# Appendix N
# Todd Creek Monitoring and Maintenance Plan, Revision 1

Jacobs

# UCC Woodbine, Camden County, Georgia Facility

## Todd Creek Monitoring and Maintenance Plan

Revision 1

September 2024

Union Carbide Corporation

# Contents

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# Acronyms and Abbreviations

| | |
|---|---|
| 3D | three-dimensional |
| CH2M | CH2M HILL Engineers, Inc. |
| CRD | Coastal Resources Division |
| DC | data collection |
| DOT | Department of Transportation |
| ECM | Erosion Control Measurement |
| GCP | ground control point |
| Georgia EPD | Georgia Environmental Protection Division |
| GPS | global positioning system |
| Jacobs | Jacobs Engineering Group Inc. |
| MW | monitoring well |
| NAVD88 | North American Vertical Datum of 1988 |
| NWP | nationwide permit |
| RCRA | Resource Conservation and Recovery Act |
| SWMU | Solid Waste Management Unit |
| Thiokol | Thiokol Corporation |
| UAV | uncrewed aerial vehicle |
| UCC | Union Carbide Corporation |

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# 1. Purpose and Objectives

This Monitoring and Maintenance Plan applies to both stabilized and native streambank areas along Todd Creek adjacent to the Resource Conservation and Recovery Act (RCRA) landfill located at the Union Carbide Corporation (UCC) Woodbine facility. The main objective of monitoring and maintenance along the Todd Creek streambank is to ensure protection of the landfill from erosion of the streambank. This Monitoring and Maintenance Plan details how monitoring of erosion and bank recession rates will be completed, indicates how often and under what conditions inspections will occur, outlines the evaluation process for monitoring data collected, and defines when maintenance is triggered.

# 2. Facility Description

The UCC Woodbine facility is located in Camden County in southeast Georgia (Figure 1). From 1963 to 1976, Thiokol Corporation (Thiokol) manufactured and tested solid fuel rocket motors, illuminating ordnance devices, riot control agents (tear gas), and assorted chemical materials under toll processing agreements with other companies. In 1976, UCC purchased the 7,193-acre facility from Thiokol. Before UCC's acquisition of the facility, Thiokol manufactured the pesticide aldicarb (trade name TEMIK) for UCC. UCC manufactured and formulated pesticides at the facility from 1976 to 1986. In December 1986, UCC sold the manufacturing plant and some adjacent land to Rhone-Poulenc, Inc., which was later renamed Aventis CropScience. In 2001, Bayer bought Aventis CropScience and operated the plant. Operations at the Bayer plant have since ceased, and several structures previously associated with operations have been demolished. Bayer sold the property in 2022. The manufacturing and production operations were located on the property formerly owned by Bayer and are not part of the current UCC facility subject to the Post-Closure Care and Corrective Action Permit HW-063(D).

UCC retained ownership of approximately 4,045 acres of the facility, which includes a 22-acre RCRA, Subtitle C permitted landfill (Solid Waste Management Unit [SWMU] 1). SWMU 1 consists of 11 hazardous waste disposal cells (Cells A through K) and two nonhazardous industrial cells. It was closed in 1988 under an approved closure plan. The landfill is monitored and maintained in compliance with the Post-Closure Care and Corrective Action Permit HW-063(D) administered by the Georgia Environmental Protection Division (Georgia EPD).

## 2.1 Todd Creek Characteristics

Todd Creek is a tidally influenced creek with pronounced meanders that bisects the facility north of SWMU 1 (Figure 1). Todd Creek is actively transporting sediment with areas of aggradation (deposition) and degradation (erosion) associated with the meander features. It is hydraulically connected with the Satilla River via Floyd Basin and Floyd Creek and has a normal wetted channel width that varies between approximately 250 and 400 feet adjacent to the site.

The northern bank of Todd Creek abuts an expansive marsh that extends north to the Satilla River. The southern streambank is composed of steep bluff that is generally 20 feet high above the mean tide water level, consisting of loose sand with some layers of finer-grained materials. Portions of the shoreline of Todd Creek, adjacent to SWMU 1, have been actively eroding, and landward recession of the top of the streambank (top of bluff) has been monitored since 1996. There is some live vegetation on the slopes, but areas of active slope recession are not vegetated.

## 2.2 Todd Creek Streambank Erosion Mechanisms

Bluff erosion at the site is driven by two primary mechanisms. One is daily erosion and bedload transport resulting from stream and tidal current velocities that cut the streambank within the normal water level fluctuations. Currents within Todd Creek near SWMU 1 are largely due to tidal action as water levels rise and fall, causing flood and ebb currents as water flows through the channel and over the marsh flats (CH2M 2008). Daily erosion near the site appears to be due, in part, to the natural process of meander migration. The channel's thalweg alignment and typical flow velocities create cutting actions that are eroding segments of the bluff. This daily erosion of soil at and below the water line causes the overlying bluff soil to collapse periodically and fill in the eroded areas. This cycle of erosion and collapse is repeated and causes gradual but steady recession of the bluff (Jacobs 2019).

The second mechanism is episodic events, which can induce wind-driven wave actions that also affect higher elevations of the streambank. At high tides, when the marsh to the north is inundated, the fetch for wind from the northeast increases significantly to 4 or 5 miles. The potential for wave growth over the tidal flats is somewhat limited by the relatively shallow water depth over the marsh flats at these high tides. However, under low-frequency, high-intensity storm events (e.g., hurricanes and "nor-easters"), the combination of a storm surge and high tides can result in greater wave action at the site. Investigations estimate the 100-year still water elevation to be 10.3 feet NAVD88 with 100-year return period wave heights of more than 4 feet in the area (Jacobs 2019).

Generally, the erosional areas are located on the western portion of SWMU 1 and the far eastern portion. Near the center of the site, a vegetated intertidal zone has developed, extending from approximately 50 to 100 feet from the toe of the bluff before dropping off to stream depths. This central intertidal area appears to be a depositional area, providing some protection of the bluff behind it against erosion from waves and currents.

