

March 26, 2024

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**SUBJECT: *Existing Conditions Stream & Streambank Structure Assessment*
Howell Creek Streambank Stabilization/Restoration
City of Winter Park, Orange County, Florida**

Ms. Eby,

Pond & Company's Environment + Water Resources team (Pond) has completed an existing conditions survey and constraints review for the Howell Creek Streambank Stabilization/Restoration project (project). Additionally, Pond staff have completed a reference reach survey to inform design development for the restoration and/or stabilization of portions of Howell Creek between Lake Sue and Lake Virginia. This report has been prepared to document the findings associated with the stream assessment and provide initial considerations of constraints associated with the project area. This report should be reviewed in conjunction with the Environmental Survey Report, which documents the water resource delineation.

SECTION 1 - INTRODUCTION

The Howell Creek stream and structure assessment was completed to collect baseline resource information necessary to inform concept design preparation and permitting constraints considerations. Existing condition observations and data collection including Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) findings are outlined in **Section 2**. A reference reach geomorphic survey was just downstream of the Lake Sue outlet. This location was deemed adequate for reference reach consideration due to both its relatively natural geomorphic stability as well as its stable altered condition that would most similarly exemplify the target conditions for restoration approaches on downstream impacted reaches. Information collected from the reference reach survey provides data necessary to inform the Howell Creek restoration/stabilization design. **Section 2** documents our findings from this survey effort.

STREAMBANK AND STRUCTURE CONDITION/REPAIR PRIORITIZATION RANKING

During the stream and baseline streambank structure assessment, Pond established a ranking system to identify and compare existing conditions and repair priority. The below descriptions summarize the zero (0) to five (5) ranking system noted in this report and the associated figures. Please note these descriptions are not all-inclusive and have been generally defined to provide perspective on the frame of reference used to evaluate streambanks and/or structures.

- **Ranking Zero (0):** Structure and/or streambank is in seemingly excellent condition, does not appear to be structurally compromised, is not contributing to streambank erosion, and/or is not actively eroding. No action is recommended for these features.
- **Ranking One (1):** Structure and/or streambank is in seemingly great condition, does not appear to be structurally compromised, and is not contributing to streambank erosion. There may be a few minor defects or cosmetic damage, but none that is of immediate concern. No action is recommended for these features.

- **Ranking Two (2):** Structure and/or streambank is in seemingly good condition, but there may be minor instability or erosion present; however, these issues do not appear to be actively worsening. Structures with this ranking are of generally lower concern; therefore, no action is recommended.
- **Ranking Three (3):** Structure and/or streambank is moderately unstable, there may be areas of accelerated erosion, and functionality is diminishing. These structures are of moderate concern and action is recommended but may not be immediately required.
- **Ranking Four (4):** Structure and/or streambank is greatly unstable and/or is actively deteriorating. Structure is either eroding or contributing to erosion up/downstream, functionality is actively diminishing, and action is highly recommended.
- **Ranking Five (5):** Structure and/or streambank is in extremely poor condition, the structure is visibly compromised, is not functioning as intended, is contributing to streambank erosion up/downstream of the observation location, and/or is actively eroding. Immediate action is recommended for this feature.

SECTION 2 – EXISTING CONDITIONS GEOMORPHIC AND STRUCTURE ASSESSMENT

2.1 – OVERVIEW

A segment of Howell Creek was evaluated to document baseline conditions: (1) from the headwaters at the outlet of Lake Sue downstream approximately 2,400 linear feet (station (Sta.) 0+00 – 24+00) to S. Pennsylvania Ave, and (2) along the downstream extent approximately 3,200 linear feet to its outfall into Lake Virginia (Sta. 24+00 – 56+30); **Figure 2, Attachment A**). Additionally, a limited geomorphic analysis was completed along this segment of Howell Creek to collect information necessary to inform the streambank stabilization design and assess the feasibility of various repair approaches. The data collected along Howell Creek will be utilized during the concept design and permitting process to establish baseline conditions.

2.2 – BASELINE RESOURCE DATA COLLECTION SUMMARY

2.2.1 Howell Creek from Lake Sue to Lake Virginia

Baseline data collection along Howell Creek included representative longitudinal profiles, cross sections, pebble counts, and planform geometry measurements (**Figure 2, Attachment A**). Each component of the baseline survey is utilized to determine the existing stream classification, impairments, and possible design considerations to stabilize/restore the stream to a more natural, yet resilient system capable of withstanding significant storm events given the geographic proclivity for hurricanes, namely within a highly urban setting.

Background research indicates that Winter Park previously experienced unprecedented rainfall, flooding, and infrastructure failures as a result of Hurricane Ian, particularly along Howell Creek and its associated lake system. Hurricane Ian, along with other similar storm events, has increased local concerns of the instability of the streambanks along private properties, public properties, and other infrastructure. Howell Creek's streambanks between Lake Sue and Lake Virginia have been historically modified and hardened with structures such as seawalls, sheet piling, and other various artificial embankments. Such structures comprise of or utilize materials such as concrete bags/blocks, crushed concrete, commercial riprap, recycled wooden crossties, plastic and composite sheeting, and/or a combination of materials. In general, modification activities to natural systems in conjunction with natural weather events, or even disasters in the case of regional hurricanes, lead to instances of structural damage, streambank erosion, and increased stress from the stream flow along its banks, particularly upstream and/or downstream of bank structures. Additional discussion of the instability noted along Howell Creek is addressed in **Section 2.3** and **Section 3.1**.

Based on the Rosgen stream classification methodology, the assessed portion of Howell Creek exhibits characteristics of E5 and F5 channel types (**Figure 1**, Rosgen, 1994). E5-type streams are sand-dominated streams that are classified as low-gradient, narrow, and deep meandering channels, with broad floodplains. F6 streams are also sand-dominated but possess lower sinuosity, wider channels, and are less entrenched as compared to an E5

stream. Because Howell Creek is within a highly residential and developed landscape/floodplain, urbanization has impacted this system through the straightening of the channel and hardening of the stream's banks. These factors have artificially decreased the system's sinuosity, increased its entrenchment, and led to instances of streambank erosion.

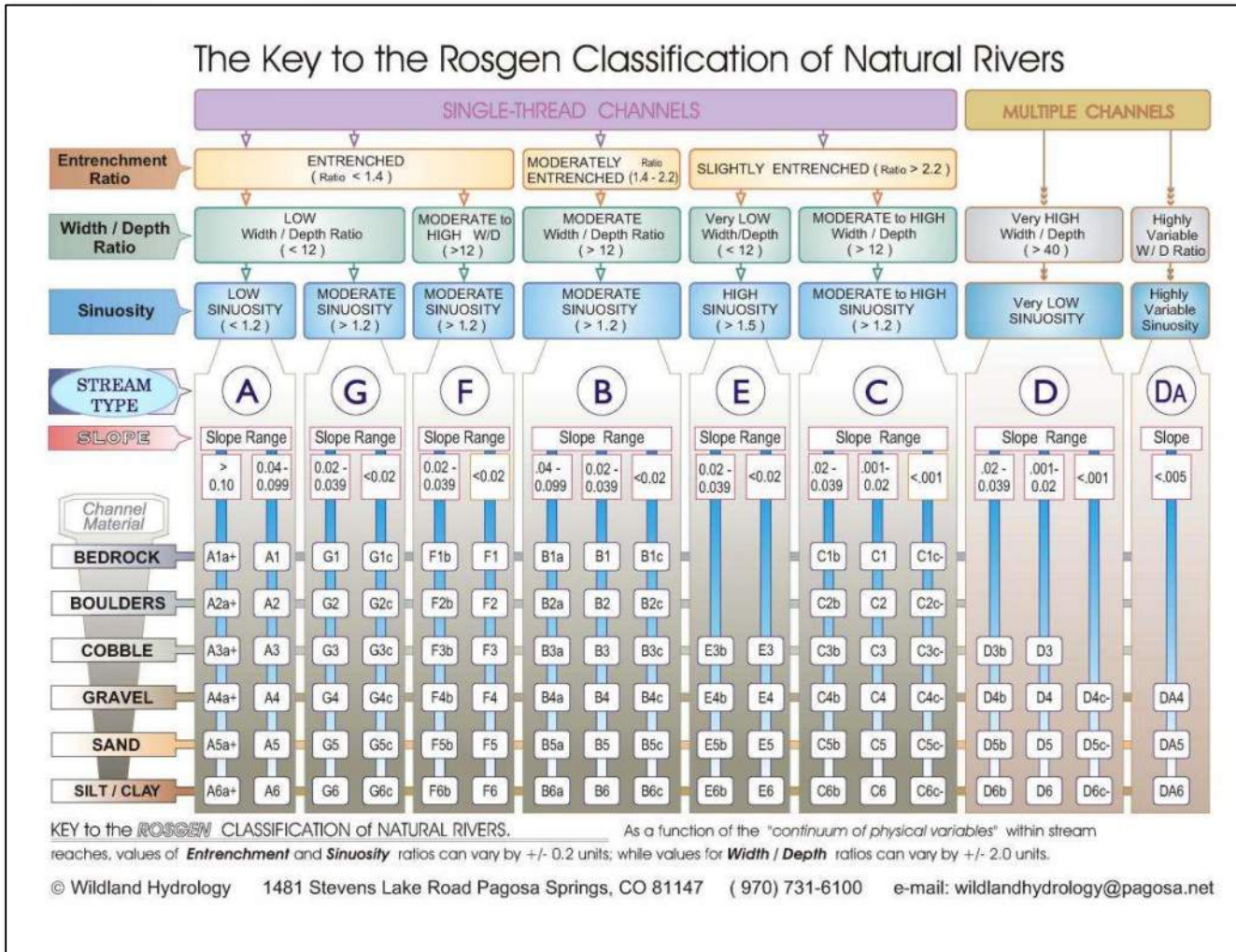


Figure 1: Rosgen Stream Classification Methodology (Rosgen 1994)

2.2.2 Howell Creek at Lake Sue Outlet – Reference Reach

As part of the stream restoration/stabilization design process, a site is identified and surveyed to document a stable stream nearby with similar watershed characteristics (e.g. drainage area, urban, impervious, and forested area), also referred to as the reference reach. The reference reach is utilized by the project team to prepare a plan that mimics a naturally stable system respective to the stream's unique characteristics. Because there will not be any geomorphic alteration of Howell Creek beyond in-situ structure repair or replacement and minor bank stabilization, utilizing reference data from a stable reach within the same system is an appropriate approach.

Reference reach baseline data collection along Howell Creek extended from the outlet of Lake Sue to station ~2+00. Various data collected included representative cross-sections, a longitudinal profile, and planform geometry measurements (**Figures 3 & 5, Attachment A**). The location of the reference reach survey represents a generally

stable condition encompassing a variety of stream bank conditions such as structurally reinforced banks, natural vegetated banks, and sodded residential banks which characterize the length of Howell Creek.

Based on the Rosgen stream classification methodology, the reference reach exhibits the characteristics of an C5 stream type (Rosgen, 1994) with a primarily fine sand substrate. A summary table of key metrics used to gauge the stable condition of the Howell Creek system is provided in **Table 1**. Howell Creek has a wide bankfull width and exhibits minor entrenchment but is well connected to its adjacent floodplain which relieves bank stress during flood events. While the reference reach has a sparse understory, the presence of a mix of large Cyprus trees, landscaped grass species, and various herbaceous natives have contributed significantly to streambank stability.

Table 1 – Howell Creek Reference Reach Key Metrics

Geometry Measurement	Value	Units
Bankfull Width	31.5	Feet
Bankfull Riffle Depth	1.22	Feet
Estimated Floodprone Width	~75	Feet
Channel Slope	0.3	Percent

2.3 – BANK EROSION HAZARD INDEX AND NEAR BANK STRESS ANALYSIS

Both BEHI and NBS analyses were completed as part of the existing conditions assessment for Howell Creek. The BEHI evaluation inventories streambank characteristics such as geometry, root cover, root depth, root density, streambank angle, streambank surface protection, and soil composition. Additionally, the NBS evaluation inventories the stream pattern, profile, streambank characteristics and forces that contribute to streambank erosion. Numerical field measurements are converted using a scaling factor to correspond with stability risk ratings. Erodibility (i.e. BEHI) and the stream forces (i.e. NBS) are ranked on a scale from very low to extreme, with extreme corresponding to conditions with the greatest instability and erosion potential. Together, BEHI and NBS provide a predictive model for streambank erosion and downstream sediment migration (David L. Rosgen, 2001). Findings from the BEHI and NBS evaluations are depicted in **Figures 3 & 4 (Attachment A)**.

2.3.1 Howell Creek from Lake Sue to Lake Virginia

As is evident from site conditions, Howell Creek has been anthropogenically reinforced along the streambanks with various forms of hardening materials along the majority of its length from Lake Sue to Lake Virginia. Structures found to be in disrepair or were actively deteriorating as well as the absence of vegetative cover along the banks were strong indicators for increased BEHI and NBS scores.

The combination of high-velocity flows and highly deteriorated structures results in an increased risk of bank and channel erosivity; therefore, other structures throughout Howell Creek in similar physical conditions demonstrate in-kind effects on streambank integrity. In addition to failing structures contributing to instability and erosion issues, banks without adequate rooted vegetation are likewise highly susceptible. Passive repair measures, such as vegetative reinforcement/improvement approach, in these areas can be beneficial not only to banks already experiencing degradation but also as a preventative measure for banks that may not yet be experiencing significant signs of erosion.

2.3.2 Howell Creek at Lake Sue Outlet – Reference Reach

BEHI and NBS surveys were completed along the reference reach to provide a target baseline for stable conditions to be achieved in repair sections throughout the project area, but it should be noted that the reference reach survey included a small reach along left bank that has been identified as a priority for repair.

From station ~1+00 to station ~1+50, left bank was noted to be actively eroding with a very high BEHI rating and a high NBS rating (**Figures 3 & 4; Attachment A**). Reduced vegetation along this portion of left bank combined

with the increasingly confined nature of Howell Creek moving downstream has contributed to accelerated forces and increased erosion/instability. The remaining portion of the reference reach provided adequate baseline data capturing a stable reach with appropriate pattern, profile, and flood prone streambank access during elevated flow conditions. Overall, the identified reference reach is characterized by a range of bank conditions that were noted throughout Howell Creek and exhibited a healthy baseline for reference design considerations.

SECTION 3 – VEGETATIVE COMMUNITIES

3.1 – EXISTING PLANT COMMUNITIES AND INVASIVES CONSIDERATIONS

The vegetative communities surrounding Howell Creek are heavily influenced by local residential landscaping preferences, though most species were found to be native to Florida. However, this region was historically a sandhills subregion of the Southern Coastal Plain, namely within the Central Florida Ridges and Uplands. The ridges and uplands that are characteristic of this central region were formed millions of years ago from the islands that once dotted the Florida peninsula which presently support many distinctive habitats and ecosystems. Not only does this geography support upland habitats, freshwater wetlands, and various transitional ecosystem regions, but it is also prime land for logging, agriculture, and human habitation according to the Florida Native Plant Society. Natural, undisturbed characteristics of a typical sandhills community include well-drained soils, widely spaced longleaf pine and turkey oak, and a wide diversity of understory grasses, woody shrubs, and wildflowers that are highly dependent on wildfires for density management and proliferation. Observations along the Howell Creek corridor substantiate such historical and present-day land-use activities.

While a well-developed canopy and understory were noted throughout portions the reach, there were scattered invasive species within the Howell Creek streambed (aquatic) and buffer understory strata, such as camphor-tree (*Cinnamomum camphora*), waterhyme (*Hydrilla verticillate*), floatingheart (*Nymphoides peltata*), wedelia (*Sphagneticola calendulacea*), and umbrella plant (*Cyperus alternifolius*). A list of vegetation observed within the buffer of Howell Creek is included in **Table 2** below. Throughout the stream and buffer corridor, the vegetative community is representative of a native Florida ecosystem influenced by the introduction of ornamental and landscape-friendly species. Considering Howell Creek flows through a highly residential landscape, the stratification of native ornamental trees and shrubs creates a well-developed canopy and understory with invasive species scattered throughout less maintained portions of the surveyed reach.

Table 2 – Howell Creek Buffer Plant Community

Common Name	Scientific Name	Strata	Exotic Plant Status*
Turk’s Cap	<i>Malvaviscus arboreus</i>	Understory	Native
Bull-tongue Arrowhead	<i>Sagittaria lancifolia</i>	Understory	Native
Dotted Smartweed	<i>Persicaria punctata</i>	Understory	Native
Arrow Arum	<i>Peltandra spp.</i>	Understory	Native
Southern Live Oak	<i>Quercus virginiana</i>	Overstory – Canopy	Native
Crepe Ginger	<i>Hellenia speciosa</i>	Understory	Native
Camphor Tree	<i>Cinnamomum camphora</i>	Mid-Story	Category 1
Red Mangrove	<i>Rhizophora mangle</i>	Aquatic	Native
Wax Myrtle	<i>Morella cerifera</i>	Overstory – Canopy	Native
Wild Coffee	<i>Psychotria nervosa</i>	Understory	Native
Dwarf Palmetto	<i>Sabal minor</i>	Mid-Story	Native
Walking Iris	<i>Neomarica gracilis</i>	Understory	Native
Carolina Cherry Laurel	<i>Prunus caroliniana</i>	Mid-Story	Native
Red Maple	<i>Acer rubrum</i>	Overstory - Canopy	Native
Water Oak	<i>Quercus nigra</i>	Overstory – Canopy	Native
American Eelgrass	<i>Vallisneria americana</i>	Aquatic	Native

Table 2 – Howell Creek Buffer Plant Community

Common Name	Scientific Name	Strata	Exotic Plant Status*
Split-leaf Philodendron	<i>Philodendron bipinnatifidum</i>	Mid-Story	Native
Waterhyme	<i>Hydrilla verticillate</i>	Aquatic	Category 1
Floating Water Moss	<i>Salvinia natans</i>	Aquatic	Native
Yellow Floatingheart	<i>Nymphoides peltata</i>	Aquatic	Category 1
Royal Fern	<i>Osmunda regalis</i>	Understory	Native
Chinese Wedelia	<i>Sphagneticola calendulacea</i>	Understory	Category 2
Umbrella Sedge	<i>Cyperus alternifolius</i>	Understory	Category 2
Lady Palm	<i>Rhapis excelsa</i>	Mid-Story	Native
Flaming Torch	<i>Billbergia pyramidalis</i>	Understory	Native

*Listing Status defined by the Florida Exotic Pest Plant Council.

Category 1 Exotic – Invasive exotics that are altering native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with natives.

Category 2 Exotic – Invasive exotics that have increased in abundance or frequency but have not yet altered Florida plant communities to the extent shown by Category 1 species.

3.2 – TARGET PLANT COMMUNITIES FOR PASSIVE RESTORATION AND ENHANCEMENT

The target condition for enhanced vegetation along Howell Creek would consist of a variety of understory, midstory, and canopy species that are typical of riparian zones in Central Florida. Locations that have been identified for a comprehensive vegetation enhancement plan include exposed sandbars in overly wide channel sections, bank reaches void of adequate vegetative variety (not including sodding), and as an additional natural protection factor to be utilized in tandem with soil layer lifts, geo-grids, or graded bank repair options. Well-established native vegetation is crucial for naturally protected and stabilized streambanks; therefore, recommended target species to be considered for such prescriptions are included in **Table 4** below. A mixed variety of container sizes, bare root seedlings, and live stakes would be recommended for vegetation improvements throughout the Howell Creek study reach.

Table 4 – Target Buffer Plant Community*

Common Name	Scientific Name	Strata
Crinum Lily	<i>Crinum americanum</i>	Understory
Chain Fern	<i>Woodwardia</i>	Understory
Royal Fern	<i>Osmunda regalis</i>	Understory
Blue-Flag Iris	<i>Iris virginica</i>	Understory
Dahoon Holly	<i>Ilex cassine</i>	Understory
Buttonbush	<i>Cephalanthus occidentalis</i>	Understory
Eelgrass	<i>Vallisneria americana</i>	Aquatic
Swamp Tupelo	<i>Nyssa biflora</i>	Mid-Story/Canopy
Wax Myrtle	<i>Morella cerifera</i>	Mid-Story/Canopy
Swamp Bay	<i>Persea palustris</i>	Mid-Story/Canopy
Red Bay	<i>Persea borbonia</i>	Mid-Story/Canopy
Cypress	<i>Taxodium spp.</i>	Mid-Story/Canopy

*Target Buffer Plant Community is subject to local nursery availability. Species utilized for streambank and buffer vegetation improvements may be modified through engagement with local nurseries and planters.

SECTION 4 – CONSTRAINTS REVIEW AND RECOMMENDED SOLUTIONS

4.2 – PROJECT CONSTRAINTS

A review of the land and tree survey, site observations, and coordination with City officials were completed to identify site-related constraints that may have implications for the construction of this project (**Attachment A-C**). The following items are initial constraints identified with property ownership, utilities, access, staging, and park operations:

1. A significant portion of the property involved in this project, including the footprint of Howell Creek is privately owned. Private landowner authorization to complete structure and/or streambank improvements would be required ahead of construction.
2. Howell Creek is located in a highly urbanized area/watershed. Access to portions of the stream reach may be challenging for construction contractors and will likely require the temporary/permanent relocation of various structures (fences, sheds, landscaping, etc.) to facilitate repair and/or installation. Additionally, unknown utilities may be present subgrade requiring greater coordination during construction for avoidance and/or relocation.
3. Several structures recommended for repair are located within the City of Winter Park-owned Mead Botanical Gardens property. Various facilities, bridges, and trails will need to be closed during the time of construction and post-construction restoration to ensure public safety and to facilitate the installation. Portions of trails may need to be relocated to accommodate the structure repair as well.
4. The environmental permitting environment in Florida is currently in a state of fluctuation as a Federal Court recently removed the state's authority over the Clean Water Act (CWA) Section 404 permitting program. The current understanding is the US Army Corps of Engineers will reinstate authority to review and issue permits associated with dredge or fill of Waters of the United States (WOTUS). This change likely will result in slower than typical permit review and issuance processes.

4.1 – DEBRIS ACCUMULATION REMOVAL RECOMMENDATION

Howell Creek receives significant flood flows from the upstream lakes and greater watershed; therefore, portions of the upstream and downstream reach of the resource exhibit signs of non-native sediment and debris presence assumably some of which can be attributed to recent hurricane events. In some cases, considerable debris deposition can increase the risk of erosion in downstream reaches due to the upstream aggradation constricting the normal flow area which in turn increases discharge velocity for downstream reaches. Due to evidence of extensive erosion and/or streambank structure instability along some areas of Howell Creek, there is reason to believe the presence of non-native debris could be contributing to this phenomenon. **Figure 5** in **Attachment A** details the portions of Howell Creek where debris accumulation was noted, and removal would benefit the system. Localized channel debris removal is recommended along with associated sediment removal to restore the functional capacity of the channel and to ensure the integrity of any newly repaired structures.

4.3 – STRUCTURE/STREAMBANK REPAIR ALTERNATIVES AND PHASING RECOMMENDATION

Stream structure improvements in high-priority locations have been recommended based on many factors including existing embankment characteristics, vulnerability priority, and constraints such as property access and proximity to nearby features. **Attachment D** includes typical details of various repair/stabilization options that may be employed to address stability concerns along Howell Creek. Each structure and repair option has been categorized according to three possible construction phasing and permitting scenarios:

Potential Permitting Scenario

- **Permitting Scenario 1:** No permit is required and/or the activity is exempt from permitting. This scenario is anticipated for repair measures that are localized in nature and are minimally to negligibly invasive/impactful.

- **Permitting Scenario 2:** Some permits may be required but can be satisfied with the presentation of design typical details and accompanying comprehensive narrative. This scenario may include coverage under a general permit requiring some level of notification to the associated agency.
- **Permitting Scenario 3:** Extensive permitting is anticipated in conjunction with thorough design development.

Proposed Construction Phasing

- **Phase 1:** Passive restoration through vegetative planting and/or the placement of coir fiber matting along portions of Howell Creek where the existing vegetation is sparse or limited to herbaceous species alone.
- **Phase 2:** A majority of structure repairs or replacements utilizing typical details and minimal auxiliary design measures. Localized channel debris removal to restore the functional capacity of the channel.
- **Phase 3:** Structure repairs requiring extensive design and permitting considerations.

A list of structures and/or streambanks recommended for repair or replacement along Howell Creek is included in **Table 5** below. Only repair priorities as defined by **Figure 5 (Attachment A)** are proposed. Also provided are parcel information, the priority ranking of each repair, the proposed measure for repair or replacement, and the anticipated phase/permitting scenario.

Table 5 – Structure and Bank Repair Options*

Structure ID	Parcel ID	Address	Repair Priority	Potential Stabilization/Restoration Measure Options	Proposed Phase & Permitting Scenario
S-1 (Sta. 0+75)	302207793900281	1741 BARCELONA WAY	0	No Action is Recommended	NA
Natural Bank (L) (Sta. 1+00)	292213066845010	3333 LAKE SHORE DR	4	Bank Grading, Coir Fiber Matting, and Plantings	2
S-2 (Sta. 1+75)	292213066845010	3333 LAKE SHORE DR	0	No Action is Recommended	NA
S-3 (Sta. 5+00)	292213066835441	1541 NOTTINGHAM ST	2	No Action is Recommended	NA
S-4 (Sta. 6+00)	302207793900250	1719 BARCELONA WAY	3	Bioengineered Natural Wall System with Plantings	2
S-5 (Sta. 8+00)	302207606000000	1300 S DENNING DR	0	No Action is Recommended	NA
S-6 (Sta. 9+50)	302207793900220	1667 BARCELONA WAY	2	No Action is Recommended	NA
S-7 (Sta. 11+50)	302207793900200	1655 BARCELONA WAY	2	No Action is Recommended	NA

Structure ID	Parcel ID	Address	Repair Priority	Potential Stabilization/Restoration Measure Options	Proposed Phase & Permitting Scenario
S-8 (Sta. 12+75)	302207793900200 302207793900190	1647/1655 BARCELONA WAY	3	Bioengineered Natural Wall System with Plantings	2
S-9 (Sta. 13+75)	302207793900190	1647 BARCELONA WAY	5	Bioengineered Natural Wall System with Plantings	2
S-10 (Sta. 14+75)	302207606000000	1300 S DENNING DR	5	Guardian Permashield or Gabion Baskets	2
S-11 / Weir #1 (Sta. 15+50)	302207606000000	1300 S DENNING DR	4	Reset Weir, Bioengineered Natural Wall System with Plantings	2
S-12 (Sta. 16+00)	302207793900170	1631 BARCELONA WAY	0	No Action is Recommended	NA
S-13 (Sta. 19+50)	302207793900150	1615 BARCELONA WAY	3	Bioengineered Natural Wall System with Plantings	2
Weir #2 (Sta. 20+75)	302207606000000	1300 S DENNING DR	4	Reset Weir, Bioengineered Natural Wall System with Plantings	2
Plastic Weir (Sta. 21+50)	302207606000000	1300 S DENNING DR	3	In-kind Maintenance, Tie Back Into Slope	2
Natural Bank (L) (Sta. 22+50)	302207606000000	1300 S DENNING DR	4	Bioengineered Natural Wall System with Plantings	3
S-14 (Sta. 23+25)	302207793900140	1607 BARCELONA WAY	4	Guardian Permashield or Sheet Pile	2
S-15 (Sta. 25+50)	302207049601010	1350 S PENNSYLVANIA AVE	1	No Action is Recommended	NA
S-16 (Sta. 26+25)	302207049601010	1350 S PENNSYLVANIA AVE	0	No Action is Recommended	NA
S-17 (Sta. 27+75)	302207049601030	1410 BONNIE BURN CIR	0	No Action is Recommended	NA
S-18 (Sta. 28+75)	302207049601040	1420 BONNIE BURN CIR	1	No Action is Recommended	NA
S-19 (Sta. 31+75)	302207049601060	1440 BONNIE BURN CIR	2	No Action is Recommended	NA

Structure ID	Parcel ID	Address	Repair Priority	Potential Stabilization/Restoration Measure Options	Proposed Phase & Permitting Scenario
S-20 (Sta. 31+75)	302207890805130	1385 RICHMOND RD	0	No Action is Recommended	NA
S-21 (Sta. 32+25)	302207049601070	1450 BONNIE BURN CIR	0	No Action is Recommended	NA
S-22 (Sta. 33+25)	302207890805140	1391 RICHMOND RD	4	Injection Grouting and Bank Void Backfill	1
S-23 (Sta. 34+50)	302207000000001	0 S PENNSYLVANIA AVE	3	Bioengineered Natural Wall System with Plantings	2
Natural Bank (Sta. 55+00)	302207890808080	275 STIRLING AVE	3	Bioengineered Natural Wall System with Plantings	2
Passive Vegetative Improvements	Multiple Reach- Wide	Multiple Reach- Wide	5	Vegetative Planting and Coir Fiber Matting Installation (as needed)	1
Debris Removal	Multiple Reach- Wide	Multiple Reach- Wide	4	Accumulated Sediment Removal to Native Substrate/Pre-Storm Condition	2
*Note that all potential repair and/or stabilization measures, their associated priority, permitting phase, etc. are subject to change upon further evaluation, design development, permit consideration review, and budgetary constraints.					

SECTION 5 – SUMMARY AND CONCLUSIONS

This stream and streambank structure assessment was completed to establish baseline conditions of Howell Creek from Lake Sue to Lake Virginia. Findings detailed in this report suggest that several locations require immediate repair of either natural streambanks or streambank retaining structures due to deteriorating conditions, erosion, and contribution to downstream sedimentation. Impacts from recent large-magnitude storm events have contributed to the poor condition of many of these structures. Failure of the structures and/or would have implications for potential property loss, downstream sedimentation, further watershed impairment, as well as increased flooding/inundation. Debris removal, structure/streambank repair, and streambank plantings are options recommended to improve the concerns for infrastructure and property along Howell Creek.

Sincerely,

Pond & Company Environment + Water Resources

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ATTACHMENTS:

Attachment A: Project Figures

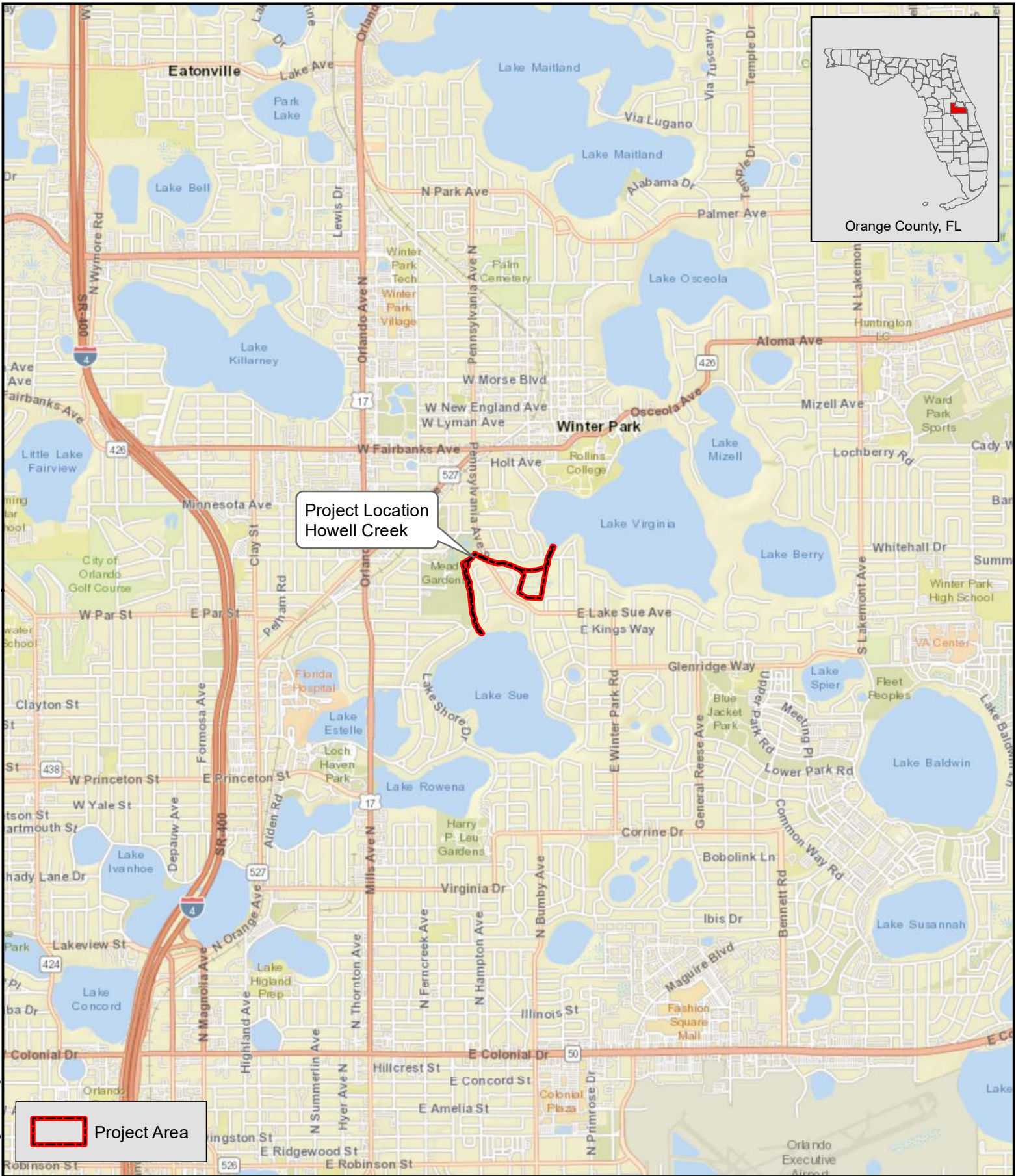
Attachment B: Photograph Log


Attachment C: Draft Land and Tree Survey

Attachment D: Structure/Bank Repair Option Typical Details

ATTACHMENT A: PROJECT FIGURES

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 Project Area

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Figure 1
Project Location Map



0 3,000 6,000 Feet

0 1,000 2,000 Meters

Howell Creek Streambank Stabilization/Restoration

City of Winter Park, FL

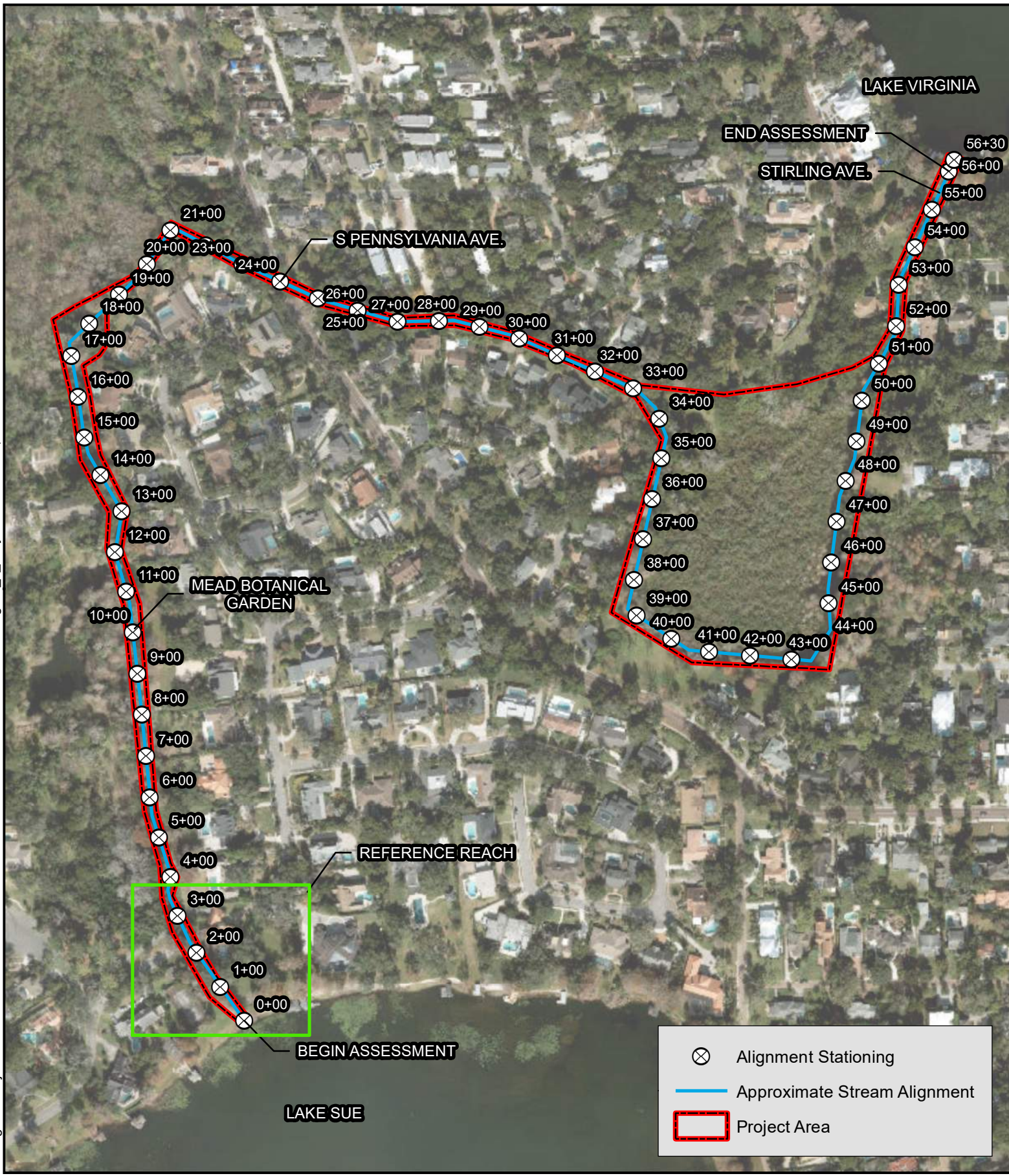
February 2024

Pond Project #: 1230646

Map Author: Alex Darr

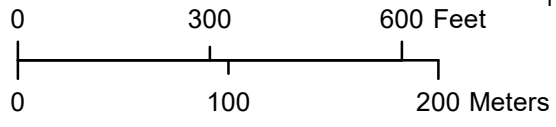
1 in = 3,000 ft

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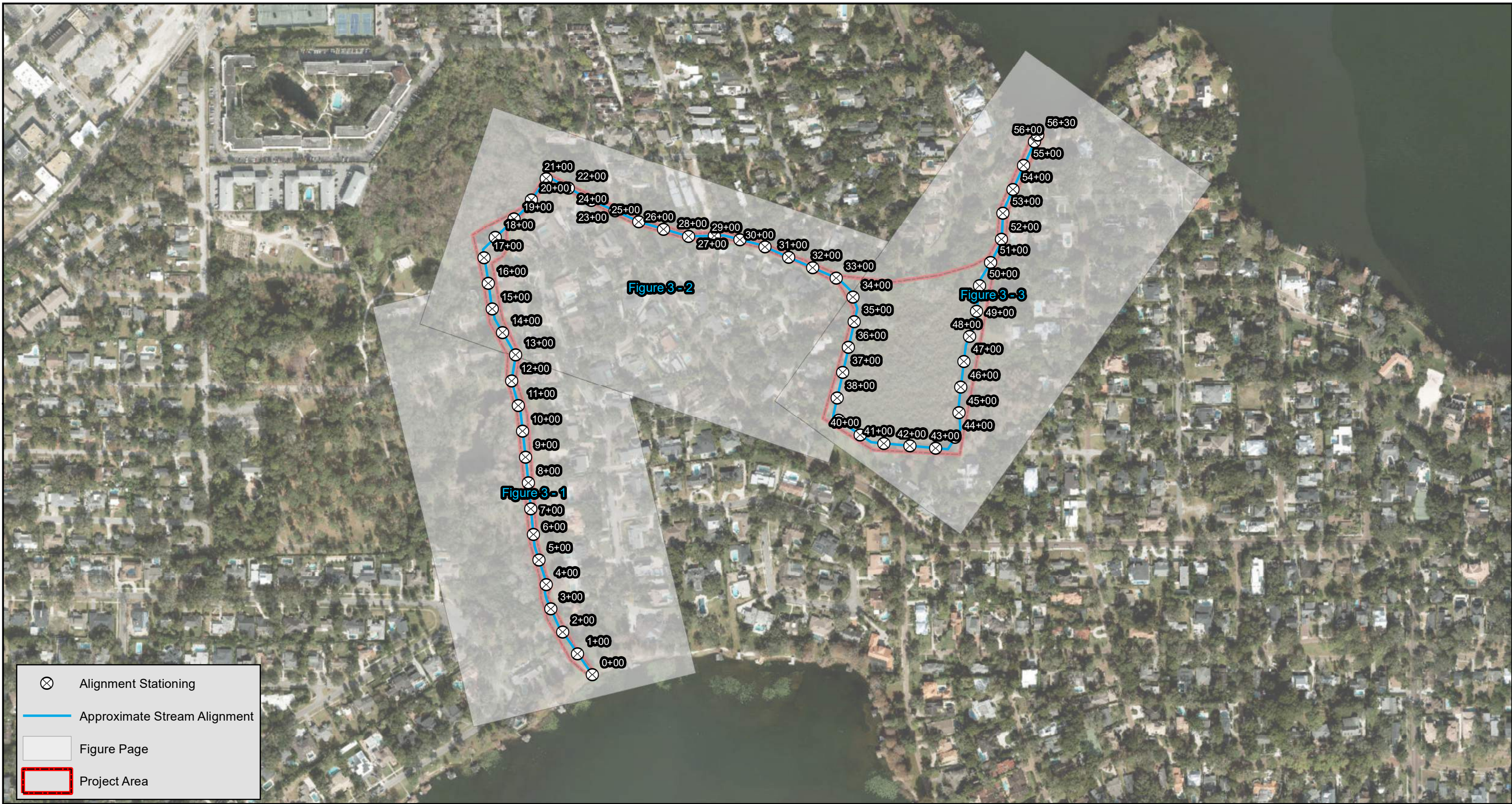
Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Figure 2
Project Overview Map



Howell Creek Streambank Stabilization/Restoration
 City of Winter Park, FL
 February 2024
 Pond Project #: 1230646
 Map Author: Alex Darr

1 in = 300 ft



Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

**Figure 3 - Index
Bank Erosion Hazard Map**

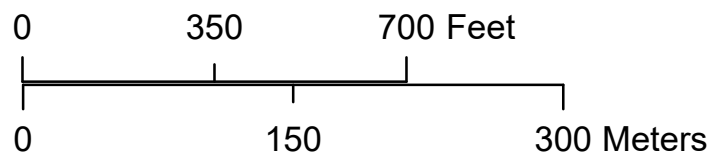
Howell Creek Streambank Stabilization/Restoration

