Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Unit 1 • Sandwich, MA 02563
508-833-6600 • horsleywitten.com

MEMORANDUM

To: Lisa Vandiver (NOAA)

From: Geoffrey Glover and Brian Daley (HW)

Date: December 13, 2018

Re: Assessment of green cay headcut stabilization project and recommended repairs

cc: May Cornwall Adams, Rudy O'Reilly (NRCS), Julie Wright (NRCS), JP Oriol (CZM), Marlon Hibberts (NOAA), Rob Ferguson (NOAA)

The purpose of this memorandum is to document current conditions at the Green Cay Headcut Stabilization Site and provide recommendations for repair activities. Construction of the stabilization project was completed at the end of 2016. Plant establishment was monitored for roughly nine months, and the engineered stone structures functioned as expected during that time. No erosion was observed within the project site prior to the hurricanes. Hurricane Maria struck the island of St. Croix as a Category 5 storm in September 2017 with sustained winds over 180 mph. Heavy rains fell during the storm and were followed by record-setting rainfalls in the period after the hurricane. These combined events likley surpassed the conditons the structure was designed for, resulting in the impact observed within (and downstream) of the project site.

Based on post-hurricane observations, we have six recommendations for project partners to consider:

1. Fix cattle exclusion fencing (immediate, minor cost).
2. Reset and reinforce the top of headcut (immediate, minor cost).
3. Repair the two uppermost stone step-pools and extend wiers (short-term, minor cost).
4. Fill and revegetate eroded or bare slopes (short-term, minor cost).
5. Evaluate conditions along the remaining downstream gut channel and develop a comprehensive restoration plan in conjunction with DPW culvert replacement planning (mid-term, medium cost).
6. Implement complete gut restoration project (long-term, high cost).

Observations and recommendations are discussed in more detail below. It is unlikely that the remaining funds under our current NOAA contract will be sufficient to completley address the first two immediate actions. Project partners will need to discuss prefered approaches, costs, and funding opportunities.

Site Assessment

HW inspected the project site on October 11, 2018 to evaluate the condition of the stabilization project and to assess potential repair needs. In addition, HW walked the full length of the downstream channel to the culvert under East End Road. This culvert was identified in the 2010 STXEEMP watershed plan as a prime candidate for replacement. In October 2017, this culvert collapsed creating a large hole in the road.

Observations made during this assessment included:

1. The headcut advanced to the east (uphill) post-hurricane. The new erosion has extended beyond the fence line by approximately 3-4 ft and is approximately 2 feet deep. This erosion has compromised the integrity of fence posts, and created a nick point where continued erosion may occur (Figure 1). The small stone apron that had been installed at the top of the channel washed out completely, due impart to installation issues as well as a minimalist design and use of non-specified materials.
2. No evidence of erosion or channel formation was observed upstream of the project site.
3. The vegetation within the fence has filled in to form a dense scrub layer. Planted species are combined with volunteer plants from the surrounding pasture. Planted vines sprawl along the surface and climb the taller trees and shrubs. No new soil erosion was observed under the vegetation layer. Native birds and butterflies were abundant. The dense vegetation restricted ability to inspect and photograph some of the damaged stone work. Vegetation did not establish in the lowermost section of the side slope on the south west side of the channel. This is presumed to be an issue with low quality clay soil. New erosion occurred in that location (Figure2).
4. Holes in the barbed-wire fence and fresh cattle tracks within the fenced off area leads us to believe that there has been a fair amount of animal activity within the site. Deep hoof prints in saturated soil have torn the erosion control fabric, resulting in continued erosion along the side slopes. Installed plants have also been browsed and crushed. The barbwire fencing at the bottom of the project site is open and was found tied back to allow open access. (Figure 3)
5. The uppermost stone weirs appear to have washed out due to large flows in the channel (enough to move boulders). There were six weirs in the original design that were constructed of 2 – 6 rows of individual boulders with a minimum boulder diameter of 3 feet. The designed weir length was to be 8 feet, with the weirs extending 2 – 7 feet further up the side slopes. Boulder sizing was designed based on modeling of flows for the 100-yr storm, which may have been exceeded during and after the hurricane. In addition, there were issues during construction (e.g. smaller average boulder size and inaccurate placement) that may have also contributed to weir instability and flow “run around.”
6. Bank erosion resulting from flow “run around” the weirs was observed at a number of locations (Figure 4). This may have been exacerbated by abnormally high rain fall and flow