## 2.3 Components of the Streambank Stabilization Areas

As a result of erosion nearing the Primary Contingency trigger pins in the areas of Erosion Control Measurement (ECM)-1 and ECM-4, UCC implemented a streambank stabilization project as an interim action to protect portions of the southern streambank in 2021. The objective of the streambank stabilization system was to address erosional areas near ECM-1 and ECM-4 from both daily and episodic wave action, resist damages by normal tidal fluctuations, and provide wave protection during 2- to 5-year return period storms to maintain the existing natural buffer zone between the landfill and Todd Creek. Figure 2 shows the streambank stabilization areas and key site features. UCC installed stabilization measures along 540 feet of streambank near ECM-1 and 465 feet of streambank near ECM-4 (Figure 2). Streambank stabilization consisted of a combination of bank grading, stone toe protection, stone keys, stone revetment, and revegetation that mitigates erosional mechanisms while minimizing impacts to Todd Creek and the environment (Jacobs 2022). Figures 3 and 4 provide the plan and cross section views of the stabilization measures installed at ECM-1 and ECM-4, respectively. The stabilization measures are detailed in the *Todd Creek Bank Stabilization Basis of Design Report* (Jacobs 2019) and the *Todd Creek Bank Stabilization Construction Completion Report* (Jacobs 2022) and are summarized in Subsections 2.3.1 through 2.3.3.

### 2.3.1 Vegetated Slope & Top of Bank

The streambank near ECM-1 and ECM-4 was regraded at a 2H:1V slope from the terrace to the top of bank (generally level ground located at the top of the vegetated slope). Biodegradable erosion control mats were placed above the stone revetment following construction to protect the earthen slopes. Trees (red maple, laurel oak, live oak, slash pine, and sweet bay magnolia) were planted at the top of bluff at each

stabilization area. Shrubs (wax myrtle, sparkleberry, saw palmetto, yaupon holly and American beauty) were installed along the vegetated slope and top of bluff. The soil was amended and hydroseeding was completed with a wetland seed mix on the slopes and an upland seed mix on the top of bluff. Rye seed was also applied to accelerate vegetation growth following construction activities. In areas where vegetation was slow to establish full coverage, additional soil amendments were applied, and sod was planted. Biodegradable erosion control mats were installed in the transition areas between the stabilization measures and the native streambank to reduce wind and rainfall erosion.

### 2.3.2 Stone Revetment and Terrace

The stone revetment is intended to protect the slope from erosion during normal tidal fluctuations and provide wave protection during a 2- to 5-year return period storm. Stone revetment extends across each stabilization area between the stone keys and was installed to 1 foot above the 100-year return period stillwater elevation of 10.3 feet NAVD88. Additional stone was installed at ECM-1 to provide protection from erosion that otherwise may have occurred during routine monitoring of the wells located in the central portion of the stabilization area near the top of bank, this material is not part of the stone revetment (Figure 3).

A 15-foot-wide level terrace was installed at the base of the stone revetment slope to provide an access path for future maintenance, as needed. The terrace has a finished grade elevation (4.5 feet NAVD88) set above the mean high water level (2.6 feet NAVD88) to reduce tidal influence.

The stone revetment and terrace were constructed of geotextile filter fabric overlain by 8 inches of crushed bedding stone under 1.5 feet of Georgia Department of Transportation (DOT) Type 3 riprap.

### 2.3.3 Stone Toe Protection and Stone Keys

The stone toe protection was installed along the toe of the streambank stabilization, extending below the mean low water level (elevation of approximately -4.0 feet NAVD88) to a bottom finished grade elevation (-5.0 feet NAVD88). The stone toe protection consists of geotextile filter fabric overlain by 8 inches of crushed bedding stone under 1.5 feet of Georgia DOT Type 3 riprap (revetment or non-launchable portion of the stone toe protection) and overlain by approximately 3 feet of Georgia DOT Type 3 riprap (launchable portion of the stone toe protection). The launchable portion of the stone toe protection was designed to self-launch a portion of the installed stone when erosive conditions cause scour holes to form adjacent to the stone toe protection. The stone installed is designed to line the advancing edge of the scour hole and reduce the rate of future toe of streambank erosion. The remaining portion of the stone toe protection (1.5 feet of riprap above the bedding stone) is designed to provide continuous protection of the streambank toe.

The stone keys are located at the upstream and downstream extent of each stabilization area and extend from the stone toe protection to the top of bank. The stone keys are an extension of the stone toe protection and provide a source of self-launching material that provides protection against erosion and flanking in the same manner that the stone toe protection can self-launch to line scour holes at the toe of the slope.

# 3. Streambank Monitoring

Recession of the bluff along the southern bank of Todd Creek adjacent to SWMU 1 has been monitored since 1996. Initial measurements were collected at transects extending from the northern landfill fence line (baseline) to the streambank through well locations MW-17, MW-20, and MW-24 (later renamed ECM reference line ECM-1, ECM-2, and ECM-3, respectively). Measurement locations were expanded in 2012

to include ECM-4 and expanded again in 2017 to include ECM-0 and two data collection (DC) reference lines located upstream and downstream of the landfill (DC-1 and DC-2, respectively) (Figure 2).

The Todd Creek Bank Stabilization Plan incorporated into the amended Post-Closure Care and Corrective Action Permit (dated June 7, 2017) established multiple trigger pins on ECM reference lines ECM-0 to ECM-4. The trigger pins outlined below were set at the following distances from the baseline and require the following actions to be implemented if streambank recession reaches the trigger pin (Georgia EPD 2017):

- Primary design trigger pin (115 feet from the baseline): Primary Contingency Plan design and permitting must be initiated no later than the point in time which is concurrent with bank erosion reaching the 115-foot trigger pin.
- Primary contingency complete pin (100 feet from the baseline): Corrective action activities described in the approved Primary Contingency Plan must be completed prior to or concurrent with bank erosion reaching the 100-foot trigger pin.
- Secondary design trigger, 5 feet past the 100-foot trigger pin (95 feet from the baseline): The Secondary Contingency Plan must be evaluated/designed.
- Secondary contingency complete pin (85 feet from the baseline): Corrective action activities described in the approved Secondary Contingency Plan must be completed prior to or concurrent with bank erosion reaching the 85-foot Trigger Pin.

## 3.1 Existing Monitoring Program

The current streambank monitoring program consists of quarterly distance measurements from the top of bluff to the trigger pins along the ECM reference lines. Cumulative recession rates are then calculated for each reference line. Quarterly distance measurements from the top of bluff to the baseline are also collected along the DC reference lines. Streambank measurements are collected following tropical storms and hurricanes.

In addition to the top of bluff distance measurements, the streambank is visually inspected for possible undercutting of the bluff and the presence of groundwater seeps. These inspections are performed concurrent with the quarterly streambank distance measurements using an uncrewed aerial vehicle (UAV) equipped with a camera and onboard global positioning system (GPS). Quarterly monitoring activities and data are summarized in a technical memorandum submitted to Georgia EPD annually.

