

**Memorandum – Coastal Engineering Review
GOGA Stinson Beach Parking Lot Repairs Review (Stinson Beach,
California)
TAR 15458**

14 December 2020

Review Request Summary:

GOGA - Coastal Engineering Review of Parking Lot Repairs Design at Stinson Beach Park

Introduction

Flooding from Easkoot Creek at Stinson Beach Park has caused several instances of damage, including two major events in 2014 and 2018 requiring immediate, temporary engineered repairs. Included in the proposed infrastructure hardening 30% design is a new high flow drainage channel to convey flow more directly to the ocean, a reconfiguration to move parking away from areas most vulnerable to flooding, and creek and floodplain restoration to accommodate flooding and sediment deposition.

Design review of the high flow channel has been requested to review if it will function as intended (i.e., allowing for occasional breakthrough flows through the dunes to the beach), and be constructed in a manner that maximizes the use of natural materials over engineered materials such as riprap or retaining walls. It was also noted that coastal considerations should be taken into account for the review. This memorandum presents a cursory review of the 30% design for this project. It should also be noted that for this review EA was not tasked with nor did the team review calculations or other background design information in detail, but performed a cursory review to assess resiliency and possible erosion considerations for the 30% preliminary design options.

Background

Easkoot Creek drains approximately 1.59 square miles of heavily forested, undeveloped land located within NPS assets. The contours of the watershed are steep and mostly located on the western escarpment of Mt. Tamalpais. This combination of area and rapid elevation change has led to periodic significant flooding impacts when heavy rainfall produces large volumes of stormwater runoff. These rainfall events frequently trigger landslides and other severe erosion events, changing the upstream flood flow in the Parks. The alluvial fan of Easkoot Creek, where the runoff waters spread out and flow rates fall, starts upstream of Stinson Beach Park, and includes a significant portion of both the Park and the developed town of Stinson.

The 2013 flood study theorized that the development of the town and gradual urbanization of the alluvial fan region has led to artificial channelization of Easkoot Creek. This, in turn, has reduced the area of the alluvial fan, meaning the upstream flooding that results from heavy rainfall events is channeled further downstream before it can begin to spread out and thus lose energy. This explanation would explain the periodic severe erosion events that have occurred in recent years and the need for the channel dredging in Easkoot Creek that has followed such rainfall events to regain creek flow capacity. The 2013 flood study also provided the 100-year design storm peak flow magnitude for Easkoot Creek at the project area of 499 cubic feet per second (cfs).

The 2020 30% design provided for review is the third design to be implemented at Stinson Beach Park to address flooding concerns since the 2014 storm event. The previous two designs were also provided and reviewed by the team to develop a better understanding of the physical processes that are driving the

erosion solutions implemented to date for the issue. The review of the two previous projects was also limited to a cursory review of limited design information and photographs.

Observations

Based upon the review of the provided information the EA project team has the following observations, analysis and comments:

2014 Engineered Repair

The 2014 engineered repair was in response to a severe storm associated erosion event. The central parking lot was damaged as the overflow from the Easkoot Creek followed the existing elevation contours across the parking lot and breached the nearby dunes, heading out to the Pacific Ocean. The erosion on the ocean side of the parking lot was severe enough to require closing this section of the lot until the temporary engineered solutions were completed.

Analysis. The westward bend of Easkoot Creek just upstream of the damaged section causes a significant increase in localized flood velocities in this area. The constructed berm is designed to diffuse the flood flow, while the armor installed on the ocean side of the parking lot to prevent further scour are assumed to have reduced storm erosion at this location. The design focused on preventing a repeat of the localized erosion damage during the 2014 event but did not focus on the overall site flooding concerns.

2018 Engineered Repair

The 2018 engineered repair was also in response to a severe storm associated erosion event. The northern parking lot was damaged as the overflow from the Easkoot Creek followed the existing elevation contours across the parking lot and breached the nearby dunes, flowing out to the ocean. This project was considered an emergency stabilization with a design life of 2-3 years and constructed with leftover material from the rebuild of the northern parking lot.

Analysis. This repair was meant to safeguard the recently renovated parking lot and provide some stabilization until a permanent engineered solution could be designed and constructed. The stepped approach to retain upland material and provide for safe access to the beach is expanded upon in the current design efforts. This design did not solve the overall flooding problem because the primary purpose was to provide temporary stability with on-site material. The loose gravel surface was not designed for the flood flows the site can be expected to experience during future flood events.

