4-inches to 12-inches	3-1/2-inches
12-inches to 2-feet	6-inches
2-feet to 4-feet	12-inches
4-feet to 8-feet	24-inches
Below 8-feet	36-inches

B. Embankments shall be constructed of material containing no muck, stumps, roots, brush, vegetable matter, rubbish or other material that will not compact into a suitable and enduring roadbed, and material designated as undesirable shall be removed from the site. Where embankments are constructed adjacent to bridge end bents or abutments, rock larger than 3-1/2 inches in diameter shall not be placed within three feet of the location of any abutment.

C. Fill material containing debris, sod, biodegradable materials shall not be used as fill in construction areas.

D. Fill material required for the building pads and for pavement subgrade shall be granular fill, free of organic material.

E. Fill material required for pervious and sodded areas shall have a maximum organic component of 10%. Contractor shall provide, at without any cost to the City, organic content test results for approval by the Engineer.

2.05 EQUIPMENT

A. Compactor for mass earthwork shall be minimum 3 ton static drum weight vibratory roller or 5 ton static drum weight sheeps footed compactor as appropriate for the type of soil material at the site or other compactor approved by the Engineer.

B. Compactor for trenches and where access or maneuverability is limited use, a double drum walk behind roller or vibratory plate compactor or "jumping jack" tampers.

PART 3 - EXECUTION

3.01 GENERAL

A. Prior to bidding of all Work within this section, the Contractor shall become thoroughly familiar with the geotechnical engineering study, if available, as well as the site, site conditions, and all portions of the Work falling within this section.

B. The Contractor shall refer to the erosion control Drawings, if provided, for staging of earthwork operations and for erosion control measures to be implemented prior to commencement of earthwork.

C. Locate and identify existing utilities that are to remain and protect them from damage.

D. Notify utility companies to allow removal and/or relocation of any utilities that are in conflict with the proposed improvements.

E. Protect fences, structures, sidewalks, paving, curbs, etc. to remain from equipment and vehicular traffic.

F. Protect benchmarks, property corners and all other survey monuments from damage or displacement. If a marker needs to be removed/relocated it shall be referenced by a licensed land surveyor and replaced, as necessary, by the same at no additional cost to the City.

G. Remove from the site, material encountered in grading operations that, in opinion of City or Engineer, is unsuitable or undesirable for backfilling in pavement or building areas as per Paragraph 2.01.

H. Identify required lines, levels, contours and datum to bring site grades to the proposed subgrade conditions inferred from the Drawings.

I. Do not perform any Work associated with this section prior to completion of all required inspections, tests and approvals.

J. When performing grading operations during periods of prolonged wet or dry weather, provide adequate measures for surface drainage and ground water control, and moisture control of soils (i.e., wetting or drying, scarify and discing) so as to place and compact the soil within the moisture content range a few percentage points of its optimum water content. Any disturbed areas should be proofrolled at the end of each day.

K. Sloping, shoring, bracing, and fencing shall be installed in accordance with Federal OSHA requirements as well as the requirements of all regulatory authorities having jurisdiction.

L. Allow no debris to accumulate on-site. Haul debris away from the site and dispose of at no cost to the City.

M. The Contractor shall remove and dispose of all excess excavated material at a site selected by the Contractor and reviewed by the Engineer.

3.02 JOB CONDITIONS

A. Protection: Use all means necessary to protect existing objects and vegetation. In the event of damage, immediately make all repairs, and replacements necessary to the acceptance of the Engineer at no cost to the City.

3.03 BACKFILL, FILLING & GRADING

A. Grades:

1. Cut, backfill, fill and grade to proper grade levels indicated. The proposed grades shown on the Drawings are for establishing a finished grade over the site.

B. Filling:

1. Fill material shall be placed in horizontal layers and spread to obtain a uniform thickness.

2. After compaction, layers of fill are not to exceed twelve (12) inches for cohesive soils or eight (8) inches for noncohesive soils.

3.04 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION

A. General: Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including all obstructions of any nature that would interfere with the proper execution and completion of the Work. The removal of said materials shall conform to the lines and grades shown or ordered. Unless otherwise provided, the entire construction site shall be stripped of all vegetation and debris, and such material shall be removed from the site prior to performing any excavation or placing any fill. The Contractor shall furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations, and all pumping, ditching, or other measure for the removal or exclusion of water, including taking care of storm water, groundwater, and wastewater reaching the site of the Work from any source so as to prevent damage to the Work or adjoining property. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable State safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

B. Excavation Beneath Structures and Embankments: Except where otherwise specified for a particular structure or ordered by the Engineer, excavation shall be carried to the grade of the bottom of the footing or slab. Where shown or ordered, areas beneath structures or fills shall be over-excavated. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6 inches of native material and where such subgrade is sloped, the native material shall be benched. When such over excavation is shown, both over-excavation and subsequent backfill to the required grade shall be performed by the Contractor. When such over-excavation is not shown but is ordered by the Engineer, such over- excavation and any resulting backfill will be paid for under a separate unit price bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price. After the required excavation or over-excavation has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 98 percent of maximum density.

C. Excavation Beneath Paved Areas: Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the paving thickness. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 98 percent of maximum density. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

D. Notification of Engineer: The Contractor shall notify the Engineer at least 3 days in

advance of completion of any structure excavation and shall allow the Engineer a review period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

3.05 PIPELINE AND UTILITY TRENCH EXCAVATION

A. General: Unless otherwise shown or ordered, excavation for pipelines and utilities shall be open-cut trenches. Trench widths shall be kept as narrow as is practical for the method of pipe zone densification selected by the Contractor, but shall have a minimum width at the bottom of the trench equal to the outside diameter of the pipe plus 24 inches for mechanical compaction methods and 18 inches for water consolidation methods. The maximum width at the top of the trench shall be equal to the outside diameter of the pipe plus 36 inches for pipe diameters 18 inches and larger and to the outside diameter of the pipe plus 24 inches for pipe diameters less than 18 inches, or as shown on the Drawings.

B. Trench Bottom: Except when pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe. The trench bottom shall be given a final trim, using a string line for establishing grade, such that each pipe section when first laid will be continually in contact with the ground along the extreme bottom of the pipe. Rounding out the trench to form a cradle for the pipe will not be required. Excavations for pipe bells and welding shall be made as required.

C. Open Trench: The maximum amount of open trench permitted in any one location shall be determined by FDOT MOT approvals. All trenches shall be fully backfilled at the end of each day. The above requirements for backfilling will be waived in cases where the trench is located further than 100 feet from any traveled roadway or occupied structure. In such cases, however, barricades meeting OSHA requirements shall be provided and maintained. Requirements of Section 01550, paragraph 1.02B shall also apply.

D. Trench Over-Excavation: Where the Drawings indicate that trenches shall be over-excavated, they shall be excavated to the depth shown, and then backfilled to the grade of the bottom of the pipe.

E. Over-Excavation: When ordered by the Engineer, whether indicated on the Drawings or not, trenches shall be over-excavated beyond the depth shown. Such over-excavation shall be to the depth ordered. The trench shall then be backfilled to the grade of the bottom of the pipe. All Work specified in this Section shall be performed by the Contractor when the over-excavation ordered by the Engineer is less than 6 inches below the limits shown.

When the over-excavation ordered by the Engineer is 6 inches or greater below the limits shown, additional payment will be made to the Contractor for that portion of the Work which is located below said 6-inch distance. Said additional payment will be made under separate unit price bid items for over-excavation and bedding if such bid items have been established; otherwise payment will be made in accordance with a negotiated price.

F. Where pipelines are to be installed in embankment or structure fills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.

3.06 OVER-EXCAVATION NOT ORDERED, SPECIFIED, OR SHOWN

A. Any over-excavation carried below the grade ordered, specified, or shown, shall be backfilled to the required grade with the specified material and compaction. Such Work shall be performed by the Contractor at its own expense.

3.07 EXCAVATION IN LAWN AREAS

A. Where excavation occurs in lawn areas, the sod shall be carefully removed, kept damp, and stockpiled to preserve it for replacement. Excavated material may be placed on the lawn; provided that a drop cloth or other suitable method is employed to protect the lawn from damage. The lawn shall not remain covered for more than 72 hours. Immediately after completion of backfilling and testing of the pipeline, the sod shall be replaced and lightly rolled in a manner so as to restore the lawn as near as possible to its original condition. Contractor shall provide new sod if stockpiled sod has not been replaced within 72 hours.

3.08 EXCAVATION IN VICINITY OF TREES

A. Except where trees are shown to be removed, trees shall be protected from injury during construction operations. No tree roots over 2 inches in diameter shall be cut without express permission of the Engineer. Trees shall be supported during excavation by any means previously reviewed and approved by the Engineer.

3.09 ROCK EXCAVATION

A. Rock is defined as follows:

1. Rock shall be classified as material having a blow count in excess of 30 blows per foot from a Standard Penetration Test (ASTM D-1586) and exceeding 1000 psi from an Unconfined Compression Strength Test (ASTM D-2938); and,

2. General Excavation - Any material that cannot be excavated with a single-toothed ripper drawn by a crawler tractor having a minimum draw bar pull rated at not less than 71,000 lbs. (Caterpillar D9N or equivalent), and occupying an original volume of at least 2 cubic yards or more; and,

3. Trench Excavation - Any material that cannot be excavated with a backhoe having a break out force rated at not less than 44,000 pounds (Caterpillar 235D or equivalent), and occupying an original volume of at least 2 cubic yards.

B. Rock excavation shall include removal and disposal of the following: (1) all boulders measuring 1/3 of a cubic yard or more in volume; (2) all rock material in ledges, bedding deposits, and unstratified masses which cannot be removed without systematic drilling and blasting; (3) concrete or masonry structures which have been abandoned; and (4) conglomerate deposits which are so firmly cemented that they possess the characteristics of rock as described in Paragraph 3.09(A).

C. Said rock excavation shall be performed by the Contractor; provided, that should the

quantity of rock excavation be affected by any change in the scope of the Work, an appropriate adjustment of the contract price will be made under a separate bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price.

D. Explosives and Blasting: Blasting will not be permitted, except by express permission of the Engineer on a case-by-case basis. The use of explosives will be subject to the approval and regulations of all agencies having jurisdiction. If blasting is utilized at the site of the Work, the Contractor shall take all precautions and provide all protective measures necessary to prevent damage to property and structures or injury to person. Prior to blasting, the Contractor shall secure all permits required by law for blasting operations and shall provide any additional hazard insurance required by the City. The Contractor shall have a fully qualified and experienced blasting supervisor in charge of all blasting operations.

E. The Contractor will be held responsible for all and shall make good any damage caused by blasting or resulting from its possession or use of explosives on the Work.

F. All operations involving the handling, storage, and use of explosives shall be conducted in accordance with the requirements of the OSHA Standards for Construction, and in accordance with all local laws and regulations.

3.10 DISPOSAL OF UNSUITABLE EXCAVATED MATERIAL

A. The Contractor shall remove and dispose of all unsuitable excavated material. This shall include muck, tree roots, rocks, garbage, debris, or any other material designated as unsuitable by Part 2 of this Section. Disposal shall be at a site selected by the Contractor that is designated as an approved disposal site for the unsuitable material.

3.11 BACKFILL - GENERAL

A. Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed. Backfill around water retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.

B. Except for drainrock materials being placed in over-excavated areas or trenches, backfill shall be placed after all water is removed from the excavation.

3.12 PLACING AND SPREADING OF BACKFILL MATERIALS

A. Backfill materials shall be placed and spread evenly in layers. When compaction is achieved using mechanical equipment the layers shall be evenly spread so that when compacted each layer shall not exceed 6 inches in thickness.

B. During spreading each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer. Pipe zone backfill materials shall be manually spread, tamped, and haunched around the pipe so that when compacted the pipe zone

backfill will provide uniform bearing and side support.

C. Where the backfill material moisture content is below the optimum moisture content water shall be added before or during spreading until the proper moisture content is achieved.

D. Where the backfill material moisture content is too high to permit the specified degree of compaction the material shall be dried until the moisture content is satisfactory.

3.13 COMPACTION - GENERAL

A. Compact each layer of fill in designated areas with approved equipment to achieve a maximum density at optimum moisture, AASHTO T 180 - latest edition.

1. Building Pads: compaction shall be to 98% of maximum density, unless otherwise shown on the DRAWINGS or specifications. Building pads shall be within plus or minus one-tenth (0.1) of a foot of the elevations shown on the plans.

2. Refer to Sections 02772 Asphaltic Pavement for compaction requirements in the affected areas.

3. Under landscaped area, compaction shall be to 85% of maximum density, unless otherwise shown on the Drawings.

B. No backfill shall be placed against any masonry or other exposed building surface until permission has been given by the Engineer and in no case until the masonry has been in place seven days.

C. Heavy construction equipment will not be permitted within ten (10) feet of any masonry or other exposed building surface.

D. Compaction in limited areas shall be obtained by the use of mechanical tampers or approved hand tampers. When hand tampers are used, the materials shall be deposited in layers not more than four inches thick. The hand tampers used shall be suitable for this purpose and shall have a face area of not more than 100 square inches. Special precautions shall be taken to prevent any wedging action against masonry, or other exposed building surfaces.

3.14 COMPACTION OF FILL, BACKFILL, AND EMBANKMENT MATERIALS

A. Each layer of Types 1, 2, 3, 7, 8, and 14 backfill materials as defined herein, where the material is graded such that at least 10% passes a No. 4 sieve, shall be mechanically compacted to the specified percentage of maximum density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content.

B. Each layer of Type 4, 5, 6, and 13 backfill materials shall be compacted by means of at least 2 passes from a flat plate vibratory compactor. When such materials are used for pipe zone backfill, vibratory compaction shall be used at the top of the pipe zone or at

vertical intervals of 24 inches, whichever is the least distance from the subgrade.

C. Type 9 and 10 material requires mechanical spreading and placement to fill voids but does not require mechanical compaction or vibration. Tamping shall be used in pipe zone areas.

D. Fill on structure roof slabs shall be deposited at least 30 days after the concrete roof slab has been placed. Equipment weighing more than 10,000 pounds when loaded shall not be used on a roof. A roller weighing not more than 8,000 pounds shall be used to compact fill on a roof.

E. Flooding, ponding, or jetting shall not be used for fill on roofs, backfill around structures, backfill around reservoir walls, for final backfill materials, or aggregate base materials.

F. Pipe zone backfill materials that are granular may be compacted by a combination of flooding and vibration using concrete vibrators or by jetting, when acceptable to the Engineer. Tamping shall be used to ensure adequate bedding in the pipe zone.

G. Pipeline trench zone backfill materials, containing 5% or less of material passing a No. 200 sieve, may be compacted using flooding and jetting or vibration if the Contractor uses effective procedures that yield the specified compaction test results. Flooding and jetting shall not be done in such a manner that the pipe or nearby utilities are damaged, in areas of poorly draining or expansive soils, or where the use of the procedure is prohibited by any agency having jurisdiction over the street or right-of-way. Approved jet pipes or immersible vibrators shall be used so that each backfill layer is saturated and consolidated to its full depth before the next layer is placed. Jet pipes shall be kept at least 6 inches away from the pipe where the backfills being consolidated and 2 feet away from other pipes or utilities.

H. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the fill at that time. Hand operated power compaction equipment shall be used where use of heavier equipment is impractical or restricted due to weight limitations.

I. Compaction Requirements: The following compaction test requirements shall be in accordance with AASHTO T-180, T-99-C or ASTM D 2487 as applicable. Where agency or utility company requirements govern, the highest compaction standards shall apply.

Location or Use of Fill	**Percentage of Maximum Density AASHTO T-180**	**Testing Frequency 1 per lift per**
Pipe zone backfill portion above bedding for flexible pipe.	100	150 LF
Pipe zone backfill bedding and over-excavated zones under bedding/pipe for flexible pipe, including trench plugs.	100	150 LF

Pipe zone backfill portion above bedding for rigid pipe.	98	150 LF
Pipe zone backfill bedding and over-excavated zones under bedding/pipe for rigid pipe.	98	100 LF
Final backfill, beneath paved areas or structures.	98	2,500 SF
Final backfill, not beneath paved areas or structures.	95	2,500 SF
Trench zone backfill, not beneath paved areas or structures, including trench plugs.	95	150 LF

Location or Use of Fill	**Percentage of Maximum Density AASHTO T-180**	**Testing Frequency 1 per lift per**
Embankments.	98	2,500 LF
Embankments, beneath paved areas or structures.	100	2,500 SF
Backfill beneath structures, hydraulic structures.	100	100 SF
Backfill around structures.	98	100 SF
Topsoil (type 14 material)	85	5,000 SF
Aggregate base or subbase (type 11or 12 material)	98	2,500 SF

J. Trench Backfill Requirements: the pipe has been structurally designed based upon the trench configuration specified herein.

K. The Contractor shall maintain the indicated trench cross section up to a horizontal plane lying 6 inches above the top of the pipe.

L. If, at any location under said horizontal plane, the Contractor slopes the trench walls or exceeds the maximum trench widths indicated in the Contract Documents, the pipe zone backfill shall be "improved" or the pipe class increased as specified herein, at no additional cost to the City. "Improved" backfill shall mean sand-cement backfill or other equivalent materials acceptable to the Engineer.

M. If the allowable deflection specified for the pipe is exceeded, the Contractor shall expose and reround or replace the pipe, repair all damaged lining and coating, and reinstall the pipe zone material and trench backfill as specified at no additional expense to the City.

3.15 PIPE AND UTILITY TRENCH BACKFILL

A. Pipe Zone Backfill: The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane 6 inches below the bottom surface of the pipe, i.e., the trench subgrade, and a plane at a point 6 inches above the top surface of the pipe. The bedding for flexible pipe is defined as that portion of pipe zone backfill material between the trench subgrade and the bottom of the pipe. The bedding for rigid pipe is defined as that portion of the pipe zone backfill material between the trench subgrade and a level line which varies from the bottom of the pipe to the springline as shown.

B. Bedding shall be provided for all sewers, drainage pipelines, and other gravity flow pipelines. Unless otherwise specified or shown, for other pipelines the bedding may be omitted if all the following conditions exist.

1. The pipe bears on firm, undisturbed native soil which contains only particles that will pass a one-inch sieve.

2. The excavation is not through rock or stones.

3. The trench subgrade soils are classified as suitable fill and backfill materials per Paragraph 2.01.

4. The trench subgrade soils have, as a maximum, a moisture content that allows compaction.

C. Where bedding is required, after compacting the bedding the Contractor shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe. Excavation for pipe bells and welding shall be made as required.

D. The pipe zone shall be backfilled with the specified backfill material. The pipe zone shall be well tamped per manufacturer's recommendation to prevent sags or settlement of the pipe. The Contractor shall exercise care to prevent damage to the pipeline coating, cathodic bonds, or the pipe itself during the installation and backfill operations.

E. Trench Zone Backfill: After the pipe zone backfill has been placed as specified above, and after all excess water has completely drained from the trench, backfilling of the trench zone may proceed. The trench zone is defined as that portion of the vertical trench cross-section lying between a plane 6 inches above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade. If flooding, ponding, or jetting is used the pipe shall be filled with water to prevent flotation.

F. Final Backfill: Final backfill is all backfill in the trench cross-sectional area within 18 inches of finished grade, of if the trench is under pavement, all backfill within 18 inches of the roadway subgrade.

3.16 EMBANKMENT CONSTRUCTION

A. The area where an embankment is to be constructed shall be cleared of all vegetation, roots and foreign material. Following this, the surface shall be moistened, scarified to a depth of 6 inches, and rolled or otherwise mechanically compacted. Embankment fill material shall be placed and spread evenly in approximately horizontal layers. Each layer shall be moistened or aerated, as necessary. Unless otherwise approved by the Engineer, each layer shall not exceed 6 inches of compacted thickness. The embankment fill and the scarified layer of underlying ground shall be compacted to 95% of maximum density under structures and paved areas, and 90% of maximum density elsewhere.

B. When an embankment fill is to be made and compacted against hillsides or fill slopes

steeper than 4:1, the slopes of hillsides or fills shall be horizontally benched to key the embankment fill to the underlying ground. A minimum of 12 inches normal to the slope of the hillside or fill shall be removed and recompacted as the embankment fill is brought up in layers. Material thus cut shall be recompacted along with the new fill material at the Contractor's expense. Hillside of fill slopes 4:1 or flatter shall be prepared in accordance with Paragraph A, above.

C. Where embankment or structure fills are constructed over pipelines, the first 4 feet of fill over the pipe shall be constructed using light placement and compaction equipment that does not damage the pipe. Heavy construction equipment shall maintain a minimum distance from the edge of the trench equal to the depth of the trench until at least 4 feet of fill over the pipe has been completed.

3.17 COMPACTION OF SUBGRADE SURFACES

A. Any soft areas exhibiting excessive weaving or unsatisfactory material identified during excavation, fill placement, compaction and proof testing shall be removed, replaced with suitable fill, and compacted as specified.

B. Prior to preparing the subgrade in low lying areas, perform the following procedures:

1. Drain standing water by gravity or with a pump. Water should not be discharged directly to a storm drain system;

2. After drainage of low area is complete, remove mulch, mud, debris, and other unsuitable material using equipment and methods that will minimize disturbance to the underlying soils;

3. Thoroughly compact subgrade as specified.

4. If proposed for fill, all muck, mud and other materials removed from above low areas shall be dried on-site by spreading in thin layers for observation by City or Engineer. If, after observation by City material is found to be unsuitable, it shall be removed from the site.

3.18 UNDERCUT EXCAVATION

A. When approved by City and recommended by the Engineer, the Contractor may be required to remove natural soil materials in areas where fills are to be placed when determined to be undesirable in their location or condition. The Contractor shall be required to remove the undesirable material and backfill with approved material properly compacted.

B. At locations where unstable soil is shown on the Drawings or identified within the geotechnical engineering study, the removal and replacement of such soil shall be as directed on the Drawings or as directed by the Engineer and the City.

C. At locations where soil is wet of optimum moisture, the Contractor shall provide a “good faith” effort in drying and discing these areas prior to completing undercut excavation as approved by the Engineer and City.

D. Where undercutting is required adjacent or beneath the location of the proposed drainage structure, undercut and backfill shall be done over a sufficient distance adjacent to the installation to prevent future operations from disturbing the completed drainage structure.

E. All material removed in the Work of undercut excavation will be classified by the geotechnical engineer and City as either suitable for other use without excessive manipulation and utilized by the Contractor elsewhere in the Work, or unsuitable for future use and disposed of by the Contractor as directed by the Engineer.

F. The Contractor shall conduct undercut operations in such a way that the necessary measurements can be taken before any backfill is placed.

G. Backfill in undercut areas shall be placed as a continuous operation along with the undercutting operation. No backfill material shall be placed in water unless otherwise permitted by the Engineer.

3.19 EXCAVATION, FILL, AND SUBGRADE PREPARATION

A. General

1. The building limits shall be as identified on the construction DRAWINGS. The building subgrade shall be constructed to include a minimum of 10 feet beyond the building limits, or as directed by the City;

2. Structures include buildings, footings, foundations, retaining walls, embankment berms for storm water detention basins, slabs, tanks, curbs, mechanical and electrical appurtenances or other man-made stationary features constructed above or below the ground surface;

3. The building pad subgrade shall be prepared in strict accordance with the geotechnical engineering study and these specifications, whichever is more stringent; and,

4. The Contractor shall cut or fill to the proposed subgrade elevations based on finished grades and the pavement thicknesses as shown on the DRAWINGS. Subgrade elevations shall be constructed to within 0 to minus ½ inch of the proposed grades specified.

B. Excavation

1. Where existing grades are above proposed subgrade elevation, excavate materials in the building areas to line and grade as shown in the Drawings being careful not to over excavate beyond the elevations needed for building subgrades;

2. Excavate organic soils from within the building area. Excavated on-site organic soils, which are unsuitable for building fill, may be used in landscaped areas. Otherwise this material shall be disposed of off-site;

3. Unsuitable material, such as wood and any other deleterious materials determined to be unsuitable by the geotechnical engineer for use as on-site fill, shall be disposed of offsite.

C. Subgrade Preparation for Fill

1. Existing grades below building areas shall be leveled prior to fill placement. The Contractor shall remove existing lawn and top soil in these areas prior to placement of any fill; and,

2. All existing grades below building areas shall be proofrolled and compacted per this section.

D. Fill Placement

1. No fill material shall be placed in areas of standing water, in areas of frozen or thawing ground, or in areas that have not been approved by the Engineer;

2. No fill materials shall be placed during unfavorable weather conditions. When Work is interrupted by heavy rains, fill operations shall not be resumed until all saturated surficial soils are returned to satisfactory moisture content as determined by the Engineer;

3. Fill lift surfaces shall be made smooth and free from ruts or indentations at the end of any workday when precipitation is forecast to prevent saturation of surficial fill material. Fill surfaces shall be graded to drain and sealed with a smooth drum roller at the completion of each work day;

4. The fill shall be placed in uniform loose lifts not exceeding 12 inches and compacted in systemic method to achieve at least 6 passes of the compactor. Larger lift thickness, but no greater than 2 feet shall be permitted if broken rock is utilized and placed at least 6 feet below of finished grade;

5. Shot rock may be utilized as engineered fill as approved by the Engineer;

6. Each lift shall be compacted to the minimum densities listed in this section as appropriate for the project and as specified in the geotechnical engineering study;

7. The Contractor shall adjust the water content by aeration or adding water to achieve the required density. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to achieve proper compaction and facilitate the construction schedule;

8. Wet, saturated material shall be air dried as necessary to achieve the field densities specified in this Section. Removal and replacement shall not occur without prior approval or City. Removal and replacement shall be used if necessary to facilitate the construction schedule;

9. Remove areas of finished subgrade found to have insufficient compaction density of depth necessary and replace with suitable compacted fill as approved by the City or Engineer. Surface of subgrade after compaction shall be hard, uniform,

smooth, stable, and true to grade and cross-section; and,

10. Fill placed on slopes greater than 1 vertical to 3 horizontal shall have each lift benched onto the slope at least 3 feet.

3.20 PROOFROLLING

A. The Work covered by this subsection consists of furnishing and operating, proofrolling equipment at the direction of the Engineer.

B. Proofrolling shall be under the observation of the geotechnical engineer as described herein and under the following schedule:

1. Immediately following the completion of excavation to proposed subgrades in cut areas, proofrolling shall be performed as specified; and,

2. Immediately prior to and following stone base course placement, in pavement and building pad areas for final floor slab preparation, all subgrade and stone base areas shall be proofrolled. Any areas which deflect, rut or pump under the loaded dump truck shall be undercut and replaced with compacted fill material or stone base course as directed by the Engineer and approved by the City, at no additional cost to the City.

C. Proofrolling shall be done with 1 pass of a fully loaded tandem dump truck equal to or exceeding 50,000 pounds or other construction equipment if approved by the Engineer.

D. Construction methods shall be as follows:

1. After the subgrade or stone base course has been completed the subgrade or stone base course shall then be proofrolled. The coverage areas and methods will be identified by the Engineer;

2. The equipment shall be operated at a speed that the Engineer can comfortably and slowly walk alongside the equipment;

3. If it becomes necessary to take corrective action, such as but not limited to underdrain installation, undercut and backfill of an unsuitable material, and aeration of excessively wet material in areas that have been proofrolled, see Paragraph 3.18. These areas shall be proofrolled again following the completion of the necessary corrections. If the corrections are necessary due to the negligence of the Contractor, the corrective Work and additional proofrolling shall be performed by the Contractor at no cost to the City;

4. The Contractor shall protect all structural facilities on the project, such as but not limited to box culverts, pipe culverts, and utilities, from damage by the proofrolling equipment.

3.21 MAINTENANCE OF SUBGRADE

A. Finished subgrades shall be verified by the Contractor to ensure proper elevation and

conditions for construction above subgrade.

B. Protect subgrade from excessive construction traffic and wheel loading including concrete and dump trucks.

C. Remove areas of finished subgrade judged to be unsatisfactory to the depth necessary and replace in a manner that will comply with compaction requirements by use of material equal to or better than the best subgrade material on site. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross-section.

3.22 CORRECTION OF GRADE

A. Bring to required grade levels areas where settlement, erosion or other grade changes occur.

3.23 MAINTENANCE AND PROTECTION OF WORK

A. While construction is in progress adequate drainage for the roadbed shall be maintained at all times.

B. The Contractor shall maintain all earthwork construction throughout the life of the contract, unless otherwise provided, and shall take all reasonable precautions to prevent loss of material from the roadway due to the action of wind or water. The Contractor shall repair without any additional expense to the City, except as otherwise provided herein, any slides, washouts, settlement, subsidence, or other mishap which may occur prior to final acceptance of the Work.

C. All channels excavated as a part of the contract Work shall be maintained against natural shoaling or other encroachments to the lines, grades, and cross sections shown on the plans, until final acceptance of the project.

3.24 AS-BUILT SURVEY

A. At the completion of the Work and prior to final inspection of the area, the Contractor shall provide the Engineer with an as-built topographic survey made by a Florida Licensed Professional Surveyor & Mapper.

B. The Florida Licensed Professional Surveyor & Mapper is to certify on the survey whether or not the as-built conditions conform to the elevations shown on the Drawings to within plus or minus one- tenth (0.1) of a foot.

3.25 MEASUREMENT AND PAYMENT

A. There shall be no special measurement or payment for the Work under this section, it shall be included in the associated bid item for this Work.

- END OF SECTION -

PROJECT NO. 11842

SECTION 02371

GEOTEXTILES

PART 1 - GENERAL

1.01 DEFINITIONS

A. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.

B. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile furnished.

C. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile furnished.

D. Nondestructive Sample: Sample representative of finished Work, prepared for testing without destruction of Work.

E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

F. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D4884.

1.02 DELIVERY, STORAGE, AND HANDLING

A. Deliver each roll with sufficient information attached to identify it for inventory and quality control.

B. Handle products in manner that maintains undamaged condition.

C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

PART 2 - PRODUCTS

2.01 SUBMITTALS

A. Submittals shall be in accordance with Section 01300 – Submittals.

2.02 NONWOVEN GEOTEXTILE

A. Pervious sheet of polypropylene, or polyethylene fabricated into stable network of fibers that retain their relative position with respect to each other. Nonwoven geotextile shall be composed of continuous or discontinuous (staple) fibers held together through needle-punching, spun-bonding, thermal-bonding, or resin-bonding.

B. Geotextile Edges: Selvaged or otherwise finished to prevent outer material from pulling away from geotextile.

C. Unseamed Sheet Width: Minimum 6 feet.

D. Physical Properties: Conform to requirements in Table No. 1.

TABLE NO 1
PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE

Property	Requirement	Test Method
Water Permittivity	14 $sec.^{-1}$, MinARV	ASTM D4491 (Falling Head)
Air Permeability	200 cf/min/sq ft, MinARV	ASTM D737
Transmissivity, Planar Waterflow/Siphonage	0.5 ft^2/sec., MinARV	ASTM D4716
Apparent Opening Size (AOS)	30 U.S. Standard Sieve Size	ASTM D4751
Grab Tensile Strength, Machine Direction	400 lb/in, MinARV	ASTM D4632
Grab Elongation, Machine Direction	50 percent, MaxARV	
Puncture Strength	400 lb, MinARV	ASTM D4833
Trapezoid Tear Strength	400 lb, MinARV	ASTM D4533
Abrasion Resistance	20 percent loss, 250 cycles, MaxARV	ASTM D4886
Ultraviolet Radiation Resistance	80 percent strength retention, MinARV after 500 hours	ASTM D4355

PART 3 - EXECUTION

3.01 LAYING GEOTEXTILE

A. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.3.02

3.02 SHEET ORIENTATION FOR SUBSURFACE DRAINAGE

A. Orient geotextile in the trench with the long dimension parallel to the trench.

B. The filter material shall not be dropped on the geotextile from heights greater than 3 feet.

3.03 JOINTS

A. Unseamed Joints:

1. Overlapped.
2. Overlap, unless otherwise shown:
   a. Foundation/Subgrade Stabilization: Minimum 18 inches.
   b. Riprap: Minimum 18 inches.
   c. Other Applications: Minimum 12 inches.

3.04 INSTALLING GEOTEXTILE IN TRENCHES

A. Place geotextile in a way that will completely envelope granular drain material to be placed in trench and with specified overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.

B. After granular drain material is placed to required grade, fold geotextile over top of granular drain material, unless otherwise shown. Maintain overlap until overlying fill or backfill is placed.

3.05 REPAIRING GEOTEXTILE

A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile.

B. Repair Procedure:

1. Place patch of undamaged geotextile over damaged area and at least 18 inches in all directions beyond damaged area.
2. Remove interfering material as necessary to expose damaged geotextile for repair.
3. Sew patches or secure them with heat fusion tacking or with pins and washers, as specified above in Article SECURING GEOTEXTILE, or by other means approved by Engineer.

3.06 REPLACING CONTAMINATED GEOTEXTILE

A. Protect geotextile from contamination that would interfere, in Engineer's opinion, with its intended function. Remove and replace contaminated geotextile with clean geotextile.

- END OF SECTION -

PROJECT NO. 11842

SECTION 02481

TREE RELOCATION AND PROTECTION

PART 1 – GENERAL

1.01 WORK TO BE PERFORMED AND WORK INCLUDED

A. Prepare and relocate trees and palms required for relocation within the project boundaries, to include all aspects of preparation, relocation, protection, and maintenance.

B. Protection and care of existing trees and palms to remain within the project boundaries, to include all aspects of protection, pruning, fertilization, and watering.

C. Watering by water truck.

D. Follow up maintenance as required by these Specifications.

E. Labor, materials, equipment, and services to complete all preparation, relocations and protection work as shown on the Drawings, as specified herein, or both.

1.02 SUBMITTALS

A. Copy of all permits submitted for tree relocations.

B. The Contractor shall utilize the services of a Licensed Landscape Architect or Certified Arborist for preparation of tree disposition plans, tree removal permits, tree relocation permits, and all required supporting documentation.

C. Verification of Qualifications: The Contractor shall provide a list of references and project list of a minimum of five (5) projects that the Contractor has successfully completed that are similar in scope and nature.

D. List of all equipment to be utilized during tree preparation and transplanting.

E. Literature on specified wetting agents, fertilizers, and soil conditioners.

1.03 APPLICABLE STANDARDS AND SPECIFICATIONS

A. Comply with the following standards and specifications for all materials, methods, and workmanship unless otherwise noted:

1. Codes and Standards of the American Association of Nurserymen.

2. Codes and Standards of the National Arborists Association.

3. Codes and Standards of the International Society of Arboriculturists.

1.04 PERMITS

A. The Contractor shall secure any permits required, including tree removal and tree relocation permits, in order to complete the work under this Section. Cost of permit fees associated with tree removals and/or relocations shall be paid for under the "Permits Allowance" bid item.

1.05 DESCRIPTION

A. Trees to be relocated within the project area will be specifically designated in the field as project work progresses or as noted in the drawings.

B. Existing trees to be relocated shall be crown pruned and be treated with soil amendments prior to relocation.

C. Existing trees to be relocated or to remain shall be protected with barricades during construction. Trees or shrubs to remain which are scarred or destroyed shall be replaced at the direction of the City Forester with the same species, size, and quality at no cost to the City.

D. Tree pits resulting from relocated material shall be backfilled with clean fill and brought flush with surrounding grade.

1.06 GUARANTEES

A. The Contractor shall guarantee his work in the following way:

1. Any tree or palm that dies or is deemed in unacceptable condition for one year following final project acceptance shall be removed by the Contractor, including root ball, and backfilling of pit, at no cost to the City.

2. The Contractor shall provide a comparable specimen at no additional cost to the City.

3. The guarantee shall be enforced if it is deemed by the City Forester that tree mortality or decline is a product of negligence by the Contractor.

PART 2 – MATERIALS

2.01 SOIL AMENDMENTS

A. Root stimulant shall be Roots Biostimulant, concentrate or powder, as manufactured by LISA Products Corp., (305) 797-6801, or City-approved equal. Stimulant shall be applied either as a wash, or by injection, mixed per manufacturer's recommendation.

B. Soil conditioner shall be Lesco Wet, as manufactured by Lesco, Inc. or NoburN, as manufactured by Roots or City-approved equal.

C. Minor element liquid fertilizer mix shall be Micro Mix liquid as produced by Lesco, Inc., or equal; to be diluted at a rate of 1 gallon per 100 gallons of water and

applied at a rate of 50 gallons per 1,000 square feet of canopy, or Iron Roots, applied per manufacturer's instructions.