## 3.2 Proposed Monitoring Program

Changes to the streambank monitoring program are necessary to establish monitoring and maintenance criteria within the areas where streambank stabilization has been implemented (ECM-1 and ECM-4) (detailed in Section 2.3). Monitoring of the stone toe protection, stone keys, and stone revetment is necessary to determine when replenishing stone is required to maintain the streambank stabilization measures. In addition, UCC desires to create a more robust data set for monitoring of the native banks to better understand the rates and mechanisms of aggradation (deposition) and degradation (erosion) associated with the meander features adjacent to the landfill. Therefore, UCC proposes updating the current monitoring program to include the following, to be implemented upon issuance of the renewed Permit HW-063(D):

- Periodic visual inspections of the native streambank and streambank stabilization areas.
- Continued collection of distance measurements to the top of the bluff along ECM and DC reference lines where there is native streambank. Distance measurements will be collected from the top of bluff

to the baseline and the trigger pins along transects ECM-0, ECM-2, and ECM-3 to determine if primary contingency triggers (as defined in Section E.9d.1.4.1 of the permit renewal application) have been reached.

- Photogrammetric surveys along Todd Creek streambank between DC-1 and DC-2. The surveys will collect aerial photos of the streambank to produce an orthomosaic figure and three-dimensional (3D) model.
- Eliminate distance measurements of the top of the bluff along transects ECM-1 and ECM-4 where the streambank stabilization measures have eliminated the presence of an erosional bluff between the trigger pins and Todd Creek. Instead, utilize the successive photogrammetric survey datasets for topographic comparisons of the streambank stabilization measures to determine whether the stone toe protection, stone keys, or stone revetment have eroded and to determine if maintenance is needed or if secondary contingency triggers (as defined in Section E.9d.1.4.2 of the permit renewal application) have been reached.

The proposed monitoring activities and frequencies are described in the following subsections and summarized in Table 1.

### 3.2.1 Inspections

Monitoring activities will be completed during low tide conditions to support visibility of the streambank stabilization components at ECM-1 and ECM-4. The streambank will be visually inspected, from top of bluff ground level, and by the UAV between DC-1 and DC-2. The UAV will provide oblique aerial photos of the streambank between DC-1 and DC-2, as well as nadir (downward-facing) photos. Inspections of the native streambank will include verifying the condition and assessing presence of the trigger pins along reference lines ECM-0, ECM-2, and ECM-3. Inspections of the streambank stabilization areas will include visual observation of the vegetated slope, stone keys, stone revetment, and stone toe protection. Inspection checklists are included in Appendix A and will be completed during each of the monitoring events.

### 3.2.2 UAV Photogrammetric Surveys

Monitoring within native streambank and transition areas (near the stabilization areas) will initially be conducted using a combination of photogrammetric measurements collected by UAV (UAV surveys) and manual distance measurements from the top of bluff to the baseline/trigger pins along existing established transects (DC-1, DC-2, ECM-0, ECM-2, and ECM-3). Photogrammetric data will be used to determine and report the location of the top of bluff, streambank profile, and elevations along the entire streambank between DC-1 and DC-2. Collection of manual distance measurements along the established transects will serve to verify the accuracy of the photogrammetric measurements to the top of the bluff.

The UAV will also be used in the areas of ECM-1 and ECM-4 to collect photogrammetric measurements of the stabilization features across the streambank stabilization areas. UAV surveys will be completed under low tide conditions, to the greatest extent possible as allowed by weather conditions, to ensure visibility of the stone toe protection. Photogrammetric data will be used to create and monitor topographic profiles and dimensions of the vegetated slope, stone keys, stone revetment, terrace, and stone toe protection. The photogrammetry software also allows for post-processing volumetric analysis to be performed for the stabilization features. This analysis will provide information regarding changes in areas and volumes for integral stabilization features (e.g., the stone toe protection, stone revetment, and stone keys).

Technical details regarding UAV surveys and photogrammetric data processing are discussed in Section 4. Photogrammetric data collected along the streambank adjacent to the landfill will be used to monitor streambank aggradation and degradation.

### 3.2.3 Monitoring Frequency

Visual inspections, manual measurements, and UAV surveys will be conducted quarterly for the first year following renewal of the Post-Closure Care and Corrective Action Permit HW-063(D). If the accuracy of the photogrammetric measurements is verified during the first year (within 0.25 feet of accuracy), it will be recommended that measurements continue using only the photogrammetric measurements. It will also be recommended that the monitoring frequency be reduced to annual such that the visual inspections and UAV survey is conducted in the fourth quarter of each calendar year, following peak tropical storm season. If accuracy cannot be verified within the first year, manual measurements will continue following the first year. UCC will send a request for approval of the monitoring method and frequency to Georgia EPD following the first year of measurements, which will include a summary of the data collected and the accuracy of the photogrammetric measurements.

A visual site inspection will be conducted following storm events where water levels in the Todd Creek/Satilla River basin are greater than 2 feet above the mean high water at National Oceanic and Atmospheric Administration tidal measurement stations: Kings Bay MSF Pier (Station ID: 8679598) or San Fernandina Beach (Station ID: 8720030). The measurement stations selected are those closest to the UCC site that record data for retrieval. If a post-storm visual site inspection determines there was substantial erosion to native or stabilized streambank areas and/or that any of the trigger pins have been damaged in the native streambank areas, a post-storm UAV survey (post-storm survey) will be conducted within 45 days, if possible, based on the extent of any post-storm damage to the access roads. If a post-storm UAV survey occurs within 3 months of a planned annual UAV survey, the post-storm UAV survey will serve as the annual UAV survey.

# 4. UAV Photogrammetry Surveys

UAV surveys, performed by Jacobs Engineering Group Inc. (Jacobs) pilots licensed and certified under Federal Aviation Administration Code of Federal Regulations Title 14, Part 107, collect photogrammetric data, and the subsequent analysis involves measuring distances using processed photographs collected during an aerial survey. This is then used to create a 3D digital surface model. Prior to mobilization for the UAV survey, an automated flight plan is developed. The parameters of the flight plan (e.g., altitude, speed, waypoints, photo overlap.) are set to achieve the desired accuracy and can be adjusted, as needed. Immediately before the survey, the UAV compass calibration is verified during the pre-flight inspection. If there is an error, the UAV compass will be recalibrated per the manufacturer's specifications. During the UAV surveys at the site, the UAV will take photographs of the area between DC-1 and DC-2 to achieve up to 80 percent overlap on each picture. This allows UAV data processing software to identify millions of common points to create an orthorectified photo (a two-dimensional, geographically accurate, aerial image that has been corrected for distortion) and capture enough angles to create a digital surface model (shape of the site surface). The UAV data processing software algorithm calibrates, densifies, meshes, and finally textures to create a 3D model of the surface.