Orange County

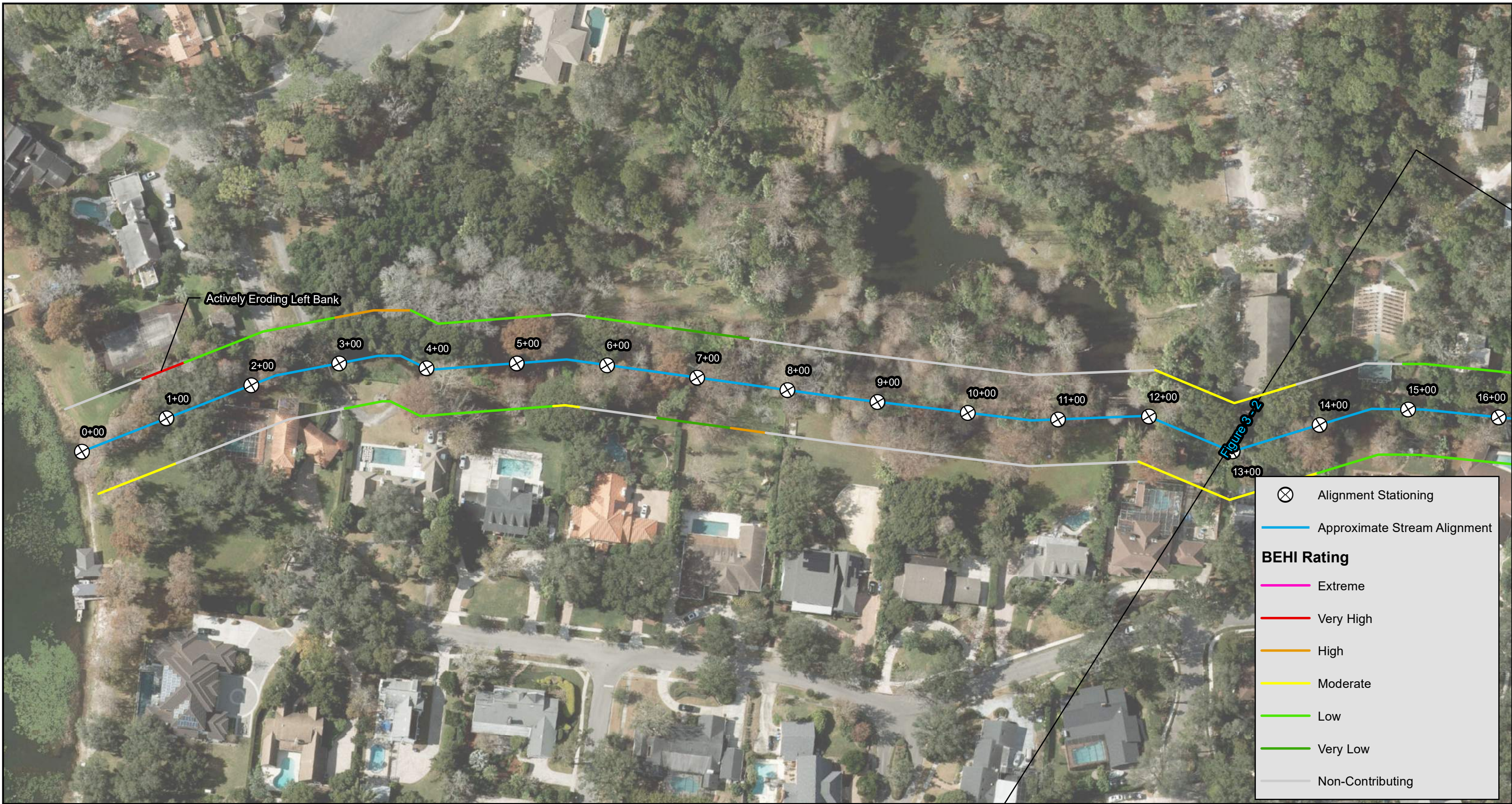
February 2024

Pond Project #: 1230646

Map Author: Alex Darr

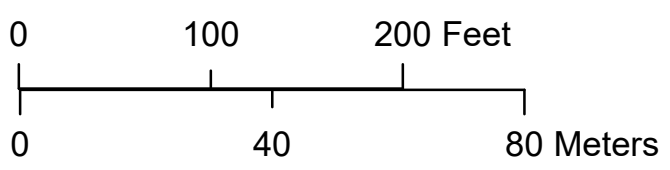


1 in = 350 ft



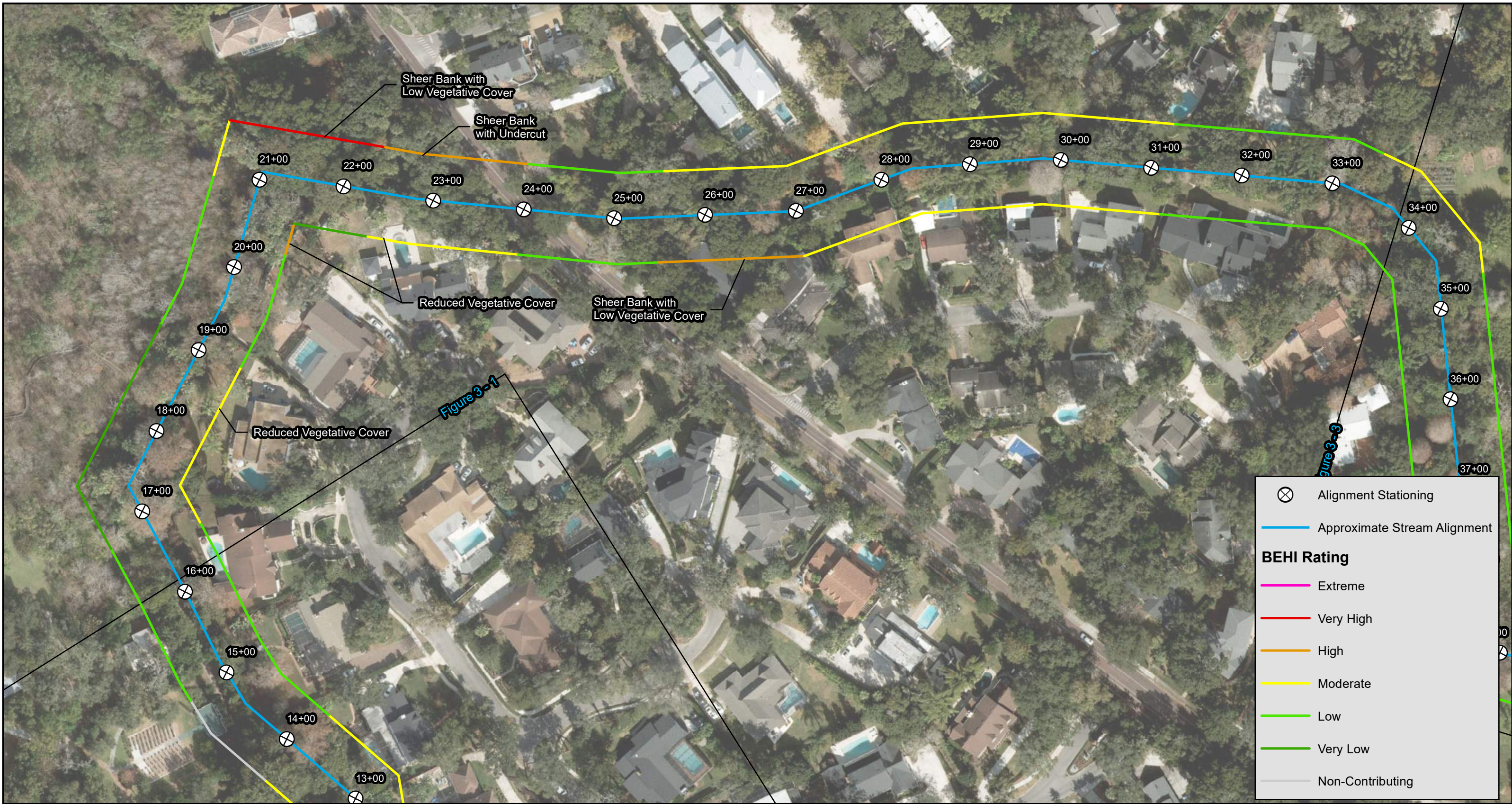
Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Figure 3 - 1
Bank Erosion Hazard Map



Howell Creek Streambank Stabilization/Restoration
Orange County
February 2024
Pond Project #: 1230646
Map Author: Alex Darr

1 in = 100 ft



Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Figure 3 - 2
Bank Erosion Hazard Map

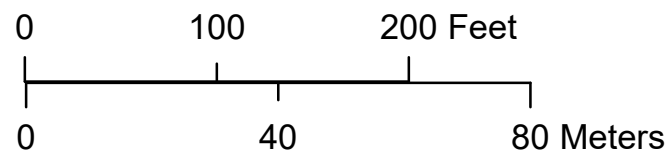
Howell Creek Streambank Stabilization/Restoration

Orange County

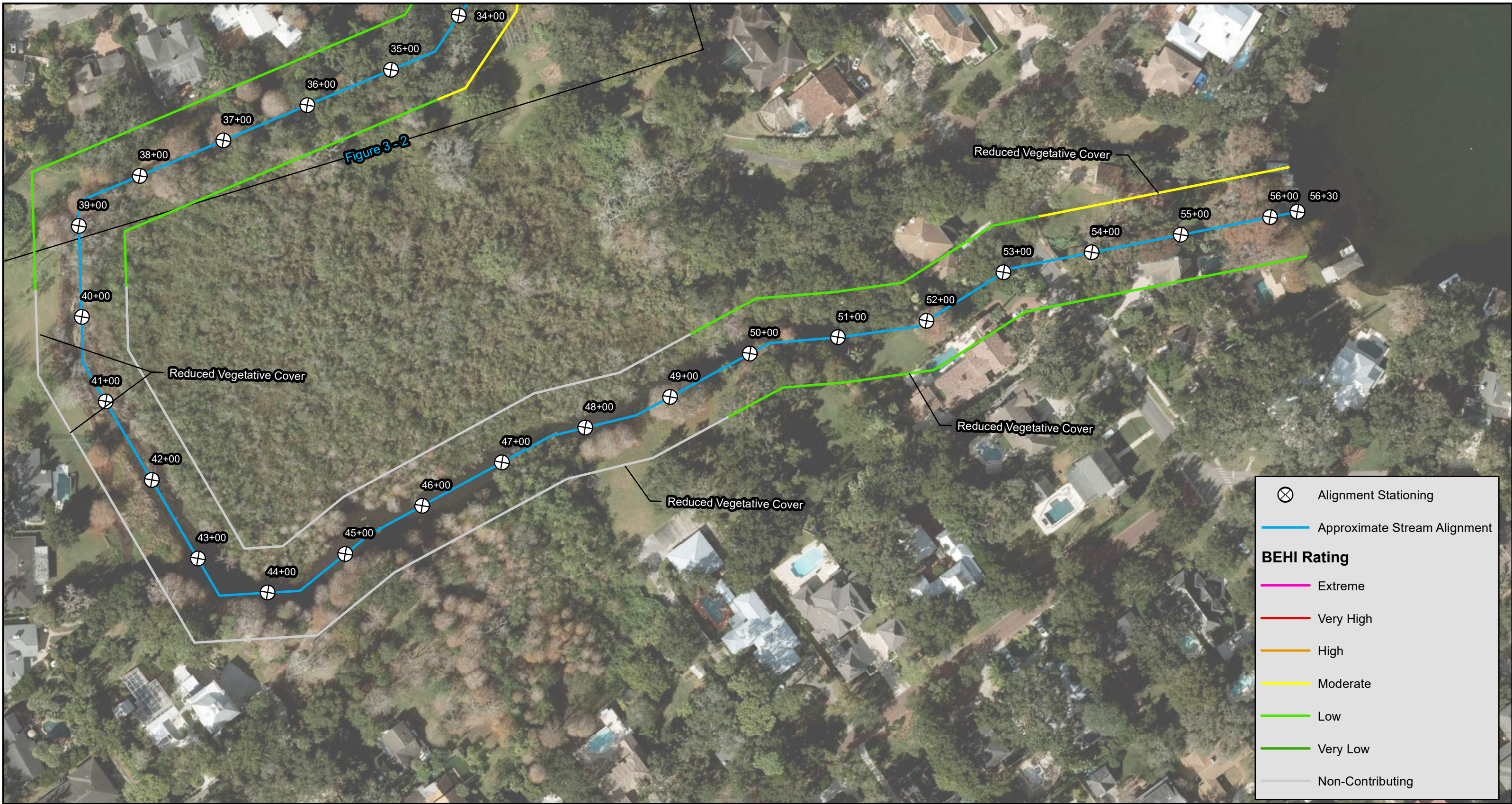
February 2024

Pond Project #: 1230646

Map Author: Alex Darr



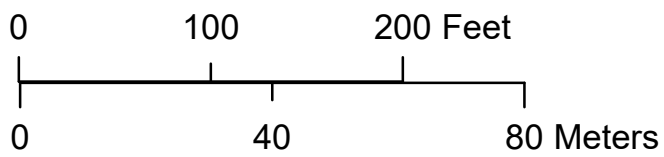
1 in = 100 ft



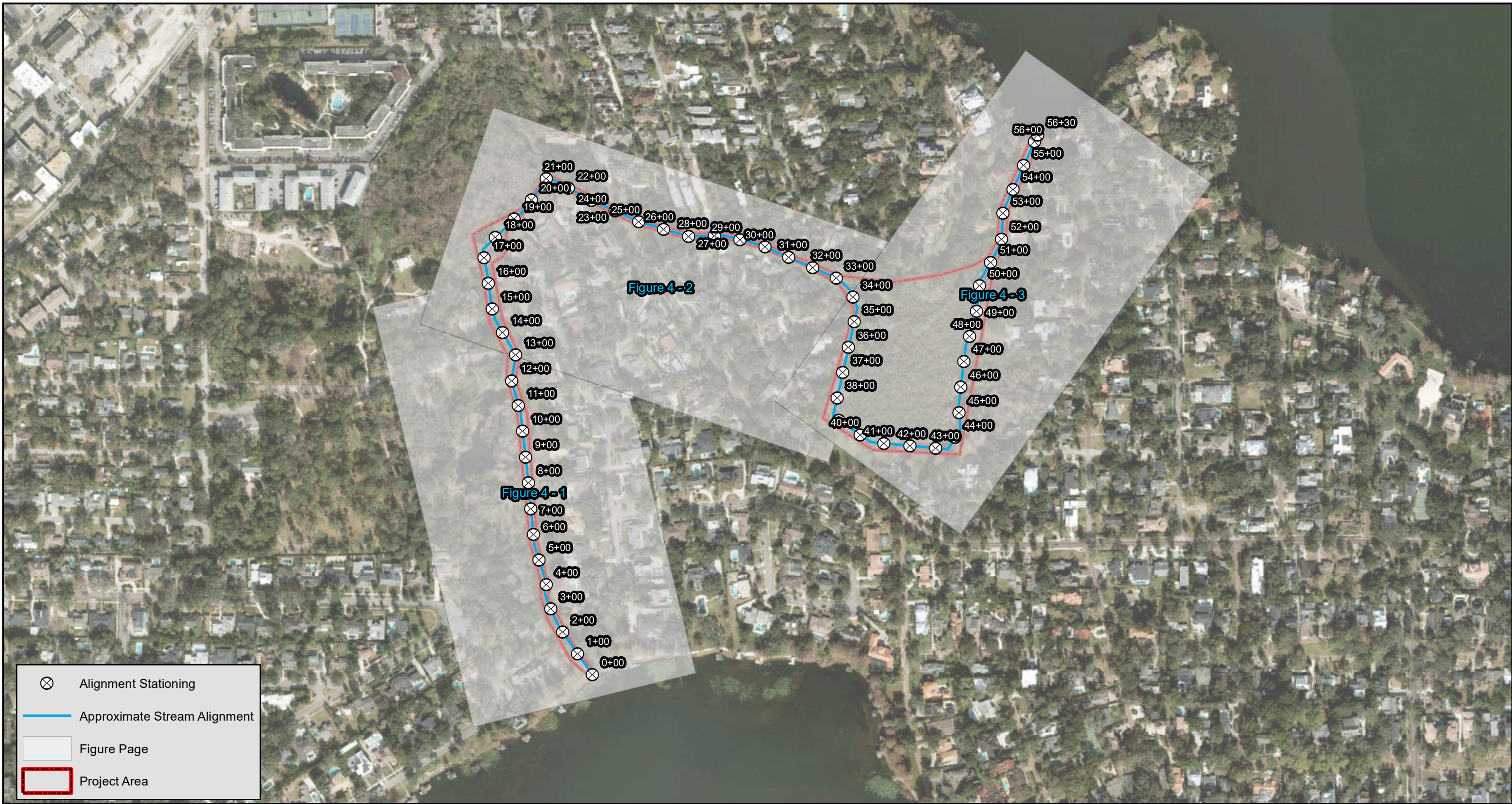
Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Figure 3 - 3
Bank Erosion Hazard Map

Howell Creek Streambank Stabilization/Restoration
Orange County
February 2024
Pond Project #: 1230646
Map Author: Alex Darr



1 in = 100 ft



Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

**Figure 4 - Index
Near Bank Stress Map**

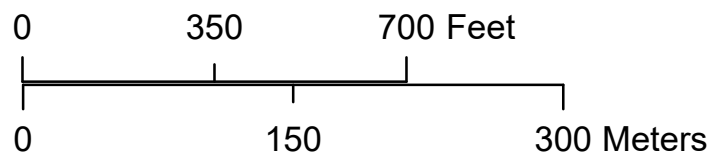
Howell Creek Streambank Stabilization/Restoration

Orange County

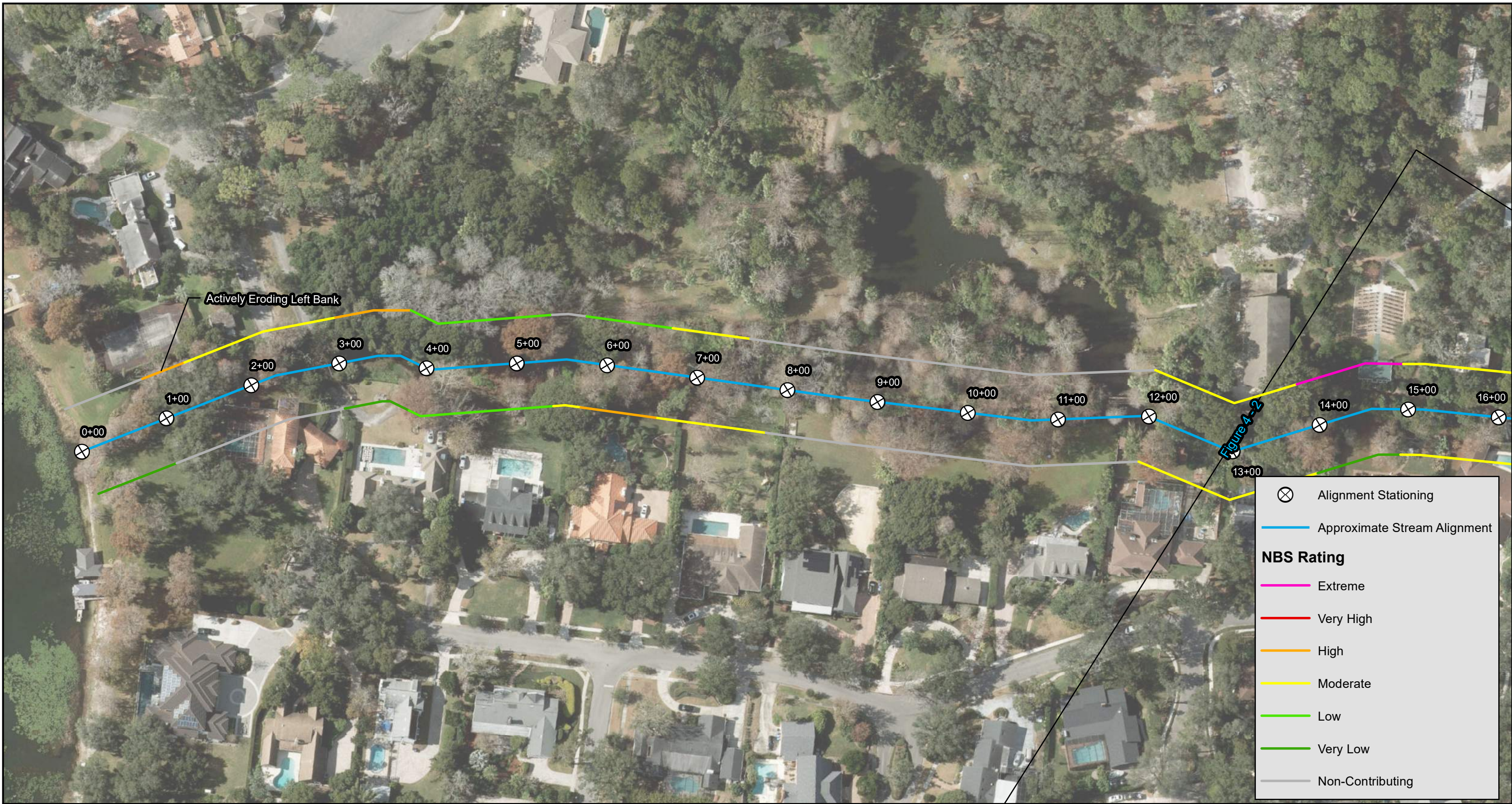
February 2024

Pond Project #: 1230646

Map Author: Alex Darr

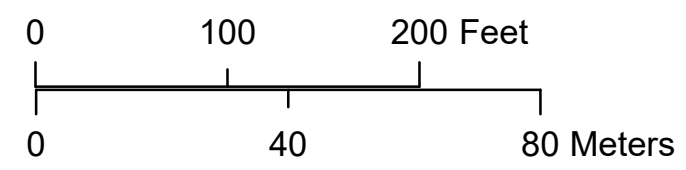


1 in = 350 ft



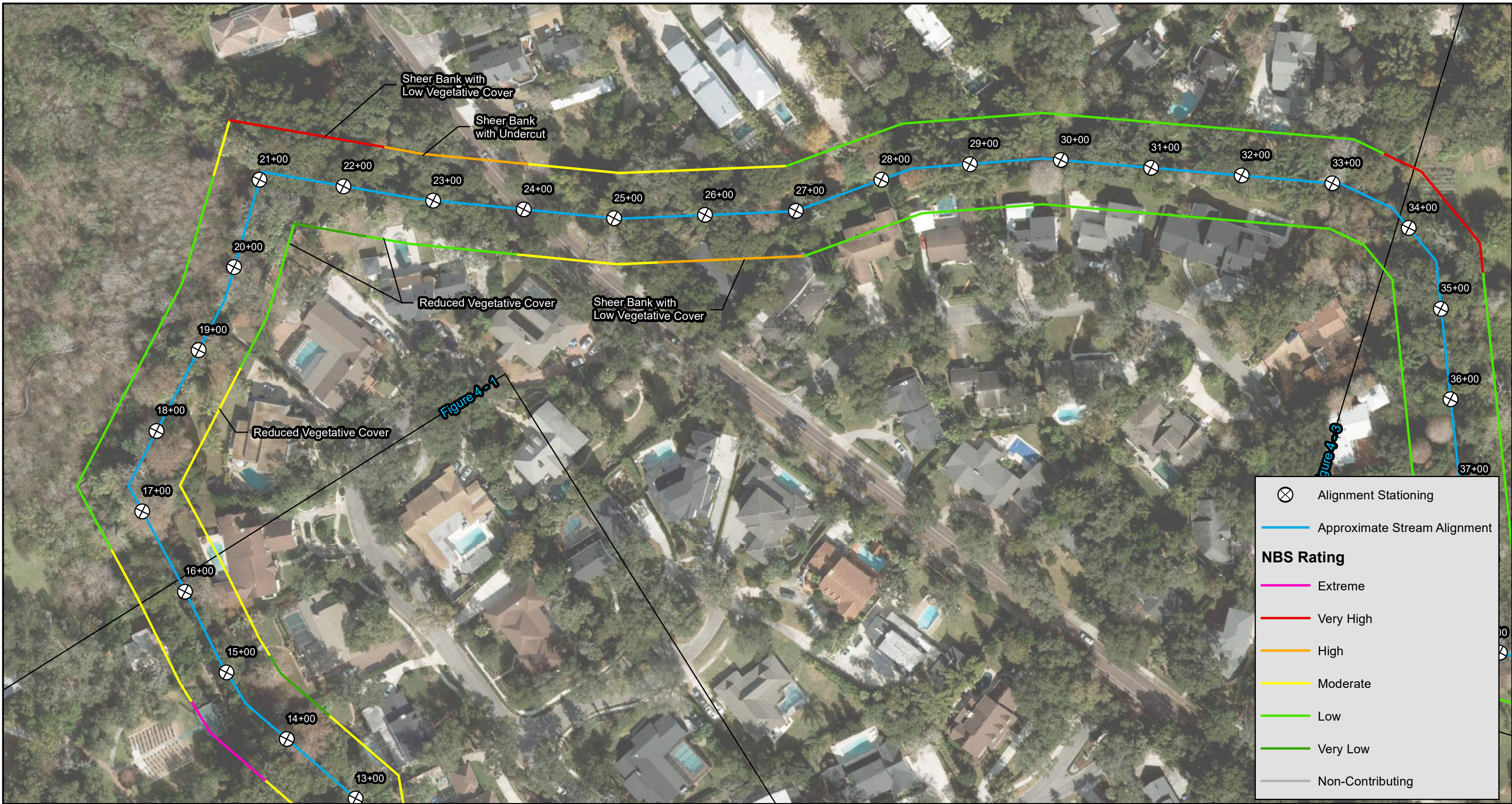
Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Figure 4 - 1
Near Bank Stress Map



Howell Creek Streambank Stabilization/Restoration
Orange County
February 2024
Pond Project #: 1230646
Map Author: Alex Darr

1 in = 100 ft



Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

**Figure 4 - 2
Near Bank Stress Map**

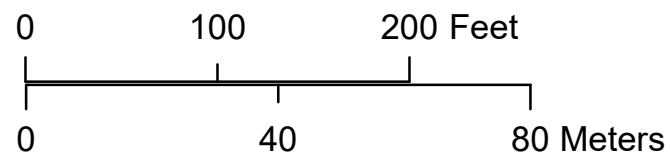
Howell Creek Streambank Stabilization/Restoration

Orange County

February 2024

Pond Project #: 1230646

Map Author: Alex Darr

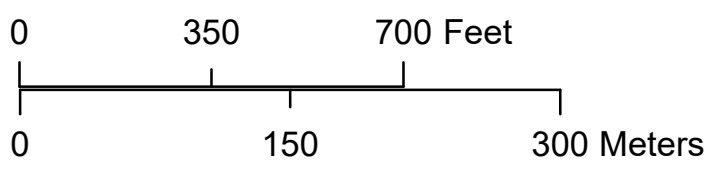


1 in = 100 ft



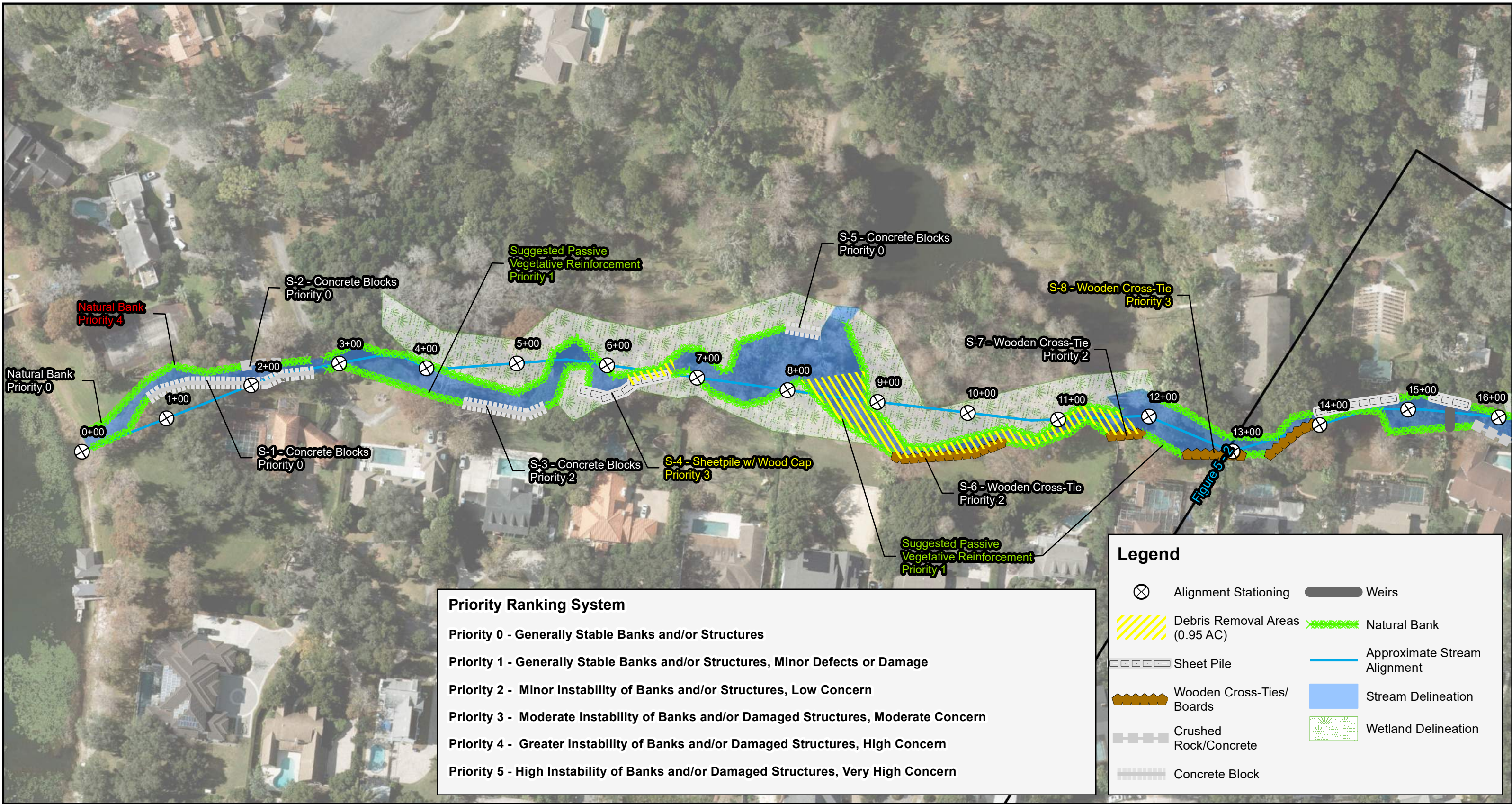
Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Figure 5 - Index
Structure and Streambank Repair Prioritization Map



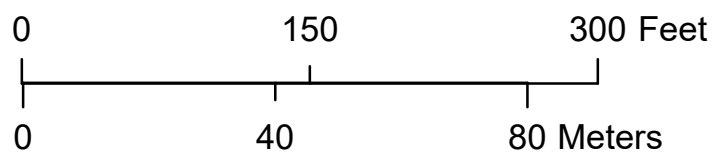
Howell Creek Streambank Stabilization/Restoration
 Orange County
 February 2024
 Pond Project #: 1230646
 Map Author: Alex Darr

1 in = 350 ft



Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Figure 5 - 1
Structure and Streambank Repair Prioritization Map



1 in = 100 ft

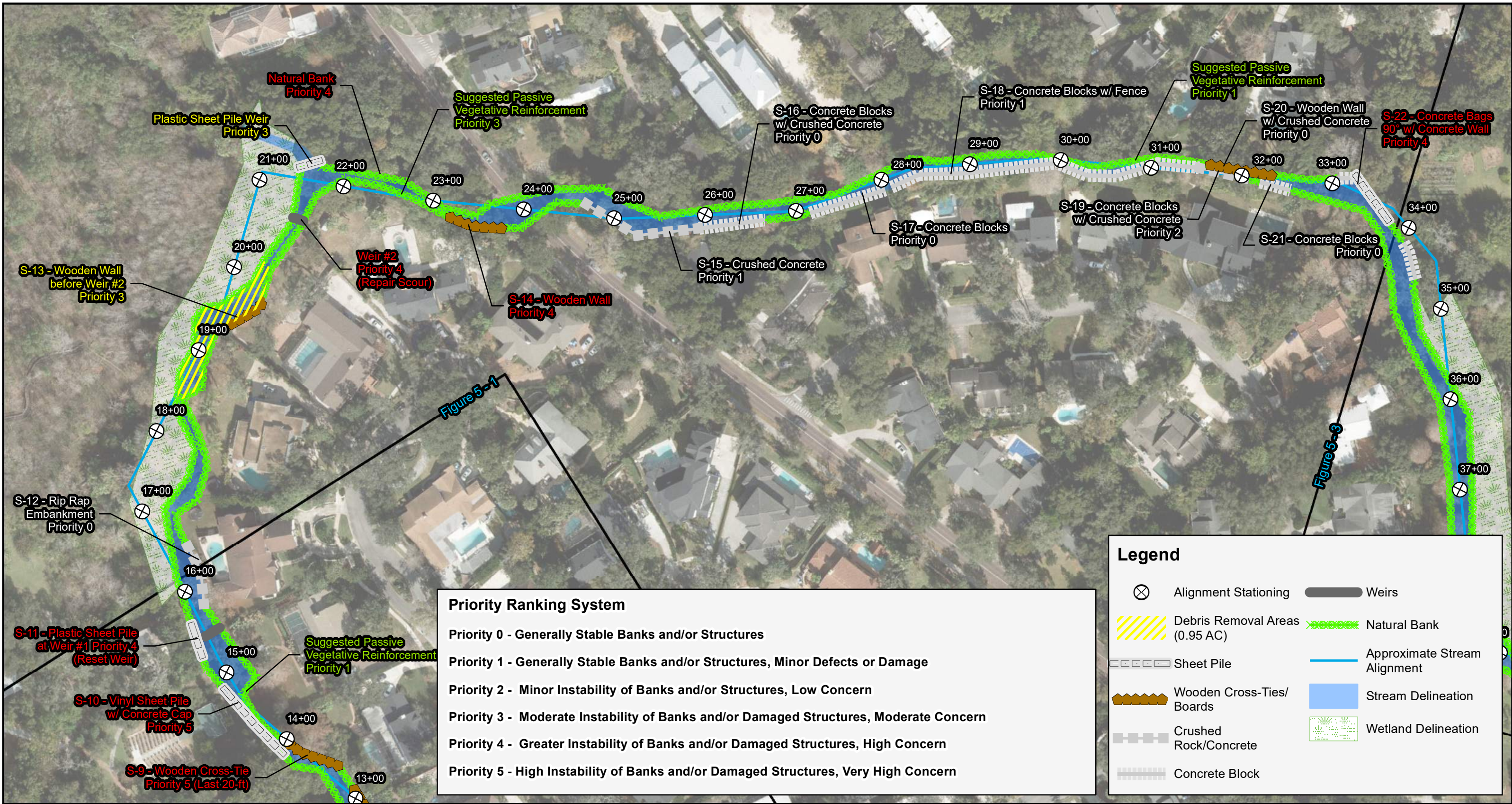
Howell Creek Streambank Stabilization/Restoration

Orange County

February 2024

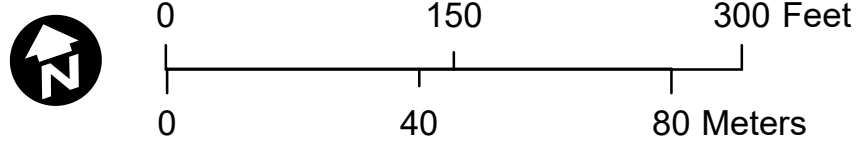
Pond Project #: 1230646

Map Author: Madison Wichmann



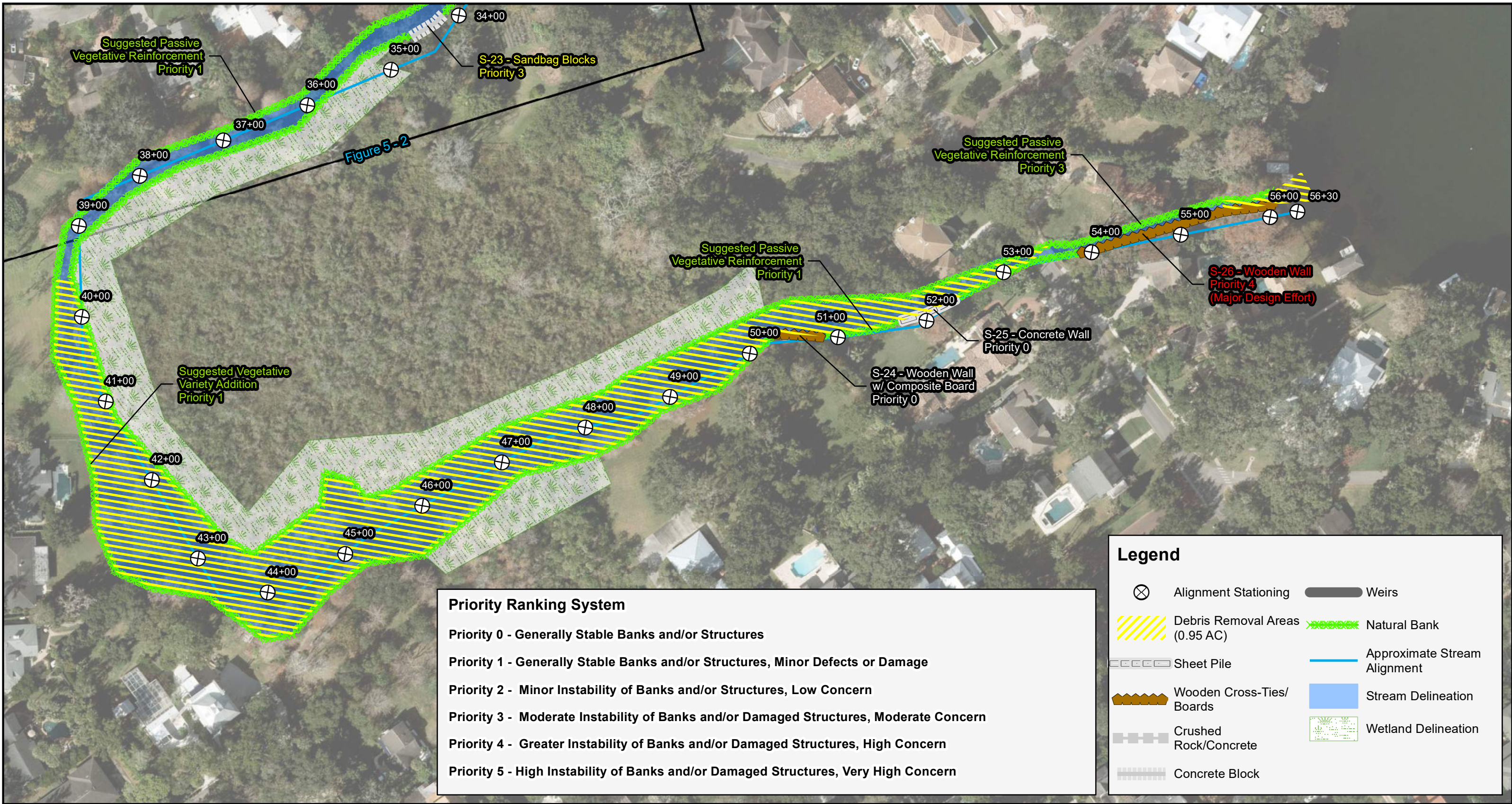
Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Figure 5 - 2
Structure and Streambank Repair Prioritization Map



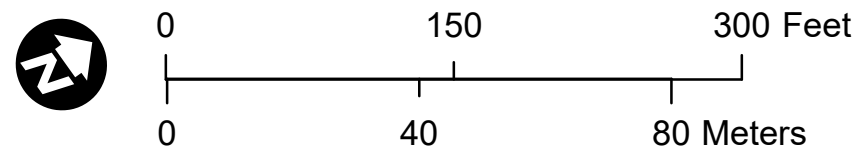
Howell Creek Streambank Stabilization/Restoration
 Orange County
 February 2024
 Pond Project #: 1230646
 Map Author: Madison Wichmann

1 in = 100 ft



Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

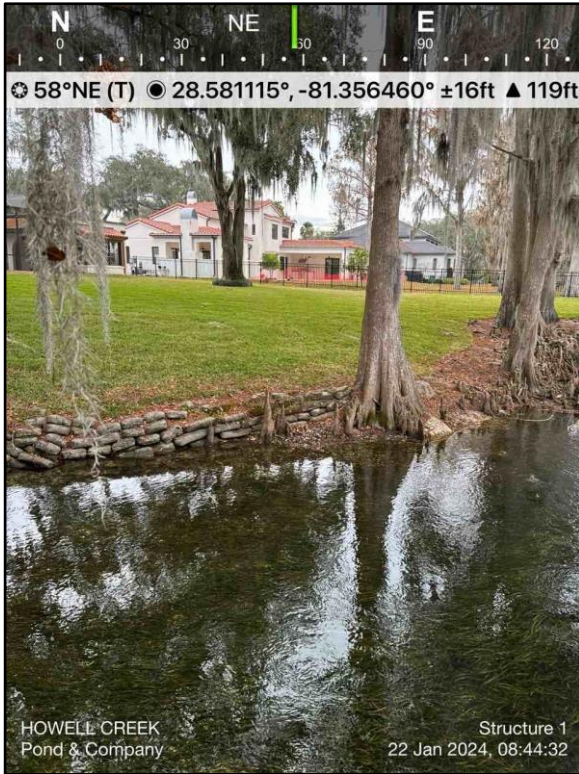
Figure 5 - 3
Structure and Streambank Repair Prioritization Map



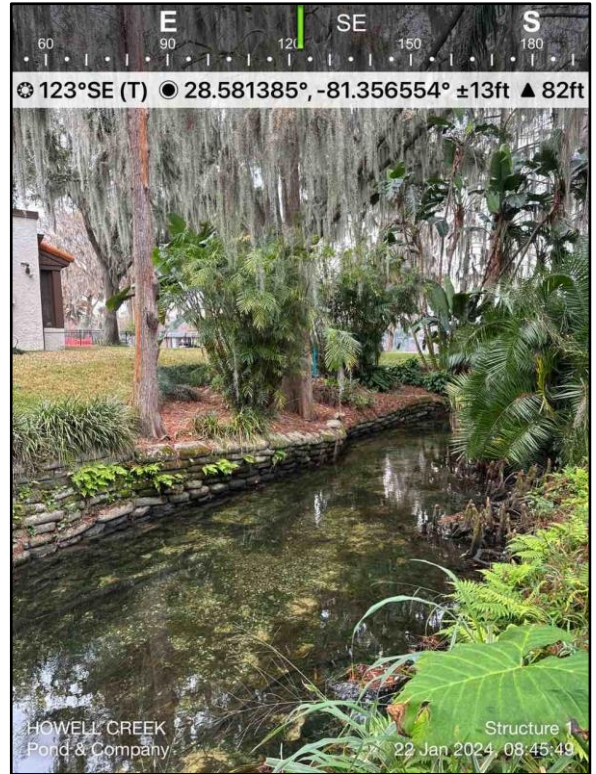
Howell Creek Streambank Stabilization/Restoration
 Orange County
 February 2024
 Pond Project #: 1230646
 Map Author: Madison Wichmann

1 in = 100 ft

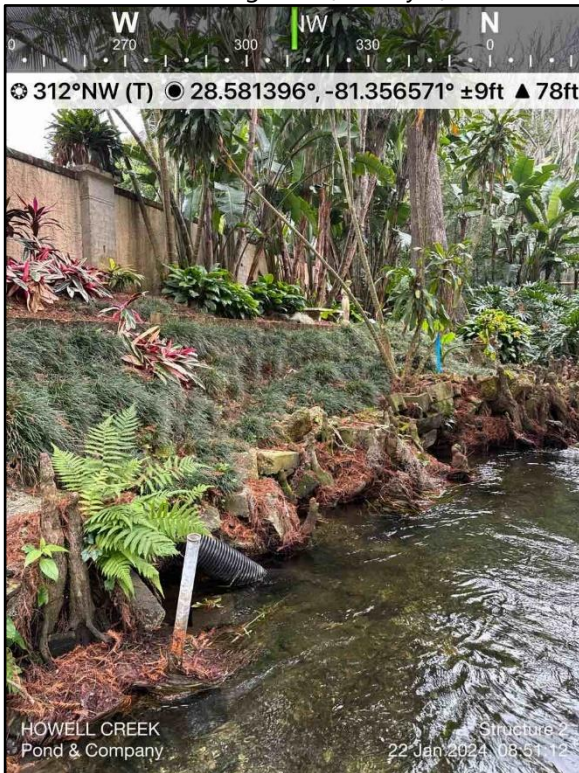
ATTACHMENT B: PHOTOGRAPH LOG



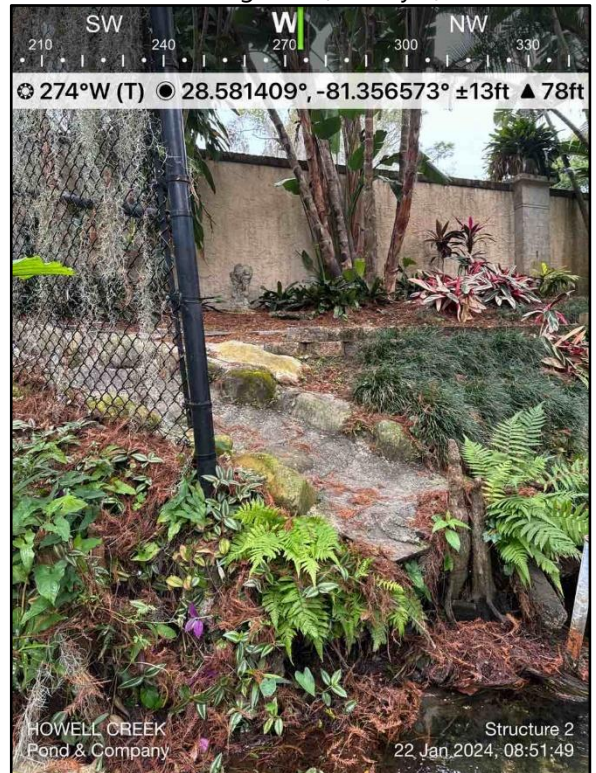
Photograph 1: Structure 1; Concrete Bag Retaining Wall (Priority 0)



