 00	65
River mud	∞ to 1	0 00	90

When the material is excavated by suction dredging and pumped back of a retaining wall which has efficient drains to carry off the water, the weight per cubic foot may be taken at 110 pounds and the slope of repose as 2 to 1 for sand and clay, clay and gravel, or clay, gravel, and sand combined. River mud may be taken at 100 lb per cu ft with a slope of 3 to 1.

Figure 1. An excerpt from Merriman (1916, p. 580) describing stable slopes in both natural sediment and excavated sediment.

Figure 2. View from the beach. The lift layers can be seen. The slope is approximately 1H:1V, compared to its original near-vertical pre-construction state. The bluff is 30+ feet tall (the rock bulkhead is 5-6 feet high).

Figure 2. A reproduction of Figure 2 from page 19 of Zelo et al. (2000) showing a stabilized and vegetated bank with a 1:1 slope in Washington State.

INTERDEPARTMENTAL MEMORANDUM

MAINE GEOLOGICAL SURVEY, DEPARTMENT OF ACF
93 STATE HOUSE STATION, AUGUSTA, ME 04333-0093, (207) 287-2801

DATE: 10/14/15

TO: DAVID CHERRY, ENVIRONMENTAL SPECIALIST, DEP BUREAU OF LAND AND WATER QUALITY, DIVISION OF LAND RESOURCE REGULATION

CC: PETER A. SLOVINSKY, MGS

FROM: STEPHEN M. DICKSON, PH.D., MARINE GEOLOGIST

RE: NRPA REVIEW COMMENTS, L-26631-4D-A-N, KING BLUFF STABILIZATION, MILLER POINT, BRUNSWICK, MAINE

After a thorough review of the above report, as presented to us, and consideration of our agency's standards, programs and responsibilities, the following comments are submitted to the Department of Environmental Protection.

The Maine Geological Survey reviewed permit modifications dated 9/8/15 illustrating the addition of Husker Fortrac 3D geotextile and re-use of additional bluff sediment over the riprap slope (Exhibits 2 Rev. 1, 2A Rev 4. 2B, Rev. 2). This modified design maintains an overall 1:1 slope of rip rap that is more irregular in relief from "interference rocks" intended to prevent soil slippage down the slope. Rip rap will still be covered by sediment removed from regrading the bluff slope. The geotextile will be buried to provide additional slope stability for re-used bluff sediment. The total sediment thickness of about one foot will cover the riprap. The native sediment will be coverd with topsoil and seeded. We suggest that a mixture of native plant seeds, rather than a lawn seed, be considered for application on the slope if practical.

As stated previously, we favor the on-site beneficial use of bluff sediment. About half of the excavated bluff sediment (estimated at 810 cubic yards) will be used to cover the riprap. If some of this sediment moves down the rip rap slope over time, it could contribute to the intertidal sediment budget of the cove, helping to somewhat minimize impacts of stabilizing the bluff.

The primary goal of this project is shoreline stabilization well into the future. If the engineering achives that goal, then additional bluff sediment from future slope failures will not reach the intertidal flats. The application proposes to leave the remaining 4/5ths of the shoreline in a natural condition to allow continued supply of sediment to the cove from adjacent bluff erosion and landslides along property. This preservation of the natural shoreline areas adjacent to the project is important in order to maintain the natural transfer of sediment from the upland to the marine environment.

We would have preferred that the project design retain an attempt to to mitigate bluff stabilization by building a fringing salt marsh at the toe of the riprap in order to minimize wave reflection and toe scour in the upper intertidal zone. From a geological perspective, this shoreline and the fringing marshes come and go over time, so even if a constructed marsh were to persist only for a few years, that would replicate a natural condition in the cove and help to further balance the sediment budget.

INTERDEPARTMENTAL MEMORANDUM

MAINE GEOLOGICAL SURVEY, DEPARTMENT OF ACF
93 STATE HOUSE STATION, AUGUSTA, ME 04333-0093, (207) 287-2801

DATE: 9/9/16

TO: DAVID CHERRY, ENVIRONMENTAL SPECIALIST, DEP BUREAU OF LAND AND WATER QUALITY, DIVISION OF LAND RESOURCE REGULATION

CC: PETER A. SLOVINSKY, MGS

FROM: STEPHEN M. DICKSON, PH.D., MARINE GEOLOGIST

RE: NRPA REVIEW COMMENTS, L-26631-4D-G-M, KING BLUFF STABILIZATION, MILLER POINT, BRUNSWICK, MAINE

After a thorough review of the above report, as presented to us, and consideration of our agency's standards, programs and responsibilities, the following comments are submitted to the Department of Environmental Protection.

We reviewed a supplemental plan and section details (Site Plan C1.1 dated June 29, 2016 and C1.2 dated July 15, 2016 from Pinkham & Greer Civil Engineers) and a geotechnical report (Kohler and St. Pierre, 2016) by S.W. Cole Engineering, Inc. The report analyzed the subsurface geology and geotechnical properties of the upland adjacent to the coastal bluff at Miller Point in Brunswick. The report also modeled slope stability with conditions representing before, during, and after construction of proposed bluff stabilization with a reduction in the slope of the bluff face, trenching to install anchor boulders at the toe of the slope, placement of riprap about 3 feet above the effective 100-year stillwater elevation, and installation of geotextiles beneath a soil cover planted with vegetation.

The Maine Geological Survey has had considerable experience with unstable coastal bluffs and landslides along the Maine coast that occur in the muddy Presumpscot Formation (Bryant et al., 2002; Dickson, 2001; Dickson and Johnston, 2015; Thompson, 2015). Thick silt and clay sediment of this formation is present at this location. As the geotechnical report identifies, there are layers in the Presumpscot Formation with differing strengths. Here as well as elsewhere, the weakest, most fluid sediment occurs at depth and is the zone where failures occur beneath and adjacent to unconfined bluffs. We are not engineers, so our review comments are based on our geological understanding and experience with the Presumpscot Formation clays and coastal erosion in Maine.

Boulder Stability

The modified plans show a slope of 1:1.5 (V:H) near the toe of the remediated slope and a lower 1:2 slope higher on the embankment (C1.2 Section 1). Landward of the highest annual tide (HAT) line a 5-foot deep excavation into the bluff would be loaded with boulders to form a footing to stabilize the slope. In all sections (1-1, 2-2, 3-3, and 4-4) the slope will be reduced and Presumpscot Formation sediment removed. Depending on the location, from 2 to in excess of 10 feet of sediment may be "unloaded" from the bank and an additional amount removed from the boulder trench. The density of boulders is normally greater than that of the mud but we see no discussion of the net difference (although this may be included in the numerical model run by S.W. Cole). Given the softness of the subsurface beneath the trench, we are not certain if the load of anchor boulders will be stable or result in settlement deeper than depicted in post-construction sections. We note that clay in the vicinity of borings B-2 and B-3 is an additional 10 to 25 feet thick below the floor of the trench.

Trench Location

The excavation for the trench is proposed to be *landward* of the highest annual tide (HAT; C1.2 Sections 1 through 3). We note that construction of the trench in this landward location also results in rocks placed about 5 feet *below* the HAT. We are not sure if there is any regulatory significance to this depth of excavation.

Top of Riprap

The Sections and Details (C1.2) places the top of the riprap at 12 feet NAVD88 and about 3.6 feet higher above the effective 100-year base flood elevation of 9 feet NGVD29 (FEMA FIRM 230042 0026B, Zone A2 EL9, effective date January 3, 1986), equal to about 8.4 feet NAVD88.

Information submitted by Pinkham and Greer (letter dated June 29, 2016) states that the project "…considered long term rising sea levels and wave action." This statement is made using out-dated (30-year-old maps) yet considered effective base flood elevation information, but not best-available information. The preliminary (yet not effective) FEMA DFIRM from November 5, 2013 changes the flood zone along the proposed project to a VE-Zone with a BFE of 12 feet NAVD88 – an approximate 3.6-foot increase. The proposed project, as designed, would therefore just *meet* the 100-year flood zone condition, based on the best-available preliminary data, and certainly not account for potential future conditions after sea level rise.

Stability Model

Several model scenarios were done to calculate a "factor of safety" for comparison of existing conditions with those during and after construction of the proposed project. The factor of safety is a comparison of the resisting force and driving force. A safety factor less than 1.0 means slope failure is expected (USACE, 2003). According to the S.W. Cole report (p. 5): "Safety factors of 1.5 or greater are considered acceptable for slopes supporting landscape areas under static conditions." In Table 1 below, we summarize a subset of the model runs provided in the geotechnical report. Transect A-A' represents an area in the vicinity of Section 3-3 and of the bluff where the upland is highest and bank steepest. Transect B-B' (and Section 4-4) is slightly to the east and in an area where there was a landslide a few years ago.