UAV photogrammetry works by matching features from the myriad images collected during the UAV survey. If the same feature is seen from three or more known positions, its location can be triangulated in space, capturing the horizontal (x,y) and vertical (z) coordinates. Photogrammetry software matches approximately 6 to 10 million points for the batch of images collected to create a "cloud" of points. Each point has a matched feature describing the surveyed area in that location.

The accuracy of photogrammetry can be within 0.1 foot depending on site conditions (e.g., lighting, wind, and weather). The field team will target an accuracy of 0.25 feet. Accuracy is established by using portable ground control points (GCPs) that consist of 2-foot by 2-foot black and white checker patterned points. These GCPs are surveyed using a real-time kinematic GPS antenna. Using a network of GCPs acts

as control benchmarks. During the flight, the UAV is collecting the GCP location in photographs and collecting onboard high accuracy GPS data. The GCP information is entered in the workflow prior to processing. They are used to align the photograph locations during the processing workflow. The GCPs eliminate the need for permanent benchmarks and help prevent human error.

The photogrammetry software then produces an estimated accuracy (x, y, z-axis, and a root mean squared error) based on the number of photos, overlap, and GCPs visible. However, checkpoints must be used to determined absolute accuracy of the orthorectified image produced. A checkpoint is an observed benchmark within the model that was not used to process the image (e.g., visible monitoring well locations or other GCPs). The checkpoint model-generated coordinates are then compared to the known coordinates to calculate a true accuracy of the surface 3D model.

Performing UAV surveys will provide the following benefits:

- Accurate measurements of the location and elevation of the top of the bluff, streambank stabilization measures, and intertidal areas along the entire length between current transects DC-1 and DC-2.
- Ability to create a surface 3D model for topographic data analysis and evaluation.
- Holistic data capture of site conditions to gain an improved understanding of site conditions and evaluate erosion processes driving long-term streambank geometry changes.
- Flexibility to assess aggradation/degradation trends at any location along Todd Creek between current transects DC-1 and DC-2.
- Accurate topographic survey of the streambank between DC-1 and DC-2 in an efficient and timely manner.
- Ability to create streambank cross sections to evaluate changes in streambank slope and stabilization measures over time (see Exhibit 1 below).
- Ability for aerial work to be viewed remotely by project engineers, allowing for more detailed inspection of areas of interest that would otherwise not be safely accessible.


**Exhibit 1. Example of UAV Photogrammetry to Look at Changes in Elevation Over Several Flights**

**Exhibit 2. UAV Survey and Portable Ground Control Tile**
*Source: Propeller Aerobotics Pty Ltd*

# 5. Maintenance

Maintenance within the native streambank areas will be limited to maintaining the trigger pins and accessibility along the ECMs and DCs for data collection during the monitoring and inspection events. Data collected at ECM-0, ECM-2, and ECM-3 will continue to be used to determine the distance to the top of bluff from the established trigger pins.

Visual inspections and photogrammetric data collected within the streambank stabilization areas (ECM-1 and ECM-4) will be used to determine when maintenance is required. The elements of the streambank stabilization areas that are subject to maintenance are summarized in Section 2.3 and depicted on Figures 3 and 4. Maintenance triggers vary based on the engineered intent of the constructed elements of the stabilization areas, as presented in the following subsections.

Deficiencies noted during monitoring events will either be addressed within 90 days of the inspection or a plan, including a schedule, for addressing the deficiency will be submitted to Georgia EPD within 90 days of the inspection.

## 5.1 Vegetated Slope & Vegetated Top of Bank

Observations collected during visual inspections and UAV surveys will be used to evaluate the condition of the vegetated slope and vegetated top of bank (Figures 3 and 4). If areas of erosion (approximately 6 inches or greater depth based on the visual inspection), distressed and/or dead vegetation, or bare areas are observed (less than 70 percent coverage), maintenance would be performed and could include, but is not limited to, the following:

- Fill erosional area(s) with soil, amend soil (as needed), install plants or seed the area to establish vegetative cover, and install erosion control matting (as needed).
- Place soil, soil amendments (as needed), and replace vegetation – plants, sod and/or seeding to address areas with sparse vegetation, bare spots, or distressed vegetation. Install erosion control matting (as needed).
- Replace distressed and/or dead shrubs and trees.

## 5.2 Stone Revetment and Terrace

Information from the UAV surveys and visual inspections of the stone revetment and terrace will be evaluated for the following:

- Visible signs of erosion as evidenced by signs of downslope stone movement, exposure of bedding stone, or exposure of underlying geotextile fabric observed during visual inspection and/or UAV aerial photography.
- Changes in surface elevation of the terrace and width of the terrace in the photogrammetric data.

Maintenance will be triggered under the following conditions:

- Exposure of underlying bedding stone, geotextile or underlying native soil.
- Decrease in stone revetment or terrace thickness to less than approximately 0.8 feet (approximately 50 percent of original thickness of 1.5 feet).
- Greater than 2 feet of erosion of the leading edge of the terrace, resulting in width of less than 13 feet.

Maintenance of the stone revetment and terrace will generally consist of grading to return subgrade to as-built configuration (as needed), repair of geotextile fabric (as needed), replenishment of stone and repairs to areas of erosion to return the areas to approximately the originally constructed elevations. If more extensive damage is observed, additional actions may be necessary. Where possible, maintenance of the stone revetment and terrace will be conducted at the same time as maintenance of the stone keys and stone toe protection.

## 5.3 Stone Toe Protection and Stone Keys

The stone toe protection and stone keys will be inspected and evaluated for signs of stone loss and self-launching, summarized as follows:

- Visible signs of erosion or stone self-launching, as evidenced by the presence of stone launched into the channel, decrease in surface elevations, exposure of bedding stone or geotextile fabric observed during visual inspection and in UAV photography.
- Measurements of depletion of stone toe protection or stone key, as evidenced by volumetric analysis using the UAV photogrammetric data.
- Measurements of depletion of stone toe protection based on erosion/losses of stone along the shoreline edge of the terrace, as evidenced by changes in elevation and/or width of the terrace in the photogrammetric data.

Maintenance will be triggered under the following conditions:

- Loss of self-launching portion of the stone toe protection or stone key such that there is less than approximately 50 percent of the original riprap per linear foot remaining of the stone toe or stone key.
- Presence of exposed underlying bedding stone, geotextile fabric, or native soil.

Maintenance will consist of replenishment of stone within the stone toe protection and/or stone keys and may include replenishment of riprap, bedding stone, and maintenance of the geotextile fabric to meet the design specifications included in the *Todd Creek Bank Stabilization Basis of Design Report* (Jacobs 2019). If more extensive damage is observed, additional actions may be necessary. Where possible, maintenance of the stone toe protection and stone keys will be conducted at the same time as maintenance of the stone revetment and stone terrace.

