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October 23, 2012

Mr. John Vasconcellos
Southeast Regional Manager
The Trustees of Reservations
Westport Field Office
1100A Main Road
Westport, Massachusetts 02790

Re: Evaluation of Proposed Emergency Shore Protection and Proposed Extension of Shore Protection Measures to East and West of the Property.
Schifter Residence
35 Pocha Road Extension
Edgartown, MA

Dear John:

Installation of emergency shore protection measures are underway on the Schifter property (the Site) that have been approved through Emergency Certification by the Edgartown Conservation Commission. You have requested that we evaluate the impact of these measures on the Trustees of Reservations' (TTOR) properties abutting to the east and west of the Site. You have further requested that we evaluate the potential impacts if the shore protection measures are extended to the west and/or to the east of the Schifter property onto the TTOR properties.

This letter-report is a revision of our October 9 Preliminary Report. I have reviewed the engineering plans by Sourati Engineering Group, the report by Sterling Wall, ground and aerial photos, historic aerial photos, and historic shoreline erosion data. Dr. Duncan FitzGerald has critically reviewed and contributed to the analysis. I performed a site inspection on October 12, discussed the setting with TTOR staff (including Chris Kennedy, Will Geresy and Katie O'Donnell), and was provided with additional air photos from October 13 by Sterling Wall.

I have experience with the coir log technology and have worked with both the installer of the proposed system (Netco Management) and the Schifter's coastal geologist, Sterling Wall.

This evaluation is coordinated with Dr. Duncan FitzGerald, Coastal Geologist, Boston University. In addition to beach processes, Dr. FitzGerald has particular expertise in tidal inlet sediment transfers, which is central to understanding the dynamics of this setting.

A. Setting

The Site conditions are accurately described in Sterling Wall's September 21 report. The property is located at the southeast corner of Chappaquiddick Island, which is the eastern end of the south shore of Marthas Vineyard and Chappaquiddick Island and the south end of the eastern shore of Chappaquiddick Island. It is the terminus of two longshore drift systems.

The larger wave and drift system is along the south coast. Marthas Vineyard is connected to Chappaquiddick by Katama Beach, a barrier beach separating Katama Bay from the ocean. While the south shore is generally a continuous sandy beach comprised of eroding glacial outwash and short retreating barrier beaches fronting tidal ponds, Katama Beach is over two miles long and has complex tidal interactions on both sides. This has resulted in a history of ongoing tidal inlet formation, migration, and closure. Presently, there tidal inlet is at Norton's Point, the east end of Katama Beach, which appears to be limiting the longshore drift to the project Site, resulting in the rapid shore retreat. The Site is located on glacial outwash sand bluffs, which extend about 0.7 miles west to the end of Chappaquiddick Island and the Katama inlet. The east boundary of the property is at a transition from glacial outwash to low barrier beach sands. The barrier beach to the east extends north 4.7 miles.

The Site is undergoing short-term shoreline retreat at rates that exceed any in the region. The Schifter property, which appears to have been conservatively constructed several hundred feet from the shoreline based on long-term averages of shoreline retreat, is currently directly threatened from these extreme and ongoing shoreline changes.

A review of the long-term shoreline history of the south-facing shoreline indicates complex inlet changes and complex shifts of both accretion and erosion at the

Site. We have not seen a record of historic retreat comparable to present conditions.

B. Norton Point Inlet Processes

Air photos are available from 1991 to the present. Through the 1990s, Katama Beach did not have any breaks, and a wide barrier beach had accreted along the south coast of Chappaquiddick Island, which was up to 1000 feet wide (up to 500 feet wide at the Site). An inlet broke across the middle of the barrier in 2007, which was up to 3,000 feet wide by 2008. In the past four years, Norton Point, the east end of the Katama barrier beach, accreted eastward 6,000 feet, such that the tidal inlet is adjacent to Chappaquiddick and now only 300 feet wide.

There had been a protective accetionary barrier beach seaward of the Schifter property through 2010 which protected the glacial upland behind it. The barrier has eroded, leading tot he present rapid retreat of the glacial upland that was behind it.