Reducing the slope at transect A-A' increases the factor of safety from 1.82 to 1.96. The safety factor increases by 0.11 more with the final condition. However, we noted that the surcharge in the final condition was reduced 50% to 125 psf (Table 1; Report Appendix A) to attain this increase in safety. If we assume a higher surcharge reduces the factor of safety, then it would be useful to know if the value for the final condition is better or not than the original, or reduced slope, values.

Similarly, the final condition at B-B' shows a factor of safety increase of 0.09 over a reduced slope condition but with a surcharge reduced by 50%.

It is unclear why there are two surcharges used in the model. The higher surcharge may represent anticipated construction conditions with equipment and earth movement. Perhaps the 125 psf condition is for a post-construction factor of safety. Nevertheless, it seems difficult to estimate what additional factor of safety the project provides over the existing condition. Additional information should be requested to clarify this issue.

Table 1. Comparison of Slope Stability Models

Transect	Model	Surcharge	Factor of Safety	Comment
A-A'	Existing	250 psf	1.82	
A-A'	Reduced Slope	250 psf	1.96	
A-A'	Final, Static	125 psf	2.07	Lower Surcharge, Slight Factor Increase
A-A'	Final, Static	250 psf	?	Better than Reduced Slope?
B-B'	Reduced Slope	250 psf	1.54	
B-B'	Final, Static	125 psf	1.63	Lower Surcharge
B-B'	Final, Static	250 psf	?	Better?

Embankment Section 4-4

This location is essentially the same as B-B' of the geotechnical report. The placement or replacement of excavated slope sediment over and above the rock boulders and riprap could be beneficial if there is a gradual release of the sediment to the cove. This release is likely to come first from the area where the most recent landslide occurred in the location where the toe of the landslide protrudes most into the intertidal zone. This slight promontory will be subject to more wave action than adjacent areas and, over time, erosion may tend to make the shoreline more linear.

We do not have a concern that the release of mud will be detrimental to either Merepoint Bay or Middle Bay since this area has been one of repeated mud releases from past landslides. The future release of sediment from this section of the project area will help maintain the "mud budget" that otherwise would be cut off by the engineering stabilization of the bluff.

We question whether or not the load of rocks and mud fill proposed at Section 4-4 will settle down into the soft clay below. The strength of the subsurface clay may have increased to some (unknown) extent as a result of loading by the landslide at that location a few years ago. However, if the clay strength is insufficient to support the rock and fill load, then deeper clay may be displaced laterally below ground and result in some increase in the elevation or mounding of the surrounding intertidal flat. This area of increased elevation, if it were to occur, we believe would experience gradual wave erosion down to the level of the current contours over a period of a year or two. In this time frame, additional mud would be released to the surrounding intertidal environments and lead to beneficial sedimentation on adjacent salt marshes and mud flats.

Section 4.4 General

This section mentions that there might be instability during or after construction and that monitoring should be done. Post-project monitoring might also be important to identify unsatisfactory slope performance (USACE, 2003). If there is a slope failure during or after construction that results in boulders, smaller rocks, and geotextiles slumping onto the intertidal zone below the HAT, how will this be addressed or mitigated? A landslide on the current shoreline is a natural process of transferring fine-grained sediment to the adjacent flats and Casco Bay. A post-project landslide would transfer more than mud to the intertidal zone. This should be clarified.

Proposed Vegetative Plantings

Submitted plans provide for revegetation of the slope (C1.2, Stabilized Slope Landscape Plantings). Although we are not landscape architects, we question whether the proposed planting protocol uses the best available native vegetation to help naturally stabilize the soil surface by root systems. We recommend that the Department require that the applicant consider proactive planting along the lower portion of the slope (elevations 9.0 to 12.0 feet NAVD88), as opposed to placing loam and seed and simply allowing the area to "naturalize with native volunteer species).

References

Bryant, M., Barnhardt, W. A., Dickson, S. M., and Kelley, J. T., 2002, Coastal bluffs in the Orrs Island quadrangle, Maine (PDF 16.8Mb): Maine Geological Survey, Open-File Map 02-201, map, scale 1:24,000.

Dickson, S. M., 2001, Coastal landslide hazards in the Orrs Island quadrangle, Maine (PDF 9.0Mb): Maine Geological Survey, Open-File Map 01-530, map, scale 1:24,000.

Dickson, S. M. and Johnston, R. A., 2015, Geomorphology of Presumpscot Formation Landslides, 2nd Symposium on the Presumpscot Formation: Advances in Geotechnical, Geologic, and Construction Practice, Landon, M.E. and Nickerson, C. Eds. Portland, Maine, 28 October 2015, 18 p.

Kohler, P. F. and St. Pierre, M. A., 2016, Report, Proposed Slope Stabilization, Miller Point, Brunswick, Maine, No. 16-0359 S, submitted to Pinkham & Greer Consulting Engineers, Portland, Maine, May 13, 2016, 34 p.

Thompson, W. B., 2015, *Surficial Geology Handbook for Southern Maine*, Maine Geological Survey Bulletin 44, Augusta, Maine, 97 p.

USACE, 2003, *Slope Stability*, Engineer Manual No. EM 1110-2-1902, U.S. Army Corps of Engineers, Washington, DC, 205 p.

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

PAUL R. LEPAGE
GOVERNOR

PATRICIA W. AHO
COMMISSIONER

June 2015

Nancy and Robert King
275 Hartshorn Drive
Short Hills, NJ 07078

RE: Natural Resources Protection Act Application, Brunswick
DEP #L-26631-4D-A-N/L-26631-TW-B-N

Dear Mr. and Mrs. King:

Please find enclosed a signed copy of your Department of Environmental Protection land use permit. You will note that the permit includes a description of your project, findings of fact that relate to the approval criteria the Department used in evaluating your project, and conditions that are based on those findings and the particulars of your project. Please take several moments to read your permit carefully, paying particular attention to the conditions of the approval. The Department reviews every application thoroughly and strives to formulate reasonable conditions of approval within the context of the Department's environmental laws. You will also find attached some materials that describe the Department's appeal procedures for your information.

If you have any questions about the permit or thoughts on how the Department processed this application please get in touch with me directly. I can be reached at (207) 523-9807 or at david.cherry@maine.gov.

Sincerely,

David Cherry, Project Manager
Division of Land Resource Regulation
Bureau of Land and Water Quality

pc: File

AUGUSTA
17 STATE HOUSE STATION
AUGUSTA, MAINE 04333-0017
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STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION
17 STATE HOUSE STATION AUGUSTA, MAINE 04333-0017

DEPARTMENT ORDER

IN THE MATTER OF

NANCY AND ROBERT KING	) NATURAL RESOURCES PROTECTION ACT
Brunswick, Cumberland County	) COASTAL WETLAND ALTERATION
SHORELINE STABILIZATION	) SIGNIFICANT WILDLIFE HABITAT
L-26631-4D-A-N (approval)	) WATER QUALITY CERTIFICATION
L-26631-TW-B-N (approval)	) FINDINGS OF FACT AND ORDER

Pursuant to the provisions of 38 M.R.S.A. Sections 480-A et seq. and Section 401 of the Federal Water Pollution Control Act, the Department of Environmental Protection has considered the application of ROBERT AND NANCY KING with the supportive data, agency review comments, and other related materials on file and FINDS THE FOLLOWING FACTS:

1. PROJECT DESCRIPTION:

A. Summary: The applicants propose to stabilize 500 linear feet of shoreline along a highly eroding bluff by using a combination of hard and soft engineering including riprap, native soils, and vegetative plantings. As a result of the placement of the riprap, approximately 2,534 square feet of area below the Highest Annual Tide (HAT) line will be altered. The riprap would extend in varying heights from 12 feet to 18 feet up the embankment. The area above the riprap on the remainder of the slope would be planted with native vegetation. The final slope for the riprap will be 1H:1V.

During the construction of the stabilized bank, and in an effort to mitigate the potential effects of the project on the mud flat and salt marsh, the applicant proposes to create a new fringe salt marsh which will be located seaward of the installed riprap as mitigation. The proposed mitigation will seek to fill isolated gaps along the shoreline where fringe marsh is not currently established, measuring approximately 16,000 to 20,000 square feet in size.