### 5.4 Permitting and Notifications

To maintain the stabilization measures near ECM-1 and ECM-4 within the original design specifications, permits and/or notifications to stakeholders may be required. The permits required for the construction of the stabilization measures are listed in Table 2 with potential notification or permitting needs for maintenance activities. If more extensive maintenance within the stabilization areas is required or additional stabilization is needed in other areas, agency notifications and new permits will be required, as detailed in Section E.9d.1.4.1.2 of the permit renewal application (Jacobs 2024).

# 6. Data Evaluation and Reporting

Data collected from routine and post-storm visual inspections and UAV surveys will be reviewed and evaluated, as described in Section 4, within 30 days of the visual inspection/UAV survey to determine if any maintenance is necessary. If it is determined that maintenance is needed, it will either be addressed within 90 days of the inspection or a plan, including a schedule, for addressing the deficiency, will be submitted to Georgia EPD within 90 days of the inspection.

In addition, a brief email summary of the results of each of the routine and post-storm visual inspections of Todd Creek streambank will be submitted to Georgia EPD within 30 days of the inspection. For the stabilized areas (ECM-1 and ECM-4) the summary will indicate if any maintenance triggers have been exceeded and the nature/magnitude of the exceedance. For the native streambank (transects DC-1, DC-2, ECM-0, ECM-2, and ECM-3) the notification will include measurements of bank recession (from the base line) and distance to the nearest trigger pin (where applicable).

The results of the site inspections and streambank monitoring will also be provided to Georgia EPD on an annual basis by April 1 for the period of January through December of the previous calendar year. The annual reports will provide the following information:

- Tabulated measurements of the distance from the baseline to the top of bluff for the established transects (DC-1, DC-2, ECM-0 to ECM-4) within areas of native streambank.
- Comparison of erosional areas to the Secondary Contingency Design line in the bank stabilization areas.
- Todd Creek visual inspection results, including any deficiencies identified and maintenance performed during the previous calendar year.
- UAV photographs of the streambank stabilization areas and native streambank for each inspection conducted during the reporting period.
- Comparisons of top of bluff measurements collected over time based on the UAV photographs.
- A data evaluation summary of the photogrammetry discussing observed changes between the design baseline, previous measurements, and current year measurements for cross sections of the bank stabilization areas, and volume of stone remaining in the bank stabilization areas. In addition, an evaluation of changes in the top of bluff for the native streambank compared to the previous year will be completed.
- Recommendations for future maintenance, if needed.

# 7. References

CH2M HILL Engineers, Inc. (CH2M). 2008. *Preliminary Design Report – Todd Creek Stabilization Project*. Prepared for UCC. April.

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# Tables

**Table 1. Monitoring & Maintenance Schedule**
Todd Creek Monitoring and Maintenance Plan
*UCC Woodbine, Camden County, Georgia*

| Description of Activity | Frequency/Schedule[1] | Notes |
|---|---|---|
| Distance to top of bluff measurements[2] | Quarterly for first year, as needed thereafter | Quarterly measurements will be discontinued if accuracy of UAV surveys is verified. |
| Inspections | Quarterly for first year, annual thereafter if approved; after storm events | Inspections will also be completed following storm events (as defined in Section 3.2.3). |
| UAV Photogrammetric Surveys | Quarterly for first year, annual thereafter if approved; after storm events | UAV surveys will also be completed within 45 days if post-storm inspection indicates substantial erosion has occurred. |
| Monitoring Data Evaluation | Within 30 days of UAV survey | Photogrammetric data processing/evaluation |
| Inspection Summary | Within 30 days of inspection | Brief email summary to Georgia EPD of the results of each of the routine and post-storm visual inspections/UAV surveys. |
| Address Maintenance Items | Within 90 days of inspection | Deficiencies noted during monitoring will either be addressed or a plan and schedule will be submitted to the Georgia EPD. Maintenance triggers are defined in Section 5. |
| Reporting | Annually by April 1 | Report summarizing monitoring and maintenance activities completed January through December of the previous calendar year. |

Notes:
[1.] Frequency/schedule to be implemented following issuance of the renewed Permit HW-063(D).
[2.] Applies to the native streambank only. All others apply to stabilized and native streambank.

**Table 2. Permits and Notifications for Maintenance Activities**

Todd Creek Monitoring and Maintenance Plan

*UCC Woodbine, Camden County, Georgia*

| Permit/Approval | Administering/ Involved Agencies | Major Requirements for Permitting/Notices | Requirements for Maintenance Within Design Specifications |
|---|---|---|---|
| Clean Water Act, Section 404 - U.S. Army Corps of Engineers (USACE) Nationwide Permit (Current Nationwide Permit SAS-2006-02190) | USACE, Savannah District | Jurisdictional Determination and Approval | No permitting or pre-construction notification requirement for maintenance activities. Nationwide Permit 3 (a) allows for the repair, rehabilitation, or replacement of any previously authorized, currently serviceable structure or fill, provided it is not to be put to uses differing from those in the original permit or most recently authorized modification. Minor deviations in the structure's configuration or filled area, including those due to changes in materials, construction techniques, requirements of other regulatory agencies, or current construction codes or safety standards that are necessary to make the repair, rehabilitation, or replacement are authorized. USACE will reissue this permit prior to the expiration date. |
| | | Section 404 Permit Joint Application with Georgia Coastal Marshlands Protection Act | |
| | Georgia Department of Natural Resources (GADNR) Environmental Protection Division | Section 401 Water Quality Certification | |
| | GADNR Environmental Protection Division Coastal Resources Division | Coastal Zone Management Act – Coastal Zone Consistency | |
| | Various Tribes | Tribal Consultation | |
| | GADNR, Historic Preservation Division | National Historic Preservation Act, Section 106 Consultation | |
| | U.S. Fish and Wildlife Service | Endangered Species Act Section 7 Consultation | |
| | | Endangered Species Act Section 7 Consultation, Migratory Bird Treaty Act | |
| | U.S. Fish and Wildlife Service<br>National Oceanic and Atmospheric Administration<br>National Marine Fisheries Service | Endangered Species Act Section 7 Consultation, Marine Mammal Protection Act<br>Magnuson–Stevens Fishery Conservation and Management Act | |
| | GADNR Wildlife Resources Division | Georgia Listed Species Consultation | |