The shoreline west of the Schifter property varies in elevation from 30 to 10 feet high. As this entire section of shoreline retreats one foot, 1,700 cubic yards of sand are released into the nearshore. The eroding property west of the Schifter site is wooded and is also eroding rapidly.   This has led to slumping of trees onto the beach, which form dense tangles of debris on the beach. These tangles play a role in dissipating wave energy and dampening shore erosion in these areas. The bluff line on this property is slightly scalloped, with bays in areas without these tangles.   The Shifter property, although topographically higher than the adjacent property, is not wooded and does not have this localized protection. Air photos show that it is slightly indented compared to the shoreline to the west, which reflected this slightly greater susceptibility to erosion.

The inlet dynamics appear to be strongly influenced by the asymmetry of tidal flow (difference between duration of ebb and flood tide cycles) in Katama Bay, which has tidal connections at both the north and south. While there is a study of tides underway in Katama Bay, I have not yet been able to access this data. This pattern has been described to me by local residents and is consistent with field observations. The dominant easterly flow of ebb currents in theis inlet tidal system interacts with the strong westerly longshore currents and drift on the south side of Katama Beach.

Southern Katama Bay is dominated by sandy intertidal shoals (flood tidal deltas), which are relict from the past generations of tidal inlets on the barrier. However, the present main ebb tidal channel is diverted to a west-east orientation along the inside of the barrier beach. The tidal inlet at the west end of the Bay, adjacent to Chappaquiddick, is also west-east oriented. This deep tidal channel at the inlet is enclosed on the seaward side by an elongated sand bar extending east from Norton Point. This sand bar is being built from the sand moving east along the south shore. This bar plays multiple roles. It will be the platform that the Katama Barrier extends onto as it continues to migrate east. In its present form, it is also a *channel margin linear bar* that contains the inlet flow and holds it against the shore of Chappaquiddick. From the form of the bar, it appears that the flood flow has broken across it in the recent past (a shorter, more efficient route for the ebb flow), but the linear bar remains intact. About 1,500 feet east of the end of Katama Bay, sand from the ebb tidal channel, possibly derived from linear bar, formed an intertidal bar roughly in the middle of the channel which diverts ebb flow into two channel around it. This may cause higher velocities in these smaller channels and does hold part of the ebb flow adjacent the shoreline.

East of the ebb channel intertidal bar, the channel margin linear bar extends about 1,000 feet further east, continuing to hold tidal flow against the shoreline. Beyond this position, the air photo indicates that the deeper ebb channel continues along the shore to the east end of the island, including along the Schifter property. A less distinct linear bar is seaward of this channel.

The Chappaquiddick Island shoreline landward of the channel margin linear bar extending east from Norton Point 1,500 feet is a broad, accretionary beach, while east of this point the rapid erosion dominates.

The present form of the inlet draws strong parallels with the history of Katama Inlets compiled by Ogden (1974) and with the form of the Wasque shoreline from 1991 through 2010.

The Katama Barrier has extended in front of the Wasque region many times. The barrier overlapped the main shoreline diverting the inlet east, comparable to the present form, in 1948 and 1951. The ebb tidal inlet flowed inside this barrier along the all of the Wasque shoreline, in 1776, 1938, 1955, and 1969. Ogden's data suggested an average duration for the tidal inlet to be about 15 years.

Air photos from 1991 through 2010 (Google Earth) show that a broad sandy beach fronted the glacial sands along the south shore of Wasque for this period. However, a long (2,300± ft), narrow (100 – 150 ft), deep (reportedly 8 ft), pond extended between the barrier and the glacial island. This pond was referred to a "The Swan Pond." This unusual pond was likely the relict ebb channel similar to present inlet conditions, and may have formed around 1969, based on Ogden's maps.

Therefore, the Katama/Wasque shoreline has undergone several cycles similar to the present. I don't believe that the inlet will close shortly, as previously suggested, as this barrier repeatedly develops long (nearly a mile) overlaps seaward of the Wasque/Chappaquiddick shoreline prior to closing. However, as the channel margin linear bar and the barrier extend to the east, the Chappaquiddick/Wasque shoreline becomes stable. The historic evidence is that this stable or accreting shoreline remains for several decades and the inlet/erosion cycle repeats following a major inlet breach along the Katama barrier shore to the east.

Presently, the inlet is following the same pattern of overlap. However, in rhw next week, strong swell or hurricane waves are predicted for south-facing coasts. Storm waves will erode significant amounts of sediment carried alongshore, so this event could fill the inlet in a shorter period of time. If the event is less intense, it could extend Norton Point in the easterly direction comparable to past episodes.