Photograph 2: Structure 1; Concrete Bag Retaining Wall (Priority 0)



Photograph 3: Structure 2; Concrete Debris Streambank, Cypress Knees, and Flume (Priority 0)



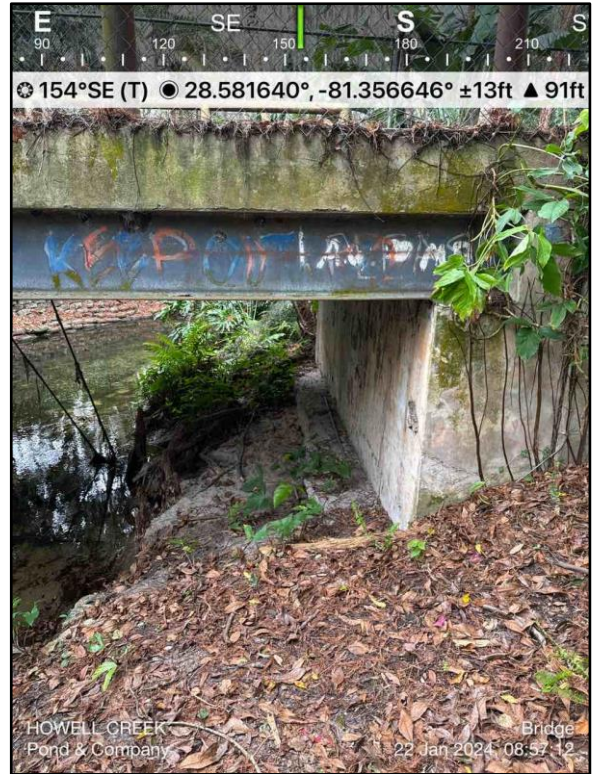
Photograph 4: Structure 2; Concrete Debris Streambank, Cypress Knees, and Flume (Priority 0)

STRUCTURE ASSESSMENT

(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



Photograph 5: Bridge Crossing of Upstream Reach of Howell Creek



Photograph 6: Bridge Crossing of Upstream Reach of Howell Creek



Photograph 7: Structure 3; Block and Mortar Retaining Wall (Priority 2)



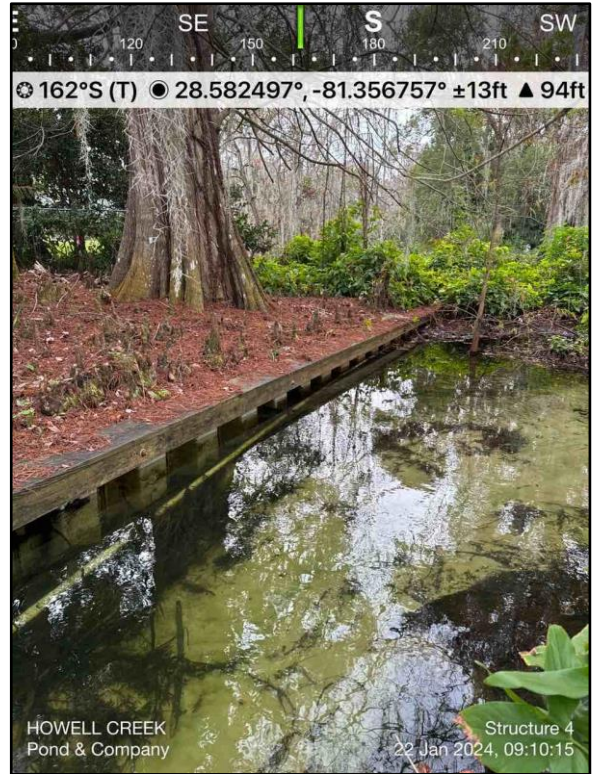
Photograph 8: Structure 3; Block and Mortar Retaining Wall (Priority 2)

STRUCTURE ASSESSMENT

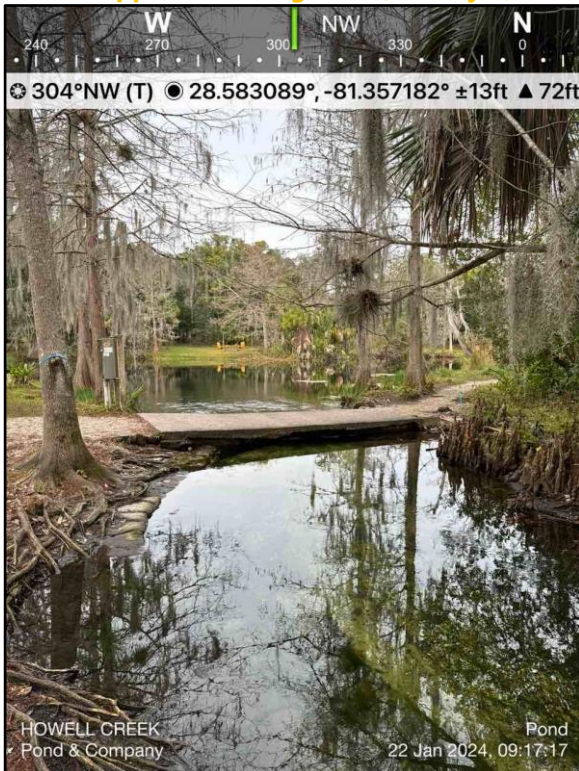
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



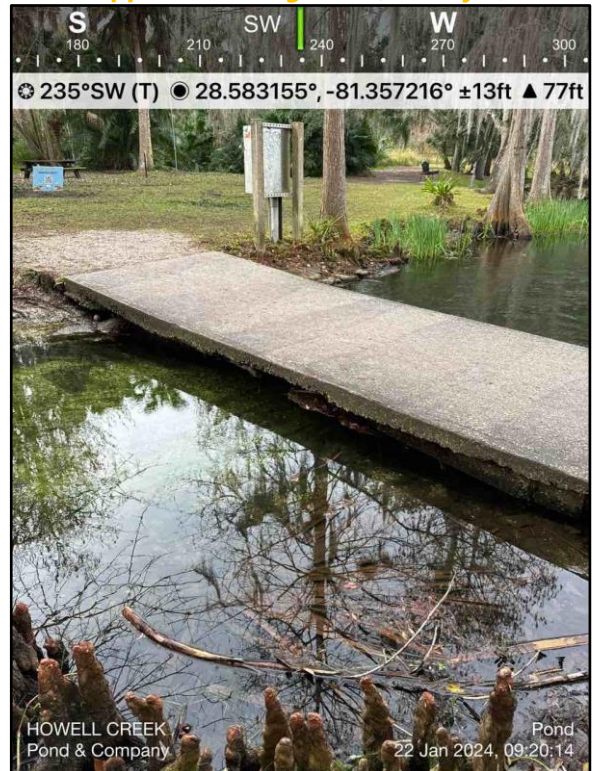
Photograph 9: Structure 4; Sheet Pile Wooden Capped Retaining Wall (Priority 3)



Photograph 10: Structure 4; Sheet Pile Wooden Capped Retaining Wall (Priority 3)



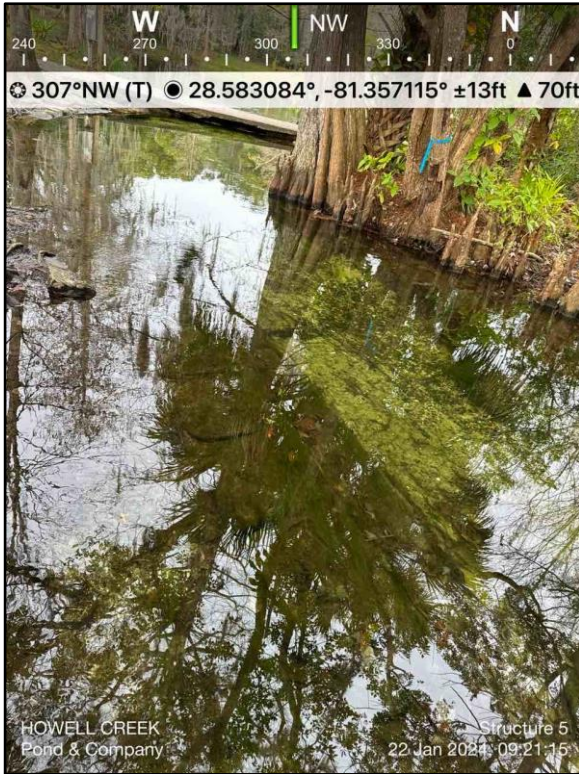
Photograph 11: Pedestrian Bridge Crossing at Mead Botanical Garden Pond



Photograph 12: Pedestrian Bridge Crossing at Mead Botanical Garden Pond

STRUCTURE ASSESSMENT

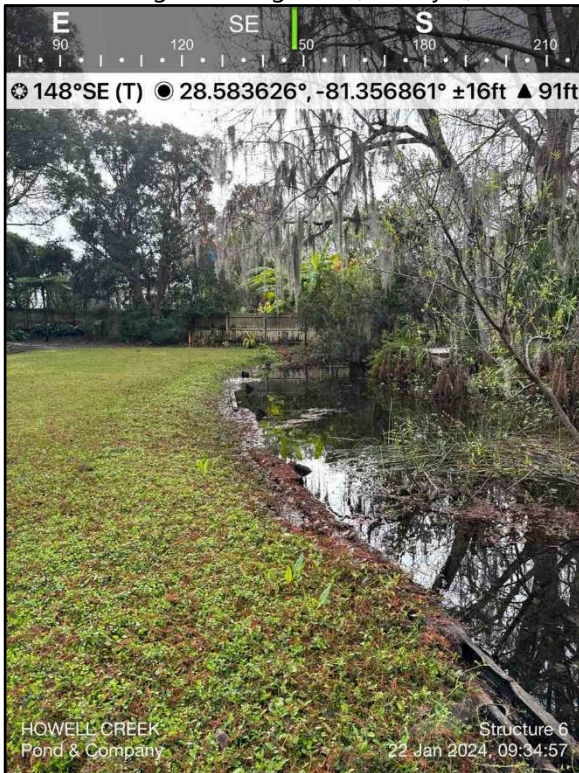
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



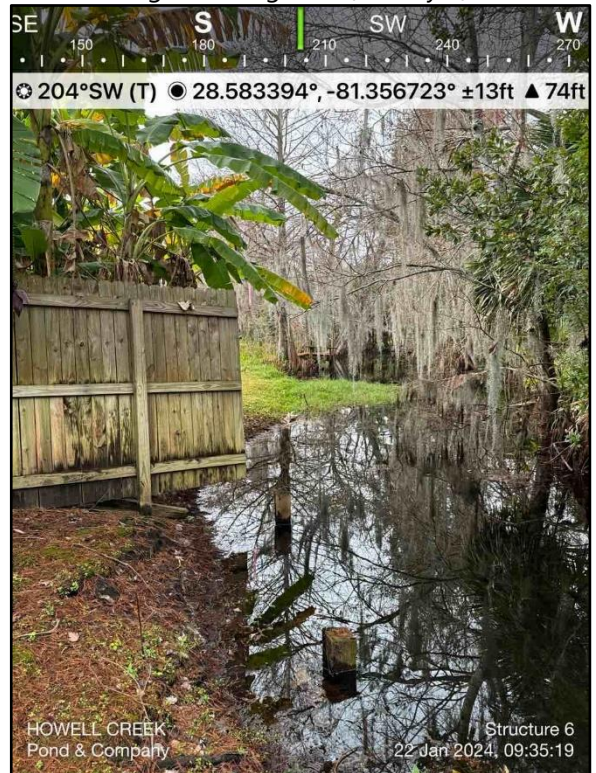
Photograph 13: Structure 5; Subgrade Concrete Bag Retaining Wall (Priority 0)



Photograph 14: Structure 5; Subgrade Concrete Bag Retaining Wall (Priority 0)



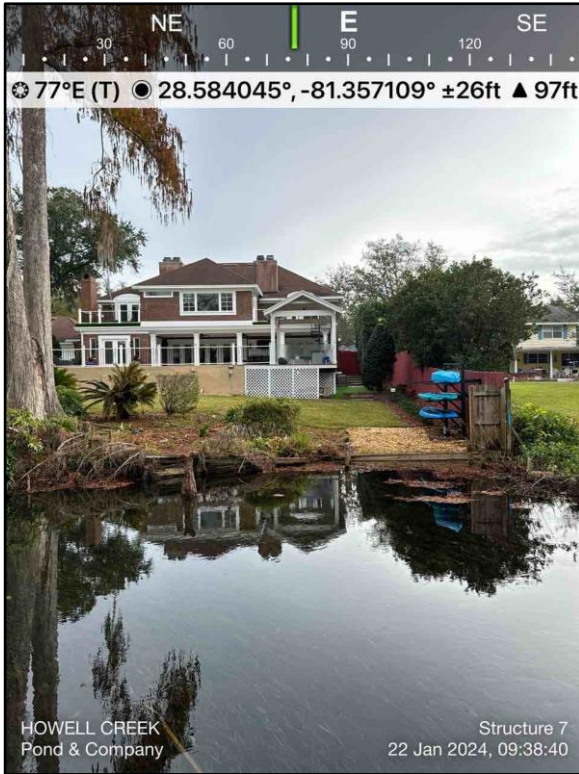
Photograph 15: Structure 6; Wooden Retaining Wall (Priority 2)



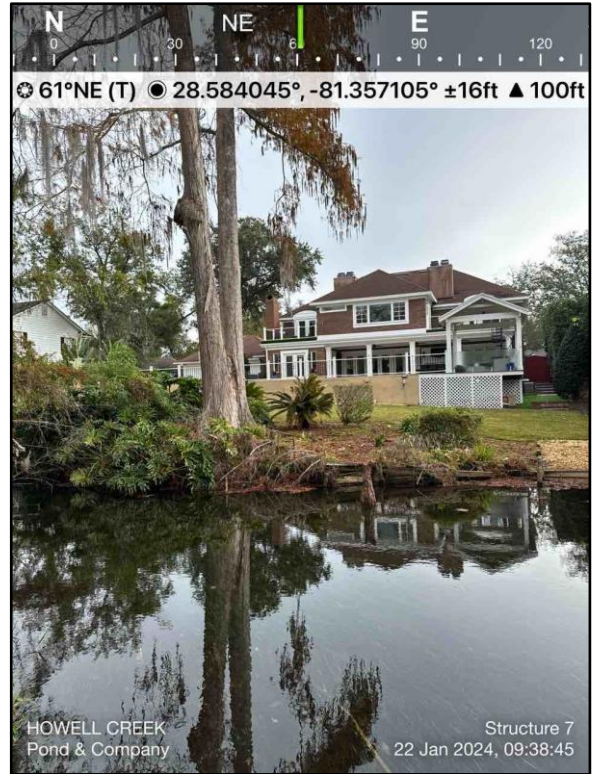
Photograph 16: Structure 6; Wooden Retaining Wall (Priority 2)

STRUCTURE ASSESSMENT

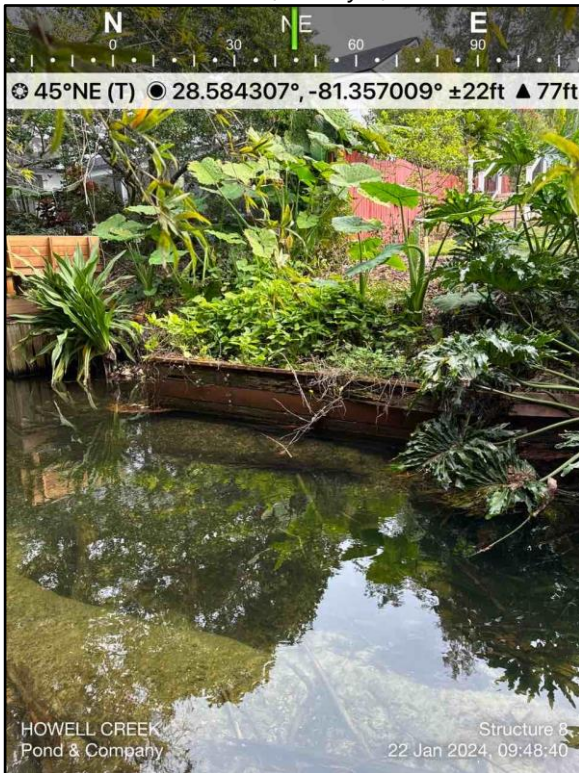
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



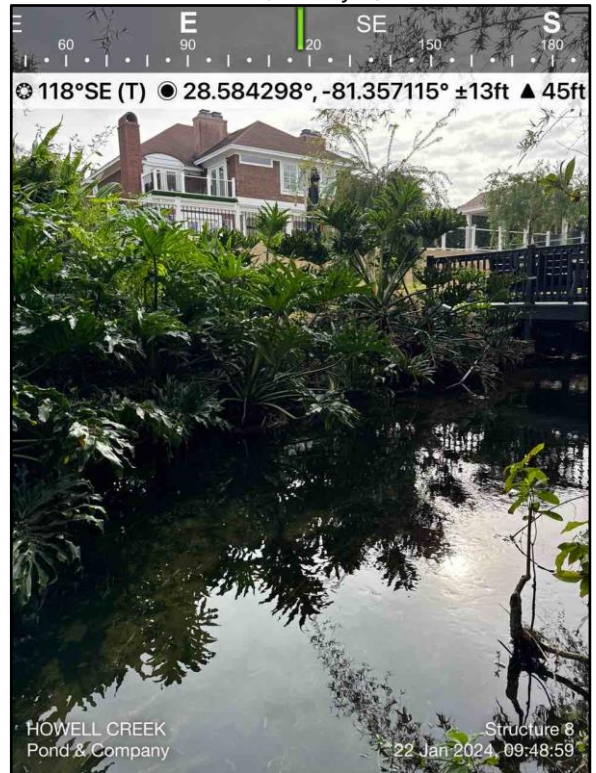
Photograph 17: Structure 7; Wooden Retaining Wall (Priority 2)



Photograph 18: Structure 7; Wooden Retaining Wall (Priority 2)



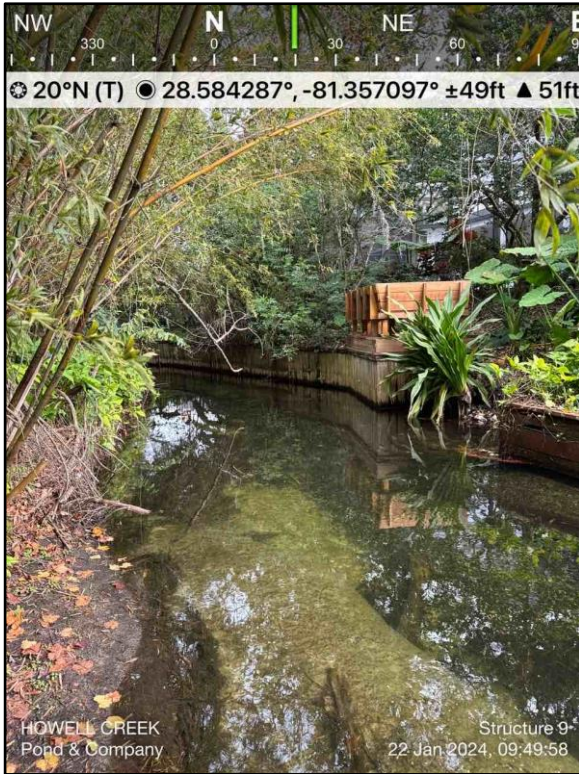
Photograph 19: Structure 8; Wooden Retaining Wall (Priority 3)



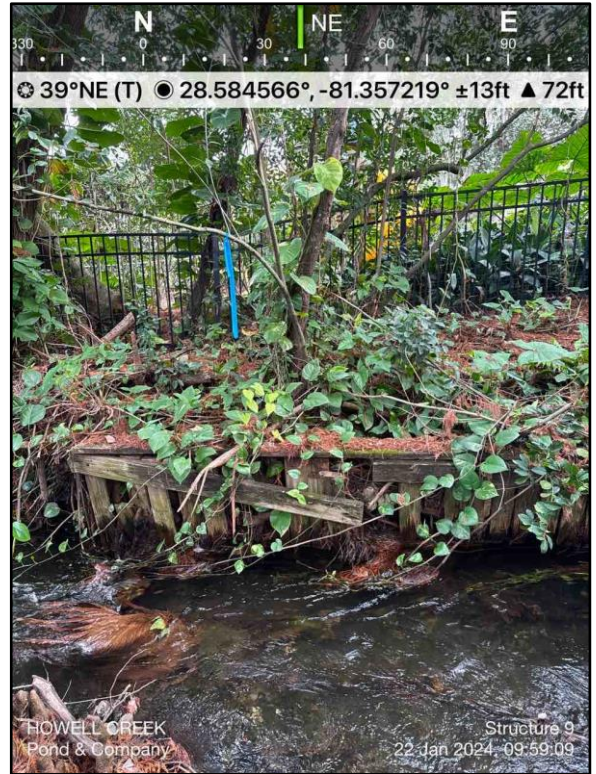
Photograph 20: Structure 8; Wooden Retaining Wall (Priority 3)

STRUCTURE ASSESSMENT

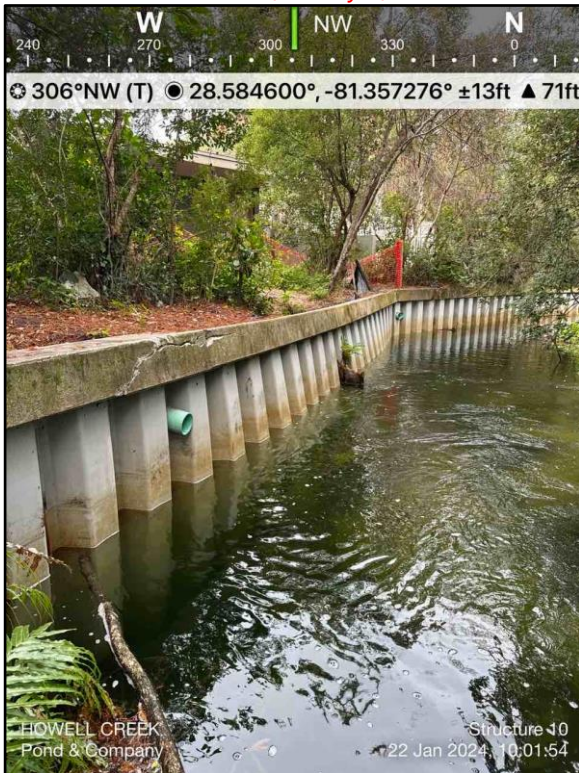
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



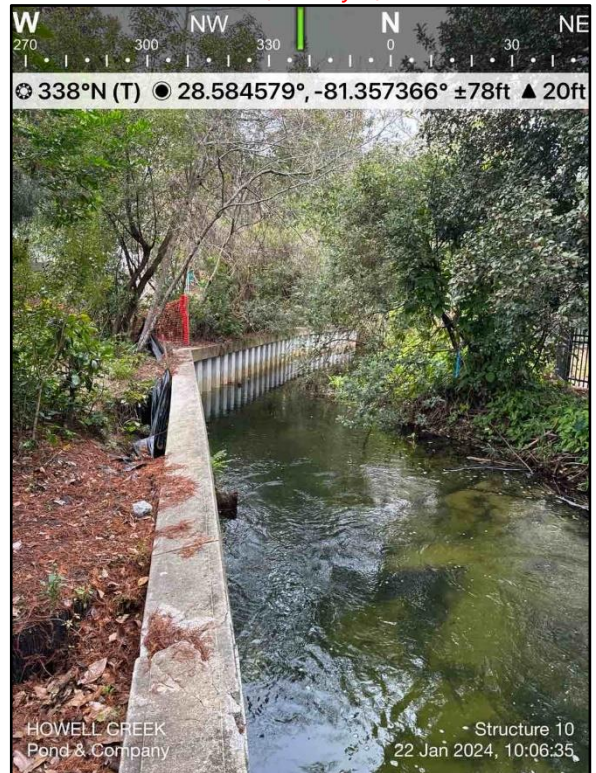
Photograph 21: Structure 9; Wooden Retaining Wall (Priority 5)



Photograph 22: Structure 9; Wooden Retaining Wall (Priority 5)



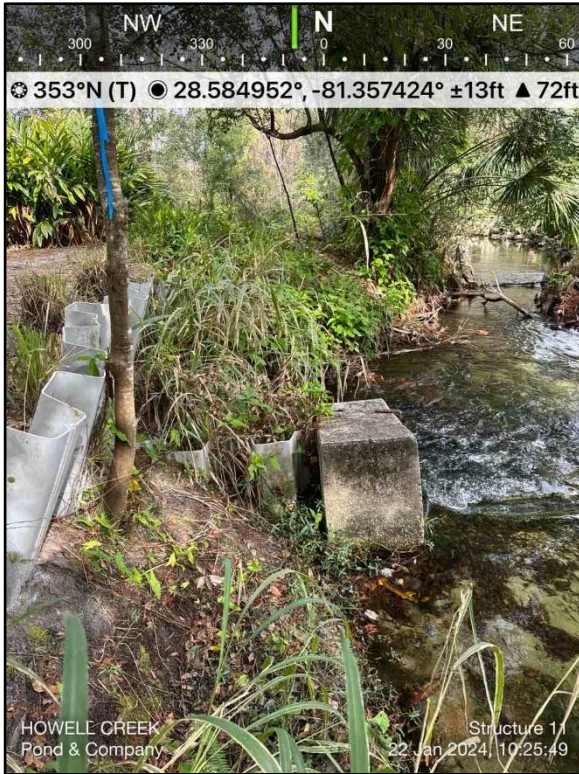
Photograph 23: Structure 10; Sheet Pile Concrete Capped Retaining Wall (Priority 5)



Photograph 24: Structure 10; Sheet Pile Concrete Capped Retaining Wall (Priority 5)

STRUCTURE ASSESSMENT

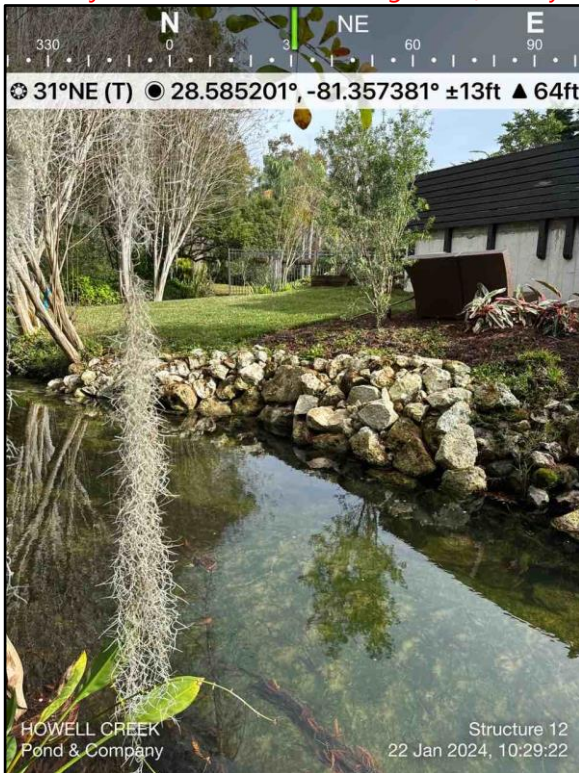
(R) = Right bank as oriented looking downstream
 (L) = Left bank as oriented looking downstream
 No indication of (R) or (L) = Caption applies to both banks
 Caption color coincides with priority color on Figure 5



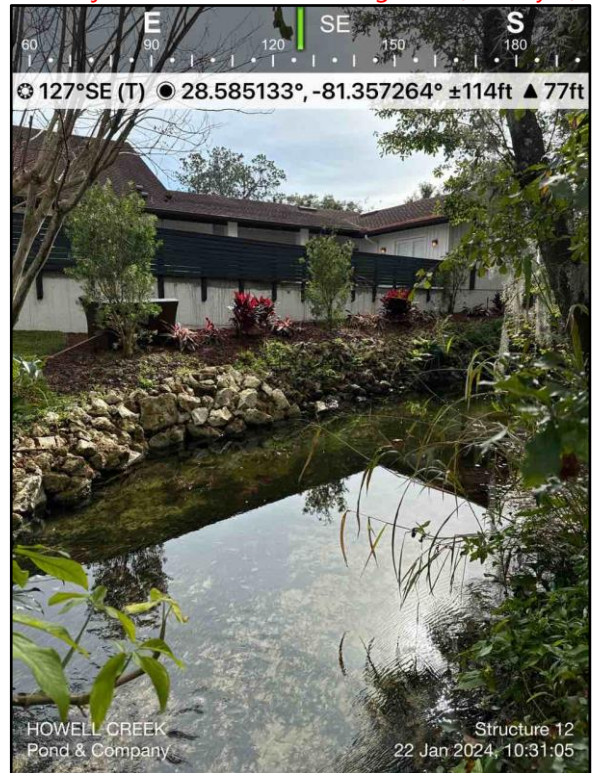
Photograph 25: Structure 11; Grade Control Weir and Adjacent Sheet Pile Retaining Wall (Priority 4)



Photograph 26: Structure 11; Grade Control Weir and Adjacent Wooden Retaining Wall (Priority 4)



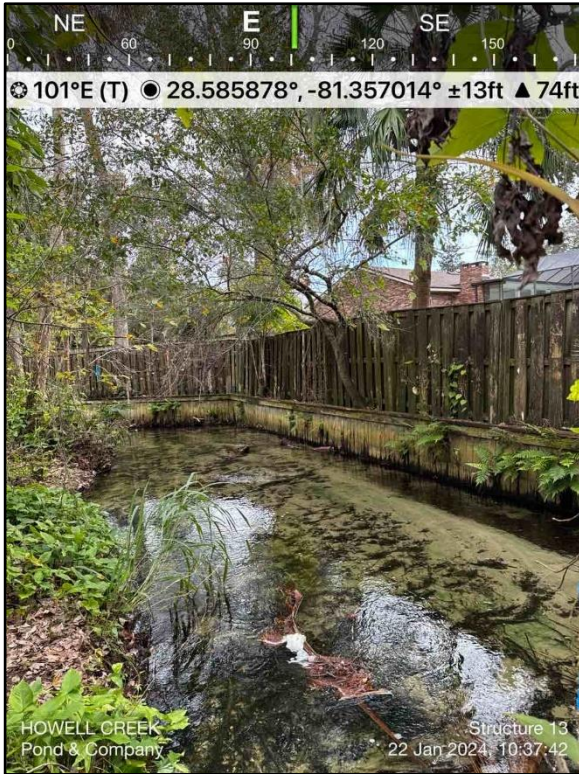
Photograph 27: Structure 12; Rock Streambank Protection (Priority 0)



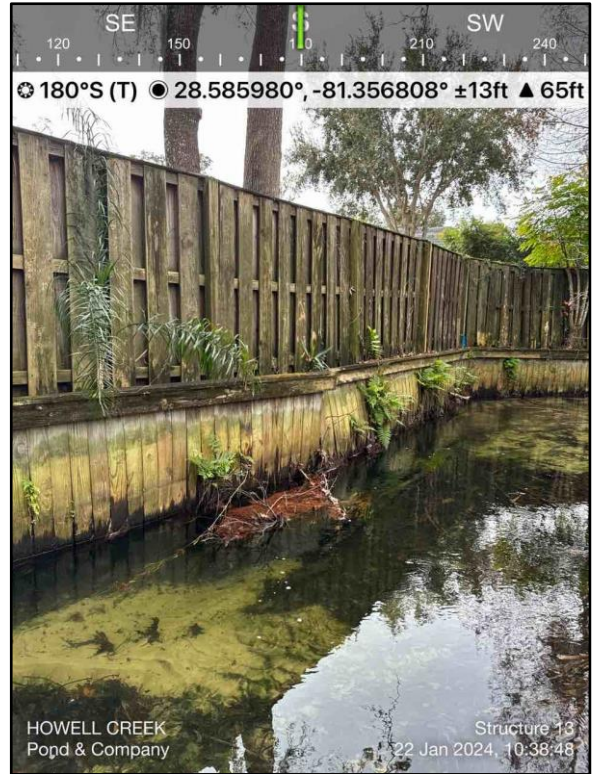
Photograph 28: Structure 12; Rock Streambank Protection (Priority 0)

STRUCTURE ASSESSMENT

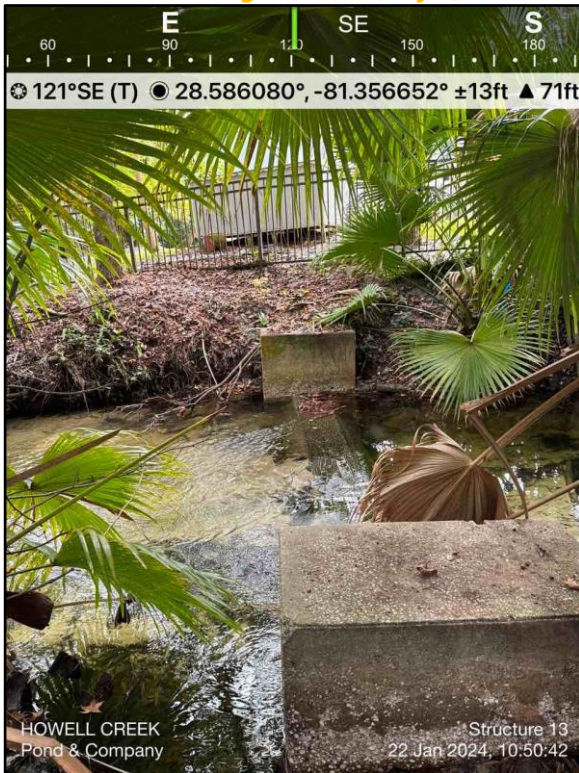
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



Photograph 29: Structure 13; Wooden Retaining Wall (Priority 3)



Photograph 30: Structure 13; Wooden Retaining Wall (Priority 3)



Photograph 31: Grade Control Wier downstream of Structure 13 (Priority 4)

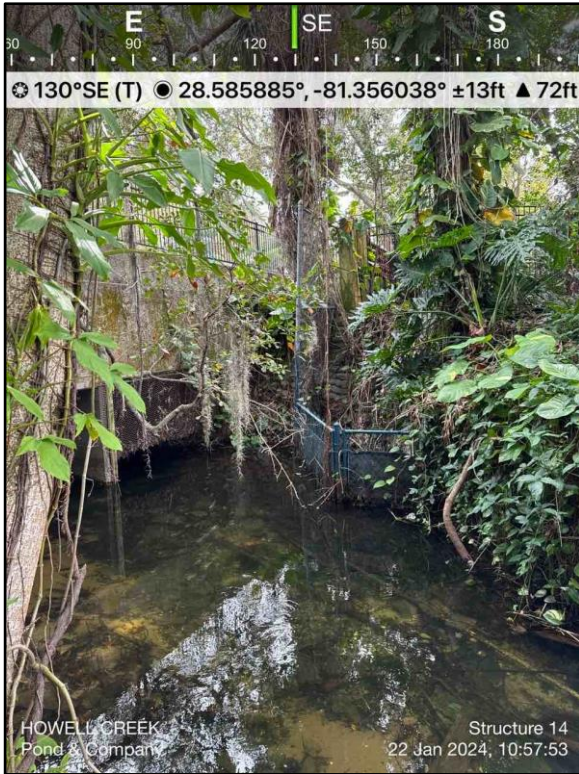


Photograph 32: Grade Control Wier downstream of Structure 13 (Priority 4)

STRUCTURE ASSESSMENT

STRUCTURE ASSESSMENT

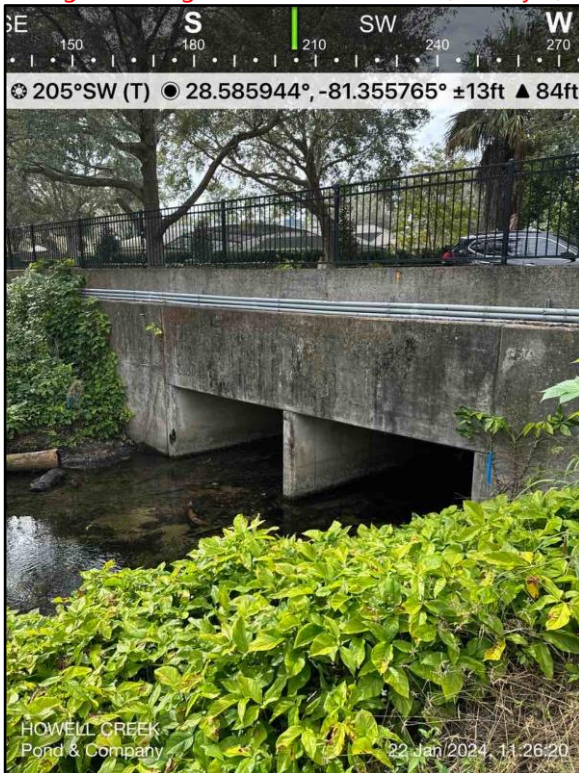
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



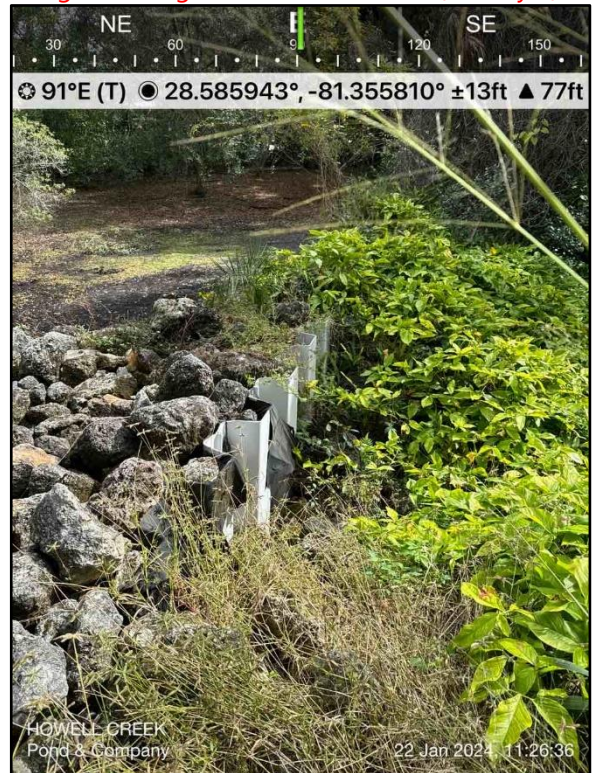
Photograph 33: Structure 14; Wooden/Concrete Bag Retaining Wall at S Penn. Ave. (Priority 4)



Photograph 34: Structure 14; Wooden/Concrete Bag Retaining Wall at S Penn. Ave. (Priority 4)



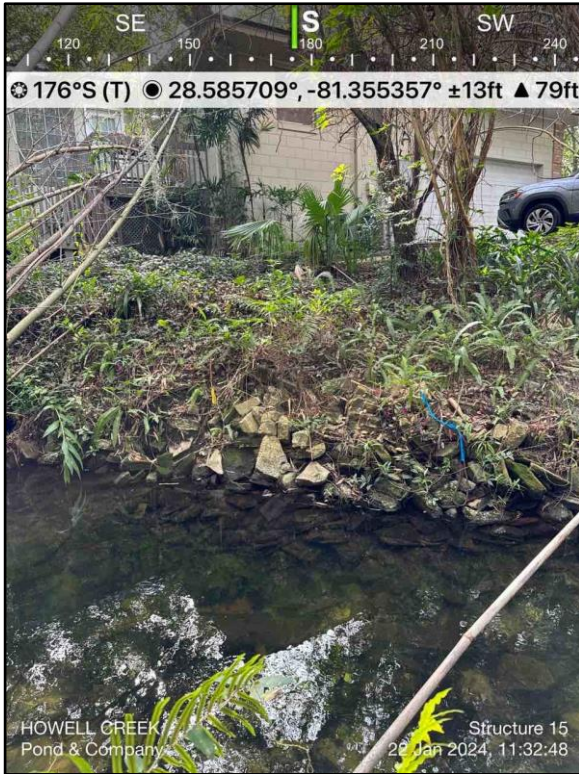
Photograph 35: S Pennsylvania Ave. Crossing and Adjacent Sheet Pile/Rock Streambank Protection



Photograph 36: S Pennsylvania Ave. Crossing and Adjacent Sheet Pile/Rock Streambank Protection

STRUCTURE ASSESSMENT

(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



Photograph 37: Structure 15; Rock Streambank Protection (Priority 1)



Photograph 38: Structure 15; Rock Streambank Protection (Priority 1)



Photograph 39: Structure 16; Rock Streambank Protection & Concrete Bag Wall (Priority 0)



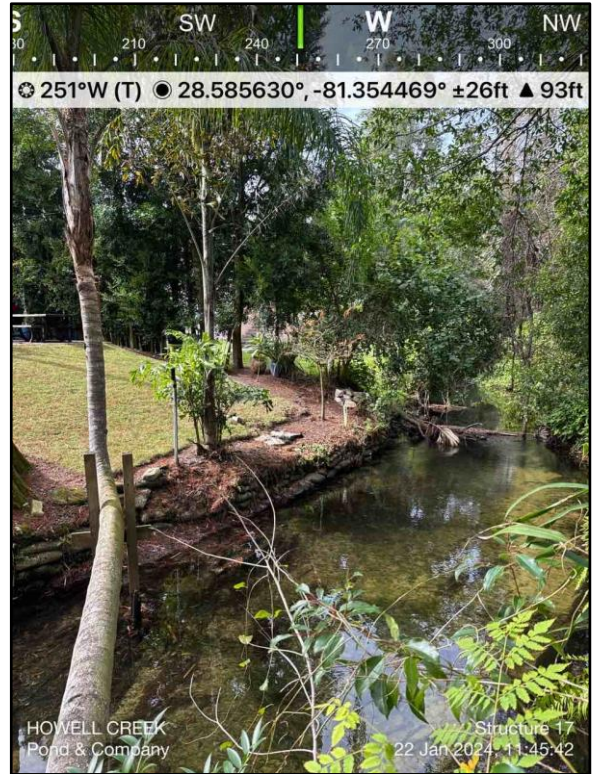
Photograph 40: Structure 16; Rock Streambank Protection & Concrete Bag Wall (Priority 0)

STRUCTURE ASSESSMENT

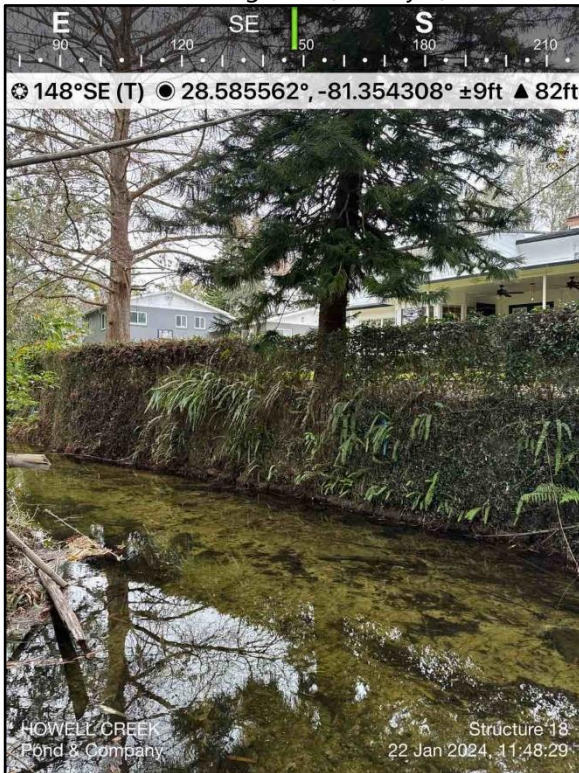
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