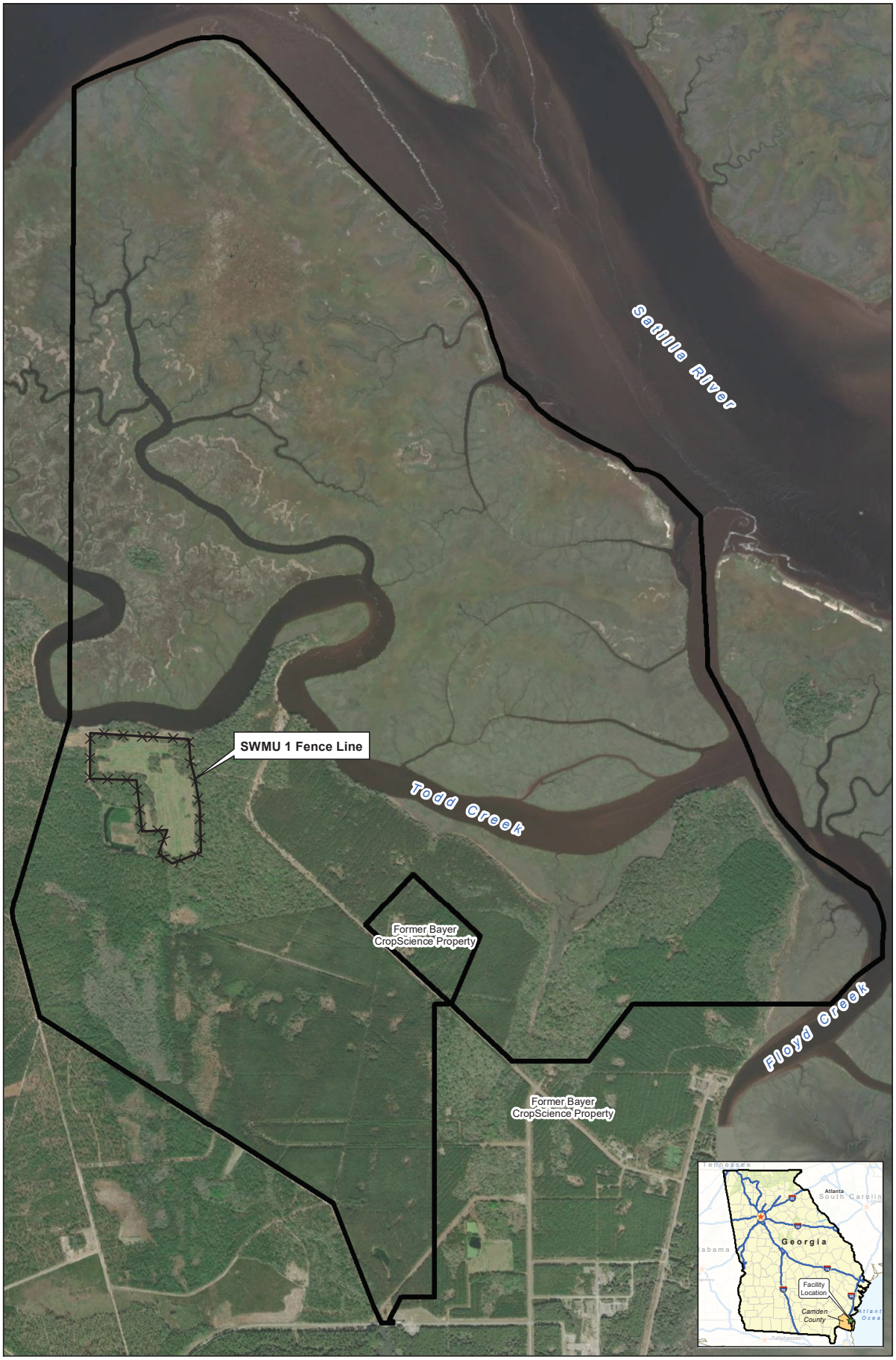
**Table 2. Permits and Notifications for Maintenance Activities**

Todd Creek Monitoring and Maintenance Plan

*UCC Woodbine, Camden County, Georgia*

| Permit/Approval | Administering/ Involved Agencies | Major Requirements for Permitting/Notices | Requirements for Maintenance Within Design Specifications |
|---|---|---|---|
| Georgia Coastal Marshlands Protection Act Permit (CMPA) | GADNR Coastal Resources Division (CRD) | Joint Application with USACE | Current CMPA (#770) expires April 17, 2025. It can be renewed for an additional 5 years. While the permit is active, maintenance activities require a verbal and written approval request submittal to CRD. Approval is expected to take days to a week to obtain. Maintenance needed following permit expiration will require a Letter of Permission from CRD which typically consists of notification to CRD, a 45-day agency review, and 15-day notice on CRD website for public viewing. Approval is expected to take 2 to 3 months to obtain. |
| | | Jurisdictional Determination and Approval | |
| | | Revocable License Request | |
| | | Permanent Easement Request | |
| | | Coastal Zone Management Act – Coastal Zone Consistency | |
| Georgia Stream Buffer Variance | GADNR Environmental Protection Division | Stream Buffer Variance | Consultation required to determine if Georgia Stream Buffer Variance is required to be issued. |
| National Pollutant Discharge Elimination System (NPDES) Permit | GADNR Environmental Protection Division | NPDES Permit for Stormwater Discharges from Construction Activities (General Permit No. GAR 100001) | NPDES permit is not required for maintenance activities within the design specifications. |
| | Camden County | | |
| Local Permits (Local Issuing Authority) | Camden County | County Land Disturbance Activity (LDA) Permit | Camden County requires an LDA permit for any land disturbance activity. Notification to the County of maintenance activities is required to determine if LDA permit is required. |
| | Georgia Soil and Water Conservation Commission | Erosion Sediment and Pollution Control Plan Review | Erosion Sediment and Pollution Control Plan Review may be required if an LDA permit is required. |

# Figures




Closed Landfill Boundary/Fence

Property Boundary

N

0 800 1,600 3,200

Feet

**Notes:**

1. ESRI Aerial from ArcGIS Online, Dated 3/5/2023
2. Property boundary based on survey completed September 21, 2017 by Geomatics Corporation.