velocities in addition to step-pool construction issues. Evidence of soil deposition and accumulation of smaller stones was observed in the last pool in the system.

7. Small rills were evident along the northern side slope at the down-gradient portion of the site. This erosion appears to originate from runoff coming down the slopes from outside the channel. Although the slope is steep, the erosion is minor. The erosion control blanket was not completely effective in this location due to inconsistent contact with the surface during installation.
8. Conditions were notably worse immediately downstream of the project site, in the reach that had been cleared by the owner in conjunction with the stabilization project (Figure 5). Here the channel appears to have downcut by several feet and there were vertical banks in several locations. Multiple sloughs were visible where large clumps of soil and small stones fell from the banks into the channel. There were deep animal prints all over the side slopes and little to no vegetation. Surface rills were present across the side slopes.
9. The culvert on East End Rd. was still blocked—one pipe is 90% blocked with rock and dirt and the second pipe is 60% blocked. The road was patched back up. The downstream channel on SEA's property contains a large scour hole below the culvert, and a debris field full of downed Manjack trees and trash.

Figure 6 is a site map mark up showing the locations of erosion and boulder displacement these features.

Despite the problems in the project site, it is reasonable to conclude that the damage from the severe rains following Hurricane Maria would have been worse without the installation of the structural erosion control/stabilization measures. However, the headcut has reformed and should be effectively resolved before additional up-gradient erosion occurs.

Figure 1. Erosion observed at top of channel.

Figure 2. Vegetative cover is dense for most of the project site (except southern slope in downstream corner).

Figure 3. Hoof prints and fencing at bottom of site (looking upstream). Note lack of established vegetation on side slope.

Figure 4. Slope erosion from runaround behind stone weirs.

Figure 5. (Left) Photo from construction inspection in Jan 2017, identifying channel instability issues. (Right) Photo taken during October 2018 site assessment on, showing signs of increasing bank erosion downstream.