D. Time Release Fertilizer tablets shall be Agriform, 15 grams, designation 8-8-8; or approved equal.

2.02 EQUIPMENT

A. Soil amendments shall be injected into the soil by means of a spray apparatus utilizing mechanical agitation to keep powdered amendments suspended.

B. Root pruning equipment shall be designed for this task, and shall produce clean cuts of roots without damage to the resulting root ball.

C. Relocation equipment shall be capable of lifting and transporting trees without damage.

2.03 SOIL

A. Soil to be placed once trees or palms are transplanted shall meet the requirements specified in the Contract Documents.

2.04 WATER

A. Water shall be clean and potable.,

2.05 MULCH

A. Grade A Eucalyptus mulch, free of viable weed seeds.

2.06 BRACING AND STAKES

A. All bracing and stakes shall be pressure treated pine. Compression bands shall be stainless steel.

PART 3 – EXECUTION

3.01 EXCAVATING NEAR EXISTING TREES

A. Maintain a minimum 6-foot clearance from all tree trucks except palm trees.

B. Use a 24-inch minimum depth saw cut in pavement or dirt/gravel roadway before start of excavation in areas where there are large trees close to the construction area. No coating application is required after saw cutting roots.

3.02 PREPARATION FOR RELOCATION OF TREES AND PALMS WITHIN THE PROJECT BOUNDARIES

A. Crown Pruning: All trees and palms shall be crown pruned prior to relocation.

1. Broadleaf Trees:

a. All trees are to be trimmed by thinning the crown only, and not by reducing crown dimensions. Trim to conform to NAA Standards, including removal of dead wood.

b. Repair any existing injuries to trees including cavities and machinery marks.

2. Palms:

a. Remove all fruits and seed pods, and all but the seven (7) youngest fronds.

b. Tie all remaining fronds with untreated cotton twine or burlap straps.

B. Fertilization and Watering:

1. Preparation: Clear the root ball area of all foreign material, trash, etc., to expose undisturbed soil.

2. Application/Schedule:

a. Trees shall be deep injection fertilized a minimum of 14 days prior to relocation. Specified liquid fertilizer shall be used and applied at the concentration and application rates stated herein.

b. Mix wetting agent, biostimulant, and minor element mix to produce a single fluid with each component included at the specified concentration. Inject into the root zone within the limits of proposed root ball at the rate of 50 gallons fluid per 1,000 square feet of tree canopy, using only approved spray equipment.

c. Form an earth berm 6 inches high outside the proposed root ball prior to watering. Water application shall saturate the root ball to its entire depth.

C. Root Pruning:

1. Technique:

a. All trees shall be excavated by digging a trench a minimum of 36 inches deep by 6 inches wide, either by hand or with a trenching machine designed for this purpose. Provide continuous trenching around the tree or palm at a minimum distance of 30 inches from the trunk. Hand cut broadleaf tree roots after trenching to produce clean cuts with no splits or tears.

b. Barricades: Barricade all root pruned trees and palms at outside of soil berm with minimum 4-foot chain link fence or other barricade approved by the City.

c. Timing:

1) All oaks to be relocated shall be maintained for a minimum of 10 weeks after root pruning prior to relocation.

2) Palms shall be maintained a minimum of 4 weeks prior to relocation.

3.03 RELOCATION OF TREES AND PALMS

A. General: Trees to be relocated shall be as directed by the Engineer.

B. Preparation:

1. Trees and palms shall be injected with soil amendments a minimum of 14 days prior to relocation. Apply at manufacturer's recommended concentration and application rates.

2. Trees and palms shall be thoroughly soaked to the full depth of the root ball daily for seven (7) consecutive days prior to relocation.

3. Accurately locate position and elevation where all trees are intended to be planted, for verification by City Forester. Verify that no overhead or underground utilities, existing or proposed, conflict with proposed locations.

4. Ascertain that all proposed paths for machinery are clear of utilities and other obstructions.

C. Excavation of Tree Pits: Dig all pits with vertical sides and flat bottom. Existing soil may be utilized as backfill as directed by the City Forester. All Tree Pits to be lined with root barrier adjacent to roadways and sidewalks as directed by City.

D. Digging and Handling - Broadleaf Trees:

1. Notify City 2 business days in advance of each relocation to allow for observation of procedures.

2. Determine line of previous root pruning and excavate around root mass to leave area 12 inches out from line of root pruning undisturbed. Digging shall be accomplished so as to produce clean cuts on all roots without tearing or splitting. Trenching shall be a minimum of 36 inches deep.

3. Trees are to be handled in such a way as to avoid damage to bark and limbs subject to support cables or chains. Attach padded support cables or chains at multiple points where possible. Alternatively, tree trunks may be drilled and doweled for broadleaf trees. The City Forester reserves the right to require doweling in lieu of lifting by straps.

4. Root balls are to be undercut prior to lifting. Do not force tree from ground prior to undercutting. Ball depth to be determined upon assessing conditions at time of trenching, to keep intact the entire root ball.

5. Trees shall be properly wrapped during moving so trunks will not be scarred and damaged and to avoid broken limbs. Broken limbs or scarred trunks shall cause tree to be unacceptable and rejected at the City's option. Broken limbs and wounds which do not (in the judgment of the City Forester) cause the tree to be rejected shall be cleanly cut.

6. Transport plant material on vehicles of adequate size to prevent overcrowding, broken limbs, foliage damage or root ball damage.

7. Root balls and foliage shall be kept moist during all phases of relocation.

8. Partially backfill tree pits with 12 inches of approved planting soil prior to setting tree. This layer of soil to be thoroughly drenched prior to relocation to achieve a stable platform at the correct elevation so that the top of rootball is 1 inch above proposed grade.

9. Rotate tree prior to setting to achieve best positioning relative to adjacent trees and viewing angles.

E. Backfilling:

1. Flood bottom soil layer to settle tree into best position and to remove air pockets.

2. Continue to flood root ball as planting soil is deposited to ensure removal of all air pockets.

3. Create a saucer to retain water.

F. Bracing:

1. Support tree with machinery until bracing is complete.

2. Buttresses may support separate trunks on multiple trunk trees.

3. Maintain braces until completion of project. Removal of braces shall be by others.

G. Watering: Relocated trees shall by watered using water-truck. Watering schedule shall be: once per day for first six weeks; followed by three times per week for following six weeks.

- END OF SECTION -

PROJECT NO. 11842

SECTION 02535

STRUCTURES

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall construct all precast concrete items as required in the Contract Documents, including all appurtenances necessary to make a complete installation.

1.02 RELATED DOCUMENTS

A. All applicable provisions of the Bidding and Contract Requirements, and Division 1 - General Requirements shall govern the work under this section.

1.03 WORK INCLUDED

A. The work covered by this section shall include the furnishing of all labor, equipment, services, materials, products and tests to perform all operations in connection with the construction of all structures as shown on the plans, defined in these specifications and subject to the terms and conditions of this contract, including, but not limited to, manhole, catch basins, and inlets.

1.04 SUBMITTALS

A. The Contractor shall furnish the Engineer shop drawings of the precast manhole for approval. Shop drawings should illustrate all dimensions, reinforcements and specifications for the complete manual.

PART 2 - PRODUCTS

2.01 MORTAR

A. Mortar for use in constructing and plastering sewer structures shall conform to ASTM C-270, "Specifications for Mortar for Unit Masonry". A Portland cement-hydrated lime mixture or a masonry cement may be used provided that the same materials are used throughout the project.

B. Mortar materials shall be proportioned by volume and shall consist of one part Type II Portland Cement to two parts aggregate (sand). Portland Cement shall conform to ASTM C-150, "Specifications for Portland Cement". Aggregate shall conform to ASTM C-144, "Specifications for Aggregate for Masonry Units."

2.02 PRECAST CONCRETE MANHOLE

A. Precast manhole sections shall conform to the plans or ASTM C-478, Specifications for Precast Reinforced Concrete Manhole Sections as modified thereto whichever is more restrictive. Concrete shall attain a minimum compressive strength of 4,000 psi at 28 days. Minimum wall thickness shall be eight (8”) inches. All manholes shall be designed and manufactured for a minimum H-20 traffic loading.

B. Unless otherwise specified on the plans, all joints shall be made with neoprene or rubber "O" ring compression joints; mastic joint sealing compound, or approved equal. After assembly, all joints shall be filled with mortar and pointed to provide a smooth surface without joint voids.

C. The base and walls that compose the bottom section of precast manhole shall be of monolithic construction, minimum 8 inches thick, and the edge of the base slab shall project a minimum 4 inches beyond the outside diameter of the wall.

D. Holes for piping shall be 6 inches larger than the outside diameter of the respective pipe. After the pipe is set, the void space between the pipe and the hole perimeter shall be completely filled with non-shrinking, quick-setting, waterproof cement mortar and struck smooth.

E. The minimum height of precast base section shall be 36 inches from the bottom of the base slab; however, no holes for piping shall be cast less than 8 inches from the top of the base section or less than 2 inches from the top of the base slab.

2.03 ENDWALLS, CATCH BASINS, INLETS AND JUNCTIONS BOXES

A. Endwalls, catch basins, inlets and junction boxes shall be constructed at the locations shown and to the dimensions indicated on site plans. Unless otherwise specified on the plans, inlets, junction boxes, catch basins, and similar structures may be constructed of brick, concrete block, poured concrete or precast concrete. Precast catch basins shall conform to latest A.C.I. and P.C.A. specifications. Concrete shall have not less than 4,000 psi compressive strength at 28 days. Minimum wall thickness shall be six (6”) inches. All structures shall be designed and manufactured for a minimum H-20 traffic loading.

B. Unless otherwise specified on the plans, all concrete for these structures shall be Class I concrete as specified in the Florida Department of Transportation "Standard Specifications for Road and Bridge Construction", latest revision, Section 345. Mortar for use in constructing and plastering shall be as previously set forth in this section.

C. Brick shall be solid hard-burned clay conforming to ASTM Serial C-32-93, Grade SM. Concrete brick shall conform to ASTM Serial C-55-75, Grade P-I. Concrete block shall conform to ASTM Serial C-90-78, Grade PI.

D. All brick or concrete block structures covered in this Section shall be plastered inside and outside with 1/2 inch of cement mortar. Inside surfaces shall be smooth and even.

E. Base slabs and walls of concrete structures shall be constructed in a continuous pour between expansion joints.

F. For each grate type inlet, two layers of Mirafi 140 fabric of "Poly Filter X" polypropylene material or approved equal, shall be sandwiched between 2 x 2 x 10/10 welded wire fabric cut to the grate size and attached to the underside of the grate. The sandwiched filter material shall be wired to the cross members of the grate each way on 4-inch centers. After inlet construction and the roadway construction is completed and the project site work (including landscaping) has been established, the filter material and fabric shall be removed with any retained silt or sand.

2.04 CASTINGS (INCLUDING FRAMES, COVERS AND GRATINGS)

A. Iron castings shall conform to ASTM A-48, "Specifications for Gray Iron Castings", and shall be Class 30. Frames and grates may be Class 20.

B. All castings shall be made of clean, even grain, tough grey cast iron. The castings shall be smooth, true to pattern and free from projections, san holes, warp and other defects. The horizontal surface of the frame cover seats and the under surface of the frame cover seat which rests upon the cover seat shall be machined. After machining, it shall not be possible to rock any after it has been seated in any position in its associated frame. Machining shall be required only on those frames and covers intended for vehicular traffic.

C. Bearing surfaces between cast frames, covers and grates shall be machined and fitted together to assure a true and even fit. Within areas of vehicular traffic, the frames, covers and gratings shall be machined-ground so that irregularity of contact will be reduced to a minimum and will be rattle-proof.

D. All manhole covers shall be provided with concealed pick holes. Manufacturer's name and catalog number shall be cast on all frames, covers, grates, etc. Covers shall be lettered "Storm" "Storm Drain" or "Storm Sewer" or "Sanitary Sewer" as applicable and shall be plainly visible. The manhole frames and covers shall be flush with finished grade. Sanitary Sewer manhole covers shall bear the City logo as manufactured by US Foundry or approved equal.

E. Grates and covers for inlets shall be as shown on the plans, set to the grades indicated and conforming with the requirements of the castings described above. Grates shall be furnished complete with frames specifically constructed to provide full bearing at all points of contract.

PART 3 - EXECUTION

3.01 CHANNELS

A. Channels shall be accurately and smoothly formed in accordance with the plans. Channels shall be constructed of concrete with trowel finished surfaces. The upper surface of the manhole shall be sloped toward the channels as shown.

B. Drop pipe at sanitary sewer manhole shall be installed when the difference in elevation between the pipe invert and the invert at the center of the manhole exceeds two feet (2'), or where directed by the City. The drop manhole shall be built according to the plans and specifications.

C. After channels are formed and section joints are pointed, the interior of the manhole shall be painted with two coats of Koppers Bitumastic 300-M (7 mils per coat) or approved equal. The exterior shall be painted in a similar manner, if required by local regulations.

3.02 CONCRETE GRADE RINGS

A. All concrete grade rings shall meet ASTM C478 and shall be a minimum 4,000 psi @ 28 days. Concrete grade rings shall be a minimum thickness of 2 inches and a maximum thickness of 6 inches. No more than 8 inches of concrete grade rings shall be installed on one manhole. Concrete grade rings shall be laid in mortar and all joints shall be finished smooth and not be less than ¼ inch or more than ½ inch in thickness. Concrete grade rings shall be painted with two coats of Koppers Bitumastic 300-M (7 mils per coat) or approved equal.

3.03 MANHOLE AND STRUCTURES

A. All joints shall be finished water tight, all openings for sewers, frames, etc., in precast manhole and catch basins shall be cast at time of manufacture. Spaces around all piping entering or leaving manhole shall be completely filled with Embeco mortar or equal.

B. All manhole shall be set plumb to line and grade and shall rest on a firm carefully graded subgrade which shall provide uniform bearing under base.

C. Grout for manhole bottoms shall consist of broken block, brick and 2:1 cement mortar.

3.04 CLEANING AND MAINTENANCE

A. All structures shall be cleaned and maintained in workable condition until accepted by the City.

- END OF SECTION -

PROJECT NO. 11842

SECTION 02630

STORM DRAINAGE FACILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. Work under this section shall consist of providing all labor, plant facilities, materials, tools, equipment, shop drawings and supervision necessary and required to install all of the storm drainage facilities, including piping, fittings, structures, bedding, and backfilling, as specified in accordance with the contract documents.

1.02 WORK INCLUDED

A. Provide all labor, materials, necessary equipment and services to complete the Storm Drainage Facilities work, as indicated on the drawings, as specified herein or both, except as for items specifically indicated as "NIC ITEMS".

1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. A185 – Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

2. A615 – Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

3. A760 – Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains

4. A798 – Installation of Corrugated-Steel Pipe for Sewers and Other Applications

5. A929 – Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe

6. C76 – Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

7. C478 – Precast Reinforced Concrete Manhole Sections

8. C1479 – Installation of Reinforced Concrete Pipe

9. C990-01A – Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

10. D2321 – Installation of Thermoplastic Pipe for Sewer/Gravity-Flow Applications

11. D3034 – Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

12. D3212 – Joints for Drain and Sewer Plastic Pipes Using Elastomeric Seals

13. F477 – Elastomeric Seals (Gaskets) for Joining Plastic Pipe

14. F794 – Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

15. F949 – Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings

B. American Association of State Highway and Transportation Officials (AASHTO)

1. M198 – Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets

2. M252 – Corrugated Polyethylene Drainage Tubing

3. M274 – Aluminum-Coated (Type 2), for Corrugated Steel Pipe

4. M294 – Corrugated Polyehtylene Pipe. 12 to 14 inch Diameter

5. M36 – Metallic Coated Corrugated Steel Culverts and Underdrains

6. M190 – Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches

7. M199 – Standard Specification for Precast Reinforced Concrete Manhole Sections

C. American Water Works Association (AWWA)

1. C110 – Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in (75 mm through 1200 mm), for Water and Other Liquids (revision of ANSI/AWWA C110/A21.10-93)

2. C111 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

3. C151 – Ductile-Iron Pipe, Centrifugally Cast, for Water

D. American Concrete Institute (ACI)

1. 301 – Structural Concrete for Buildings, Specifications for

2. 318 – Building Code Requirements for Structural Plain Concrete

1.04 EXISTING UTILITIES

A. Furnish temporary support, adequate protection and maintenance of all underground and surface utility structures, drains, sewers, cables, etc., and other obstructions encountered in the progress of the work.

B. When the grade of alignment of the pipe is obstructed by existing utility structures, such

as conduits, ducts, pipes, branch connections to water or sewer mains, and other obstructions, the obstructions shall be permanently supported, relocated, removed or reconstructed by the Contractor in cooperation with the owners of such structures. No deviation shall be made from the required line or grade except as directed in writing by the Engineer.

C. It shall be the responsibility of the Contractor to notify the owners of existing utilities in the area of construction a minimum of 48 hours prior to any excavation adjacent of such utilities, so that field locations of said utilities may be established.

D. Temporary relocation of existing utilities (to be removed) to accommodate installation of storm drain pipe shall be the responsibility of the Contractor and approved by the Engineer. No additional payment shall be made for temporary relocation of existing utilities and shall be considered part of the bid item for the pipe.

1.05 QUALITY ASSURANCE

A. All costs related to re-inspection due to failures shall be paid for by the Contractor at no additional expense to the City. City reserves the right to direct any inspection that is deemed necessary. Contractor shall provide free access to site for inspection activities.

PART 2 - PRODUCTS

2.01 REINFORCED CONCRETE PIPE (RCP)

A. REINFORCED CONCRETE PIPE – ASTM C 76

1. Unless noted otherwise, all RCP pipe shall be in accordance with the requirements of “Reinforced Concrete Pipe – ASTM C 76”.

2. RCP shall be manufactured in accordance with ASTM C 76, Wall Type B or C, unless otherwise specified herein; and shall be minimum Type III, subject to recommendation from the pipe manufacturer based on project specific requirements unless noted otherwise in the Contract Documents. Minimum pipe laying lengths shall be four (4) feet. Portland cement shall conform to ASTM C 150, Type II.

3. Pipe shall have bell and spigot ends with O-ring rubber gaskets. The gaskets shall be smooth solid rubber of circular and uniform cross section conforming to ASTM C 43. The spigot end of the pipe shall contain a special groove or slot to receive and hold the gasket in position during the joint assembly. The complete joint shall be subjected to hydrostatic tests conforming to ASTM C 443.

4. All pipe and specials shall be aged at the manufacturing plant for at least fourteen (14) days before delivery to the job site.

B. REINFORCED CONCRETE PIPE – ASTM C361

1. Reinforced concrete low-head pressure pipe shall be manufactured in accordance with ASTM C361, and shall be minimum Type III, subject to recommendation from the pipe manufacturer based on project specific requirements unless noted otherwise in the Contract Documents. Minimum pipe laying lengths shall be twelve (12) feet.

2. Pipe shall have steel joint rings with O-ring rubber gaskets. The gaskets shall be smooth solid rubber of circular and uniform cross section and shall be confined in an annular space formed by shoulders on the bell and spigot or in a special groove in the spigot to receive and hold the gasket in position during the joint assembly. The complete joint shall be subjected to hydrostatic tests conforming to ASTM C361.

3. All pipe and specials shall be aged at the manufacturing plant for at least fourteen (14) days before delivery to the job site.

C. CONCRETE CULVERT AND DRAIN PIPE

1. All reinforced concrete culvert and drain pipe shall be manufactured in accordance with ASTM C76, Wall Type B or C, and shall be of the class that equals or exceeds the pipe class as specified herein or as shown on the Contract Drawings. Minimum pipe laying lengths shall be four (4) feet. Testing shall be in accordance with FDOT Road and Bridge Manual (latest edition). Portland cement shall conform to ASTM C150, Type II.

2. Joints for the reinforced concrete culvert and drain pipe shall have bell and spigot ends with flexible plastic gaskets meeting the requirements of AASHTO M198, Type B.

3. All pipe shall be aged at the manufacturing plant for at least fourteen (14) days before delivery to the job site.

2.02 HIGH PERFORMANCE POLYPROPYLENE PIPE

1. High Performance polypropylene storm pipe shall be produced by a reputable manufacturer engaged in the full time business of manufacturing of piping.

2. All High Performance polypropylene storm pipe shall have a smooth wall interior and annular exterior corrugations conforming to the requirements of ASTM F2736 and AASHTO M330.

3. Joints: Pipe shall be joined with a gasket integral bell and spigot joint meeting the requirements of ASTM F2736. Joint must be completely water tight according to the requirements of ASTM 3212. Spigots shall have gaskets meeting requirements of ASTM F477. The gasket joint on the inside of the bell shall be installed on the pipe at

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the plant by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant provided from the manufacturer shall be used on the gasket and bell during assembly. All materials and accessories for the gasket joint and the methods of jointing shall be in strict conformance with the pipe manufacturer's direction and recommendation.

2.03 HIGH DENSITY POLYETHYLENE PIPE:

1. High Density Polyethylene Pipe (HDPE), shall be corrugated type, smooth interior, conforming to ASTM F2648, ASTM F477, ASTM 3212, AASHTO M252 and AASHTO M294 and shall be smooth interior and annular exterior corrugations with a Manning's "n" value of 0.012l.

2. Basic Material:

    a. Extruded Pipe and Blow Molded Fittings: Pipe and fittings shall be made of virgin PE compounds which conform with the requirements for Type III, Category 4 or 5, Grade P33, Class C; or Grade P34, Class C, as defined and described in ASTM D 1248.

    b. Rotational Molded Pipe and Fittings: Pipe and fittings shall be made of virgin PE compounds which conform with the requirements of Type III, Category 3, Grade P33, Class C: or Grade P34, Class C, as defined and described in ASTM D1248.

3. Corrugated Polyethylene Pipe shall meet the requirements as describe in ASTM D 2412 for pipe stiffness.

4. Corrugated Polyethylene Pipe shall be in accordance for brittleness with ASTM D 2444.

2.04 PVC CORRUGATED PIPE

1. PVC Corrugated storm pipe shall be produced by a reputable manufacturer engaged in the full time business of manufacturing of piping and conform to the requirements of ASTM F949.

2. PVC Corrugated storm pipe shall have smooth wall interior and annular exterior corrugations. Pipe shall be made of PVC having a minimum cell classification of 12454 per ASTM D1784.

3. Joints: Pipe shall be joined with a gasket integral bell and spigot joint meeting the requirements of ASTM F2736. Joint must be completely water tight according to the requirements of ASTM 3212. Spigots shall have gaskets meeting requirements of ASTM F477. The gasket joint on the inside of the bell shall be installed on the pipe at the plant by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant provided from the manufacturer shall be used on the gasket and bell during assembly. All materials and accessories for the gasket joint and the methods of jointing shall be in strict conformance with the pipe manufacturer's direction and recommendation.

PART 3 – EXECUTION

3.01 GENERAL

A. Contractor shall only use the pipe material as specified on the plans. Alternate materials will not be allowed unless approved by the Engineer in writing.

B. The Contractor shall install all drainage structures and pipe in the locations shown on the drawings and/or as approved by the City. Pipe shall be of the type and sizes specified on the drawings and shall be laid accurately to line and grade. Structures shall be accurately located and properly oriented.

C. Excavation and Backfilling for Utilities – The provisions of the Contract Documents for Excavation and Backfilling shall govern all work under this Section.

D. Storage and Handling of Pipe – All pipe shall be protected against impact, shock and free fall, and only equipment of sufficient capacity and proper design shall be used in the handling of the pipe. Storage of pipe on the job shall be in accordance with the pipe manufacturer's recommendations.

E. Damage to Pipe

1. Pipe which is defective from any cause, including damage caused by handling, and determined by the City as unrepairable, shall be unacceptable for installation and shall be replaced at no cost to the City and as directed by the City; and,

2. Pipe that is damaged or disturbed through any cause prior to acceptance of the work, shall be repaired realigned or replaced as directed by the City, at the Contractor's expense.

F. Manholes, catch basins and drain inlets shall be constructed as soon as the pipe laying reaches the location of the structures. Should the Contractor continue his pipe laying without making provisions for completion of the structures, the City shall have the authority to stop the pipe laying operations until the structure is completed.

G. Any structure, which is mislocated or oriented improperly, shall be removed and re-built in its proper location, alignment and orientation at the Contractor's expense.

3.02 EXCAVATION AND BACKFILL

A. Excavation and backfill shall be as per the Section entitled "Excavation and Backfill for Utilities".

3.03 PIPE INSTALLATION

A. Laying Pipe

1. Unloading and Handling: All pipes shall be unloaded and handled with reasonable care. Pipes shall not be rolled or dragged over gravel or rock during handling. The

Contractor shall take necessary precautions to ensure the method used in lifting or placing the pipe does not induce stress fatigue in the pipe and the lifting device used uniformly distributes the weight of the pipe along its axis or circumference.

2. Each length of pipe shall be inspected for defects and cracks before carefully lowered into the trench. Any damaged or any pipe that has had its grade disturbed after laying shall be removed and replaced. Bituminous coated pipe shall be handled with special care and repair of damaged coating shall conform with AASHTO M190.

3. Lay pipe on prepared foundation starting at the downgrade end according to line and grade with the necessary drainage structures, fittings, bends and appurtenances as shown on the drawings. Rigid pipes shall be laid with the bell or groove ends upgrade with the spigot or tongue fully inserted. Reinforced concrete pipe shall be installed in accordance with ASTM C1479.

4. Pipe sections shall be firmly joined together with appropriate gaskets or bands.

5. Pipe shall be protected during handling against impact shocks and free falls. Pipe shall be kept clean at all times and no pipe shall be used that does not conform to the Specifications.

6. The laying of the pipe shall be commenced at the lowest point with spigot ends pointing in the direction of flow. All pipe shall be laid with ends abutting and true to line and grade. They shall be laid in accordance with manufacturer's requirements as approved by the Engineer.

7. Pipe shall be laid accurately to the line and grade as designated on the plans. Preparatory to making pipe joints, all surfaces of the portions of the pipe to be jointed, or of the factory made jointing material, shall be clean and dry. Lubricant, primers, adhesive, etc., shall be used as recommended by the pipe or joint manufacturer's specifications. The jointing materials or factory fabricated joints shall then be placed, fitted, joined and adjusted in such a manner as to obtain a water tight line. As soon as possible after the joint is made, sufficient backfill material shall be placed along each side of the pipe to prevent movement of pipe off line and grade.

8. The exposed ends of all pipe shall be suitably plugged to prevent earth, water, or other substances from entering the pipe when construction is not in progress.

3.04 CONCRETE ENCASEMENT OF DRAINAGE PIPE

A. Trenches in which encasement for pipe are to be placed may be excavated completely with mechanical equipment. Prior to formation of the encasement, temporary supports consisting of timber wedges or masonry shall be used to support the pipe in place. Temporary supports shall have minimum dimensions and shall support the pipe at no more than two places, one at the bottom of the barrel of the pipe adjacent to the shoulder of the socket and the other near the spigot end.

3.05 DRAINAGE STRUCTURES

A. All structures shall be built to the line and grade shown on drawings. All reinforced concrete work shall be in strict conformance with the concrete specifications contained

herein. After erection of the forms and placing of the steel, the Contractor must have inspection and approval from the Engineer before placing any concrete. After removal of the forms, the Contractor shall backfill around each structure with approved granular fill. The fill shall be placed in layers not exceeding 8 inches in depth measured loose and compacted to 98% of the maximum density as determined by the modified proctor, AASHTO T-180. No defects of any kind in the pipe section will be accepted. All pipe stubs shall be made of the same type of pipe. Pipe stubs shall be sealed with a concrete plug, water tight. The ends of the pipes which enter masonry shall be neatly cut to fit the inner face of the masonry. Cutting shall be done before the pipes are built in.

3.06 INFILTRATION AND EXFILTRATION TESTS

A. Tests for watertightness shall be made by the Contractor. Leakage of completed storm drainage system shall not exceed 500 U.S. gallons per day per inch diameter per mile of pipe under minimum hydrostatic pressure of 2 feet. Test shall be conducted in a manner satisfactory to the Engineer. Any portion of the project not conforming to the above requirements shall be corrected by the Contractor, at his own expense, prior to acceptance by the Engineer.

3.07 PROTECTION AND CLEANING

A. The Contractor shall maintain all pipe installations and drainage structures in a condition such that they will function continuously and shall be kept clean of silt, debris and other foreign matter from the pipe and drainage structure is installed until the project is accepted.

3.08 FINAL INSPECTION

A. All storm sewers shall be lamped by the Engineer prior to acceptance of the work. Repairs or misalignment shown necessary by the tests shall be corrected at the Contractor's expense. All sewers shall be thoroughly cleaned before being placed into use and shall be kept clean until final acceptance by the Engineer.

B. Upon completion of the work and before final acceptance by the City, the entire drainage system shall be subject to a final inspection in the presence of the City and/or Engineer. The work shall not be considered as complete until all requirements for line, grade, cleanliness, and workmanship have been completed.

C. For flexible pipes, 48 inches or less in diameter, the Contractor shall submit to the Engineer a video file and Pipe Ovality Report for each pipe run using low barrel distortion video equipment with laser profile technology, non-contact video micrometer and associated software. The report shall include pipe stationing and pipe deformation/deflections measurements with deflection limits clearly delineated. Laser profiling and measurement technology must be certified by the company performing the work to be in compliance with the calibration criteria posted at https://www.fdot.gov/construction/Engineers/Environment/Laser.shtm. The Engineer may waive this requirement for side drains and cross drains which are short enough to inspect manually from each pipe end.

- END OF SECTION -

PROJECT NO. 11842

SECTION 02710

LIMEROCK BASE

PART 1 - GENERAL

1.01 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross section.

B. Completed Lift: Compacted with uniform surface reasonably true to cross-section.

PART 2 – MATERIALS

2.01 LIMEROCK BASE ROCK

A. The material used in limerock base shall be material classified as Miami Oolite Formation.

B. The minimum of carbonates of calcium and magnesium in the limerock shall be 70 percent. The maximum percentage of water-sensitive clay material shall be 3.

C. Limerock material shall be uniform in color and not contain cherty or other extremely hard pieces, or lumps, balls, or pockets of sand or clay size material in sufficient quantities as to be detrimental to the proper bonding, finishing, or strength of the limerock base.

D. The limerock base shall be uniformly graded from coarse to fine with 97 percent passing a 3-1/2-inch sieve, 80 percent passing a 2-inch sieve. The fine material shall consist entirely of dust of fracture. All crushing or breaking up, which might be necessary in order to meet such size requirements, shall be done before the material is placed on the road.

E. Physical Qualities:

1. Liquid Limit, AASHTO T89: Maximum 35 percent.

2. Nonplastic.

3. Limerock material shall have an average limerock bearing ratio (LBR) value of not less than 100.

2.02 SOURCE QUALITY CONTROL

A. Contractor: Perform tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on materials' test results on installed materials.

C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

A. As specified in the Contract Documents.

B. Obtain City's acceptance of subgrade before placement of limerock base rock.

C. Do not place base materials on soft, muddy subgrade.

3.02 EQUIPMENT

A. Use mechanical rock spreaders, equipped with a device that strikes off the rock uniformly to laying thickness, capable of producing even distribution. For areas where the use of a mechanical spreader is not practicable, the Contractor may spread the rock using bulldozers or blade graders.

3.03 HAULING AND SPREADING

A. Hauling Materials:

1. The limerock shall be transported to the point where it is to be used and dumped on the end of the preceding spread.

2. Do not haul over surfacing in process of construction.

3. Loads: Of uniform capacity.

4. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

B. Spreading Materials:

1. Distribute material to provide required density, depth, grade and dimensions with allowance for subsequent lifts.

2. Produce even distribution of material upon roadway without segregation.

3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.04 CONSTRUCTION OF COURSES

A. General: Complete each lift in advance of laying succeeding lift to provide required results and adequate inspection.

B. Limerock Base:

1. Maximum Completed Lift Thickness: 6 inches or equal thickness.

2. Completed Course Total Thickness: As shown on the Drawings.

3. Spread lift on preceding course to required cross-section.

4. Lightly blade and roll surface until thoroughly compacted.

5. Blade or broom surface to maintain true line, grade, and cross-section.

C. Gravel Surfacing:

1. Maximum Completed Lift Thickness: 6 inches or equal thickness.

2. Completed Course Total Thickness: As shown on the Drawings.

3. Spread on preceding course in accordance with cross-section shown.

4. Blade lightly and roll surface until material is thoroughly compacted.

3.05 ROLLING AND COMPACTION

A. Commence compaction of each layer of base after spreading operations and continue until density of 98 percent of maximum density has been achieved as determined by AASHTO T 180.

B. Density tests will be conducted every 500 square yards or as directed by the City.

C. Roll each course of surfacing until material shall not creep under roller before succeeding course of surfacing material is applied.

D. Commence rolling at outer edges of surfacing and continue toward center; do not roll center of road first.

E. When the material does not have the proper moisture content to ensure the required density, wet or dry, as required. When adding water, uniformly mix it in by disking to the full depth of the course that is being compacted. During wetting or drying operations, manipulate as a unit, the entire width and depth of the course that is being compacted.

F. Place and compact each lift to required density before succeeding lift is placed.

G. Bind up preceding course before placing leveling course. Remove floating or loose stone from surface.

H. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

I. Surface Defects: Remedy surface defects by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

J. Finished Surface: True to grade and crown before proceeding with surfacing.

3.06 SURFACE TOLERANCES

A. Finished Surface of Base Course and Leveling Course: Within plus or minus 0.04-foot of grade shown at any individual point.

B. Compacted Surface of Leveling Course: Within 0.04-foot from lower edge of 10-foot straightedge placed on finished surface, parallel to centerline.

C. Overall Average: Within plus or minus 0.01-foot from crown and grade specified.

3.07 GRAVEL DRIVEWAY RESURFACING

A. Replace gravel surfacing on driveways which were gravel surfaced prior to construction.

B. Provide compacted gravel surfacing to depth equal to original, but not less than 4 inches.

C. Leave each driveway in as good or better condition as it was before start of construction.

3.08 FIELD QUALITY CONTROL

A. In-Place Density Tests:

1. Construct base course so areas shall be ready for testing.

2. Allow reasonable length of time for City to perform tests and obtain results during normal working hours.

3.09 CLEANING

A. Remove excess material; clean stockpile areas of aggregate.

- END OF SECTION -

PROJECT NO. 11842

SECTION 02761

PAVEMENT MARKING

PART 1 - GENERAL

1.01 STANDARD SPECIFICATIONS

A. When referenced in this section, Standard Specifications shall mean Florida Department of Transportation, Standard Specifications for Road and Bridge Construction, current edition. All Pavement Markings and Signage shall conform to the Broward County Traffic Engineering Division (BCTED) Standards, latest revision.

1.02 SUBMITTALS

A. The Contractor shall submit all products used for pavement markings in accordance with the Section entitled “Submittals”.

1.03 DELIVER, STORAGE, AND PROTECTION

A. Packaging and Labeling: All coatings and traffic marking materials shall be shipped in strong containers plainly marked with the weight in pounds per gallon, the volume of coatings and traffic marking materials content in gallons, the color, user information, date of manufacture, LOT, batch and DOT code number. Each batch manufactured shall have a unique number. A true statement of the percentage composition of the pigment, the proportion of pigment to vehicle, and the name and address of the manufacturer, also shall be shown. The label shall warn the user of any special handling or precautions of the material, as recommended by the manufacturer. Any package not so marked will not be accepted for use under these Specifications.

B. Storage: Any coatings and traffic marking materials which, although inspected and approved at the point of manufacture, hardens or livers in the containers so that it cannot be readily broken up with a paddle to a smooth, uniform painting consistency, will be rejected. All materials shall have a container storage life of one year from date of manufacture. Any coatings and traffic marking materials not acceptable for proper application will be rejected, even though it conforms to these Specifications in all other respects.

C. Mixing: All paints except aluminum shall be delivered to the project completely mixed, and ready to be used without additional oil or thinner. Gasoline shall not be used for thinner under any circumstances.

PART 2 - MATERIALS

2.01 PAINT

A. Color: White, yellow, or blue traffic striping meeting the requirements of BCTED and the Standard Specifications.

B. Homogeneous, easily stirred to smooth consistency, with no hard settlement or other objectionable characteristics during a storage period of 6 months.

2.02 THERMOPLASTIC STRIPING

A. White or yellow thermoplastic striping material meeting the requirements of BCTED and the Standard Specifications.

2.03 RAISED REFLECTIVE MARKERS

A. Metallic or nonmetallic, or prismatic reflector type, of permanent colors retaining color and brightness under action of traffic.

