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DEPARTMENT OF CONSERVATION
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August 17, 2007

Donald Wadleigh
FEMA

RE: Camp Ellis dune reconstruction

Dear Mr. Wadleigh,

The information provided in this letter is intended to suggest a conceptual design for dune construction along and on Surf Street in Saco, Maine for a distance of approximately 1000 feet from the vicinity of Island View Avenue to Sunrise Avenue (Figure 1). This summary is provided at the request of FEMA and the City of Saco in order to evaluate mitigation options for shoreline erosion caused by the 2007 Patriots' Day Storm in April. Coastal geologists at the Maine Geological Survey prepared this concept. Please note that the development of this concept into a construction design requires the expertise of a coastal engineer; the Maine Geological Survey does not have this expertise.

Historical Erosion at Ferry Beach and Camp Ellis

Erosion along this shoreline is chronic and has averaged 2 to 3 feet per year over the last 100 years and recently has accelerated to closer to 10 feet per year along Ferry Beach as a result of several severe storms since 2004. Due to the high-energy shoreline environment and coastal currents (influenced in part by the jetty and in part by offshore islands), sand is exported from this shoreline area and the natural process of beach and dune restoration during the summer months is abbreviated. Hence erosion has continued to lower the beach, remove part of the frontal dune, and allow waves to damage Surf Street and rearrange riprap adjacent to the road. The severity of recent erosion rates has profound implications for the design lifetime and functionality of any shoreline project in this area.

Longevity of Camp Ellis Beach Nourishment

Past experience with beach nourishment with sand from the Saco River at Camp Ellis to the south has shown that 80,000 cubic yards or more of sand is reworked immediately over the beach profile away from the high intertidal zone (wet beach) when it is emplaced seaward of the riprap and adjacent to the jetty.

Longevity of Ferry Beach Nourishment

Given the highly erosive nature of the beach and shoreline at Camp Ellis and part of Ferry Beach, any sand placed on the beach profile or near the current high tide line will be eroded and spread across the intertidal and subtidal beach profile in a matter of days to weeks. Over a period of months, sand will be transported in the longshore drift to the north.

Sacrificial Dune Construction

Sand built into the form of a dune ridge must also be considered sacrificial and not a permanent solution to the large-scale erosion taking place along the Camp Ellis and Ferry Beach shorelines.

Winter storms can be expected to reach the dune and result in partial or total loss – perhaps in a single winter season. The loss of the dune, however, will provide some protection to roads, infrastructure, and structures on the landward side. Due to a limited lifetime of the dune, repeated dune restoration should be anticipated.

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Dune Construction Seaward of Surf Street

Due to the high wave energy environment, coastal currents, a low beach profile, and the presence of wave-reflecting riprap, we do not expect a dune to survive seaward of the Surf Street riprap. Any small volumes of sand (perhaps under 100,000 cubic yards) placed seaward of the riprap would be considered beach nourishment and should be expected to have a longevity of less than a year and only offer limited wave and flood protection to Surf Street, infrastructure, and adjacent development.

Dune Enlargement – Island View to Eagle Avenue

Our recommendation is to construct an artificial dune that connects with the natural dunes north of Island View Avenue, perhaps tying into or leading to an area of dune restoration being considered north of Island View Avenue by several property owners. This connection would increase the integrity of the dune ridge and provide some form and function of a natural dune during storms.

Surf Street Dune and Beach Nourishment – Eagle Avenue South

To the south, the dune must be placed on Surf Street due to the steep riprap seaward of the road and location of the high-tide line. From the north, the dune should taper on its seaward side to merge with the riprap slope using some of the sand as beach nourishment on the upper beach profile. The seaward project limit would be on the beach and might extend to 0 or 1 ft NAVD in order to mimic the natural rise in beach elevations to the seaward dune edge and to tie in the new elevation contours with those of the lower beach profile. Full nourishment of the beach profile would require much larger volumes of sand and has not been considered.

Dune Ridge Elevation and Width

The dune ridge crest elevation should be on the order of 16 feet NAVD to mimic past frontal dune ridge elevations. The historic ridge crest elevation was produced by wave run-up and is a good proxy for how high wave action and flooding may become in large storms. The ridge crest should be designed to be approximately 10 feet wide in order to contain a small volume of sand to absorb wave run-up and scour during storm high tides. (See following discussion of FEMA flood hazard elevations.)