**Figure 1.** Site Location Map
Todd Creek Monitoring and Maintenance Plan
*UCC Woodbine Facility, Camden County, Georgia*


**LEGEND**

- Erosion Control Measurement (ECM) or Data Collection (DC) Line
- Design Initiation Trigger Pin
- Primary Contingency Pin
- Secondary Contingency Pin
- Monitoring Well
- Fence
- Reference Line
- Streambank Stabilization Areas
- Transitional Grading Areas
- Landfill Boundary

Notes:
Aerial Imagery: November 2023

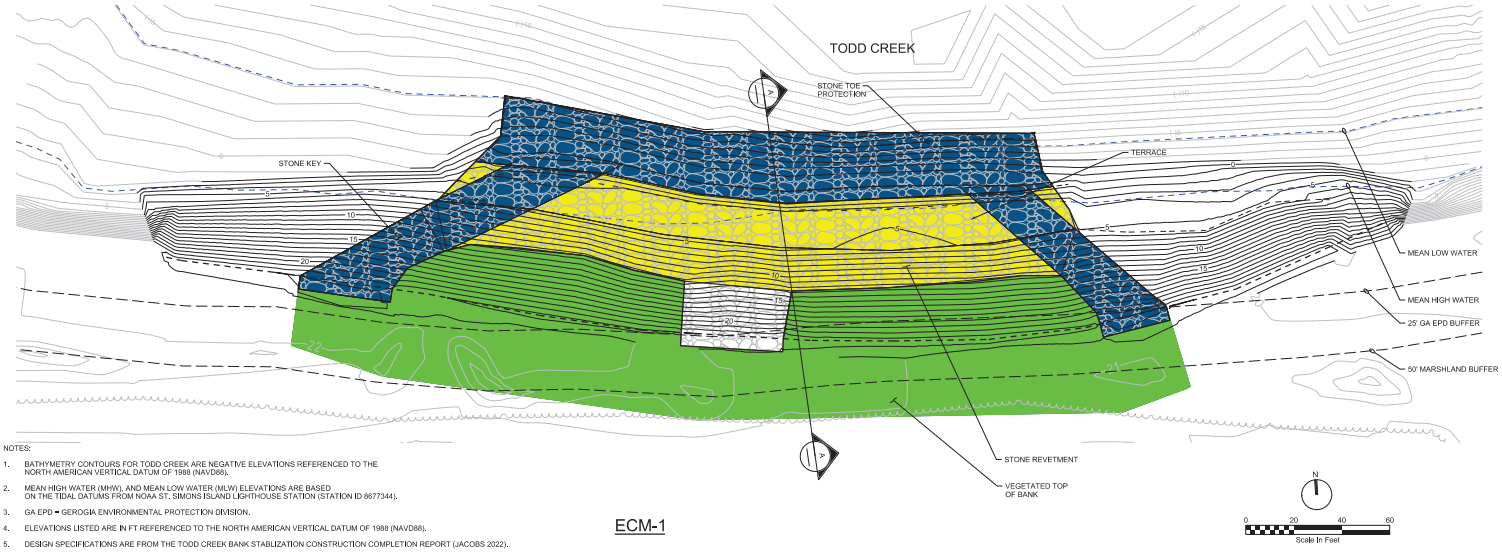
N

0 150 300
Approximate scale in feet

**Figure 2. Streambank Monitoring Area and Features**
Todd Creek Monitoring and Maintenance Plan
*Union Carbide Corporation*
*UCC Woodbine, Camden County, Georgia*

Jacobs

\\DC1VS01\GISPROJ\DJDOW\CHEMICALS\WOODBINE\MAPFILES\2024\TODDCREEK_MONITORING_AND MAINT\FIGURE02_SITE MAP AND EXISTING CONDITIONS.MXD STOLZRC 8/4/2024



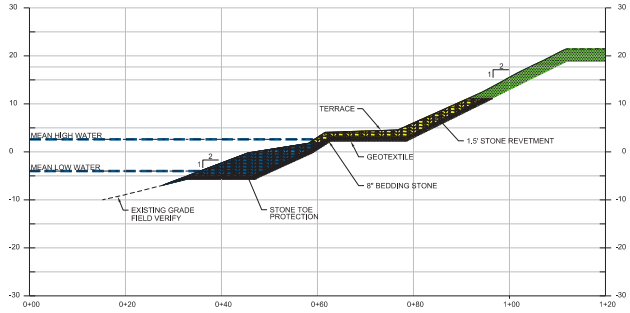

NOTES:

1. BATHYMETRY CONTOURS FOR TODD CREEK ARE NEGATIVE ELEVATIONS REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
2. MEAN HIGH WATER (MHW), AND MEAN LOW WATER (MLW) ELEVATIONS ARE BASED ON THE TIDAL DATUMS FROM NOAA ST. SIMONS ISLAND LIGHTHOUSE STATION (STATION ID 8677344).
3. GA EPD = GEROGIA ENVIRONMENTAL PROTECTION DIVISION.
4. ELEVATIONS LISTED ARE IN FT REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
5. DESIGN SPECIFICATIONS ARE FROM THE TODD CREEK BANK STABILIZATION CONSTRUCTION COMPLETION REPORT (JACOBS 2022).

ECM-1

LEGEND

- VEGETATED SLOPES & TOP OF BANK
- STONE REVETMENT
- STONE TOE PROTECTION & STONE KEYS
- RIPRAP




SECTION A-A

SCALE: 1" = 10' HORIZ
1" = 10' VERT

FIGURE 3. ECM-1 STABILIZATION MEASURES
TODD CREEK MONITORING AND MAINTENANCE PLAN
UCC WOODBINE FACILITY, CAMDEN COUNTY, GEORGIA

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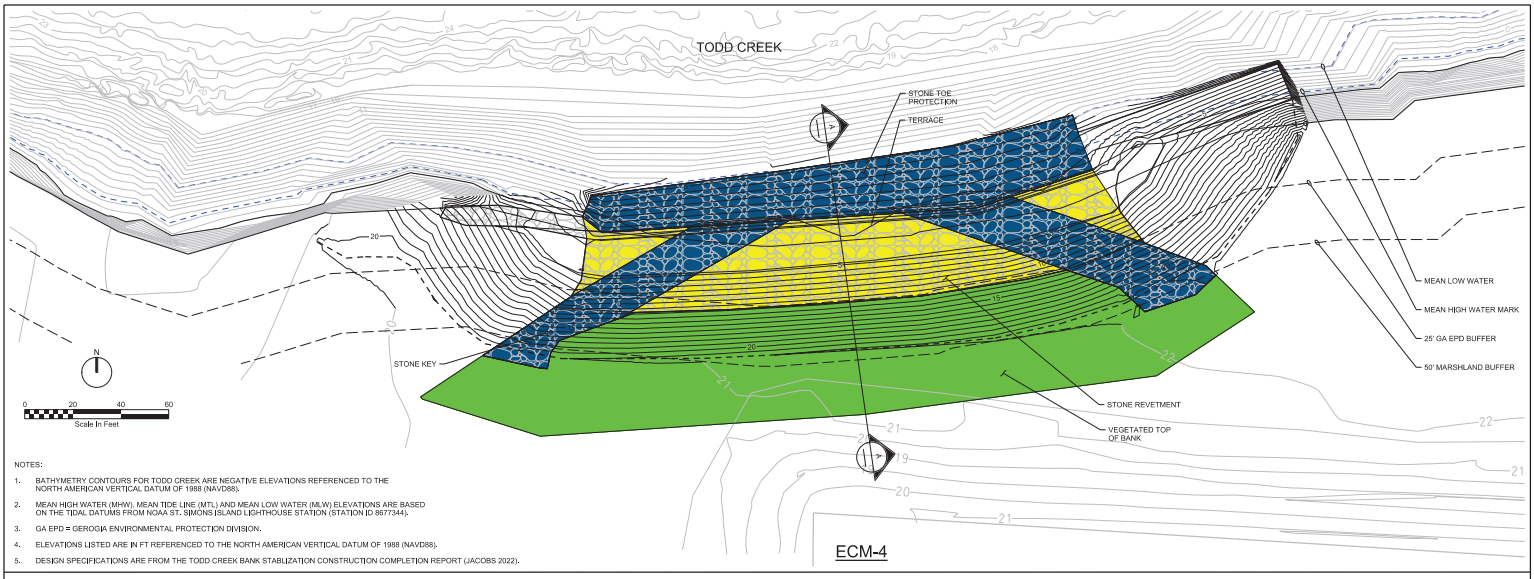