Specifically, the applicants propose to remove approximately 48,000 to 60,000 cubic feet of material, consisting of silty soil, from the eroding embankment and place it at the toe of the proposed riprap slope in areas where existing fringe marsh is not located. The areas proposed for marsh construction will consist of a base material of clay and mineral soils from the upper part of the bank. The material will be secured with a combination of small trees from the upland, coir logs, and wood stakes. Once the project has been completed, the applicants propose to install approximately 5,000 marsh grass (*Spartina patens*) plugs to vegetate the area.

The proposed project is shown on a set of plans, the first of which is titled "Exhibit 1D," drawn by LeBlanc Associates, Inc. and dated, by revision, June 1, 2015. The project site is located off of Simpson Point Road in the Town of Brunswick.

B. Current Use of the Site: The project parcel is currently developed with a gravel road. The parcel is approximately 177 acres in size and is identified as Lots 31, 32, and 33 on Map 31 of the Town of Brunswick's tax maps.

2. EXISTING SCENIC, AESTHETIC, RECREATIONAL OR NAVIGATIONAL USES:

In accordance with Chapter 315, Assessing and Mitigating Impacts to Scenic and Aesthetic Uses, the applicant submitted a copy of the Department's Visual Evaluation Field Survey Checklist as Appendix A to the application along with a description of the property and the proposed project. The applicant also submitted several photographs of the proposed project site including an aerial photograph of the project site. Department staff visited the project site on December 1, 2014 and on April 29 and May 12, 2015.

The proposed project is located in Merepoint Bay, which is a scenic resource visited by the general public, in part, for the use, observation, enjoyment and appreciation of its natural and cultural visual qualities. The applicants will use rock similar in color to the native stone in the area, and will use native soils to place over the top part of the embankment to grow vegetation, in order to reduce the visibility of the riprap from the scenic resource. The applicants have also proposed to create a fringe saltwater marsh at the toe of the riprap slope to further minimize the visibility from the resource. The applicants propose to install approximately 5,000 marsh grass (*Spartina patens*) plugs to vegetate the salt marsh.

The applicants must monitor both the plantings on the upper part of the slope and the marsh grass, and the plantings must be replaced or maintained as necessary to achieve 85% survival after one full growing season. The applicants must also submit annual reports to the Department detailing the survival and health of the marsh grass plantings, including photographs, for a period of three years following completion of the project. These reports are due no later than December 15th of each year.

The proposed project was evaluated using the Department's Visual Impact Assessment Matrix and was found to have an acceptable potential visual impact rating. Based on the information submitted in the application, the visual impact rating, and the site visits, the Department determined that the location and scale of the proposed activity is compatible with the existing visual quality and landscape characteristics found within the viewshed of the scenic resource in the project area.

The Department did not identify any issues involving existing recreational and navigational uses.

The Department finds that the proposed activity will not unreasonably interfere with existing scenic, aesthetic, recreational or navigational uses of the protected natural resource provided that the applicant monitors and maintains the plantings as described above.

3. SOIL EROSION:

The applicants have proposed to construct the riprap and fringing salt marsh during periods of dry weather and low tides. Excavated materials, such as topsoil to be reused once the riprap is complete, will be stockpiled at an upland location. To further reduce the likelihood for erosion and sedimentation problems, the applicants will complete the riprap and marsh creation work in sections.

The applicants propose to install the riprap in conjunction with the fringe salt marsh construction. Doing so will allow the contractor to incorporate excavated materials from the lower portion of the embankment, the marine clay and soils above, into the fringing salt marsh creation area. Constructing both projects simultaneously also minimizes the need for the contractor to have equipment operating on the mudflat. Construction of the salt marsh will be limited to a corridor immediately adjacent to the base of the riprap and will be accomplished with rubber-tracked equipment or crane mats, as shown on the plan titled "Supplemental Information – Fringe Marsh Addition," dated June 2, 2015 and submitted with the application.

To construct the fringe salt marsh project, marine clay and other soils from the embankment will be used as the ground base and marsh grass will be planted when conditions allow. Small trees from the upland will be laid down parallel with the shoreline to create a barrier between the edge of the constructed marsh and the mudflat to help retain the soil until salt marsh vegetation is established. Once construction is complete, the applicants must submit an as-built plan to the Department that includes details of the types of materials used and final grades for both the riprap/vegetated slope and the salt marsh creation area. The applicants must include photographs of the completed project with the as-built plan.

The Department finds that the activity will not cause unreasonable erosion of soil or sediment nor unreasonably inhibit the natural transfer of soil from the terrestrial to the marine or freshwater environment provided as-built plans and photographs are submitted as described above.

4. HABITAT CONSIDERATIONS:

According to the Department's Geographic Information System (GIS) database the project area is mapped as Tidal Waterfowl and Wading Bird Habitat (TWWH), which is designated as Significant Wildlife Habitat under the Natural Resources Protection Act (NRPA). No Essential Habitat was identified at the project site.

The Department of Marine Resources (DMR) reviewed the proposed project and determined that the proposed project is located in a known resource with significant shellfish resource with no seasonal closures. However DMR stated that the proposed project is unlikely to severely impact the resource, particularly if construction of the project takes place during the proposed time frame of July and August, when shellfish are not as plentiful. DMR also recommended that the applicants limit the amount of

disturbance necessary for construction equipment to install the riprap and construct the salt marsh.

The Maine Department of Inland Fisheries and Wildlife (MDIFW) reviewed the proposed project and found that with the stabilization and fringe marsh creation as proposed, the project will have minimal impacts to wildlife.

The Maine Department of Environmental Protection, Division of Environmental Assessment (DEA), reviewed the proposed project and stated that the project as proposed would have little effect on water quality, and that the salt marsh creation is a logical mitigation step to replace lost functions of the wetland and potentially improve functionality of the upper intertidal area.

The Maine Geological Survey (MGS) reviewed the proposed project and found that the combination of riprap and salt marsh creation at the toe of the slope has both hazard reduction and ecosystem benefits. By creating salt marsh in front of the riprap, the release of sediments and organic matter will help maintain the mudflats that otherwise would be submerged due to erosion and gradual sea level rise of about an inch per decade. The salt marsh will also minimize wave reflection caused from using solely riprap, which would also negatively impact the mudflat.

The Department finds that the activity will not unreasonably harm any significant wildlife habitat, freshwater wetland plant habitat, threatened or endangered plant habitat, aquatic or adjacent upland habitat, travel corridor, freshwater, estuarine or marine fisheries or other aquatic life.

5. WATER QUALITY CONSIDERATIONS:

The applicants proposed an acceptable erosion and sedimentation control plan as described in Finding 3 above.

The Department finds that the proposed project will not violate any state water quality law, including those governing the classification of the State's waters.

6. WETLANDS AND WATERBODIES PROTECTION RULES:

The applicants propose to stabilize approximately 500 linear feet of shoreline and alter 2,534 square feet of coastal wetland below the HAT line to install the proposed riprap. Also below the HAT line, the applicants propose to impact approximately 16,000 to 20,000 square feet to create the salt marsh.

The Wetland and Waterbodies Protection Rules, 06-096 CMR 310, interpret and elaborate on the NRPA criteria for obtaining a permit. The rules guide the Department in its determination of whether a project's impacts would be unreasonable. A proposed project would generally be found to be unreasonable if it would cause a loss in wetland area, functions and values and there is a practicable alternative to the project that would

be less damaging to the environment. Each application for a NRPA permit that involves a coastal wetland alteration must provide an analysis of alternatives in order to demonstrate that a practicable alternative does not exist.

A. Avoidance. No activity may be permitted if there is a practicable alternative to the project that would be less damaging to the environment. The applicants submitted an alternatives analysis for the proposed project completed by LeBlanc Associates. The project purpose is to stabilize a highly eroding bluff so that residential dwellings can be built behind it. As part of the stabilization effort, the applicants have proposed to create a fringe marsh seaward of the riprap. The applicants considered other options including the no-build alternative and using vegetative controls only to stabilize the bank. The applicants determined that leaving the embankment in its current condition would create potential problems when the residential dwellings are constructed behind it. The use of only vegetative controls was determined to not be suitable for the project location due to the unstable nature of the underlying soils. To provide a stable slope, the applicants would need to remove a much more significant amount of material from the upland. This would further minimize the building envelope for the dwellings, which have been limited to this area because of vernal pools and freshwater wetlands on the remainder of the lot. The applicants concluded that to meet the project purpose, impact to the coastal wetland could not be avoided.

B. Minimal Alteration. The amount of coastal wetland to be altered must be kept to the minimum amount necessary for meeting the overall purpose of the project. The applicants have minimized impact to the extent possible by utilizing a 1H:1V slope, which reduces the amount of riprap material below the HAT. The applicants have also designed the riprap portion of the project to be located behind all existing salt marsh areas and large areas of slumps. Doing so will minimize impacts to the existing salt marsh and minimize the loss of natural supply of sediments to the mudflat.