Sand Volume Estimate for the Artificial Dunes and Beach

A general estimate of the sand volume for dune construction and minor beach nourishment at the toe of the dune was made by the Maine Geological Survey for the purpose of providing a general understanding of the scope of a project that might be considered for Ferry Beach and Surf Street. Construction of a dune to 16 feet NAVD in elevation and with a crest of approximately 10 feet in width may require on the order of 100,000 cubic yards of sand.

Sand Grain Size Characteristics

Longevity and retention of sand is due, in part, to the grain size present in the surf zone or blown by wind. Dunes tend to be finer grained than the beach face since wind acts to transport sand onto the dune ridge in addition to occasional wave action. Beach grain sizes in the vicinity of Surf Street have been measured in several past studies (including the Woods Hole Group in 2006 for the US Army Corps of Engineers) and at Camp Ellis in 2003 the beach had a median diameter of 1.4 millimeters (very coarse sand; Modified Wentworth Scale). Other samples taken by Barber (1995) on the upper beach profile and berm at Ferry Beach had a median grain size of 0.4 to 0.5 mm (medium sand), significantly finer than that in the 2006 WHG study.

MGS recommends careful sampling of grain size in and around the project area. Median sand grain size should meet or slightly exceed that found on the beach for all aspects of the project. A larger grain size may slightly improve project longevity. If sand is derived from a borrow pit, additional volumes may be needed and could be calculated based on a comparison of grain size characteristics of the beach and the imported sand. A more deliberate analysis and calculation is necessary before a final project sand volume can be accurately estimated.

Existing Site Conditions are Needed

The estimate for our recommendation is not made with current land elevations or beach topography – much of which changed drastically in the Patriots' Day Storm this year. The estimate relied on 2004 LIDAR dune topography (Figure 2) and beach slopes at the north end of the project area that have migrated landward on the order of 40 feet since 2004 and based on an RTK-GPS dune-edge survey MGS conducted in May 2007 after the storm. We understand that the City of Saco is planning to collect current elevations shortly, which can be used by a coastal engineer to further refine the sand volume estimate.

FEMA Flood Hazard Area Elevations

The FEMA Flood Insurance Rate Map elevations for the V-zone flood hazard area for this section of shoreline have elevations of 10 and 12 feet NAVD. These heights for 100-year storm surf zone are unrealistically too low given recent experience with the Patriots' Day Storm as well as the existing land elevations and location of the mapped landward boundary of the V-zone (Figure 3). We do not recommend designing a dune crest that corresponds with these low base flood elevations. In fact some of the existing land surface is higher than this and has provided insufficient protection.

Consideration of a Geotube Core

A geotube core (perhaps 3 feet in diameter) completely buried within the dune could be considered in a project design. The tube would be considered a structure under state regulations (Coastal Sand Dune Rules, Ch. 355 of the Natural Resources Protection Act) and consultation with the Maine Department of Environmental Protection is recommended to see if such a structure could be emplaced for a period of more than 7 months per year.

This geotube might act as a final defense against erosion during a storm, as it would be exposed only after most of the dune has already been sacrificed to storm waves. If a geotube is used, every time it is exposed (perhaps after a storm) it would need to be reburied with sand to restore some of the natural function of the dune ridge and to prevent sunlight degradation of the tube itself. We do not recommend a geotube core for dune reconstruction seaward of our recommended location on Surf Street. A geotube in a more seaward position will be exposed by waves almost immediately, degrade under sunlight, and afford little storm protection to landward areas.

A Detailed Design Plan is Needed

We recommend a more detailed topographic and engineering study be undertaken to make estimates of sand volumes and, using published design criteria for severely eroding shorelines, develop a more accurate project design and estimate of sand volumes. Such an undertaking is strongly recommended and beyond the scope of work that the Maine Geological Survey is capable of providing to the City of Saco. MGS recommends that a qualified consultant with experience in the design of beach and dune restoration or construction projects be contracted to help design a detailed project plan.

Potential Sand Sources

Although there are several areas within the Saco River and near shore that might provide dredge spoils for beach nourishment, the slurry nature of sand dredged by suction or hopper methods complicate its placement on the dry portion of the beach. Several gravel pits in the area could provide sand for the dune construction recommended here. We investigated a potential source pit several years ago in Scarborough owned by R.J. Grondin & Sons, Inc. This pit contains sand of suitable grain size and, at the time of our investigation, had enough reserves to meet the volume requirement of this project. The road distance from the pit to Camp Ellis is approximately 18 miles.

Do not hesitate to contact me with questions about this discussion.

Sincerely,

Robert G. Marvinney, Ph.D.
State Geologist and Director

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