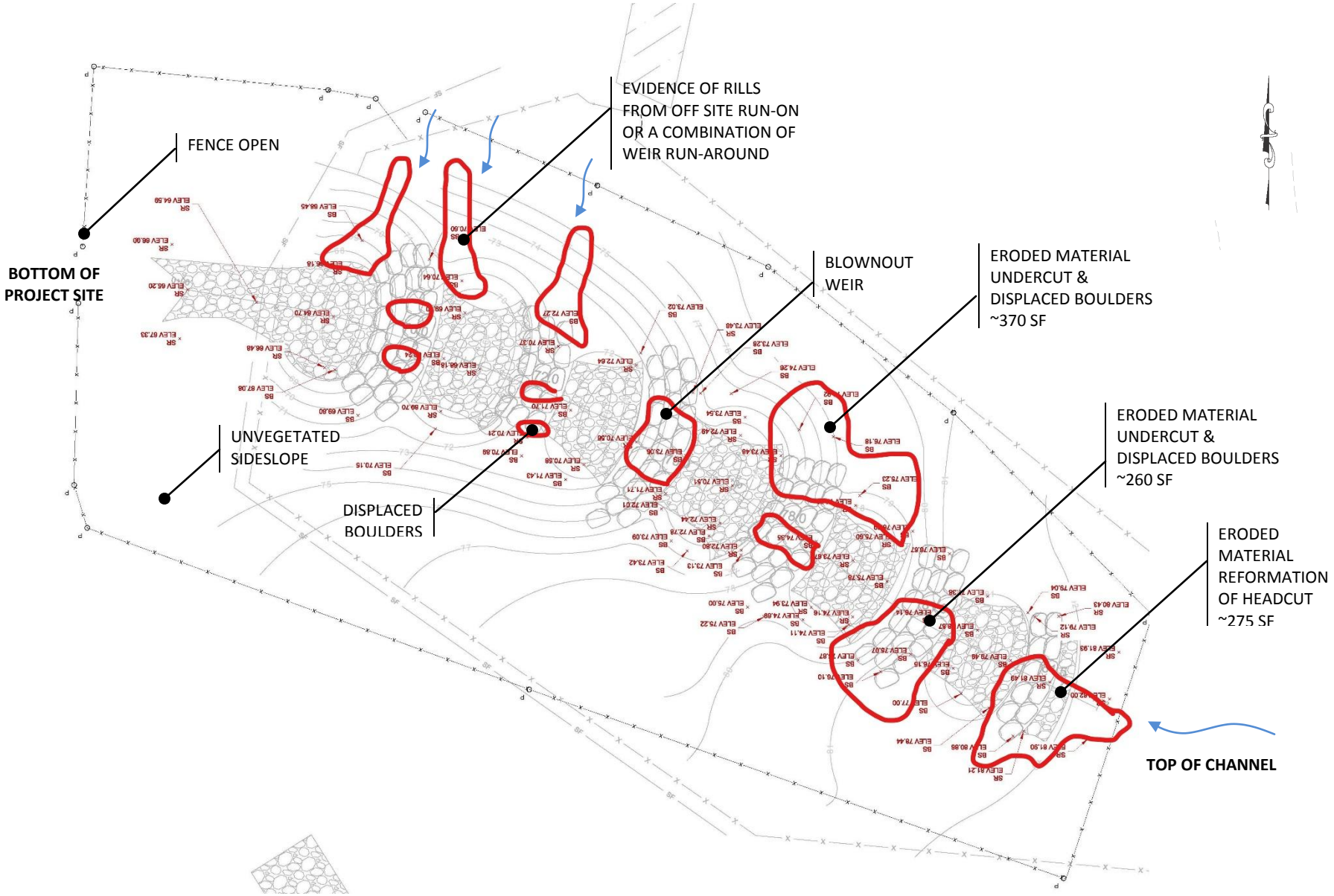


Figure 6. Locations of erosion and boulder movement (in red circles) over preliminary as-built survey

Recommended Repairs

There are several recommendations for repairing the project site and addressing erosion issues on the remaining gut. Repairs that should be implemented as soon as possible to stop any further deterioration of the project site include:

1. **Fix cattle exclusion fencing** to prevent horses/cattle from entering the project site. It is unclear when the fencing was compromised, but no work should be performed until the site can be fully secured. The fencing at the top of the project site will need to be expanded outward to accommodate repair work at the top of the channel. Make sure the gate is properly secured to restrict access.

2. **Reset and reinforce the top of headcut**. The headcut now has an elevation change of approximately 2 feet. We recommend filling in this area with a stabilized stone apron and installing an impermeable barrier to stop any progression of the headcut and prevent sediment movement underneath. In addition, we recommend including a reinforced turf mat and a plastic geogrid wrapped in an impermeable liner to be installed 6" below the current existing grade.