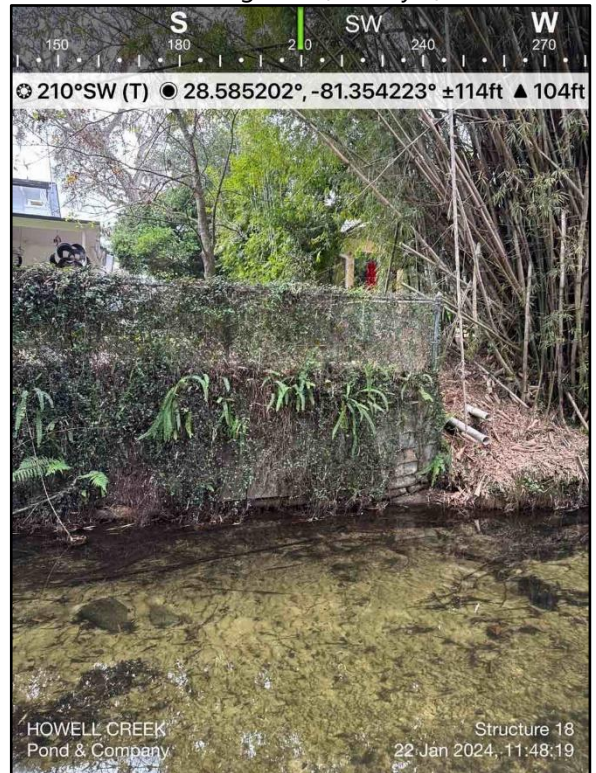
Photograph 41: Structure 17; Concrete Bag Retaining Wall (Priority 0)



Photograph 42: Structure 17; Concrete Bag Retaining Wall (Priority 0)



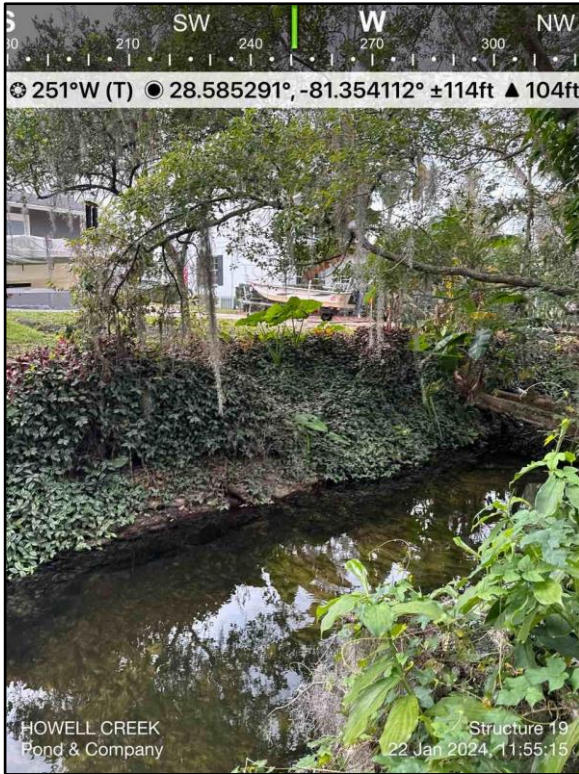
Photograph 43: Structure 18; Concrete Block and Bag Retaining Wall (Priority 1)



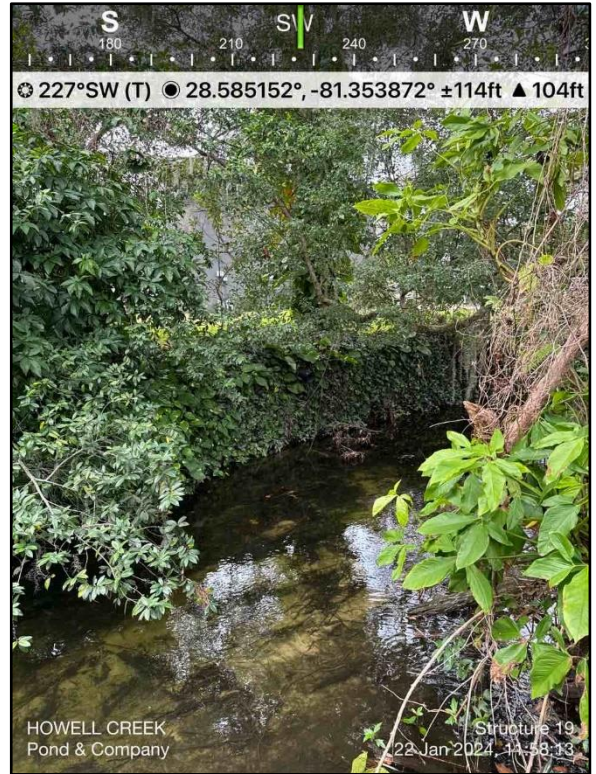
Photograph 44: Structure 18; Concrete Block and Bag Retaining Wall (Priority 1)

STRUCTURE ASSESSMENT

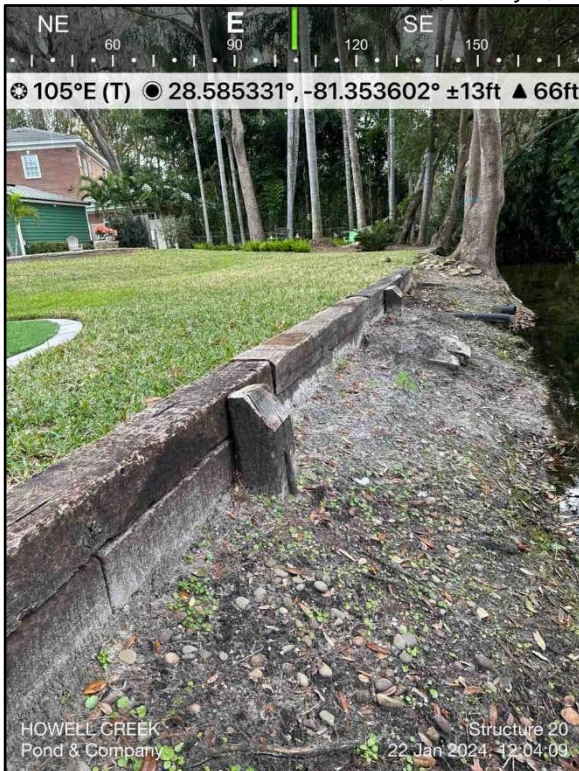
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



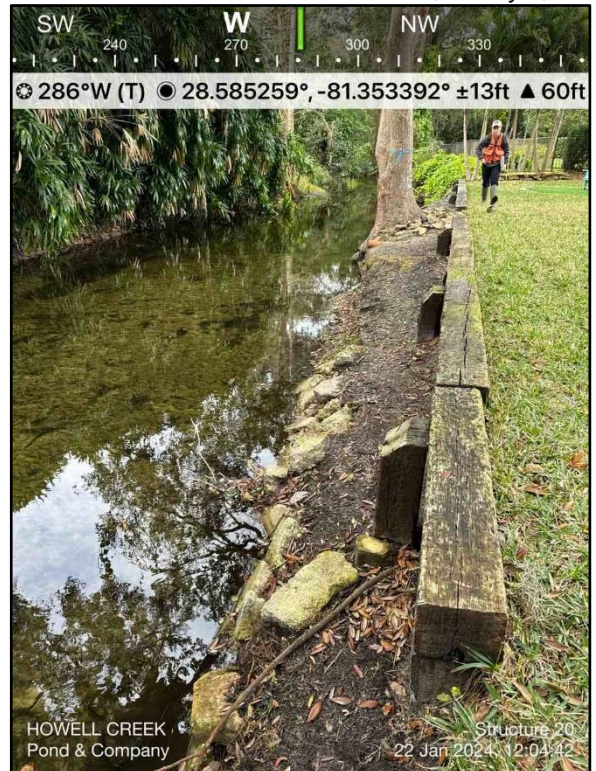
Photograph 45: Structure 19; Concrete Bag Wall and Rock Streambank Protection (Priority 2)



Photograph 46: Structure 19; Concrete Bag Wall and Rock Streambank Protection (Priority 2)



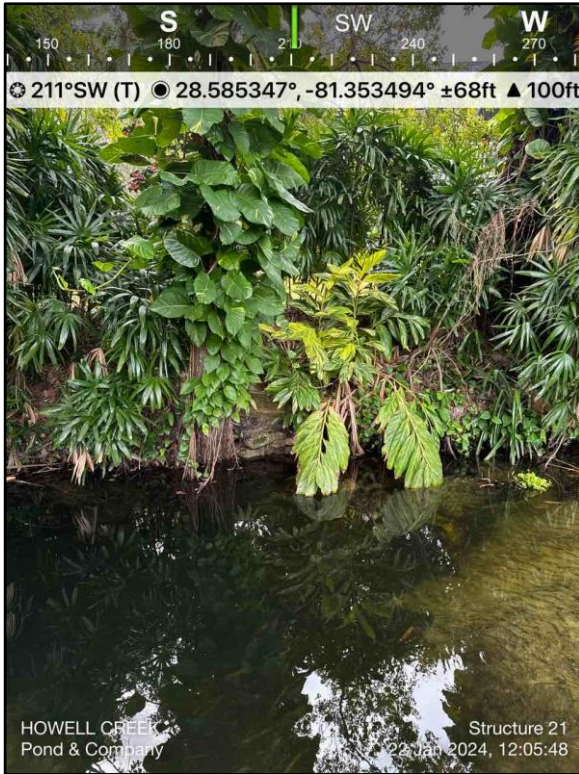
Photograph 47: Structure 20; Wooden Cross Tie Retaining Wall (Priority 0)



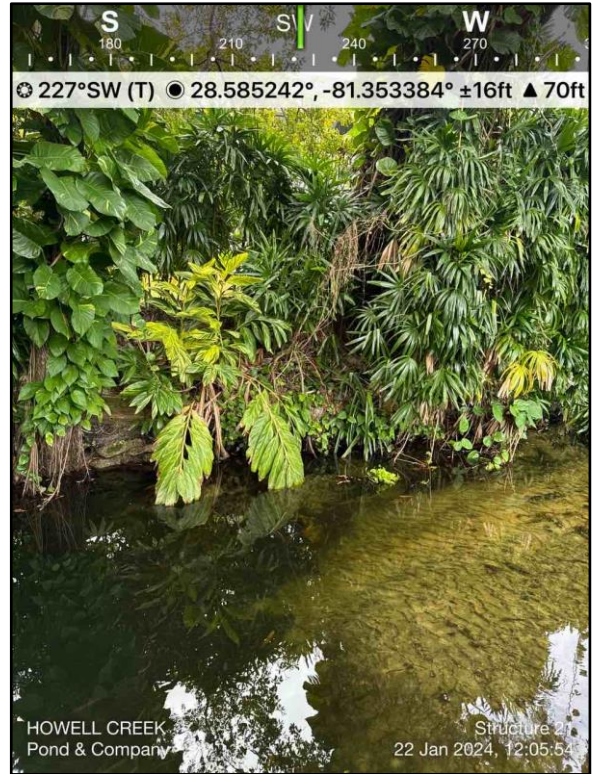
Photograph 48: Structure 20; Wooden Cross Tie Retaining Wall (Priority 0)

STRUCTURE ASSESSMENT

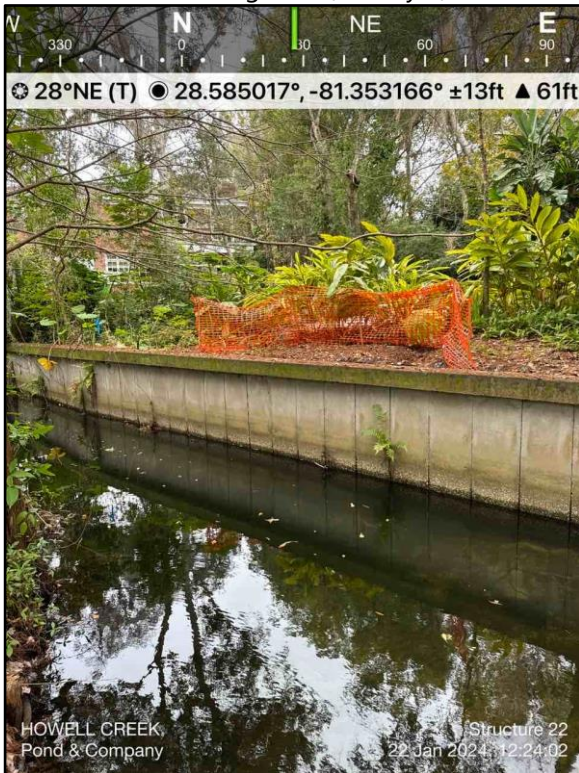
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



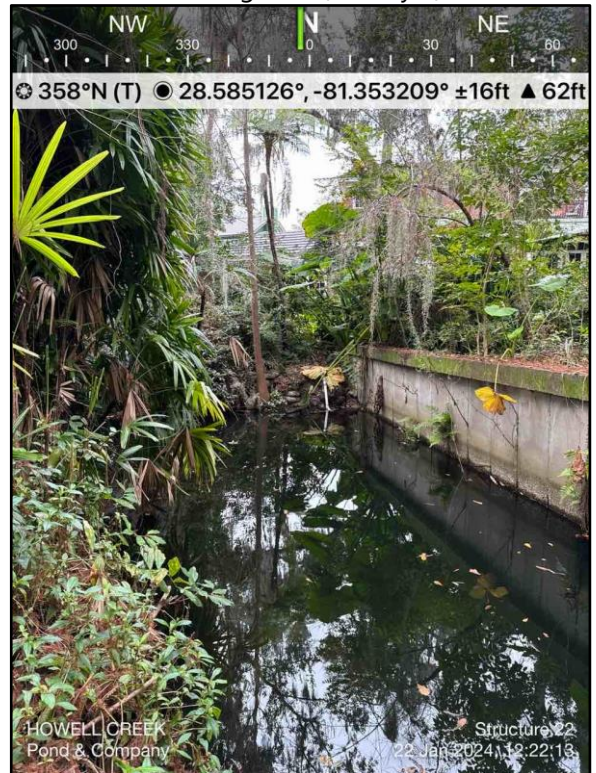
Photograph 49: Structure 21; Concrete Bag Retaining Wall (Priority 0)



Photograph 50: Structure 21; Concrete Bag Retaining Wall (Priority 0)



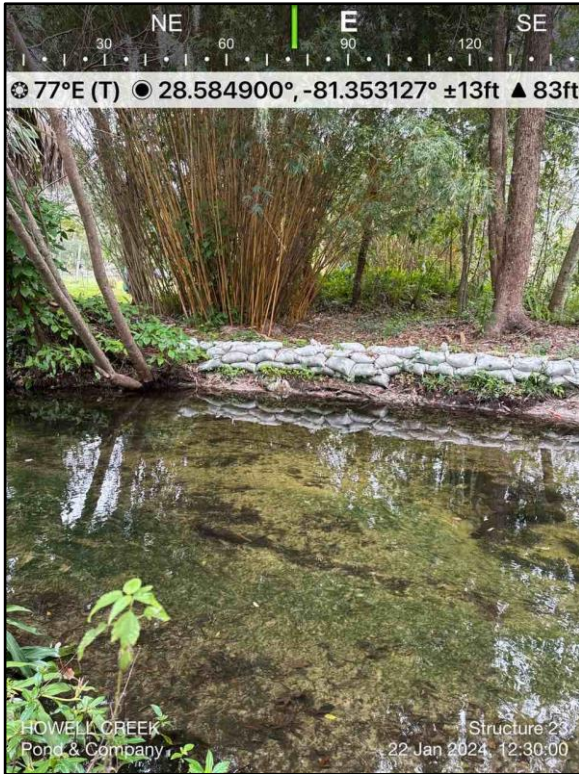
Photograph 51: Structure 22; Concrete Wall/Capped Retaining Wall (Priority 4)



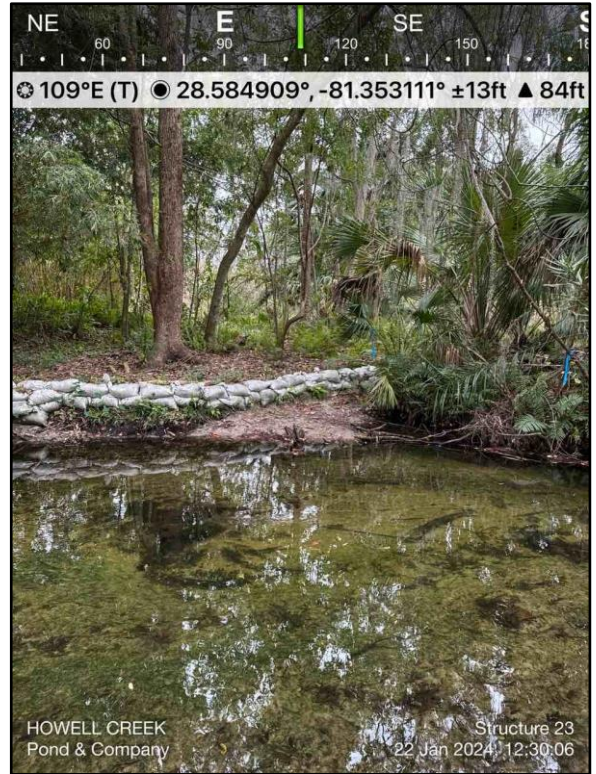
Photograph 52: Structure 22; Concrete Wall/Capped Retaining Wall (Priority 4)

STRUCTURE ASSESSMENT

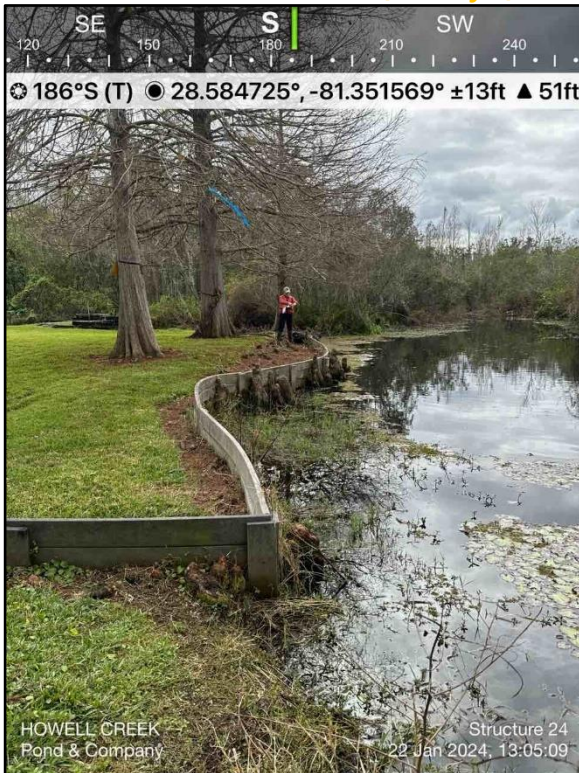
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



Photograph 53: Structure 23; Sandbag Streambank Protection (Priority 3)



Photograph 54: Structure 23; Sandbag Streambank Protection (Priority 3)



Photograph 55: Structure 24; Wooden/Composite Retaining Wall (Priority 2)



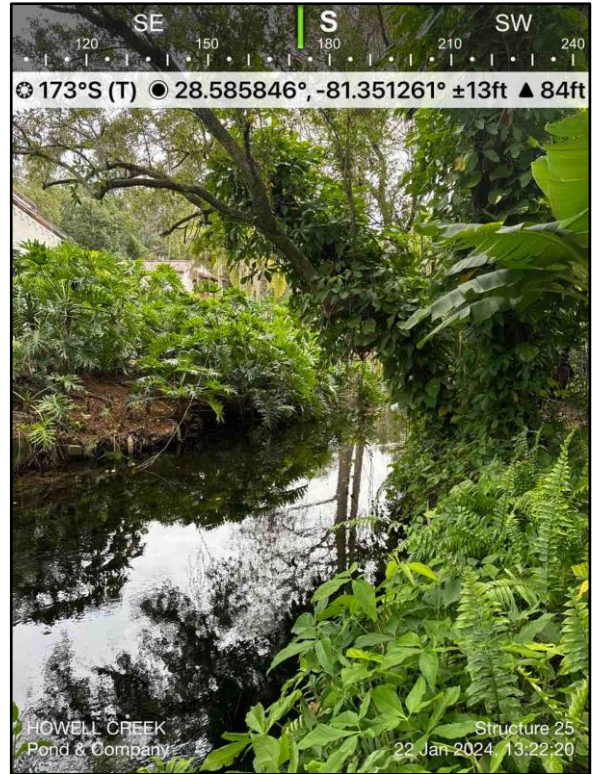
Photograph 56: Structure 24; Wooden/Composite Retaining Wall (Priority 2)

STRUCTURE ASSESSMENT

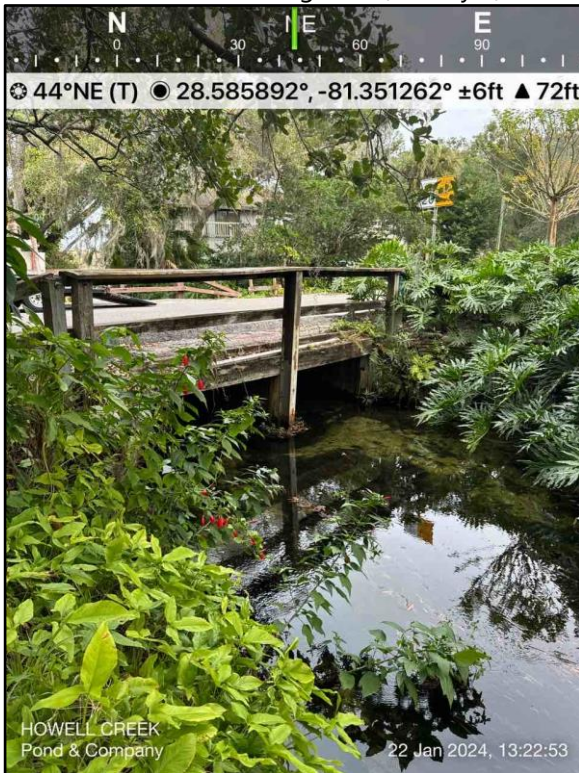
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



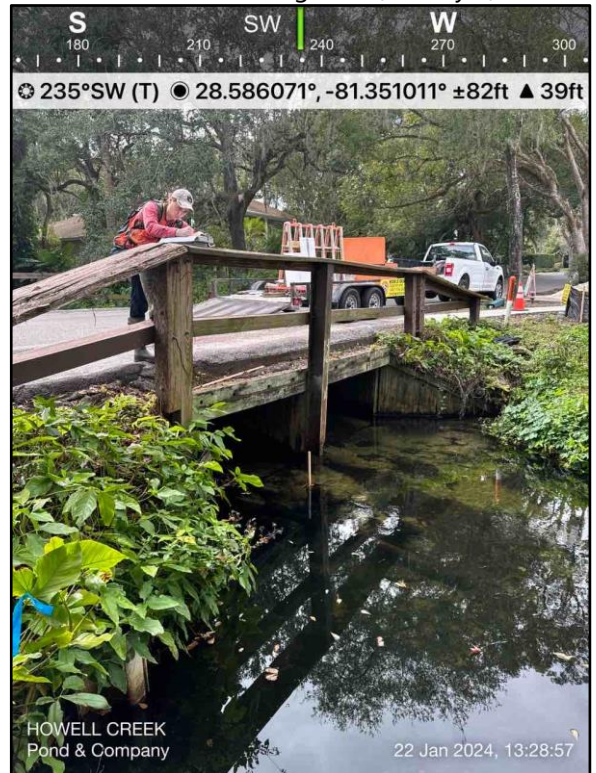
Photograph 57: Structure 25; Concrete and Wooden Retaining Wall (Priority 0)



Photograph 58: Structure 25; Concrete and Wooden Retaining Wall (Priority 0)



Photograph 59: Stirling Ave. Crossing Looking Downstream



Photograph 60: Stirling Ave. Crossing Looking Upstream

STRUCTURE ASSESSMENT

(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5

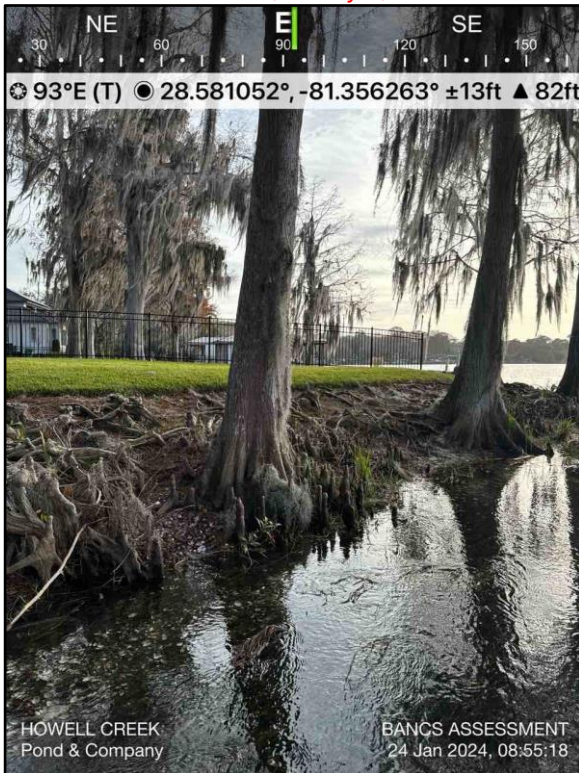


Photograph 61: Structure 26; Wooden Retaining Wall (Priority 4)

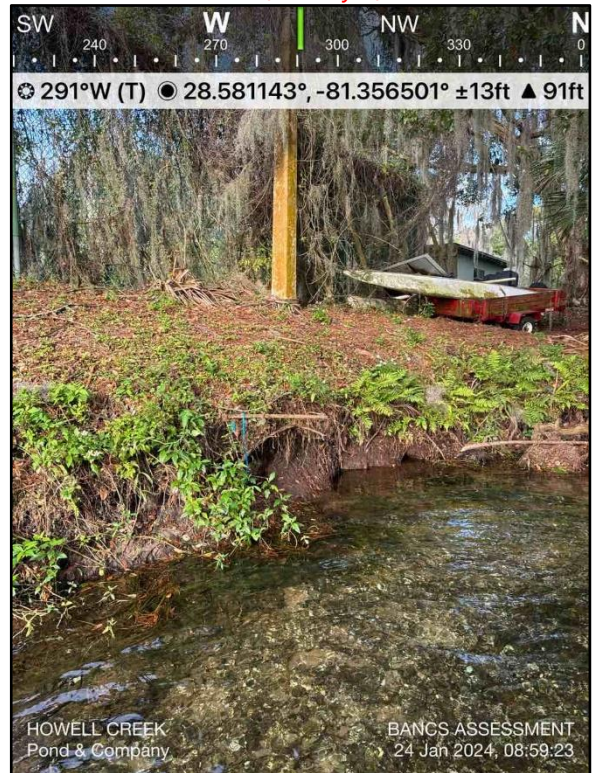


Photograph 62: Structure 26; Wooden Retaining Wall (Priority 4)

STRUCTURE ASSESSMENT



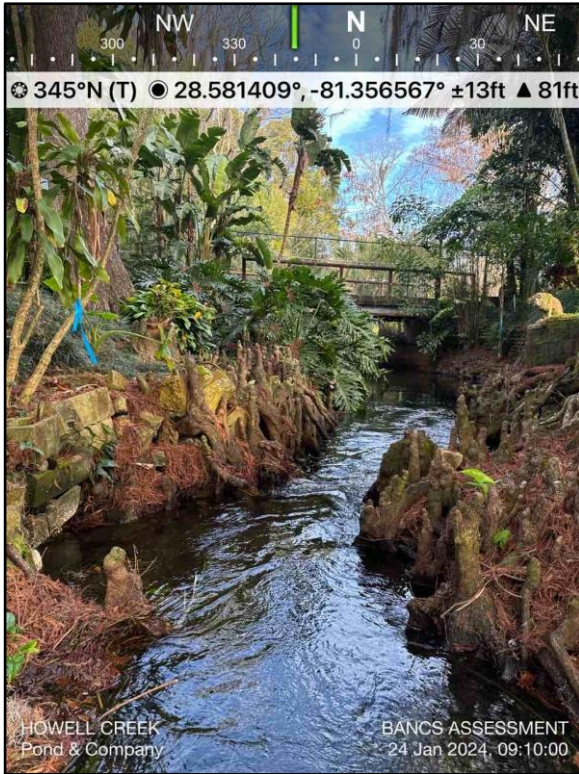
Photograph 63: Lake Sue outlet. BEHI = Moderate (R), NBS = Very Low (R); ~Sta. 0+25.



Photograph 64: BEHI = Very High (L), NBS = High (L); ~Sta. 1+00 (Priority 4).

STREAMBANK ASSESSMENT

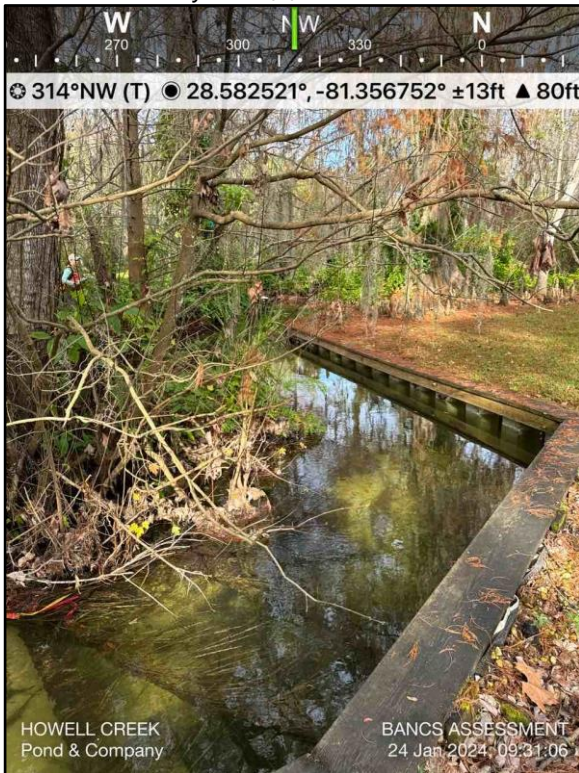
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



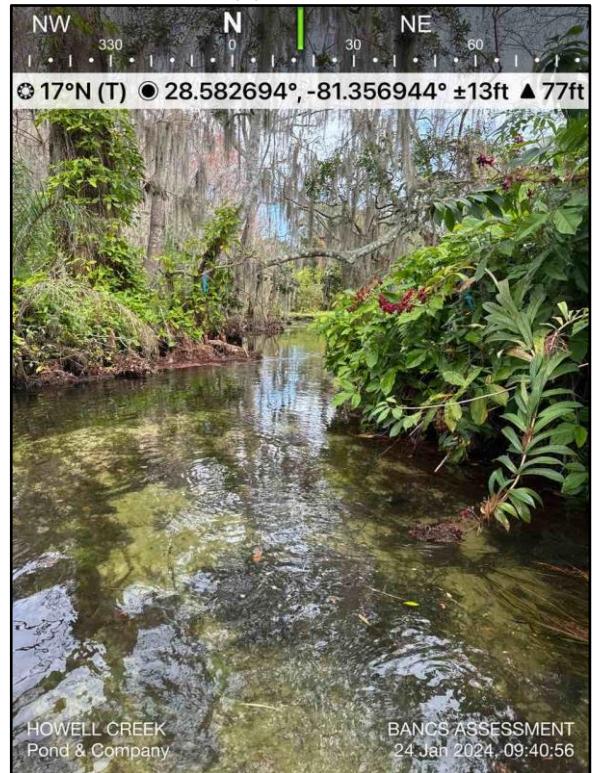
Photograph 65: BEHI = Low, NBS = Moderate (L), Very Low (R); ~Sta. 2+00.



Photograph 66: BEHI = Low, NBS = Moderate (L), Low (R); ~Sta. 5+50.



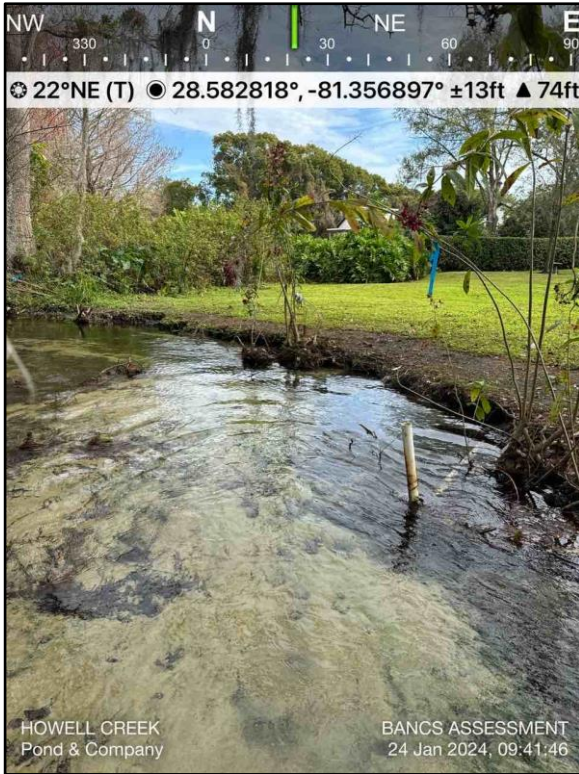
Photograph 67: BEHI = Non-Contributing, NBS = High (R); ~Sta. 6+00.



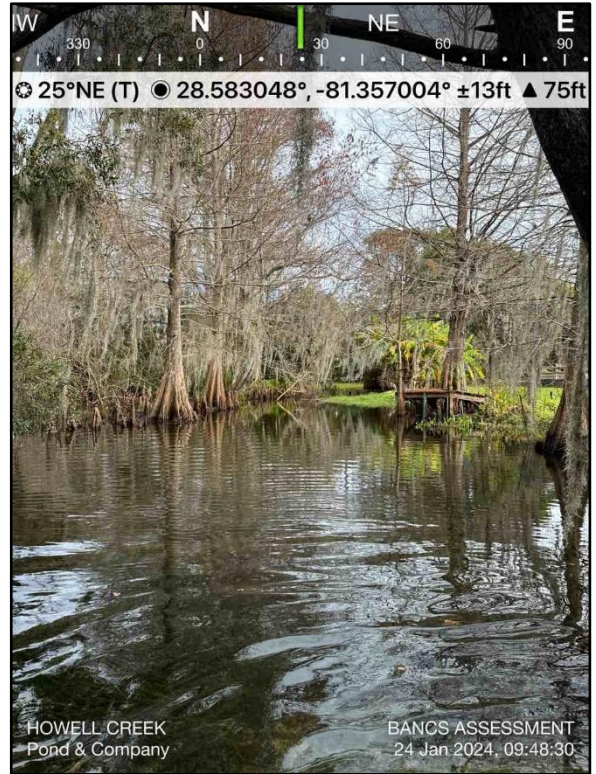
Photograph 68: BEHI = Very Low; NBS = Moderate; ~Sta. 7+00

STREAMBANK ASSESSMENT

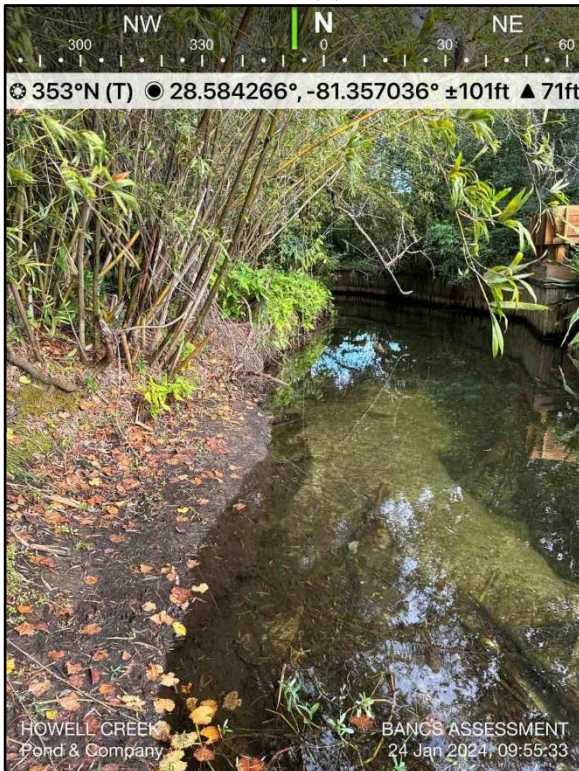
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



Photograph 69: BEHI = High (R),
NBS = Moderate (R); ~Sta. 7+25.



Photograph 70: BEHI = Non-Contributing,
NBS = Non-Contributing; ~Sta. 8+00 – 10+00.



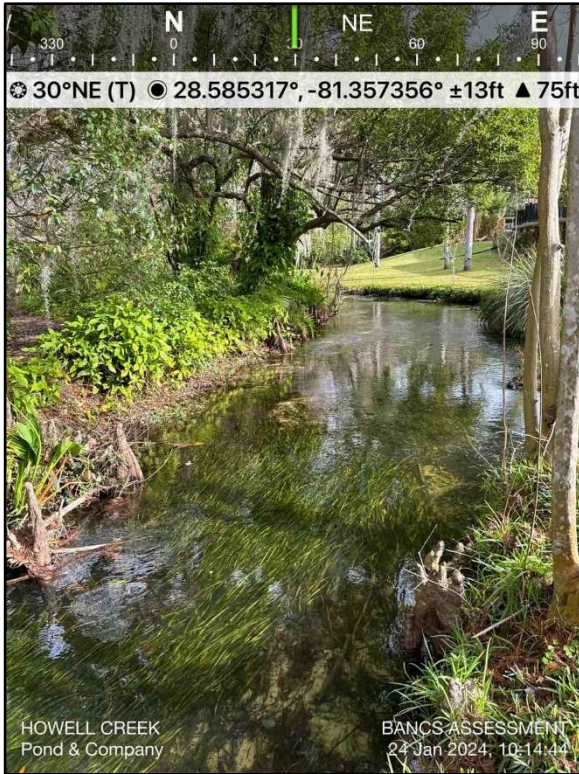
Photograph 71: BEHI = Moderate,
NBS = Moderate; ~Sta. 12+00.



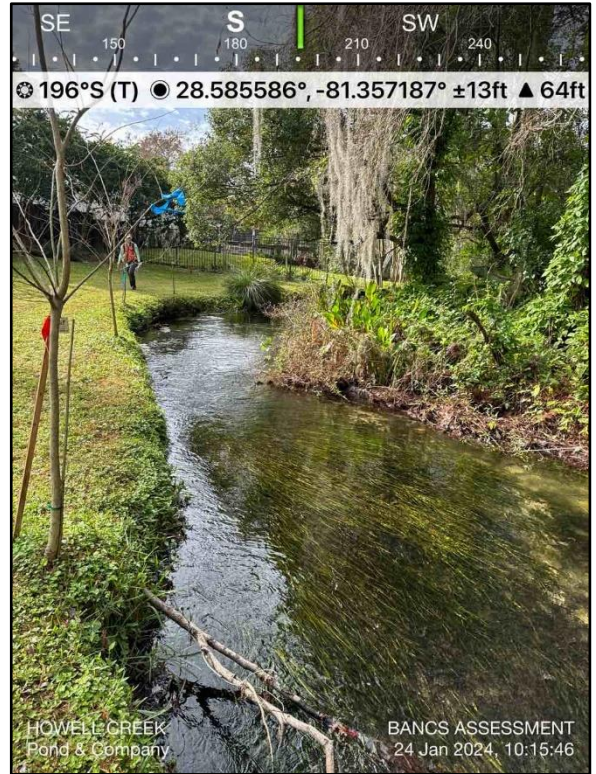
Photograph 72: BEHI = Moderate,
NBS = Moderate; ~Sta. 13+50.

STREAMBANK ASSESSMENT

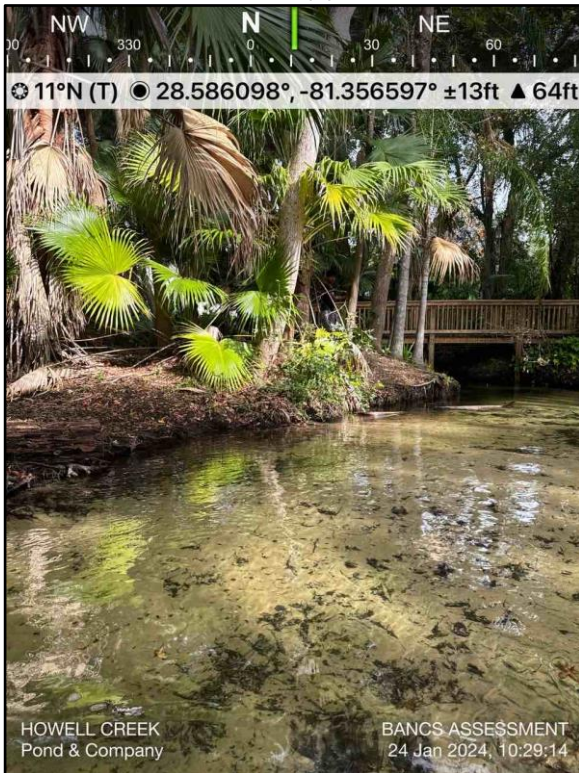
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



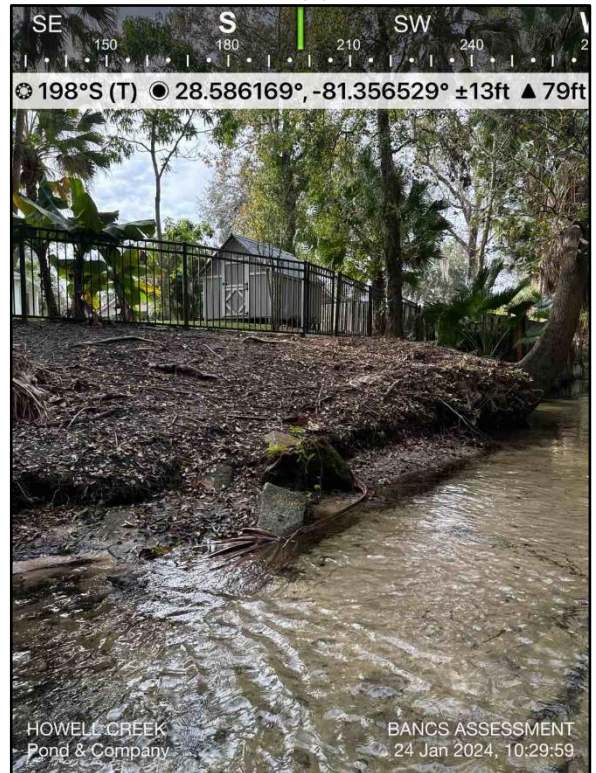
Photograph 73: BEHI = Moderate (R),
NBS = Moderate (R); ~Sta. 16+50.



Photograph 74: BEHI = Moderate (R),
NBS = Moderate (R); ~Sta. 18+00.



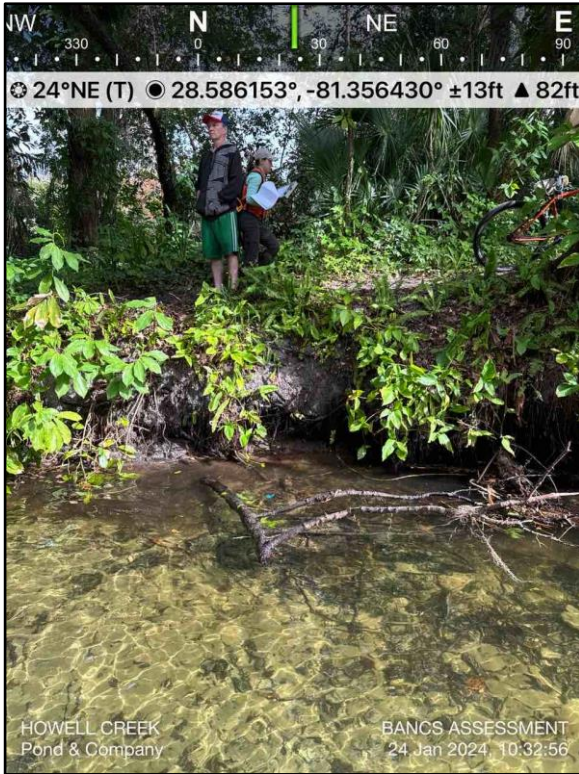
Photograph 75: BEHI = Moderate (L),
NBS = Moderate (L); ~Sta. 21+00 (Priority 4)



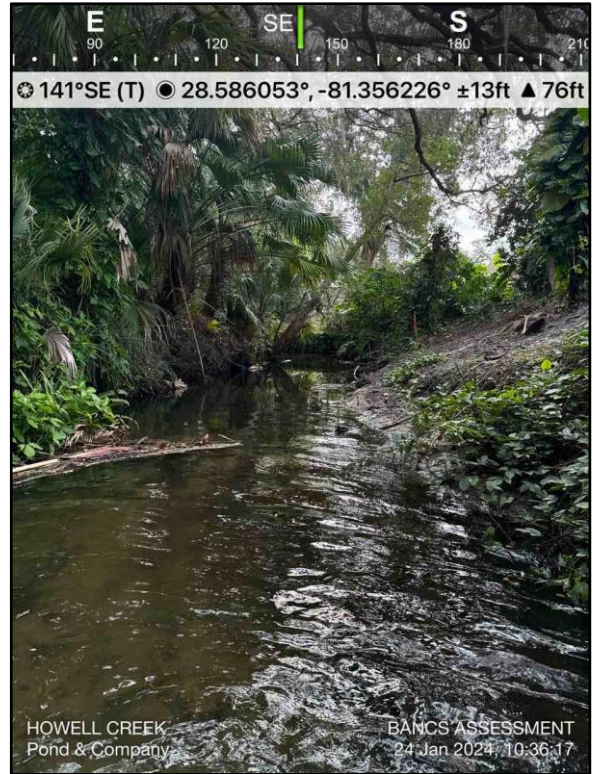
Photograph 76: BEHI = High (R), NBS = Low (R);
~Sta. 22+00.