C. Compensation. In accordance with Chapter 310 Section 5(C)(6)(b), compensation is generally required to achieve the goal of no net loss of coastal wetland functions and values if the activity would result in over 500 square feet of fill in the resource. To compensate for the proposed impacts to the coastal wetland, the applicants propose to make a contribution into the In-Lieu Fee (ILF) program of the Maine Natural Resource Conservation Program (MNRCP) in the amount of $21,944. Prior to the start of construction, the applicant must submit a payment in the amount of $21,944, payable to "Treasurer, State of Maine", and directed to the attention of the ILF Program Administrator at 17 State House Station, Augusta, Maine 04333.

The Department finds that the applicants have avoided and minimized coastal wetland impacts to the greatest extent practicable, and that the proposed project represents the least environmentally damaging alternative that meets the overall purpose of the project provided that the salt marsh creation is implemented and monitored and that, prior to project construction, the applicant submits the ILF payment as described above.

7. OTHER CONSIDERATIONS:

The Department did not identify any other issues involving existing scenic, aesthetic, or navigational uses, soil erosion, habitat or fisheries, the natural transfer of soil, natural flow of water, water quality, or flooding.

BASED on the above findings of fact, and subject to the conditions listed below, the Department makes the following conclusions pursuant to 38 M.R.S.A. Sections 480-A et seq. and Section 401 of the Federal Water Pollution Control Act:

A. The proposed activity will not unreasonably interfere with existing scenic, aesthetic, recreational, or navigational uses provided that the applicant monitors and maintains vegetation and submits reports as described in Finding 2.

B. The proposed activity will not cause unreasonable erosion of soil or sediment.

C. The proposed activity will not unreasonably inhibit the natural transfer of soil from the terrestrial to the marine or freshwater environment.

D. The proposed activity will not unreasonably harm any significant wildlife habitat, freshwater wetland plant habitat, threatened or endangered plant habitat, aquatic or adjacent upland habitat, travel corridor, freshwater, estuarine, or marine fisheries or other aquatic life provided that the applicants submit an as-built plan and photographs following completion of the project as discussed in Finding 3and that prior to construction the applicants make a contribution to the In-Lieu Fee (ILF) program as described in Finding 6.

E. The proposed activity will not unreasonably interfere with the natural flow of any surface or subsurface waters.

F. The proposed activity will not violate any state water quality law including those governing the classifications of the State's waters.

G. The proposed activity will not unreasonably cause or increase the flooding of the alteration area or adjacent properties.

H. The proposed activity is not on or adjacent to a sand dune.

I. The proposed activity is not on an outstanding river segment as noted in Title 38 M.R.S.A. Section 480-P.

THEREFORE, the Department APPROVES the above noted application of ROBERT AND NANCY KING to stabilize an eroding bluff as described in Finding 1, SUBJECT TO THE ATTACHED CONDITIONS, and all applicable standards and regulations:

1. Standard Conditions of Approval, a copy attached.

2. The applicants shall take all necessary measures to ensure that their activities or those of their agents do not result in measurable erosion of soil on the site during the construction of the project covered by this approval.

3. Severability. The invalidity or unenforceability of any provision, or part thereof, of this License shall not affect the remainder of the provision or any other provisions. This License shall be construed and enforced in all respects as if such invalid or unenforceable provision or part thereof had been omitted.

4. Prior to the start of construction, the applicant shall submit a payment in the amount of $21,944, payable to "Treasurer, State of Maine", to the attention of the ILF Program Administrator at 17 State House Station, Augusta, Maine 04333.

5. The applicants shall monitor both the plantings on the upper part of the slope and the marsh grass, and the plantings shall be replaced or maintained as necessary to achieve 85% survival after one full growing season. The applicants shall also submit annual reports to the Department detailing the survival and health of the marsh grass plantings, including photographs, for a period of three years following completion of the project. These reports are due no later than December 15th of each year.

6. Within 60 days from completion of the approved project, the applicants shall submit an as-built plan for the shoreline stabilization and salt marsh creation area. The as-built plan shall include details regarding the materials used and final grades for both the riprap/vegetated slope and for the salt marsh creation area, and shall include photographs of the completed project.

THIS APPROVAL DOES NOT CONSTITUTE OR SUBSTITUTE FOR ANY OTHER REQUIRED STATE, FEDERAL OR LOCAL APPROVALS NOR DOES IT VERIFY COMPLIANCE WITH ANY APPLICABLE SHORELAND ZONING ORDINANCES.

DONE AND DATED IN AUGUSTA, MAINE, THIS 25th DAY OF June, 2015.

DEPARTMENT OF ENVIRONMENTAL PROTECTION

Filed
JUN 26 2015
State of Maine
Board of Environmental Protection

BY: Michael Kuhns
For: Patricia W. Aho, Commissioner

PLEASE NOTE THE ATTACHED SHEET FOR GUIDANCE ON APPEAL PROCEDURES…

DC/L26631ANBN/ATS#79012, 79013

LICENSE REVIEW ROUTING SHEET

PROJECT MANAGER: David Cherry

					DRAFT
	ORIGINAL ORDER (N)		CONDITION COMPLIANCE (C)		3PI
X	MINOR REVISION (M)		TRANSFER (T)		SEND TO REGISTRY
	AMENDMENT (A)		AFTER-THE-FACT		CORRECTED ORDER

Copies of **NRPA**'s that need to be sent to the **Registry** must have box checked above.

APPLICANT NAME:	Robert and Nancy King		
APPLICANT ADDRESS:	275 Hartshorn Drive Short Hill, NJ 07078	FAX#:	
E-MAIL ADDRESS: (License will be e-mailed to this address when decision is made)		Email agent	
PROJECT LOCATION:	Brunswick, Cumberland County	PROJECT #	L-26631-4D-C-M L-26631-TW-D-M
APPLICATION TYPE:(Use Site/NRPA or NRPA/SW)		NRPA ATS#:	79713 & 79714
ISSUES/COMMENTS:			
ACCEPT DATE:	September 14, 2015		
AGENT NAME:	LeBlanc Associates, Inc. Attn: Joseph LeBlanc		
AGENT ADDRESS:	67 Dipper Cove Road Orr's Island, ME 04066	FAX#	
E-MAIL ADDRESS: (License will be e-mailed to this address when decision is made)		leblancjd@comcast.net	

Final copies of NRPA's orders go automatically to the **Town & IFW.** List others to receive a copy here:

ABSTRACT (Please note if CZM & follow sample format below, then delete sample

- *Robert and Nancy King (Brunswick) (approval):* In Department Order #L-26631-4D-C-M/L-26631-TW-D-M, the Department approved changes to a previously approved shoreline stabilization project to eliminate the creation of a fringe marsh in front of the riprap and instead place soil material, Fortrac 3D matting, and native seed mixture to stabilize the slope. The project is located off Simpson Point Road in the Town of Brunswick. *(Cherry)*

REVIEWED BY	SIGNATURE	OK DATE
ENFORCEMENT STAFF (if enforcement involved):		
REGIONAL SUPER:		**10.23.15**
Ret'd to PROJ. MGR:		
LIC / COMPLIANCE Coordinator:		**10/26/15**

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

PAUL R. LEPAGE
GOVERNOR

AVERY T. DAY
ACTING COMMISSIONER

October 2015

Robert and Nancy King
275 Hartshorn Drive
Short Hills, NJ 07078

RE: Natural Resource Protection Act Minor Revision Application, Brunswick
DEP #L-26631-4D-C-M/L-26631-TW-D-M

Dear Mr. and Mrs. King:

Please find enclosed a signed copy of your Department of Environmental Protection land use permit. You will note that the permit includes a description of your project, findings of fact that relate to the approval criteria the Department used in evaluating your project, and conditions that are based on those findings and the particulars of your project. Please take several moments to read your permit carefully, paying particular attention to the conditions of the approval. The Department reviews every application thoroughly and strives to formulate reasonable conditions of approval within the context of the Department's environmental laws. You will also find attached some materials that describe the Department's appeal procedures for your information.

If you have any questions about the permit or thoughts on how the Department processed this application please get in touch with me directly. I can be reached at (207) 523-9807 or at david.cherry@maine.gov .