B. Rounded surfaces presenting a smooth contour to traffic. The minimum area of each reflective face shall be 2-1/2 inches squared.

C. Marker and adhesive epoxy in accordance with ASTM D4280

D. Markers shall meet the requirements of BCTED and the Standard Specifications.

2.04 GLASS SPHERES

A. Glass spheres shall be of a composition designed to be highly resistant to traffic wear and to the effects of weathering.

B. In accordance with AASHTO M247, Type I with moisture resistant coating or a formulation specified by the traffic striping material manufacturer and the BCTED and the Standard Specifications.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. Cleaning:

1. Thoroughly clean surfaces to be marked before application of pavement marking material.

2. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water or a combination of these methods.

3. Completely remove rubber deposits, surface laitance, existing paint markings, and other coatings adhering to pavement with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion.

4. Scrub areas of old pavement affected with oil or grease with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application.

5. Surfaces shall be completely free of dry dirt and ice, and dry of water at the time of application of any of the materials specified herein.

6. Oil-Soaked Areas: After cleaning, seal with cut shellac to prevent bleeding through the new paint.

7. Reclean surfaces when Work has been stopped due to rain.

8. Existing Pavement Markings:

   a. Remove existing pavement markings that may interfere or conflict with newly applied marking patterns, or that may result in a misleading or confusing traffic pattern.

   b. Do not apply thermoplastic markings over existing preformed or thermoplastic markings.

   c. Perform grinding, scraping, sandblasting or other operations so finished pavement surface is not damaged.

B. Pretreatment for Early Striping: Where early striping is required on rigid pavements, pretreat with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride.

C. New Concrete Pavement:

1. Allow a minimum cure time of 30 days before cleaning and marking.

2. Clean by either sandblasting or water blasting to the following results:

   a. No visible evidence of curing compound on peaks of textured concrete surface.

   b. No heavy puddled deposits of curing compound in valleys of textured concrete surface.

   c. Remaining curing compound is intact, with loose and flaking material completely removed.

   d. Peaks of textured pavement surface are rounded in profile and free of sharp edges and irregularities.

3. Allow a minimum drying time of 24 hours after water blasting before applying thermoplastic markings.

3.02 ALIGNMENT FOR MARKINGS

A. The Contractor shall be responsible for all measurements, reference points and marks, string lining, and any other steps required in establishing pavement marking locations and alignment. On tangents and on curves up to 1 degree, the alignment of the marking shall not deviate from the string line by more than 1 inch. On curves exceeding 1 degree, the maximum permissible deviation shall be 2 inches. All alignment width and location shall conform to the details shown on the Drawings.

3.03 PAINT APPLICATION

A. General:

1. Thoroughly mix pigment and vehicle together prior to application, and keep thoroughly agitated during application.

2. Do not add thinner.

3. Apply only when air and pavement temperatures are above 40 degrees F and less than 95 degrees F. Maintain paint temperature within these same limits.

4. Apply only when surface is dry.

5. Do not apply when conditions are windy to the point of causing overspray or fuzzy line edges.

6. New Asphalt Pavement: Allow a minimum pavement cure time as recommended by the manufacturer before applying paint.

7. Provide guide lines and templates to control paint application.

8. Take special precautions in marking numbers, letters, and symbols.

9. Sharply outline edges of markings and apply without running or spattering.

B. Rate of Application:

1. Reflective Markings:

a. Paint: Apply evenly, 105 plus or minus 5 square feet per gallon.

b. Glass Beads: Apply uniformly, 6 plus or minus 0.5 pounds of glass spheres per gallon of paint.

2. Nonreflective Markings: Apply paint evenly to pavement surface at a rate of 105 plus or minus 5 square feet per gallon.

3. On new pavement or new asphalt surface treatments, apply two coats of paint at a uniform rate of 210 square feet per gallon.

C. Drying:

1. Provide maximum drying time to prevent undue softening of bitumen and pickup, displacement, or discoloration by traffic.

2. If drying is abnormally slow, discontinue painting operations until cause is determined and corrected.

3.04 THERMOPLASTIC MARKING APPLICATION

A. Following specified surface preparation, prime and apply marking and glass beads to provide a reflectorized strip as shown on Drawings.

B. The material shall be applied to the pavement by the extrusion method only, wherein one side of extrusion shaping die is the pavement and the other sides are formed by suitable equipment for heating and controlling the flow of the material.

C. Application Temperatures:

1. Pavement Surface: Minimum 40 degrees F and rising.

2. Thermoplastic: Minimum 375 degrees F, maximum 425 degrees F.

D. Primer:

1. On portland cement concrete and existing asphalt pavements, apply epoxy resin primer/sealer according to the thermoplastic manufacturer’s recommendations.

2. All primer/sealer to dry prior to applying thermoplastic.

E. Thermoplastic Marking:

1. Extrude in a molten state, free of dirt or tint. at a thickness of 0.10 to 0.15 inch for lane lines and 0.07 to 0.10 inch for edge or other lines in accordance with FDOT Design Standards.

2. Apply centerline, skipline, edgeline, and other longitudinal type markings with a mobile applicator.

3. Apply special markings, crosswalks, stop bars, legends, arrows, and similar patterns with a portable, extrusion-type applicator.

F. Glass Bead Application:

1. Immediately after marker application, mechanically apply such that the beads are held by and imbedded in the surface of the molten material.

2. Application Rate: One pound per 20 square feet of compound.

G. Cool completed marking to ambient temperature prior to allowing vehicular traffic.

3.05 INSTALLATION OF RAISED REFLECTIVE MARKERS

A. Apply markers to the bonding surface using bituminous adhesives only.

B. Apply the adhesive to the binding surface (not the marker) so that 100 percent of the bonding area of the marker will be covered.

C. Align markers carefully, projecting no more than 3/4-inch above level of pavement. Reflective face of the marker shall be perpendicular to a line parallel to the roadway centerline. Do not install markers over longitudinal or transverse joints of the bonding surface.

D. Spacing: As shown on the Drawings or as required by BCTED.

E. Immediately remove excess adhesive from the bonding surface and exposed surface of the marker.

F. Use only a mineral spirits meeting Federal Specifications TT-T-291 to remove adhesive from exposed faces of markers.

3.06 GLASS BEAD APPLICATION

A. Apply immediately following application of paint.

B. Use evenly distributed, drop-on application method.

C. Rate: 10 pounds per gallon of paint.

3.07 PROTECTION

A. The Contractor shall erect adequate warning signs and/or provide sufficient number of flagmen, and take all necessary precautions for the protection of the materials and safety of the public.

B. Protect surfaces from disfiguration by paint spatters, splashes, spills, or drips.

3.08 CLEANUP

A. Remove paint spatters, splashes, spills, or drips from Work and staging areas and areas outside of the immediate Work area where spills occur.

- END OF SECTION -

PROJECT NO. 11842

SECTION 02771

CONCRETE CURBS AND SIDEWALKS

PART 1 - GENERAL

(NOT USED)

PART 2 - MATERIALS

2.01 EXPANSION JOINT FILLER

A. 1/2-inch thick, preformed asphalt-impregnated, expansion joint material meeting AASHTO M153 Type I, II, or III, or AASHTO M213, or cellulose fiber types meeting the requirements of AASHTO M213, except the asphalt content is acceptable provided they contain minimum of 0.2 percent copper pentachlorophenate as a preservative and 1 percent water proofing wax.

2.02 CONCRETE

A. Ready-mixed meeting ASTM C94, Option A, with compressive strength of 3,000 psi at 28 days.

B. Maximum Aggregate Size: 1-1/2 inch.

C. Slump: 2 to 4 inches.

2.03 CURING COMPOUND

A. Liquid membrane-forming, clear or translucent, suitable for spray application and meeting ASTM C309, Type 1.

PART 3 - EXECUTION

3.01 FORMWORK

A. Lumber Materials:

1. 2 inch dressed dimension lumber, or metal of equal strength, straight, free from defects that would impair appearance or structural quality of completed curb and sidewalk.

2. 1 inch dressed lumber or plywood may be used where short-radius forms are required.

B. Metals: Steel in new undamaged condition.

C. Setting Forms:

1. Construct forms to shape, lines, grades, and dimensions.

2. Stake securely in place.

D. Bracing:

1. Brace forms to prevent change of shape or movement resulting from placement.

2. Construct short-radius curved forms to exact radius.

E. Tolerances:

1. Do not vary tops of forms from gradeline more than 1/8 inch when checked with 10-foot straightedge.

2. Do not vary alignment of straight sections more than 1/8 inch in 10 feet.

3.02 PLACING CONCRETE

A. Excavate to the required depth, place and compact limerock base rock as specified in the Contract Documents. Compact directly under the area and 1 foot beyond each side of the sidewalk and curb.

B. Prior to placing concrete, remove water from excavation and debris and foreign material from forms.

C. Place concrete as soon as possible, and within 1-1/2 hours after adding cement to mix without segregation or loss of ingredients, and without splashing.

D. Place, process, finish, and cure concrete in accordance with applicable requirements of ACI 304, and this section. Wherever requirements differ, the more stringent shall govern.

E. To compact, vibrate until concrete becomes uniformly plastic.

F. All edges shall be smooth and rounded.

3.03 CURB CONSTRUCTION

A. Construct ramps at pedestrian crossings in compliance with FDOT and PROWAG minimum standards. Standards apply to work in the City's Rights of Way.

B. Expansion Joints: Place at maximum 20-foot intervals and at the beginning and end of curved portions of curb, and at connections to existing curbs. Install expansion joint filler at each joint.

C. Gutter minimum slope shall be 0.33% unless otherwise approved by the City.

D. Curb Facing: Do not allow horizontal joints within 7 inches from top of curb.

E. All gutters and curb and gutters shall have a minimum 4” think limerock “curb pad” LBR 100.

F. Contraction Joints:

1. Maximum 10-foot intervals in curb.

2. Provide open joint type by inserting thin, oiled steel sheet vertically in fresh concrete to force coarse aggregate away from joint.

3. Insert steel sheet to full depth of curb.

4. Remove steel sheet with sawing motion after initial set has occurred in concrete and prior to removing front curb form.

5. Finish top of curb with steel trowel and finish edges with steel edging tool.

G. Front Face:

1. Remove front form and finish exposed surfaces when concrete has set sufficiently to support its own weight.

2. Finish formed face by rubbing with burlap sack or similar device to produce uniformly textured surface, free of form marks, honeycomb, and other defects.

3. Remove and replace *defective* concrete.

4. Apply curing compound to exposed surfaces of curb upon completion of finishing.

5. Continue curing for minimum of 5 days.

H. Backfill curb with earth upon completion of curing period, but not before 7 days has elapsed since placing concrete.

1. Backfill shall be free from rocks 2 inches and larger and other foreign material.

2. Compact backfill firmly.

3.04 SIDEWALK CONSTRUCTION

A. Thickness:

1. 4 inches thick minimum, 6 inches thick at driveways, extended two feet beyond drive on both sides

B. Connection to Existing Sidewalk:

1. Remove old concrete back to an existing contraction joint.

2. Clean the surface.

3. Apply a neat cement paste immediately prior to placing new sidewalk.

C. Expansion Joints: Place at maximum 20-foot intervals, at adjacent curb expansion joint, where sidewalk ends at curb, and around posts, poles, or other objects penetrating sidewalk. Install expansion joint filler at each joint.

D. Contraction Joints:

1. Provide transversely to walks at locations opposite contraction joints in curb.

2. Dimensions: 3/16-inch by 1-inch weakened plane joints.

3. Construct straight and at right angles to surface of walk.

E. Finish:

1. Broom surface with fine-hair broom at right angles to length of walk and tool at edges, joints, and markings.

2. Ensure that the surface variations are not more than ¼ inch under a 10-foot straightedge, or more than 1/8 inch on a 5-foot transverse section.

3. Mark walks transversely at 5 foot intervals, or in pattern shown on Drawings, with jointing tool; finish edges with rounded steel edging tool.

4. Apply curing compound to exposed surfaces upon completion of finishing.

5. Protect sidewalk from damage and allow to cure for at least 7 days.

F. Curb Ramps:

1. All curb ramps and detectable warnings shall comply with the current FDOT Index 304 and the Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way by the United States Access Board.

- END OF SECTION -

PROJECT NO. 11842

SECTION 02772

ASPHALT CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 STANDARD SPECIFICATIONS

A. When referenced in this Section, Standard Specifications shall mean Florida Department of Transportation, Standard Specifications for Road and Bridge Construction, current edition.

1.02 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329.

2. Asphalt concrete mix formula shall be prepared by an approved certified independent laboratory under the supervision of a certified asphalt technician.

1.03 SUBMITTALS

A. The Contractor shall submit its proposed formula for the asphaltic concrete paving for review in accordance with the Section entitled “Submittals”.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 10 degrees C (50 degrees F), or air temperature is lower than 4 degrees C (40 degrees F). Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.

B. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

PART 2 - MATERIALS

2.01 MATERIALS

A. Prime Coat: Cut-back asphalt, Grades RC-70 or RC-250 meeting the requirements of the Standard Specifications.

B. Tack Coat: Emulsified asphalt, Grade RS-2, SS-1, or SS-1H meeting the requirements of the Standard Specifications. The bituminous material shall be heated to a suitable consistency as directed by the City.

C. Sand (Blotter Material): Clean, dry, with 100 percent passing a 4.75 mm (No. 4) sieve, and a maximum of 10 percent passing a 75 mm (No. 200) sieve.

2.02 ASPHALT CONCRETE MIX

A. General:

1. Mix formula shall not be modified except with the written approval of City.

2. Source Changes:

a. Should material source(s) change, establish a new asphalt concrete mix formula before the new material(s) is used.

b. Perform check tests of properties of the plant-mix bituminous materials on the first day of production and as requested by City to confirm that properties are in compliance with design criteria.

c. Make adjustments in gradation or asphalt content as necessary to meet design criteria.

B. Asphalt Concrete: Type SP meeting the requirements of the Standard Specifications.

C. Composition: Hot-plant mix of aggregate, mineral filler, and paving grade asphalt cement. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the mix formula.

D. Aggregate:

1. The aggregate shall meet the requirements of the Standard Specifications.

2. Mineral Filler shall meet the requirements of the Standard Specifications

E. Asphalt Cement: Paving Grade AC-30 meeting the requirements of the Standard Specifications.

PART 3 - EXECUTION

3.01 GENERAL

A. Traffic Control: Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.

B. Driveways: Repave driveways from which pavement was removed. Leave driveways in as good or better condition than before start of construction.

3.02 LINE AND GRADE

A. Provide and maintain intermediate control of line and grade, independent of the underlying base to meet finish surface grades and minimum thickness.

B. Shoulders: Construct to line, grade, and cross-section shown.

3.03 PREPARATION

A. Prepare subgrade as specified in the Contract Documents.

B. Existing Roadway:

1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce a smooth riding connection to existing facility.

2. Resurface entire roadway following adjustment of base and asphalt grades.

3. Paint edges of meet line with tack coat prior to placing new pavement.

C. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

3.04 PAVEMENT APPLICATION

A. General: Place asphalt concrete mixture on an approved, prepared base in conformance with this Section.

B. Cold Milling

1. Milling of existing asphalt pavement shall be at the depth and location as indicated on the Construction Drawings or as directed by the City.

2. The milled surface shall be reasonably smooth and free of excessive scarification marks, gouges, ridges, continuous grooves, or other damage. The milled pavement surface shall be thoroughly cleaned of all loose aggregate particles, dust, and other objectionable material by the use of power brooms, power blowers, power vacuums or other means.

3. The Contractor shall coordinate the adjustment of maintenance access structures, meter boxes, drainage inlets, and valve boxes with the milling operation.

4. All milled material shall become the property of the Contractor and shall be disposed of off-site or used in conformance with the Contract Documents, or for utilization as Reclaimed Asphalt Pavement, in

conformance with the specification provided above, as approved by the City.

C. Prime Coat:

1. Heat cut-back asphalt between 100 degrees F and 150 degrees F prior to application.

2. Apply uniformly to clean, dry surfaces. Avoiding overlapping of applications.

3. Do not apply when moisture content of upper 3 inches of base exceeds optimum moisture content of base, or if free moisture is present.

4. Application Rate: Minimum 0.1 gallons per square yard of surface area.

5. Remove or redistribute excess material.

6. Allow a minimum of 5 full days for curing of primed surface before placing asphalt concrete.

D. Tack Coat:

1. Apply uniformly to clean, dry surfaces. Avoiding overlapping of applications.

2. Do not apply more tack coat than necessary for the day's paving operation.

3. Touch up missed or lightly coated surfaces and remove excess material.

4. Application Rate:

a. Minimum 0.05 gallons to maximum 0.12 gallons of asphalt (residual if diluted emulsified asphalt) per square yard of surface area.

b. Apply at rate, within range specified, sufficient to assure good bonding, but not so heavy that surplus asphalt flushes into asphalt concrete being placed.

E. Pavement Mix:

1. Prior to Paving:

a. Sweep primed surface free of dirt, dust, or other foreign matter.

b. Patch holes in primed surface with asphalt concrete pavement mix.

c. Blot excess prime material with sand.

2. Place asphalt concrete pavement mix in lifts as shown.

3. Compacted Lift Thickness:

a. Minimum: Twice the maximum aggregate size, but in no case less than 1 inch. Minimum thickness for Type SP-9.5 is 1.0 inches.

b. Maximum: 4 inches.

4. Total Compacted Thickness: Per Contract Documents.

5. Apply such that meet lines are straight and edges are vertical.

6. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.

7. Joints:

a. Offset edge of each layer a minimum of 6 inches so joints are not directly over those in underlying layer.

b. Offset longitudinal joints in roadway pavements, so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.

c. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.

8. Succeeding Lifts: Apply tack coat to pavement surface between each lift.

9. After placement of pavement, seal meet line by painting a minimum of 6 inches on each side of the joint with cut-back or emulsified asphalt. Cover immediately with sand.

F. Compaction:

1. Roll until roller marks are eliminated and compacted to 100 percent of the laboratory compacted mixture.

2. Joint Compaction:

a. Place top or wearing layer as continuously as possible.

b. Pass roller over unprotected end of freshly laid mixture only when placing of mix is discontinued long enough to permit mixture to become chilled.

c. Cut back previously compacted mixture when Work is resumed to produce a slightly beveled edge for full thickness of layer.

d. Cut away waste material and lay new mix against fresh cut.

G. Tolerances:

1. General: Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.

2. Completed Surface or Wearing Layer Smoothness:

a. Uniform texture, smooth, and uniform to crown and grade.

b. Maximum Deviation: 1/8 inch from lower edge of a 12-foot straightedge, measured continuously parallel and at right angle to centerline.

c. If surface of completed pavement deviates by more than twice the specified tolerances, remove and replace wearing surface.

3. Transverse Slope Maximum Deviation: ¼ inch in 12 feet from the rate of slope shown.

4. Finished Grade:

a. Perform a field differential level survey on a maximum 50-foot grid and along all grade breaks.

b. Maximum Deviation: 0.02 foot from the grade shown.

H. Seal Coat:

1. General: Apply seal coat of paving grade or emulsified asphalt to finished surface at longitudinal and transverse joints, joints at abutting pavements, areas where the asphalt concrete was placed by hand, patched surfaces, and other areas as directed by the City.

2. Preparation:

a. Maintain surfaces that are to be sealed free of holes, dry, and clean of dust and loose material.

b. Seal in dry weather and when the temperature is above 35 degrees F.

3. Application:

a. Fill cracks over 1/16 inch in width with an asphalt-sand slurry or approved crack sealer prior to sealing.

b. When sealing patched surfaces and joints with existing pavements, extend minimum 6 inches beyond edges of patches.

3.05 PAVEMENT OVERLAY

A. Preparation:

1. Remove fatty asphalt, grease drippings, dust, and other deleterious matter.

2. Surface Depressions: Fill with asphalt concrete mix, and thoroughly compact.

3. Damaged Areas: Remove broken or deteriorated asphalt concrete and patch as specified in Article Patching.

4. Portland Cement Concrete Joints: Remove joint filler to minimum 1/2 inch below surface.

B. Application:

1. Tack Coat: As specified in this Section.

2. Place and compact asphalt concrete as specified in Article Pavement Application.

3. Place first layer to include widening of pavement and leveling of irregularities in the surface of the existing pavement.

4. When leveling irregular surfaces and raising low areas, the actual compacted thickness of any one lift shall not exceed 2 inches.

5. The actual compacted thickness of intermittent areas of 120 square yards or less may exceed 2 inches, but not 4 inches.

6. Final wearing layer shall be of uniform thickness, and meet grade and cross-section as shown.

3.06 PATCHING HOT MIX ASPHALT

A. Preparation:

1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.

2. Prepare patch subgrade as specified in the Contract Documents.

B. Application:

1. Patch Thickness: 3 inches or thickness of adjacent asphalt concrete, whichever is greater.

2. Place asphalt concrete mix across full width of patch in layers of equal thickness.

3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

C. Compaction:

1. Roll patches with power rollers capable of providing compression of 200 to 300 pounds per linear inch. Use hand tampers where rolling is impractical.

2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least 1/2 the roller width. Progress toward center of patch overlapping each preceding track by at least 1/2 the width of roller.

3. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

D. Tolerances:

1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.

2. Tolerance: Surface smoothness shall not deviate more than plus 1/4 inch or minus 0 when a straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.07 FIELD QUALITY CONTROL

A. General: Provide services of an approved certified independent testing laboratory to conduct tests.

B. Field Density Tests:

1. Perform tests from cores or sawed samples.

2. Measure with properly operating and calibrated nuclear density gauge.

3. Maximum Density: In accordance with ASTM D2041, using a sample of mix taken prior to compaction from the same location as the density test sample.

C. Testing Frequency:

1. Quality Control Tests:

a. Asphalt Content, Aggregate Gradation: Once per every 500 tons of mix or once every 4 hours, whichever is greater.

b. Mix Design Properties, Measured Maximum (Rice's) Specific Gravity: Once every 1,000 tons or once every 8 hours, whichever is greater.

2. Density Tests: Once every 500 tons of mix or once every 4 hours, whichever is greater.

- END OF SECTION -

PROJECT NO. 11842

SECTION 02795

PERVIOUS CONCRETE

PART 1 - GENERAL

1.01 THE REQUIREMENTS

A. The Contractor is responsible for installing pervious concrete to manage post-construction stormwater runoff. This item covers the work necessary for installation of the pervious concrete. The Contractor shall furnish all material, labor, and equipment necessary for the proper installation of this facility.

B. It is the intent of this Specification that the Contractor conducts the construction activities in such a manner that the pervious concrete functions as a stormwater management practice, which includes the minimization of upstream erosion and sedimentation.

C. Installation of the pervious concrete shall occur after the contributing watershed has been stabilized. It shall be the responsibility of the Contractor to make any necessary repairs if the performance of the system is impacted by sediment during construction or due to improper construction sequencing. The Contractor shall implement additional measures as deemed necessary to prevent sediment impacts to the pervious concrete during construction.

D. Activities related to the installation of pervious concrete shall include but not be limited to the following items of work:

1. Excavation of pervious concrete subgrade.

2. Installation of concrete headers and edge restraints.

3. Installation of pervious concrete components, including aggregate, underdrains, cleanouts, observation wells, and surface pavement materials.

E. All Work shall be conducted in accordance with the most current version of all applicable codes, standards, and permits.

1.02 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions, the Contractor shall submit the following:

1. Name and location of all material suppliers.

2. Certificate of compliance with the standards specified for each source of each material.

3. Shop drawings of precast pervious concrete paving slab with permanent lifting points embedded in the surface of the slab, edge restraint details, profiles, and sections.

4. Test results performed by an independent testing laboratory of the following:

   a. Infiltration rate in accordance with ASTM C 1701/C 1701M and bulk density for the precast slabs conforming to ACI 522R.

   b. Compressive strength in accordance with ASTM C39/C39M of cores obtained in accordance with ASTM C42/C42M.

   c. Particle-size analysis in accordance with ASTM C136 for the stone base and crushed stone choker course (if applicable) with source of supply noted.

5. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.

6. Results of functional testing.

1.03 GUARANTEE

A. All work related to the installation of the pervious concrete shall be subject to the guarantee period of the Contract as specified in the General Conditions.

PART 2 - MATERIALS

2.01 GENERAL

A. All pervious concrete facilities and facility components shall meet the latest ADA requirements and accessibility guidelines.

B. All pervious concrete facilities shall support AASHTO HS-20 loads.

C. Pervious concrete materials shall at a minimum satisfy the safety and durability requirements established by the City for sidewalk and/or roadway surfaces.

2.02 PERVIOUS CONCRETE PAVEMENT

A. Pervious concrete shall be precast panels unless otherwise approved by the Engineer.

B. Pervious concrete slabs shall be 5 inches thick or as shown on the Contract Drawings.

C. Pervious concrete slabs shall have the following properties:

1. Color: standard natural grey concrete

2. Minimum compressive strength: 3,000 lbs/in² per ASTM C39/C39M

3. Minimum infiltration rate: 250 in/hr per ASTM C1701/1701M

4. Concrete average unit weight: 125 lb/ft³ (+/- 5% conforming to ACI 522R)

D. Pervious concrete slabs shall not be shipped until the concrete has cured to achieve 85% of the minimum compressive strength.

E. All pervious concrete slabs shall be provided by the same manufacturer.

F. The slab units shall include a minimum of 2 permanent lifting points embedded in the top of the slabs for ease of installation, maintenance, removal, and reinstallation.

2.03 UNDERDRAINS

A. Underdrains shall be constructed of Schedule 40 or SDR 35 smooth wall PVC pipe. The minimum pipe diameter shall be 4 inches. The underdrains shall be installed within the stone base.

B. A minimum of 4 rows of perforations shall be provided around the diameter of the underdrain pipe and the perforations shall be placed 6 inches on center within each row for the entire length of the drainage lateral. Perforations shall be 3/8 inch diameter. More perforations shall be provided for pipes 10 inches in diameter and larger.

C. Filter socks or geotextile fabric shall not be used to wrap the underdrain pipes within the stone base.

D. Underdrain pipes directing flow outside the pervious concrete facility shall be solid starting at a point a minimum of 1 foot from the interior wall of the pervious concrete before exiting.

E. The minimum slope of all non-perforated piping within the underdrain system shall be 0.5 percent.

F. Connections within the underdrain system and to any outflow structures, manholes, or catch basins shall be watertight.

G. Cleanouts shall be provided at the end of all underdrain lines (minimum one per every 1,000 square feet of surface area). Cleanouts shall consist of Schedule 40 or SDR 35 smooth wall PVC pipe with a threaded cleanout cover.

H. All pipes and pipe system components including but not limited to joints, caps, and cleanouts, shall meet DOT requirements for structural loading when installed within areas subject to vehicular or pedestrian traffic loads.

I. The maximum allowable angle for change in direction of any pipe segment shall not exceed forty-five (45) degrees, unless the change in direction occurs within a manhole or catch basin.

J. The underdrain shall have sufficient capacity to drain the pervious concrete system within 8 hours.

2.04 STONE BASE

A. A stone base layer shall be provided at the bottom depths of the pervious concrete system. Underdrains, if required, shall be installed within the stone base.

B. The stone base shall consist of #57 stone per ASTM C33 (or AASHTO M 6/M 80).

C. The stone base shall have a minimum installed porosity of 0.4.

D. Aggregates used in the stone base shall consist of clean, tough, durable fragments of crushed stone of uniform quality.

E. Aggregates shall be double-washed and free of fines and foreign material.

F. Aggregates shall have no more than 0.5% wash loss per AASHTO T-11 wash loss test.

G. Aggregates shall be free from clay balls, organic matter, and other deleterious substances.

2.05 LEVELING COURSE

A. A leveling course with a minimum depth of 2” shall be installed between the pervious concrete slabs and stone base.

B. Leveling course shall consist of #8 stone per ASTM C33 (or AASHTO M 6/M 80).

C. Leveling course stone shall consist of clean, tough, durable fragments of crushed stone of uniform quality.

D. Aggregates shall be double-washed and free of fines and foreign material.

E. Aggregates shall have no more than 0.5% wash loss per AASHTO T-11 wash loss test.

F. Aggregates shall be free from clay balls, organic matter, and other deleterious substances.

2.06 GEOTEXTILE

A. The Contractor shall furnish and install non-woven geotextile in accordance with the Contract Drawings and as directed by the Engineer.

B. Geotextile fabric shall not be installed horizontally across the base of the pervious concrete system or between any stone layers unless directed by the Engineer.

C. Geotextile fabric shall be in accordance with the section entitled “Geotextiles”.

2.07 EDGE RESTRAINT

A. Edge restraints shall consist of one of the following:

1. Saw cut edges of existing pavement with expansion joint filler positioned between the precast pervious concrete paving slabs and existing pavement.

2. Existing curb with expansion joint filler positioned between precast pervious concrete paving slabs and existing curb.

3. Cast-in-place edge restraints as shown on the Contract Drawings with expansion joint filler positioned between the precast pervious concrete paving slabs and edge restraint.

2.08 JOINT FILLER

A. Filler for expansion joints shall be installed between pervious concrete panels and as otherwise indicated in the Contract Drawings.

B. Preformed expansion joint filler shall meet the requirements of AASHTO M 153, Type II.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall keep the construction site neat at all times and free of debris at the conclusion of each workday. The Contractor shall conduct work such that debris and other construction materials do not unintentionally leave the construction site. Any debris or construction material that does leave the construction site shall be immediately removed and properly disposed of at no additional cost to the City.

B. Installation of precast pervious concrete panels shall be in accordance with manufacturer's recommendations and the requirements herein.

C. All pavement and curbing disturbed or damaged during construction shall be repaired and/or replaced in accordance with City requirements.

D. Pervious concrete slabs shall be handled and transported in a position consistent with their shape and design to avoid stresses which could cause cracking or damage.

E. Units must be lifted or supported only at the points shown on the working drawings or as recommended by the manufacturer.

F. The Contractor shall test the bearing capacity of underlying soils for all pervious concrete subject to vehicular traffic in accordance with ASTM D4429. The Contractor shall consult the Engineer before proceeding if the measured CBR is below 4%.

G. Protection of pervious concrete facilities:

1. The Contractor shall protect pervious concrete surfaces, excavations, and materials storage areas from severe weather conditions and contamination by dust, dirt, mud, cement, or other fine-grained material or sediment.

2. Pervious concrete footprints and all materials, including aggregates, shall be protected from the start of construction until final acceptance of the project. Any damage caused by the Contractor's equipment or lack of compliance with these requirements shall be repaired by the Contractor at no cost to the City.

3. Runoff onto pervious concrete or areas where materials are stored shall be prohibited until the site is fully stabilized.

4. Any sediment or debris accumulation onto the pervious concrete or underlying layers may require cleaning or removal and replacement of those materials to the satisfaction of the Engineer at no cost to the City.

3.02 EQUIPMENT

A. All equipment used to mix, transport, handle, and/or place construction material shall be washed clean and free from sediment, debris, or any other materials which could negatively impact performance of the bioswale.

3.03 EXCAVATION

A. The pervious concrete subgrade shall be excavated to the dimensions, side slopes, and elevations as shown in the Contract Drawings.

B. The method of excavation shall minimize compaction and surface sealing of the subgrade.

C. Unless otherwise approved by the City, equipment used to excavate the subgrade shall operate on the adjacent ground and not within the pervious concrete footprint.

D. Excavated materials shall be removed and disposed of in conformance with all laws, rules, regulations, codes, and ordinances.

E. Prior to installation of the stone base, the bottom of the excavation shall be scarified to a minimum depth of 6 inches with the bucket teeth of a backhoe or other method as approved by the Engineer. The soil shall not be saturated at the time of scarifying and the stone base shall be placed after the soil has been scarified and before rain is forecast.

F. The Contractor shall install any measures necessary to stabilize the excavation sidewalls and protect adjacent utilities and infrastructure.

3.04 GEOTEXTILE INSTALLATION

A. Geotextile shall be installed along the sides of the excavated basin as shown on the Contract Drawings.

B. Geotextile shall be protected from all damage prior to installation, including other construction activities and UV degradation.

C. Geotextiles shall be cut and fit to the dimensions shown on the Contract Drawings with a minimal amount of seams and with excess materials removed and disposed of properly.

D. Wrinkles and folds shall be removed by stretching and pinning, where applicable.

E. Geotextiles shall be overlapped by a minimum of 3 feet at roll edges and ends and secured with a minimum of pins or stables 1 foot on center at the seam.

F. Geotextiles shall be secured to the excavation wall with pins or staples at all turns and a minimum of 5 feet on center.

3.05 STONE BASE INSTALLATION

A. The stone base shall be installed in the bottom of the pervious concrete system. Underdrains, if required, shall be installed within the stone base.

B. Do not install aggregate when rainfall or other weather conditions will detrimentally affect the quality of the Work.

C. Evenly place and spread aggregate on the prepared sub-grade in 8 inch lifts of uniform thickness without segregation.

D. Aggregate shall be compacted with two passes per lift with a low-amplitude, high-frequency vibratory 10 t drum roller or a static drum roller.

E. Installation of the gravel drainage layer shall be completed with equipment which minimizes compaction of underlying soils.

F. The surface tolerance of the stone base shall be +/- 3/8 in under a 10 ft straightedge.

G. The leveling course shall be installed to a uniform depth and compacted as specified in the Contract Drawings.

H. The leveling course shall be free of depressions, protrusions, or gaps that would cause the precast pervious concrete slab to be unevenly supported.

3.06 UNDERDRAIN INSTALLATION

A. The underdrains shall be installed within the stone base as shown in the Contract Drawings.

B. Newly placed pipe shall be protected from damage during construction.

C. Construction traffic on exposed pipe material is strictly prohibited.

D. Prevent any aggregate and other construction materials and debris from entering underdrain pipes.

E. Observation wells and cleanouts shall be installed vertically as indicated in the Contract Drawings.

F. Solid pipe used to convey runoff from the pervious concrete facility shall have a minimum slope of 0.5%.

3.07 PRECAST SLAB PLACEMENT

A. Lay slabs as shown on the Contract Drawings and as approved by the Engineer.

B. Slabs must only be lifted and placed using swivels and spreader chains. Chains, cables, or slings should never be wrapped around slabs for lifting under any circumstances. Swivels shall be bolted securely, but not over-tightened.

C. Precast pervious concrete paving slabs must be placed so they are separated with 1/8-inch spacers provided by the manufacturer of the slabs. Joint widths and lines must be continually straight as paving proceeds.

D. Place units hand tight without using metal hammers, pry bars, or drift pins. Make horizontal adjustments to placement of laid slabs with wood wedges and levers, and rubber mallets, as needed.

E. Provide joints between slabs of 1/8-inch wide. No joints are to exceed 3/16-inch in width.

F. Joint lines must not deviate more than +/- 0.5-inch over 50-ft from string lines.

G. Joints must never be filled with loose material, including but not limited to sand, stone dust, stone chips, etc.

H. Fill gaps at the edges of the paved area with properly-sized end slabs.

I. Cut end slabs to be placed along the edge or corners with a masonry saw. Cut units must be not shorter than ¼ of a whole slab.

J. Adjust bond pattern at pavement edges such that cutting of edge slabs is minimized. Do not expose cut slabs to vehicular traffic. Cut slabs at edges as indicated on the Contract Drawings.

K. Keep equipment off unrestrained paving slabs.

L. After an area is completely paved, set the precast pervious concrete slabs into the leveling course layer by trafficking with light rubber-tired equipment.

M. Remove and replace any slabs cracked or damaged during installation with new slabs. Reset slabs not in conformance with specified installation tolerances.

N. Check final surface elevations of set slabs for conformance with Contract Drawings. The final surface tolerance from grade elevations must not deviate more than +/- 3/8-inch under a 10-ft straightedge.

O. The surface elevation of set slabs shall be flush with manholes or the top of utility structures.

P. After slabs are placed in their final position, apply clear, all weather silicone sealant to the surface of each lifting point hole in a manner such that the hole is completely covered, and debris and water will not enter the hole. Do not completely fill the hole with sealant. Follow manufacturer’s recommendations for application and curing instructions.

3.08 FUNCTIONAL TESTING

A. On-site infiltration testing shall be performed utilizing a single-ring infiltrometer to demonstrate compliance with infiltration criteria.