Current Project 30% Design

Overview. The 30% preliminary design drawings address several project objectives related to flow control and removal of parking from likely flood ways. This design includes the proposed overflow channel between the North and Central Parking Lots and the relocation of Marine Way and the North and Central Parking Lots. The overall design objective addresses hydraulic flooding from Easkoot Creek primarily by providing an engineered overflow spillway and channel to direct floodwaters from the creek directly to the ocean. The design does not appear to take into account sea level rise or associated potential impacts although a report or text document was not provided for review if it exists. The 30% design also provides a listing of several possible stabilization treatment options for the lining of the spillway and channel. The final choice of stabilization treatment will impact the flow conveyance characteristics as well as the appearance of the spillway and channel areas.

Flow Channel. The provided file *Stinson_Channel_items_10132020.pdf* details the drainage channel in plan and profile, along with several options of erosion control surface treatments. The proposed channel includes two 30-inch retaining wall structures, indicated as meandering benches. The first wall is located approximately 5 feet from the peak elevation of the Easkoot Creek which will act to direct the flow to the narrow portions of the drainage channel before the runoff flow would continue toward outfall onto the beach before then flowing to the ocean. In addition, the lower portion of the channel also includes 2-foot high border walls at the edge of the flow channel prior to intersecting with the beach area.

Although the EA team was not provided any design flow calculations for review, based upon the 30% cross-sections, the flow capacity at the narrowest portion of the channel would be a capacity of approximately 95 cfs (cross section of 112 square feet with a 0.75% slope) which represents a carrying capacity of approximately 20% of the 100-year peak discharge identified for Easkoot Creek. This provides a rough estimate for the bank-full capacity, however without design calculations it was beyond the scope of this effort to identify the overflow capacity of the channel. Based upon this cursory review the general alignment for the spillway and drainage channel appears to be sound.

Erosion Control Surface Treatment Options and Wall Structures. The file *Stinson_Channel_items_10132020.pdf* presents 8 different erosion control treatments and 1 retaining wall treatment option. Within the 30% design information provided none of the 8 ground stabilization treatments are compared with one another other. In addition the inclusion of the files *1Biofiltration_Sod_DBC-pic.JPG* and *1Biofiltration_Sod_DBC-pic-proj.jpg* indicates the biofiltration sod is under consideration as the vegetative element for planting within the other treatments or as a stand-alone erosion control element as well.

As a cursory review, these treatment options have been inspected in brief from the perspective of both meeting the natural appearance design objective and also the possible engineering requirements. The table below provides a summary of maximum allowable flow velocity and allowable shear stress (if provided) and general deployment appearance notes for each:

Table 1. Review of Surface Treatment Options

Treatment	Maximum Allowable Velocity	Maximum Allowable Shear	Deployment Appearance Notes
GEORUNNER Surface Flow Mats	2.6 fps	6.1 psi	Grids allow for easy vegetation growth to obscure other structural elements
Scourtop	31 fps	16 psi	Grids allow for easy vegetation growth to obscure other structural elements
Geoweb	30 fps	16 psi	Grids allow for easy vegetation growth to obscure other structural elements
Flexamat (Moz Enterprises)	30 fps	24 psi	All utilize concrete blocks linked together with spacing to provide for some vegetative growth to obscure other structural elements
Flexamat (ASP Enterprises)	30 fps	24 psi	All utilize concrete blocks linked together with spacing to provide for some vegetative growth to obscure other structural elements
Concrete Mats	not provided	24 psi	All utilize concrete blocks linked together with spacing to provide for some vegetative growth to obscure other structural elements
Flexterra	not provided	not provided	All require vegetation as part of the stabilization efforts
InstaTurf	25 fps	12 psi	All require vegetation as part of the stabilization efforts
Biofiltration Sod	not provided	not provided	Vegetative planting

It should be noted that all treatments listed as options once vegetated after deployment would meet the visual objective of a natural appearance. Based on the engineering criteria, the overall recommendation will need to consider the design flows within the channel of the final design. As can be seen from the supplied information, the Georunner surface flow mat installation has a much lower maximum allowable flow velocity and shear force than the other identified alternatives and may not be applicable based upon the final design criteria.

The wall structures incorporated into the 30% design drawings noted above as the meandering bench which will direct flow from Easkoot Creek (30-inch high) under high water conditions and the flow channel bordering walls (2-feet high) were not discussed in any detail within the 30% design. One of the surface treatments listed within the 30% design and assumed to be under consideration for these portions of the project is the Reno Mattress System which in appearance is similar to a rock wall. While this is more natural in appearance than steel or concrete, should NPS wish to move to other options a vegetated structure could be used instead. One example of this type of wall structure material is Econcrete (<https://econcretetech.com/econcrete-bio-active-wall-innovative-green-solution/>). Econcrete can be more expensive than conventional options and should be verified by the design engineer for suitability under the design flood flows, but does provide another alternative NPS could consider.