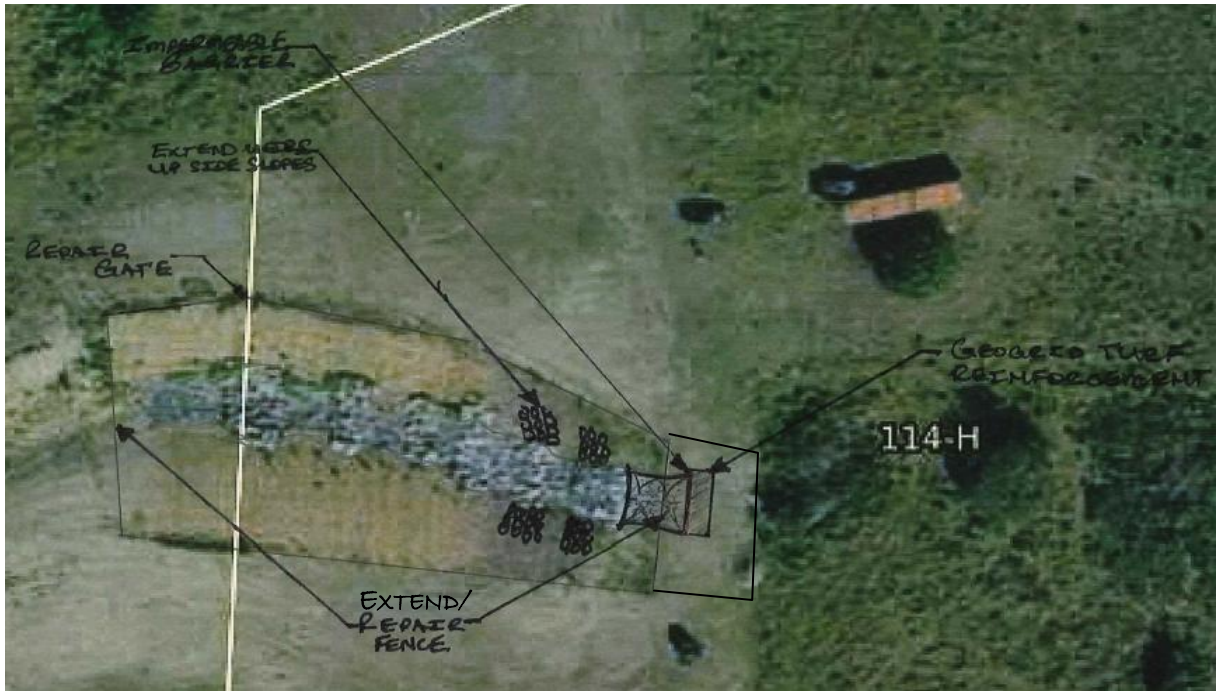
   Once installed, we recommend monitoring of the site during a rain event to observe runoff patterns above the project site, identify locations where sheet flow becomes concentrated, and how runoff enters and flows through the stabilized gut. If warranted, planting rows of vetiver grass to serve as check dams to slow and spread flows above the project site could be considered.

Recommendations for repair work that should be done in the short-term includes:

3. **Repair the two uppermost stone step-pools and extend wiers**. We recommend reconstructing and enhancing the first two steps pools. The weir wings should be extended an additional 3-7 feet up the side slopes. Proper construction is critical to prevent shortcutting or run-around at high flows and to maintain proper elevation differences between weir crest and pool inverts. While laborers and equipment are on site, consider reshaping any downstream weirs where boulders were dislodged.

4. **Fill and revegetat eroded or bare slopes**. Add suitable soil and reseed southern corner of project site where vegetation never established. Where slopes were distrurbed for step-pool repairs, this area will need to be revegetated as well. Use alternative soil stabilization techinque such as wood chips rather than erosion control blanket, if needed.

Figure 7 provides a sketch showing the location of immediate and short term measures, and includes a detail illustrating the proposed measures at the top of the headcut.