B. Infiltration testing shall be conducted with clean water, free of suspended solids or other deleterious liquids.

3.09 LONG-TERM INSPECTION AND MAINTENANCE

A. Monthly and after every rainfall during the first year:

1. Inspect pervious concrete surface and underdrain cleanouts for signs of standing water.

2. Identify and address potential sources of sedimentation.

3. Remove all trash, leaves, sediment, and other debris from the pavement surface.

4. Contact Engineer if standing water remains for longer than 48 hours after rainfall. Remediation may be necessary.

B. Every six months for one year:

1. Vacuum the pervious concrete surface with regenerative air sweeper or another device approved by the City to prevent clogging and maintain the permeability of the system. The pervious concrete surface shall be dry prior to vacuuming. Sweep broom and water spray attachments and/or pressure washers shall not be used unless approved by the City.

2. Remove volunteered vegetation from pavement joints.

C. Inspection and Maintenance Reporting

1. All inspection and maintenance activities should be reported. Copies of the reports shall be sent to the Engineer monthly. The reports shall include the following.

a. Date of inspection

b. Name of inspector

c. Condition of the pervious concrete:

1) Perimeter

2) Paving surface

3) Joint material

4) Inlets and overflows

5) Underdrain system

d. Maintenance work performed

e. Issues noted for future maintenance

- END OF SECTION -

PROJECT NO. 11842

SECTION 02796

PERMEABLE INTERLOCKING CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 THE REQUIREMENTS

A. The Contractor is responsible for installing permeable interlocking concrete pavement (PICP) to manage post-construction stormwater runoff. This item covers the work necessary for installation of the PICP. The Contractor shall furnish all material, labor, and equipment necessary for the proper installation of this facility.

B. It is the intent of this Specification that the Contractor conducts the construction activities in such a manner that the PICP functions as a stormwater management practice, which includes the minimization of upstream erosion and sedimentation.

C. Installation of the PICP shall occur after the contributing watershed has been stabilized. It shall be the responsibility of the Contractor to make any necessary repairs if the performance of the system is impacted by sediment during construction or due to improper construction sequencing. The Contractor shall implement additional measures as deemed necessary to prevent sediment impacts to the PICP during construction.

D. Activities related to the installation of PICP shall include but not be limited to the following items of work:

1. Excavation of the subgrade.

2. Installation of edge restraints.

3. Installation of PICP components, including aggregate, underdrains, cleanouts, observations wells, and surface pavement materials.

E. All Work shall be conducted in accordance with the most current version of all applicable codes, standards, and permits.

1.02 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions, the Contractor shall submit the following:

1. Name and location of all material suppliers.

2. Certificate of compliance with the standards specified for each source of each material.

3. Shop drawings including perimeter conditions, junction with other materials, expansion and control joints, paver dimensions and layout, interlocking pattern, and paver color.

4. Minimum of 4 representative full-size samples of each paver type, thickness, color, and finish.

5. Proposed paver installation method and equipment.

6. Test results performed by an independent testing laboratory demonstrating compliance of concrete pavers with ASTM C 936.

7. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.

8. Results of functional testing.

1.03 GUARANTEE

A. All work related to the installation of the PICP shall be subject to the guarantee period of the Contract as specified in the General Conditions.

PART 2 - MATERIALS

2.01 GENERAL

A. All PICP facilities and facility components shall meet the latest ADA requirements and accessibility guidelines.

B. All PICP facilities shall support AASHTO HS-20 loads.

C. PICP materials shall at a minimum satisfy the safety and durability requirements established by the City for sidewalk and/or roadway pavement.

2.02 PAVING UNITS

A. PICP paving units shall be precast concrete interlocking blocks with voids contained within the interlocking pattern to allow water movement through the installed pavement surface.

B. Paving units shall comply with ASTM C 936.

C. Paving units shall have a minimum depth of 3.5 in.

D. Paving units shall be standard natural grey concrete unless otherwise directed by the Contract Documents or Engineer.

E. All paving units shall be provided by the same manufacturer.

2.03 UNDERDRAINS

A. Underdrains shall be constructed of Schedule 40 or SDR 35 smooth wall PVC pipe. The minimum pipe diameter shall be 4 inches. The underdrains shall be installed within the stone base.

B. A minimum of 4 rows of perforations shall be provided around the diameter of the underdrain pipe and the perforations shall be placed 6 inches on center within each row for the entire length of the drainage lateral. Perforations shall be 3/8 inch diameter. More perforations shall be provided for pipes 10 inches in diameter and larger.

C. Filter socks or geotextile fabric shall not be used to wrap the underdrain pipes within the stone base.

D. Underdrain pipes directing flow outside the PICP facility shall be solid starting at a point a minimum of 1 foot from the interior wall of the PICP facility before exiting.

E. The minimum slope of all non-perforated piping within the underdrain system shall be 0.5 percent.

F. Connections within the underdrain system and to any outflow structures, manholes, or catch basins shall be watertight.

G. Cleanouts shall be provided at the end of all underdrain lines (minimum one per every 1,000 square feet of surface area). Cleanouts shall consist of Schedule 40 or SDR 35 smooth wall PVC pipe with a threaded cleanout cover.

H. All pipes and pipe system components including but not limited to joints, caps, and cleanouts, shall meet City requirements for structural loading when installed within areas subject to vehicular or pedestrian traffic loads.

I. The maximum allowable angle for change in direction of any pipe segment shall not exceed forty-five (45) degrees, unless the change in direction occurs within a manhole or catch basin.

J. The underdrain shall have sufficient capacity to drain the PICP facility within 8 hours.

2.04 STONE BASE

A. A stone base layer shall be provided at the bottom depths of the PICP facility. Underdrains, if required, shall be installed within the stone base.

B. The stone base shall consist of #57 stone per ASTM C33 (or AASHTO M 6/M 80).

C. The stone base shall have a minimum installed porosity of 0.4.

D. Aggregates used in the stone base shall consist of clean, tough, durable fragments of crushed stone of uniform quality.

E. Aggregates shall be double-washed and free of fines and foreign material.

F. Aggregates shall have no more than 0.5% wash loss per AASHTO T-11 wash loss test.

G. Aggregates shall be free from clay balls, organic matter, and other deleterious substances.

2.05 LEVELING COURSE

A. A leveling course with a minimum depth of 2” shall be installed between the PICP paver units and stone base.

B. Leveling course shall consist of #8 stone per ASTM C33 (or AASHTO M 6/M 80).

C. Leveling course stone shall consist of clean, tough, durable fragments of crushed stone of uniform quality.

D. Aggregates shall be double-washed and free of fines and foreign material.

E. Aggregates shall have no more than 0.5% wash loss per AASHTO T-11 wash loss test.

F. Aggregates shall be free from clay balls, organic matter, and other deleterious substances.

2.06 GEOTEXTILE

A. The Contractor shall furnish and install non-woven geotextile in accordance with the Contract Drawings and as directed by the Engineer.

B. Geotextile fabric shall not be installed horizontally across the base of the PICP facility or between any stone layers unless directed by the Engineer.

C. Fibers used in the manufacture of drainage geotextiles, and the threads used in joining geotextiles by sewing, must consist of long-chain, synthetic polymers, composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. The fibers must be formed into a stable network such that the filaments or yarns retain their dimensional stability relative to each other including selvages.

D. The geotextile must have not tears or defects which adversely alter its physical properties.

E. The geotextile shall be mildew and rot resistant.

F. Geotextiles shall conform to the following properties:

Property	ASTM Test	Requirements
Structure		Non-Woven
Elongation	ASTM D4595	≥ 50%
Grab Strength (min)	ASTM D4632	700 N (157 lbs)
Tear Strength (min)	ASTM D4533	250 N (56 lbs)
Puncture Strength (min)	ASTM D4833	250 N (56 lbs)
Apparent Opening Size (max)	ASTM D4751	0.25 mm (0.0098 inch)
Allowable Flow Rate (min)		110 gal/ft²/min

2.07 EDGE RESTRAINT

A. Edge restraints shall consist of one of the following:

1. Existing curb.

2. Cast-in-place edge restraints as shown on the Contract Drawings.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall keep the construction site neat at all times and free of debris at the conclusion of each workday. The Contractor shall conduct work such that debris and other construction materials do not unintentionally leave the construction site. Any debris or construction material that does leave the construction site shall be immediately removed and properly disposed of at no additional cost to the City.

B. Installation of PICP shall be in accordance with manufacturer's recommendations and the requirements herein.

C. All pavement and curbing disturbed or damaged during construction shall be repaired and/or replaced in accordance with City requirements.

D. PICP shall be handled and transported in a position consistent with their shape and design in order to avoid stresses which could cause cracking or damage.

E. The Contractor shall test the bearing capacity of underlying soils for all PICP subject to vehicular traffic in accordance with ASTM D4429-09a. The Contractor shall consult the Engineer before proceeding if the measured CBR is below 4%.

F. Protection of PICP facilities:

1. The Contractor shall protect PICP surfaces, excavations, and materials storage areas from severe weather conditions and contamination by dust, dirt, mud, cement, or other fine-grained material or sediment.

2. PICP footprints and all materials, including aggregates, shall be protected from the start of construction until final acceptance of the project. Any damage caused by the Contractor's equipment or lack of compliance with these requirements shall be repaired by the Contractor at no cost to the City.

3. Runoff onto PICP or areas where materials are stored shall be prohibited until the site is fully stabilized.

4. Any sediment or debris accumulation onto the PICP or underlying layers may require cleaning or removal and replacement of those materials to the satisfaction of the Engineer at no cost to the City.

3.02 EQUIPMENT

A. All equipment used to mix, transport, handle, and/or place construction material shall be washed clean and free from sediment, debris, or any other materials which could negatively impact performance of the bioswale.

3.03 EXCAVATION

A. The PICP subgrade shall be excavated to the dimensions, side slopes, and elevations as shown in the Contract Drawings.

B. The method of excavation shall minimize compaction and surface sealing of the subgrade.

C. Unless otherwise approved by the Engineer, equipment used to excavate the subgrade shall operate on the adjacent ground and not within the pervious concrete footprint.

D. Excavated materials shall be removed and disposed of in conformance with all laws, rules, regulations, codes, and ordinances.

E. Prior to installation of the stone base, the bottom of the excavation shall be scarified to a minimum depth of 6 inches with the bucket teeth of a backhoe or other method as approved by the Engineer. The soil shall not be saturated at the time of scarifying and the stone base shall be placed after the soil has been scarified and before rain is forecast.

F. The Contractor shall install any measures necessary to stabilize the excavation sidewalls and protect adjacent utilities and infrastructure.

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3.04 GEOTEXTILE INSTALLATION

A. Geotextile shall be installed along the sides of the excavated basin as shown on the Contract Drawings.

B. Geotextile shall be protected from all damage prior to installation, including other construction activities and UV degradation.

C. Geotextiles shall be cut and fit to the dimensions shown on the Contract Drawings with a minimal amount of seams and with excess materials removed and disposed of properly.

D. Wrinkles and folds shall be removed by stretching and pinning, where applicable.

E. Geotextiles shall be overlapped by a minimum of 3 feet at roll edges and ends and secured with a minimum of pins or stables 1 foot on center at the seam.

F. Geotextiles shall be secured to the excavation wall with pins or staples at all turns and a minimum of 5 feet on center.

3.05 STONE BASE INSTALLATION

A. The stone base shall be installed in the bottom of the PICP facility. Underdrains, if required, shall be installed within the stone base.

1. Do not install aggregate when rainfall or other weather conditions will detrimentally affect the quality of the Work.

2. Evenly place and spread aggregate on the prepared sub-grade in 8 inch lifts of uniform thickness without segregation.

3. Aggregate shall be compacted with two passes per lift with a low-amplitude, high-frequency vibratory 10 t drum roller or a static drum roller.

4. Installation of the gravel drainage layer shall be completed with equipment which minimizes compaction of underlying soils.

5. The surface tolerance of the stone base shall be +/- 1 in under a 10 ft straightedge.

B. The leveling course shall be installed to a uniform depth and compacted as specified in the Contract Drawings.

1. The leveling course shall be free of depressions, protrusions, or gaps that would cause the PICP to be unevenly supported.

2. The surface tolerance of the leveling course shall be +/- 3/8 in under a 10 ft straightedge.

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3.06 UNDERDRAIN INSTALLATION

A. The underdrains shall be installed within the stone base as shown in the Contract Drawings.

B. Newly placed pipe shall be protected from damage during construction.

C. Construction traffic on exposed pipe material is strictly prohibited.

D. Prevent any aggregate and other construction materials and debris from entering underdrain pipes.

E. Observation wells and cleanouts shall be installed vertically as indicated in the Contract Drawings.

F. Solid pipe used to convey runoff from the PICP facility shall have a minimum slope of 0.5%.

3.07 PAVER UNIT PLACEMENT

A. Lay paver units as shown on the Contract Drawings and as approved by the Engineer.

B. Paver units shall be installed in a manner that maintains straight pattern lines.

C. Fill gaps at the edges of the paved area with cut units.

D. Cut pavers subject to tire traffic shall be no smaller than 1/3 of a whole unit.

E. Pavers shall be cut using a masonry saw.

F. Joints and openings shall be filled with double-washed #8 stone per ASTM C33 (or AASHTO M 6/M 80).

G. Remove excess aggregate on the surface by sweeping pavers clean.

H. Compact and seat the pavers into the bedding material with two passes of a low-amplitude, 75-90 Hz plate compactor capable of at least 5,000 lbf.

I. Do not compact within 6 ft of the unrestrained edges of the paving units.

J. Apply additional aggregate to the openings and joints if needed, filling them completely. Remove excess aggregate by sweeping then compacting the pavers.

K. The final surface tolerance of compacted pavers shall not deviate more than +/- 3/8 in under a 10 ft straightedge.

L. The surface elevation of installed pavers shall be 1/8 to 1/4 in above adjacent drainage inlets, concrete collars, or channels.

3.08 FUNCTIONAL TESTING

A. On-site infiltration testing shall be performed utilizing a single-ring infiltrometer to demonstrate compliance with infiltration criteria.

B. Infiltration testing shall be conducted with clean water, free of suspended solids or other deleterious liquids.

3.09 LONG-TERM INSPECTION AND MAINTENANCE

A. Monthly and after every rainfall during the first year:

1. Inspect PICP surface and underdrain cleanouts for signs of standing water.

2. Identify and address potential sources of sedimentation.

3. Remove all trash, leaves, sediment, and other debris from the pavement surface.

4. Contact Engineer if standing water remains for longer than 48 hours after rainfall. Remediation may be necessary.

B. Bi-annually:

1. Vacuum the PICP surface with regenerative air sweeper or another device approved by the City to prevent clogging and maintain the permeability of the system. The PICP surface shall be dry prior to vacuuming. Sweep broom and water spray attachments and/or pressure washers shall not be used unless approved by the City. Following pavement vacuuming, apply #8 stone (ASTM C33) to voids and openings and sweep clean.

2. Remove volunteered vegetation from pavement joints.

C. Inspection and Maintenance Reporting

1. All inspection and maintenance activities should be reported. Copies of the reports shall be sent to the Engineer monthly. The reports shall include the following.

a. Date of inspection

b. Name of inspector

c. Condition of the PICP:

1) Perimeter

2) Paving surface

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3) Inlets and overflows
4) Underdrain system

d. Maintenance work performed

e. Issues noted for future maintenance

- END OF SECTION -

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SECTION 02911

SOIL PREPARATION

PART 1 - GENERAL

1.01 SEQUENCING AND SCHEDULING

A. Rough grade areas to be planted or seeded prior to performing Work specified under this Section.

1.02 APPLICABLE STANDARDS AND SPECIFICATIONS

A. Comply with the following standards and specifications for all materials, methods, and workmanship unless otherwise noted:

1. Florida Department of Transportation Standard Specifications for Road and Bridge Construction, current edition.

2. City of Fort Lauderdale Code of Ordinances.

PART 2 - PRODUCTS

2.01 TOPSOIL

A. General: Uniform mixture of 50 percent sand and 50 percent muck in a loose friable condition, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

B. Textural Amendments: Amend as necessary to conform to required composition.

C. Source: Import topsoil if onsite material fails to meet specified requirements or is insufficient in quantity.

2.02 SOURCE QUALITY CONTROL

A. Topsoil Analysis/Testing: Performed by county or state soil testing service or approved certified independent testing laboratory.

B. Should soil tests prove the topsoil to alkaline or above the accepted minimum for salt content, the topsoil shall be removed and replaced by acceptable material at Contractor’s expense.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

A. The subgrade shall be 4 inches lower than finished grade with 2 inches of topsoil added to sod areas.

B. Scarify subgrade to minimum depth of 6 inches where topsoil is to be placed.

C. Remove stones over 2-1/2 inches in any dimension, sticks, roots, rubbish, and other extraneous material.

D. Limit preparation to areas which will receive topsoil within 2 days after preparation.

3.02 TOPSOIL PLACEMENT

A. Topsoil Thickness:

1. Sodded Areas: 2 inches.
2. Planting Beds: 6 inches.

B. Do not place topsoil when subsoil or topsoil is excessively wet or otherwise detrimental to the Work.

C. Mix soil amendments with topsoil before placement or spread on topsoil surface and mix thoroughly into entire depth of topsoil before planting or seeding.

D. Uniformly distribute to within 1/2-inch of final grades. Fine grade topsoil eliminating rough or low areas and maintaining levels, profiles, and contours of subgrade.

E. Remove stones exceeding 1-1/2 inches, roots, sticks, debris, and foreign matter during and after topsoil placement.

F. Remove surplus subsoil and topsoil from site. Grade stockpile area as necessary and place in condition acceptable for planting or seeding.

- END OF SECTION -

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SECTION 02920

SODDING

PART 1 - GENERAL

1.01 DEFINITIONS

A. Maintenance Period: Begin maintenance immediately after each area is planted (sod) and continue for a period of 8 weeks after all planting under this Section is completed.

B. Satisfactory Stand:

1. Grass or section of grass that has:

a. No bare spots larger than 3 square feet.

b. Not more than 10 percent of total area with bare spots larger than 1 square foot.

c. Not more than 15 percent of total area with bare spots larger than 6 square inches.

1.02 DELIVERY, STORAGE, AND PROTECTION

A. Sod:

1. Do not harvest if sod is excessively dry or wet to the extent survival may be adversely affected.

2. Harvest and deliver sod only after laying bed is prepared for sodding.

3. Roll or stack to prevent yellowing.

4. Deliver and lay within 24 hours of harvesting.

5. Keep moist and covered to protect from drying from time of harvesting until laid.

1.03 WEATHER RESTRICTIONS

A. Perform Work under favorable weather and soil moisture conditions as determined by accepted local practice.

1.04 SEQUENCING AND SCHEDULING

A. Prepare topsoil as specified in the Contract Documents, before starting Work of this Section.

B. Complete Work under this section within ten (10) days following completion of soil preparation.

C. Notify City at least three (3) days in advance of:

1. Each material delivery.

2. Start of planting activity.

D. Planting Season: Those times of year that are normal for such Work as determined by accepted local practice. At a minimum, Contractor shall avoid planting in January or February.

1.05 MAINTENANCE SERVICE

A. Contractor: Perform maintenance operations during maintenance period to include:

1. Watering: Keep surface moist.

2. Washouts: Repair by filling with topsoil, and replace sodded areas.

3. Mowing: Mow to 2 inches after grass height reaches 3 inches, and mow to maintain grass height from exceeding 3 1/2 inches.

4. Re-sod unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced, at which time maintenance period shall recommence.

5. Re-sod during next planting season if scheduled end of maintenance period falls after September 15.

PART 2 - MATERIALS

2.01 FERTILIZER

A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose. Minimum percentage of plant food by weight.

B. Mix:

1. Nitrogen: Sixteen.

2. Phosphoric Acid: Four.

3. Potash: Eight.

2.02 SOD

A. Unless a particular type of sod is called for, sod may be of either St. Augustine Floritam, Bahia grass or Seashore Paspalum, in accordance with the following:

1. Use Bahia grass where no irrigation system exists.

2. Use St. Augustine Floritam where an irrigation system is in place. If original sod being replaced is St. Augustine Floritam, replacement sod shall match.

3. Seashore Paspalum sod will be used in areas prone to salt water flooding.

B. Strongly rooted pads, capable of supporting own weight and retaining size and shape when suspended vertically from a firm grasp on upper 10 percent of pad.

1. Grass Height: Normal.

2. Strip Size: Supplier's standard, commercial size rectangles.

3. Soil Thickness: Uniform; 1-inch plus or minus 1/4-inch at time of cutting.

4. Age: Not less than 10 months or more than 30 months.

5. Condition: Healthy, green, moist; free of diseases, nematodes and insects, and of undesirable grassy and broadleaf weeds. Yellow sod, or broken pads, or torn or uneven ends will not be accepted

6. Any netting contained within the sod shall be certified by the manufacturer to be bio-degradable within a period of 3 months from installation.

PART 3 - EXECUTION

3.01 PREPARATION

A. Grade Areas to Smooth, Even Surface with Loose, Uniformly Fine Texture:

1. Roll and rake, remove ridges, fill depressions to meet finish grades.

2. Limit such Work to areas to be planted within immediate future.

3. Remove debris, foreign material and stones larger than 1 1/2 inches diameter, and other objects that may interfere with planting and maintenance operations.

B. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface to dry off before seeding. Do not create muddy soil.

C. Restore prepared areas to specified condition if eroded or otherwise disturbed after preparation and before planting.

D. Limit preparation to those areas that can be sodded within 72 hours after preparation.

3.02 FERTILIZER

A. Apply evenly over area in accordance with manufacturer's instructions. Mix into top 2 inches of top soil.

B. Application Rate: 20 pounds per 1,000 square feet (1,000 pounds per acre).

3.03 SODDING

A. Do not plant dormant sod, or when soil conditions are unsuitable for proper results.

B. Pre-wet the area prior to placing sod. Lay sod to form solid mass with tightly fitted joints; butt ends and sides, do not overlap:

1. Stagger strips to offset joints in adjacent courses.

2. Work from boards to avoid damage to subgrade or sod.

3. Tamp or roll lightly to ensure contact with subgrade; work sifted soil into minor cracks between pieces of sod, remove excess to avoid smothering adjacent grass.

4. Complete sod surface true to finished grade, even, and firm.

C. Fasten sod on slopes to prevent slippage with wooden pins 6 inches long driven through sod into subgrade, until flush with top of sod. Install at sufficiently close intervals to securely hold sod.

D. Water sod with fine spray immediately after planting. During first month, water daily or as required to maintain moist soil to depth of 4 inches.

3.04 FIELD QUALITY CONTROL

A. Eight weeks after sodding is complete and on written notice from Contractor, City will, within 15 days of receipt, determine if the sod has been satisfactorily established.

B. If the sod is not satisfactorily established, Contractor shall replace the sod and repeat the requirements of this Section.

- END OF SECTION -

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SECTION 02930

LANDSCAPE WORK

PART 1 - GENERAL

1.01 DEFINITIONS

A. Measurement:

1. In size grading balled and burlapped (B & B), caliper takes precedence over height.

2. Take trunk caliper 6 inches above the ground level (up to and including 4-inch caliper size) and 12 inches above the ground level for larger trees.

3. Measure size of container-grown stock by height and width of plant.

4. Measure herbaceous perennials pot size, not top growth.

1.02 DELIVERY, STORAGE, AND HANDLING

A. Inspection and Transporting: Movement of nursery stock shall comply with all Federal, State, and local laws and regulations. Therefore, required inspection certificates shall accompany each shipment, and shall be submitted in accordance with Section 01300.

B. Cover plants during shipment with a tarpaulin or other suitable covering to minimize drying.

C. Balled and Burlapped Plants: Wrap each ball firmly with burlap and securely bind with twine, cord, or wire for shipment and handling. Drum-lace balls with a diameter of 30 inches or more. Wire wrap burlap if root ball is not sufficiently compacted. Palms will not require burlap wrapping if the following requirements are met:

1. Dug from marl or heavy soil that adheres to roots and retains shape without shattering.

2. Moistened material used to cover ball and roots not exposed to wind and sun.

3. Transport material on vehicles large enough to allow plants not to be crowded. Plants shall be covered to prevent wind damage during transit and shall be kept moist, fresh and protected at all times. Such protection shall encompass the entire period which the plants are in transit, being handled, or are in temporary storage.

D. All plant material shall not remain on the work site longer than two (2) days prior to being installed.

E. As specified herein for transplanting.

1.03 MAINTENANCE

A. Commence to maintain plant life immediately after planting and maintain for a minimum of one growing season, and until plants are well established and exhibit a vigorous growing condition.

B. In accordance with accepted submittal on care and maintenance of plants and as follows:

1. Maintain by watering, pruning, cultivating, and weeding as required for healthy growth. Restore planting saucers.

2. Tighten and repair stake and guy supports and reset trees and shrubs to proper grades or vertical position as required.

3. Restore or replace damaged wrappings. Spray as required to keep trees and shrubs free of insects and disease.

4. Remove guys, stakes, and other supports at end of maintenance service.

5. Maintenance includes temporary protection fences, barriers, and signs as required for protection.

6. Coordinate watering to provide deep root watering to newly installed trees.

1.04 SCHEDULING AND SEQUENCING

A. Plant Deliveries: Notify Engineer at least 3 days in advance of each delivery.

B. Planting Season: Conduct planting during times of year that are normal for such work as determined by accepted local practice.

C. Plant trees and shrubs after final grades are established and before planting of lawns or grasses.

PART 2 - MATERIALS

2.01 PLANT MATERIALS

A. Provide quantity, size, genus, species, and variety of trees and shrubs indicated; comply with applicable requirements of ANSI Z60.1.

B. Nomenclature (Names of Plants): In accordance with “Hortus Third”.

C. Quality and Size:

1. Nursery-grown, habit of growth normal for species.

2. Sound, healthy, vigorous, and free from insects, diseases, and injuries - Florida #1 quality or better.

3. Equal to or exceeding measurements specified in plant list. Measure plants before pruning with branches in normal position.

4. Root System of Container-Grown Plants: Well developed and well distributed throughout the container, such that the roots visibly extend to the inside face of the growing container.

5. Perform necessary pruning at time of planting.

6. Sizes: Dimensional relationship requirements of ANSI Z60.1 for kind and type of plants required.

7. Balled and Burlapped Plants: Firm, intact ball of earth encompassing enough of the fibrous and feeding root system to enable full plant recovery.

   a. Ball Size: ANSI Z60.1.

8. Container-Grown Plants: Self-established root systems, sufficient to hold earth together after removal from container, without being rootbound.

   a. Stock: Grown in delivery containers for at least 6 months, but not over 2 years.

9. Label each tree and shrub of each variety with securely attached waterproof tag, bearing legible designation of botanical and common name.

10. All trees must have a fully developed fibrous root system, be heavily branched, or in palms, heavily leafed, free from all insects, fungus, and other diseases.

11. Palms: Wrap the roots of all plants of the palm species before transporting, except if they are container grown plants and ensure that they have an adequate root ball structure, and mass for healthy transplantation as defined in “Florida Grades and Standards for Nursery Plants.”

12. Burlapping is not required if the palm is carefully dug from marl or heavy soil that adheres to the roots and retains its shape without crumbling. During transporting and after arrival, carefully protect root balls of palms from wind and exposure to the sun. Muck grown palms are not allowed. After delivery to the job site, if not planting the palm

within 24 hours, cover the root ball with a moist material. Plant all palms within 48 hours of delivery to the site.

13. Move sabal and coconut palms in accordance with the “Florida Grades and Standards for Nursery Plants.”

D. Replacement Shrubs and Trees: Same species, size, and quality as specified for plant being replaced, except existing trees larger than 4-inch caliper, may be replaced with 4-inch caliper trees to satisfy the caliper inches lost, subject to approval through tree removal and replacement permits by CITY.

2.02 ANTIDESICCANT

A. Provide transpiration retarding material to be used where any plant material is moved during the growing season.

2.03 GUYING, STAKING, AND WRAPPING MATERIALS

A. Wood Stake: 2 inches by 2 inches by 8 feet.

B. Guy Wires: Galvanized, 12-gauge, ductile steel.

C. Flags:

1. Wood: 1/2-inch by 3 inches by 12 inches, with 3/8-inch hole centered 1-1/2 inches from each end, painted white.

2. Sheet Metal: 1-1/2-inch with clipped corners and both ends punched, painted white.

D. Hose: Two-ply, reinforced rubber garden hose, not less than 1/2-inch diameter, new or used.

E. Burlap: Of first quality, minimum 8 ounces in weight, not less than 6 inches nor more than 10 inches in width.

2.04 MULCH

A. Mulch shall be free from noxious weed seed and foreign material harmful to plant growth and shall be an approved non-native tree bark mulch. It must be uniformly shredded and be free from large pieces of bark, foreign matter, weed seeds and any other organic or inorganic material.

B. Barkdust: Medium grind, pine; maximum 3/4-inch particle size.

2.05 PLANTING SOIL MIX

A. Proportion by Weight: 75% approved good quality top soil mixed with 25% approved organic matter as approved by Engineer. The soil must be taken from ground that has never been stripped, with a slight acid reaction

(5.5 to 6.5 ph) and without an excess of calcium or carbonate. Soil shall have a loose friable condition.

B. Special Type: Planting soil for palms shall be a good grade of salt free sand, which is free of all weeds.

2.06 TOPSOIL

A. General: Uniform mixture of 75 percent good grade of clean, salt free, weed free sand and 25 percent organic material in a loose friable condition, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

B. Textural Amendments: Amend as necessary to conform to required composition.

C. Source: Import topsoil if onsite material fails to meet specified requirements or is insufficient in quantity.

D. 95% of topsoil shall pass a ¼ inch sieve.

E. Organic matter content shall be 4% to 12% of total dry weight.

2.07 SOURCE QUALITY CONTROL

A. Topsoil Analysis/Testing: Performed by county or state soil testing service or approved certified independent testing laboratory.

B. Should soil tests prove the topsoil to alkaline or above the accepted minimum for salt content, the topsoil shall be removed and replaced by acceptable material at Contractor’s expense.

PART 3 - EXECUTION

3.01 TRANSPLANTING

A. Remove existing plantings identified for transplant prior to beginning Work in area in accordance with standard nursery practices and as specified herein.

B. Nondormant Plants: Prior to digging, spray foliage with antidesiccant, as recommended by manufacturer.

C. Cover balls and containers of plants that cannot be planted immediately, with moist soil or mulch.

D. Water plants as often as necessary to prevent drying until planted.

E. Do not remove container-grown stock from containers before time of planting.

F. Bare-Root Plants:

1. Dig up with least possible injury to fibrous root system.

2. Immediately upon removal from ground, cover roots with thick coating of mud or wrap in wet straw, moss, or other suitable packing material for protection from drying until planted.

3. Plant or heel-in immediately upon relocation to temporary storage. Open and separate bundles of bare-root plants, and eliminate air pockets among roots as they are covered.

G. Replant each temporarily removed tree, shrub, or other plant only after construction activities are completed and applicable grading and topsoil replacement is completed in its vicinity. Replant trees, shrubs, and other plants in their original positions unless otherwise shown or approved. Plant as specified for new plants.

H. Maintain transplanted materials in same manner as new trees and shrubs.

3.02 LOCATION OF PLANTS

A. Locate new planting or stake positions as shown unless obstructions are encountered, in which case notify Engineer.

B. Locate no planting, except ground cover, closer than 18 inches to pavements, pedestrian pathways, and structures.

C. Request Engineer observe locations, and adjust as necessary before planting begins.

3.03 PREPARATION

A. Subsoil Drainage: Furnish for plant pits and beds.

B. Planting Soil: Delay mixing of amendments and fertilizer if planting will not follow preparation of planting soil within 2 days. For pit and trench type backfill, mix planting soil prior to backfilling and stockpile at site.

C. Plants: Place on undisturbed existing soil or well-compacted backfill.

D. Trees and Shrubs:

1. Pits, Beds, and Trenches: Excavate with vertical and scarified sides.

2. B & B Trees and Shrubs: Make excavations at least twice as wide as root ball.

3. Container-Grown Stock: Excavate as specified for B & B stock, adjust for size of container width and depth.

4. Bare-Root Trees: Excavate pits to a width to just accommodate roots fully extended and depth to allow uppermost roots to be below original grade.

5. Fill excavations with water and allow to percolate out prior to planting.

E. Ground Cover Beds:

1. Mix amendments and fertilizer with top soil prior to placing or apply on surface of top soil and mix thoroughly before planting.

2. Scarify top soil to a depth of 4 to 6 inches.

3. Establish finish grading of soil. Rake areas to smooth and create uniform texture and fill depressions.

4. Moisten.

3.04 PLANTING

A. Plant trees before planting surrounding smaller shrubs and ground covers. Adjust plants with most desirable side facing toward the prominent view (sidewalk, building, street).

B. B & B Plants: Place in pit by lifting and carrying by its ball (do not lift by branches or trunk). Lower into pit. Set straight and in pit center with tip of rootball 1 to 2 inches above adjacent finish grade.

C. Bare-Root Plants: Spread roots and set stock on cushion of planting soil mixture. Set straight in the pit center so that roots, when fully extended, will not touch walls of the planting pit and the uppermost root is just below finish grade. Cover roots of bare-root plants to the crown.

D. Container-Grown Plants: Remove containers, slash edges of rootballs from top to bottom at least 1-inch deep. Plant as for B & B plants.

E. Ground Covers: Dig planting holes through mulch with one of the following: hand trowel, shovel, bulb planter, or hoe. Split biodegradable pots or remove nonbiodegradable pots. Root systems of all potted plants shall be split or crumbled. Plant so roots are surrounded by soil below the mulch. Set potted plants so pot top is even with existing grade.

3.05 BACKFILLING

A. Backfill with planting soil, except where existing soil is suitable according to top soil analysis.

B. B & B Plants:

1. Partially backfill pit to support plant. Remove burlap and binding from sides and tops of B & B plants, do not pull burlap from under balls.

2. When excavation is approximately 2/3 full, water thoroughly before placing remainder of backfill to eliminate air pockets even if it is raining. Finish backfilling pit sides.

3. Never cover top of rootball with soil. Form a saucer above existing grade, completely around the outer rim of the plant pit.

C. Bare-Root Plants:

1. Plumb before backfilling and maintain plumb while working backfill around roots and placing layers above roots.

2. Set original soil line of plant 1-inch to 2 inches above adjacent finish landscape grades. Spread out roots without tangling or turning up to surface. Cut injured roots cleanly; do not break.

3. Carefully work backfill around roots by hand; puddle with water until backfill layers are completely saturated.

3.06 GUYING AND STAKING

A. Support trees immediately after planting to maintain plumb position.

B. Guying: Support all trees over 4 inches in caliper with 3 guys equally.

C. Special Requirements for Palm Trees: Brace palms which are to be staked with three 2-inch by 4-inch wood braces, toe-nailed to cleats which are securely banded at two points to the palm, at a point one third the height of the trunk. Pad the trunk with five layers of burlap under the cleats. Place braces approximately 120 degrees apart and secure them underground by 2- by 4- by 12-inch stake pads.

3.07 SUBGRADE PREPARATION

A. The subgrade shall be 4 inches lower than finished grade with 2 inches of topsoil added to sod areas.

B. Scarify subgrade to minimum depth of 6 inches where topsoil is to be placed.

C. Remove stones over 2-1/2 inches in any dimension, sticks, roots, rubbish, and other extraneous material.

D. Limit preparation to areas which will receive topsoil within 2 days after preparation.

3.08 TOPSOIL PLACEMENT

A. Topsoil Thickness:

1. Sodded Areas: 2 inches.

2. Planting Beds: 6 inches.

3. Planting Beds in Roadways and Parking Lots: All planting areas shall be excavated to a minimum depth of 24” or greater as needed to remove all road base/rock down to native soil prior to backfilling with approved planting soil.

B. Do not place topsoil when subsoil or topsoil is excessively wet or otherwise detrimental to the Work.

C. Mix soil amendments with topsoil before placement or spread on topsoil surface and mix thoroughly into entire depth of topsoil before planting or seeding.

D. Uniformly distribute to within 1/2-inch of final grades. Fine grade topsoil eliminating rough or low areas and maintaining levels, profiles, and contours of subgrade.

E. Remove stones exceeding 1-1/2 inches, roots, sticks, debris, and foreign matter during and after topsoil placement.

F. Remove surplus subsoil and topsoil from site. Grade stockpile area as necessary and place in condition acceptable for planting or seeding.

3.09 MULCHING

A. Cover planting beds and area of saucer around each plant with 3-inch thick layer of mulch within 2 days after planting. Saturate planting area with water.