Sincerely,

David Cherry, Project Manager
Bureau of Land Resources

pc: File

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web site: www.maine.gov/dep

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION
17 STATE HOUSE STATION AUGUSTA, MAINE 04333-0017

DEPARTMENT ORDER

IN THE MATTER OF

ROBERT AND NANCY KING	) NATURAL RESOURCES PROTECTION ACT
Brunswick, Cumberland County	) COASTAL WETLAND ALTERATION
REVISE PROJECT SCOPE	) WATER QUALITY CERTIFICATION
L-26631-4D-C-M (approval)	) MINOR REVISION
L-26631-TW-D-M (approval)	) FINDINGS OF FACT AND ORDER

Pursuant to the provisions of 38 M.R.S.A. Sections 480-A et seq. and Section 401 of the Federal Water Pollution Control Act, the Department of Environmental Protection has considered the application of ROBERT AND NANCY KING with the supportive data, agency review comments, and other related materials on file and FINDS THE FOLLOWING FACTS:

1. PROJECT DESCRIPTION:

A. History: In Department Order #L-26631-4D-A-N/L-26631-TW-B-N, dated June 25, 2015, the Department approved the construction of a 500-linear foot shoreline stabilization project. The project included the alteration of approximately 2,534 square feet of coastal wetland below the Highest Annual Tide (HAT) line. The applicants submitted a payment to the In-Lieu Fee Program on June 30, 2015 for this impact. A component of the project was to construct a fringe marsh in front of the proposed riprap that would have resulted in the alteration of approximately 16,000 to 20,000 square feet of mudflat. The applicants have not started construction of the project approved in Department Order #L-26631-4D-A-N/L-26631-TW-B-N.

B. Summary: The applicants propose to remove the construction of fringe marsh in front of the riprap slope. The applicants state that they have consulted with the U.S. Army Corps of Engineers (Corps) and determined that the approval process for such a project by the Corps would take a significant amount of time. The applicants have proposed to employ a shoreline stabilization system that will consist of armoring 500 linear feet, as originally approved, and place a combination of slope soil material and Fortrac 3D matting with native vegetation to stabilize the slope. This design would allow the soils above the riprap to settle and eventually be deposited into the mudflat below. The proposed project is shown on a plan titled "Exhibit 2A," prepared by LeBlanc Associates, Inc., and dated September 9, 2015. The project is located off Simpson Point Road in the Town of Brunswick.

C. Current use of Site: The project parcel is currently developed with a road.

2. FINDING:

The Maine Department of Marine Resources (DMR) reviewed the proposed project and raised no concerns with the proposed plan. To minimize impacts to shellfish and marine

worm habitat and the surrounding fringe marsh, DMR recommended that construction occur between October and March.

The Maine Geological Survey (MGS) reviewed the proposed project and found that, although the proposed project would not provide the same recharge of soil to the mud flat below the riprap, the combination of preserving the remaining shoreline and the design for material above the riprap would be beneficial in maintaining a natural transfer of sediment from the upland to the marine environment. MGS also recommended the use of native plant seeds rather than lawn seed for the planting of the slope.

The Bureau of Water Quality, Division of Environmental Assessment (DEA) reviewed the proposed project and provided comments regarding the use of the Fortrac 3D mat. DEA questioned whether the additional embankment materials and topsoil over the mat would readily erode with tidal, wave, and storm actions once seeded and established, and whether or not the embankment materials below the mat would eventually be available to contribute to the intertidal mud budget once the overlying materials and topsoil have eroded down slope. Finally, DEA requested information regarding the porosity of the mat relative to the size of the underlying materials.

The applicants provided a response to the review comments outlined above. The applicants have agreed to comply with the work window recommended by DMR and the use of native seed mixture for the slope as recommended by MGS. The applicant also provided a response to the DEA and stated that the Fortrac 3D mat is typically used as a permanent stabilization measure for embankments with minimal concentration of clay soils. The product is designed in varying thicknesses, with a lighter grade of mat being used for the proposed project. The goal of using the lighter grade is to provide stability while allowing the clay particles within the soil to gradually erode from underneath and make their way to the mudflat below as surface runoff.

The applicant has satisfactorily addressed the concerns from the MGS, DEA, and DMR. The proposed change is a minor change that will not significantly affect any issues identified during previous Department reviews of the project site, nor will it include any additional impact on the coastal wetland than what was previously approved in Department Order #L-26631-4D-A-N/L-26631-TW-B-N.

Based on its review of the application, the Department finds the requested minor revision to be in accordance with all relevant Departmental standards. All other findings of fact, conclusions and conditions remain as approved in Department Order #L-26631-4D-A-N/L-26631-TW-B-N.

BASED on the above findings of fact, and subject to the conditions listed below, the Department makes the following conclusions pursuant to 38 M.R.S.A. Sections 480-A et seq. and Section 401 of the Federal Water Pollution Control Act:

A. The proposed activity will not unreasonably interfere with existing scenic, aesthetic, recreational, or navigational uses.

B. The proposed activity will not cause unreasonable erosion of soil or sediment.

C. The proposed activity will not unreasonably inhibit the natural transfer of soil from the terrestrial to the marine or freshwater environment.

D. The proposed activity will not unreasonably harm any significant wildlife habitat, freshwater wetland plant habitat, threatened or endangered plant habitat, aquatic or adjacent upland habitat, travel corridor, freshwater, estuarine, or marine fisheries or other aquatic life.

E. The proposed activity will not unreasonably interfere with the natural flow of any surface or subsurface waters.

F. The proposed activity will not violate any state water quality law including those governing the classifications of the State's waters.

G. The proposed activity will not unreasonably cause or increase the flooding of the alteration area or adjacent properties.

H. The proposed activity is not on or adjacent to a sand dune.

I. The proposed activity is not on an outstanding river segment as noted in 38 M.R.S.A. Section 480-P.

THEREFORE, the Department APPROVES the application of ROBERT AND NANCY KING to revise their shoreline stabilization project as described in Finding 1, SUBJECT TO THE FOLLOWING CONDITIONS and all applicable standards and regulations:

1. The Standard Conditions of Approval, a copy attached.

2. In addition to any specific erosion control measures described in this or previous orders, the applicant shall take all necessary actions to ensure that its activities or those of its agents do not result in noticeable erosion of soils or fugitive dust emissions on the site during the construction and operation of the project covered by this approval.

3. Severability. The invalidity or unenforceability of any provision, or part thereof, of this License shall not affect the remainder of the provision or any other provisions. This License shall be construed and enforced in all respects as if such invalid or unenforceable provision or part thereof had been omitted.

4. All other Findings of Fact, Conclusions and Conditions remain as approved in Department Order #L-26631-4D-A-N/L-26631-TW-B-N.

THIS APPROVAL DOES NOT CONSTITUTE OR SUBSTITUTE FOR ANY OTHER REQUIRED STATE, FEDERAL OR LOCAL APPROVALS NOR DOES IT VERIFY COMPLIANCE WITH ANY APPLICABLE SHORELAND ZONING ORDINANCES.

DONE AND DATED IN AUGUSTA, MAINE, THIS 29TH DAY OF OCTOBER, 2015.

DEPARTMENT OF ENVIRONMENTAL PROTECTION

Filed
OCT 30 2015
State of Maine
Board of Environmental Protection

BY: _____
For: Avery T. Day, Acting Commissioner

PLEASE NOTE ATTACHED SHEET FOR GUIDANCE ON APPEAL PROCEDURES.

DC/L26631CMDM/ATS#79713, 79714

INTERDEPARTMENTAL MEMORANDUM

MAINE GEOLOGICAL SURVEY, DEPARTMENT OF ACF
93 STATE HOUSE STATION, AUGUSTA, ME 04333-0093, (207) 287-2801

DATE: 10/25/16

TO: DAVID CHERRY, ENVIRONMENTAL SPECIALIST, DEP BUREAU OF LAND AND WATER QUALITY, DIVISION OF LAND RESOURCE REGULATION

CC: PETER A. SLOVINSKY, MGS; DENIS-MARC NAULT, DMR

FROM: STEPHEN M. DICKSON, PH.D., MARINE GEOLOGIST

RE: NRPA REVIEW COMMENTS, L-27186-4D-A-M, CAREY BLUFF STABILIZATION, BUNGANUC LANDING, BRUNSWICK, MAINE

After a thorough review of the above project, as presented to us, and consideration of our agency's standards, programs and responsibilities, the following comments are submitted to the Department of Environmental Protection.

We reviewed the application including plans and section details dated July 26, 2016 prepared by Walsh Engineering Associates, Inc. We also reviewed a June 4, 2016 geotechnical report (Coolidge, 2016) by Summit Geoengineering Services. MGS attended a pre-application meeting February 2, 2016 at the DEP office in Portland. I have visited this bluff shoreline several times starting in 1986. A site visit was not made for this review. The reports, prior studies, and images on Google Earth provided sufficient information on recent changes to the shoreline and long-term trends.