STREAMBANK ASSESSMENT

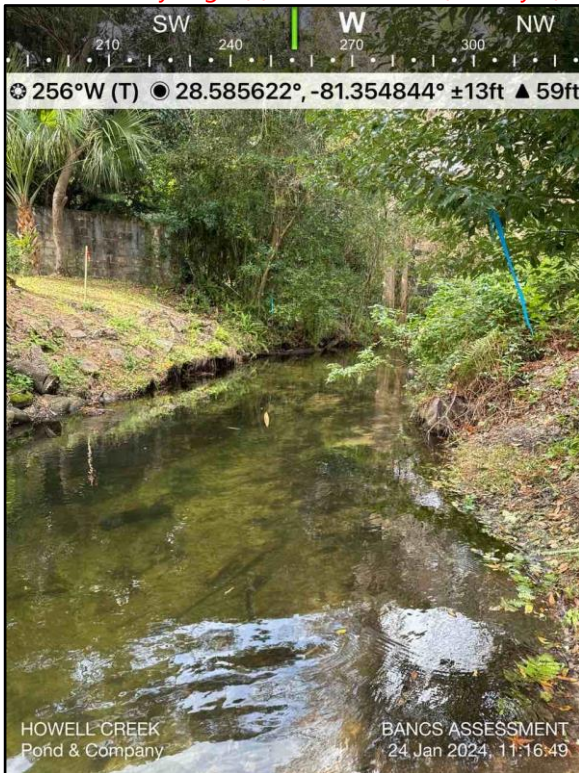
(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



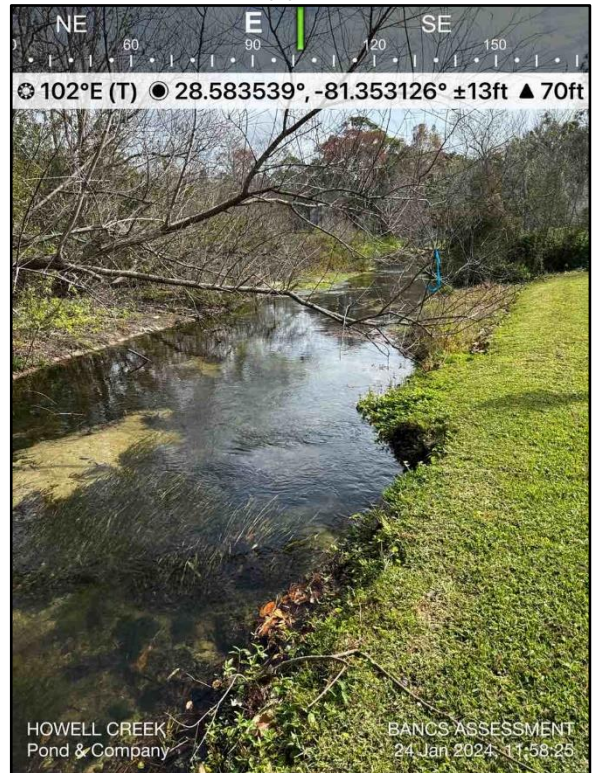
Photograph 77: BEHI = Very High (L),
NBS = Very High (L); ~Sta. 22+25. (Priority 4)



Photograph 78: BEHI = Moderate (R),
NBS = Low (R); ~Sta. 23+00.



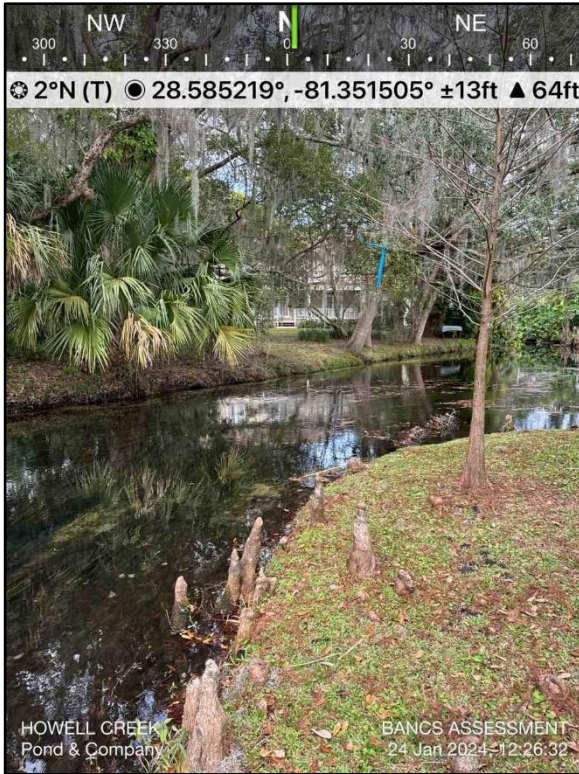
Photograph 79: BEHI = Moderate,
NBS = Low; ~Sta. 25+75.



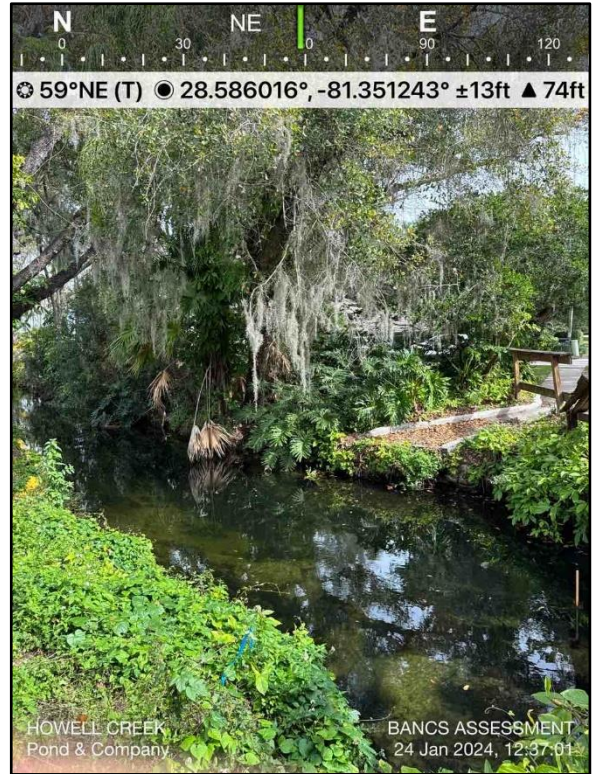
Photograph 80: BEHI = Non-Contributing,
NBS = Non-Contributing; ~Sta. 39+50.

STREAMBANK ASSESSMENT

(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5



Photograph 81: BEHI = Low,
NBS = Low; ~Sta. 50+25.



Photograph 82: BEHI = Moderate (L), Low (R),
NBS = Moderate; ~Sta. 53+50.

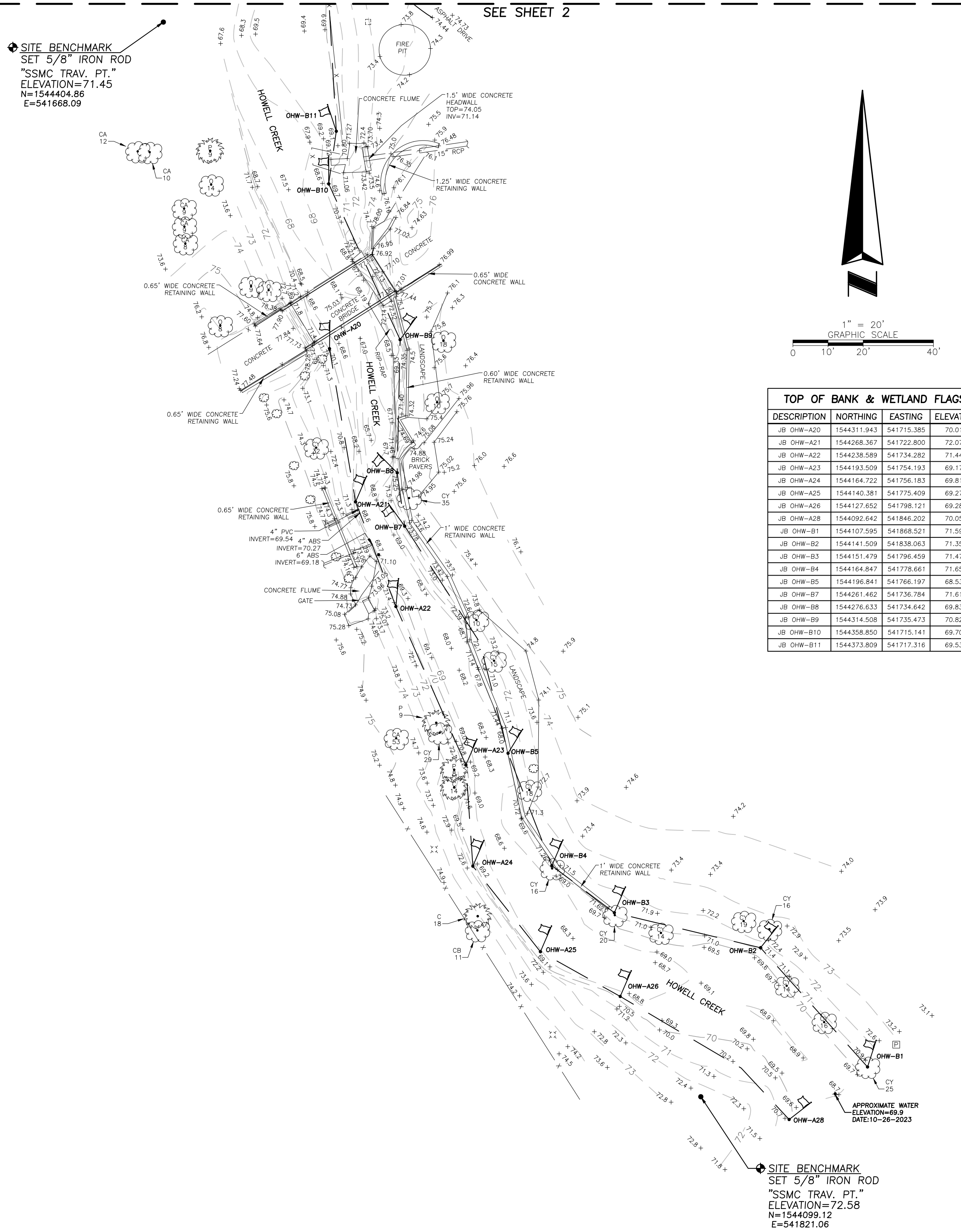
STREAMBANK ASSESSMENT

(R) = Right bank as oriented looking downstream
(L) = Left bank as oriented looking downstream
No indication of (R) or (L) = Caption applies to both banks
Caption color coincides with priority color on Figure 5

ATTACHMENT C: DRAFT LAND AND TREE SURVEY

HOWELL CREEK STREAM RESTORATION

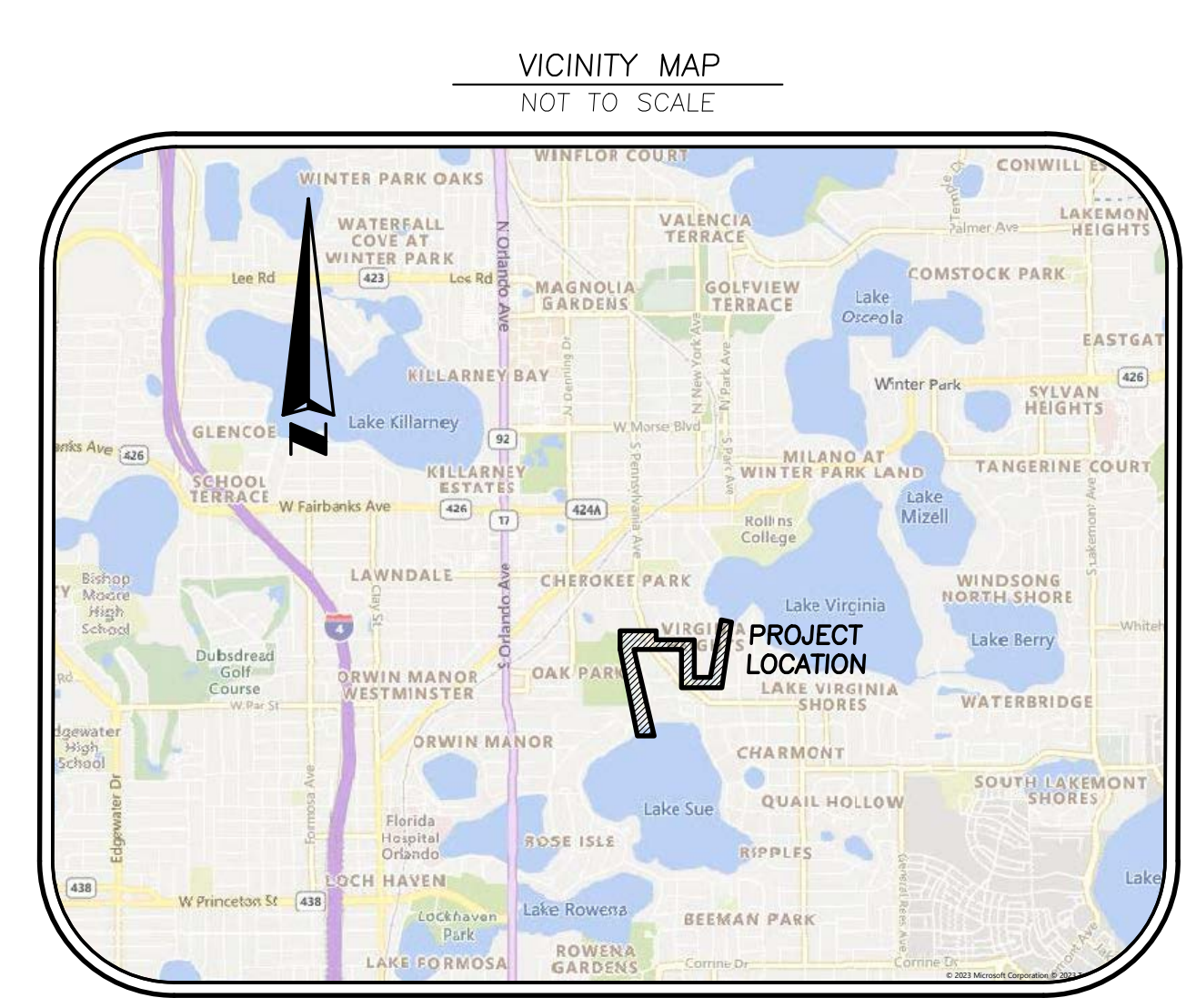
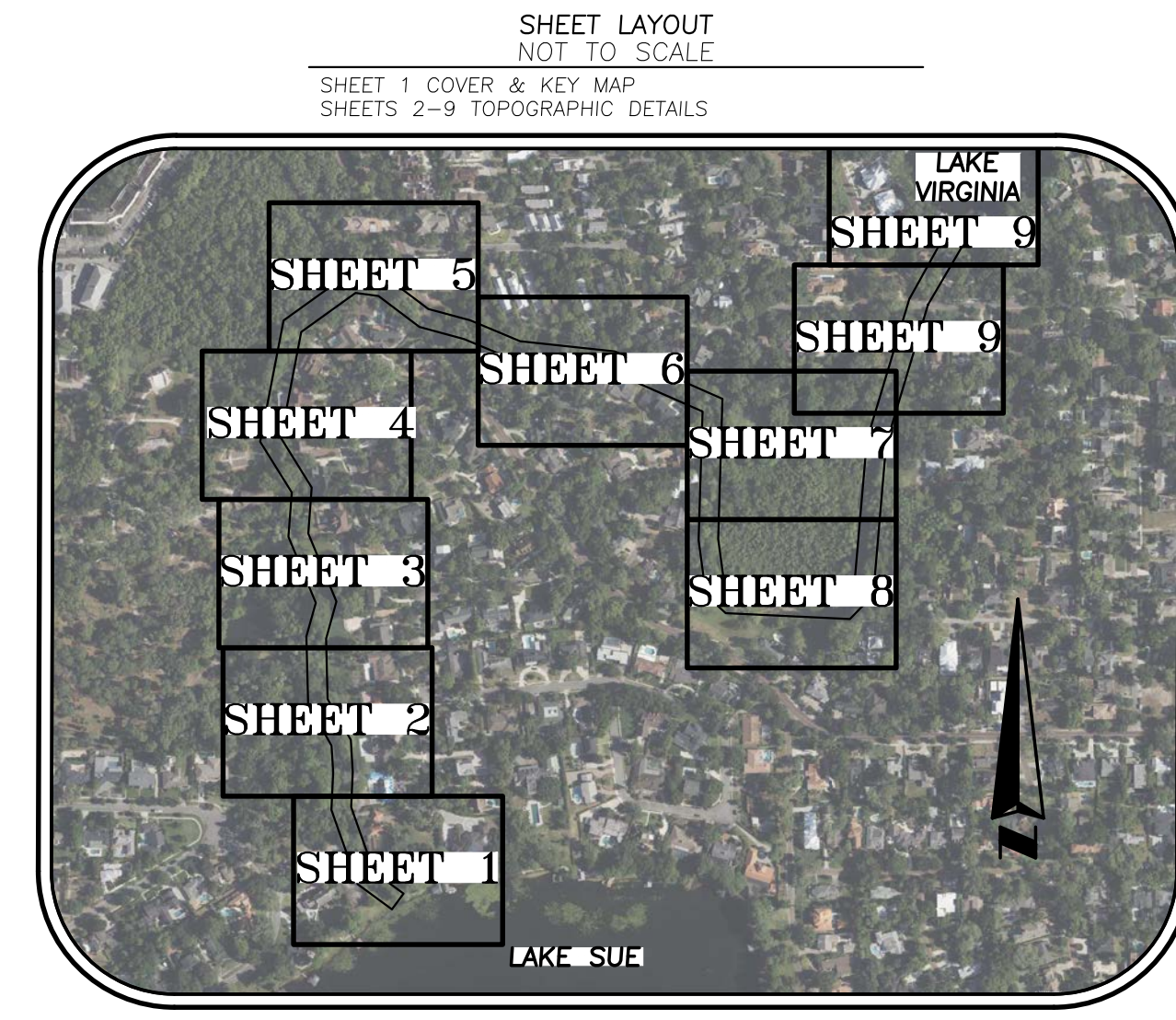
SECTIONS 7 AND 18, TOWNSHIP 22 SOUTH, RANGE 30 EAST, ORANGE COUNTY, FLORIDA



SITE BENCHMARK
SET 5/8" IRON ROD
"SSMC TRAV. PT."
ELEVATION=71.45
N=1544404.86
E=541668.09

SEE SHEET 2

TOP OF BANK & WETLAND FLAGS			
DESCRIPTION	NORTHING	EASTING	ELEVATION
JB OHW-A20	1544311.943	541715.385	70.019
JB OHW-A21	1544268.367	541722.800	72.073
JB OHW-A22	1544238.089	541734.282	71.445
JB OHW-A23	1544193.509	541754.193	69.172
JB OHW-A24	1544164.722	541756.183	69.819
JB OHW-A25	1544140.381	541775.409	69.279
JB OHW-A26	1544127.652	541798.121	69.282
JB OHW-A28	1544092.642	541846.202	70.053
JB OHW-B1	1544107.595	541868.521	71.594
JB OHW-B2	1544141.509	541838.063	71.354
JB OHW-B3	1544151.479	541796.459	71.476
JB OHW-B4	1544164.847	541778.661	71.657
JB OHW-B5	1544196.841	541766.197	68.539
JB OHW-B7	1544281.462	541736.784	71.815
JB OHW-B8	1544276.633	541734.642	69.837
JB OHW-B9	1544314.508	541735.473	70.825
JB OHW-B10	1544358.850	541775.141	69.706
JB OHW-B11	1544373.809	541777.316	69.533



- SYMBOL LEGEND:**
- ACU = AIR CONDITIONING UNIT
 - h = BENCH
 - BUSH = BUSH
 - BT = BURIED TELEPHONE PEDESTAL
 - EF = ELECTRIC FIXTURE
 - FGI = FLAT GRATE INLET
 - GM = GAS METER
 - WS = WATER SPIGOT
 - HH = HAND HOLE
 - IR = IRON ROD
 - IV = IRRIGATION VALVE
 - IVB = IRRIGATION VALVE BOX
 - LSL = LANDSCAPE LIGHTING
 - LP = LIGHT POLE
 - PB = POST/BOLLARD
 - PUMP = PUMP
 - NTS = NON-TRAFFIC SIGN
 - SPR = SPRINKLER
 - TS = TRAFFIC SIGN
 - TSLS = TRANSFORMER ON SLAB
 - VAULT = VAULT
 - WM = WATER METER
 - WV = WATER VALVE
- LINE TYPE LEGEND:**
- X- = CHAINLINK FENCE
 - O- = WOOD FENCE
 - *- = WIRE FENCE
 - ||- = METAL FENCE
 - = POST & RAIL FENCE
 - Δ- = VINYL FENCE
 - BCL- = BURIED CABLE LINE
 - BE- = BURIED ELECTRIC LINE
 - BTL- = BURIED TELEPHONE LINE
 - BTE- = BURIED TELEPHONE DUCT
 - OHL- = OVERHEAD UTILITY LINE
 - WL- = WATER LINE
 - UNK- = UNKNOWN UTILITY LINE
 - ||- = TREE/HEDGE LINE
 - ||- = GUARDRAIL
- ABBREVIATION LEGEND:**
- FF = FINISH FLOOR ELEVATION
 - INV = INVERT
 - LB = LICENSED BUSINESS
 - ID = IDENTIFICATION
 - FF = FINISH FLOOR ELEVATION
 - EOI = END OF INFORMATION
 - TRAV.PT. = TRAVERSE POINT
 - SSMC = SOUTHEASTERN SURVEYING & MAPPING CORPORATION
- TREE LEGEND:**
- SIZE SHOWN IS TRUNK DIAMETER IN INCHES MEASURED AT CHEST HEIGHT
- P = PALM
 - C = CABBAGE
 - S = SABL
- TREE:**
- B = BAY
 - BI = BIRCH
 - CA = CAMPHOR
 - CY = CYPRESS
 - EA = EAR
 - E = ELM
 - GU = GUM
 - MA = MAGNOLIA
 - M = MAPLE
 - MY = MYRTLE
 - O = OAK
 - PI = PINE
 - S = SYCAMORE
 - T = TALLOW
 - UK = UNKNOWN
- PIPE LEGEND:**
- ABS = ACRYLONITRILE BUTADIENE STYRENE PIPE
 - CMP = CORRUGATED METAL PIPE
 - CPP = CORRUGATED PLASTIC PIPE
 - PVC = POLYVINYL CHLORIDE PIPE
 - RCP = REINFORCED CONCRETE PIPE
 - VCP = VITRIFIED CLAY PIPE

DESCRIPTION:
A PORTION OF SECTIONS 7 AND 18, TOWNSHIP 22 SOUTH, RANGE 30 EAST, LYING IN ORANGE COUNTY, FLORIDA.

- SURVEYOR'S REPORT:**
- UTILITY LOCATIONS SHOWN HEREON ARE BASED ON FIELD LOCATIONS OF MARKINGS BY SOUTHEASTERN SURVEYING & MAPPING CORP. FIELD MARKINGS ARE BASED ON SIGNALS RECEIVED FROM GROUND PENETRATING RADAR (GPR) AND ELECTRONIC EQUIPMENT. LOCATIONS ARE APPROXIMATE AND TEST HOLES SHOULD BE PERFORMED FOR VERIFICATION.
 - EASEMENTS OR RIGHTS OF WAY THAT APPEAR ON RECORDED PLANS OR THAT HAVE BEEN FURNISHED TO THE SURVEYOR BY OTHERS HAVE BEEN INCORPORATED INTO THIS DRAWING WITH APPROPRIATE NOTATION. OTHER EASEMENTS MAY BE DISCOVERED BY A SEARCH OF THE PUBLIC RECORDS.
 - MINIMUM HORIZONTAL ACCURACY FOR THIS SURVEY IS IN ACCORDANCE WITH THE STANDARDS OF PRACTICE SET FORTH BY THE BOARD OF PROFESSIONAL SURVEYORS AND MAPPERS IN CHAPTER 5J-17 REQUIREMENTS OF FLORIDA ADMINISTRATIVE CODE. THE MAP AND MEASUREMENT METHODS USED FOR THIS SURVEY MEET OR EXCEED THIS REQUIREMENT. THE DIMENSIONS SHOWN HEREON ARE IN UNITED STATES SURVEY FEET AND DECIMALS THEREOF.
 - THIS SURVEY DOES NOT DETERMINE OWNERSHIP OF THE LANDS SHOWN HEREON.
 - UNDERGROUND FOUNDATIONS HAVE NOT BEEN LOCATED.
 - SURVEY MAP AND REPORT OR THE COPIES THEREOF ARE NOT VALID WITHOUT THE ORIGINAL SIGNATURE AND SEAL OR THE ELECTRONIC SIGNATURE AND SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER, AND IF SHOWN HEREON IS IN COMPLIANCE WITH FLORIDA ADMINISTRATIVE CODE 5J-17.062 AND FLORIDA STATUTE 472.025.
 - FEATURES SHOWN BY SYMBOL AS INDICATED IN THE LEGEND ARE NOT TO SCALE.
 - ADDITIONS OR DELETIONS TO SURVEY MAPS OR REPORTS BY OTHER THAN THE SIGNING PARTY OR PARTIES IS PROHIBITED WITHOUT WRITTEN CONSENT OF THE SIGNING PARTY OR PARTIES.
 - HORIZONTAL FEATURES SHOWN ON THE MAP REFER TO A NATIONAL GEODETIC SURVEY POINT WITH DESIGNATION "GIS 0131 KAREN MCKEE", PID NUMBER AK7129 AND IS RELATIVE TO NORTH AMERICAN DATUM OF 1983 (NAD83), 2011 ADJUSTMENT, STATE PLANE COORDINATE SYSTEM, FLORIDA EAST ZONE. DISTANCES SHOWN ARE GRID DISTANCES.
 - VERTICAL INFORMATION SHOWN HEREON REFERS TO A NATIONAL GEODETIC SURVEY (NGS) POINT WITH DESIGNATION "GIS 0131 KAREN MCKEE", PID NUMBER AK7129 AND HAS A PUBLISHED ELEVATION OF 79.26 FEET NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
 - IMPROVEMENTS AND TOPOGRAPHIC FEATURES SHOWN HEREON ARE LIMITED TO AREAS PER SPECIFIC INSTRUCTIONS OF THE CLIENT.
 - RIGHT OF WAY INFORMATION SHOWN HEREON WAS DETERMINED BY FOUND MONUMENTATION, RECORDED PLATS, RECORDED RIGHT OF WAY MAPS, AND INFORMATION OBTAINED ON THE ORANGE COUNTY PROPERTY APPRAISERS WEB SITE. NO RIGHT OF WAY DOCUMENTATION WAS PROVIDED BY CLIENT.

NOTICE OF LIABILITY:
THIS SURVEY IS CERTIFIED TO THOSE INDIVIDUALS SHOWN ON THE FACE THEREOF. ANY OTHER USE, BENEFIT OR RELIANCE BY ANY OTHER PARTY IS STRICTLY PROHIBITED AND RESTRICTED. SURVEYOR IS RESPONSIBLE ONLY TO THOSE CERTIFIED AND HEREBY DISCLAIMS ANY OTHER LIABILITY AND HEREBY RESTRICTS THE RIGHTS OF ANY OTHER INDIVIDUAL OR FIRM TO USE THIS SURVEY, WITHOUT EXPRESS WRITTEN CONSENT OF THE SURVEYOR.

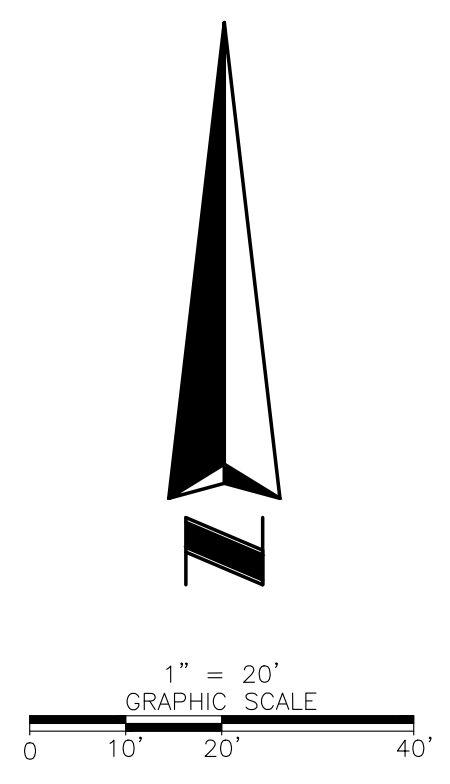
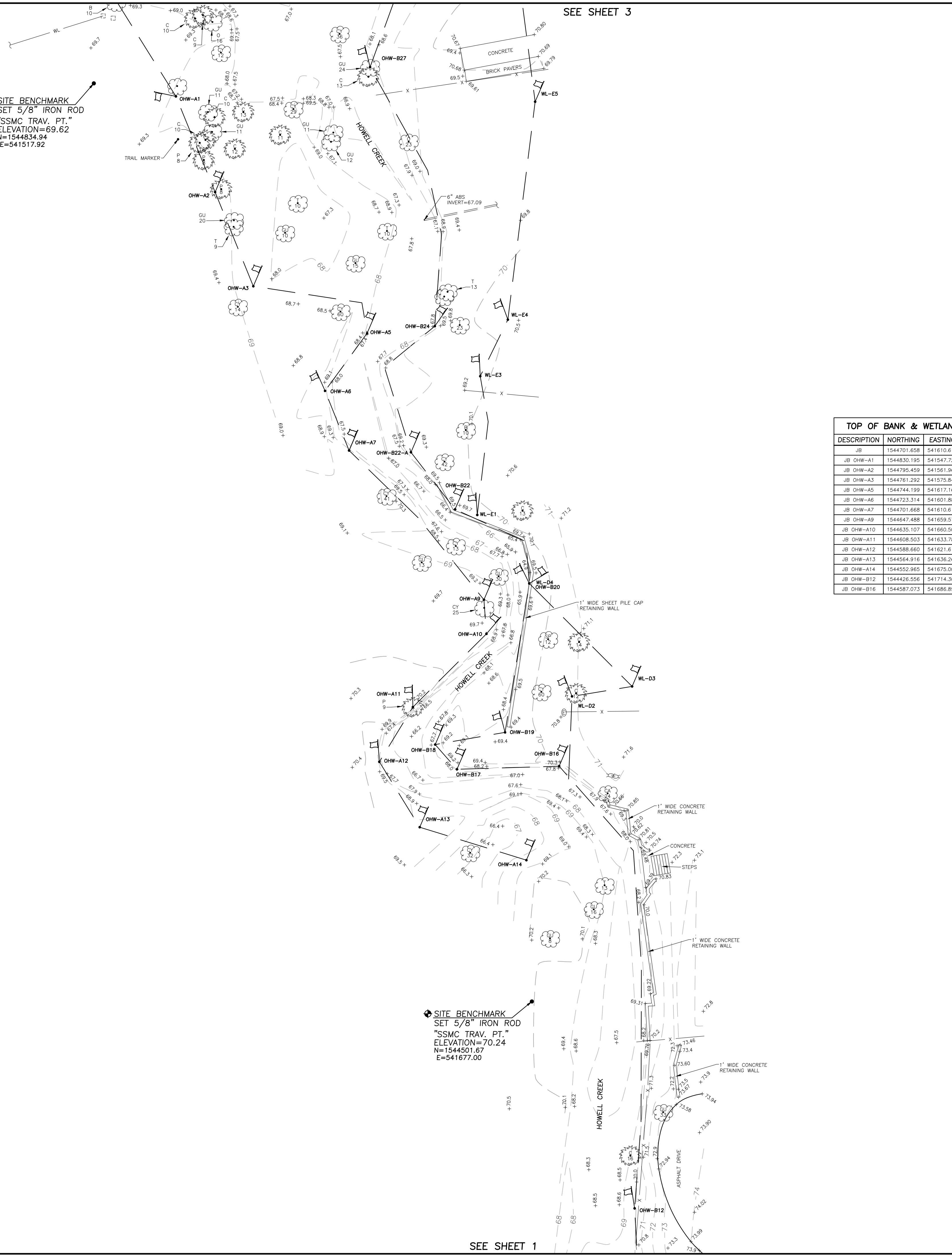
SOUTHEASTERN SURVEYING AND MAPPING CORPORATION
 6000 All American Boulevard
 Orlando, Florida 32817-4309
 Phone: (407) 292-8580
 e-mail: info@southesternsurveying.com
 Certification Number: 12E108

TOPOGRAPHIC SURVEY
 HOWELL CREEK
 WINTER PARK, FLORIDA 32789
 Project: _____
 Field Date: JANUARY 23, 2023
 Drawn By: CWS
 Scale: 1" = 20'
 SHEET NUMBER 1 OF 9
 NOT VALID WITHOUT SHEETS 1 THROUGH 9

POND & COMPANY
 Certified to: _____
 DRAWING NUMBER
 70144001
 SHEET NUMBER
 1 OF 9

◆ SITE BENCHMARK
 SET 5/8" IRON ROD
 "SSMC TRAV. PT."
 ELEVATION=69.62
 N=1544834.94
 E=541517.92

SEE SHEET 3



TOP OF BANK & WETLAND FLAGS			
DESCRIPTION	NORTHING	EASTING	ELEVATION
JB	1544701.658	541610.618	68.275
JB OHW-A1	1544830.195	541547.729	69.062
JB OHW-A2	1544795.459	541561.966	69.604
JB OHW-A3	1544761.292	541575.844	68.940
JB OHW-A5	1544744.199	541617.160	67.868
JB OHW-A6	1544723.314	541601.885	69.067
JB OHW-A7	1544701.668	541610.617	66.461
JB OHW-A9	1544647.488	541659.579	68.923
JB OHW-A10	1544635.107	541660.500	69.156
JB OHW-A11	1544608.503	541633.782	70.510
JB OHW-A12	1544588.660	541621.616	68.701
JB OHW-A13	1544564.916	541636.262	69.178
JB OHW-A14	1544552.965	541675.003	69.170
JB OHW-B12	1544426.556	541714.309	69.973
JB OHW-B16	1544587.073	541686.895	68.208

TOP OF BANK & WETLAND FLAGS			
DESCRIPTION	NORTHING	EASTING	ELEVATION
JB OHW-B17	1544585.942	541649.788	68.023
JB OHW-B18	1544594.914	541641.892	68.290
JB OHW-B19	1544599.347	541667.256	68.903
JB OHW-B20	1544653.405	541676.060	64.844
JB OHW-B22	1544680.292	541649.093	69.537
JB OHW-B22-A	1544701.011	541633.086	68.990
JB OHW-B24	1544746.784	541641.744	68.455
JB OHW-B27	1544840.823	541618.243	66.844
JB WL-D2	1544612.403	541691.582	71.061
JB WL-D3	1544616.021	541713.402	71.301
JB WL-D4	1544653.405	541676.060	0.000
JB WL-E1	1544678.257	541657.167	69.835
JB WL-E3	1544728.629	541658.243	69.636
JB WL-E4	1544749.162	541668.284	70.159
JB WL-E5	1544828.274	541678.188	69.694

◆ SITE BENCHMARK
 SET 5/8" IRON ROD
 "SSMC TRAV. PT."
 ELEVATION=70.24
 N=1544501.67
 E=541677.00

SEE SHEET 1

SHEET NUMBER 2 OF 9
NOT VALID WITHOUT SHEETS 1 THROUGH 9

SSMC
SUE • SURVEY • GIS

SOUTHEASTERN SURVEYING
AND MAPPING CORPORATION
6000 All American Boulevard
Orlando, Florida 32817-4339
Phone: (407) 292-8580
e-mail: info@southesternsurveying.com
Certification Number: 12E108

BY	REVISION	DATE	DESCRIPTION

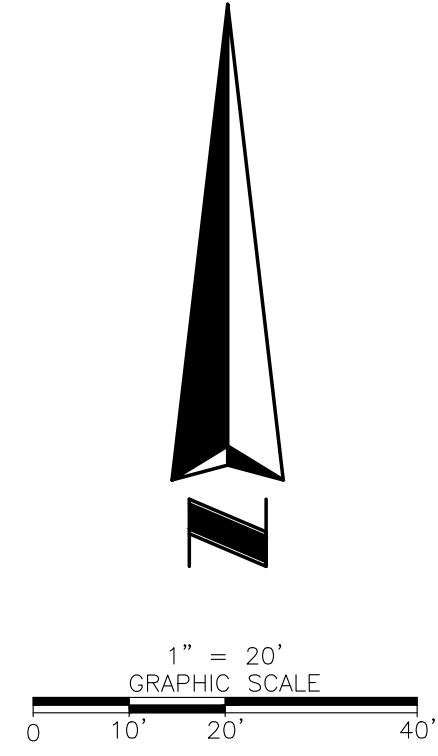
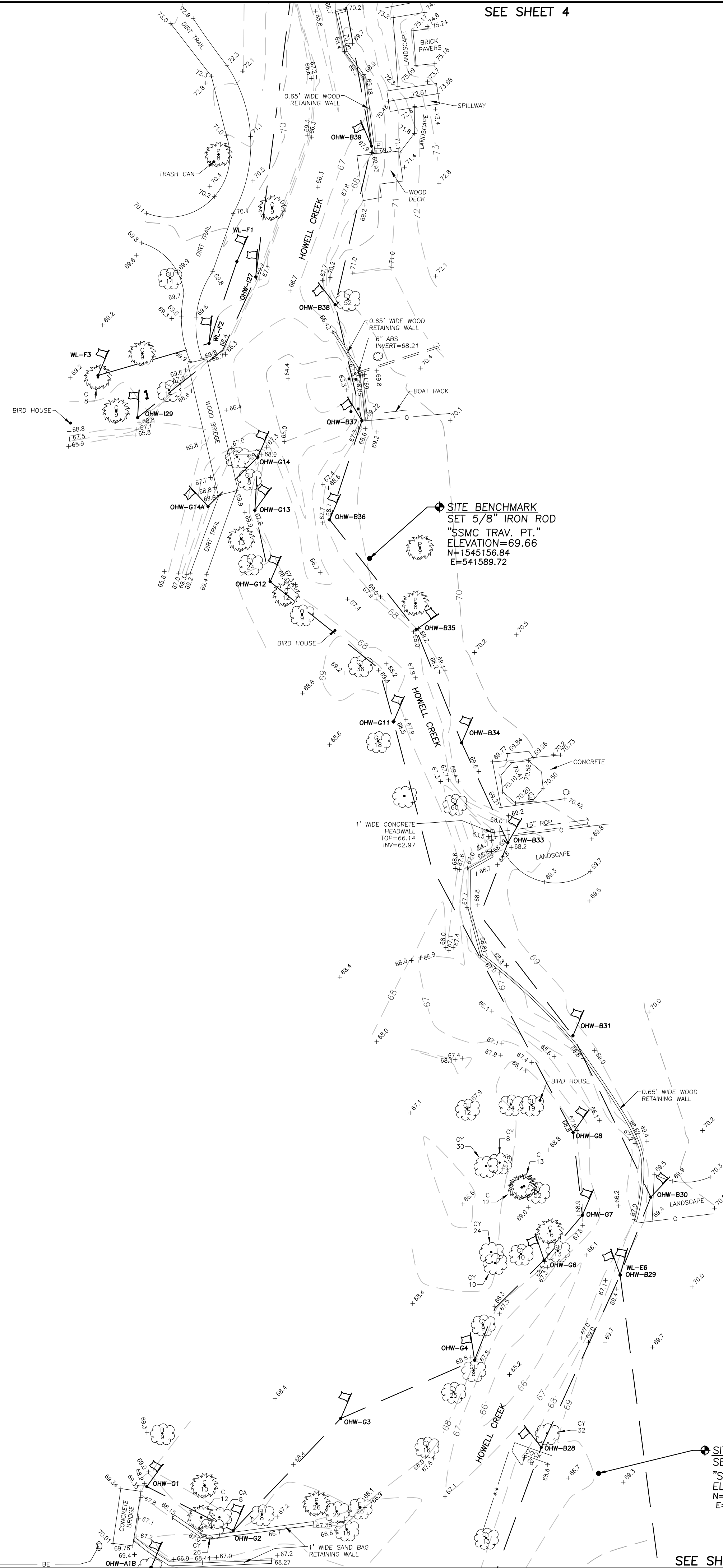
TOPOGRAPHIC SURVEY
HOWELL CREEK
WINTER PARK, FLORIDA 32789

Scale: 1" = 20'
Drawn By: CWS
Field Date: JANUARY 23, 2023

SEE SHEET 1 FOR NOTES,
LEGEND AND DESCRIPTION.