C. Proposed Project

The project approved and presently underway is described in the plan, Proposed Plan of Emergency Stabilization System, dated September 21, 2012 by Sourati Engineering Group (The Plan). 20 inch diameter coir logs are being installed in 10 foot segments to protect the eroding coastal bank on the Site. The contractor has reportedly also used larger diameter logs. The logs will have five courses up the face of the bank to a height of 6.3 ft above MHHW. Double logs are being buried 4 feet beneath the toe of the bank to prevent undercutting and support the logs above. The logs are being anchored into the bank with 12 foot duckbill anchors, and anchored downward with 12 foot helical screw anchors. On October 12, a temporary line of logs anchored into the beach were in place and the contractor was beginning excavating and burying the logs at the west end of the site, consistent with the plan. The project is being installed by Netco Management, who has extensive experience at installations similar to this.

The plan shows the project ends at the west boundary of the site, and about 50 feet in from the east boundary of the site.

D. Impacts of the Project

If the coir log system is successfully constructed, it will have an impact on dissipating incoming wave energy on the coastal bank and diminishing or stopping erosion of the bank. The buried toe logs address a frequent reason for failure, which is erosion undercutting beneath the logs leading to collapse and failure of the array. The aggressive anchoring system further diminishes potential for shifting of the logs. This is a short-term measure using natural materials that may last several years.

The susceptibility of this system, like nearly all approaches to bank protection, is end-effects. The boundary between the end of the coir log system and the unprotected bluff will be a focus for wave energy and will undergo accelerated erosion. This is due to several factors, including wave flow diverted along the harder logs onto loose sand causing rapid erosion and wave focus onto the contact point, leading to scour at the end of the logs. This scour causes the unprotected bluff at the boundary to erode many times the ambient erosion rate, and taper off to ambient rates of retreat some distance along the unprotected bluff. The result is a “log-spiral” shaped deep erosional bite at the boundary. Once the end erosion begins, incoming waves become more focused at the end of the structure, increasing scour at that point. As the overall shoreline retreats, the coir structure projects further seaward from the shore, continuing to increase the wave focus and magnitude of erosion.

In addition to the accelerated erosion due to focus of the waves on the end of the structure, once the scour has formed, erosion can continue to erode behind the coir log structure, leading to landward shifting and collapse despite the anchoring system. This zone of failure continues once formed, since wave flow is pushed up the narrow passage behind the logs with no release.

Impacts of this nature are well known and can be addressed by continuing sand nourishment at the point of scour, and/or continuing installation of coir logs against the bank as the scour continues. Both of these actions are appropriate, and may reduce the rate of accelerated shore retreat from end-effects. However, there may be limited success in this high wave energy setting, and the existing banks are densely vegetated at the top and are on the order of 30 foot height. Once lost, they cannot be fully reconstructed in this setting.

If the structure is removed in the future, the shoreline will tend be straighten over time. This may include higher retreat of ambient shorelines flanking the scour zone.

The south-facing setting of the Site is one of the highest wave energy exposures in New England and the present wave impacts on the bluff are extreme, so the end-effects will likely be severe. Most shoreline change takes place during extreme events. This setting is protected from direct impacts from Northeast storms, which increase in frequency in the fall and winter months. However, hurricanes making landfall on southern New England have winds from the south. As well, winter storms throughout the Atlantic increase southerly swell on the south-facing New England shorelines (including the Site), which have increased wave heights and energy, and are associated with increased shore erosion.

While any structure terminus with unlimited exposure to open ocean waves will likely undergo continuing scour and erosion at the end of the structure, most severe erosion takes place during extreme events (storms, southerly swell). The shoreline is presently in a sediment starved situation and retreating rapidly. End-effects will locally be many times this rate, and can become geometrically greater during storms and during fall and winter seasons.

E. Proposed Extension of the Ends of the Structure

We have discussed a proposal to extend the ends of the coir log structure onto the TTOR properties.

<u>West of Site</u>

Based on review of the Plan and air photos, the west end of the structure is most critical. The Plan shows that the proposed structure ends at the property line. This area was reported to be about 60 feet from the existing dwelling. The end effect scour will be on TTOR property and both scour and back-cutting may be on the Schifter property. The boundary line is the terminus point that has least direct impact on the TTOR property. However, the Schifter dwelling is the only structure directly threatened by these impacts, so TTOR may consider an accommodation to reduce the direct threat on the dwelling by granting an easement extending the structure to the west onto TTOR property. In this case, the end effects will likely be the same, but all of the effects will be on TTOR property and the threat to the dwelling will be removed.