The Maine Geological Survey has had considerable experience with unstable coastal bluffs and landslides along the Maine coast that occur in the muddy Presumpscot Formation (Bryant et al., 2002; Dickson, 2001; Dickson and Johnston, 2015; Thompson, 2015; Weddle, 1999). Thick silt and clay sediment of this formation is present at this location (Weddle, 2002). Landslides have been documented here back to 1952 and before the area was developed (Weddle and Berry, 2004). Geotechnical characteristics of were examined by Amos and Sandford (1987). Bunganuc Bluff has also been the site of multiple scientific investigations that have led to a better understanding of coastal erosion and landslide hazards (*e.g.* Amos and Sandford, 1987; Hay, 1988; Smith, 1980; Novak, 1990; Weddle and Berry, 2004; Whiteman et al., 2016). This area has been identified for over 25 (Novak, 1990) years as a landslide hazard area and is illustrated on a maps by the Maine Geological Survey (Dickson, 2001).

Sediment Budgets and Buff Erosion

Retreat of shorelines along coastal bluffs is episodic. As a consequence of discrete slope failures, sediment is introduced from the upland to the intertidal zone at an irregular rate. Both slumps on a bluff face and larger, more deeply-seated, landslides add sediment to the intertidal zone over time. This sediment released from the embankment contributes to the sediment budget of mud flats, salt marshes, and even subtidal environments of adjacent bays and estuaries.

At Bunganuc Bluff, the geomorphology of the shoreline recession has been relatively linear along the shore despite periodic slope failures at discrete locations (Dickson and Johnston, 2015). Sediment is deposited at the base of the bluff in the form of lobate mud deposits or small patches of soil. Some

sediment blocks appear to have moved out beyond the toe of the slope and been deposited on tidal flats seaward of the bluff (Weddle and Berry, 2004; Whitman et al., 2016). More resistant and larger deposits can become colonized by salt marsh vegetation and create a protective terrace at the base of the slope. These deposits act to reduce toe erosion and temporarily reduce land loss.

Over time, sediment from the bluff is reworked by waves, tides, and ice. Redistribution of this sediment results in broad intertidal mud flats and shallow subtidal bays. This flat surface provides a shallow slope across which both fair-weather and storm waves are dissipated. In general, the higher the intertidal flat, the more wave dissipation there is farther from the base of a coastal bluff. So sediment supplied to intertidal flats from an eroding bluff helps reduce bluff erosion from wave action over a period of decades or perhaps longer. Conversely, reduction in sediment from bluff erosion may lead to deepening of the intertidal zone and greater wave attack on the base of a bluff. Thus cutting off the natural sediment supply has the potential to result in increased shoreline erosion and land loss over time.

Eroded bluff sediment helps maintain the elevation of nearby salt marshes and mud flats. The historical rate of sea-level rise in this region has been about an inch per decade (Zervas, 2009). Salt marshes and mud flats rely on sediment from bluff erosion to maintain their elevation relative to sea level. Since the early 1900s, sea level in this bay has risen about 7 inches so about 7 vertical inches of mud (and organic matter) from bluffs and rivers entering the bay would have been necessary to maintain the same acreage of mud flats and salt marshes. Cutting off the natural sediment supply has the potential to result in reduced acreage of flats and salt marshes over time.

Elimination of sediment release from a bluff as a result of shoreline stabilization will have the effect of reducing input to the local sediment budget of mud flats and salt marshes. Since the goal of stabilization is to be permanent, the impact on the sediment budget is ongoing from years to decades. The longer stabilization is in place, the greater the net loss of sediment to the intertidal zone. Shoreline stabilization permanently reduces the supply of sediment from the land to the sea.

Our knowledge of coastal processes helps to qualitatively understand the impact of permanent shoreline stabilization of coastal bluffs. Direct impacts to the intertidal zone are harder to quantify. One approach is to estimate the rate of sediment supplied from bluff erosion at a particular location in order to estimate the volume loss to the intertidal zone over time.

Bunganuc Bluff Sediment Budget

Because land movements are episodic, a time span of many years is needed to calculate an average annual erosion rate. We estimate that the top of the bluff retreated about 25 feet from 1998 to 2015 using historical images in Google Earth along a transect seaward of the house (Figure 1). This included a period of stability from 1998 to 2003 at the transect while there were slope failures to the west and east (Figure 2). Around the year 2012 there was a landslide on the transect (Figure 3). By 2014 there was a salt marsh established in the high intertidal zone on the slumped sediment (Figure 4). The average retreat rate from 1998 to 2015 was about 1.5 feet per year at the top of the bluff. Smith (1990) also calculated a rate of Bunganuc Bluff erosion from the base of the slope to be 1.5 feet per year between 1940 and 1986.

The March 2016 slope failure described in the permit application happened along this transect. This slump resulted in an additional 20 to 25 feet of bluff retreat at the top of the slope (Attachment 1; Sheet C1.0). Using this additional land loss of 20 feet, the average bluff retreat rate from 1998 to 2016 was about 2.5 feet per year at this one more localized section.

A simple estimate of the surface area of the bluff can be calculated from the measurements in the application. The erodible bluff height is about 35 feet on average (40 feet – 5 feet NAVD88; Attachment 1 and Sheet C2.0). Using a 2:1 slope as an average (Attachment 1 suggest slopes vary from 1:1 to 3:1) allows the approximation of a sloped surface length of 78 feet. Using the project plans (Sheet C2.0), the length of the shoreline to be stabilized is approximately 350 feet. The bluff surface area is about 27,300 square feet.

Using an average annual retreat rate of 1.5 feet per year, the sediment volume eliminated by this project is approximately 46,800 cubic feet per year. With a higher erosion rate of 2.5 feet per year, the reduction is 68,250 cubic feet per year. This is a range of 1,500 to 2,500 cubic yards per year or a middle value of about 2,000 cubic yards per year. The proposed project might result in a sediment reduction to the intertidal zone of about 20,000 cubic yards per decade.

Intertidal Sediment Budget

In a three-year study of Bunganuc Bluff and adjacent tidal flats, Smith (1990) found a negative sediment flux from land to the sea of -9.6 yd^3 per year / yard of shoreline length (-8 $m^3/m*yr$; Smith's Table 21). This condition suggests that sediment release is important to maintain the elevation of the adjacent tidal flat. A negative flux would result in tidal flat erosion if mud were not supplied from another area (Smith, 1990, p.207). It is not clear in the study by Smith if there was a landslide during the three years of investigation. Episodic sediment release via a landslide could have resulted in a more positive sediment budget than was reported in the 3-year investigation.

In order to estimate the impact to the intertidal zone, the area of the intertidal surface seaward of the property must be calculated. A simple 350 feet (117 yards) of frontage at the high tide line was used for the shore-parallel length of the intertidal zone. The distance offshore of the intertidal zone was estimated to be on the order of 500 yards using Nautical Chart 13290, the relative position of Bunganuc Rock, and Google Earth (Figure 5). The intertidal area by this estimate is 58,500 square yards.

The potential reduction in sedimentation rate is 2,000 yd^3 per year / 58,500 yd^2 or 1.2 inches per year. To put this number in context, the historical rate of sea-level rise from 1912 to 2015 was about 7 inches (NOAA, 2016) so *conceptually* the bluff supplied sufficient sediment to maintain the elevation and area of the tidal flat during sea-level rise *and* export mud to other parts of Maquoit Bay.

Maquoit Bay Sediment Budget

On a time scale of centuries and longer, Hay (1988) determined that Maquoit Bay was likely to have exported mud to outer Casco Bay. This study, however, examined periods of time over the last few thousand years when the rate of relative sea-level rise was lower than present – conditions under which it would have been easier to export mud from Maquoit Bay due to a reduced sediment accumulation rate on mud flats.

Not all shorelines in Maquoit Bay are eroding sediment nor are many as high as Bunganuc Bluff, so the "surplus sediment" from Bunganuc Bluff is likely to have been redistributed across a much wider area of Maquoit Bay (and perhaps beyond) to deposit sediment onto other intertidal and subtidal flats during the last century of sea level rise.

Sediment released from Bunganuc Bluff to Maquoit Bay has likely helped to maintain intertidal mudflats and likely subtidal environments of inner Casco Bay for as long as the bluff has existed. The estimated rate of sediment released to the marine environment at this project site is on the order of 2,000 cubic yards

of mud per year. The proposed shoreline stabilization would eliminate that sediment release for the foreseeable future.