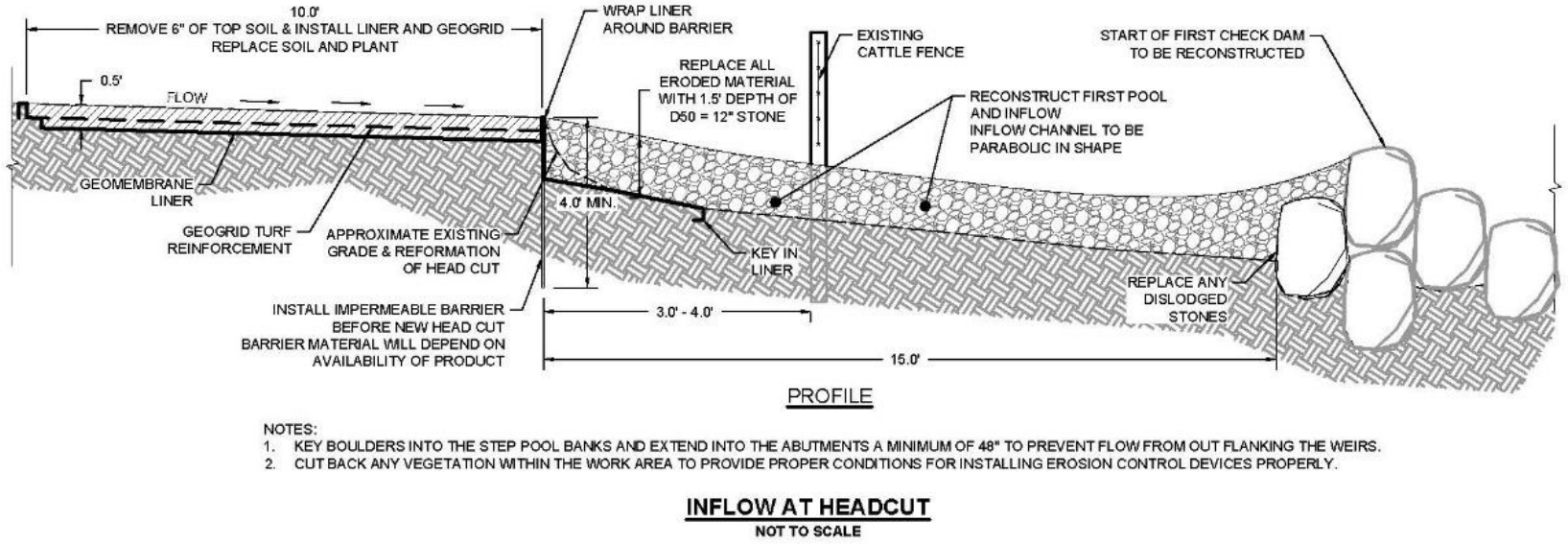


Figure 7. Site sketch and detail showing immediate and short-term repair recommendations.

In the long-term, we recommend the following gut restoration measures:

5. **Evaluate conditions along the remaining downstream gut channel** and develop a comprehensive restoration plan in conjunction with DPW culvert replacement planning (mid-term, medium cost). Much of the green cay gut channel is eroded between the project site and East End Rd. It was recongized that the original stabilization project was not intended to address full channel restoration, rather it was limited to arresting the active migration of the headcut. During construction of the stabilization project, however, vegetation was cleared and the banks disturbed along 300 feet of channel directly downstream of the project site. This activity likely contributed to additional erosion along this segment of the gut as evidence by sloughing slopes, exposed soils, and erosional features created by new side discharges. Due to these concerns, HW offered a restoration plan to the owner in January 2017 (Figure 8). It is unclear if elements of this plan were implemented.

   Once the short-term repair actions are completed, we recommend conducting a comprehensive assessment of conditions along the full gut length and developing a restoration plan that incorporates DPW's culvert replacement under East End Rd. and wetland restoration on SEA's Southgate property adjacent to the Chenay Bay resort. This assessement should look at the condition of the downstream farm pond (Schuester's property) that is currently bypassed by the gut, and evaluate the benefits (if any) of reconnection options (Figure 9).

6. **Implement complete gut restoration project**. This could be expensive. Planning for the implementaiton of a comprehensive gut restoration plan should include the identification of funding sources. This gut should be on the list of St. Croix's priority hurricane recovery funds, especially given the issues with the culvert failure and headcut stabilization project impacts directly attributed to the hurricane. FEMA Hazardous Mitigation grants, USDA, or 319 grants through EPA may be options.