3.10 PRUNING AND REPAIR

A. Prune only after planting and in accordance with standard horticultural practice to preserve natural character of the plant. Perform in presence of Engineer or City’s representative. Remove all dead wood, suckers, and broken or badly bruised branches. Use only clean, sharp tools. Do not cut lead shoot.

B. For Existing Trees Impacted by Construction Activities:

1. Maintain a minimum 6-foot clearance from the trunk of all trees except palm trees. Existing trees to remain shall be protected during all construction phases. Protective barriers shall be provided at the drip line of existing trees adjacent to construction operations. Replacement of any trees that are damaged or destroyed due to the Contractor’s operations shall be the Contractor’s responsibility and shall be replaced at the Contractor’s expense

2. Where roots of trees are encountered in the excavation area, use a 24-inch deep saw cut prior to excavation. Roots shall not be torn by excavating equipment. Hand dig around roots. Cut roots do not require coating.

3. Overhead branches not trimmed prior to construction and interfering with construction activities will be pruned and cut as approved by the City Forester and not torn or broken off with excavating equipment.

3.11 WEED CONTROL

A. Maintain a weed-free condition within planting areas. Apply pre-emergent selective herbicide to mulched beds at manufacturer's recommended rate of application.

3.12 PROTECTION OF INSTALLED WORK

A. Protect planting areas and plants against damage for duration of maintenance period.

3.13 ROOT BARRIERS

A. Root barriers shall be installed parallel to all trees (except palms) when there is a sidewalks, roadway or utility adjacent to the planting area. Root barriers will be installed as directed by Engineer.

- END OF SECTION -

PROJECT NO. 11842

SECTION 15000

BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install to the required line and grade, all piping together with all fittings and appurtenances, required for a complete installation. All piping located outside the face of structures or building foundations and all piping embedded in concrete within a structure or foundation shall be considered exterior piping.

B. The Contractor shall provide taps on piping where required or shown on the Drawings. Where pipe or fitting wall thicknesses are insufficient to provide the required number of threads, a boss or pipe saddle shall be installed.

C. The work shall include, but not be limited to, the following:

1. Connections to existing pipelines.

2. Test excavations necessary to locate or verify existing pipe and appurtenances.

3. Installation of all new pipe and materials required for a complete installation.

4. Cleaning, testing and disinfecting as required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 1 – General Requirements

B. Division 2 – Sitework

1.03 MATERIAL CERTIFICATION AND SHOP DRAWINGS

A. The Contractor shall furnish to the City (through the Engineer) a Material Certification stating that the pipe materials and specials furnished under this Section conform to all applicable provisions of the corresponding Specifications. Specifically, the Certification shall state compliance with the applicable standards (ASTM, AWWA, etc.) for fabrication and testing.

B. Shop Drawings for major piping (2 inches in diameter and greater) shall be prepared and submitted in accordance with the Section entitled “Submittals.” In addition to the requirements of the Section entitled “Submittals,” the Contractor shall submit laying schedules and detailed Drawings in plan and profile for all piping as specified and shown on the Drawings.

C. Shop Drawings shall include, but not be limited to, complete piping layout, pipe material, sizes, class, locations, necessary dimensions, elevations, supports, hanger details, pipe

joints, and the details of fittings including methods of joint restraint. No fabrication or installation shall begin until Shop Drawings are approved by the Engineer.

PART 2 - PRODUCTS

2.01 GENERAL

A. All specials and every length of pipe shall be marked with the manufacturer's name or trademark, size, class, and the date of manufacture. Special care in handling shall be exercised during delivery, distribution, and storage of pipe to avoid damage and unnecessary stresses. Damaged pipe will be rejected and shall be replaced at the Contractor's expense. Pipe and specials stored prior to use shall be stored in such a manner as to keep the interior free from dirt and foreign matter.

B. Testing of pipe before installation shall be as described in the corresponding ASTM or AWWA Specifications and in the applicable standard specifications listed in the following sections. Testing after the pipe is installed shall be as specified in the Section entitled “Pipeline Testing and Disinfection”.

C. All buried exterior piping shall have restrained joints for thrust protection unless otherwise specified or shown on the drawings.

D. The Contractor shall verify existing buried piping tie-in connections before fabricating new piping assemblies. The Contractor shall verify size, type, and location of all existing buried piping and appurtenances by excavating test pits as required of all buried connections and crossings which may affect the Contractor's work prior to ordering pipe and fittings to determine sufficient information for ordering materials. The Contractor shall take whatever measurements that are required to complete the work as shown or specified.

2.02 SOLID SLEEVE COUPLINGS

A. Solid sleeve couplings shall be used to connect buried service piping where shown on the Drawings. Solid sleeves shall be ductile iron, long body and shall conform to the requirements of ANSI A21.10 (AWWA C110). Unless otherwise shown or specified, solid sleeve couplings shall be Style A11760 as manufactured by American Cast Iron Pipe Co., or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All piping shall be installed by skilled workers and in accordance with the best standard practice for piping installation as shown on the Drawings, specified or recommended by the pipe manufacturer. Proper tools and appliances for the safe and convenient handling and installing of the pipe and fittings shall be used. Great care shall be taken to prevent any pipe coating from being damaged on the inside or outside of the pipe and

fittings. All pieces shall be carefully examined for defects, and no piece shall be installed which is known to be cracked, damaged, or otherwise defective. If any defective pieces should be discovered after having been installed, it shall be removed and replaced with a sound one in a satisfactory manner by the Contractor and at their own expense. Pipe and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they are accepted in the complete work.

B. All excavation shall be made in such a manner and to such widths as will provide ample room for properly installing the pipe and permit thorough compaction of backfill around the pipe. The minimum trench widths shall be in strict accordance with the "Trench Width Excavation Limits" as shown on the Drawings. All excavation and trenching shall be done in strict accordance with these specifications and all applicable parts of the OSHA Regulations, 29CFR 1926, Subpart P.

C. All excavation required by this contract shall be unclassified. No additional payment will be made for rock excavation required for the installation of pipe or structures shown on the drawings.

D. Enlargements of the trench shall be made as needed to give ample space for operations at pipe joints. The width of the trench shall be limited to the maximum dimensions shown on the Drawings, except where a wider trench is needed for the installation of and work within sheeting and bracing. Except where otherwise specified, excavation slopes shall be flat enough to avoid slides which will cause disturbance of the subgrade, damage to adjacent areas, or endanger the lives or safety of persons in the vicinity.

E. Hand excavation shall be employed wherever, in the opinion of the Engineer, it is necessary for the protection of existing utilities, poles, trees, pavements, or obstructions.

F. No greater length of trench in any location shall be left open, in advance of pipe laying, than shall be authorized or directed by the Engineer and, in general, such length shall be limited to approximately 100 feet. The Contractor shall excavate the trenches to the full depth, width and grade indicated on the Drawings including the relevant requirements for bedding. The trench bottoms shall then be examined by the Engineer as to the condition and bearing value before any pipe is laid or bedding is placed.

G. Joint deflection shall not exceed 75 percent of the manufacturers recommended deflection. Excavation and backfilling shall conform to the requirements of Division 2, and as specified herein. Maximum trench widths shall conform to the Trench Width Excavation Limits shown on the Drawings

H. Following proper preparation of the trench subgrade, pipe and fittings shall be carefully lowered into the trench so as to prevent dirt and other foreign substances from gaining entrance into the pipe and fittings. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall any of the materials be dropped or dumped into the trench.

I. Water shall be kept out of the trench until jointing and backfilling are completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no water, earth, or other substance will enter the pipes, fitting, or valves. Pipe

ends left for future connections shall be valved, plugged, or capped, and anchored as required.

J. All piping shall be installed in such a manner that it will be free to expand and/or contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. Pipes crossing within a vertical distance of less than or equal to one (1) foot shall be encased and supported with concrete at the point of crossing to prevent damage to the adjacent pipes as shown on the Drawings.

K. The full length of each section of pipe shall rest solidly upon the bed of the trench, with recesses excavated to accommodate bells, couplings, joints, and fittings. Before joints are made, each pipe shall be well bedded on a solid foundation; and no pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid by the Contractor at their own expense. Pipe shall not be laid in water or when trench conditions are unsuitable for work.

L. Proper and suitable tools and appliances for the safe convenient handling and laying of pipe shall be used and shall in general agree with manufacturer's recommendations.

M. At the close of each work day the end of the pipeline shall be tightly sealed with a cap or plug so that no water, dirt, or other foreign substance may enter the pipeline, and this plug shall be kept in place until pipe laying is resumed.

N. During the laying of pipe, each pipe manufacturer shall provide their own supervisor to instruct the Contractor's pipe laying personnel in the correct procedure to be followed.

O. Ordinarily only full lengths of pipe (as furnished by the pipe manufacturer) shall be used exceptions: closure pieces at maintenance holes and areas where joint deflection is required.

P. For gravity sewer installations, the Contractor shall use a laser device to maintain the trench and pipe alignment. The laser device shall be re-checked for correct elevation and pipe alignment prior to pipe installation if the device is left in the pipe overnight. Corrected invert elevations at each maintenance hole and any adjustments will be coordinated and approved by the Engineer.

Q. All piping shall have type "a" bedding as shown on the drawings, unless otherwise specified herein or indicated on the drawings.

3.02 REINFORCED CONCRETE PIPE, CONCRETE CULVERT, AND DRAIN PIPE

A. The laying of reinforced concrete pipe shall conform to the applicable sections of the Concrete Pipe Handbook as published by the American Concrete Pipe Association.

3.03 DUCTILE IRON PIPE

A. Ductile iron pipe (DIP) shall be installed in accordance with the requirements of the Ductile Iron Pipe Handbook published by the Ductile Iron Pipe Research Association, and AWWA C600.

B. Where it is necessary to cut ductile iron pipe in the field, such cuts shall be made carefully in a neat professional manner using approved methods to produce a clean square cut. The outside of the cut end shall be conditioned for use by filing or grinding a small taper, at an angle of approximately 30 degrees.

C. Unless otherwise approved by the Engineer, field welding of ductile iron will not be permitted.

3.04 PVC/CPVC AND HDPE PIPE

A. Polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC) and High Density Polyethylene (HDPE) pipe shall be laid and joints assembled according to the respective manufacturer's recommendation. PVC pipe installation shall comply with applicable sections of the Uni-Bell PVC Pipe Association Recommended Standard Specifications.

B. Plastic piping shall not be installed when the temperature is less than 60 degrees F except as otherwise recommended by the manufacturer and approved by the Engineer.

3.05 JOINTS IN PIPING

A. Restrained joints shall be provided on all pipe joints as specified herein and shown on the Drawings. Restrained joints shall be made up similar to that for push-on joints.

B. Push-on joints include a single rubber gasket which fits into the bell end of the pipe. The gasket shall be wiped clean, flexed and then placed in the socket. Any bulges in the gasket which might interfere with the entry of the plain end of the pipe shall be removed. A thin film of lubricant shall be applied to the gasket surface which will come into contact with the spigot end of the pipe. The lubricant shall be furnished by the pipe manufacturer. The plain end of the pipe, which is tapered for ease of assembly, shall be wiped clean and a thick film of lubricant applied to the outside. The pipe shall be aligned and carefully entered into the socket until it just makes contact with the gasket. The joint assembly shall be completed by entering the pipe past the gasket until it makes contact with the bottom of the socket. The pipe shall be pulled "home" with an approved jack assembly as recommended by the pipe manufacturer. If assembly is not accomplished by reasonable force, the plain end shall be removed and the condition corrected.

C. Mechanical joints shall be made up with gaskets, glands and bolts. When a joint is to be made up, the bell or socket and plain end shall be cleaned and washed with a solution of mild soap in water; the gland and gasket shall be slid onto the plain end and the end then entered into the socket until it is fully "home" on the centering ring. The gasket shall then be painted with soapy water and slid into position, followed by the gland. All bolts shall be inserted and made up hand tight and then tightened alternately to bring the gland into position evenly. Excessive tightening of the bolts shall be avoided. All nuts shall be pulled up using a torque wrench which will not permit unequal stresses in the bolts. Torque shall not exceed the recommendations of the

manufacturer of the pipe and bolts for the various sizes. Care shall be taken to assure that the pipe remains fully "home" while the joint is being made. Joints shall conform to the applicable AWWA Specifications.

D. Eccentric reducers shall be installed where air or water pockets would otherwise occur in mains because of a reduction in pipe size.

- END OF SECTION -

PROJECT NO. 11842

SECTION 15006

DUCTILE IRON PIPE

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install ductile iron pipe and all appurtenant Work, complete in place, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. All applicable sections of the Contract Documents

1.03 REFERENCED SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

AWWA C104	Cement Mortar Lining for Ductile Iron Pipe and Fittings For Water.
AWWA C110	Ductile-iron and Gray-Iron Fittings.
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
AWWA C150	Thickness design of ductile iron pipe.
AWWA C151	Ductile-iron Pipe, Centrifugally Cast, For Water.
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances.

1.04 SUBMITTALS

A. Shop Drawings: The Contractor shall submit Shop Drawings of pipe and fittings in accordance with the requirements set forth in the Sections entitled “Basic Mechanical Requirements” and “Submittals.”

B. Contractor shall submit certification that all materials coming in contact with potable water comply with the requirements of NSF 61.

PART 2 - PRODUCTS

2.01 GENERAL

A. Pipe shall be centrifugally cast in metal molds or sand lined molds in accordance with AWWA C151 of grade 60-42-10 ductile iron. The above standard covers ductile iron pipe with nominal pipe sizes from three inches up to and including sixty-four inches in diameter. Working pressure shall be as specified herein.

B. Wall Thickness

1. Buried Pipe:

   a. 30 inch diameter and greater shall be Pressure Class 300.

   b. 24 inch diameter and smaller shall be Pressure Class 350.

2. Flanged Pipe: Pipe wall thickness of threaded pipe for a flanged pipe end shall be minimum special thickness Class 53 from 4-inch to 54-inch and/or minimum Pressure Class 350 for 60-inch to 64-inch diameter pipe in accordance with AWWA C115.

3. Grooved Pipe: Grooved coupling pipe shall be special thickness Class 54, or greater if required by pipe manufacturer. Pipe groove dimensions shall be for rigid joints unless otherwise indicated on the drawings.

C. Joints

1. Ductile iron pipe above grade shall be flanged.

2. All pipe and fittings below grade shall be restrained joint type.

3. Mechanical and push-on type joints shall be in accordance with AWWA C111.

4. Flanges for flanged pipe shall be in accordance with AWWA C115, shall be ductile iron, shall be rated at 250 psi maximum working pressure, and shall be similar to flange Class 125 per ASME B16.1. Where shown on the Drawings, pipe and fittings shall be furnished with flanges similar to flange Class 250 per ASME B16.1. Fittings shall be provided with flanges having a bolt circle and bolt pattern the same as the adjacent pipe and/or mechanical devices. Joint materials shall be ANSI sized and approved and shall consist of hot dip galvanized carbon steel bolts and nuts and full faced gaskets, unless otherwise specified.

5. No raised face flanges shall be used. The raised faces shall be milled flat.

6. Flange gaskets shall be full face Toruseal gaskets by American Cast Iron Pipe Co., or FLANGE-TYTE gaskets by U.S. Pipe, or equal. Gaskets shall be nominal 1/8" thick SBR rubber.

D. Restrained Joints

1. All ductile iron pipe and fittings below grade shall be restrained joint.

2. Manufactured Proprietary Restrained Joint Piping: Restrained joint pipe shall be as specified in the City of Fort Lauderdale Department of Sustainable Development Engineering Division Shop Drawing Submittals and Approved Utility Product List provided in Appendix B.

3. Restrained Mechanical Joint Fittings: All mechanical joint fittings, valves and appurtenances shall be restrained as described herein. Restrained joint fittings shall be mechanical joint fittings with restraint assemblies such as Stargrip by Star Pipe

Systems, Mega Lug by EBAA Iron, ONE LOK by Sigma, or approved equal. Manufacturers and model numbers shall be as specified in the City of Fort Lauderdale Department of Sustainable Development Engineering Division Shop Drawing Submittals. Use of this restraining system shall be approved by the Engineer for each application.

E. Fittings

1. General: Fittings shall be manufactured in accordance with AWWA C110 or the manufacturer's standard. Fittings shall be as specified in the City of Fort Lauderdale Department of Sustainable Development Engineering Division Shop Drawing Submittals and Approved Utility Product List provided in Appendix B.

2. Pressure Rating: 350 psi minimum working pressure for 4- to 24-inch fittings and 250 psi minimum working pressure for 30- to 64-inch fittings.

3. Materials: Fittings shall be ductile iron.

4. Joints - General: Fittings shall be either flanged, mechanical joint or manufactured proprietary restrained joint type as indicated on the Drawings and specified herein.

5. Flanged Joint Fittings: Above ground fittings shall be flanged.

6. Manufacturer Proprietary Restrained Joint Fittings: Unless otherwise indicated on the Drawings or specified herein, all below ground fittings 30 inches in diameter and greater shall be manufacturer proprietary restrained joint type.

7. Mechanical Joint Fittings: Underground ductile iron fittings 24 inches in diameter and less shall be mechanical joint type fittings.

F. Pipe Lining and Coating General: Pipe linings and coatings shall be as follows:

1. Buried Service: The piping manufacturer's standard asphaltic coating shall be applied prior to shipment to the exterior wall of buried pipe and fittings in accordance with AWWA C151.

2. Above Ground Piping and Exposed Piping within Underground Vaults: A coating of rust inhibitive primer, compatible with the coating system specified in the Section entitled "Painting," shall be applied to the pipe exterior prior to shipment for piping that is above ground and exposed piping within vaults. Primer for pipe used for potable water main applications shall be compliant with NSF Standard 61.

3. Cement-Mortar Lining: Pipe and fittings for potable water service shall be cement-lined and seal-coated in accordance with AWWA C104, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

4. Protecto 401 Ceramic Epoxy Lining: The interior of all ductile iron pipe and fittings for wastewater services shall be lined with an epoxy lining. The epoxy lining shall be Protecto 401 Ceramic Epoxy as manufactured by the Protecto Division of Vulcan Painters, Inc, or equal. All pipe and fittings shall be lined with a minimum dry film thickness of 40 mils, except for the gasket groove and spigot end up to six inches

back from the end of the spigot which shall be lined with ten mils of the material. All ductile iron pipe and fittings shall be checked for dry film thickness in accordance with the SSPC-PA2. Each pipe joint and fitting shall be marked with the date of application of the lining system and with its numerical sequence of application on that date. The pipe supplier shall furnish a certificate stating that lining applicator has complied with all specification requirements relative to the material, its application and inspection. Surface preparation, number of coats, application of the lining material and field touch-up shall be in strict accordance with the lining material manufacturer's recommendations. During the installation of the pipe, the lining material manufacturer shall provide the services of a field engineer to instruct and demonstrate to the Contractor's personnel, the procedure for the field touch-up of lining where field cuts and taps were required. Holiday inspection shall be conducted using test equipment described in American Water Works Association Standard, AWWA C210, Section 5.3.3.1. In accordance with coating manufacturer's recommendation, holiday testing may be conducted any time after the coating has reached sufficient cure.

5. Polyethylene Encasement: All ductile iron pipe, fittings and valves installed underground shall be encased with polyethylene film in accordance with ANSI Standard A21.5, Method A or B at the Contractor’s option. Encasement shall terminate 3-inches to 6-inches above ground where pipe is exposed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor shall perform all earthwork including excavation, backfill, bedding, compaction, sheeting, shoring and bracing, dewatering and grading in accordance with Division 2 - Sitework.

B. Unless otherwise directed, ductile iron pipe shall be laid with the bell ends facing upstream in the normal direction of flow and in the direction of laying.

C. Thrust restrained and mechanical joints shall be made in accordance with the manufacturer's standards except as otherwise specified herein. Joints between mechanical joint pipe and/or fittings shall be made in accordance with AWWA C600, except that deflection at joints shall not exceed one-half of the manufacturer's recommended allowable deflection, or one-half of the allowable deflection specified in AWWA C600, whichever is the lesser amount.

D. Before laying thrust restrained and mechanical joint pipe and fittings, all lumps, blisters and excess bituminous coating shall be removed from the bell and spigot ends. The outside of each spigot and the inside of each bell shall be wire brushed, and wiped clean and dry. The entire gasket groove area shall be free of bumps or any foreign matter which might displace the gasket. The cleaned spigot and gasket shall not be allowed to touch the trench walls or trench bottom at any time. Vegetable soap lubricant shall be applied in accordance with the pipe manufacturer's recommendations, to aid in making the joint. The Contractor shall exercise caution to prevent damage to the gasket or the adherence of grease or particles of sand or dirt. Deflections shall only be made after the joint has been assembled.

E. Prior to making up flanged joints in ductile iron pipe and fittings, the back of each flange under the bolt heads and the face of each flange shall have all lumps, blisters and excess bituminous coating removed and shall be wire brushed and wiped clean and dry. Flange faces shall be kept clean and dry when making up the joint, and the Contractor shall exercise caution to prevent damage to the gasket or the adherence of grease or particles of sand or dirt. Bolts and nuts shall be tightened by opposites in order to keep flange faces square with each other, and to ensure that bolt stresses are evenly distributed.

F. Bolts and nuts in thrust restrained, mechanical and flanged joints shall be tightened in accordance with the recommendations of the pipe manufacturer for a leak-free joint. The mechanics shall exercise caution to prevent overstress. Torque wrenches shall be used until, in the opinion of the Engineer, the mechanics have become accustomed to the proper amount of pressure to apply on standard wrenches.

G. Cutting of the ductile iron pipe for inserting valves, fittings, etc., shall be done by the Contractor in a neat and professional manner without damage to the pipe, the lining, or the coating. Pipe 16 inches and larger in diameter shall be cut with a mechanical pipe saw. After cutting the pipe, the plain end shall be beveled with a heavy file or grinder to remove all sharp edges.

H. Areas of loose or damaged lining associated with field cutting shall be repaired or replaced as recommended by the pipe manufacturer and required by the Engineer. Repair methods shall be as recommended by the manufacturer and shall be submitted to the Engineer for review.

I. Any work within the pipe shall be performed with care to prevent damage to the lining. No cable, lifting arms or other devices shall be inserted into the pipe. All lifting, pulling or pushing mechanisms shall be applied to the exterior of the pipe barrel.

J. Homing the pipe shall be accomplished by the use of a hydraulic or mechanical pulling device, unless otherwise accepted by the Engineer. No pipe shall be driven or struck in order to seat it home.

K. Cleaning: Cleaning methods shall be acceptable to the Engineer, and must be sufficient to remove silt, rocks, or other debris which may have entered the pipeline during its installation and shall also follow the requirements of the Section entitled "Pipeline Testing and Disinfection."

- END OF SECTION -

PROJECT NO. 11842

SECTION 15007

PVC C900 PIPE

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install 4-inch to 48-inch polyvinyl chloride (PVC) pressure pipeline, complete in place, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

All applicable sections of the Contract Documents

1.03 REFERENCED SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ANSI/AWWA C104/A21	Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water
ANSI/AWWA C110/A21	Ductile Iron and Gray Iron Fittings 3-inch through 48-inch for Water and other Liquids
ANSI/AWWA C111/A2	Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings
ANSI/AWWA C600	Installation of Ductile Iron Water Mains and Appurtenances
ANSI/AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe for Water
ASTM D 2584	Test Method for Ignition Loss of Cured Reinforced Resins
PPI Technical Report	Policies and Procedures for Developing
TR ¾	Recommended Hydrostatic Design Stresses for Thermoplastic
AWWA Manual M23	PVC Pipe – Design and Installation

1.04 SUBMITTALS

A. Shop Drawings: The Contractor shall submit Shop Drawings of pipe and fittings and appurtenances in accordance with the requirements in the Section entitled “Submittals”.

B. Certifications

1. The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards.

2. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.05 QUALITY ASSURANCE

A. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of this Section of the Specifications, as specified in the referenced standards, as applicable.

B. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the City. The additional samples shall be furnished at no additional cost to the City.

PART 2 – PRODUCTS

2.01 GENERAL

A. Approved PVC pipe manufacturers are:

1. Diamond Plastic

2. Freedom Plastic

3. Griffico

4. JM Eagle

5. IPEX

6. National

7. Napco

8. Or Equal

B. PVC pressure pipe shall conform to the applicable requirements of ANSI/AWWA C900 and subject to additional requirements specified herein.

2.02 PIPE

A. The pipe shall be of the diameter and pressure class specified or shown, shall be furnished complete with rubber gaskets, and all specials and fittings shall be provided as required in the Contract Documents. The dimensions and pressure classes for Dimension Ratios for large PVC pressure pipe with Cast-Iron Pipe Equivalent O.D.'s shall conform to the requirements of AWWA.

B. Unless otherwise provided in alternate qualification procedures of PPI-TR3, compounds which have a Hydrostatic Design Basis (HDB) of 4000 psi at 73.4 degrees F for water

shall not contain additives and fillers that exceed the recommended values in Table 1, Part Y of PPI-TR3 (e.g., allowable content range for calcium carbonate is 0.0-5.0 parts per hundred of resin). If requested by the Engineer, the additive and filter content shall be determined using the prolysis method as specified in ASTM D 2584.

C. Joints: All joints for the buried PVC pipe shall be either an integral bell manufactured on the pipe or a separate coupling both employing a rubber ring joint. The bell and coupling shall be the same thickness as of the pipe barrel, or greater thickness. The sealing ring groove in the coupling shall be of the same design as the groove in cast iron fittings and valves available from local water works supply distributors. Where required, restrained joint retainer glands shall be used and shall be cast from 60-42-10 ductile iron and shall have a sufficient number of ductile tie bolts to restrain working and test pressures as required. The retainer clamp shall be of two piece construction with serrations on the I.D. sufficient to hold the required pressures with a safety factor of 2:1. The retainers shall be Series 1500 or 6500 as manufactured by EBAA, Iron, Inc.

D. Joint Deflection: Deflection at the joint shall not exceed 1.5 degrees or one half the maximum deflection recommended by the manufacturer. No deflection of the joint shall be allowed for joints which are overbelled or not belled to the stop mark.

2.03 FITTINGS

A. Fittings in the pipe shall be ductile iron and shall conform to the requirements of AWWA C110, Class 250. PVC pipe fittings shall be restrained joint.

B. All fittings shall be lined and coated in accordance with the requirements of Section entitled “Ductile Iron Pipe” and “Piping, General”.

C. Each fitting shall be clearly labeled to identify its size and pressure class.

D. Mechanical joint restraint shall be incorporated in the design of the follower gland. The restraint mechanism shall consist of a plurality of individually activated gripping surfaces to maximize restraint capability. Glands shall be manufactured of ductile iron conforming to ASTM A536-80. The gland shall be such that it can replace the standardized mechanical joint gland and can be used with the standardized mechanical joint bell conforming to ANSI/AWWA A21.11/C111 and ANSI/AWWA A21.53/C153 of latest revision. Twist-off nuts, sized same as tee-head bolts, shall be used to insure proper actuating of restraining devices. The restraining glands shall have a pressure rating equal to that of the PVC pipe on which it is used and shall be Megalug Series 2000 PV or 2000SV as manufactured by EBAA, Iron Inc., or equal.

2.04 BURIED PIPING IDENTIFICATION

A. Polyethylene Underground Warning Tape for Non-Metallic Pipelines:
1. Tracer tape shall be of inert, acid- and alkali-resistant, polyethylene, four mils thick, six inches wide, and suitable for direct burial. Tape shall be capable of stretching to twice its original length.

2. Message shall read, “CAUTION PIPE BURIED BELOW”, with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet.

3. Manufacturer: Provide products of one of the following:
   a. Brady Corporation
   b. Seton Identification Products
   c. Marking Services, Inc.
   d. Or equal.

PART 3 – EXECUTION

3.01 GENERAL

A. All laying, jointing, testing for defects and for leakage shall be performed in the presence of the Engineer, and shall be subject to acceptance by the Engineer. All material found during the progress to have defects will be rejected and the Contractor shall promptly remove such defective materials from the site of the work.

B. Installation shall conform to the requirements of AWWA M23, instructions furnished by the pipe manufacturer, and to the supplementary requirements or modifications specified herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.02 HANDLING AND STORAGE

A. Handling

1. Pipe, fittings and accessories shall be carefully inspected before and after installation and those found defective shall be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, pipe, fittings, and accessories shall be cleaned, and shall be maintained in a clean condition. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings or any other material be dropped or dumped into trenches.

B. Storage

1. Pipe should be stored, if possible at the job site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to bell ends of pipe. Pipe should be stored in such a way as to prevent sagging or bending and protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets should be stored in a cool, dark place out of the direct rays of the sun, in the original packaging.

3.03 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Division 2 and as specified herein.

3.04 INSTALLATION

A. Bell and spigot pipe shall be laid with the bell end pointing in the direction of laying. Pipe shall be graded in straight lines, taking care to avoid the formation of any dips or low points. Pipe shall not be laid when the conditions of trench or weather are unsuitable. At the end of each days work, open ends of pipe shall be closed temporarily with wood blocks or bulkheads.

B. Pipe shall be supported at its proper elevation and grade, care being taken to secure firm and uniform support. Wood support blocking will not be permitted. The full length of each section of pipe and fittings shall rest solidly on the pipe bed, with recessed excavation to accommodate bells, joints and couplings. Anchors and supports shall be provided where necessary and where indicated on the Drawings for fastening work into place. Fittings shall be independently supported.

C. Short lengths of pipe shall be used in and out of each rigid joint or rigid structure. Piping that does not allow sufficient space for proper installation of jointing material shall be replaced by one of proper dimensions. Blocking or wedging between bells and spigots will not be permitted.

D. Joints shall be installed according to manufacturer's recommendations. Trenches shall be kept free of water until joints have been properly made. The maximum combined deflection at any coupling shall be in accordance with the manufacturer's recommendations.

E. Pipe shall be cut by means of saws, power driven abrasive wheels or pipe cutters, which will produce a square cut. No wedge-type roller cutters will be permitted. After cutting, the end of the pipe shall be beveled using a beveling took, portable type sander or abrasive disc.

3.05 FIELD TESTING AND DISINFECTION

A. Field testing and disinfection of water mains shall conform to the requirements of Section entitled "Pipeline Testing and Disinfection".

3.06 TRACER WIRE

A. All non-ferrous pipe (PVC AND HDPE) shall be furnished and installed with tracer wire. Special care in handling shall be exercised during delivery, distribution, and storage of tracer wire to avoid damage and unnecessary stresses. Damaged tracer wire will be rejected and shall be replaced at the Contractor's expense. The tracer wire shall have water-blocking characteristics, be corrosive resistant, and have UV protection. The tracer wire shall be copper or copper clad steel with polyethylene insulation and core material of woven polyester and water blocking polyester yarns. The wire shall have an outer jacket of high-density polyethylene. The wire shall be HDD-CCS PE45 as manufactured by Pro Trace; or Soloshot EHS by Copperhead Industries. Manufacturer/distributor furnished water-blocking connectors and locate clip shall be used as needed.

PROJECT NO. 11842

- END OF SECTION -

PROJECT NO. 11842

SECTION 15008

PVC NON-PRESSURE PIPE

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all 6- to 15-inch underground PVC non-pressure pipe for gravity sewer replacement and all appurtenant work, complete in place, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

All applicable sections of the Contract Documents

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM D 1784	Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
ASTM D 2241	Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
ASTM D 2321	Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
ASTM D 3034	Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

1.04 SUBMITTALS

A. Samples: The Contractor shall submit to the City for review, samples of all the materials proposed for use on the Work. The samples shall be clearly marked to show the manufacturer's name and product identification and shall be submitted along with the manufacturer's technical data and application instructions. All sample submittals shall conform to the requirements for "Samples" in Section 01300, "Submittals".

B. Shop Drawings: The Contractor shall submit shop drawings and laying diagrams of all Pipe, joints, bends, special fittings, and piping appurtenances in accordance with Section 01300, "Submittals".

C. Certificates: The Contractor shall provide manufacturer's certificates for all materials indicating conformance to the Contract Documents.

1.05 QUALITY ASSURANCE

A. Testing: All materials testing will be based upon applicable ASTM Test Methods and AWWA Standards referenced herein for the materials specified.

B. Certificates: Manufacturer's notarized certificates of compliance shall be furnished by the Contractor.

C. The pipe shall be subjected to the specified hydrostatic strength tests, flexure tests, and crushing tests. The crushing tests shall be made on samples taken from the center of full-length sections of pipe.

1.06 CLEANUP

A. In addition to the requirements of Section 01700, "Project Closeout", the Contractor, upon completion of backfilling and grading over trenches shall remove all excess materials and equipment from the site.

PART 2 - PRODUCTS

2.01 GENERAL

A. All PVC pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and pressure rating in psi.

B. The Contractor shall also require the manufacturer to mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control tests, raw material batch number, and other information deemed necessary by the manufacturer.

2.02 PIPE

A. All PVC pipe shall be joined by compression joints unless otherwise shown or specified in the Piping Schedule, and shall conform to the following requirements:

1. Polyvinylchloride pipe (PVC) shall conform to the requirements of ASTM D 3034, Class SDR 35. Material for PVC pipe shall conform to the requirements of ASTM D 1784 for Class 12454-B or 12454-C as defined therein.

2. Flexible rubber rings for compression type joints for PVC pipe and fittings shall conform to the requirements of ASTM D 1869.

2.03 FITTINGS

A. All fittings for PVC pipe shall conform to the requirements of ASTM D 2241. The ring groove and gasket ring shall be compatible with PVC pipe ends. The flanged fittings shall be compatible with cast-iron or ductile iron pipe fittings.

B. The strength class of the fittings shall be not less than the strength class of any adjoining pipe.

2.04 BEDDING MATERIAL

A. Unless otherwise specified or shown, all material used for pipe bedding shall conform to the requirements for "Embedment materials" as specified in ASTM D 2321.

PART 3 - EXECUTION

3.01 GENERAL

A. All laying, jointing, testing for defects and for leakage shall be performed in the presence of the City, and shall be subject to his approval before acceptance. All material found during the progress to have defects will be rejected and the Contractor shall promptly remove such defective materials from the site of the Work.

B. Installation shall conform to the requirements of ASTM D 2321 and to the supplementary requirements or modifications specified herein. Wherever the provisions of this Section and the requirements of ASTM D 2321 are in conflict, the more stringent provision shall apply.

3.02 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of the Section entitled "Excavation and Backfill for Utilities", and as specified herein.

B. Unless otherwise specified or shown, the maximum width of trenches shall be as specified in said ASTM D 2321.

3.03 LAYING PIPE

A. The pipe shall be installed in accordance with the requirements of ASTM D 2321 and as specified herein and shown and the sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for joining, the bedding for the pipe shall be checked for firmness and uniformity of surface.

B. Proper implements, tools, and facilities as recommended by the pipe manufacturer's standard printed installation instructions shall be provided and used by the Contractor for safe and efficient execution of the Work. All pipe, fittings, valves, and accessories shall be carefully lowered into the trench by means of backhoe, ropes, or other suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.

C. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, nor any other method that may fracture the pipe or will produce ragged, uneven edges.

D. The pipe and accessories shall be inspected for defects prior to lowering into the trench. Any defective, damaged or unsound pipe shall be repaired or replaced. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position

in the trench. Pipe shall be kept clean during and after laying. All openings in the pipe line shall be closed with water tight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

E. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the Work shall be furnished by the Contractor.

F. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the Contractor in cooperation with owners of such utility structures.

3.04 HANDLING

A. Handling of the PVC pipe shall be done with care to ensure that the pipe is not damaged in any manner during storage, transit, loading, unloading, and installation.

B. Pipe shall be inspected both prior to and after installation in the ditch and all defective lengths shall be rejected and immediately removed from the working area.

3.05 FIELD JOINTING

A. Each pipe compression type joint shall be joined with a lock-in rubber ring and a ring groove that is designed to resist displacement during pipe insertion.

B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. At this time a thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.

C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer of the coupling.

D. When pipe laying is not in progress, the open ends of the pipe shall be closed to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe which has floated shall be removed from the trench, cleaned, and relaid in an acceptable manner. No pipe shall be laid when, in the opinion of the City, the trench conditions or weather are unsuitable for such Work.

3.06 INSTALLATION OF BENDS, TEES, AND REDUCERS

A. Cast-iron and PVC fittings shall be installed Utilizing standard installation procedures. Fittings shall be lowered into trench by means of rope, cable, chain, or other acceptable means without damage to the fittings. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope or other device be attached through the fitting's interior for handling. Fittings shall be carefully connected to pipe or other facility, and joint shall be checked to insure a sound and proper joint.