Sterling Wall, coastal geologist for Mr. Schifter, has indicated that he would like to extend the coir log system about 70 feet west, where is will interest a dense tangle of trees that are presently dissipating wave energy. I estimated that distance to be 150 feet. I agree with Mr. Wall's plan, as there is nothing to be gained by altering the tangles of trees, and ending at that point will reduce any end effects. Further, I believe that the structure should be extended roughly 100 feet to insure protection of the Schifter dwelling. Since conditions change rapidly, the exact distance would need to be finalized later.

Air photos indicate that the eroding bank on the Schifter property is landward (*i.e.*, retreating faster) than the TTOR properties to the west of the Site. I believe that this is due to the natural forest at the top of the bank and the forest debris at the base of the bank, which is temporarily dissipating wave energy. It appears that the higher erosion on the Site corresponds to removal of the protection of the forest.

This proposed shift in the location of the terminus will have no significant impact on the overall accelerated erosion and scour from the end of the structure. It will shift most of the impact being located on TTOR property to all of the impact.

If TTOR chooses to grant an easement, it should formulate a plan to measure the increased loss of land, and the value for the permanent loss of land. I suggest that the loss of land be measured by comparison of surveys of the terminus area to retreat rates west of the site (for instance, for a distance of 500 feet (at 100 ft intervals) from the terminus to remove natural retreat from accelerated retreat rates) for the duration of the time the structure is in place and for one to two years subsequent to removal of all structures. Frequent monitoring may be necessary during periods of rapid change, but if permanent posts are installed along the shore, retreat can be monitored with a tape to edge of bluff.

East of Site

End scour will also take place at the east end of the structure. However, this accelerated erosion will have fewer immediate impacts on the dwelling. The project plan indicates that the structure end about 50 feet from the property line. As planned, most impact will be on the Schifter property, but there can be impact on the TTOR property. I suggest that surveyed posts be installed in this area also, to document changes due to the structure.

The Site yields approximately 310 cubic yards of sand into the nearshore for each foot of coastal bank that erodes. This volume of sand will be removed from the longshore sediment stream east of the Site as a result of the stabilization project.

Based on vegetation patterns on air photos, the eastern property boundary is near the eastern limit of glacial outwash sands. Barrier beach sands extend the shoreline to the east. The barrier beach appears to be eroding synchronously with adjacent glacial shorelines facing south. This is the end of a continuous barrier beach that extends north, and encloses the east coast of Chappaquiddick Island. In the vicinity of the site, the beach forms is a 350 to 500 foot wide barrier enclosing Pocha Pond. Based on shore ridges and vegetation, this barrier has both accreted and eroded in the past, and the orientation of the shoreline has changed. However, air photos from 1991 to 2012 show only minor changes in this barrier.

Extending the terminus of the structure east to the property boundary or onto TTOR property moves the zone of erosion and loss of property fully onto TTOR property. It increases the slight possibility that barrier erosion will overtop or breach Pocha Pond. While the barrier beach shoreline cannot be restored in the seaward direction, barrier sand can be banked through nourishment, fencing, and vegetation management.

F. Conclusions

If the coir log structure is successfully constructed, it can cause localized erosion at both ends that is many times greater than that of nearby shorelines. This accelerated erosion will be maximum at the structure end, and will decrease with distance from the structure end to a rate consistent with nearby areas. I estimate that the distance of shoreline impacted can be over 50 to 100 feet wide. The end effects can also lead to back-cutting of the structure and partial collapse.

TTOR property west of Schifler will endure most of these impacts under the existing plan, and all of these impacts under a proposed extension of the structure. However, if the structure is not extended to the west, the existing Schifter dwelling will be directly threatened. If the structure is extended west, TTOR must determine the magnitude of increased property loss, which includes both the end scour and the readjustment of the larger shoreline after the structure is removed in the future. Accommodation for this easement and property loss may be in the form of sediment or a property exchange. Regardless, I recommend in this setting that steps should be taken to minimize the loss.

Regardless whether the easements are granted or not, a system for monitoring the local impacts and the larger impacts taking place on the Wasque area should be established. This can include a series of benchmarks or posts from which bluff distance can be measured with a tape, allowing short term monitoring of changes. The Sterling Wall report indicated that the structure should be monitored regularly. Similarly, the end-effects both at and proximal to the ends should be monitored at a regular basis.