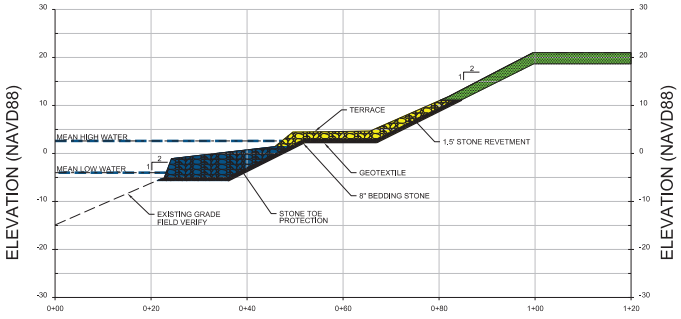

NOTES:

1. BATHYMETRY CONTOURS FOR TODD CREEK ARE NEGATIVE ELEVATIONS REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
2. MEAN HIGH WATER (MHW), MEAN TIDE LINE (MTL) AND MEAN LOW WATER (MLW) ELEVATIONS ARE BASED ON THE TIDAL DATUMS FROM NOAA ST. SIMONS ISLAND LIGHTHOUSE STATION (STATION ID 8677344).
3. GA EPD = GEROGIA ENVIRONMENTAL PROTECTION DIVISION.
4. ELEVATIONS LISTED ARE IN FT REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
5. DESIGN SPECIFICATIONS ARE FROM THE TODD CREEK BANK STABLIZATION CONSTRUCTION COMPLETION REPORT (JACOBS 2022).

ECM-4

LEGEND

- VEGETATED SLOPES & TOP OF BANK
- STONE REVETMENT
- STONE TOE PROTECTION & STONE KEYS
- RIPRAP




SECTION A-A

SCALE: 1" = 10' HORIZ
1" = 10' VERT

FIGURE 4. ECM-4 STABILIZATION MEASURES
TODD CREEK MONITORING AND MAINTENANCE PLAN
UCC WOODBINE FACILITY, CAMDEN COUNTY, GEORGIA

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# Appendix A
# Inspection Checklists

**TODD CREEK STREAMBANK STABILIZATION AREA INSPECTION LOG**

UNION CARBIDE CORPORATION WOODBINE FACILITY, CAMDEN COUNTY, GEORGIA

| | |
|---|---|
| Erosion Control Measurement Transect (ECM) ID | |
| Date/Time of Inspection | |
| Reason for Inspection | |
| Weather Conditions:<br>Temperature (°F)<br>Wind Speed/Direction | |
| Time of Low Tide | |
| Inspector Full Name | |
| Type of UAV inspection completed | |
| Drone Pilot | |

**Condition of vegetated slope and top of bank**

| INSPECTION ITEM | Y/N | NOTES |
|---|---|---|
| Is vegetation distressed/dead? | | |
| Any bare spots needing soil/seed? If so, provide dimensions in feet. | | |
| Is there evidence of erosion on the slopes? If so, provide dimensions in feet. | | |
| Any evidence of burrowing / damage? | | |

**Condition of the stone revetment & terrace**

| INSPECTION ITEM | Y/N | NOTES – INDICATE FEATURE(S) IMPACTED |
|---|---|---|
| Is there visible riprap erosion? | | |
| Is bedding stone visible/ exposed? | | |
| Is the geotextile filter fabric exposed? | | |
| Is underlying soil exposed (geotextile disturbed or missing)? | | |
| Is there sediment deposition and/or debris present? | | |

**Condition of the stone toe protection & stone keys**

| INSPECTION ITEM | Y/N | NOTES - INDICATE FEATURE(S) IMPACTED |
|---|---|---|
| Is there visible riprap erosion? Visible areas of loss / launching stone? | | |
| Is bedding stone visible/ exposed? | | |
| Is the geotextile filter fabric exposed? | | |
| Is underlying soil exposed (geotextile disturbed or missing)? | | |
| Is there sediment deposition and/or debris present? | | |

**TODD CREEK NATIVE STREAMBANK INSPECTION LOG**

UNION CARBIDE CORPORATION WOODBINE FACILITY, CAMDEN COUNTY, GEORGIA

| | |
|---|---|
| Erosion Control Measurement Transect (ECM) / Data Collection (DC) ID: | |
| Date/Time of Inspection: | |
| Reason for Inspection: | |
| Weather Conditions:<br>Temperature (°F)<br>Wind Speed/Direction | |
| Time of Low Tide: | |
| Inspector Full Name: | |
| Type of UAV inspection completed: | |
| Drone Pilot: | |

| INSPECTION ITEM | Y/N | NOTES |
|---|---|---|
| Is there downed or overgrown vegetation present along the measurement transect? | | |
| Is Primary Design trigger pin (115 ft pin) present / stable? | | |
| Is Primary Installation trigger pin (100 ft pin) present / stable? | | |
| Is Secondary Installation trigger pin (85 ft pin) present / stable? | | |
| Any evidence of burrowing / damage near trigger pins? | | |
| Is there evidence of undercutting / erosion? If no, note if aggradation (deposition) is occurring. | | |

**Transition areas adjacent to the stabilization areas**

| INSPECTION ITEM | Y/N | NOTES |
|---|---|---|
| Is erosion control mat/fabric present / intact? | | |
| Is vegetation distressed/dead? | | |
| Is there erosion / undercutting of native streambank immediately adjacent to the stabilization area? | | |
| Are groundwater seeps visible within the transition areas? | | |