Based on this analysis and those by Hay (1988) and Smith (1990) the impact of this project on the intertidal sediment budget is difficult to quantify. If there is an ongoing surplus of mud from other eroding shorelines in Maquoit Bay, then the impact should be lessened. If other shorelines are similarly engineered to prevent erosion, then the cumulative sediment deficit for the Bunganuc flats and others in the bay may, over time and with continuing sea-level rise, result in a reduction in the area of tidal flats and lower sedimentation rates on salt marshes.

Shoreline Change

As described above, the rate of shoreline recession at Bunganuc Bluff has been about 1.5 feet per year on average over the last several decades. This average rate can be expected to continue for the next several decades. If the rate of sea level rise increases, then the rate of bluff erosion may also increase. Sea-level rise over the next several decades is not expected to decline nor be less than that of the 20th century. Consequently, shoreline retreat is expected to continue along all of Bunganuc Bluff for the foreseeable future.

Stabilization at this project site is intended to eliminate shoreline recession. The design of the structure takes into consideration our concerns about end-effect erosion that MGS provided at the pre-application meeting in June. At the eastern end, the structure connects with existing riprap. At the western end the structure ends before the property line. This termination on the applicant's property is tapered and may reduce end-effect erosion. In our opinion, the end-effect cannot be totally eliminated from such a dynamic shoreline with both ongoing wave action and shoreline recession. If erosion were to become significant adjacent to the structure, it may be necessary to take remedial action at some future time.

We expect the shorelines to the west of the project site to recede at the historical rate. If recession continues along this adjacent natural bluff shoreline, then the proposed structure may become outflanked in the future. If this were to happen, then the structure itself may become less stable and land loss could occur behind the western termination of the structure. If no additional measures are taken such as addition of compatible sediment to offset erosion or the addition of more riprap, the engineering structure will act like a bedrock headland and wave attack on the adjacent natural shoreline may increase and result in an increased erosion rate. At some future time, end-effect erosion might lead to additional shoreline engineering west of the project site.

Geotechnical Properties

The geotechnical report (Coolidge, 2016) analyzed the subsurface geology and geotechnical properties of the upland adjacent to and at the base of the coastal bluff. We are not engineers, so our review comments are based on our geological understanding and experience with the Presumpscot Formation clays and coastal erosion in Maine.

The geotechnical report identifies layers in the Presumpscot Formation with differing strengths. Here, as well as nearby (Amos and Sandford, 1987), the weakest, most fluid sediment occurs at depth and is the zone where failures occur beneath and adjacent to unconfined bluffs. Borings confirmed the presence of the Presumpscot Formation to depths below the toe of the bluff and the HAT. The report modeled slope stability with conditions representing before construction of the proposed bluff stabilization. Without stabilization, landslides can be expected to continue at this site due to structural weakness in the subsurface geology, a high water table, and coastal erosion at the base of the slope.

Stability During and After Construction

The geotechnical report (Coolidge, 2016) mentions that there might be instability during or after construction and that monitoring should be done. Post-project monitoring might also be important to identify unsatisfactory slope performance (USACE, 2003). If there is a slope failure during or after construction that results in boulders, smaller rocks, and geotextiles slumping onto the intertidal zone, how will this be addressed or mitigated? A landslide on the current shoreline is a natural process of transferring fine-grained sediment to the adjacent flats and Casco Bay. A post-project landslide could also transfer geotextiles and rocks to the intertidal zone. If there is a landslide or structural failure during or after construction, remediation and its impact on the intertidal zone should be considered.

Excavation for Riprap Footing

The excavation for the riprap footing is proposed to be *seaward* of the highest annual tide (HAT; C1.0, C2.0, 2.1, 2.2). Construction of the trench in this location also results in rocks placed about +/- 2 feet from elevation 0 NAVD88 or approximately mean tide level and deeper. We are not sure if there is any regulatory significance to this depth of excavation.

Alternatives

Alternatives 1 and 3 place riprap around the toe of the 2016 landslide. This protrusion in the hardend shoreline is likely to result in irregular scour of the intertidal zone due to wave refraction and reflection across the mud flat. The depth of scour is difficult to predict but erosion of the flats to a lower level may also result in irregular wave attack on the structure itself and lead to increased wave forces on and reflected by parts of the structure. From a geological perspective, these are not preferred alternatives.

Alternatives 2 and 4 have a more linear riprap shoreline than Alternatives 1 and 3. This is a more favorable configuration in terms of impacts of wave reflection on the intertidal zone. We concur with the conclusion in the application materials, that the toe of the 2016 landslide will gradually be eroded and contribute sediment to the adjacent flats and benefit the sediment budget – just as it would if the shoreline were to remain natural.

Alternative 4 is farther landward and has less of physical footprint on the tidal flat. Alternative 4 is likely to have reduced wave reflection reaching the patches of salt marsh illustrated on the plans than Alternative 2. As described above, these patches of marsh tend to form on landslide sediment and gradually erode by wave action from the bay. It is difficult to quantify if wave reflection off the riprap will hasten erosion of the marsh areas but qualitatively, riprap should have more wave reflection and scour than the natural shoreline.

Alternative 4 includes turf reinforcement mat (TRM) from 15 feet NAVD88 up to the flood elevation of 19 feet as indicated by the preliminary Flood Insurance Rate Map as the 100-year base flood elevation. Use of TRM also minimizes the weight of riprap at the base of the slope and may absorb more floodwater or splashover during storms.

Alternative 4 includes drainage to reduce erosion from groundwater and surface water. This drainage is important to increase the slope stability above the riprap. Groundwater is present up the bluff to about 10 feet below the top of the embankment (Amos and Sandford, 1987; Coolidge, 2016) that weakens the clay and silt below. The inclusion of these structural additions to Alternative 1 improves the stability of the slope and probably the integrity of the riprap over time. This alternative seems to be the best choice

presented for slope stabilization with the least physical impact (3,600 square feet) below the highest annual tide.

Alternative 4 does not state why it is not feasible to create a 4:1 slope farther north and starting closer to the HAT with less area of the tidal flat impacted. The area east of the 2016 landslide sediment it appears from Sections C.5, D, E, and E.5 that the top of the bank might be cut back an additional 15 feet and perhaps some trees would be cut.

It would be a more complete analysis if there was an explanation of the sediment volumes redistributed within the project area and the amount to be removed from the property. If there is a sediment surplus, perhaps some of it could be placed above the HAT on the toe of the 2006 landslide. Some such arrangement might allow more bluff sediment to reach the intertidal zone over time – as it would if the project were not constructed.

Living Shoreline Alternative

A living shoreline was not presented as an alternative in the permit application. Construction of a fringing salt marsh at the base of the slope would mimic natural process of slumps becoming salt marsh terraces (Figure 4; Sheet C2.0; Jones Associates, 2016). These marsh platforms have persisted for years to decades. Because they are raised in elevation relative to the adjacent mud flat and have salt marsh cord grass (*Spartina patens*) to both hold and trap sediment, they dissipate wave energy at the toe of the bluff better than an unvegetated tidal flat.

A fringing salt marsh at this location could slow the loss of sediment and help protect the base of the slope from erosion. At this site, a living shoreline would be sacrificial and likely need maintenance on decadal scale in order to keep protecting the base of the bluff. In our opinion, this alternative might delay, but by itself will not prevent, landslides at this location since a marsh will not provide the buttressing counter forces to inhibit deep-seated rotational earth movements (Figure 6) described by Coolidge (2016).

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Figure 1. Shoreline change at Bunganuc Bluff seaward of the Carey residence. Each pin shows the location of the top of the bluff in different years. The bluff retreated 25 feet from 1998 to 2015 for an erosion rate of about 1.5 feet per year.

Figure 2. This December 31, 2002 photo shows the same pins as in Figure 1. From 1998 to the date of the photo there is very little retreat of the top of the bluff where the pins are located. Exposed sediment on the bluff face on the left and right sides of the photo are from slope failures that have removed vegetation. Note there are fallen trees at the base of the bluff but no patches of fringing salt marsh.

Figure 3. This September 18, 2013 image also shows the same two pins as in Figures 1 and 2 for reference. A landslide next to the 1998 pin shows vegetation and sediment slumped seaward of the base of the former bluff toe. The slump resulted in the headwall retreating 10 feet or more toward the house. The tide is relatively high and covers a fringing salt marsh seaward of the slump.