In this open-ocean setting, minor adjustment of the ends will have limited benefits. However, tying the end of the coir structure into naturally-forming forest debris is consistent with sound shoreline management principles. There is a major cluster of debris about 100 feet west of the Schifter property line, which is a logical point for the extended coir to tie into the natural protection, which will minimize overall impacts due to end effects.

Please feel free to call me.

Yours truly,

Peter S. Rosen

Peter S. Rosen, Ph. D.
Coastal Geologist

Cc: Brian Degasperis, TTOR Coastal Ecologist

Figure 1A. Norton Point Inlet Oct 13, 2012 (source: Sterling Wall)
Looking Northwest showing Katama Bay, Katama Beach, and Wasque

Figure 1B. Norton Point Inlet Oct 13, 2012 (source: Sterling Wall)
Looking West showing inlet, channel margin linear bar and Katama Beach.

Figure 1C. Norton Point Inlet Oct 13, 2012 (source: Sterling Wall)
Looking West showing Schifter property, TTOR property, inlet and Katama Beach

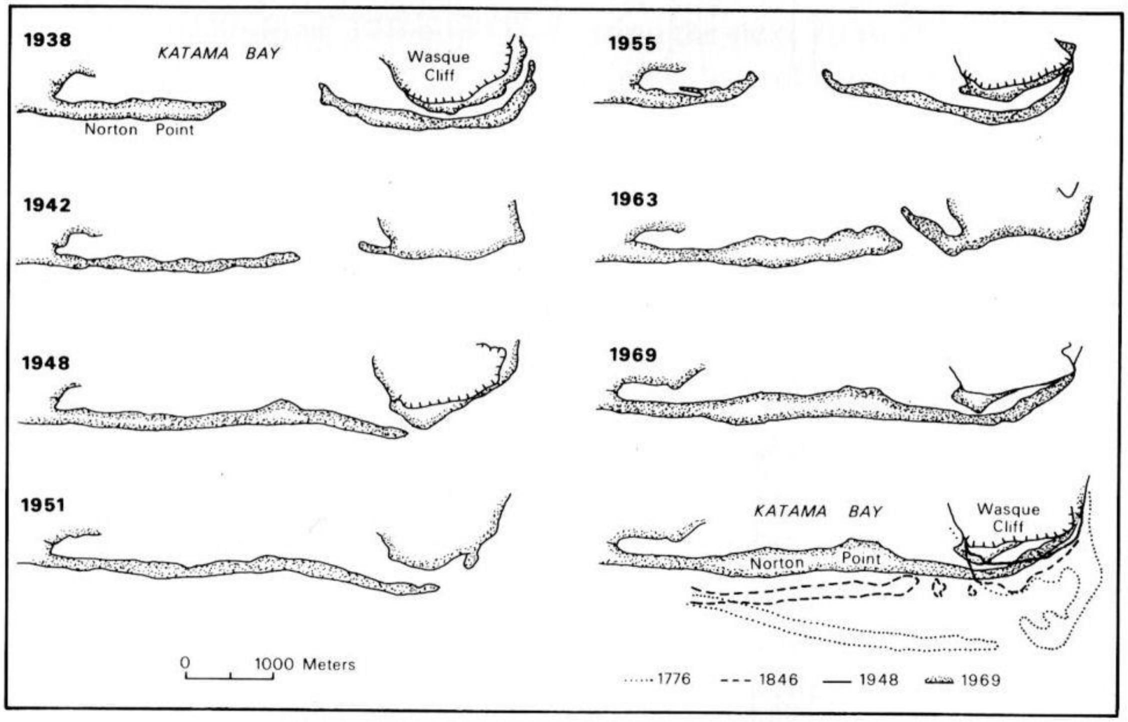

Figure 2. Shoreline changes along Katama Beach 1776 – 1969. (Source: Ogden, J.G., 1974, Shoreline Changes Along the Southeastern Coast of Marthas Vineyard, Massachusetts for the Past 200 Years, *Quaternary Research* v. 4, p. 496-508. Figure compiled in FitzGerald, D. M., 1993. Origin and Stability of Tidal Inlets in Massachusetts, p. 1 – 64, *in* Aubrey, D. G. and Giese, G. S. (eds), Formation and Evolution of Multiple Tidal Inlets)

Figure 3. July, 2008 air photo showing protective beach along Wasque and the Swan Pond, which is a relict of an ebb channel from an earlier tidal inlet. (Source: Google Earth)