3.07 PIPE-TO-PIPE CONNECTIONS

A. Pipe-to-pipe connections shall be made by using flexible banded, sheer reinforced couplings or adapter couplings, each with compression joints, in compliance with ASTM C 425.

3.08 PIPE-TO-PIPE MANHOLE CONNECTIONS

A. When a sound pipe stub-out exists at a manhole to which connection is to be made, a pipe-to-pipe connection shall be made as described above. If a stub-out is not present or is faulty, an opening shall be cut in the manhole wall and the connection made. The connection shall consist of a pipe stub-out with elastomeric waterstop grouted into the opening with non-shrink grout. A flexible band coupling, as shown on the details for new manholes, shall join the pipe stub-out to the replacement pipe. The invert or floor inside the manhole shall be cut and reshaped as necessary.

3.09 GRAVITY SEWER SERVICE LATERALS

A. Lateral sewers shall be installed in accordance with all the applicable requirement for pipe installation. Branch fittings shall be installed in the main line sewer as it is constructed, in the locations and configuration of the original laterals or as designated by the City.

B. The existing laterals shall be hand excavated to a joint, saw cut, clean and square and the appropriate adapter installed to connect the replacement laterals. Care shall be taken to maintain the slopes of the existing laterals. The laterals shall be removed and replaced from the main line to a point along the existing lateral as determined by the City to be in acceptable condition.

C. The Contractor shall not excavate trenches for laterals on both sides of the street at the same time unless written permission has been secured in advance to close the street.

3.10 TESTING

A. Field testing of gravity sewer pipe shall conform to the requirements of Section 15995, "Pipeline Testing and Disinfection".

- END OF SECTION -

PROJECT NO. 11842

SECTION 15108

GATE VALVES

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The CONTRACTOR shall furnish and install gate valves, complete and operable, as shown and specified herein, including operators, coating, control units, and appurtenant work, all in accordance with the requirements of the Contract Documents.

1.02 SUBMITTALS

A. Submit shop drawings and Operation and Maintenance Manual all in accordance with the Sections entitled “Submittals”.

1.03 REFERENCE STANDARDS

A. AWWA C509 Resilient-Seated Gate Valves for Water-Supply Service

B. ANSI/NSF 61 Drinking Water System Components - Health Effects

C. AWWA C550 Protective Epoxy Interior Coating for Valves and Hydrants

PART 2 - PRODUCTS

2.01 RESILIENT-SEATED GATE VALVES

A. Resilient-seated gate valves shall conform to ANSI/AWWA C509 for valves up to 12 inches in diameter and shall conform to ANSI/AWWA C515 for valves 14 inches in diameter and larger.

B. Resilient-seated gate valves shall have ductile iron bodies and bonnets.

C. Stem o-rings shall be replaceable with the valve fully opened and subject to full line pressure.

D. Valves 14 inches and larger installed in vertical pipes with their stems horizontal or in horizontal pipes with their stems horizontal shall be fitted with bronze slides, track rollers, scrapers and a standard by-pass valve to assist the travel of the gate assembly.

E. Valves intended for above ground service shall have flanged end that comply with ANSI B16.1 125 pound.

F. Gate valves intended for underground service shall have mechanical joint ends in accordance with ANSI A21.11 (AWWA C111).

G. Valves 16 through 20 inches nominal size shall be fitted with a three inch by-pass valve. By-pass valves shall comply with AWWA specifications.

H. Valves 24 and 30 inches nominal size shall be fitted with a four inch by-pass valve. By-pass valves shall comply with AWWA specifications.

I. The valve shall turn counter clockwise to open.

J. Underground service valves shall be equipped with a non-rising stem.

K. Aboveground service valves shall be outside screw and yoke, unless shown otherwise on the Drawings.

L. Valves intended for underground service shall be provided with a 2 inch operating nut, valve box and operating extension in accordance with the details shown on the Drawings. Provide necessary accessories for operating underground valve when the stem must be in a horizontal orientation when required by the depth of the proposed piping and valves.

M. Valves intended for aboveground service shall be provided with a hand wheel. Above ground valves shall be rotated so that the operating stem is horizontal and the hand wheel is accessible to a person standing at ground surface.

N. Markings: Markings shall be cast on the bonnet or body of each valve and shall show the manufacturer's name, year the valve casting was made, the size of the valve and the designated working water pressure. An arrow shall indicate the direction of turning to open.

O. Manufacturers: American Flow Control, Clow/Kennedy, Mueller Company, or equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Coatings: Interior and exterior ferrous surfaces of valves that will be in contact with water shall receive a 10 mil dry film thickness thermosetting epoxy coating conforming to AWWA C550. Coating shall be suitable for contact with potable water and shall meet the requirements of ANSI/NSF Standard 61: Drinking Water System Components.

B. All valves shall be installed in strict accordance with the Supplier's published recommendations.

- END OF SECTION -

PROJECT NO. 11842

SECTION 15177

INLINE CHECK VALVES

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install inline check valves, complete and operable, as shown and specified herein, including appurtenances and accessories, all in accordance with the requirements of the Contract Documents.

B. The requirements of the section entitled “Basis Mechanical Requirements” apply to the work of this section.

1.02 SUBMITTALS

A. Shop Drawings: Submit shop drawings in accordance with the section entitled “Submittals”. The shop drawings shall include but not limited to:

1. Manufacturer’s standard literature including head loss, flow data, pressure ratings, and vertical and horizontal opening pressures

2. Dimension drawings for all valves to be supplied

3. Valve manufacture’s recommended installation instructions

B. Operation and Maintenance Manuals: Submit operation and maintenance manuals in accordance with the section entitled “Submittals”.

C. Field Test Reports: Submit field test reports as required by this Section.

1.03 QUALITY ASSURANCE

A. Documented head loss tests are to be provided by the manufacturer. These are to be third party tests performed by a hydraulic testing institute and shall show head loss in open air and submerged conditions. Vertical opening pressure shall be tested and documented.

1.04 MANUFACTURER’S SERVICE REPRESENTATIVE

A. The Contractor shall furnish the services of a qualified manufacturer’s technical representative as described below. If multiple inline check valves are required for the Work, the times and trips apply to each size of inline check valve installed.

1. At least one trip of one day to check and supervise the equipment installation

2. At least one trip of one day to supervise testing and adjustments of the equipment

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Inline check valves shall be WASTOP by WAPRO Inc., no substitutions.

2.02 INLINE CHECK VALVES

A. Inline check valves shall be installed where shown in the Contract Documents. Inline check valves shall be designed to operate in installations using flanges, flat irons, slide muffs, joint couplings, or custom-made mounting tabs/brackets. If required, mounting tables shall be custom extended lengths as required to accommodate installation conditions. Inline check valves shall be designed to operate on an inlet, an outlet, vertically, horizontally, inside pipes, or between two pipes. The housing of the valve should be stainless steel.

B. The membrane should be conical and should be attached to the housing along the top of the membrane, and the outlet side of the housing allowing maximum flow through the membrane. Unless noted otherwise, opening and closing pressures shall conform to the “Standard” valve configuration.

C. Body lengths shall be standard or short body as required by the individual installation. Body length shall take into consideration operation and maintenance activities, including access for future replacement. Valves installed or accessed through manholes shall be short body length.

D. Each inline check valve shall be labeled with flow direction and unique serial number.

E. Materials of construction shall be as follows:

Housing / Tube	316 SS
Membrane	Polyurethane
Sealing/Gasket	EPDM
Collar Plate	316 SS
Whale Tail	Polyethylene
Bracket	316 SS
Nuts, Bolts, Washers	316 SS
Mounting Tabs	316 SS
Seal/Gasket	CR, EPDM
Flanges (when used)	316 SS

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PART 3 - EXECUTION

3.01 GENERAL

A. All valves shall be installed in accordance with manufacturer recommendations and instructions.

3.02 TESTING

A. After installation, the manufacturer shall field-test the valve in the presence of authorized representative of the City. All field tests including but not limited to those specified herein shall be made at the expense of the Contractor

1. A 10-foot head of water shall be introduced on the discharge side of the valve, with leakage not to exceed that recommended by the manufacturer.

2. A head of water shall be introduced on the inlet side of the valve, to verify opening pressures in the submerged and in the dry conditions.

3. Make all necessary equipment adjustments and corrective work indicated by tests.

PART 4 – VALVE SCHEDULE

Valve No.	Sheet No.	Structure Associated	Structure Type	Structure Size	Location	Size	Type
1	2C-02	STIN-13	Catch Basin	6' Diameter	N:638663.79 E:929700.28	24"	Standard
2	2C-14	STIN-12	Catch Basin	6' Diameter	N:637024.67 E:930360.21	24"	Standard
3	2C-12	STMH-350	Manhole	6' Diameter	N:637153.89 E:930277.27	18"	Standard
4	2C-28	STMH-74	Manhole	6'x4.5'	N:639538.91 E:932892.38	36"	Short Body
5	2C-75	STIN-1400	Catch Basin	6' Diameter	N:640225.97 E:936885.64	24"	Standard
6	2C-75	STMH-1500	Manhole	6' Diameter	N:640190.55 E:937161.82	24"	Standard
7	2C-75	STMH-1600	Manhole	5' Diameter	N:640123.16 E:937251.91	18"	Standard

- END OF SECTION -

PROJECT NO. 11842

SECTION 15995

PIPELINE TESTING AND DISINFECTION

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The CONTRACTOR shall perform flushing, disinfection and testing of all pipelines and appurtenant piping, complete, including conveyance of test water from CITY-designated source to point of use and all disposal thereof, all in accordance with the requirements of the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

1.	ANSI / AWWA B300	Hypochlorites
2.	ANSI / AWWA B301	Liquid Chlorine
3.	ANSI / AWWA C651	Disinfecting Water Mains

1.03 SUBMITTALS

A. A testing schedule, including proposed plans for water conveyance, control, and disposal shall be submitted in writing for approval a minimum of seven (7) days before testing is to start.

B. The CONTRACTOR shall submit hydrostatic test reports in accordance with the Sections entitled “Submittals” and “Contract Closeout.”

PART 2 - PRODUCTS

2.01 MATERIALS REQUIREMENTS

A. All test equipment, temporary valves or bulkheads, temporary vents or drains, or other water control equipment and materials shall be determined and furnished by the CONTRACTOR subject to the CITY’S review.

B. No materials shall be used which would be injurious to the construction or its future function.

PROJECT NO. 11842

PART 3 - EXECUTION

3.01 GENERAL

A. Notify the ENGINEER and CITY 48 hours in advance to obtain CITY approval to commence testing and/or disinfection of any particular structure and/or pipeline.

B. Unless otherwise provided herein, water for flushing and testing pipelines will be furnished by the CITY; however, the CONTRACTOR shall make all necessary provisions for conveying the water from the CITY-designated source to the points of use.

C. All pressure and gravity pipelines shall be tested. All testing operations shall be performed in the presence of the CITY.

3.02 FLUSHING

A. At the conclusion of the installation work, the CONTRACTOR shall thoroughly clean all new liquid conveying pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, etc., which may have entered the pipe during the construction period.

B. If after this cleaning any obstructions remain, they shall be corrected by the CONTRACTOR, at the CONTRACTOR's expense, to the satisfaction of the CITY. Liquid conveying pipelines shall be flushed at the rate of at least 2.5 feet per second for a duration suitable to the CITY or shall be flushed by other methods approved by the CITY.

3.03 HYDROSTATIC TESTING OF PIPING

A. Following pipeline flushing, the CONTRACTOR shall hydrostatically test all pipelines either in sections or as a unit. No section of the pipeline shall be tested until all field-placed concrete or mortar have attained an age of 14 days. The test shall be made by closing valves when available, or by placing temporary bulkheads in the pipe and filling the line slowly with water. The CONTRACTOR shall be responsible for ascertaining that all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to, or movement of, the adjacent pipe. Care shall be taken to see that all air vents are open during filling.

B. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb what water it will and to allow the escape of air from any air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the CITY shall be taken.

C. The test pressure for the hydrostatic test shall be 150psi unless noted otherwise.

D. The hydrostatic test shall consist of holding the test pressure on the pipeline for a period of four (4) hours. All visible leaks shall be repaired in a manner acceptable to the CITY.

E. The maximum allowable leakage shall be determined by the following formula:

$$L = \frac{SD\sqrt{P}}{148{,}000}$$

Where: D = Pipe diameter in inches

S = Length of lines in linear feet

P = Average test pressure in pounds per square inch gauge

L = Allowable leakage for system in gallons per hour

F. In the case of pipelines that fail to pass the prescribed leakage test, the CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipelines. The CONTRACTOR shall provide all reaction blocking and necessary plugs and caps required to test all piping installed as part of this Contract.

G. The CONTRACTOR shall submit to the CITY a detailed description of the testing procedures to be utilized.

3.04 FLUSHING

A. All piping shall be flushed clean of all dirt and foreign material following completion of the hydrostatic and leakage test. Air and gas piping shall be purged with air or nitrogen gas as directed by the ENGINEER.

B. Equipment and Supplies. The CONTRACTOR shall provide all equipment, and supplies for performing the work, and shall waste the water at locations or by procedures approved by the ENGINEER.

3.05 DISINFECTION

A. Disinfection of potable water lines shall be performed in accordance with AWWA Standard C-651, State of Florida and local applicable regulations. The CONTRACTOR shall provide a Disinfection Plan to the ENGINEER for approval. The CONTRACTOR shall be responsible for furnishing fittings and all special pipe taps required by the pipe disinfection work.

B. Provide list of equipment required and a disinfection plan to execute the Work of this Section.

C. Inject the required amount of disinfectant to yield a minimum chlorine content of 50 parts per million into piping system.

D. Allow solution to remain in the pipes for twenty-four hours or longer, if required, to destroy all harmful bacteria.

E. Operate all valves and other appurtenances during disinfection to assure the sterilizing mixture is dispersed into all parts of the system.

F. After the solution has been retained for the required time, pipes shall be flushed and filled with municipal domestic water. Sterilizing water shall be disposed of in an approved manner. Sterilizing water shall not be allowed to flow into a waterway without reducing chlorine concentrations to a safe level. The CONTRACTOR shall be responsible for meeting all applicable requirements and acquiring all necessary permits for this work.

G. Take one bacteriological sample and test from every segment of pipeline tested. Samples shall be taken and tested on each of two successive days. CONTRACTOR shall submit sample to a laboratory, approved by ENGINEER, for testing. The disinfection process shall be repeated if laboratory test results reflects presence of harmful bacteria in the water.

3.06 TESTS

A. Provide analysis of treated water to meet standards and received acceptance from the Florida Department of Environmental Protection.

B. Test samples in accordance with AWWA C651.

C. Quality Assurance: Testing Laboratory: Certified for examination of drinking water in compliance with applicable legislation of the State of Florida.

D. Regulatory Requirements: Conform to Chapter 62-555 of the Florida Administrative Code.

E. Submittals

1. Submit name of testing laboratory and evidence of qualification.

2. Submit three copies of reports.

F. Project Record Documents

1. Submit reports under provisions of the Sections entitled “Submittals” and “Contract Closeout.”

2. Bacteriological report; accurately record:

a. Date issued, project name, and testing laboratory name, address, and telephone number.

b. Time and date of water sample collection.

c. Name of person collection sample.

d. Test locations.

e. Initial and twenty-four- hour disinfectant residuals in ppm for each outlet tested.

f. Coliform bacteria test results for each outlet tested.

g. Certification that water conforms, or fails to conform to bacterial standards of State of Florida.

h. Bacteriologist's signature.

3.07 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

B. Prior to actual connections to the existing potable water system, record drawings, hydrostatic pressure test results, and bacterial test results shall be submitted to the ENGINEER. Upon approval from the Department of Environmental Protection, the connection can be constructed.

- END OF SECTION -

APPENDIX

Geotechnical Services Report

RADISE
Infrastructure Engineers • Software Developers

February 8, 2018

Hazen and Sawyer
4000 Hollywood Blvd., Suite 750N
Hollywood, Florida 33201

Attn: Mr. Robert B. Taylor, Jr., P.E.
Office: (954) 987- 0066
Cell: (772) 595- 2535
Email: rbtaylor@hazenandsawyer.com

RE: Geotechnical Services Report
City of Fort Lauderdale
Stormwater Master Plan Modeling and Design Implementation
Broward County, Florida
RADISE Project No: 170901

Dear Mr. Taylor,

RADISE International, LC (RADISE) is pleased to submit this *Geotechnical Services Report* for the above-referenced project. The purpose of this report is to provide geotechnical information and recommendations to aid in the design and construction of the project. This report describes the field exploration and laboratory testing performed, presents the data obtained, and provides our recommendations regarding geotechnical aspects of the of the proposed project.

The study was performed in general accordance with our agreement executed on August 30, 2017 and our scope of work for geotechnical services.

We appreciate the opportunity to work with Hazen and Sawyer on this project, and trust that the information presented is clear. Should you have any questions regarding this report, or if we can be of additional assistance as this project develops, please contact us at (561) 841-0103.

Sincerely,
RADISE International
Infrastructure Engineers & Software Developers

Akash Bissoon, P.E.
Project Engineer
Florida Registration No. 74582

Thomas F. Mullin LICENSE No. 43366 STATE OF FLORIDA PROFESSIONAL ENGINEER

Thomas F. Mullin, P.E.
Chief Engineer &
Geotechnical Services Group Manager
Florida Registration No. 34466

This document has been digitally signed and sealed by Thomas F. Mullin, P.E. on June 11, 2018 using Identrust. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

4152 West Blue Heron Blvd, Suite 1114, Riviera Beach, FL 33404 Phone: 561.841.0103 / Fax: 561.841.0104 www.radise.net
Offices in Miami-Dade, Broward, Palm Beach and Orange Counties

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APPENDIX B

Preliminary Design Geotechnical Services Report

1.0 INTRODUCTION

RADISE understands that the City of Fort Lauderdale is performing a study for seawall replacement designs, stormwater master plan modeling, and design implementation within the City of Fort Lauderdale. To aid in the evaluation and design of the project, RADISE was requested to provide subsoil investigation and evaluation services that included drilling of exploratory borings to determine the subsurface stratigraphy, groundwater levels and physical properties of the soils underlying the site.

The information presented in this report is based upon our interpretation of the subsurface information revealed by the test borings. The report does not reflect variations in subsurface conditions that may exist between or beyond these borings. Variations in soil and groundwater conditions should be expected, the nature and extent of which might not become evident until construction is undertaken. If variations are encountered, and/or the scope of the project altered, we should be consulted for additional recommendations.

2.0 PROJECT DESCRIPTION

The project is located in the City of Fort Lauderdale, Florida and includes seven (7) neighborhoods and twelve (12) seawall segments located east of interstate highway (I-95) and between the Port Everglades Expressway and Sunrise Boulevard. The approximate locations and limits of the seawall and neighborhood projects are shown on the attached *Vicinity Map*, Sheet 1.

The stormwater systems for the seven (7) neighborhoods are proposed to provide improved flood protection and enhanced water quality treatment by using Best Management Practices (BMPs). The proposed stormwater collection and conveyance systems will include, but are not limited to:

- Swales
- Inlets and catch basins
- Exfiltration trenches
- Dry and wet retention systems (basins)
- Backflow prevention valves
- Underdrain systems
- Stormwater pump stations
- Electrical equipment buildings
- Outfalls
- Control structures
- Drainage wells
- Green infrastructure such as bio-swales and precast porous pavement

In addition, detailed designs for twelve (12) seawall segments are proposed. Seawall and neighborhood boring location information is summarized in Table 1 and Table 2.

Table 1 – Seawall Location Information

Seawall	Boring No.	Boring Location Remarks	Asphalt Thickness (inches)	Base Course Thickness* (inches)
Seawall 9	S-28	Inside Victoria Park. At the intersection of Broward Boulevard and North Victoria Park Road.	-	-
Seawall 10	S-29	At the intersection of SE 23rd Avenue and Del Mar Place. Approximately 450 feet north of E Las Olas Boulevard.	3.75	4.5
Seawall 12	S-15	South side of E Las Olas Boulevard, between Lido Drive and San Marco Drive.	-	-
Seawall 13	S-14	South side of E Las Olas Boulevard, between San Marco Drive and Coral Way.	-	-
Seawall 14	S-13	South side of E Las Olas Boulevard, between Coral Way and Royal Plaza Drive.	-	-
Seawall 15	S-9	On the east side of Isle of Palms Drive. Approximately 800 feet south of E Las Olas Boulevard.	4.5	6.0
	S-10	On the east side of Isle of Palms Drive. Approximately 570 feet south of E Las Olas Boulevard.	5.25	4.0
	S-11	On the east side of Isle of Palms Drive. Approximately 350 feet south of E Las Olas Boulevard.	5.75	6.0
	S-12	On the east side of Isle of Palms Drive. Approximately 120 feet south of E Las Olas Boulevard.	6.25	6.0
Seawall 17	S-8	On the south side of SE 5th Street. Approximately 75 feet west of the intersection of Riviera Isle Drive and SE 5th Street.	6.5	6.0
Seawall 29	S-17	On the east side of Cordova Road. Between SE 7th Street and SE 8th Street. Approximately 230 feet south of the intersection of Cordova Road and SE 7th Street.	12.0	6.0
	S-18	On the east side of Cordova Road. Between SE 8th Street and SE 9th Street. Approximately 175 feet south of the intersection of Cordova Road and SE 8th Street.	9.5	5.0
	S-19	On the east side of Cordova Road. Between SE 8th Street and SE 9th Street. Approximately 400 feet south of the intersection of Cordova Road and SE 8th Street.	8.25	6.0
	S-20	On the east side of Cordova Road. Between SE 8th Street and SE 9th Street. Approximately 175 feet south of the intersection of Cordova Road and SE 8th Street.	9.0	5.0
	S-21	On the east side of Cordova Road. Between SE 8th Street and SE 9th Street. Approximately 220 feet south of the intersection of Cordova Road and SE 9th Street.	5.75	6.0

Seawall	Boring No.	Boring Location Remarks	Asphalt Thickness (inches)	Base Course Thickness* (inches)
	S-22	On the east side of Cordova Road. Between SE 10th Street and SE 11th Street. Approximately 215 feet south of the intersection of Cordova Road and SE 10th Street.	5.0	5.0
	S-23	On the east side of Cordova Road. Between SE 11th Street and SE 12th Street. Approximately 160 feet south of the intersection of Cordova Road and SE 11th Street.	5.0	8.0
Seawall 30	S-26	On the south side of SE 10th Street. Approximately 2,000 feet east of the intersection of Cordova Road and SE 10th Street.	5.25	6.0
	S-27	On the south side of SE 10th Street. Approximately 2,250 feet east of the intersection of Cordova Road and SE 10th Street.	3.75	5.0
Seawall 32	S-16	On Mola Avenue. Approximately 775 feet south of the intersection of SE 17th Way and Mola Avenue.	-	-
Seawall 34	S-30	Located on the north side of Barcelona Drive. At the northeast quadrant of Barcelona Drive and NE 26th Terrace.	3.5	6.0
Seawall 35	S-24	Located on the south side of SE 8th Street. Approximately 1,000 feet east of Cordova Road.	4.5	6.0
	S-25	Located on the south side of SE 8th Street. Approximately 1,335 feet east of Cordova Road.	4.5	6.0

*Base course thicknesses were measured in the field to the nearest half inch.

Table 2 – Neighborhood Location Information

Neighborhood	Boring No.	Boring Location Remarks	Asphalt Thickness (inches)	Base Course Thickness* (inches)
Durrs	D-1	Intersection of NW 9th Street and NW 17th Avenue.	4.0	5.0
	D-2	Intersection of NW 16th Avenue and NW 8th Street.	7.0	3.0
	D-3	On NW 19th Avenue. Approximately 60 feet south of the intersection of NW 19th Avenue and NW 7th Street.	4.0	8.0
	D-4	Intersection of NW 8th Street and NW 13th Terrace.	1.3	3.0
	D-5	On the west side of NW 14th Way. Approximately 170 feet north of the intersection of NW 14th Way and NW 6th Street.	3.2	3.0

Neighborhood	Boring No.	Boring Location Remarks	Asphalt Thickness (inches)	Base Course Thickness* (inches)
Dorsey Riverbend	DR-1	Approximately 160 feet north of NW 5th Street, between NW 15th Terrace and NW 15th Avenue.	-	-
	DR-2	On the east side of NW 15th Avenue. Approximately 200 feet north of the intersection of NW 15th Street and NW 15th Avenue.	-	-
	DR-3	Intersection of NW 4th Street and NW 15th Avenue.	5.0	6.0
	DR-4	Approximately 75 feet north of the intersection of NW 4th Street and NW 18th Avenue.	5.2	1.0
	DR-5	On the west side of NW 18th Avenue, approximately 130 feet south of the intersection of NW 6th Street and NW 18th Avenue.	1.0	2.0
Edgewood	E-1	Intersection of SW 15th Avenue and SW 32nd Court.	1.2	4.0
	E-2	Intersection of SW 15th Avenue and SW 31st Street.	3.7	4.0
	E-3	Intersection of SW 15th Avenue and SW 29th Street.	2.2	4.0
	E-4	On SW 30th Street. Approximately 400 feet east of the intersection of SW 15th Avenue and SW 30th Street.	3.2	4.0
	E-5	On SW 32nd Street. Approximately 400 feet east of the intersection of SW 15th Avenue and SW 32nd Street.	2.0	6.0
	E-6	Intersection of SW 14th Avenue and SW 28th Street.	1.7	9.0
	E-7	On SW 28th Street. Approximately 620 feet east of the intersection of SW 12th Avenue and SW 28th Street.	4.7	6.0
	E-8	On SW 12th Avenue, between SW 31st Street and SW 32nd Street.	1.5	4.0
	E-9	On SW 29th Street. Approximately 240 feet east of the intersection of SW 12th Avenue and SW 29th Street.	-	-
	E-10	On SW 9th Avenue, between SW 30st Street and SW 31st Street.	6.0	3.0

Neighborhood	Boring No.	Boring Location Remarks	Asphalt Thickness (inches)	Base Course Thickness* (inches)
	E-11	Intersection of SW 8th Avenue and SW 30th Street.	3.7	4.0
	E-12	Intersection of SW 8th Avenue and SW 28th Street.	5.0	4.0
	E-13	On SW 9th Avenue, between SW 26th Court and SW 27th Court.	1.7	6.0
	E-14	On the west side of S Andrews Avenue. Near the intersection of S Andrews Avenue and SE 26th Street.	3.5	4.0
	E-15	On S Andrews Avenue. Between SE 30th Street and SE 31st Street.	3.0	4.0
Progresso	P-1	On the east side of SW 4th Avenue. Approximately 100 feet north of the intersection of Himmarshee Street and SW 4th Avenue.	3.0	4.0
	P-2	On NW 5th Avenue. Approximately 150 feet north of the intersection of Broward Boulevard and NW 5th Avenue.	3.2	2.0
	P-3	Intersection of NW 2nd Street and NW 4th Avenue.	2.7	6.0
	P-4	Intersection of NW 7th Street and NW 3rd Avenue.	1.2	8.0
	P-5	Intersection of NW 7th Street and NW 3rd Avenue.	-	-
	P-6	Approximately 130 feet north of NW 8th Street and between NW 4th Avenue and NW 3rd Avenue.	-	-
	P-7	On NW 7th Avenue. Between NW 5th Street and NW 4th Street.	2.0	7.0
	P-8	Intersection of NW 7th Street and NW 7th Terrace.	1.7	7.0
River Oaks	R-1	On SW 15th Avenue. Approximately 100 feet north of the intersection of SW 15th Avenue and Marina Boulevard.	2.7	6.0
	R-2	On SW 15th Avenue. Between SW 22nd Avenue and SW 23rd Street.	1.5	8.0
	R-3	On SW 24th Street. Between SW 18th Terrace and SW 24th Street.	1.5	6.0
	R-4	At the intersection of SW 17th Avenue and SW 22nd Street.	1.0	6.0

Neighborhood	Boring No.	Boring Location Remarks	Asphalt Thickness (inches)	Base Course Thickness* (inches)
	R-5	On SW 19th Avenue. Between SW 21st Street and SW 22nd Street.	1.7	6.0
	R-6	On SW 20th Street. Between SW 15th Avenue and Coconut Drive.	5.0	10.0
	R-7	At the intersection of SW 18th Court and SW 14th Avenue.	2.0	8.0
	R-8	At the intersection of SW 17th Street and SW 13th Avenue.	1.2	9.0
	R-9	Approximately 610 feet west of the intersection of SW 19th Avenue and SW 21st Street. Near a wooded area.	-	-
	R-10	Approximately 550 feet west of the intersection of SW 19th Avenue and SW 21st Street. Near a wooded area.	-	-
	R-11	Approximately 150 feet north west of the intersection of SW 19th Avenue and SW 23rd Court.	-	-
	R-12	Approximately 240 feet north west of the intersection of SW 19th Avenue and SW 23rd Court.	-	-
	R-13	Intersection of SW 18th Court and SW 10th Avenue.	1.7	9.0
Southeast Isles	S-1	Approximately 65 feet west of the intersection of SE 17th Way and Mola Avenue.	-	-
	S-2	On the south side of E Las Olas Boulevard, between SE 18th Avenue and Lido Drive.	-	-
	S-3	On the west side of Lido Drive, approximately 130 feet south of the intersection of E Las Olas Boulevard and Lido Drive.	-	-
	S-4	On the south side of E Las Olas Boulevard, between Royal Plaza Drive and Isle of Palms Drive.	-	-
	S-5	On the south side of E Las Olas Boulevard. Approximately 100 feet west of the intersection of E Las Olas Boulevard and Sunset Drive.	-	-

Neighborhood	Boring No.	Boring Location Remarks	Asphalt Thickness (inches)	Base Course Thickness* (inches)
	S-6	In the south east quadrant of the intersection of E Las Olas Boulevard and Poinciana Drive. In Merle Fogg Park.	-	-
	S-7	In the south east quadrant of the intersection of E Las Olas Boulevard and Poinciana Drive. In Merle Fogg Park.	-	-
Victoria Park	V-1	Intersection of NE 6th Street and NE 10th Avenue.	3.0	7.0
	V-2	Intersection of NE 6th Street and NE 16th Avenue.	7.0	4.0
	V-3	Intersection of NE 9th Street and NE 15th Avenue.	2.0	6.0
	V-4	Intersection of NE 8th Street and NE 16th Terrace.	3.8	3.0
	V-5	Intersection of NE 7th Street and NE 17th Way.	1.0	7.0
	V-6	On Victoria Trace. Approximately 250 feet north of the intersection of NE 5th Street and Victoria Way.	2.0	7.0
	V-7	Intersection of NE 20th Avenue and NE 19th Avenue.	3.0	6.0
	V-8	Intersection of NE 20th Avenue and NE 7th Street.	5.0	6.0
	V-9	Approximately 160 feet east of the intersection of NE 20th Avenue and NE 7th Street.	-	-
	V-10	On NE 20th Avenue. Approximately 900 feet north of the intersection of NE 20th Avenue and NE 7th Street.	2.2	9.0

*Base course thicknesses were measured in the field to the nearest half inch.

A review of the asphalt and base rock thicknesses data tabulated in Tables 1 and 2 for the various Seawall and Neighborhood projects, indicates that there are a number of apparent cores with either thin or thick pavement layers. Discussion of the nature and locations of deficient cores along with comparisons to more current day pavement design sections, is included in Section 7.4 - Pavement Design Considerations of this report.

3.0 PURPOSE AND SCOPE OF WORK

The purpose of this study was to perform a limited exploration of the subsurface conditions within the project proposed areas, to aid in the planning and design of the overall neighborhood site drainage infrastructure and seawalls.

More specifically, the purpose of the work included the following:

- Development of the anticipated soil profiles and the subsurface conditions within the depth of influence at the seawall structure locations and anticipated stormwater management infrastructure improvements.
- Identification of critical geotechnical design or construction considerations based on the soil and groundwater conditions encountered in the borings.

RADISE performed the following services in accordance with the proposed scope of work:

1. Visited the sites to field mark (paint or/and stake) the planned soil boring test locations and observe existing site conditions.

2. Contacted Sunshine 811 to request the field location and clearance of underground utilities in the areas of the proposed borings, as per Florida Statutes.

3. Set up Maintenance of Traffic (MOT) safety controls prior to and during the field drilling operations.

4. Mobilized drilling equipment to the site to perform:

    - Fifty (50) Standard Penetration Test (SPT) soil borings within the various seven (7) neighborhoods. Borings were drilled to depths of fifteen (15) feet

    - Thirty-six (36) SPT borings within the seawall and pump station locations. Borings were drilled to depths of 50 feet below the existing ground surface.

    - Asphalt pavement cores at sixty- eight (68) of the SPT boring locations.

    Samples of the subsurface soils encountered in the SPT borings were obtained and placed in labeled air-tight containers. The depth to the groundwater level was measured and recorded for each of the borings. Following completion of the groundwater measurements, the boreholes were backfilled with neat cement grout.

5. Visually classified the SPT soil samples retrieved from the soil borings in accordance with the Unified Soil Classification System (USCS) using the Visual-Manual Procedure in general accordance with the American Society of Testing and Materials (ASTM) test method D 2488, *Description and Identification of Soils*.

6. Reviewed, assigned and performed a limited laboratory testing program for soil index property determinations on selected SPT samples to aid in the classification process in general accordance with the ASTM test method D 2487, *Classification of Soils for Engineering Purposes*.

7. Prepared this Geotechnical Services Report to summarize the results of the field exploration and laboratory testing, and to present our findings, evaluations and design recommendations.

8. Reviewed and incorporated our Geotechnical Services Report prepared for the preliminary design of this project. The preliminary design Geotechnical Services Report is included in Appendix B of this report.

4.0 FIELD EXPLORATION

During this work phase, MOT was used to protect our field personnel, equipment, and the general public. The MOT was designed and set up in accordance with the FDOT Design Standards.

4.1 CORING

The field exploration program to evaluate the existing asphalt pavement thicknesses consisted of a total of sixty-eight (68) Pavement Cores, sampled at each of the sixty-eight of the SPT borings locations. The approximate boring locations are shown on the attached *Boring Location Plan*, Sheets 2A through 2Q.

Tables 1 and 2 in Section 1.0 presents a summary of the measured asphalt section thickness and the base thickness at the boring locations. Latitude and Longitude coordinates of the boring locations were obtained by the field crew using hand-held GPS equipment.

Pavement Core samples were obtained at sixty-eight (68) locations using a portable electric stand-up core drill with a 6-inch diameter diamond tipped core drill bit. Upon removal of the asphalt core, a hand-held power auger and a hand operated bucket-type auger were used to loosen the base course material and to clean out the borehole. Subsequent down-hole field measurements were made using a surveyor's tape to document the approximate thickness and composition of the encountered pavement base course materials.

Representative samples of the base course, obtained from the hand bucket-type auger, were placed in moisture proof bags and transported to our laboratory. The samples were then examined by a geotechnical engineer in the lab to confirm the field classifications.

4.2 SOIL BORINGS

The field exploration program to evaluate the existing subsurface conditions consisted of drilling eighty-six (86) SPT borings. Fifty (50) of the SPT soil borings were drilled to depths of fifteen (15) feet below the existing ground surface within the various seven (7) neighborhoods and thirty-six (36) of the SPT borings were drilled to depths of 50 feet in the vicinity of the seawall and pump station locations. The approximate locations of the SPT borings are depicted on the attached Boring Location Plan, Sheets 2A through 2Q. Latitude and Longitude coordinates of the test locations were obtained by the field crew using hand-held GPS equipment and are listed on the attached Subsurface Profiles, Sheets 3A through 10D.

The SPT borings were performed in general accordance with ASTM D 1586, "Standard Test Method for the Standard Penetration Test and Split-Barrel Sampling". Upon retrieval, the split-spoon, soil samples were visually classified and placed in moisture proof containers for transportation to our laboratory. Each borehole was backfilled with neat cement grout to the ground surface after the completion of drilling, sampling and monitoring operations.

4.3 GROUNDWATER LEVEL MEASUREMENTS

After completion of the borings and after a short stabilization period, the depth to the groundwater was measured from the existing ground surface in each boring. The measured groundwater depth/elevation is plotted adjacent to the soil profiles shown on the attached *Subsurface Profiles*, Sheets 3A through 10D.

5.0 LABORATORY TESTING

5.1 GENERAL

Representative soils samples collected from the borings were visually reviewed in the laboratory by a RADISE Geotechnical Engineer to confirm field classifications. The samples were classified in general accordance with the Unified Soil Classification System (USCS). The classifications were based on visual observations supplemented by laboratory test results performed on selected representative SPT samples. Laboratory index tests consisting of Full Sieve Analysis, Percent Passing No. 200 Sieve, Moisture, Atterberg limits, and Organics Content tests were performed on selected samples to further confirm and finalize field soils classifications.