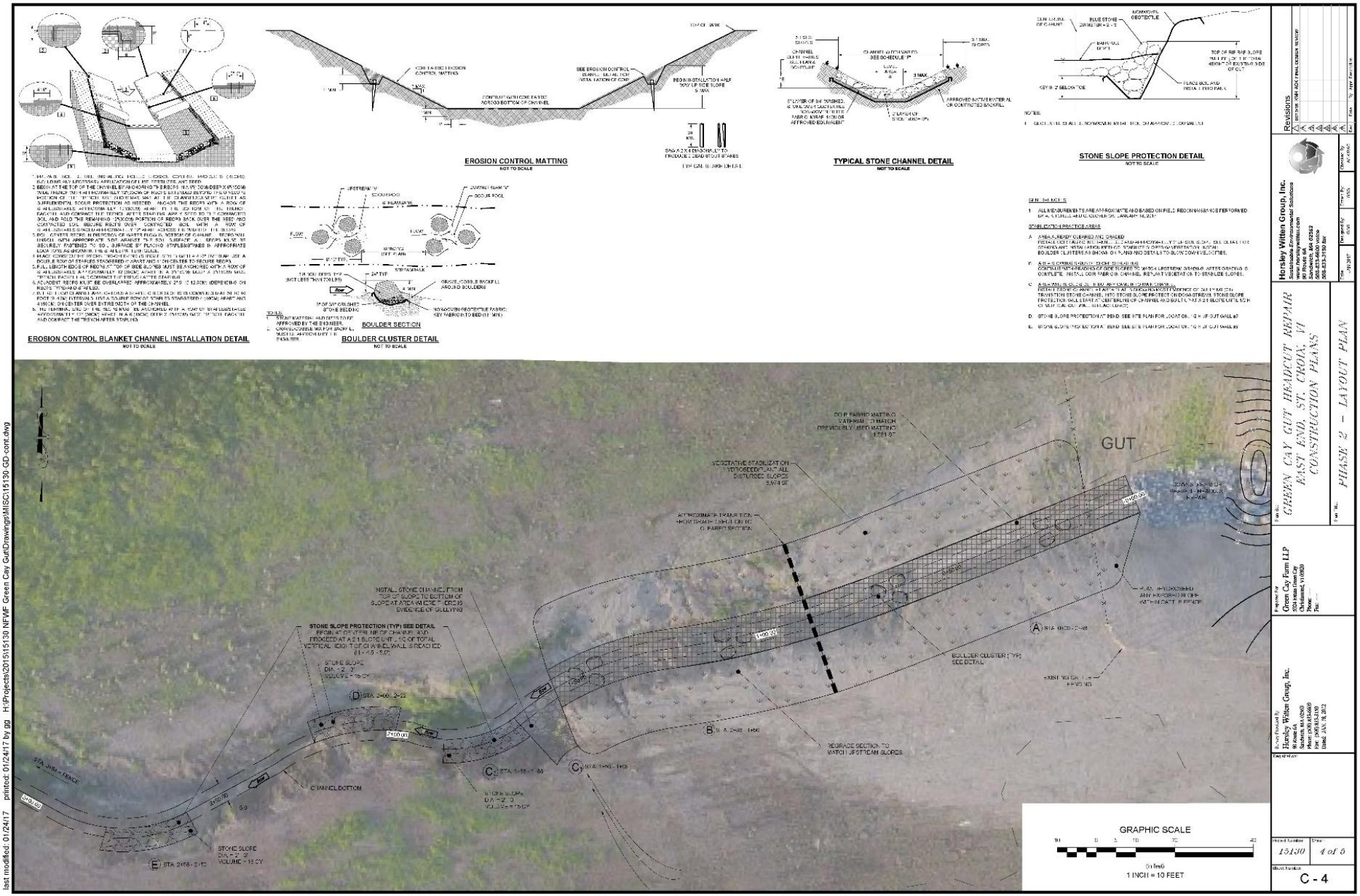


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Figure 8. Phase II design plan for reach downstream of project site

Figure 9. Full length of Green Cay gut