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February 19, 2015

Mr. Richard J. Johnson; Town Manager
Town of Glastonbury
Town Hall
Glastonbury, CT 06033

Re: Glastonbury Boathouse: Slope Remediation Alternatives

Dear Mr. Johnson

Pursuant to discussions during the last meeting it was decided to document the various potential alternatives for addressing the current failed slope and wall movement condition at the subject site. The current conditions at the subject site consist of an excavated area along the top of the slope and an 8 feet excavation at the apron adjacent to the boathouse. Possible remedial concepts are as follows:

Alternative 1: Do Nothing
This alternative involves minimizing remediation at the slope, and essentially leaving the site in its currently excavated condition, with the exception that new access to the building from the south would be required. Engineering evaluations indicate that this slope in its current configuration is in incipient failure with a Factor of Safety near 1. This condition will prohibit or significantly reduce the use of the building and boat launch due to an unsafe situation. Additionally, this alternative does not address the fact that there may be long term changes at the river bank due to typical river bottom scour, which could ultimate result in a complete landslide. As such, this alternative is considered not viable from both technical and programmatic perspectives. Action is required to restore the safety of the boathouse and boat landing by eliminating potential for a landslide.

Alternative 2: Reduce Load
This remediation alternative involves removing the existing fill at the boathouse apron area and inside the boathouse back about 30 feet from the front/west wall to the bottom of the building footings and reconstructing the slab as a structural slab supported on new piers. The area to the north would be cut down to about Elev. 18 and re-constructed with lightweight fill. The handicapped ramp would be excavated and replaced with structural slabs. The above efforts are related to lessening the loading on the driving part of potential slides. The proximity to the river with on-going scour and accretion may diminish the benefits of these efforts. As cited below, permit applications in 1966 and 1974 indicate not only bottom scour, but actual loss of the shore

line in the 8 year period. This option does not provide sufficient factor of safety, is highly destructive, and impractical for facility use.

Alternative 3: Retaining Structure

This remediation alternative involves the placement of a supporting steel structure roughly at the base of the actuating part of the slide. Appendix 1 contains calculations for design, which involves vertical H-piles on one line and battered H-piles on a second line. The piles would be about 100 feet in length and extend into underlying glacial till and/or bedrock below the varved clay and silt layers. The piles would have a large cap beam at the top to provide partial structural fixity. The basis of the design relates to an initial slide curve with a factor of safety of about 1.0. The loading on the pile system is taken as a value required to increase the factor safety on the slip surface to about 1.2. What is important in considering this type of remediation is strain compatibility between the soil wedge and the resisting structural system. For the system to act as it is designed and provide resistance, it must move. This clearly counters the requirement to avoid further movement of the soil at the building. Similar to the "Do Nothing" concept, this alternative would also be threatened by further erosion of the unprotected river bank, and is therefore considered not viable.

Alternative 4: Increase Resistance

This remediation alternative involves providing a counter-weight on the resisting side of the slide, which often consists of a rock fill buttress at the base of the slope. With the project specific constraints for top of berm elevation in the river and the geometry of the river bed, this remediation concept (by itself) does not result in adequate factor of safety for the slope.

Alternative 5: Reduce Load and Increase Resistance

This remediation alternative involves reducing the load on the driving side of the slide by leaving void space at the top of the slope, and simultaneously increasing resistance on the river side of the slide by providing a counter-weight buttress as described in Alternative 4. The current slope is incipient failure (factor of safety approaching 1). The combination of reducing driving forces at the top of the slope and adding resisting forces (rock fill buttress) at the base of the slope will place the slide into a stable condition and arrest movements. This remediation concept is well-suited for the subject site considering the site conditions/constraints and that it will quickly begin to increase the stability of slope by decreasing the driving force and increasing the resisting force with minimal additional retaining wall and building movement. Additionally, this concept provides protection from future slope instability resulting from river bottom scour.

Recommendation and Discussion

For this site, Alternative 5 – Reduce Load and Increase Resistance is considered the most feasible solution to adequately stabilize this slope in both the current and future conditions. This concept achieves a satisfactory Factor of Safety and addresses the need to minimize additional retaining wall and building movements. To achieve the required result, the slope will be altered to (1) leave a void space with a structural slab at the top of the slope and (2) place rip rap on the river bank.

The proposed rip rap in this alternative will be maintained below Elev. -2. The rip rap will be standard rip rap size in accordance with CTDOT Form 816, section M.12.02-1. The areal extent of the rip rap in the river below Elev. 3.5, as requested by DEEP will be 25,660 sf (0.59acres). The approximate volume of rip rap below Elev.1.5, as requested by ACOE will be 5,300 cubic yards (6,900 Tons). The placement will not impede traffic in the river channel. The proposed rip rap will be placed to a thickness of about 6 feet. The attached plan (Plan Showing Proposed Rip Rap Limits, revised February 20, 2015) gives the approximate extent of required rip rap to achieve a minimum acceptable Factor of Safety.

Historically, the placement of rip rap within and along the river's edge has been a solution in prior slides. Appendix 2 includes a 1975 permit, filed with ACOE and DEP, relating to remediation of a slide at the subject site in 1974. This concept was used to remediate a slide in proximity to a 5,000,000 gallon tank and also at the south end of the slide at an existing bulkhead. The former (north) area on the 1975 permit application was completed and the south area was not completed due to costs. Additionally, a slide in 1978 at the Atlas Oil terminal in East Hartford also used a similar concept with placement of rip rap to stop an active slide.

For the reasons explained in this letter, Alternative 5 - Reduce Load and Increase Resistance is recommended to stabilize this slope. This solution will provide an acceptable factor of safety against sliding along with long term control of the river bank against future erosion.

If you have any questions, please call me.

Very truly yours,

Clarence Welti, PhD, P. E.
Pres. Dr. Clarence Welti, P. E., P. C.

cc: Allen Marr (Geocomp); John Difini (H&A); Michael Cegan; Michael Plickys