DRAWING NUMBER
70144001
SHEET
NUMBER
2 OF **9**

SEE SHEET 4



TOP OF BANK & WETLAND FLAGS			
DESCRIPTION	NORTHING	EASTING	ELEVATION
JB OHW-A18	1544864.392	541526.380	69.554
JB OHW-B28	1544899.157	541639.510	68.722
JB OHW-B29	1544949.108	541662.385	68.926
JB OHW-B30	1544971.704	541671.269	69.168
JB OHW-B31	1545018.460	541648.682	68.206
JB OHW-B33	1545074.431	541629.821	67.876
JB OHW-B34	1545103.366	541616.419	69.197
JB OHW-B35	1545136.167	541603.200	68.434
JB OHW-B36	1545168.033	541578.122	68.755
JB OHW-B37	1545196.702	541587.474	67.865
JB OHW-B38	1545230.348	541579.774	69.678
JB OHW-B39	1545276.326	541590.249	67.766
JB OHW-G1	1544887.814	541525.109	68.760
JB OHW-G2	1544874.992	541550.134	67.715
JB OHW-G3	1544907.530	541581.344	67.716

TOP OF BANK & WETLAND FLAGS			
DESCRIPTION	NORTHING	EASTING	ELEVATION
JB OHW-G4	1544924.425	541620.148	68.102
JB OHW-G6	1544953.448	541640.317	68.536
JB OHW-G7	1544966.439	541651.419	68.586
JB OHW-G8	1544990.405	541648.743	68.792
JB OHW-G11	1545109.520	541596.663	68.529
JB OHW-G12	1545150.062	541560.872	68.549
JB OHW-G13	1545170.798	541556.454	67.804
JB OHW-G14	1545186.201	541557.322	68.780
JB OHW-G14A	1545171.915	541542.856	69.186
JB OHW-J27	1545238.396	541556.722	69.188
JB OHW-J29	1545197.630	541522.444	68.739
JB WL-E6	1544949.103	541662.384	68.924
JB WL-F1	1545242.885	541551.238	69.530
JB WL-F2	1545219.143	541543.144	69.190
JB WL-F3	1545209.851	541510.951	70.119

SEE SHEET 2

P:\70144 Howell Creek Stream Restoration\DWG C3D\70144001.dwg

SHEET NUMBER 3 OF 9
NOT VALID WITHOUT SHEETS
1 THROUGH 9

SSMC
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Certification Number: 12E108

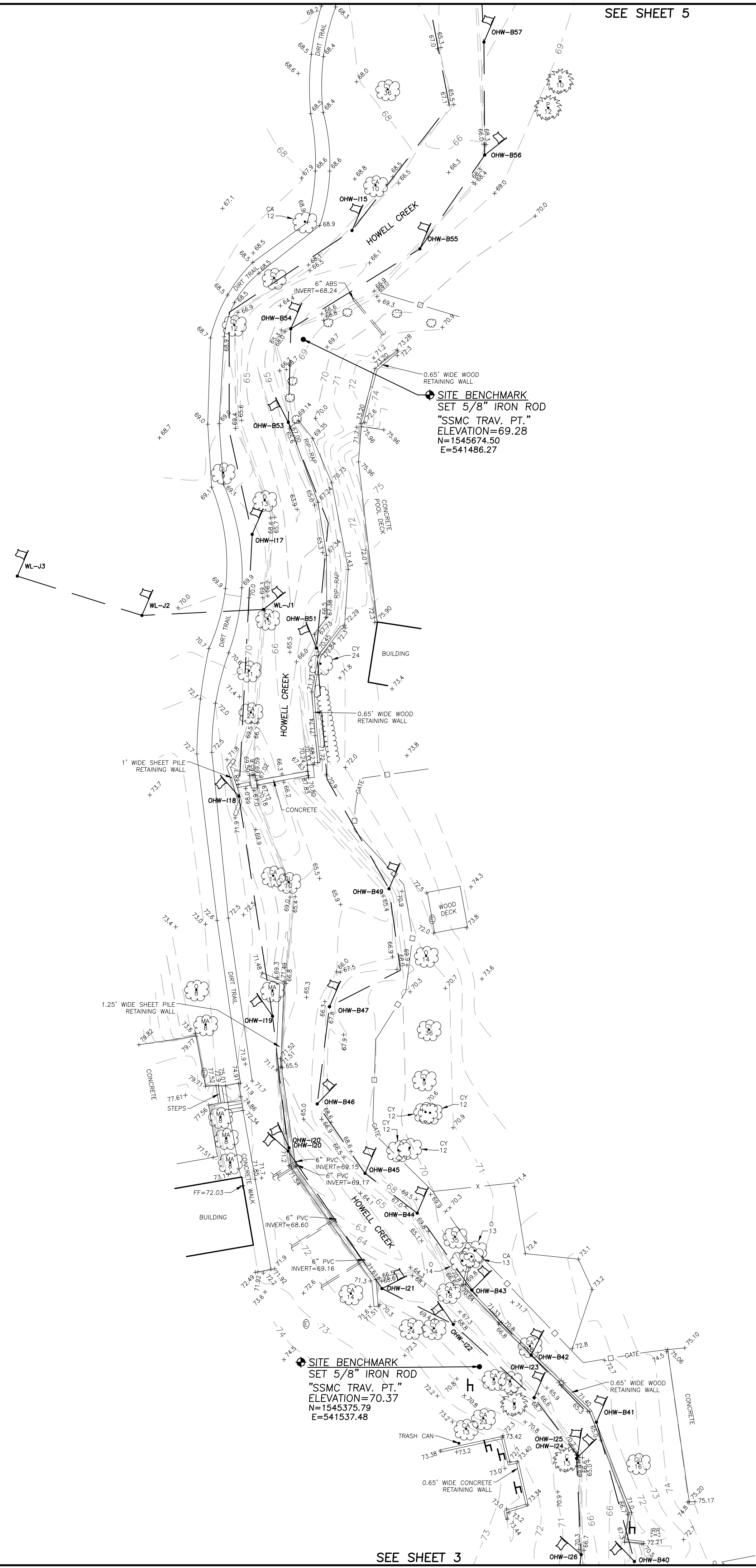
REVISION	DATE	BY

TOPOGRAPHIC SURVEY
HOWELL CREEK
WINTER PARK, FLORIDA 32789
Scale: 1" = 20'
Drawn By: CWS
Field Date: JANUARY 23, 2023

SEE SHEET 1 FOR NOTES,
LEGEND AND DESCRIPTION.

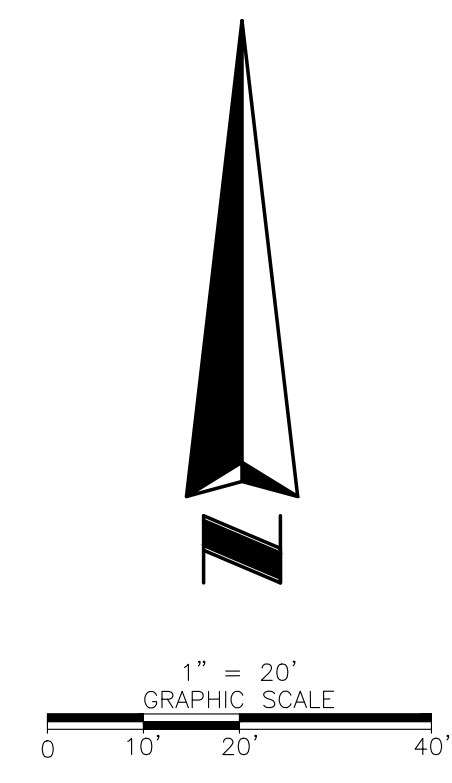
DRAWING NUMBER
70144001
SHEET
NUMBER
3 OF 9

SEE SHEET 5



SITE BENCHMARK
 SET 5/8" IRON ROD
 "SSMC TRAV. PT."
 ELEVATION=69.28
 N=1545674.50
 E=541486.27

SITE BENCHMARK
 SET 5/8" IRON ROD
 "SSMC TRAV. PT."
 ELEVATION=70.37
 N=1545375.79
 E=541537.48



TOP OF BANK & WETLAND FLAGS			
DESCRIPTION	NORTHING	EASTING	ELEVATION
JB OHW-B40	1545319.161	541582.533	67.706
JB OHW-B41	1545359.660	541571.489	70.977
JB OHW-B42	1545379.169	541552.506	70.427
JB OHW-B43	1545398.064	541535.271	69.658
JB OHW-B44	1545420.445	541519.277	70.121
JB OHW-B45	1545432.012	541504.223	66.956
JB OHW-B46	1545452.206	541490.319	67.005
JB OHW-B47	1545480.483	541493.876	67.843
JB OHW-B48	1545514.767	541511.186	67.888
JB OHW-B49	1545584.733	541490.130	70.646
JB OHW-B50	1545650.385	541481.908	68.214
JB OHW-B51	1545677.605	541482.639	67.675
JB OHW-B52	1545700.824	541520.155	67.224
JB OHW-B53	1545728.114	541539.015	68.248
JB OHW-B54	1545760.952	541538.779	67.916

TOP OF BANK & WETLAND FLAGS			
DESCRIPTION	NORTHING	EASTING	ELEVATION
JB OHW-B15	1545706.169	541500.426	66.634
JB OHW-B17	1545617.813	541471.402	69.267
JB OHW-B18	1545561.689	541467.506	71.381
JB OHW-B19	1545477.715	541477.326	71.242
JB OHW-B20	1545438.490	541481.860	71.428
JB OHW-B21	1545439.442	541482.137	71.168
JB OHW-B22	1545398.515	541509.135	69.245
JB OHW-B23	1545368.109	541529.886	69.305
JB OHW-B24	1545366.776	541553.390	68.717
JB OHW-B25	1545349.959	541565.995	70.256
JB OHW-B26	1545349.132	541565.693	70.287
JB OHW-B27	1545321.156	541567.049	66.914
JB WL-J1	1545595.980	541474.721	69.670
JB WL-J2	1545594.234	541439.346	69.887
JB WL-J3	1545605.677	541403.113	71.575

P:\70144 Howell Creek Stream Restoration\DWG C3D\70144001.dwg

SEE SHEET 3

SHEET NUMBER 4 OF 9
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REVISION	DATE	BY

TOPOGRAPHIC SURVEY
HOWELL CREEK
WINTER PARK, FLORIDA 32789

Project: HOWELL CREEK
 Field Date: JANUARY 23, 2023
 Drawn By: CWS
 Scale: 1" = 20'

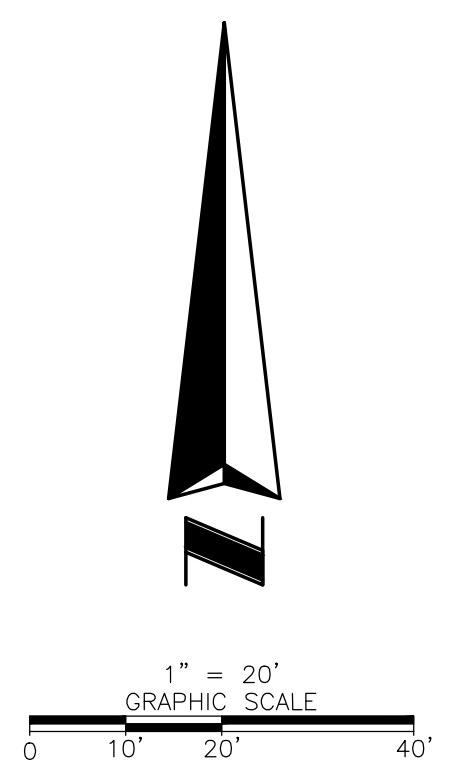
SEE SHEET 1 FOR NOTES,
 LEGEND AND DESCRIPTION.

DRAWING NUMBER
70144001
 SHEET NUMBER
4 OF 9

SEE SHEET 5



TOP OF BANK & WETLAND FLAGS			
DESCRIPTION	NORTHING	EASTING	ELEVATION
JB OHW-B77	1545801.291	542121.618	66.951
JB OHW-B78	1545786.995	542198.723	68.843
JB OHW-B79	1545773.887	542244.032	66.374
JB OHW-B80	1545779.195	542337.290	66.551
JB OHW-B82	1545756.546	542433.855	68.354
JB OHW-B83	1545743.631	542480.294	65.521
JB OHW-B84	1545728.536	542525.958	64.341
JB OHW-B86	1545701.111	542587.063	64.584
JB OHW-B87	1545691.690	542634.235	63.728
JB OHW-B88	1545672.713	542678.305	66.109
JB OHW-B89	1545638.854	542722.694	66.576
JB OHW-H26	1545664.698	542724.107	68.409
JB OHW-H27	1545700.929	542664.841	65.075
JB OHW-H32	1545788.868	542400.812	64.539
JB OHW-H33	1545797.331	542364.885	65.554
JB OHW-H34	1545788.064	542278.683	65.363
JB OHW-H35	1545811.568	542155.832	66.068



SEE SHEET 7

TOPOGRAPHIC SURVEY

HOWELL CREEK
WINTER PARK, FLORIDA 32789

Project:
Field Date: JANUARY 23, 2023
Drawn By: CWS
Scale: 1" = 20'

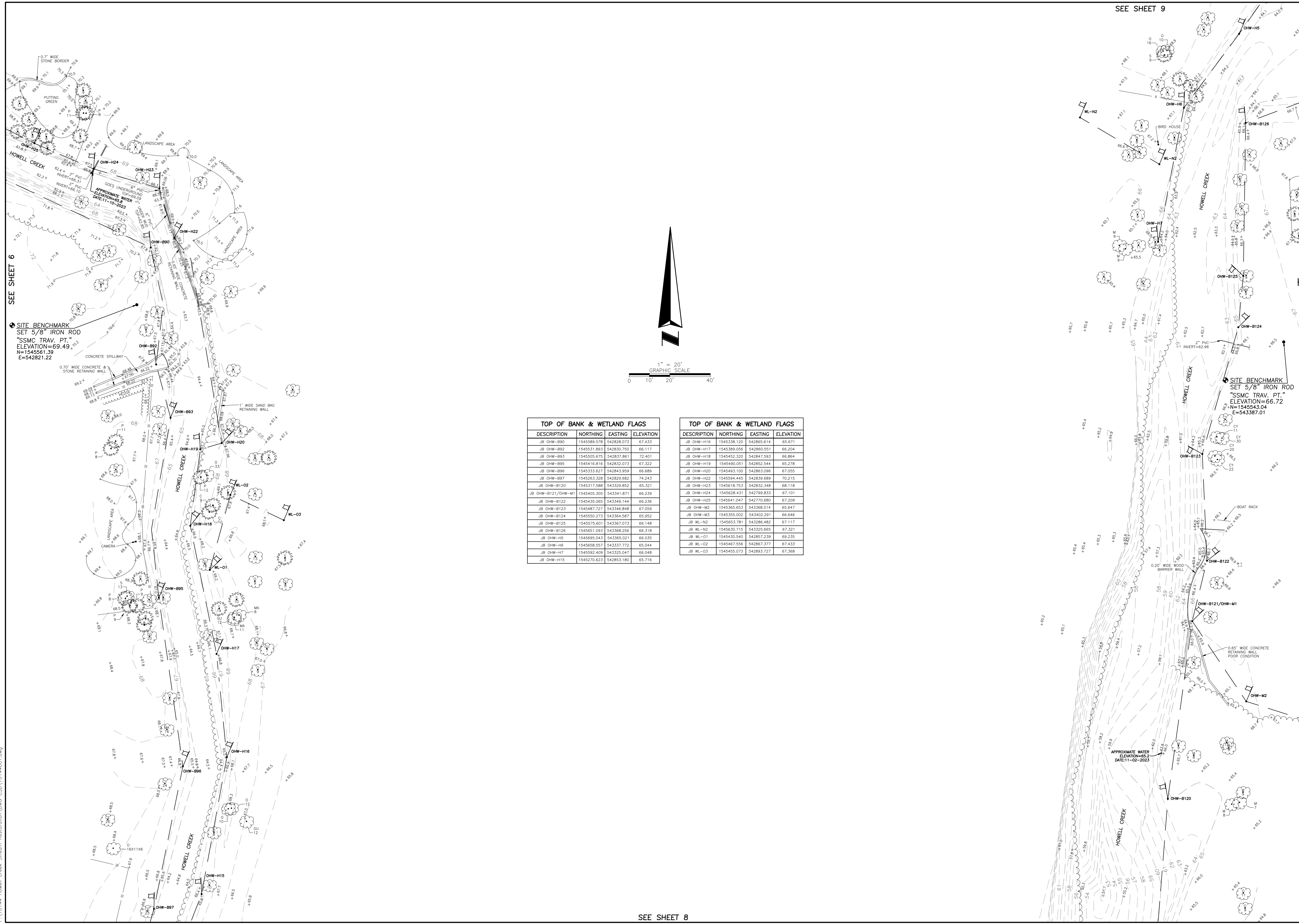
DRAWING NUMBER
70144001
SHEET NUMBER
6 OF 9

BY: _____
REVISION DATE: _____
REVISION: _____

SOUTHEASTERN SURVEYING
AND MAPPING CORPORATION
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Certification Number: 12E108

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1 THROUGH 9

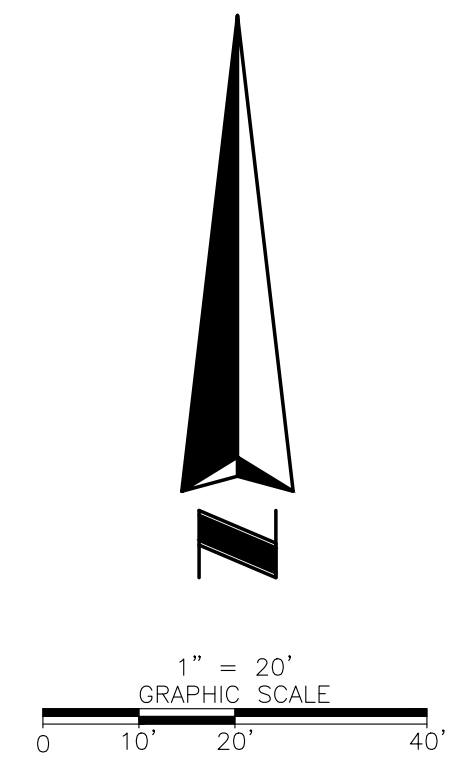


TOP OF BANK & WETLAND FLAGS

DESCRIPTION	NORTHING	EASTING	ELEVATION
JB OHW-B90	1545389.578	542828.073	67.433
JB OHW-B92	1545531.893	542830.750	66.117
JB OHW-B93	1545505.675	542837.861	72.401
JB OHW-B95	1545416.816	542832.073	67.322
JB OHW-B96	1545333.627	542843.959	66.889
JB OHW-B97	1545263.328	542829.682	74.243
JB OHW-B120	1545317.588	543329.852	65.321
JB OHW-B121/OHW-M1	1545409.309	543341.871	66.239
JB OHW-B122	1545435.065	543349.144	66.236
JB OHW-B123	1545487.727	543346.848	67.059
JB OHW-B124	1545550.273	543364.587	65.952
JB OHW-B125	1545575.601	543367.073	66.148
JB OHW-B126	1545651.093	543368.256	66.318
JB OHW-H5	1545695.043	543365.021	66.035
JB OHW-H6	1545658.557	543337.772	65.044
JB OHW-H7	1545592.409	543325.047	66.048
JB OHW-H15	1545270.623	542853.180	65.716

TOP OF BANK & WETLAND FLAGS

DESCRIPTION	NORTHING	EASTING	ELEVATION
JB OHW-H16	1545338.120	542865.614	65.671
JB OHW-H17	1545389.056	542860.551	66.204
JB OHW-H18	1545452.320	542847.593	66.864
JB OHW-H19	1545490.051	542852.544	65.278
JB OHW-H20	1545493.100	542863.096	67.055
JB OHW-H22	1545599.445	542839.689	70.215
JB OHW-H23	1545618.753	542832.348	68.118
JB OHW-H24	1545628.431	542799.833	67.101
JB OHW-H25	1545641.047	542770.680	67.209
JB OHW-M2	1545365.653	543368.514	65.647
JB OHW-M3	1545355.002	543402.291	66.646
JB WL-N2	1545653.781	543296.482	67.117
JB WL-N2	1545630.715	543325.665	67.321
JB WL-O1	1545430.540	542857.239	69.235
JB WL-O2	1545467.556	542867.377	67.433
JB WL-O3	1545455.073	542893.727	67.368



SEE SHEET 6

SEE SHEET 9

SITE BENCHMARK
 SET 5/8" IRON ROD
 "SSMC TRAV. PT."
 ELEVATION=69.49
 N=1545561.39
 E=542821.22

SITE BENCHMARK
 SET 5/8" IRON ROD
 "SSMC TRAV. PT."
 ELEVATION=66.72
 N=1545543.04
 E=543387.01

SHEET NUMBER 7 OF 9
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BY	REVISION	DATE

TOPOGRAPHIC SURVEY

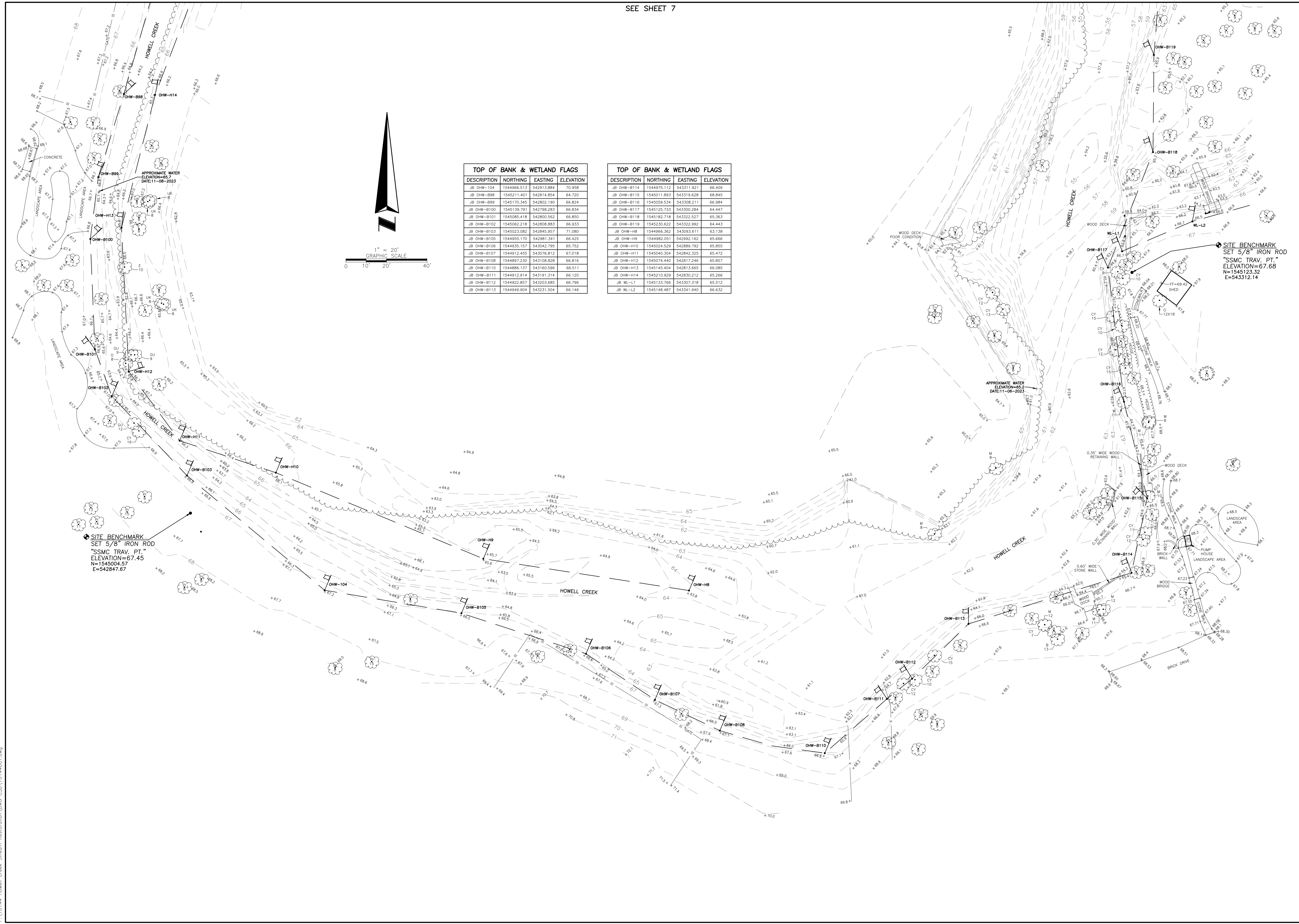
HOWELL CREEK
WINTER PARK, FLORIDA 32789

Project: _____ Scale: 1" = 20'
Field Date: JANUARY 23, 2023 Drawn By: CWS

SEE SHEET 1 FOR NOTES, LEGEND AND DESCRIPTION.

DRAWING NUMBER
70144001
SHEET NUMBER
7 OF 9

SEE SHEET 8



TOP OF BANK & WETLAND FLAGS

DESCRIPTION	NORTHING	EASTING	ELEVATION
JB OHW-104	1544966.513	542913.884	70.958
JB OHW-898	1545211.401	542814.854	64.720
JB OHW-899	1545170.345	542802.190	66.824
JB OHW-B100	1545139.791	542798.283	66.834
JB OHW-B101	1545085.418	542800.562	66.850
JB OHW-B102	1545062.218	542808.883	66.933
JB OHW-B103	1545023.082	542845.957	71.080
JB OHW-B105	1544955.170	542981.341	66.425
JB OHW-B106	1544935.157	543042.795	65.752
JB OHW-B107	1544912.455	543076.812	67.018
JB OHW-B108	1544897.230	543108.828	66.816
JB OHW-B110	1544886.137	543160.596	66.511
JB OHW-B111	1544912.914	543191.314	66.120
JB OHW-B112	1544922.857	543203.685	66.796
JB OHW-B113	1544949.904	543231.004	66.146

TOP OF BANK & WETLAND FLAGS

DESCRIPTION	NORTHING	EASTING	ELEVATION
JB OHW-B114	1544975.112	543311.921	66.409
JB OHW-B115	1545011.893	543319.628	68.845
JB OHW-B116	1545059.534	543308.211	66.984
JB OHW-B117	1545125.733	543300.284	64.447
JB OHW-B118	1545182.718	543322.527	65.363
JB OHW-B119	1545230.822	543322.992	64.443
JB OHW-H8	1544966.362	543093.611	63.138
JB OHW-H9	1544982.051	542992.162	65.666
JB OHW-H10	1545024.529	542899.792	65.855
JB OHW-H11	1545040.304	542842.325	65.472
JB OHW-H12	1545074.440	542817.246	65.857
JB OHW-H13	1545145.404	542813.665	66.085
JB OHW-H14	1545210.929	542830.212	65.266
JB WL-11	1545133.766	543307.318	65.512
JB WL-12	1545148.487	543341.940	66.632

SHEET NUMBER 8 OF 9
NOT VALID WITHOUT SHEETS
1 THROUGH 9

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Certification Number: 182108

REVISION	DATE	BY

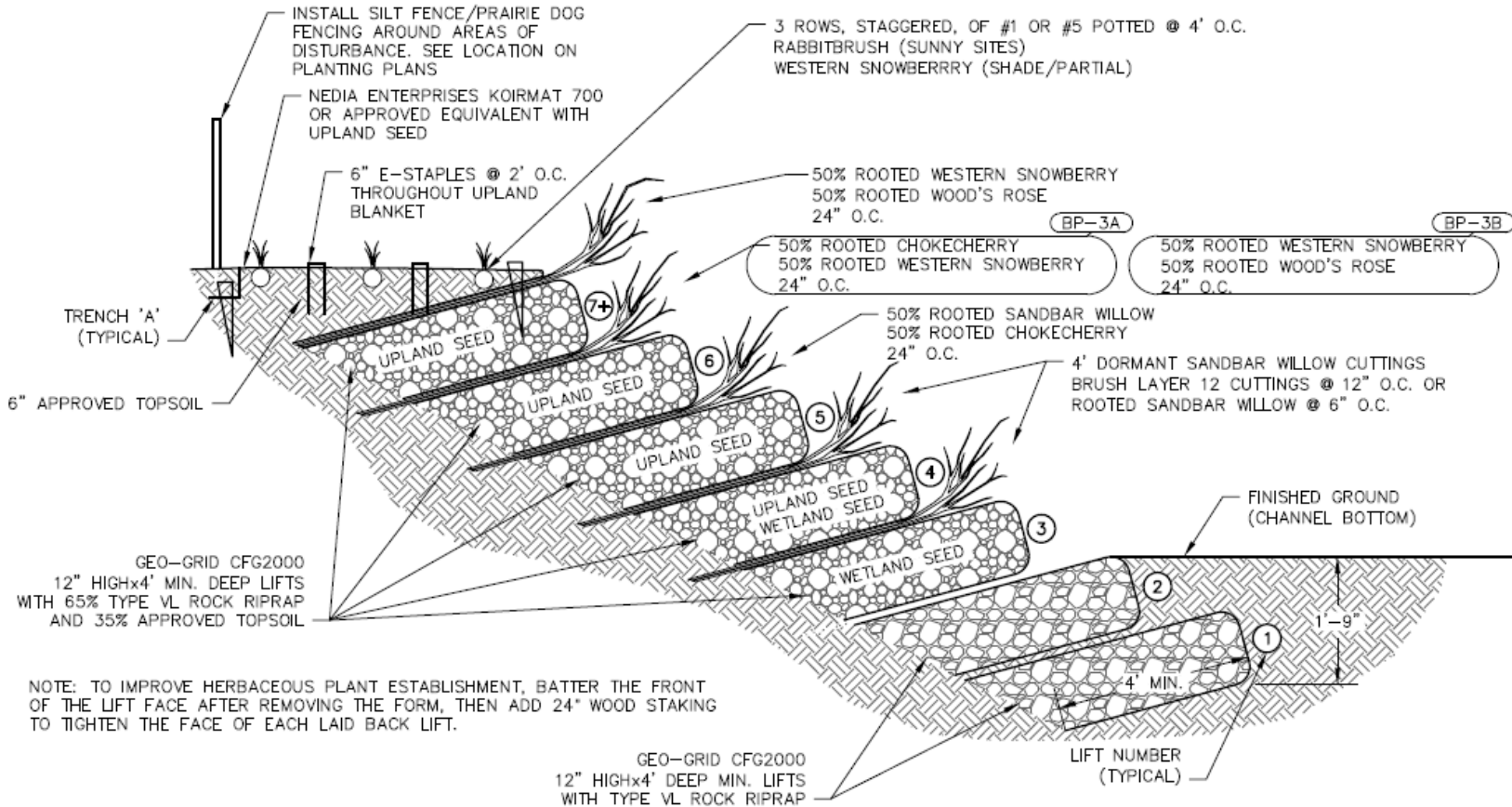
TOPOGRAPHIC SURVEY
HOWELL CREEK
WINTER PARK, FLORIDA 32789
Scale: 1" = 20'
Field Date: JANUARY 23, 2023
Drawn By: CWS

SEE SHEET 1 FOR NOTES,
LEGEND AND DESCRIPTION.

DRAWING NUMBER
70144001
SHEET
NUMBER
8 OF 9

ATTACHMENT D: STRUCTURE/BANK REPAIR OPTION TYPICAL DETAILS

TYPICAL DETAIL - SOIL LAYER LIFTS

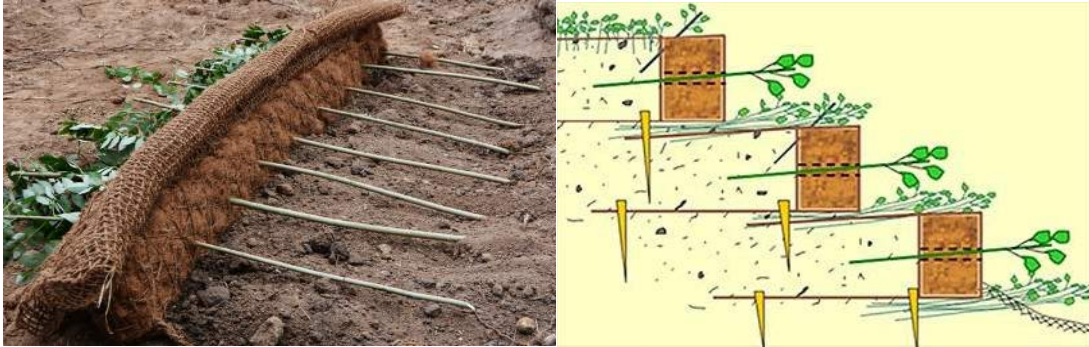


2 BP-3A AND BP-3B: SLOPE PROTECTION FOR SLOPES STEEPER THAN 3:1
DT3 Scale: NOT TO SCALE

BioD-Block™ 12-300

Fabric attached coir block system

US Patent #: 6893193 and 9,315,962 B2
Sri Lanka Patent #: 12692 and 18277



Description

The BioD-Block™ 12-300 consists of a 10-ft long, 12-in tall and 5-inch thick densely packed mattress coir block with BioD-Mat 70 woven coir fabric attached. Three sides of the coir fiber block is wrapped with woven coir fabric and free ends of woven coir fabric is extended from top and bottom of the coir fiber block. The BioD-Block™ system has invisible holes in the middle of the coir block at 12-in spacing at the face through the entire fiber block. Each hole is covered with a coir plug. When these coir plugs are removed, the open hole can be used to plant live plant cuttings. When these plants grow in the soil mass they provide essential stability to the soil mass through their root mass. Also, these plants act as long-term anchors for the fiber blocks. Construction of vegetated soil lifts with coir block system is much easier and more efficient than making soil lifts with fabrics. More importantly, soil lifts constructed with BioD-Block provide long-term protection for the soil layers from its coir fiber block. History has shown failure in fabric wrap soil lifts before mature vegetation establish in the soil mass.

Specification

Property	BioD-Block™ 12-300
Unit weight	3.3 lbs./ft. (5 kg/m)
Block size Height Thickness Length	12 in. (30 cm) 5 in. (13 cm) 10 ft. (305 cm)
Fabric length Top Bottom	47 in. (117.5 cm) 47 in. (117.5 cm)
Tensile strength of fabric MD CD	1740 lbs. /ft. (25.4 kN/m) 1176 lbs. /ft. (17.2 kN/m)
Fabric length at female end	6 in (15 cm)
Invisible planting holes	Each block has 9 holes placed in 12-in spacing. Each hole is covered with a coir plug.



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Web: www.rolanka.com

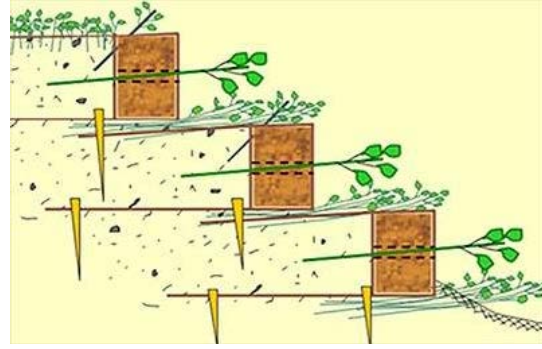
GA DOT DBE Certified

BioD-Block™ 16-300

Fabric attached coir block system

US Patent #: 6893193 and 9,315,962 B2

Sri Lanka Patent #: 12692 and 18277



Description

The BioD-Block™ 16-300 consists of a 10-ft long, 16-in tall and 9-in thick densely packed mattress coir block with BioD-Mat 70 woven coir fabric attached. Three sides of the coir fiber block is wrapped with woven coir fabric and free ends of woven coir fabric is extended from top and bottom of the coir fiber block. The BioD-Block™ system has invisible holes in the middle of the coir block at 12-in spacing at the face through the entire fiber block. Each hole is covered with a coir plug. When these coir plugs are removed, the open hole can be used to plant live plant cuttings. When these plants grow in the soil mass they provide essential stability to the soil mass through their root mass. Also, these plants act as long-term anchors for the fiber blocks. Construction of vegetated soil lifts with coir block system is much easier and more efficient than making soil lifts with fabrics. More importantly, soil lifts constructed with BioD-Block provide long-term protection for the soil layers from its coir fiber block. History has shown failure in fabric wrap soil lifts before mature vegetation establish in the soil mass.

Specification

Property	BioD-Block™ 16-300
Unit weight	4.4 lbs./ft. (6.6 kg/m)
Block size Height Thickness Length	16 in (40 cm) 9 in (23 cm) 10 ft. (305 cm)
Fabric length Top Bottom	28 in (71 cm) 56 in (142 cm)
Tensile strength of fabric MD CD	1740 lbs./ft. (25.4 kN/m) 1176 lbs./ft. (17.2 kN/m)
Fabric length at female end	6 in (15 cm)
Invisible planting holes	Each block has 9 holes placed in 12-in spacing. Each hole is covered with a coir plug.



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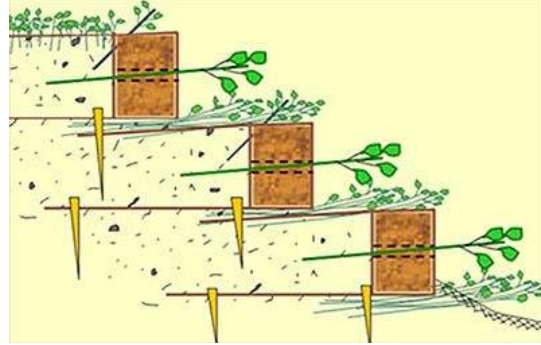
Web: www.rolanka.com

GA DOT DBE Certified

BioD-Block™ 16-400

Fabric attached coir block system

US Patent #: 6893193 and 9,315,962 B2
Sri Lanka Patent #: 12692 and 18277



Description

The BioD-Block™ 16-400 consists of a 10-ft long, 16-in tall and 9-inch thick densely packed mattress coir block with BioD-Mat 70 woven coir fabric attached. Three sides of the coir fiber block is wrapped with woven coir fabric and free ends of woven coir fabric is extended from top and bottom of the coir fiber block. The BioD-Block™ system has invisible holes in the middle of the coir block at 12-in spacing at the face through the entire fiber block. Each hole is covered with a coir plug. When these coir plugs are removed, the open hole can be used to plant live plant cuttings. When these plants grow in the soil mass they provide essential stability to the soil mass through their root mass. Also, these plants act as long-term anchors for the fiber blocks. Construction of vegetated soil lifts with coir block system is much easier and more efficient than making soil lifts with fabrics. More importantly, soil lifts constructed with BioD-Block provide long-term protection for the soil layers from its coir fiber block. History has shown failure in fabric wrap soil lifts before mature vegetation establish in the soil mass.

Specification

Property	BioD-Block™ 16-400
Unit weight	4.8 lbs./ft. (7.3 kg/m)
Block size	
Height	16 in (40 cm)
Thickness	9 in (23 cm)
Length	10 ft (305 cm)
Fabric length	
Top	48 in (122 cm)
Bottom	75 in (190 cm)
Tensile strength of fabric	
MD	1740 lbs./ft. (25.4 kN/m)
CD	1176 lbs./ft. (17.2 kN/m)
Fabric length at female end	6 in (15 cm)
Invisible planting holes	Each block has 9 holes placed in 12-in spacing. Each hole is covered with a coir plug.



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Encapsulated Soil Lifts

Encapsulated soil lifts are a best management practice that are used as a bioengineered shoreline erosion control strategy. Encapsulated soil lifts create a lake-friendly shoreline that can be used on lakefronts that experience moderate to high wind, wave, and ice action. Encapsulated soil lifts can also be used to replace seawalls. These bioengineered structures are built on a rock base and are used to rebuild eroded shorelines. Layers of soil are “encapsulated” inside biodegradable fabric to form the lift. Each lift is placed on top of the preceding lift, but stepped back, to create the desired slope. Encapsulated soil lifts are planted or seeded with deep-rooted, Michigan-native plants that stabilize the soil layers. Once plants are established, the encapsulated soil lifts will protect lakeshore properties and property values, improve recreational opportunities, and promote lake health. Diverse, natural plant communities and natural shorelines are the foundation of a healthy lake.

ADVANTAGES

of installing encapsulated soil lifts

Erosion Control

Encapsulated soil lifts built on a rock base effectively stabilize the shoreline – even in areas of relatively high wave and ice action.

Improved Water Quality

Encapsulated soil lifts’ natural vegetation filters pesticides and pollutants before they enter the lake.

Fish and Wildlife Habitat

Encapsulated soil lifts’ natural vegetation provides habitat for wildlife, while acting as a deterrent for geese.



This encapsulated soil lift and the established native shoreline vegetation stabilize the shoreline – even with moderate to high wave and ice action. Encapsulated soil lifts also slow runoff from upland areas, improve fish and wildlife habitat, improve water quality, and deter geese from damaging property. Photo courtesy of Michigan Natural Shoreline Partnership.



Seawalls cause poor lakeshore habitat. Poor biological health is three times more likely in lakes with poor lakeshore habitat. Forty percent of Michigan’s inland lakes have poor lakeshore habitat. Photo courtesy of Michigan Natural Shoreline Partnership.

DISADVANTAGES

of hardened shorelines and lawn to water’s edge

Habitat Elimination

Seawalls eliminate habitat required for fish and wildlife feeding, nesting, and spawning. Seawalls also act as a wildlife barrier, impeding natural movement.

Degraded Water Quality

Seawalls cause the suspension of sediments, increasing lake turbidity and algae. Seawalls also promote runoff, lowering the water quality of the lake.

Cumulative Impacts

The effects of multiple shoreline developments around a lake accumulate over time, impairing peoples’ use of the water.

INLAND LAKE FACT SHEET SERIES: ENCAPSULATED SOIL LIFTS

The figure below shows a cross-section of a typical soil lift design, although soil lifts may be constructed to various heights (up to 8 feet) and at various slopes.

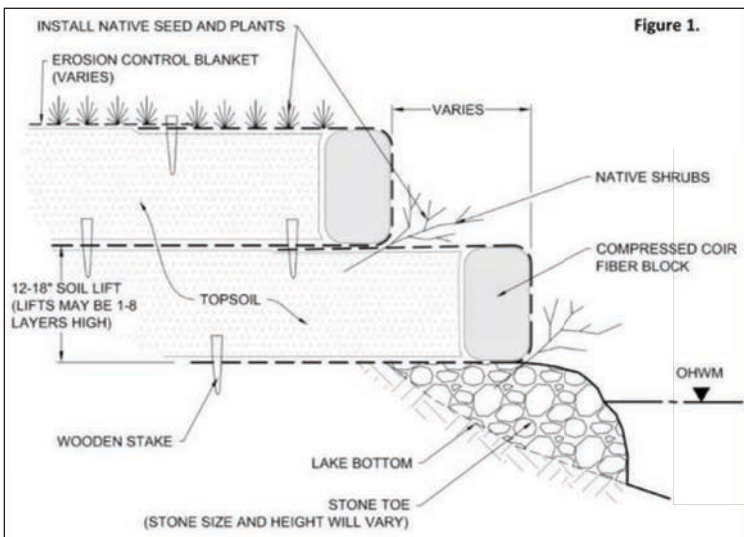
The height of the rock base should be adjusted to accommodate the Ordinary High Water Mark (OHWM) and wave energy at the site. The lower lift should be placed as close to the OHWM as possible to allow for capillary action of water into the lift. For traditional, built-on-site lifts, plywood forms are lined with a layer of woven coir mat and then a layer of light-grade totally biodegradable coir fiber erosion control blanket. Soil is tamped into the forms to create the lift. If the lift is to be seeded, seeds must be added and lightly tamped (to create soil contact) before securing the blanket.

If the lift is to be planted with plants or shrubs (potted stock, bare root stock or dormant live cuttings) position the plant stock between lifts so as to provide as much soil contact as possible for adventitious rooting along the stems. Lifts may be planted and seeded. Long-rooted native plants that have the ability to stabilize the soil layers are recommended.

For the next course of lift, reposition the forms and repeat the process, stepping the forms back to create the desired slope. Seed or plant the lift and repeat until the desired bank height is reached.



Stages of encapsulated soil lift establishment from construction through three years of growth. A video of encapsulated soil lift construction is available at Shoreline.msu.edu/shorelinemgt/natural-shoreline-constructing-encapsulated-soil-lifts. Photos courtesy of Michigan Natural Shoreline Partnership.



Apply for a Permit

If you would like to install encapsulated soil lifts on your shoreline, a permit from EGLE is required. If your project meets the criteria in EGLE's Minor Project Categories or General Permit Categories it can be processed on a faster timeline and at a reduced fee. For more information, and to submit a permit application visit Michigan.gov/JointPermit.

For More Information

EGLE Inland Lakes: Michigan.gov/LakesAndStreams

Michigan Natural Shoreline Partnership: ShorelinePartnership.org

Michigan Inland Lakes Partnership: Canr.msu.edu/MichiganLakes

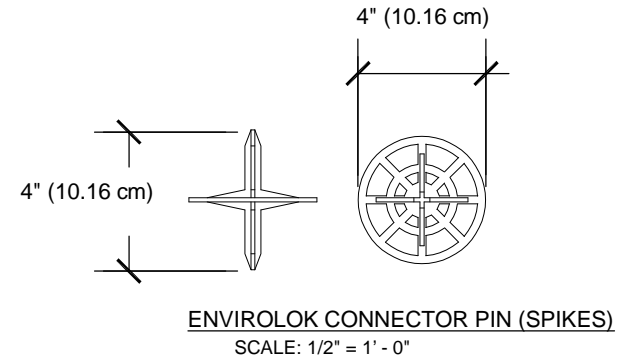
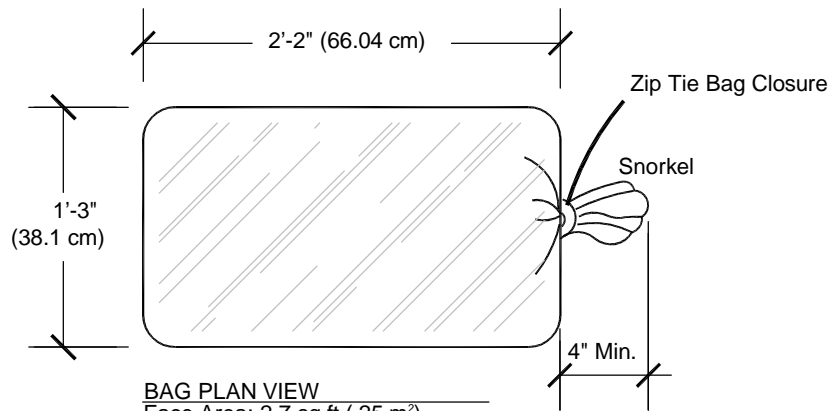
Michigan Shoreland Stewards: MiShorelandStewards.org



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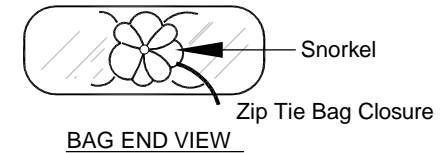
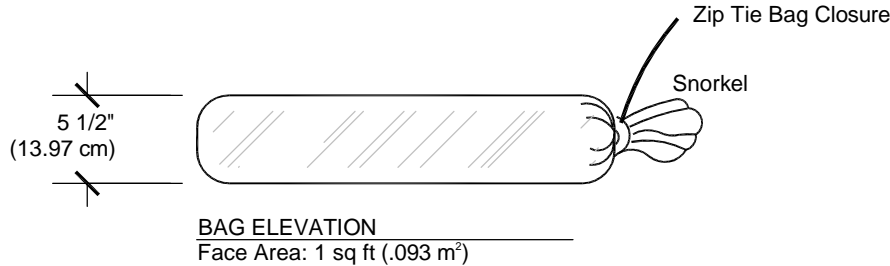
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09/2021



NOTE:

- Two Connector Pins shall be installed per bag, interconnecting the bags vertically
- Connector Pins shall be used to connect the first row of bags to the base setting course.
- Connector Pins shall penetrate each bag and/ or base course minimum of 2".
- Pin locations will vary with the slope of the structure and should be placed in the center of the bag contact area between courses.