5.2 LABORATORY TEST RESULTS

Test assignments were provided by a Geotechnical Engineer during the laboratory review of secured soil samples. Laboratory assignments were made to supplement and confirm soil classification at each general boring location.

The following list summarizes the types and numbers of laboratory tests performed.

- Ninety-six (96) Moisture Content Tests (ASTM D 2216).
- Sixty-two (62) Organics Content Tests (ASTM 2216 D).
- Twenty-six (26) Full Sieve Analysis Test (ASTM D422).
- Fifteen (15) Percent Passing No. 200 Sieve Tests (ASTM D 1140).
- Three (3) Atterberg limits tests (ASTM D 4318).

All of the laboratory test results are presented on the attached *Subsurface Profiles*, Sheet 3A through 10D, and on Table A - *Laboratory Test Results Summary* in Appendix A.

6.0 SURFACE AND SUBSURFACE EXPLORATION

6.1 STRATIGRAPHY

Stratification of the explored soils is based on visual examination of the recovered soil samples, index testing, laboratory classification and interpretation of the field boring logs by a geotechnical engineer in accordance with the Unified Soil Classification System (USCS). Subsurface profiles showing the soil stratification at the boring locations were developed and are presented on the attached *Subsurface Profiles*, Sheets 3A through 10D. Stratification lines represent approximate boundaries between soil types, but the actual transition between layers may be gradual or abrupt. Additionally, soil and groundwater conditions will vary between boring locations.

The soils encountered in all eighty-six (86) of the soil borings generally consist of sand with varying amounts of silt and limestone fragments mostly underlain by limestone. Some of the borings encountered a layer of soil containing appreciable amounts of organic matter. Generalized descriptions of the soil stratigraphy are provided in Table 3:

TABLE 3 - STRATIGRAPHY

Stratum No.	Description	USCS Class.
1	Brown, fine to medium SAND, occasionally with Gravel, Limestone fragments, and Silt	SP, SP-SM
2	Gray, fine to medium Silty SAND, occasionally with Gravel and Limestone fragments	SM
3	Gray, Sandy SILT	ML
4	Tan to gray, LIMESTONE	-
5	Tan, Sandy LIMESTONE	-
6	Dark Brown Organic Material	PT

It is noted that the Layer 6 Dark Brown Organic Material were primarily encountered in the borings performed in the River Oaks, Seven Isles, and Victoria Park neighborhoods. Review of the boring logs and boring locations for the River Oaks neighborhood area indicates organic material was encountered in the borings performed in an undeveloped, wooded area adjacent to the east side of Interstate I-95 and just south of the South Fork New River. It appears this area contains a layer of fill soils placed over organic soils along the south side of the South Fork New River. Review of the boring logs and boring locations for the Seven Isles and Victoria Park neighborhood areas indicates there appear to be layers of fill soils which were placed over remnant buried mangrove preserve areas along the Intracoastal Waterway. This land reclamation occurred during early development periods in the history of the coastal Ft. Lauderdale area.
Table 4 summarizes the borings, depths and thickness of the Stratum 6 soils that contain 5.3 to 67.3 percent organics encountered:

TABLE 4 – STRATUM 6 SOILS (PEAT)

Boring No.	Depth from (feet)	Depth to (feet)	Organic layer thickness (feet)
R-9	2	6	4
R-10	2	4	2
R-12	4	6	2
S-2	4	10	6
S-3	6	8	2
S-4	4	8	4
S-5	4	10	6
S-8	2	6	4
S-14	4	9	5
S-15	4	9	5
S-16	4	6	2
S-17	4	12	8
S-18	4	12	8
S-19	4	12	8
S-20	4	8	4
S-21	4	6	2
S-22	8	12	4
S-23	8	12	4
S-23	8	10	2
S-27	8	10	2
S-28	0	2	2
S-29	6	10	4
S-30	2	6	4

Boring No.	Depth from (feet)	Depth to (feet)	Organic layer thickness (feet)
S-30	10	15	5
V-1	4	8	4
V-7	4	8	4
V-8	4	10	6
V-10	8	10	2

6.2 GROUNDWATER LEVELS

Groundwater was encountered in each of the SPT borings. The groundwater level varied between 0.5 to 6.5 feet below the existing ground surface. It is our recommendation that the seasonal high groundwater table levels along the various project infrastructure alignments, be based on the normal high tide water levels of the adjacent waterways existing near the various neighborhood project areas and with additional geotechnical explorations. In inland areas not directly influenced by the water levels in the adjacent waterways and canals, normal high groundwater levels can be expected to be on the order of as much as two feet above the measured groundwater levels in the borings. It should be noted that the groundwater levels will fluctuate with variations of precipitation.

Borings P-4 and P-7 encountered groundwater at 0.5 feet below the existing ground surface. These two boings were performed in the Progresso neighborhood and the high groundwater is suspected be caused by adjacent exfiltration trenches which were filled up from recent storm events.

7.0 ENGINEERING CONSIDERATIONS AND RECOMMENDATIONS

The soils encountered in the majority of the borings performed for this study will be suitable for the proposed construction. However, it was previously noted that the portions of the River Oaks, Victoria Park and Seven Isles areas are likely historical land reclamation areas. These areas as well as several others in the surrounding region, were infilled sometime in the historical past to facilitate the construction of the present residential communities.

The presence of the buried organics will be problematic to the installation of underground utilities especially when the inverts of such systems are founded in the organic layers. Such organics have very low shear strengths and will not support significant excavations made within or through them. As such, it is anticipated that the significant use of sliding trench boxes/shoring/sheet piling will be required to install infrastructure systems in this area.

Lift station structures are anticipated to be constructed well into the underlying sands and limestones. Uplift flotation resistance may be a concern for their design and construction. The buried organics encountered are expected to have little effect on the stability of the wet well structures in the ground since the bottom of the wet wells will be bearing in the sand and limestone layers. Sheet piling will likely be required to support excavations for these deep structures.

Valve vault and pavement structures are anticipated to be constructed above the buried organics. The organic material can remain in-place and a geogrid layer can be placed below the bottom of the valve vault and pavement bedding materials during construction.

7.1 SEAWALL STRUCTURE DESIGN RECOMMENDATIONS

We understand new seawalls are proposed on to be constructed within18 inches on the water side of the existing seawalls. A #57 stone backfill is proposed for filling between the existing seawalls and the new seawalls. Twelve (12) separate seawall segments are proposed. Twenty-three (23) SPT borings were performed for the seawall structures. The adjacent roadway or park, approximate wall length, and borings performed for each wall are presented in Table 5:

Table 5 – Sea Wall Locations and Lengths

Seawall Number	Adjacent to	Approximate Length of Wall (feet)	Borings
Seawall 9	Victoria Park	110	S-28
Seawall 10	NE 23rd Avenue	275	S-29
Seawall 12	E Las Olas Boulevard	90	S-15
Seawall 13	E Las Olas Boulevard	80	S-14
Seawall 14	E Las Olas Boulevard	90	S-13
Seawall 15	Isle of Palms Drive	910	S-9 through S-12
Seawall 17	SE 5th Street	170	S-8
Seawall 29	Cordova Road	2,440	S-17 through S-23
Seawall 30	SE 10th Street	360	S-26 and S-27
Seawall 32	Mola Avenue	215	S-16
Seawall 34	Barcelona Drive	110	S-30
Seawall 35	SE 8th Street	550	S-24 and S-25

7.1.1 SOIL DESIGN PARAMETERS FOR SEAWALLS

Geotechnical soil design parameters for the seawall systems were derived based on field data, laboratory test data, established empirical correlations based on SPT N-values, and our experience. The design soil parameters were developed on an average boring soil profile/per wall basis.

The proposed seawalls will be subjected to lateral earth pressures. The final design elevation of the wall base was not decided and provided at the time of this study. The seawalls will be subjected to lateral at-rest or active earth pressures acting in the direction of the adjacent canal. We have also assumed that adequate drainage provisions will be incorporated into the wall design as needed to prevent hydrostatic build up behind the walls where practical.

The lateral active earth pressures acting on the roadway side of the seawalls, will primarily be resisted by the lateral wall resistance resulting from the wall embedment below the canal side ground elevation exterior face of the wall. The recommend soil parameters with respect to strata are presented in Tables 6 through 17. Input parameters for LPILE are also included in Tables 6 through 17. LPILE is a special-purpose program published by ENSOFT Inc and is used for analyzing a single pile (or drilled shaft) under lateral loading using the p-y method.

Table 6 – Recommended Soil Parameters for Seawall #9 (Boring S-28)

Depth [1] (ft. – ft.)	Average N_{ES}	Recommended Values					Earth Pressure (Rankine's) Coefficients			LPILE Parameters			Soil Class. (USCS/ Soil Type)
		Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Wall Friction Angle (Degrees) with Steel	Wall Friction Angle (Degrees) with Concrete	Active, Ka	Passive, Kp	At rest, K_O	Cohesion (psf)	Subgrade Modulus (k, pci)	E50 [2]	
0 – 2	4	22	75	13	11	14	0.455	2.198	0.625	–	5	–	PT
2 – 4	4	29	102	40	16	22	0.347	2.882	0.515	–	10	–	SM
4 – 6	14	36	110	48	19	26	0.260	3.852	0.412	–	30	–	Limestone
6 – 10	6	30	105	43	16	23	0.333	3.000	0.500	–	12	–	Limestone
10 – 20	15	37	110	48	20	26	0.249	4.023	0.398	–	35	–	Limestone
20 – 25	1	28	105	43	15	21	0.361	2.770	0.531	–	5	–	Limestone
25 – 30	29	40	115	53	22	26	0.217	4.599	0.357	4,000	1,000	0.004	Limestone[3]
30 – 40	76	38	115	53	17	22	0.238	4.204	0.384	–	125	–	SP
40 – 45	4	29	105	43	16	22	0.347	2.882	0.515	–	10	–	Limestone
45 – 50	12	36	110	48	19	26	0.260	3.852	0.412	–	25	–	Limestone

Note: 1. Depth below the existing ground surface.
2. E50 is soil stain parameters for LPILE software analysis.
3. Hard Limestone layer should be modeled as Hard to Stiff Clay in LPILE software analysis.
4. Wall friction angle is based on Table 3-3 in the US Army Corps of Engineers Manual (Design of Sheet Pile Walls, EM 1110-2-2504).

Table 7 – Recommended Soil Parameters for Seawall #10 (Boring S-29)

Depth [1] (ft. – ft.)	Average N_{ES}	Recommended Values					Earth Pressure (Rankine's) Coefficients			LPILE Parameters			Soil Class. (USCS/ Soil Type)
		Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Wall Friction Angle (Degrees) with Steel	Wall Friction Angle (Degrees) with Concrete	Active, Ka	Passive, Kp	At rest, K_O	Cohesion (psf)	Subgrade Modulus (k, pci)	E50 [2]	
0 – 6	17	32	114	52	17	22	0.307	3.255	0.470	–	40	–	SP, SP-SM
6 – 10	11	24	82	20	12	15	0.422	2.371	0.593	–	10	–	PT
10 – 40	18	38	110	48	21	26	0.238	4.204	0.384	–	45	–	Limestone
40 – 50	34	40	115	53	22	26	0.217	4.599	0.357	4,000	1,000	0.004	Limestone[3]

Note: 1. Depth below the existing ground surface.
2. E50 is soil stain parameters for LPILE software analysis.
3. Hard Limestone layer should be modeled as Hard to Stiff Clay in LPILE software analysis.
4. Wall friction angle is based on Table 3-3 in the US Army Corps of Engineers Manual (Design of Sheet Pile Walls, EM 1110-2-2504).

Table 8 – Recommended Soil Parameters for Seawall #12 (Boring S-15)

Depth [1] (ft. – ft.)	Average N_{ES}	Recommended Values: Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Wall Friction Angle (Degrees): with Steel	Wall Friction Angle (Degrees): with Concrete	Earth Pressure (Rankine's) Coefficients: Active, Ka	Passive, Kp	At rest, K_O	LPILE Parameters: Cohesion (psf)	Subgrade Modulus (k, pci)	E50 [2]	Soil Class. (USCS/ Soil Type)
0 – 4	14	31	110	48	17	22	0.320	3.124	0.485	–	30	–	SP, SP-SM
4 – 9	5	22	75	13	11	14	0.455	2.198	0.625	–	5	–	PT
9 – 50	17	37	110	48	20	26	0.249	4.023	0.398	–	40	–	Limestone

Note: 1. Depth below the existing ground surface.
2. E50 is soil stain parameters for LPILE software analysis.
3. Wall friction angle is based on Table 3-3 in the US Army Corps of Engineers Manual (Design of Sheet Pile Walls, EM 1110-2-2504).

Table 9 – Recommended Soil Parameters for Seawall #13 (Boring S-14)

Depth [1] (ft. – ft.)	Average N_{ES}	Recommended Values: Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Wall Friction Angle (Degrees): with Steel	Wall Friction Angle (Degrees): with Concrete	Earth Pressure (Rankine's) Coefficients: Active, Ka	Passive, Kp	At rest, K_O	LPILE Parameters: Cohesion (psf)	Subgrade Modulus (k, pci)	E50 [2]	Soil Class. (USCS/ Soil Type)
0 – 4	14	32	114	52	17	22	0.307	3.255	0.470	–	30	–	SP, SP-SM
4 – 9	6	22	75	13	11	14	0.455	2.198	0.625	–	5	–	PT
9 – 50	15	37	110	48	20	26	0.249	4.023	0.398	–	35	–	Limestone

Note: 1. Depth below the existing ground surface.
2. E50 is soil stain parameters for LPILE software analysis.
3. Wall friction angle is based on Table 3-3 in the US Army Corps of Engineers Manual (Design of Sheet Pile Walls, EM 1110-2-2504).

Table 10 – Recommended Soil Parameters for Seawall #14 (Boring S-13)

Depth [1] (ft. – ft.)	Average N_{ES}	Recommended Values					Earth Pressure (Rankine's) Coefficients			LPILE Parameters			Soil Class. (USCS/ Soil Type)
		Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Wall Friction Angle (Degrees) with Steel	Wall Friction Angle (Degrees) with Concrete	Active, Ka	Passive, Kp	At rest, K_O	Cohesion (psf)	Subgrade Modulus (k, pci)	E50 [2]	
0 – 2	17	32	114	52	17	22	0.307	3.255	0.470	–	40	–	SP
2 – 8	10	30	106	44	16	22	0.333	3.000	0.500	–	20	–	SP-SM (Gravelly Sand)
8 – 10	6	30	106	44	16	22	0.333	3.000	0.500	–	12	–	SM
10 – 35	18	38	110	48	21	26	0.238	4.204	0.384	–	45	–	Limestone
35 – 40	10	30	105	43	16	22	0.333	3.000	0.500	–	20	–	Limestone
40 – 50	26	40	115	53	22	26	0.217	4.599	0.357	4,000	1,000	0.004	Limestone[3]

Note: 1. Depth below the existing ground surface.
2. E50 is soil stain parameters for LPILE software analysis.
3. Hard Limestone layer should be modeled as Hard to Stiff Clay in LPILE software analysis.
4. Wall friction angle is based on Table 3-3 in the US Army Corps of Engineers Manual (Design of Sheet Pile Walls, EM 1110-2-2504).

Table 11 – Recommended Soil Parameters for Seawall #15 (Boring S-10)

Depth [1] (ft. – ft.)	Average N_{ES}	Recommended Values					Earth Pressure (Rankine's) Coefficients			LPILE Parameters			Soil Class. (USCS/ Soil Type)
		Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Wall Friction Angle (Degrees) with Steel	Wall Friction Angle (Degrees) with Concrete	Active, Ka	Passive, Kp	At rest, K_O	Cohesion (psf)	Subgrade Modulus (k, pci)	E50 [2]	
0 – 4	17	32	114	52	17	22	0.307	3.255	0.470	–	40	–	SP-SM
4 – 8	9	30	106	44	16	22	0.333	3.000	0.500	–	17	–	SP
8 – 20	15	37	110	48	20	26	0.249	4.023	0.398	–	35	–	Limestone
20 – 25	10	30	105	43	16	22	0.333	3.000	0.500	–	20	–	Limestone
25 – 45	13	36	110	48	19	26	0.260	3.852	0.412	–	30	–	Limestone
9 – 50	10	30	105	43	16	22	0.333	3.000	0.500	–	20	–	Limestone

Note: 1. Depth below the existing ground surface.
2. E50 is soil stain parameters for LPILE software analysis.
3. Wall friction angle is based on Table 3-3 in the US Army Corps of Engineers Manual (Design of Sheet Pile Walls, EM 1110-2-2504).
4. Wall friction angle is based on Table 3-3 in the US Army Corps of Engineers Manual (Design of Sheet Pile Walls, EM 1110-2-2504).

Table 12 – Recommended Soil Parameters for Seawall #17 (Boring S-8)

Depth [1] (ft. – ft.)	Average N_{ES}	Recommended Values					Earth Pressure (Rankine's) Coefficients			LPILE Parameters			Soil Class. (USCS/ Soil Type)
		Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Wall Friction Angle (Degrees) with Steel	Wall Friction Angle (Degrees) with Concrete	Active, Ka	Passive, Kp	At rest, K_O	Cohesion (psf)	Subgrade Modulus (k, pci)	E50 [2]	
0 – 2	14	31	110	48	17	22	0.320	3.124	0.485	–	32	–	SP
2 – 6	5	22	75	13	11	14	0.455	2.198	0.625	–	5	–	PT
6 – 10	10	30	106	44	16	22	0.333	3.000	0.500	–	20	–	SP-SM
10 – 15	19	31	110	48	11	14	0.320	3.124	0.485	–	30	–	ML
15 – 40	17	37	110	48	20	26	0.249	4.023	0.398	–	40	–	Limestone
40 – 50	33	40	115	53	22	26	0.217	4.599	0.357	4,000	1,000	0.004	Limestone[3]

Note: 1. Depth below the existing ground surface.
2. E50 is soil stain parameters for LPILE software analysis.
3. Hard Limestone layer should be modeled as Hard to Stiff Clay in LPILE software analysis.
4. Wall friction angle is based on Table 3-3 in the US Army Corps of Engineers Manual (Design of Sheet Pile Walls, EM 1110-2-2504).

Table 13 – Recommended Soil Parameters for Seawall #29 (Boring S-22)

Depth [1] (ft. – ft.)	Average N_{ES}	Recommended Values					Earth Pressure (Rankine's) Coefficients			LPILE Parameters			Soil Class. (USCS/ Soil Type)
		Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Wall Friction Angle (Degrees) with Steel	Wall Friction Angle (Degrees) with Concrete	Active, Ka	Passive, Kp	At rest, K_O	Cohesion (psf)	Subgrade Modulus (k, pci)	E50 [2]	
0 – 4	11	31	110	48	17	22	0.320	3.124	0.485	–	22	–	SP
4 – 12	1	20	66	70	8	14	0.490	2.040	0.658	–	2	–	PT/CL
12 – 20	20	38	110	48	21	26	0.238	4.204	0.384	–	50	–	Limestone
20 – 25	10	30	105	43	16	23	0.333	3.000	0.500	–	20	–	Limestone
25 – 38	11	31	110	48	17	22	0.320	3.124	0.485	–	22	–	SP
38 – 50	14	36	110	48	19	26	0.260	3.852	0.412	–	32	–	Limestone

Note: 1. Depth below the existing ground surface.
2. E50 is soil stain parameters for LPILE software analysis.
3. Wall friction angle is based on Table 3-3 in the US Army Corps of Engineers Manual (Design of Sheet Pile Walls, EM 1110-2-2504).

Table 14 – Recommended Soil Parameters for Seawall #30 (Boring S-26)

Depth [1] (ft. – ft.)	Average N_{ES}	Recommended Values					Earth Pressure (Rankine's) Coefficients			LPILE Parameters			Soil Class. (USCS/ Soil Type)
		Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Wall Friction Angle (Degrees) with Steel	Wall Friction Angle (Degrees) with Concrete	Active, Ka	Passive, Kp	At rest, K_O	Cohesion (psf)	Subgrade Modulus (k, pci)	E50 [2]	
0 – 4	26	35	120	58	17	22	0.271	3.690	0.426	–	68	–	SP
4 – 8	15	32	114	52	17	22	0.307	3.255	0.470	–	35	–	SP-SM
8 – 10	4	22	75	13	11	14	0.455	2.198	0.625	–	5	–	PT
10 – 20	27	40	115	53	22	26	0.217	4.599	0.357	4,000	1,000	0.004	Limestone[3]
20 – 25	4	29	105	43	16	22	0.347	2.882	0.515	–	10	–	Limestone
25 – 35	14	37	110	48	20	26	0.249	4.023	0.398	–	32	–	Limestone
35 – 40	10	30	105	43	16	23	0.333	3.000	0.500	–	20	–	Limestone
40 – 50	12	36	110	48	19	26	0.260	3.852	0.412	–	25	–	Limestone

Note: 1. Depth below the existing ground surface.
2. E50 is soil stain parameters for LPILE software analysis.
3. Hard Limestone layer should be modeled as Hard to Stiff Clay in LPILE software analysis.
4. Wall friction angle is based on Table 3-3 in the US Army Corps of Engineers Manual (Design of Sheet Pile Walls, EM 1110-2-2504).

Table 15 – Recommended Soil Parameters for Seawall #32 (Boring S-16)

Depth [1] (ft. – ft.)	Average N_{ES}	Recommended Values					Earth Pressure (Rankine's) Coefficients			LPILE Parameters			Soil Class. (USCS/ Soil Type)
		Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Wall Friction Angle (Degrees) with Steel	Wall Friction Angle (Degrees) with Concrete	Active, Ka	Passive, Kp	At rest, K_O	Cohesion (psf)	Subgrade Modulus (k, pci)	E50 [2]	
0 – 4	12	31	110	48	17	22	0.320	3.124	0.485	–	25	–	SP
4 – 6	9	24	82	20	12	15	0.422	2.371	0.593	–	10	–	PT
6 – 10	6	30	106	44	16	22	0.333	3.000	0.500	–	12	–	SP
10 – 30	16	37	110	48	20	26	0.249	4.023	0.398	–	38	–	Limestone
30 – 35	29	40	115	53	22	26	0.217	4.599	0.357	4,000	1,000	0.004	Limestone[3]
35 – 50	20	38	110	48	21	26	0.238	4.204	0.384	–	50	–	Limestone

Note: 1. Depth below the existing ground surface.
2. E50 is soil stain parameters for LPILE software analysis.
3. Hard Limestone layer should be modeled as Hard to Stiff Clay in LPILE software analysis.
4. Wall friction angle is based on Table 3-3 in the US Army Corps of Engineers Manual (Design of Sheet Pile Walls, EM 1110-2-2504).

Table 16 – Recommended Soil Parameters for Seawall #34 (Boring S-30)

Depth [1] (ft. – ft.)	Average N_{ES}	Recommended Values					Earth Pressure (Rankine's) Coefficients			LPILE Parameters			Soil Class. (USCS/ Soil Type)
		Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Wall Friction Angle (Degrees) with Steel	Wall Friction Angle (Degrees) with Concrete	Active, Ka	Passive, Kp	At rest, K_O	Cohesion (psf)	Subgrade Modulus (k, pci)	E50 [2]	
0 – 2	16	32	114	52	17	22	0.307	3.255	0.470	–	37	–	SP
2 – 6	12	24	82	20	11	14	0.422	2.371	0.593	–	10	–	PT
6 – 10	4	29	102	40	16	22	0.347	2.882	0.515	–	10	–	SP
10 – 15	21	25	86	24	11	14	0.406	2.464	0.577	–	15	–	PT
15 – 20	15	37	110	48	20	26	0.249	4.023	0.398	–	35	–	Limestone
20 – 30	26	40	115	53	22	26	0.217	4.599	0.357	4,000	1,000	0.004	Limestone[3]
30 – 50	19	38	110	48	21	26	0.238	4.204	0.384	–	47	–	Limestone

Note: 1. Depth below the existing ground surface.
2. E50 is soil stain parameters for LPILE software analysis.
3. Hard Limestone layer should be modeled as Hard to Stiff Clay in LPILE software analysis.
4. Wall friction angle is based on Table 3-3 in the US Army Corps of Engineers Manual (Design of Sheet Pile Walls, EM 1110-2-2504).

Table 17 – Recommended Soil Parameters for Seawall #35 (Boring S-25)

Depth [1] (ft. – ft.)	Average N_{ES}	Recommended Values					Earth Pressure (Rankine's) Coefficients			LPILE Parameters			Soil Class. (USCS/ Soil Type)
		Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Wall Friction Angle (Degrees) with Steel	Wall Friction Angle (Degrees) with Concrete	Active, Ka	Passive, Kp	At rest, K_O	Cohesion (psf)	Subgrade Modulus (k, pci)	E50 [2]	
0 – 4	17	32	114	52	17	22	0.307	3.255	0.470	–	40	–	SP
4 – 10	11	31	110	48	17	22	0.320	3.124	0.485	–	22	–	SP
10 – 50	16	37	110	48	20	26	0.249	4.023	0.398	–	37	–	Limestone

Note: 1. Depth below the existing ground surface.
2. E50 is soil stain parameters for LPILE software analysis.
3. Wall friction angle is based on Table 3-3 in the US Army Corps of Engineers Manual (Design of Sheet Pile Walls, EM 1110-2-2504).

7.2 FOUNDATION RECOMMENDATIONS FOR PUMP STATIONS

Based on the geotechnical exploration and providing the subgrade preparation procedures presented below are followed, it is our opinion that the sites are suitable for the planned pump station construction. The proposed structures may be supported on a mat foundation.

Following the in-situ foundation preparation recommendations below, the proposed structure foundations may bear within the prepared existing sands and limestones beneath the organic materials. The net allowable soil bearing pressures are provided in Tables 18 through 29. The net bearing pressure is defined as the soil bearing pressure at the foundation bearing level in excess of the natural overburden pressure at that level. To verify suitable bearing, we recommend that the foundation excavation subgrade be checked by a geotechnical engineer just prior to mat rebar placement. The excavation bottom should be kept as dry as practically possible during construction.

Resistance to lateral loads can be derived from 1) passive pressure acting on the sides of the foundations and any grade beams, and 2) lateral resistance along the base of the foundations. Lateral resistance derived from friction between the soil and the bases of the footings should be calculated based on a friction factor of 0.35 times the base contact bearing pressure. Passive resistance of the upper foot of soil should be neglected, unless it is confined by a slab or pavement. Passive resistance on the sides of the foundations should be ignored if these soils can be hypothetically washed away during a hurricane storm event.

A subgrade modulus of 250 psi/in may be used in the design of a mat/raft foundation provided that the subgrade and subsequent engineered granular fill is prepared as described below. A 6-inch leveling layer of clean (less than 5% passing a #200 sieve) granular fill is recommended to be placed directly below slab-on-grade floors where appropriate. The granular fill should be compacted until densities of at least 95% of the maximum dry density as determined by ASTM D1557, the Modified Proctor method. Based on our assumption of a structure supported on a shallow footing or mat foundation system, the total settlement should be less than 1.0 inches, and differential settlements should be less than 0.50 inches.

7.2.1 RECOMMENDED SOIL PARAMETERS FOR PUMP STATION DESIGN

Underground pump stations for this project will need to be designed to resist pressures exerted by the adjacent soils and hydrostatic uplift head conditions on the base of the structure. For walls that are not restrained during backfilling but are free to rotate at the top, active earth pressure should be used in design. Walls that are restrained should be designed assuming at-rest pressures. Recommended soil parameters for the soils encountered at the sites are given in Tables 18 through 29.

Table 18 – SPT BORING DR-1

Boring depth (ft - ft)	Average N_{AUTO}	Average N_{ES}	Recommended Values			Earth Pressure Coefficients			Bearing Capacity (psf)
			Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Active, Ka	Passive, Kp	At rest, Ko	
0 - 8	7	8	30	108	46	0.333	3.000	0.500	1250
8 - 10	2	2	29	106	44	0.347	2.882	0.515	400
10 - 25	15	18	33	114	52	0.295	3.392	0.455	2500
25 - 30	13	16	32	112	50	0.307	3.255	0.470	3000
30 -50	28	34	40	128	66	0.217	4.599	0.357	4000

Table 19 – SPT BORING DR-2

Boring depth (ft - ft)	Average N_{AUTO}	Average N_{ES}	Recommended Values			Earth Pressure Coefficients			Bearing Capacity (psf)
			Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Active, Ka	Passive, Kp	At rest, Ko	
0 - 2	7	9	30	108	46	0.333	3.000	0.500	1250
2 - 4	9	11	31	110	48	0.320	3.124	0.485	1800
4 - 6	6	7	30	108	46	0.333	3.000	0.500	1200
6 - 10	3	4	29	106	44	0.347	2.882	0.515	500
10 - 30	13	16	32	112	50	0.307	3.255	0.470	3000
30 - 50	23	29	40	128	66	0.217	4.599	0.357	4000

Table 20 – SPT BORING P-5

Boring depth (ft - ft)	Average N_{AUTO}	Average N_{ES}	Recommended Values			Earth Pressure Coefficients			Bearing Capacity (psf)
			Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Active, Ka	Passive, Kp	At rest, Ko	
0 - 2	7	9	30	108	46	0.333	3.000	0.500	1200
2 - 4	11	14	31	110	48	0.320	3.124	0.485	2000
4 - 10	7	9	30	108	46	0.333	3.000	0.500	1500
10 - 30	13	16	32	112	50	0.307	3.255	0.470	3000
30 - 50	19	24	39	126	64	0.228	4.395	0.371	4000

Table 21 – SPT BORING P-6

Boring depth (ft - ft)	Average N_{AUTO}	Average N_{ES}	Recommended Values			Earth Pressure Coefficients			Bearing Capacity (psf)
			Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Active, Ka	Passive, Kp	At rest, Ko	
0 - 2	4	5	29	106	44	0.347	2.882	0.515	750
2 - 4	9	11	31	110	48	0.320	3.124	0.485	1500
4 - 10	6	7	30	108	46	0.333	3.000	0.500	1000
10 - 30	13	16	32	112	50	0.307	3.255	0.470	3000
30 - 50	19	24	39	126	64	0.228	4.395	0.371	4000

Table 22 – SPT BORING R-9

Boring depth (ft - ft)	Average N_{AUTO}	Average N_{ES}	Recommended Values			Earth Pressure Coefficients			Bearing Capacity (psf)
			Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Active, Ka	Passive, Kp	At rest, Ko	
0 - 2	9	11	31	110	48	0.320	3.124	0.485	1500
2 - 6	7	9	27	102	40	0.376	2.663	0.546	1000
6 - 8	3	4	29	106	44	0.347	2.882	0.515	500
8 - 15	7	9	30	108	46	0.333	3.000	0.500	1500
15 - 25	14	17	32	112	50	0.307	3.255	0.470	2500
25 - 30	7	9	30	108	46	0.333	3.000	0.500	2500
30 - 50	10	12	31	110	48	0.320	3.124	0.485	3000

Table 23 – SPT BORING R-10

Boring depth (ft - ft)	Average N_{AUTO}	Average N_{ES}	Recommended Values			Earth Pressure Coefficients			Bearing Capacity (psf)
			Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Active, Ka	Passive, Kp	At rest, Ko	
0 - 2	9	11	31	110	48	0.320	3.124	0.485	1500
2 - 4	6	7	27	102	40	0.376	2.663	0.546	1000
4 - 6	9	11	31	110	48	0.320	3.124	0.485	1500
6 - 8	5	6	30	108	46	0.333	3.000	0.500	750
8 - 10	3	4	29	106	44	0.347	2.882	0.515	500
10 - 15	7	9	30	108	46	0.333	3.000	0.500	1250
15 - 20	9	11	31	110	48	0.320	3.124	0.485	1750
20 - 25	8	10	30	108	46	0.333	3.000	0.500	1750
25 - 50	11	14	31	110	48	0.320	3.124	0.485	2500

Table 24 – SPT BORING R-11

Boring depth (ft - ft)	Average N_{AUTO}	Average N_{ES}	Recommended Values			Earth Pressure Coefficients			Bearing Capacity (psf)
			Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Active, Ka	Passive, Kp	At rest, Ko	
0 - 4	7	8	30	108	46	0.333	3.000	0.500	1100
4 - 6	3	4	29	106	44	0.347	2.882	0.515	500
6 - 15	7	9	30	108	46	0.333	3.000	0.500	1250
15 - 30	19	24	34	116	54	0.283	3.537	0.441	3000
30 - 40	28	35	37	122	60	0.249	4.023	0.398	4000
40 - 50	19	24	34	116	54	0.283	3.537	0.441	4000

Table 25 – SPT BORING R-12

Boring depth (ft - ft)	Average N_{AUTO}	Average N_{ES}	Recommended Values			Earth Pressure Coefficients			Bearing Capacity (psf)
			Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Active, Ka	Passive, Kp	At rest, Ko	
0 - 4	8	10	30	108	46	0.333	3.000	0.500	1500
4 - 6	2	2	10	68	6	0.704	1.420	0.826	0
6 - 8	9	11	31	110	48	0.320	3.124	0.485	1500
8 - 15	6	7	30	108	46	0.333	3.000	0.500	1000
15 - 35	20	25	34	116	54	0.283	3.537	0.441	3000
35 - 40	29	36	35	118	56	0.271	3.690	0.426	4000
40 - 50	20	25	34	116	54	0.283	3.537	0.441	4000

Table 26 – SPT BORING S-6

Boring depth (ft - ft)	Average N_{AUTO}	Average N_{ES}	Recommended Values			Earth Pressure Coefficients			Bearing Capacity (psf)
			Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Active, Ka	Passive, Kp	At rest, Ko	
0 - 2	5	6	30	108	46	0.333	3.000	0.500	800
2 - 6	12	15	32	112	50	0.307	3.255	0.470	2100
6 - 8	7	9	30	108	46	0.333	3.000	0.500	1250
8 - 10	2	2	29	106	44	0.347	2.882	0.515	250
10 - 35	26	32	35	118	56	0.271	3.690	0.426	3000
35 - 50	6	7	30	108	46	0.333	3.000	0.500	2000

Table 27 – SPT BORING S-7

Boring depth (ft - ft)	Average N_{AUTO}	Average N_{ES}	Recommended Values			Earth Pressure Coefficients			Bearing Capacity (psf)
			Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Active, Ka	Passive, Kp	At rest, Ko	
0 - 2	5	6	30	108	46	0.333	3.000	0.500	800
2 - 6	10	12	31	110	48	0.320	3.124	0.485	1750
6 - 10	6	7	30	108	46	0.333	3.000	0.500	1000
10 - 20	31	38	40	128	66	0.217	4.599	0.357	3500
20 - 25	9	11	31	110	48	0.320	3.124	0.485	2500
25 - 35	15	19	38	124	62	0.238	4.204	0.384	2750
35 - 40	7	9	30	108	46	0.333	3.000	0.500	2500
40 - 50	12	15	37	122	60	0.249	4.023	0.398	3000

Table 28 – SPT BORING V-8

Boring depth (ft - ft)	Average N_{AUTO}	Average N_{ES}	Recommended Values			Earth Pressure Coefficients			Bearing Capacity (psf)
			Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Active, Ka	Passive, Kp	At rest, Ko	
0 - 4	14	17	32	112	50	0.307	3.255	0.470	2500
4 - 10	3	4	10	68	6	0.704	1.420	0.826	0
10 - 20	10	12	36	120	58	0.260	3.852	0.412	1500
20 - 30	12	15	32	112	50	0.307	3.255	0.470	2500
30 - 50	35	43	40	128	66	0.217	4.599	0.357	4000

Table 29 – SPT BORING V-9

Boring depth (ft - ft)	Average N_{AUTO}	Average N_{ES}	Recommended Values			Earth Pressure Coefficients			Bearing Capacity (psf)
			Friction Angle (Degrees)	Total Unit Weight (pcf)	Submerged Unit Weight (pcf)	Active, Ka	Passive, Kp	At rest, Ko	
0 - 6	3	3	29	106	44	0.347	2.882	0.515	400
6 - 8	11	14	31	110	48	0.320	3.124	0.485	1500
8 - 15	6	7	30	108	46	0.333	3.000	0.500	1000
15 - 35	7	9	30	108	46	0.333	3.000	0.500	1500
35 - 50	11	14	36	120	58	0.260	3.852	0.412	2000

Design should incorporate hydrostatic effects. In order to avoid wall damage due to excessive compaction, hand operated mechanical tampers should be used to densify backfill soils. Heavy vibratory compaction equipment should not be allowed within five feet of walls. The soils behind walls should consist of clean sands as described in the Select Fill Composition, Placement and Compaction section of this report and should be compacted to approximately 95 percent of the material's modified Proctor (ASTM D-1557) maximum dry density.