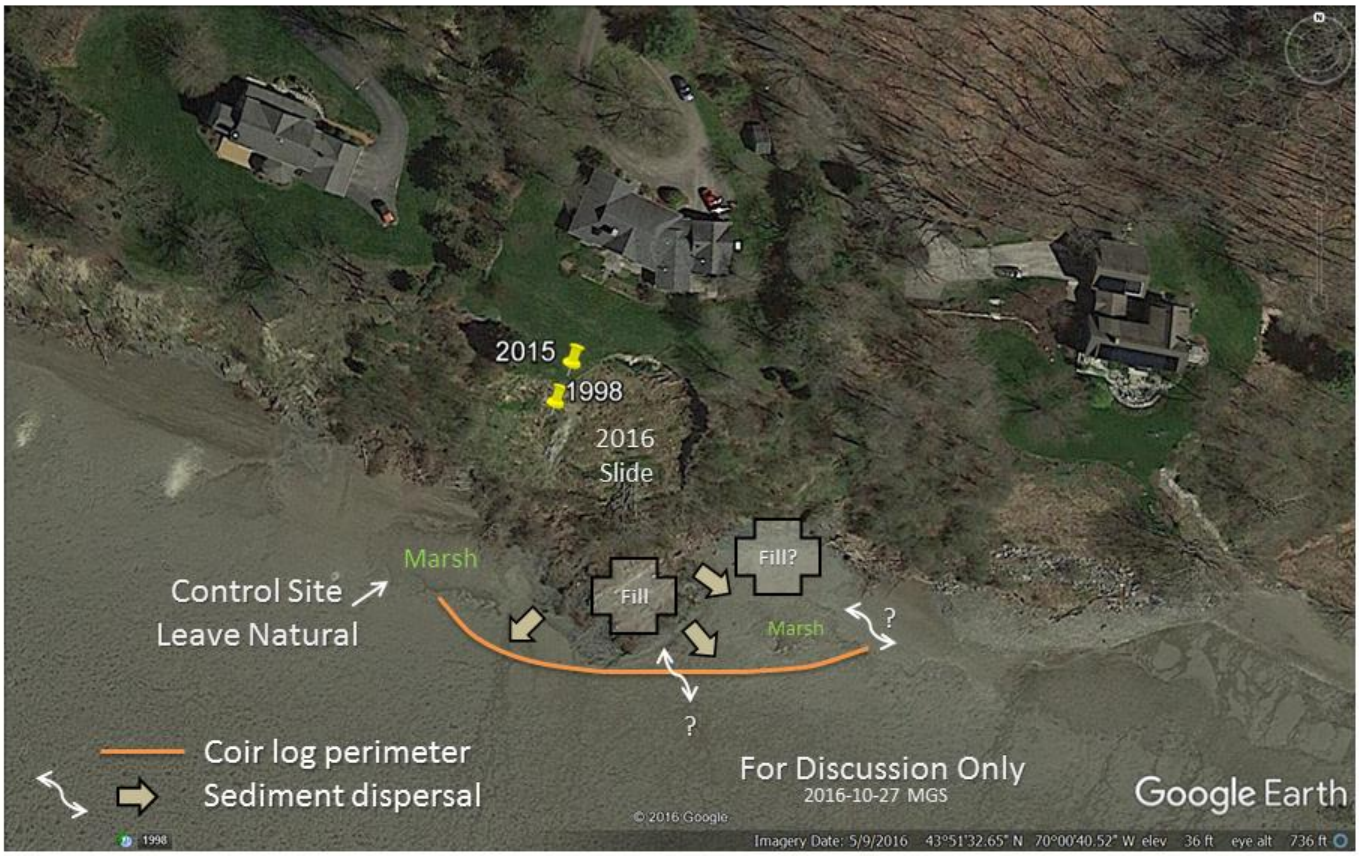
Figure 4. By September 27, 2014 the landslide area was grown in with vegetation and the toe area with trees still forming a protrusion along the shoreline. A fringing salt marsh is visible in the high intertidal zone and the tide is out. The March 2016 landslide has not yet occurred.

Figure 5. A shore-perpendicular transect 500 yards long is illustrated with the yellow line used to estimate an intertidal sediment budget. For reference, Bunganuc Rock is visible about 200 yards south of the end of the yellow line.

Figure 6. An oblique aerial photograph of the March 2016 landslide at Bunganuc Bluff. The slope failed east of the 2013 landslide shown in Figure 3. June 30, 2016 photo courtesy of Rick Harbison, GPCOG.

Bunganuc Bluff Living Shoreline Concept Sketch

Surplus bank mud from grading placed over slide as fill above HAT or at base of slope below HAT
Natural dispersal of landslide toe and fill is impounded (?) behind coir log sill
Sediment accumulation and sill may favor salt marsh formation along toe of bank / riprap



INTERDEPARTMENTAL MEMORANDUM

MAINE GEOLOGICAL SURVEY, DEPARTMENT OF ACF
93 STATE HOUSE STATION, AUGUSTA, ME 04333-0093, (207) 287-2801

DATE: 6/15/16

TO: LYNN CARON, ENVIRONMENTAL SPECIALIST, DEP BUREAU OF LAND AND WATER QUALITY, DIVISION OF LAND RESOURCE REGULATION

CC: PETER A. SLOVINSKY, MGS

FROM: STEPHEN M. DICKSON, PH.D., MARINE GEOLOGIST

RE: NRPA REVIEW COMMENTS, L-26861-TW-B-N, SITE REMEDIATION, 135 MAIN ST, TOWN OF LUBEC, LUBEC, MAINE

After a thorough review of the above report, as presented to us, and consideration of our agency's standards, programs and responsibilities, the following comments are submitted to the Department of Environmental Protection.

The Maine Geological Survey reviewed the application materials provided as well as a time series of air photographs at the former Columbian Factory site at 135 Main Street and on Johnson Bay in Lubec. We examined water levels reached by the 2015 highest annual tide (HAT), storm surges of 1, 2, 3.3, and 6 feet as well as Categories 1-4 of hurricanes (using the MGS Coastal Hazards web site) in relation to the project plans and new location of the historic building.

- Relocation of the building north on the lot does not increase its vulnerability to storm flooding. In the new location the building setback will be about 40 feet from the HAT, about the same as the current setback. Hazards mapping (mentioned above) does not project that a storm surge of 6 feet on top of the HAT or that a hurricane surge would reach the proposed building footprint. As shown in the plans, the 1% flood event does not reach the site either.
- The relocated building will not be behind the engineered shoreline but rather sited landward of a natural coastal bluff. While we do not have an erosion rate of the bluff, given experience with other bluffs and this type of location in a bay with bedrock outcrops in the intertidal zone, it seems likely that the current rate of erosion of the embankment is less than a foot per year. Since the building can be moved if threatened by future erosion, the proposed site seems suitable in terms of erosion risk.
- Demolition of the former factory will result in some re-use of the building and its foundation for "back fill" beneath a slope that will be covered with a geotextile, soil, and revegetated. Some of the high intertidal zone and bluff embankment will be buried where the structure has already collapsed. As a result, the HAT will shift seaward and slightly protrude onto the intertidal zone. The northeastern end

of the structure matches in well with elevation contours and is not likely to induce different wave action on the adjacent shoreline.

- The southwestern termination of the structure juts out onto the intertidal zone and has a more pronounced influence on the offset of the high intertidal contours compared to the shoreline on the rest of the property. However, this offset mostly exists in the pre-project conditions due to the presence of the original foundation and a nearby square cement structure out on the intertidal zone. The mid-tide to low-tide contours are likely to remain the same after the project is constructed.
- Rip-rap and cobble is proposed to be placed below the highest annual tide – within a coastal wetland - which is referenced as 12.9 ft in the application and on submitted plans. As described in the application, this will result in approximately 1,750 square feet of fill below the HAT.
- The primary difference with the project design is that the tides have been able to flow beneath the dilapidated building whereas after the project the tides will not. Consequently, the new structure will be more reflective of wave energy than in the pre-existing condition.
- It is possible that the proposed structure may induce end-effect scour that may affect Lot 19. End-effect scour may also result in reworking of the cobble beach nourishment to the southwest. If this transport occurs, it may minimize scour induced by the end-effect.
- Over time it may be necessary to reintroduce cobbles if maintaining the original project dimensions are desired. Maintaining a cobble apron might be a condition of the permit in order to minimize the end effect, prevent exposure of buried demolition materials, and minimize the potential for scour on the abutting shoreline if it occurs.
- Plans should be revised to include details on proposed vegetative plantings, which are described in the application materials, but not included in submitted plans.
- The use of a cobble toe structure is geologically better than constructing a solid rock structure. The ability of cobbles to shift and move with tidal and wave action reduces the wave reflection and scour that would come off a hard riprap or seawall structure.