ENVIROLOK BAG SPECIFICATION:

- Calculated Unit Fill: 1.25 cu ft (.0354 m³)/unit
- Face Area (Slope Application): 1 sq ft (.093 m²)
- Face Area (Mattress Application): 2.7 sq ft (.25 m²)/unit

ENVIROLOK BAG-FILL SPECIFICATION:

- Bag-Fill Volume: 1.25 cf (.0354 m³)/unit
- Bag-Fill Content: 80% Granular Sand / 20% Topsoil.
- 3/4" Clear Gravel may be Substituted as Bag-Fill for Embedded Bags
- See Sheet GN1-20 And Project Specifications for Additional Notes.

NOTE:

- Quantities required vary based on unit filling and design layout
- See Sheet GN1-20 and Project Specifications for Additional Details & Installation Instructions
- One Envirolok Unit consists of:
One (1) Envirolok Bag
Two (2) Connector Pins
One (1) Zip Tie Bag Closure

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TITLE
STANDARD UNIT DETAIL

DATE
JANUARY 2020

SCALE
1" = 1' - 0"

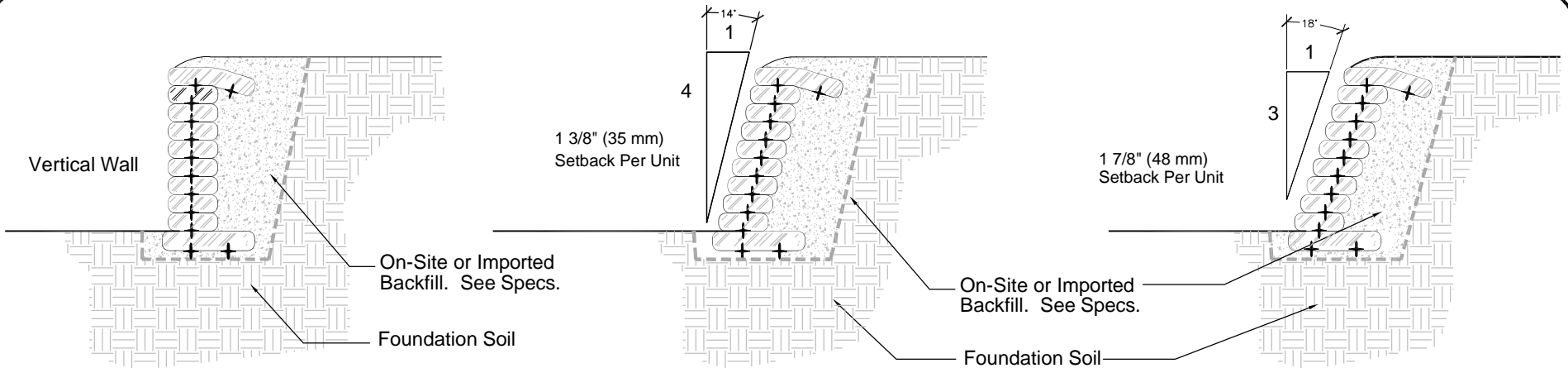
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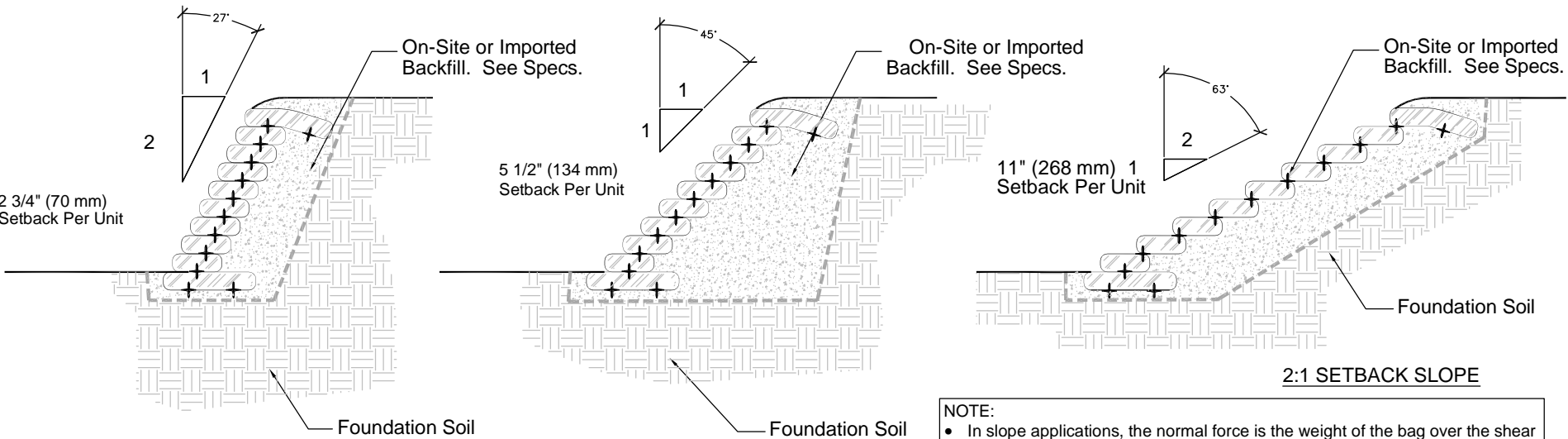
REVISIONS



0:1 SETBACK SLOPE

1:4 SETBACK SLOPE

1:3 SETBACK SLOPE



1:2 SETBACK SLOPE

1:1 SETBACK SLOPE

2:1 SETBACK SLOPE

NOTE:

- In slope applications, the normal force is the weight of the bag over the shear connectors. In flat slopes, the normal force is minimal.
- Additional Reinforcement may be Required for Site Specific Applications
- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions
- Min. of 4" (10 cm) Bag Overlap Required for Proper Spike Connection
- See Sheets SD 3.21 & 4.21 for Slopes < 2H:1V

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TITLE
**STANDARD SETBACKS
 FOR SLOPE APPLICATIONS**

DATE: MARCH 2021 SCALE: 1/4" = 1' - 0"

SHEET: SHEET S2.21



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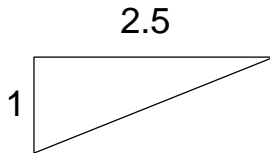
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REVISIONS

NOTE:

- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions

Set Units @ 5-10% Angle to Achieve Less than 2H:1V Slope

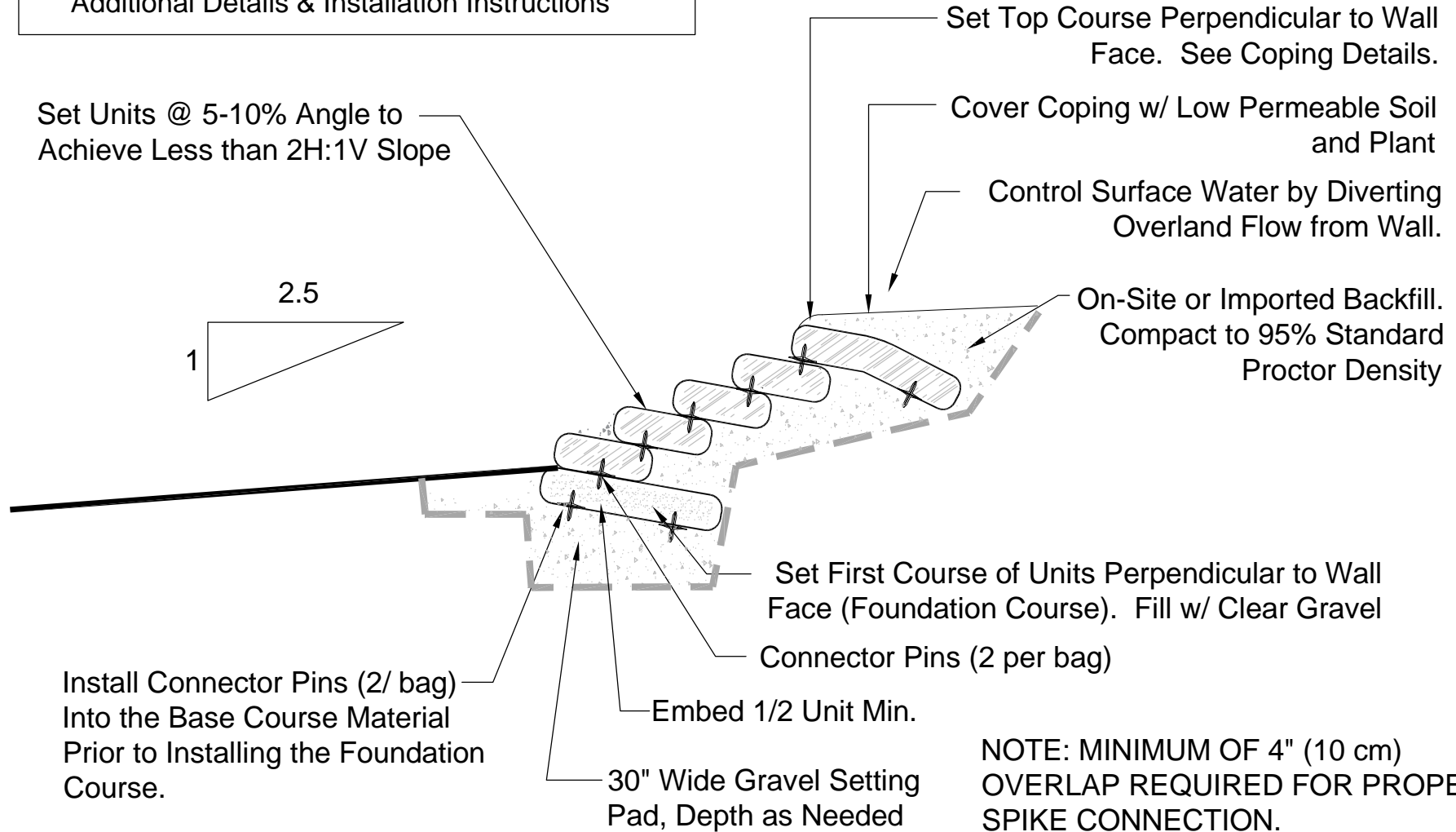


Set Top Course Perpendicular to Wall Face. See Coping Details.

Cover Coping w/ Low Permeable Soil and Plant

Control Surface Water by Diverting Overland Flow from Wall.

On-Site or Imported Backfill. Compact to 95% Standard Proctor Density



Set First Course of Units Perpendicular to Wall Face (Foundation Course). Fill w/ Clear Gravel

Connector Pins (2 per bag)

Embed 1/2 Unit Min.

30" Wide Gravel Setting Pad, Depth as Needed

Install Connector Pins (2/ bag) Into the Base Course Material Prior to Installing the Foundation Course.

NOTE: MINIMUM OF 4" (10 cm) OVERLAP REQUIRED FOR PROPER SPIKE CONNECTION.

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TITLE
**STANDARD SETBACK
DETAIL 1V:2.5H**

DATE
MARCH 2021

SCALE
1/2" = 1' - 0"

SHEET
SHEET S3-21

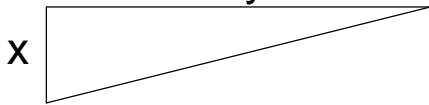
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REVISIONS

Slope Varies



Envirolok Unit

Embed Base Course Flush with Bottom of Pond
(Number of Courses will Vary with Stability of Soil)

Apply Hydroseed or Place Live Plant Material Planted Between Envirolok Bags

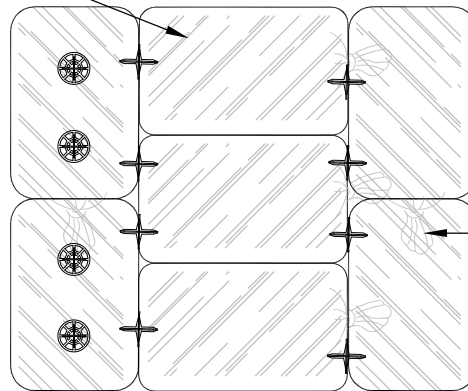
Envirolok Connector Pin (two each per unit)

Native Soil Bank

Additional Embedded Unit may be Required for Taller Slopes

SECTION

Rotate 2nd Course of Units to Provide Recommended Bag Overlap



PLAN

NOTES:

- Mattress Application Can Install on Flat Areas or Slopes up to 2.5H:1V
- Some Applications May Require Additional Spikes Between Bags and Base Course (2/ Bag)
- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions

Wrap Snorkel Below Bag

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TITLE
**MATTRESS APPLICATION
DETAIL**

DATE SCALE
1/2" = 1' - 0"

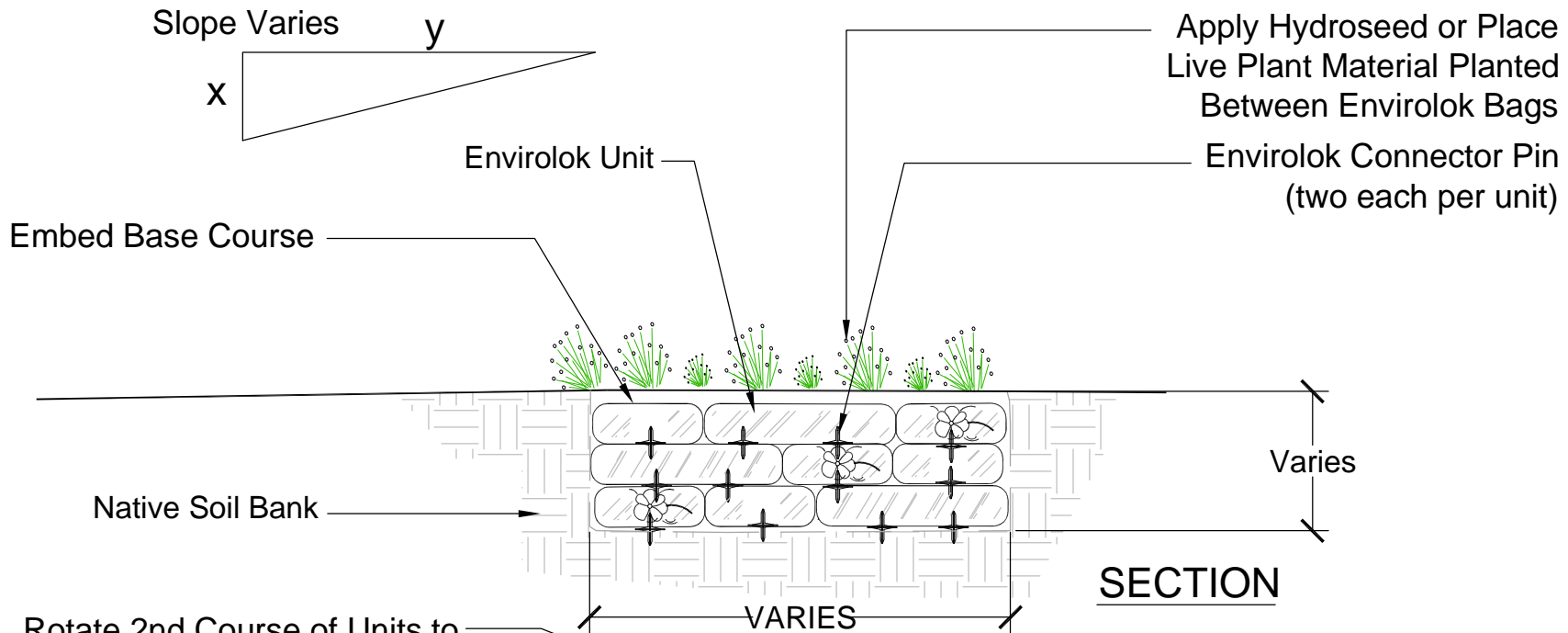
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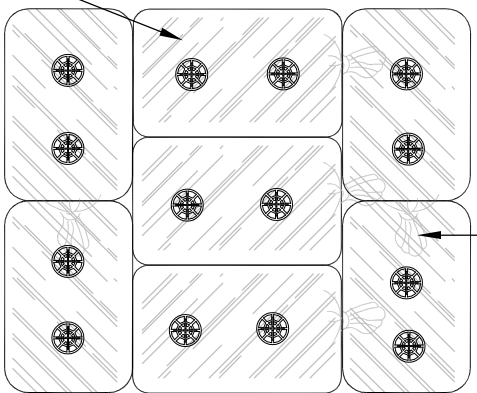
REVISIONS



Rotate 2nd Course of Units to Provide Recommended Bag Overlap

NOTES:

- Mattress Application Can Install on Flat Areas or Slopes up to 2.5H:1V
- Some Applications May Require Additional Spikes Between Bags and Base Course (2/ Bag)
- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions



PLAN

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TITLE
**MATTRESS STACKING
DETAIL**

DATE _____ SCALE
1/2" = 1' - 0"

SHEET
SHEET S4B-21

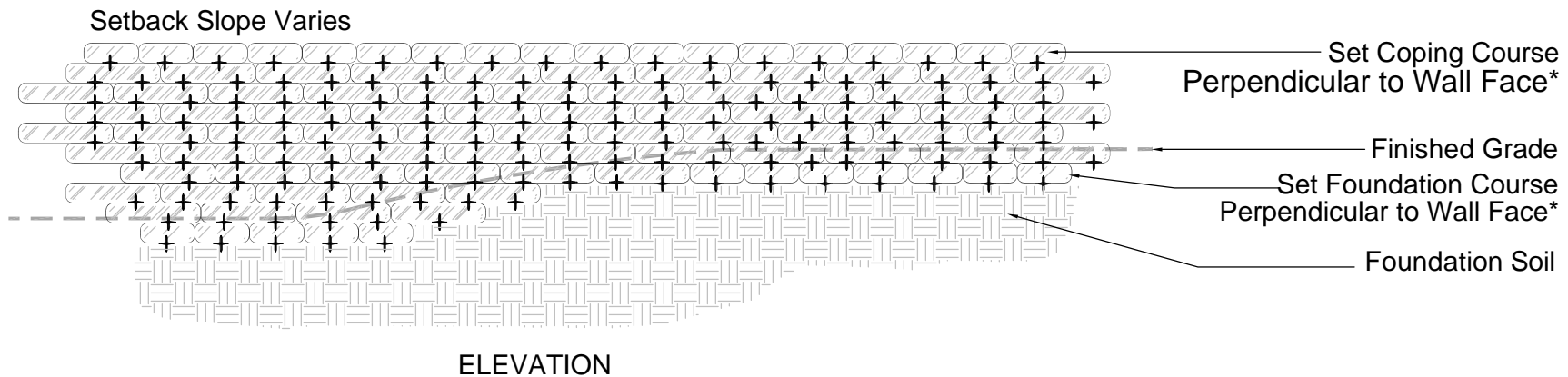


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REVISIONS

NOTE:

- Limit Changes in Foundation Course Elevation to Two Courses per Step to Avoid Differential Settling
- Install Steps as Needed to Minimize Number of Buried Units and Maintain Required Minimum Embedment
- Initial Foundation Course and Coping Course may be set Perpendicular to Face of Wall for Larger or More Complex Installations. Consult an Engineer for Walls over 48" in Exposed Height.*
- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions



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TITLE
**STEPPED FOUNDATION
COURSE DETAIL**

DATE
MARCH 2021

SCALE
1/4" = 1' - 0"

SHEET
SHEET S5-21



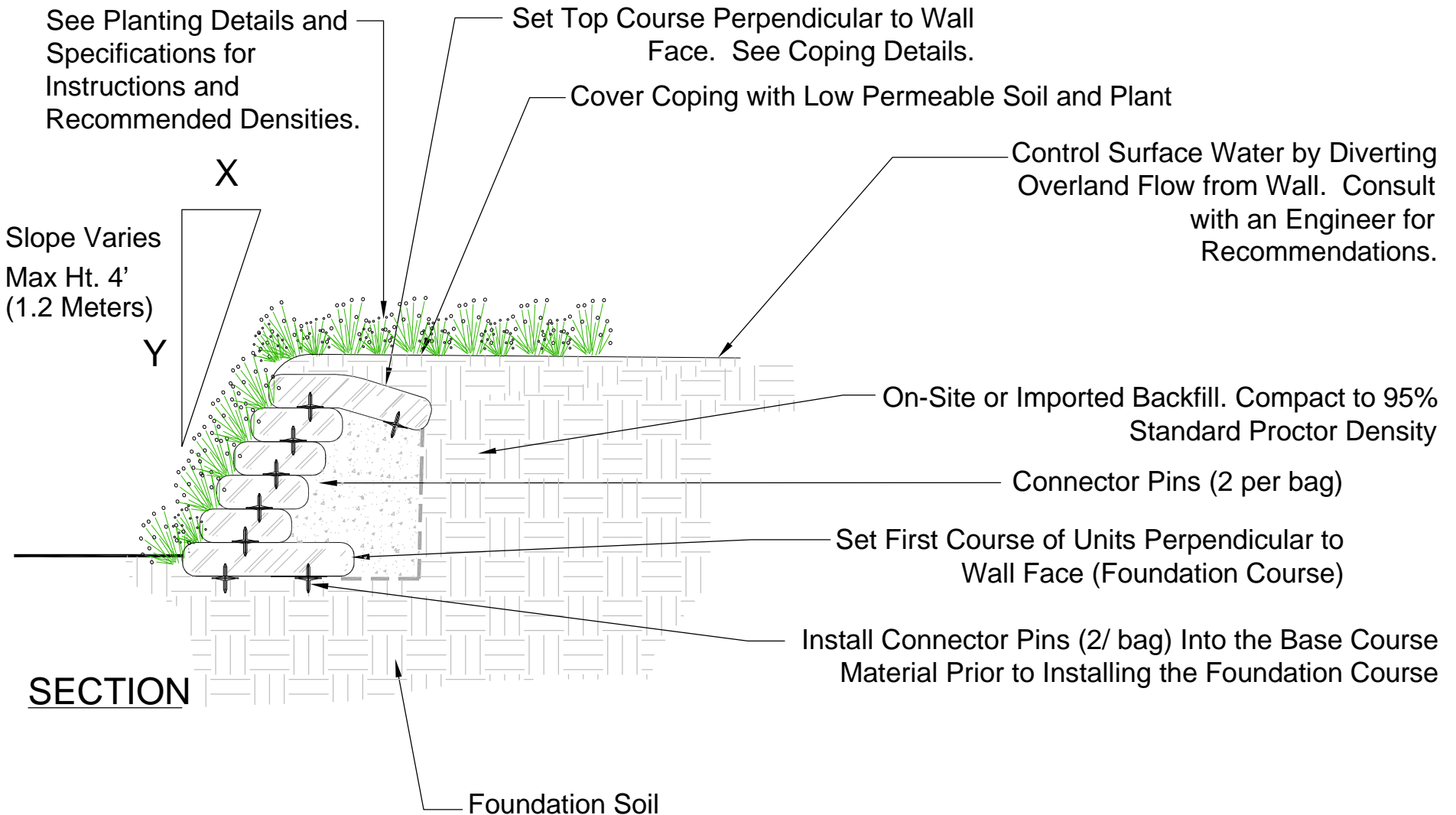
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NOTE:

- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions



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TITLE STANDARD SLOPE DETAIL 1 OF 2	
DATE MARCH 2021	SCALE 1/2" = 1' - 0"
SHEET SHEET S6-21	

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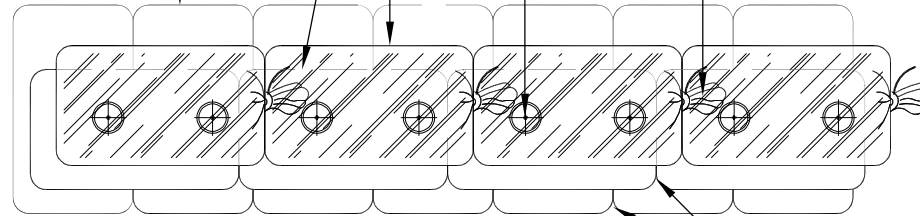
REVISIONS

Set Additional Courses Parallel to the Slope with Seam Facing Outward.

Envirolok Connector Pin
(two per bag)

Foundation Course may be Set Perpendicular to Slope with Snorkel Facing Inward

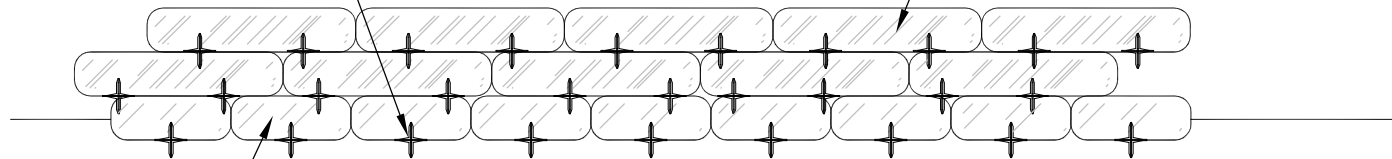
Set Bags with Snorkel Facing Out To Allow 'Snorkel' to be Tucked Below Adjoining Unit



PLAN VIEW

Stagger Bag Units Between Consecutive Rows

Install Connector Pins in Base Setting Course Prior to Setting Foundation Course (two per bag)



ELEVATION

Foundation Course to be Embedded a Minimum of 3" (7.5 cm), or as Specified by Project Designer or Engineer.

NOTE:

- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions

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TITLE
**STANDARD SLOPE
DETAIL 2 OF 2**

DATE
MARCH 2021

SCALE
1/2" = 1' - 0"

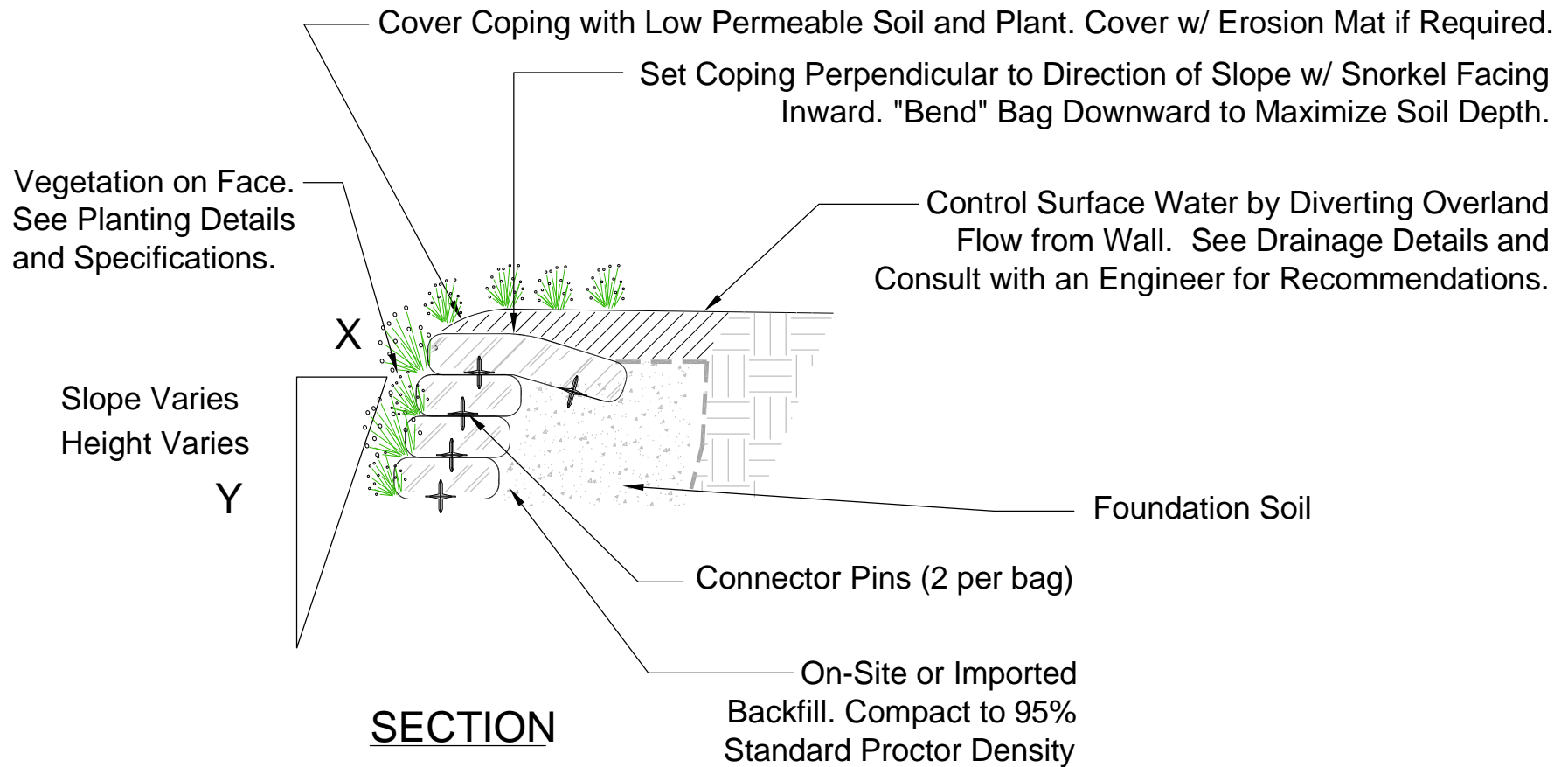
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NOTE:

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TITLE
**COPING COURSE
DETAIL 1 OF 2**

DATE
MARCH 2021

SCALE
1/2" = 1' - 0"

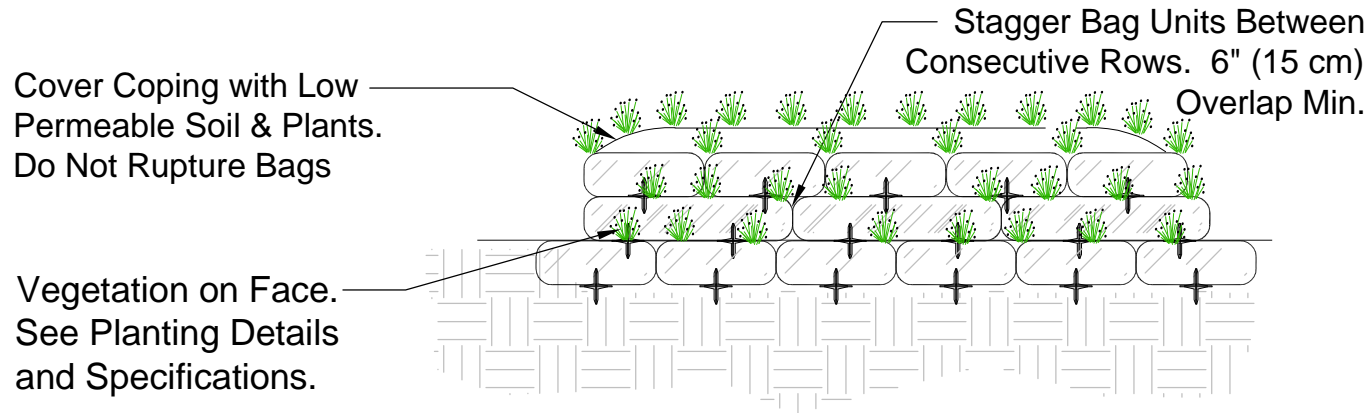
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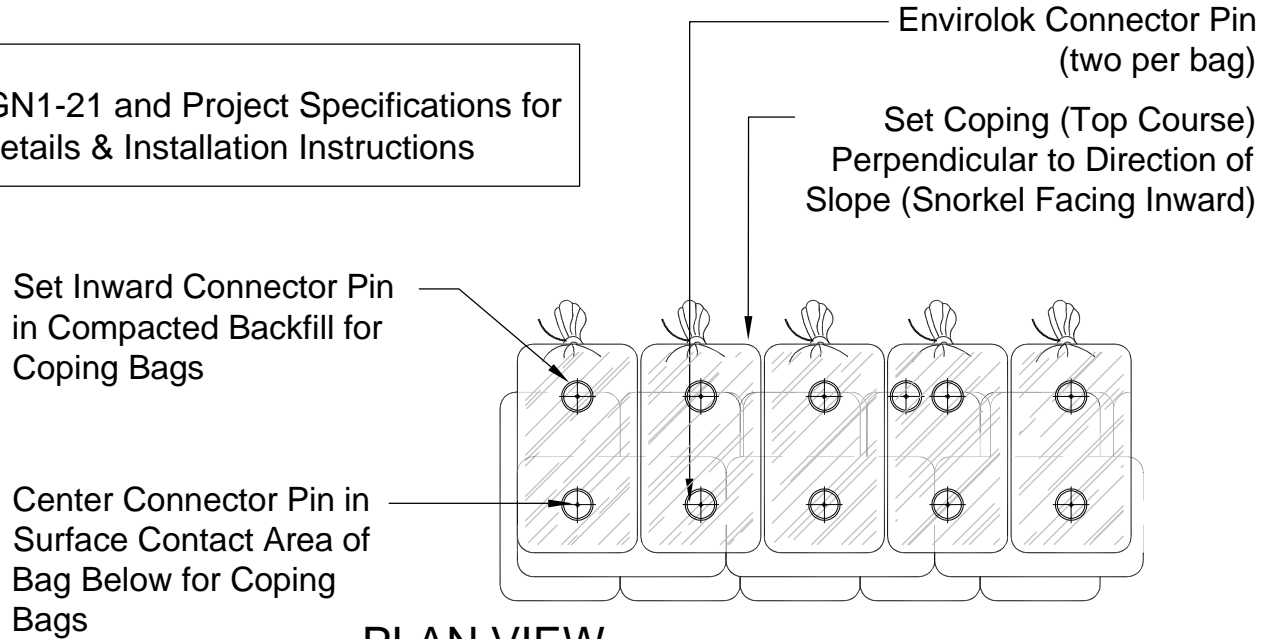
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ELEVATION

NOTE:

- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions



PLAN VIEW

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TITLE
**COPING COURSE
DETAIL 2 OF 2**

DATE
MARCH 2021

SCALE
1/2" = 1' - 0"

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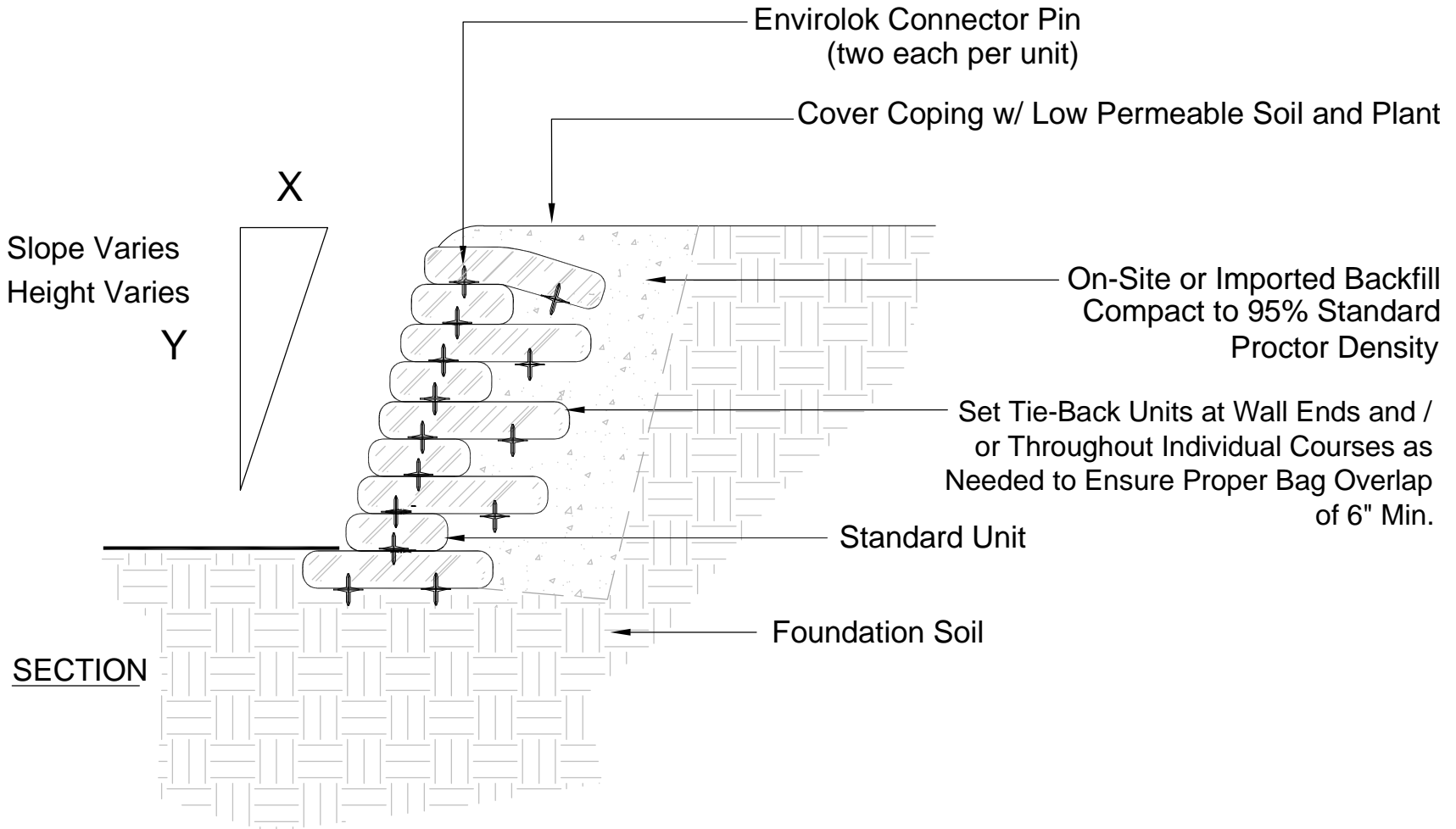
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NOTE:

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TITLE
**TIE-BACK UNIT
DETAIL 1 OF 2**

DATE
MARCH 2021

SCALE
1/2" = 1' - 0"

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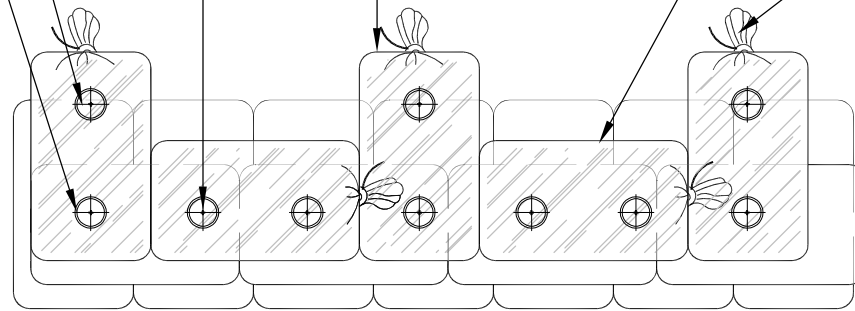
Set Inward Connector Pin in Compacted Backfill for Tie-Back Bags

Center Connector Pin in Surface Contact Area of Bag Below for Tie-Back Bags

Envirolok Connector Pin (two per bag)

Tie-Back Unit Standard Unit

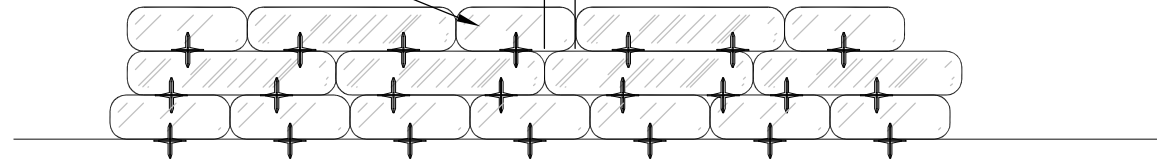
Set Tie-Back Back Bags w/ Snorkel Facing Inward



PLAN VIEW

Set Tie-Back Units at Wall Ends and / or Throughout Individual Courses as Needed to Ensure Proper Bag Overlap of 6" Min.

6" Overlap Min.



ELEVATION

NOTE:

- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions

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TITLE
**TIE-BACK UNIT
DETAIL 2 OF 2**

DATE
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SCALE
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REVISIONS

Control Surface Water by Diverting
Overland Flow from Wall.
Consult with an Engineer for
Recommendations.

Backfill or Retained Soil

Curve Proposed Wall into
Existing Bank 3-4' Min.