Sea level Rise and Storm Surge Considerations. The drainage profile within the 30% design places the relocated Marine Way road surface elevation at approximately +18.2 feet NAVD88 while the invert for the flow channel before beginning descent to the beach is approximately +12.0 NAVD88 as it enters the final section of launchable revetment. The indicated grade on the 30% design for the exit to beach is +8.5 NAVD88. In reviewing the NOAA Station 9414290 – San Francisco tidal datums, the current MHHW tidal datum is +5.92 feet NAVD88. Estimates for SLR presented in the [State of California Sea-Level Rise Guidance](#) (2018) following the Medium-High projections with High Emissions indicate a +0.8 foot change by 2030, a +1.9 foot change by 2050, and a +6.9 foot change by 2100, leading to a new MHHW datum of approximately +6.72 feet by 2030, +7.82 feet by 2050, and +12.82 feet by 2100. This is a more conservative estimate than the estimated +1.4 feet of sea level rise by 2100 utilizing the RCP 6.0 projections from the Sea Level Rise and Storm Surge Projections from the National Park Service, dated 2018.

Reviewing the data from the National Data Buoy Center (NDBC) Station 46026 offshore of San Francisco provides a 100-yr offshore wave height of 33.5 feet, which would equate to a wave-induced setup of approximately +3 feet above still water level. Reviewing the various reported sea level rise values from the State of California Sea-Level Rise Guidance, the still water elevation plus wave-induced setup gives an inundation elevation of +12.5 feet in 2030, +13.6 feet in 2050, and +18.6 feet in 2100. Typical wave conditions lead to a wave-induced setup of approximately +1.8 feet in current conditions, leading to wave action occurring up to elevation +11.3 feet (+1.9 feet wave setup) in 2030, elevation +12.6 feet (+2.0 feet wave setup) in 2050, and elevation +15.9 feet (+2.3 feet wave setup) in 2100. All of the elevations in this section are in NAVD88 datum. Refer to the following Table that summarizes average conditions and storm conditions for the various timescales.

Table 2. Sea Level Rise and Storm Surge Water Level Elevations

Year	MHHW Water Elevation	1% Annual Chance Storm Water Elevation	1% Annual Chance Storm Water Elevation Plus Average Wave Runup	1% Annual Chance Storm Water Elevation Plus 1% Annual Chance Wave Runup
Current	5.92 ft	8.7 ft	10.5 ft	11.7 ft
2030	6.72 ft	9.5 ft	11.3 ft	12.5 ft
2050	7.82 ft	10.6 ft	12.6 ft	13.6 ft
2100	12.82 ft	15.6 ft	17.9 ft	18.6 ft

The review of the 30% design in comparison to current expected coastal impacts indicates that the launchable revetement area is in the current 1% annual chance (100-year) wave impact area. Care should be taken to provide design elements in this area to protect against wave impacts if practical for the base foundation. The launchable stone elements if dislodged by wave force can be replaced after events. Looking into the future and taking into account sea level rise and wave runup by 2100, the profile for the 30% indicates that Marine Drive would be just impacted by a 100-year wave height event at that time (18.6 ft vs. 18.2 ft). For this reason, depending upon the NPS defined design life for the flow channel, it is also recommended that the flow channel be designed in a resilient manner for the eventuality of these coastal impacts in addition to the stormwater flow as well. To meet these criteria the foundations of the flow channel could be designed to resist these forces where practical.

It should be noted that the above information and analysis represents a statistical review of the site conditions. It is the responsibility of the project engineer to verify the information presented above is appropriate for the proposed design.

Summary

The 30% design intention of the drainage channel is to allow flood water to overflow Easkoot Creek and drain through the channel to the Pacific Ocean without causing erosive events such as the ones requiring the emergency repairs to infrastructure that occurred during the 2014 and 2018 flood events. It is the intention of NPS to have this work constructed in a manner that maximizes the use of natural materials over engineered materials such as riprap or retaining walls.

A cursory review of the 30% design indicates that the layout of the flow channel appears to be sound, although overall design calculations were not provided or reviewed. A review of the indicated options for erosive surface control of the flood channel is robust and each meets the criteria of a natural appearance once vegetated. The retaining walls for the project could incorporate options of a vegetated structure as well as the stone appearance option provided in the design.

Finally, a review of sea level rise and storm surge indicates the lower reaches of the channel will be exposed to wave impact and considerations for appropriate foundation stabilization should be considered within the final design, depending on the specific design life of the structure.

References

- California Natural Resources Agency and California Ocean Protection Council. 2018. State of California Sea-Level Rise Guidance. http://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A OPC SLR Guidance-rd3.pdf
- ECONcrete. 2020. Bio-Active Wall-innovative green solution. <https://econcretetech.com/econcrete-bio-active-wall-innovative-green-solution/>