Foundation Course of
Envirolok Units

Existing Edge of Slope or
Wall. Restore and Vegetate
Disturbed Areas or Areas as
Required in Plan Set

Face of Slope

Plan View

NOTE:

- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions

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TITLE
**STANDARD WALL END
DETAIL**

DATE
MARCH 2021

SCALE
1/2" = 1' - 0"

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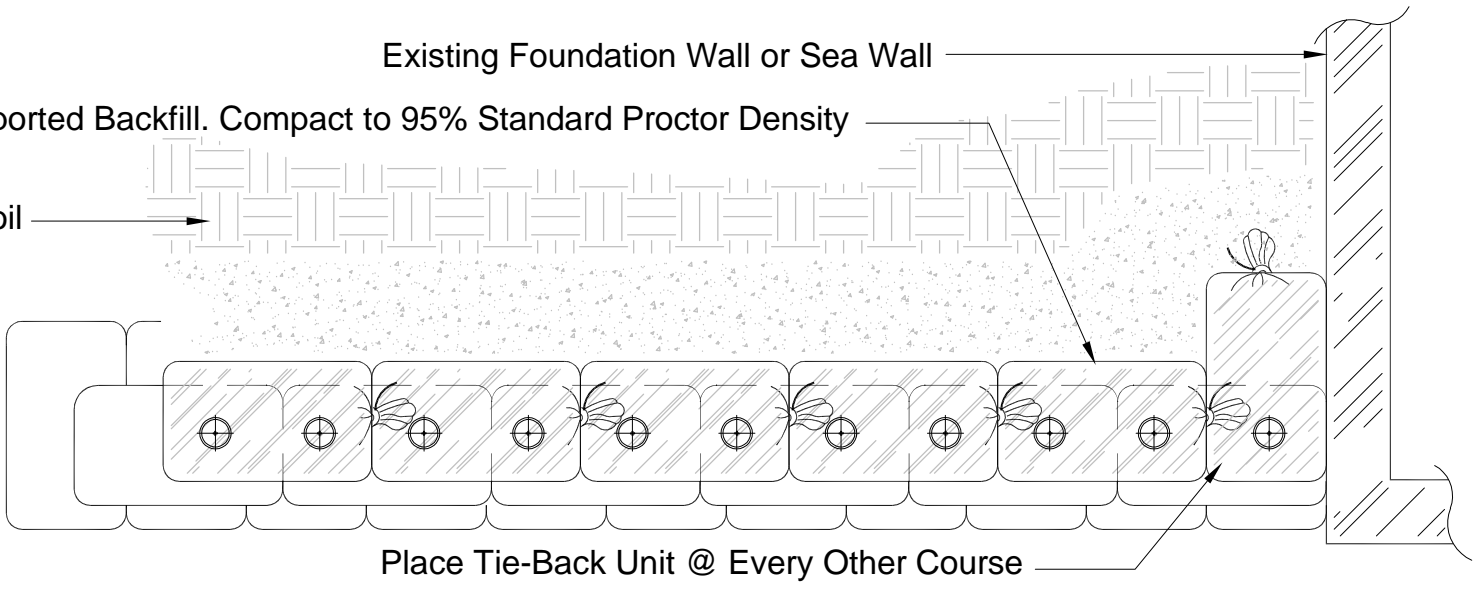
REVISIONS

Existing Foundation Wall or Sea Wall

On-Site or Imported Backfill. Compact to 95% Standard Proctor Density

Foundation Soil

PLAN



Place Tie-Back Unit @ Every Other Course

NOTE:

- Bags may be Angled or Placed in Tie-Back Pattern to Fit Against Ex. Site Features.
- Bag Height and Width can also be Adjusted by Removing Up To 30% of Fill.
- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions

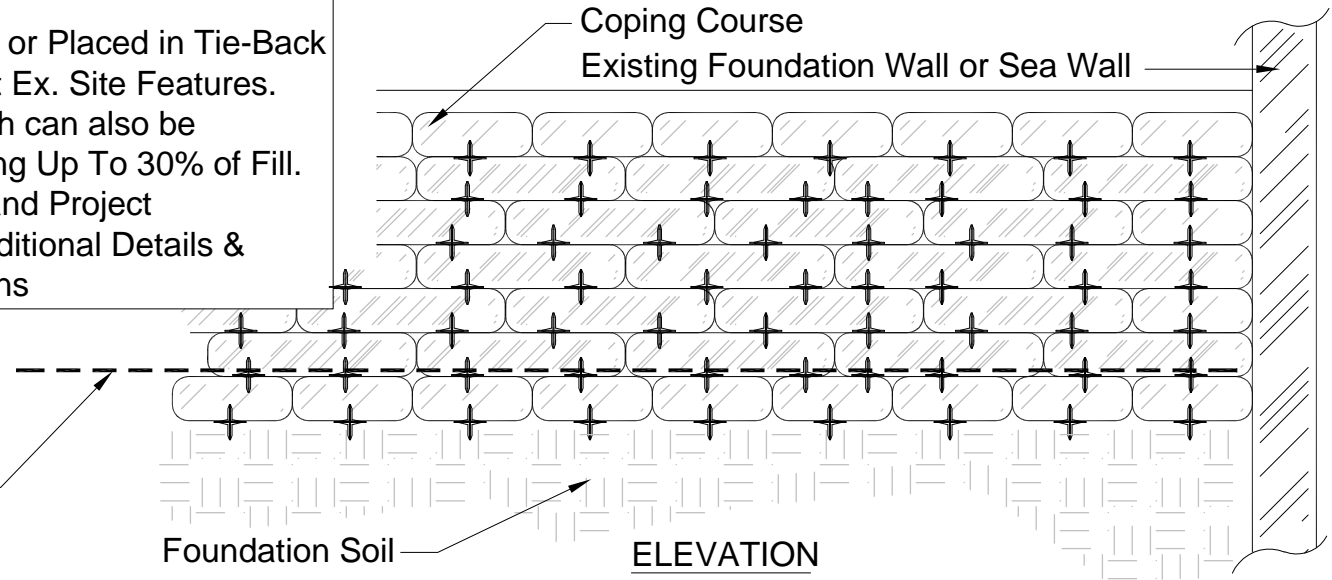
Coping Course

Existing Foundation Wall or Sea Wall

Finished Grade

Foundation Soil

ELEVATION



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TITLE
**WALL ABUTMENT
DETAIL**

DATE
MARCH 2021

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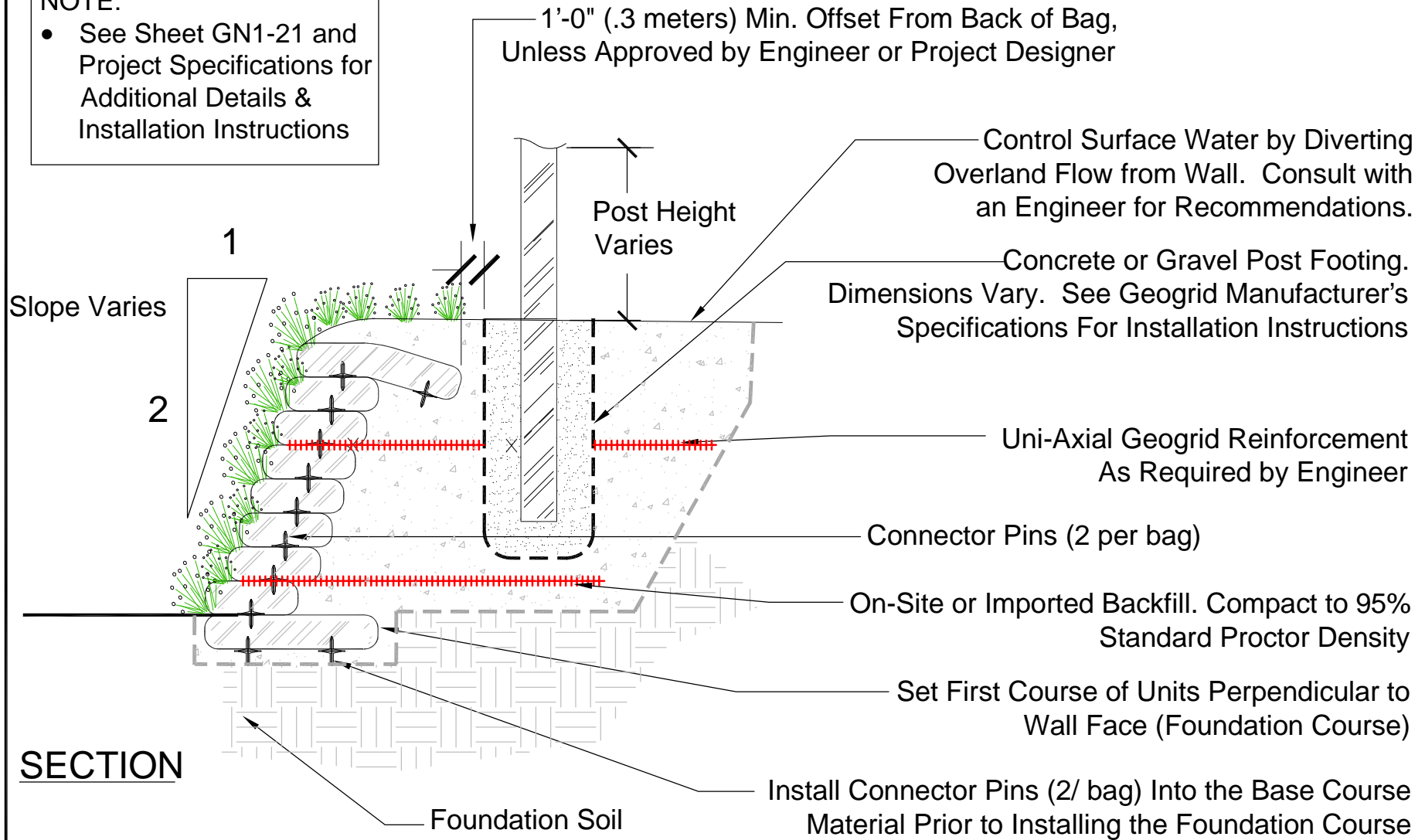
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NOTE:

- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions



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TITLE
**FENCE POST / RAILING
INSTALLATION DETAIL**

DATE
MARCH 2021

SCALE
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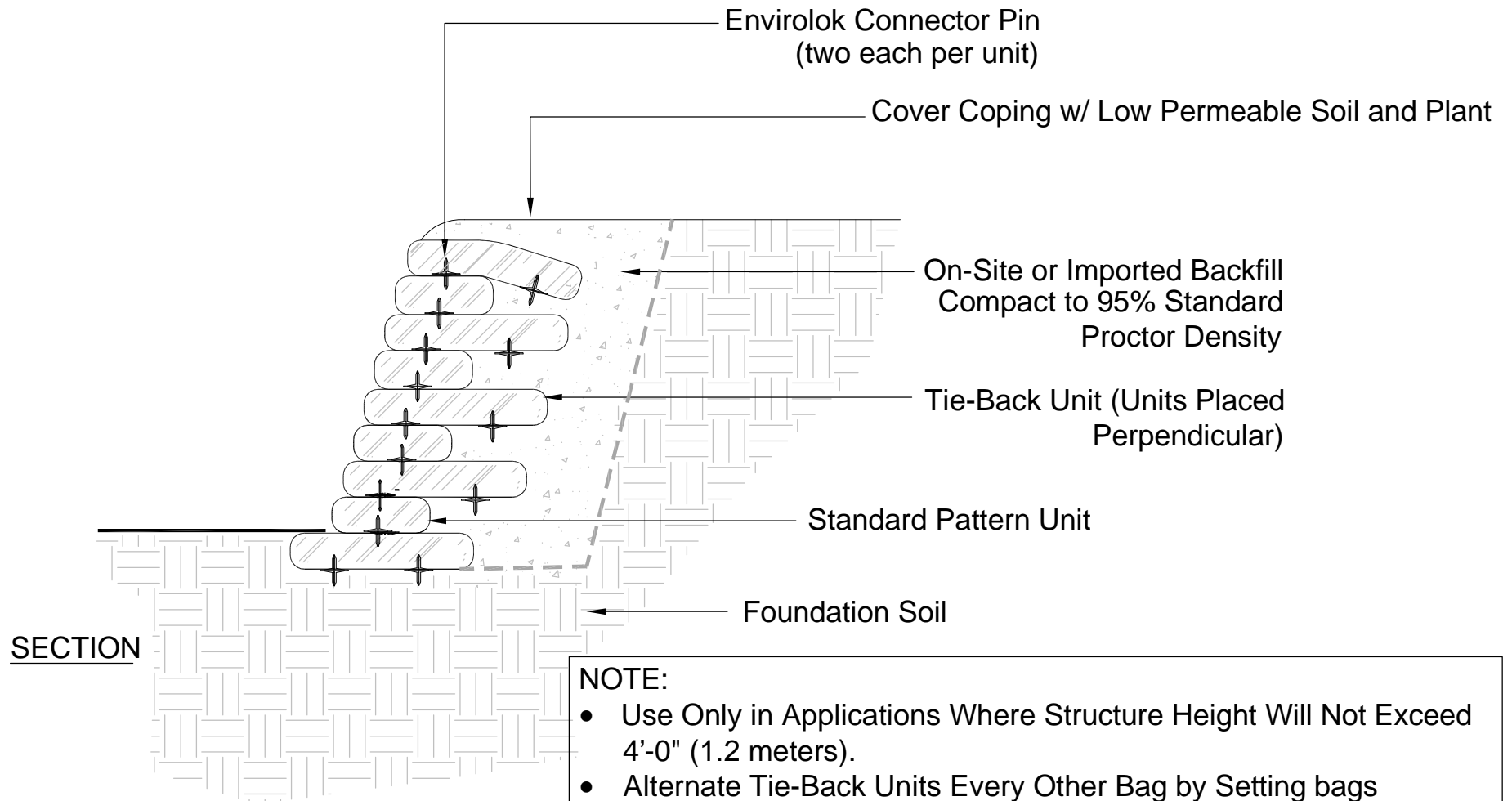
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REVISIONS



NOTE:

- Use Only in Applications Where Structure Height Will Not Exceed 4'-0" (1.2 meters).
- Alternate Tie-Back Units Every Other Bag by Setting bags Perpendicular to Wall Face.
- Tie-Back Rows Shall be Alternated Every Other Row.
- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions

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TITLE
**TIE-BACK DETAIL
1 of 2**

DATE
MARCH 2021

SCALE
1/2" = 1' - 0"

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SHEET RD1-21



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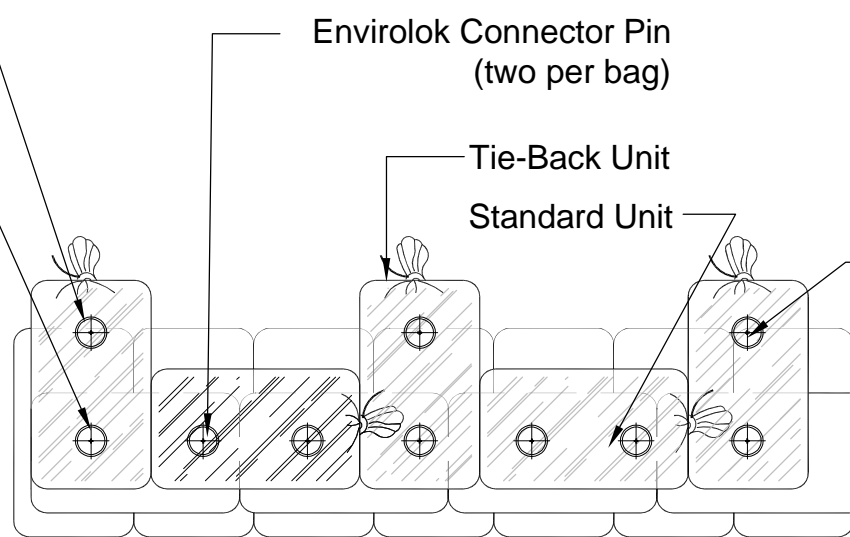
Set Inward Connector Pin in Compacted Backfill for Tie-Back Bags

Center Connector Pin in Surface Contact Area of Bag Below for Tie-Back Bags

Envirolok Connector Pin (two per bag)

Tie-Back Unit
Standard Unit

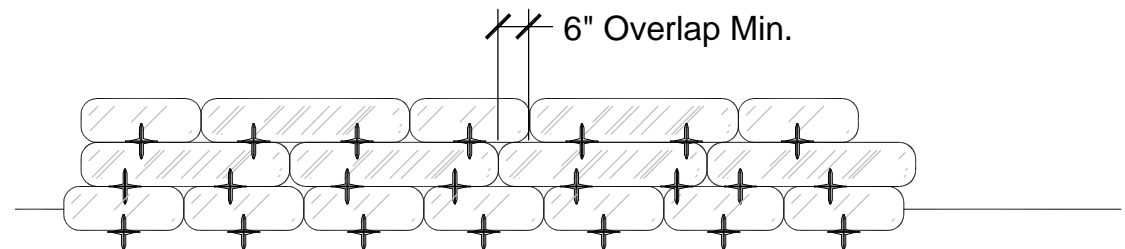
Set Tie-Back Back Bags w/ Snorkel Facing Inward



NOTE:

- Use Only in Applications Where Structure Height Will Not Exceed 4'-0" (1.2 meters).
- Alternate Tie-Back Units Every Other Bag by Setting bags Perpendicular to Wall Face.
- Tie-Back Rows Shall be Alternated Every Other Row.
- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions

PLAN VIEW



ELEVATION

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TITLE
**TIE-BACK
DETAIL 2 of 2**

DATE
MARCH 2021

SCALE
1/2" = 1' - 0"

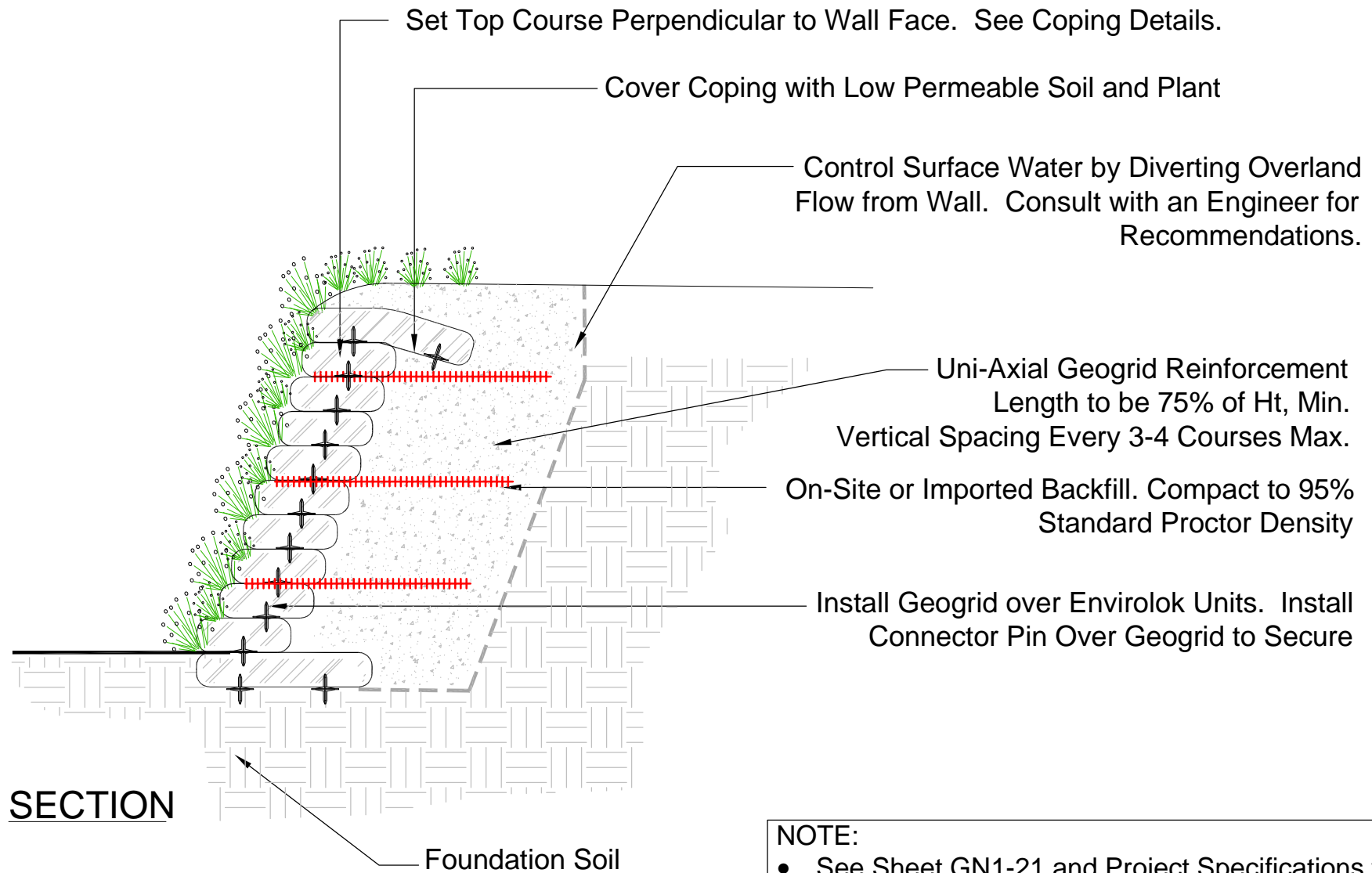
SHEET
SHEET RD2-21

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REVISIONS



NOTE:

- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions

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TITLE
**GEOGRID LAYERING
REINFORCEMENT 1 OF 2**

DATE
MARCH 2021

SCALE
1/2" = 1' - 0"

SHEET
SHEET RD3-21

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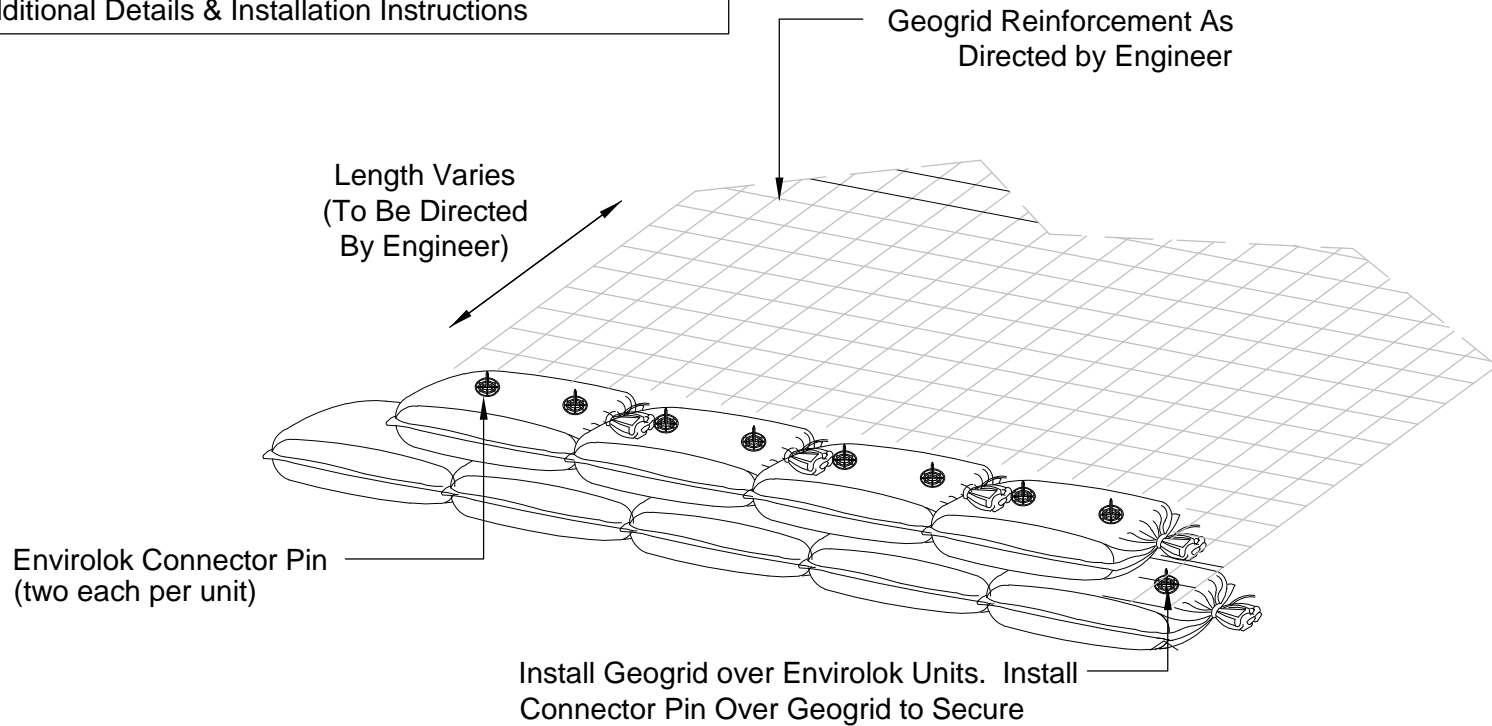
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NOTE:

- Follow Geogrid Manufacturer's Installation Specifications
- Length, Vertical Spacing and Geogrid Type to be Directed by Engineer or Project Designer
- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions



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TITLE
**GEOGRID LAYER
 REINFORCEMENT 2 OF 2**

DATE
 MARCH 2021

SCALE
 NTS

SHEET
 SHEET RD4-21



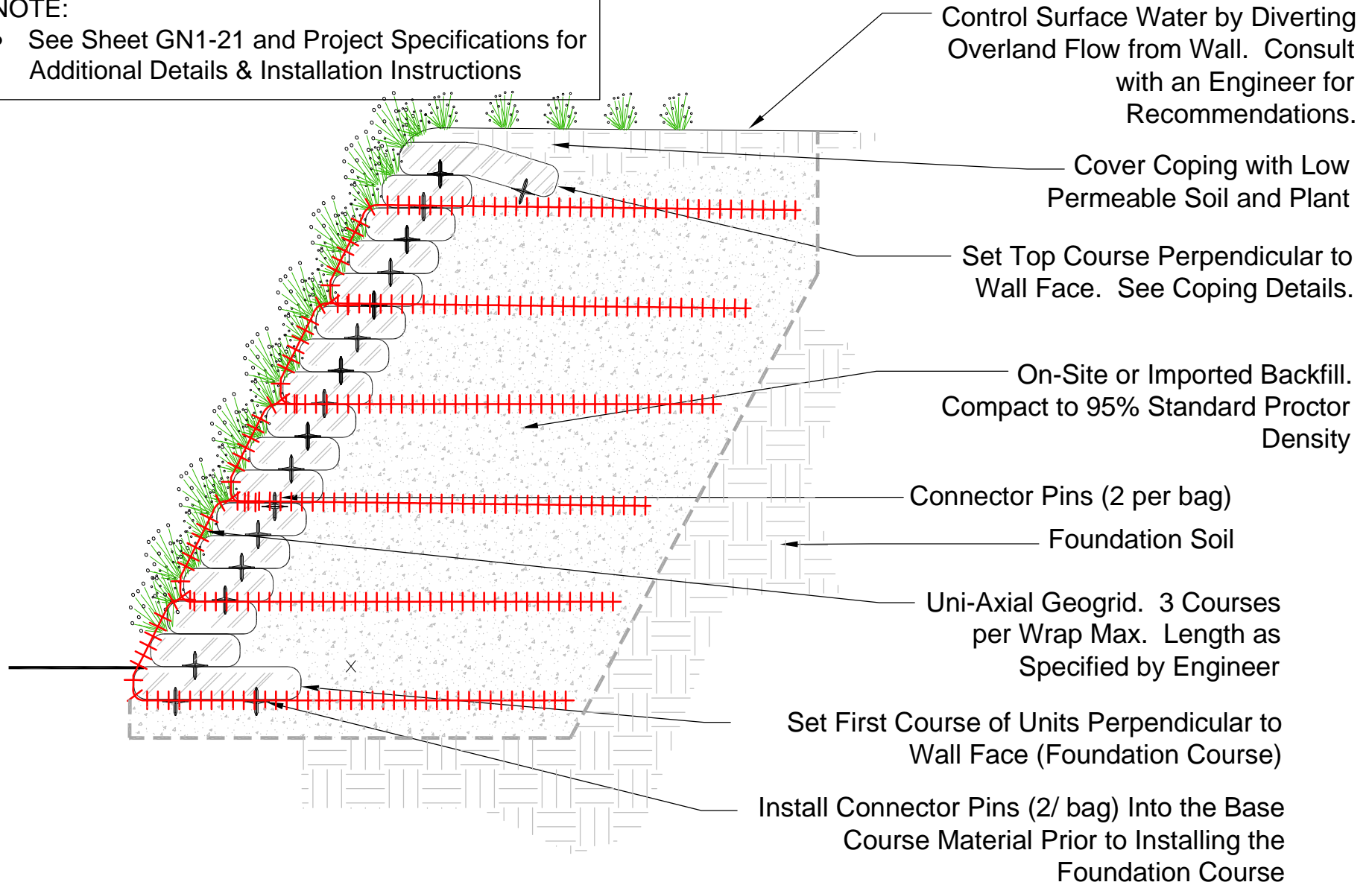
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- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions



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TITLE
GEOGRID WRAP REINFORCEMENT

DATE
MARCH 2021

SCALE
1/2" = 1' - 0"

SHEET
SHEET RD5-21



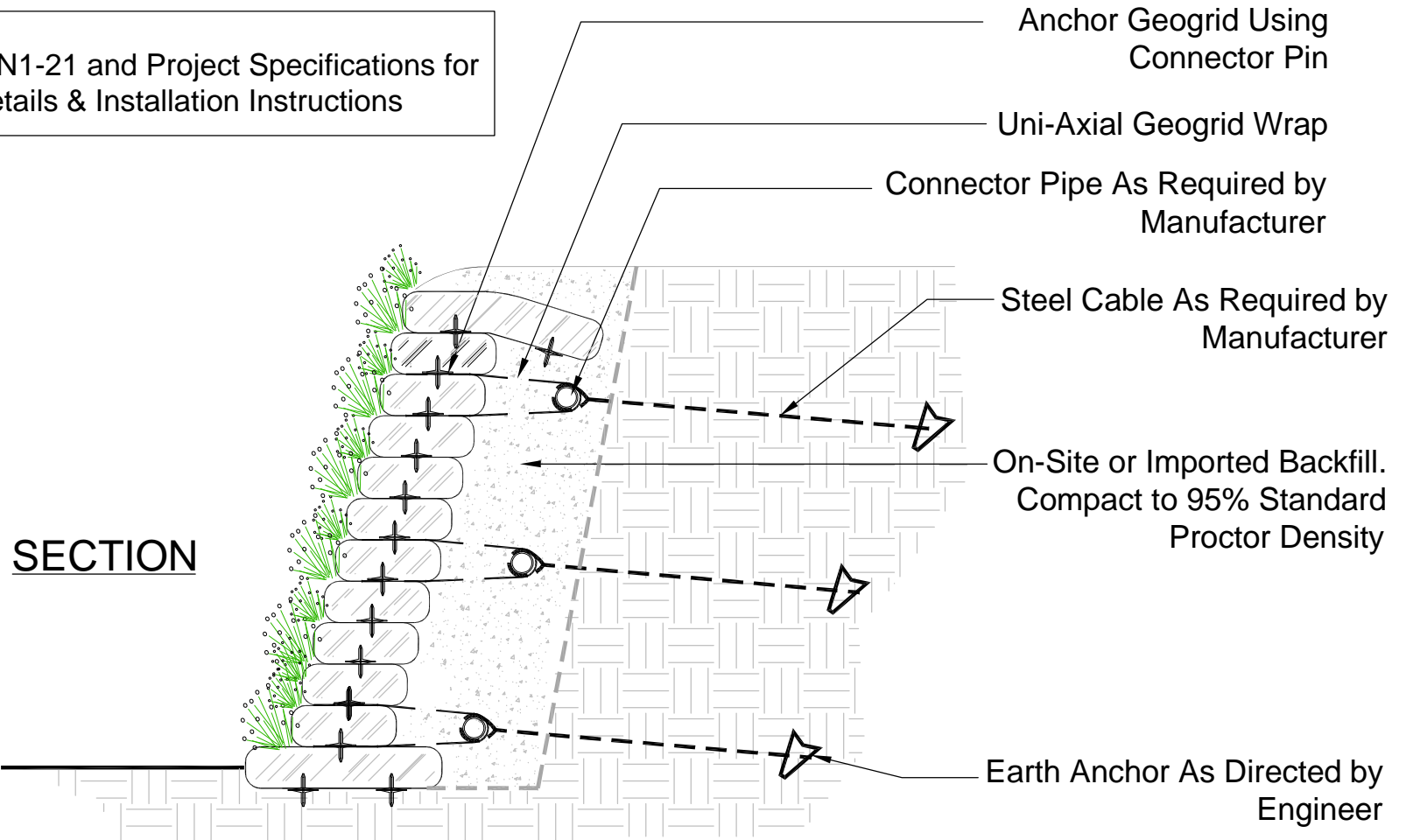
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NOTE:

- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions



NOTE:

Stagger anchors at 2 ft (1.22m) vertical spacing, 6ft (1.83 m) horizontal spacing. See Detail RD7.20 (Placement may vary with specific site conditions.)

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TITLE
EARTH ANCHOR REINFORCEMENT 1 OF 2

DATE
MARCH 2021

SCALE
1/2" = 1' - 0"

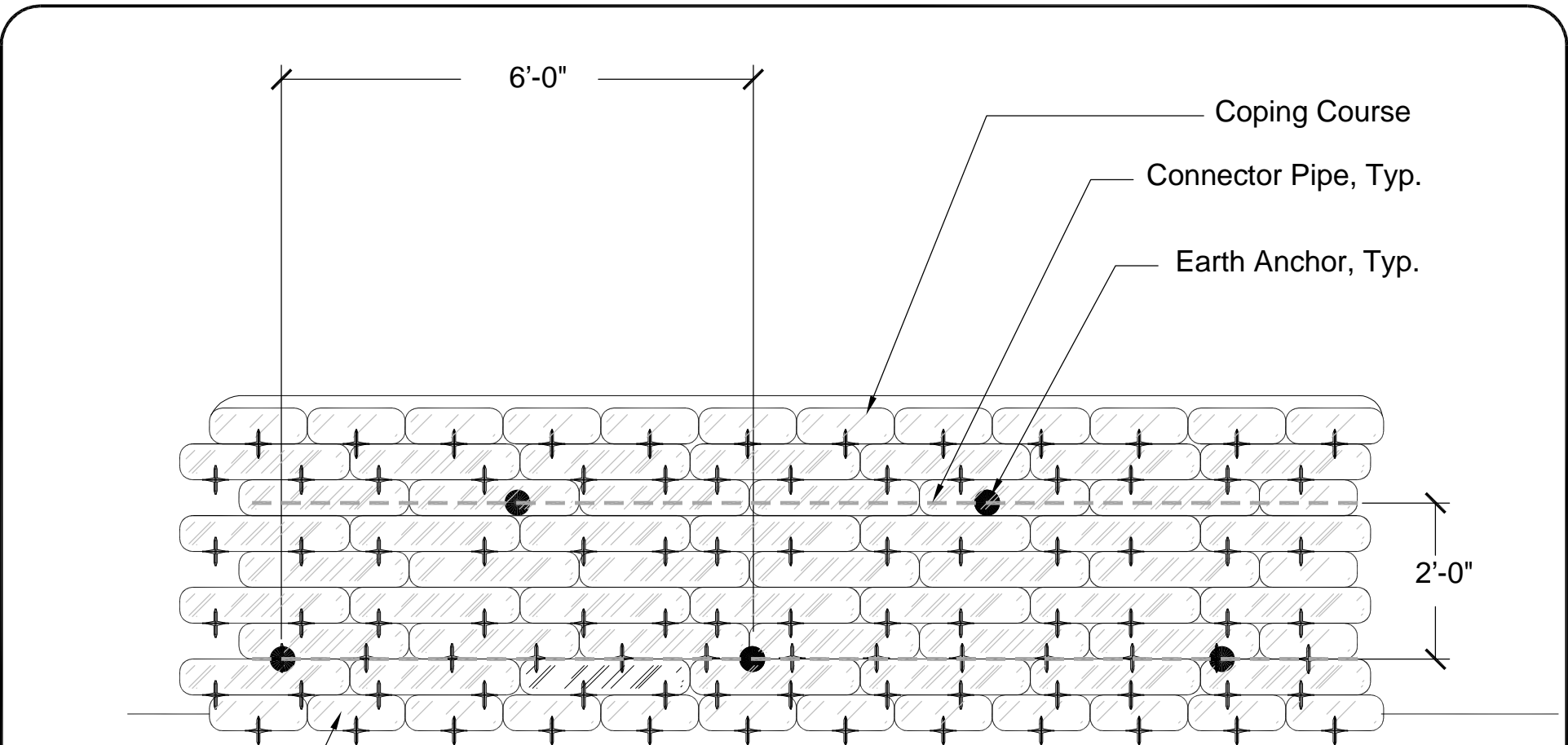
SHEET
SHEET RD6-21



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REVISIONS



ELEVATION - ANCHOR PATTERN

NOTE:

- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions

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TITLE
EARTH ANCHOR REINFORCEMENT 2 OF 2

DATE
 MARCH 2021

SCALE
 1/2" = 1' - 0"

SHEET
 SHEET RD7-21

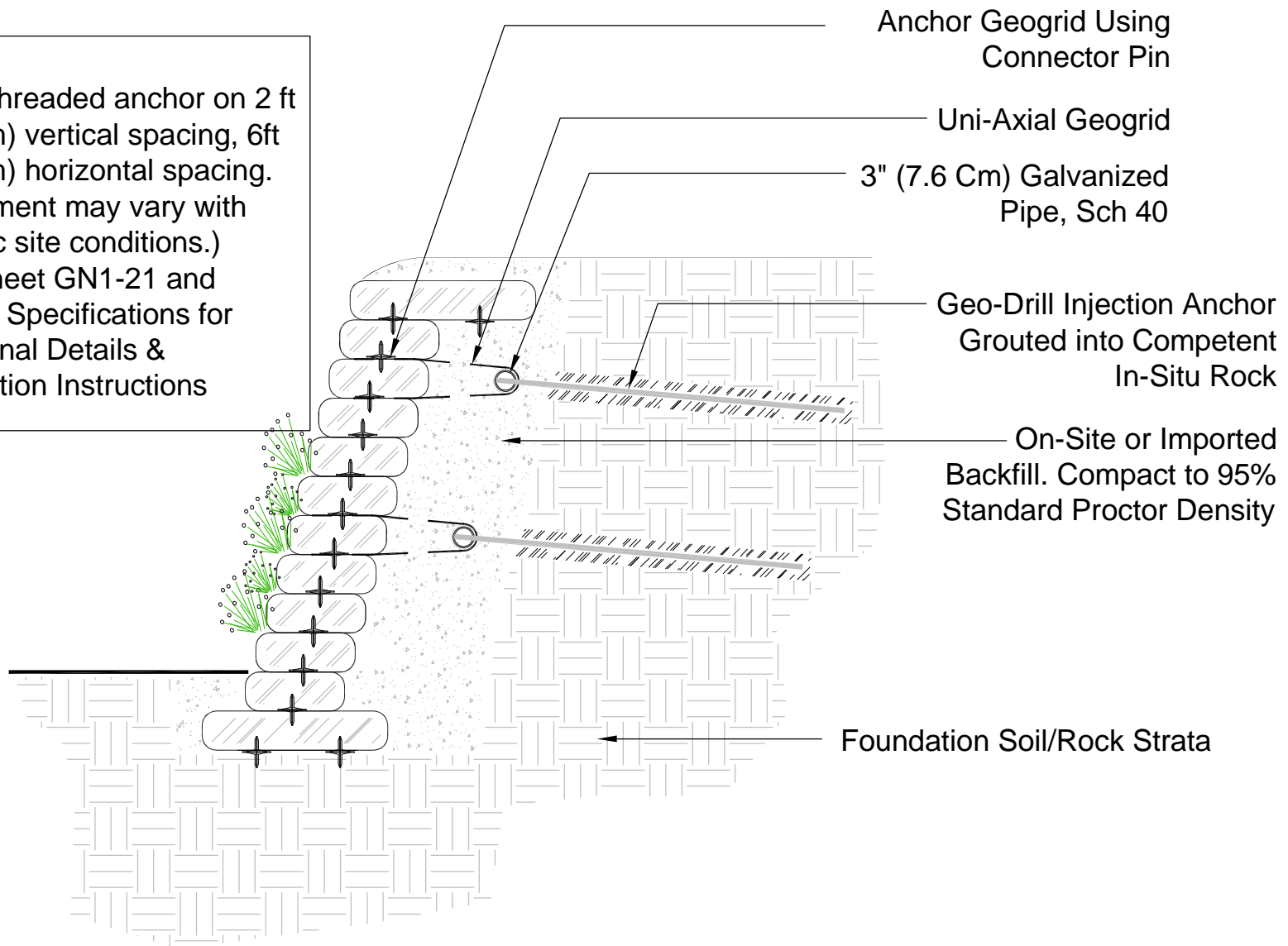


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NOTE:

- Place threaded anchor on 2 ft (1.22 m) vertical spacing, 6ft (1.83 m) horizontal spacing. (Placement may vary with specific site conditions.)
- See Sheet GN1-21 and Project Specifications for Additional Details & Installation Instructions



Anchor Geogrid Using Connector Pin

Uni-Axial Geogrid

3" (7.6 Cm) Galvanized Pipe, Sch 40

Geo-Drill Injection Anchor Grouted into Competent In-Situ Rock

On-Site or Imported Backfill. Compact to 95% Standard Proctor Density

Foundation Soil/Rock Strata

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TITLE
ROCK ANCHOR REINFORCEMENT

DATE
MARCH 2021

SCALE
1/2" = 1' - 0"

SHEET
SHEET RD8-21



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RETENTION SYSTEMS

CUSTOM FINISH OPTIONS

Our concrete walls are fully customizable with an array of color and texture options. All texture packages are waterproof and flexible to withstand the toughest elements of nature.

- Rubbed Finish Concrete
- Dyed Concrete
- Textured and Colored Concrete
- Popcorn Textured and Colored Concrete

· TREE BARK · GNARLY ROCK · LIMESTONE
AND MORE!

DECORATIVE CONCRETE



RETAINING WALLS

Permashield™ system is a proven, effective solution to the toughest erosion situations. This multipurpose barrier system can be used to stabilize slides, reinforce banks/levees, provide road shoulders in areas at high erosion risk, and much more. The ONLY solution of its kind that can be filled with concrete: ANY LENGTH ANY HEIGHT



VERSATILE

- Retaining Walls
- Permanent Barriers
- Custom Cofferdams
- Levee Reconstruction
- Shoreline Management
- Bank Stabilization
- Flood Protection
- Foundation Protection
- Pier Scour Protection

- Biodegradable Cells
- 3x < Industry Avg. Safety Factor

Performance Studies By:

- Precision Engineering, LLC
- ACES, Inc
- Army Corps of Engineers

100' Poured Concrete in just
ONE HOUR

FLOOD FIGHTING

Permashield™ system is a quick and efficient solution to rising flood waters. The shape of the system allows for impenetrable protection and is specifically designed to resist overturning, and washing out.

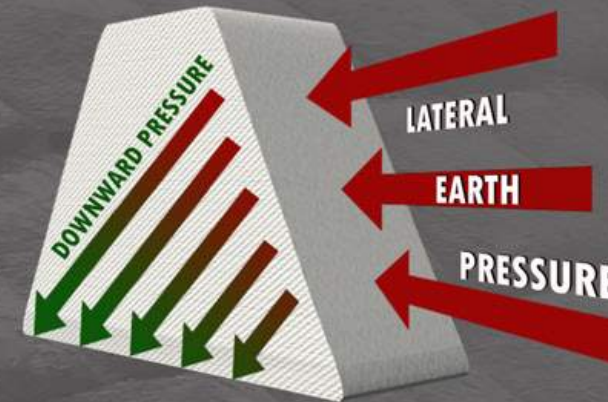
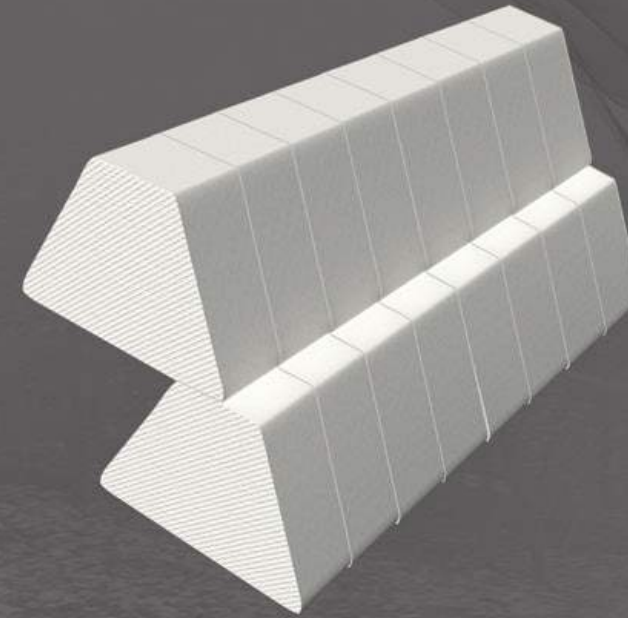
- 6' Height x 100' Length erected in just 20 minutes
- Army Corps of Engineers tested and approved
- Steel delivery system designed for any terrain



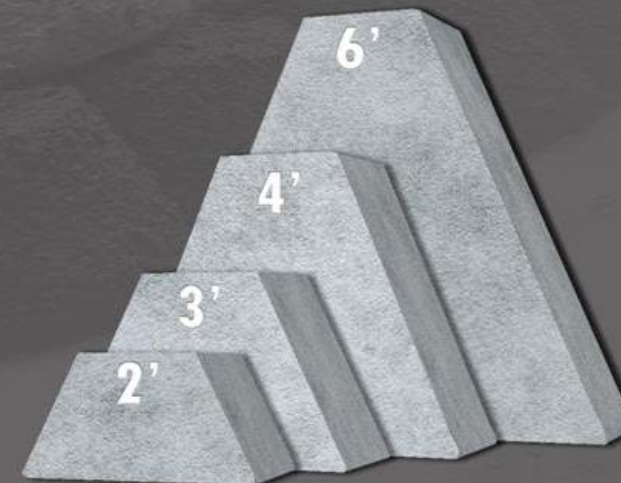
1 MILE PERIMETER
8' TALL FLOOD WALL
ERECTED IN 35 HOURS



PROTECTION FROM NATURE™



Redirects lateral earth pressure to downward pressure, stabilizing the base and reinforcing the wall



STRONG: Each cell is made from Heavy-Duty '8' ounce woven polypropylene coated fabric secures the material

WATERTIGHT: Trapezoid creates downward 'sealing' pressure

CONTINUOUS CHAIN: Permashield™ systems come in 50' sections and are joined together via 3,000 LB tensile strength nylon strapping with metal D-Rings

RAPID INSTALLATION: Permashield™ system produces the quickest custom concrete wall on the market

The Permashield™ system is the only of its kind shaped as an "Isosceles Trapezoid"

This provides symmetry about the center axis

- Stable base resists sliding
- Stable base resists rotational forces

The non-wire frame of the Permashield system allows it to take the shape of the ground, which increases the actual footprint

Permashield™ comes in a versatile range of systems. Each system is compatible with the next, allowing for a combination to reach your desired height.

- Flexible to match unlevel surfaces
- Ability to match any radius