7.2.2 AUGER CAST PILE RECOMMENDATIONS FOR LIFT STATION DESIGN

At the time of this report, three lift stations were proposed. The proposed locations and depths of the lift stations are presented in the following Table 30:

Table 30 – Lift Station Information

Lift Station Location	Bottom Depth from existing ground surface (feet)	Borings
Merle Fogg Park	12	S-6 and S-7
River Oaks Outfall	19	R-9 through R-12
Victoria Park	16	S-28

Due to the depth of the lift stations, buoyancy is a potential concern where the weight of concrete structure is not sufficient to resist uplift without using piles in tension. Auger cast piles are reportingly being proposed to counter act the buoyancy forces. An Augered Cast-In Place (ACIP) cast pile tension capacity of 35 tons is necessary to counteract the buoyancy forces.

The pile capacity estimate considers 16-inch diameter Auger Cast Piles. Estimates indicate the following:

- For the Merle Fogg Park lift station, ACIP piles tipped 50 feet below the existing ground surface can achieve approximately fifteen (15) tons of design tension capacity each.
- For the River Oaks lift station, piles tipped 50 feet below the existing ground surface can achieve approximately eight (8) tons of tension capacity each.
- For the Victoria Park lift station, piles tipped 50 feet below the existing ground surface can achieve approximately eight (8) tons of tension capacity each.

It should also be noted that additional uplift capacity can be achieved by overbuilding the Lift Station mat so that it protrudes a few to several feet beyond the walls of the structure. Under such a design, the submerged unit weight of the soils above the outer extending foundation mat lip will help hold the structure down. If the mat is enlarged enough, the weight of the exterior submerged soils above the extending lip may be able to resist a significant portion of the uplift. For analysis purposes, an average submerged unit weight of 62.4 pcf can be used for the Lift Station backfill for that soil volume directly around the structure and above the mat. Additionally, if the Lift station were to begin to rise, it would also have to shear the soil in a box type vertical plane surrounding the structure mat perimeter. This shear will add additional uplift resistance to the structure and can be calculated using a soil Phi (ϕ) value of 32 degrees times the average normal in-situ horizontal (Ko) effective (i.e. submerged) soil pressure along the vertical plane surrounding the structure.

7.3 FOUNDATION RECOMMENDATIONS FOR ELECTRICAL EQUIPMENT BUILDINGS

Our recommendations for foundation design and construction of the electrical equipment buildings are based on the following:

1. Two buildings are proposed,
    a. One building is proposed at Merle Fogg Park, in the southeast quadrant of the intersection of E. Las Olas Boulevard and Poinciana Drive in the Southeast Isles Neighborhood. Borings S-6 and S-7 are located in this area.
    b. The second building is proposed at the River Oaks-Outfall. The River Oaks Outfall is located in the west side of the River Oaks neighborhood, adjacent to the east side of I-95 and just south of the South Fork New River. Borings R-9 through R-12 are located in this area.
2. The buildings will be one-story in height, and will house electrical equipment.
3. The floor elevation of the buildings will be approximately 6 feet above current grade.
4. The anticipated foundation system will be a combination of continuous strip footings under walls and isolated spread footing under columns.

If this information is incorrect or changes, we should be notified so we can review our recommendations and revise them if necessary.

Based on the geotechnical exploration and providing that the subgrade preparation procedures presented below are followed, it is our opinion that the site is suitable for the planned building construction.

The proposed structure may be supported on shallow footings or preferably a raft mat type of foundation.

Following the in-situ foundation preparation recommendations herein, the proposed structure foundation may be designed using a net allowable soil bearing pressure of up to 1500 pounds per square foot (psf) bearing when founded within the densified existing sands. When founded within a well compacted, elevated fill pad constructed with select engineered granular fill, a net allowable soil bearing pressure of up to 2500 pounds per square foot (psf) bearing may be utilized.

The net bearing pressure is defined as the soil bearing pressure at the foundation bearing level more than the natural overburden pressure at that level. To verify suitable bearing, we recommend that the foundation excavation subgrade be checked by a RADISE geotechnical engineer just prior to concreting. The excavation bottom should be kept as dry as practical during construction.

A subgrade modulus of 200 psi/in may be used in the design of a mat/raft foundation if the subgrade and subsequent engineered granular fill is prepared as described below. A 6-inch layer of clean (less than 5% passing a #200 sieve) granular fill is recommended to be placed directly below slab-on-grade floors where appropriate. The granular fill should be compacted until densities of at least 95% of the maximum dry density as determined by ASTM D1557, the Modified Proctor method. This layer will aid in providing a capillary moisture break below the concrete slab. We also recommend a moisture vapor barrier be placed under all areas especially

where floors will have moisture sensitive coverings, or where stored materials are moisture sensitive.

To assure an adequate factor of safety against a shearing failure in the subsoils:

- Footing base should be at a depth of at least 18 inches below lowest adjacent grades.
- Continuous footings should be at least 16 inches wide.
- Isolated foundations should not be less than 30 inches wide.
- The required embedment depth may be reduced to 12 inches if a monolithic raft/ mat slab type of foundations is used.

7.3.1 RIVER OAKS OUTFALL ELECTRICAL EQUIPMENT BUILDING

For Merle Fogg Park, none of the borings performed in this location encountered any organic material. For the River Oaks Outfall, three of the four soil borings (R-9, R-10, and R-12) performed in the area of the proposed electrical equipment building encountered a 2 to 4 feet thick layer of organic material at depths ranging from 2 to 5 feet below the existing ground surface. The evaluation of the organic material layer is only relevant for the electrical equipment building, since the bearing depth of the foundation for the lift station structure is well below the organic material layer.

The foundation for the electrical equipment building is expected to bear above the organic material layer encountered in the borings. If the organic material layer is left in place below the electrical equipment building, some total and differential settlement (both short-term "immediate-type" will occur. Such settlements result from the weight of the structural fill and structure placed above the organic material and the associated short term primary settlement and long term "creep-type" secondary settlement inherent to compressible organic soil material. Settlement caused by the encountered organic material layer beneath he structure is expected to moderately affect the proposed electrical equipment building.

If moderate settlements of the electrical equipment building on the order of 3-4 inches is considered problematic, then we recommend that to eliminate settlement related issues, the organic material encountered in the borings be excavated and removed prior to construction of the electrical equipment building. Alternatively, the organic material can be left in place and the area preloaded with 5 feet of dumped and stacked fill to induce settlement similar to the increased stress caused by the construction of the proposed control building. Excavated organic material is generally not appropriate for reuse in other construction as it has a tendency to consolidate, erode and generally bio-degrade with time. Therefore, excavated organic material should be disposed of at a suitable on or off-site location.

7.4 PAVEMENT DESIGN CONSIDERATIONS

The following information is provided and intended as a guideline only, as the roadway or any replacements/repairs thereof, should be designed specifically for the vehicle load intensities for the respective roadways and frequencies anticipated during the life of the project. Flexible pavement systems in this south Florida geographic area, typically consist of an asphaltic concrete wearing course, limerock base course and a stabilized pavement subgrade. Based on our preliminary findings and analysis and experience in the area, the typical pavement section thicknesses shown in the following Table 30, are commonly used by local pavement design engineers.

TABLE 30: TYPICAL FLEXIBLE AND RIGID PAVEMENT DESIGN

TYPE OF PAVEMENT	LAYER	MATERIAL DESCRIPTION	LAYER THICKNESS		
			LIGHT DUTY	MEDIUM DUTY	HEAVY DUTY
Flexible	Asphaltic concrete	Florida DOT Asphalt Type S	1.5	1.75	2.0
	Base course	Crushed limerock with minimum LBR of 100, compacted to 98% of the Modified Proctor maximum dry density	6.0	7.0	8.0
	Stabilized subbase	Stabilized sub-base fill with a minimum LBR of 40 compacted to 95% of the Modified Proctor maximum dry density	12.0	12.0	12.0
Rigid	Concrete	Florida DOT Portland Cement Concrete	6.0	7.0	8.0
	Compacted subgrade	Natural in place soils compacted to at least 95 percent of the materials Modified Proctor maximum dry density	12.0	12.0	12.0

Comparison of the above typical design thicknesses with asphalt pavement measurements provided in Tables 1 and 2, Pages 1 through 6, indicates that most of the asphalt cores measured thickness would comply with or exceed the above typical design thicknesses for light duty pavements. The asphalt cores that do not comply with the above typical asphalt design thickness for light duty asphalt pavement were encountered at borings D-4, DR-5, E-1, P-4, R-4, R-8, and V-5. We suspect that the substandard asphalt thicknesses were likely adequate for the design traffic loading conditions at the time of the initial roadway design and construction. For the asphalt thickness that exceed the above recommended thicknesses, we suspect that asphalt mill and resurfacing overlays were installed over the original asphalt to repair distress.

From a base thickness perspective, thirty-eight (38) of the sixty-eight (68) base rock thickness measurements meet or exceeds a base rock thicknesses of 6 inches and are considered acceptable for light duty pavement design and use in light duty trafficked areas. However, given the thickness of the asphalt cores and a general rule of thumb that one inch of asphalt is equivalent to two inches of compacted limerock base, the combination of both of the measured base and asphalt material thicknesses would appear to provide a suitable pavement section thickness in most areas such that a pavement mill and re-surface program may prove cost effective. Further analyses of the pavement section will need to be provided by a civil pavement design engineer experienced with such evaluations. We suspect that the substandard base course thicknesses were adequate for the traffic loading during the initial roadway construction.

From a subgrade perspective, in our opinion the nature and composition of the subgrade soils at the location of the borings performed for this study would essentially be in compliance with typical pavement construction designs for light duty pavement section design.

Any new or re-constituted base course material should consist of crushed limestone having a minimum Limerock Bearing Ratio (LBR) of 100. Base materials should meet the requirements presented in the latest revisions of the Florida Department of Transportation "Specifications for Road and Bridge Construction", Section 911 (limestone). The base course should be compacted to at least ninety-eight (98) percent of its maximum dry modified proctor density (AASHTO T 180).

We recommend that any new pavement subgrade be stabilized to a depth of twelve (12) inches to achieve a minimum LBR of 40. If necessary, this LBR value can be achieved by blending base material (limerock) with the existing sandy subgrade soils. The required mixing ratio should be determined by laboratory testing. The stabilized subgrade should be compacted to at least ninety-eight (98) percent of its maximum dry as determined per ASTM D 1557, the Modified Proctor Method.

A Portland concrete pavement thickness in the range of eight (8) inches would also be recommended for the project if a rigid pavement is to be employed (the thickness would depend on specific pavement use). Any concrete pavement should be reinforced to withstand the anticipated traffic loadings and jointed to reduce the chances for rigid pavement crack development. The minimum rigid pavement thickness recommended above is based upon concrete with an unconfined compressive strength of at least 3,000 psi and a modulus of rupture of at least 450 psi. It should be noted that this recommendation is intended for the street pavement and not for concrete driveway aprons or sidewalks.

Actual pavement section thickness should be determined by the Design Civil Engineer based on traffic loads, volume, and the Owner's design life requirements. The above sections represent minimum thickness representative of typical local construction practices and, as such, periodic maintenance should be anticipated. All pavement materials and construction procedures should conform to FDOT, American Concrete Institute (ACI), and/or appropriate City or County requirements for roadway pavement construction.

7.4.1 PERVIOUS PAVEMENT DESIGN CONSIDERATIONS

The soil borings and laboratory test results indicate that most of the existing sands encountered are suitable for subgrade use in pervious pavement areas, as defined by the South Florida Water Management District (SFWMD). The sand subgrade soils should be compacted to a maximum density of 95% of the maximum dry density as determined by ASTM D1557, or AASHTO T180, to a minimum depth of 24 inches. As per the SFWMD specifications, subgrade stabilization is not required for sand type of soils (SP). If additional fill material is required to bring the subgrade to final elevation, it should be hydraulically clean (maximum of 10% silt or clay), and free of deleterious materials.

For redevelopment projects where the existing pavement section is to be removed; the compacted base should also be removed and the underlying subgrade soils scarified to a minimum depth of 20 inches. The subgrade should be re-graded and filled with clean (hydraulically clean and free of deleterious material) soils. The clean soils should be placed in 8-inch maximum layers and compacted to a maximum density of 95% of the Modified Proctor density within 3% of the optimum moisture content (ASTM D-1557, or AASHTO T180).

It is recommended by SFWMD that the Seasonal High Groundwater Table (SHGWT) elevation be greater than 24 inches below the bottom of any pervious pavement system. The pervious pavement system is suggested to include an underlying storage reservoir consisting of pea rock, #57 stone, etc. If utilized, the underlying storage reservoir should be wrapped with geo-fabric. SFWMD recommends that the underlying storage reservoir layer be no more than 36 inches thick. Runoff from adjacent landscaped areas should not be directed onto any pervious pavement system unless the adjacent landscape areas that drain onto the pervious pavement, will not increase sediment, silt, sand, or organic debris deposition on the pavement that increases the potential for clogging of the pervious pavement section. The site design should include measures to reduce the likelihood of silts and sands from entering and plugging the pervious pavement system void spaces.

Periodic vacuum sweeping of pervious pavements can be used and is recommended. For areas where wind transported soil (i.e. near sand dunes or other coastal areas), or other conditions where excessive soil or other material deposition can occur, vacuum sweeping should be utilized a minimum of twice a year.

7.5 CLEARING AND GRUBBING

Clearing and grubbing may be required in some of the proposed construction areas. Clearing and grubbing where required should include the complete removal and disposal of surficial grasses, associated root systems, topsoil, rubbish, debris, any demolition material/pavement and all other obstructions resting on or protruding through the surface of the existing ground and the surface of excavated areas.

7.6 UNDERGROUND UTILITIES

Existing underground utilities and structures are likely to be present in the proposed construction areas. These utilities need to be properly identified, and located and/or relocated as necessary to construct the new components of the project. The excavation bottoms of any relocated or replacement utilities should be cleaned of any undesirable materials prior to placing any engineered backfill.

Site preparation, excavation, and backfilling for new utilities or re-aligned utilities should follow all of the applicable recommendations of this report.

7.7 EXCAVATIONS

The project construction Contractor is solely responsible for making any utility or other excavations in a safe manner and to provide appropriate measures to retain side slopes to ensure that persons working in or near the excavation are protected. Any structural retaining walls shall be designed and sealed by a structural engineer registered in the State of Florida.

Excavations shall comply with Occupational Health and Safety Administration (OHSA) stipulations for Trench Excavation Safety including all temporary design and safety requirements. The soils encountered in the majority borings outside of the Victoria Park and Southeast Isles area, generally consist of relatively clean sands. OSHA 29 CFR part 1926 (Subpart P, Excavations) defines such soils as Type C soils. As such, the granular deposits encountered in the borings are readily capable of being excavated to a depth of several feet with standard backhoe construction equipment. As such, temporary side slopes in fully dewatered excavations could be made at a 1½H:1V inclination or flatter. Adjustment to this inclination and/or the use of sheeting, shoring or sliding trench boxes should be evaluated by the Contractor if other soil strata are encountered.

It is noted that in the Victoria Park, River Oaks, and Southeast Isles areas, that significant Muck deposits were encountered in the borings performed for these areas. Correspondingly, utilities installed in these areas are likely to encounter organic Muck deposits during the utility excavation and installation process requiring cleaning or removing of the Muck deposits prior to placing any engineered backfill as mentioned in section 7.10.

7.8 DEWATERING

At the time of the field exploration (i.e. September and October 2017), the groundwater encountered varied between 0.5 to 6.5 feet below the existing ground surface. In-the-dry construction of the underground utilities may require groundwater lowering and control of groundwater seepage depending on the design installation depths. Dewatering of the excavations may necessitate the use of sumps, wells, wellpoints or combinations thereof. Control of groundwater should be accomplished in a manner that preserves the integrity of the in-situ soils and limestones and does not cause instability of the excavation sidewalls. The dewatering system employed should be capable of maintaining a pre-drained surface a minimum of 24 inches below the excavation bottoms.

7.9 PIPE BEDDING

Most of the sands encountered in the borings are expected to provide good support for utility pipelines without the need for bedding when the invert elevations are at least 24 inches above the groundwater level (natural or pre-drained by dewatering). Should or where organics or other deleterious materials be encountered at or within 2 feet below the pipe invert, such soils shall be considered compressible and unsuitable for pipe support. These soils should be over-excavated and replaced with compacted clean sand or FDOT No. 57 coarse aggregate or an approved equivalent. If FDOT No. 57 stone or an approved equivalent is utilized, such stone material will need to be encapsulated and/or covered with a geosynthetic fabric especially beneath pavement areas. Such fabric material is needed to prevent granular excavation soils and trench backfill from penetrating/settling into the void volumes of the open stone resulting in loss of ground and eventual settlement of the ground surface above the piping.

The bedding surface should be uniformly compacted to a density of not less than 95 percent of the maximum dry density in accordance with ASTM D 1557, the Modified Proctor Method.

7.10 TRENCH BACKFILL AND COMPACTION

Soils used to backfill utility excavations should consist of clean sands having no materials larger than one inch in size, not more than ten (10) percent passing the U.S. Standard No. 200 sieve, and not more than three (3) percent organics or other deleterious materials by weight. Some of the subsurface soils encountered at these neighborhood sites appear to meet these criteria and are suitable for reuse as backfill once inspected, tested and approved.

Granular backfill should be placed at a moisture content within three (3) percent of its ASTM D 1557 determined optimum moisture and in level lifts whose thickness does not exceed eight (8) inches. Each fill lift should be stable, unyielding and uniformly compacted to at least 95 percent of the maximum dry density in accordance with ASTM D 1557, the Modified Proctor Method. We recommend the use of only relatively light, hand-held compaction equipment in the densification operations around utilities to limit the potential damage to the pipelines and buried structures.

7.11 SITE PREPARATION

The site preparation for any roadway modifications should consist of necessary clearing and grubbing in general accordance with Section 110 of the FDOT Standard Specifications for Road and Bridge Construction or any similar City/County standard design criteria applicable to the project. Any topsoil or other deleterious material encountered in proposed pavement areas, will need to be stripped, removed and replaced with embankment or roadway fill. If buried organic soils, debris or other unsuitable materials are encountered during the construction, which are or are not disclosed by the borings, they should be removed and replaced with a backfill material as described in following sections.

The Stratum 1 soils are select granular soils and are satisfactory to use in the subgrade and embankment when utilized in general accordance with FDOT Standard Index 505 or any similar City/County standard design criteria applicable to the project. Soils exposed at the stripped grades will require moisture conditioning to near the optimum moisture content prior to initiating the densification operations. In residential areas, the use of such heavy vibratory compaction equipment may prove problematic and disruptive or even damaging to existing/adjacent home owner's properties. In such cases, the compaction will need to be performed and achieved with lighter weight, less vibration generation capable equipment such as walk behind (e.g. Whacker) ground pounder or small vibratory rolling equipment.

Each section of the stripped grade should be subjected to multiple, overlapping coverages of the compactor as it operates at a travel speed of no more than 1.5 miles per hour (normal walking speed). Compaction should be continued until no further settlement can be visually discerned at the ground surface. The densified areas should include a 3-foot perimeter along proposed new pavement areas.

Density control should be exercised for the exposed subgrade for any roadway repairs. Soils in this interval should be compacted to not less than 95 percent of the maximum dry density in accordance with ASTM D 1557, the Modified Proctor Method. Subgrade soils that noticeably pump or deflect under the weight of the passing compaction equipment, could indicate the presence of soft, weak, overly saturated soils or compressible and loose soil zones existing in the near surface subgrade within the depth of influence of the roller. In such cases, those areas should be remedied by appropriate means to be determined by the inspecting field representative in consultation with representatives of the design team.

7.12 SELECT FILL COMPOSITION, PLACEMENT AND COMPACTION

Site structural and pavement embankment fill and backfill required for construction should consist of clean, granular materials that are free of debris, cinders, combustibles and organic matter. The fines content (i.e., material passing U.S. Standard No. 200 sieve) should not be more than ten (10) percent by weight, no particle sizes larger than one (1) inches in any direction and the organic content should not exceed three (3) percent by dry weight. The on-site sand soils appear to meet the above criteria and are suitable for use as structural fill and backfill material. Organic laidened soils encountered in several of the borings soils beneath the upper sand layer such as those encountered in the River Oaks, Victoria Park and Southeast Isles area, will not be suitable for use of Select Fill.

The granular fill should be placed at a moisture content within three (3) percent of its Modified Proctor (ASTM D 1557) determined optimum in level lifts whose loose thickness does not exceed twelve (12) inches. In areas where heavy equipment cannot be operated for compaction, the fill should be placed in six (6) inch thick level lifts. Each fill lift should be stable, unyielding and uniformly compacted to 95 percent of the ASTM D 1557 maximum dry density, as verified by the designated site construction inspecting representative.

Select fill soils will require moisture conditioning to near the optimum moisture content prior to initiating the densification operations. Similar to the subgrade preparation, the fill densification should normally be accomplished using a self-propelled vibratory compactor which imparts a dynamic drum force of not less than 44,000 pounds. However, in residential areas, the use of such heavy vibratory compaction equipment may prove problematic and disruptive or even damaging to existing/adjacent home owner's properties. In such cases, the compaction will need to be performed and achieved with lighter weight, less vibration generation capable equipment such as walk behind (e.g. Whacker) ground pounder or small vibratory rolling equipment.

7.13 OBSERVATION AND TESTING

It is recommended that a geotechnical engineer be retained to provide soil engineering inspection services during the construction excavation phase of the project. This is to observe compliance with the design concept, specifications and recommendations, and to allow design changes in the event subsurface conditions differ from those anticipated. In addition, an inspection and testing representative of a geotechnical engineer should be present to provide monitoring and testing of both fill and concrete placement during the construction phase of the project.

8.0 EXISTING UTILITIES

Existing utilities could potentially be present within or near the proposed seawalls. Precautionary measures should be taken to identify and locate any such systems impacted by the planned construction. Where encountered, mitigative design details should be provided accordingly. Consideration should be given as to what kind of utilities are present (i.e. nature and composition), and what the utility or other owner's guidelines and specifications are regarding their re-location etc. Utility locates should be in general accordance with the FDOT Plans Preparation Manual, Section 5.3 – Utility Locates.

9.0 PROTECTION OF EXISTING STRUCTURES

Ground vibrations induced upon adjacent structures, primarily by soil compaction equipment or any other construction activities such as pile driving, should be monitored to assure that they do not reach levels which prove damaging to any adjacent/nearby structures. Vibration Monitoring should be performed in general accordance with "Section 108, Protection of Existing Structures" of the current FDOT Standard Specifications for Road and Bridge Construction or other similar local City/County regulations or ordinances.

Vibration levels on adjacent facilities should generally be maintained below a 0.25 inches/second peak particle velocity level however, more restrictive/lessor levels as low as 0.10 inches/second may be specified for highly sensitive residential or historical areas. The construction Contractor will need to inventory and provide a pre-construction inspection of adjacent structures and determine suitable vibration monitoring programs and impact limits for their construction activities. Such monitoring will be particularly important for the Victoria Park and Southeast Isles

area as the ground conditions will have a higher tendency and capability to transmit vibrations horizontally from the construction activities.

It is noted that the residential homes in the Victoria Park and Southeast Isles area are likely founded on short driven piles installed to sound bearing conditions beneath the buried organics. Vibrations in the lower soil/rock layers beneath the organics, from construction activities such as sheet piling installation, will have the potential to be transmitted into the residences via the piling foundations installed for the structures. Typically, for sheet piling and driven pile installations, a maximum allowable peak particle velocity of 0.10 inches/second has been used in the construction specifications for areas of similar natured residential and commercial structures that exist in this project area.

10.0 LIMITATIONS

This report is intended for geotechnical purposes only, and not to document or detect the presence, or absence of any environmental conditions at the site, or to perform an environmental assessment of the site.

The analysis and recommendations presented in this report are based upon our interpretation of the subsurface information revealed by the test borings. The report does not reflect variations in subsurface conditions that may exist between or beyond these borings. Variations in soil and groundwater conditions should be expected, the nature and extent of which might not become evident until construction is undertaken. If variations are encountered, and/or the scope of the project altered, we should be consulted for additional recommendations.

RADISE International warrants that the professional services performed and presented in this report are prepared for Hazen and Sawyer, and are based upon typical standard of care recognized principles and practices in the discipline of geotechnical engineering and hydrogeology at this place and point in time, for this project site. No other warranties are expressed or implied.

-oOo-

RADISE appreciates the opportunity to be of service to you. Please feel free to contact us at 561-841-0103 if you have any questions or comments regarding this report.

Respectfully submitted
RADISE International, L.C.

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SCALE: VERTICAL N.T.S.

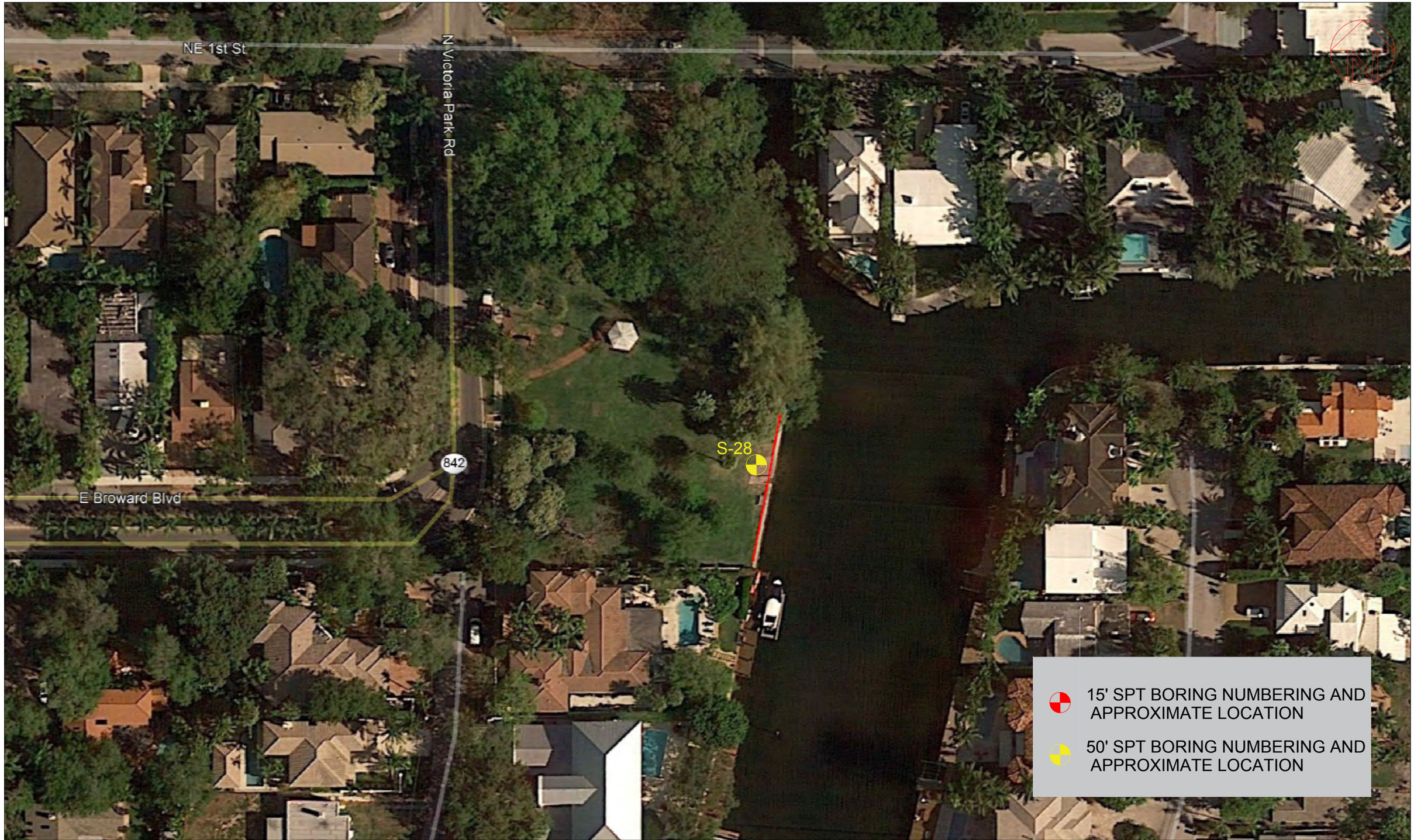
SCALE: HORIZONTAL N.T.S.

SHEET TITLE: VICINITY MAP

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 1

RADISE PROJECT NO: 170901



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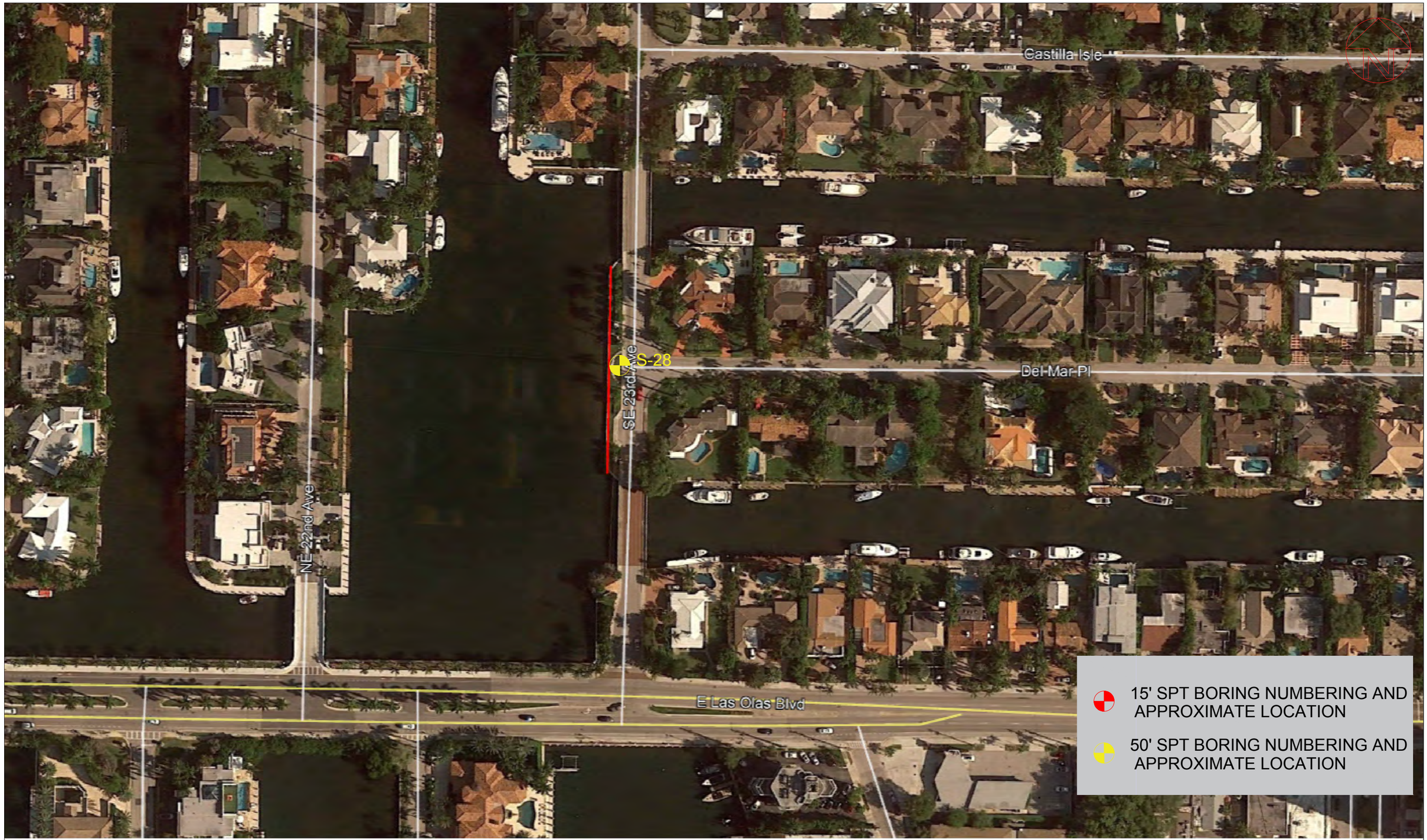
SCALE: HORIZONTAL N.T.S.

SHEET TITLE: BORING LOCATION PLAN (SEAWALL 9)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2A

RADISE PROJECT NO: 170901



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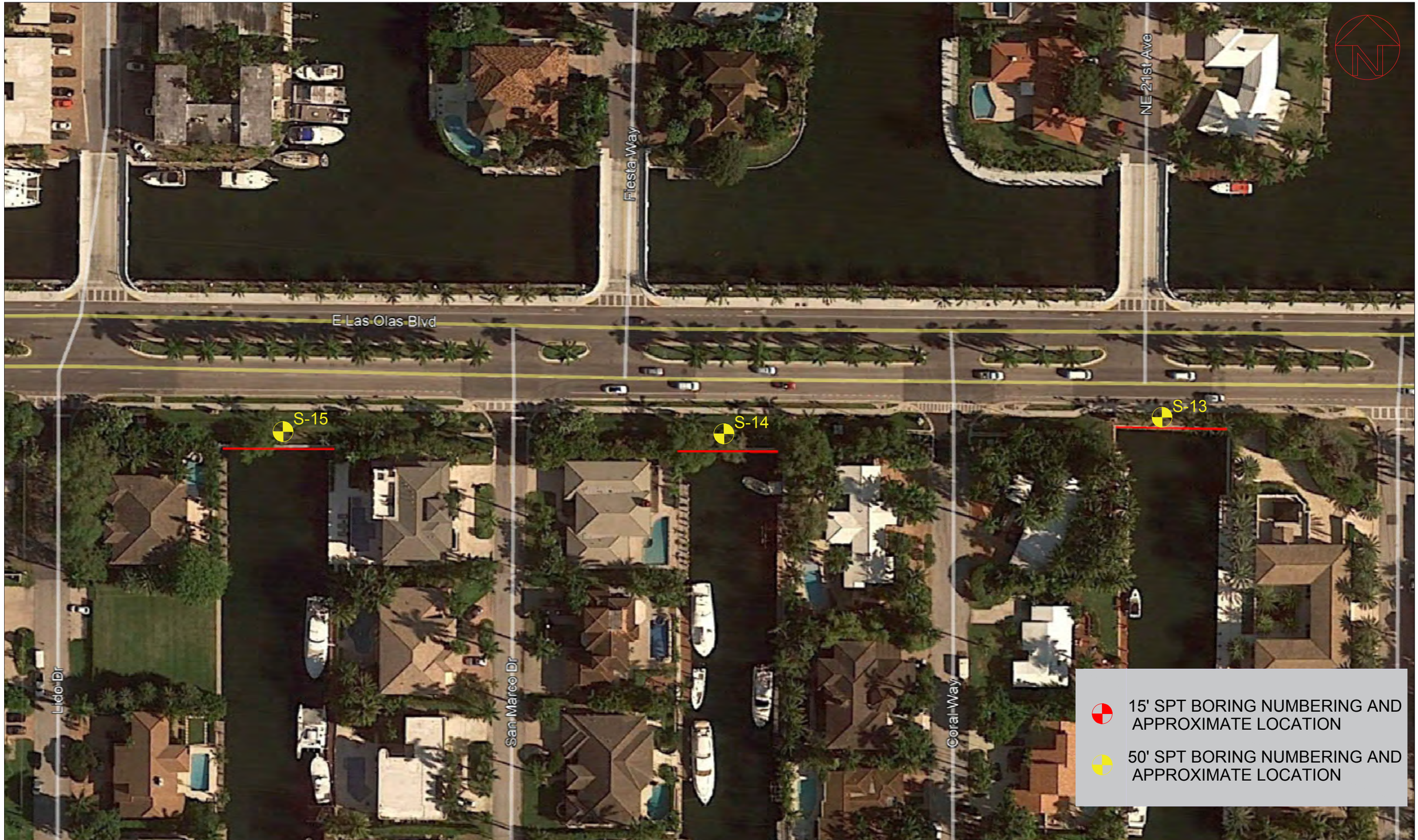
SHEET TITLE: BORING LOCATION PLAN (SEAWALL 10)
PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2B
RADISE PROJECT NO: 170901



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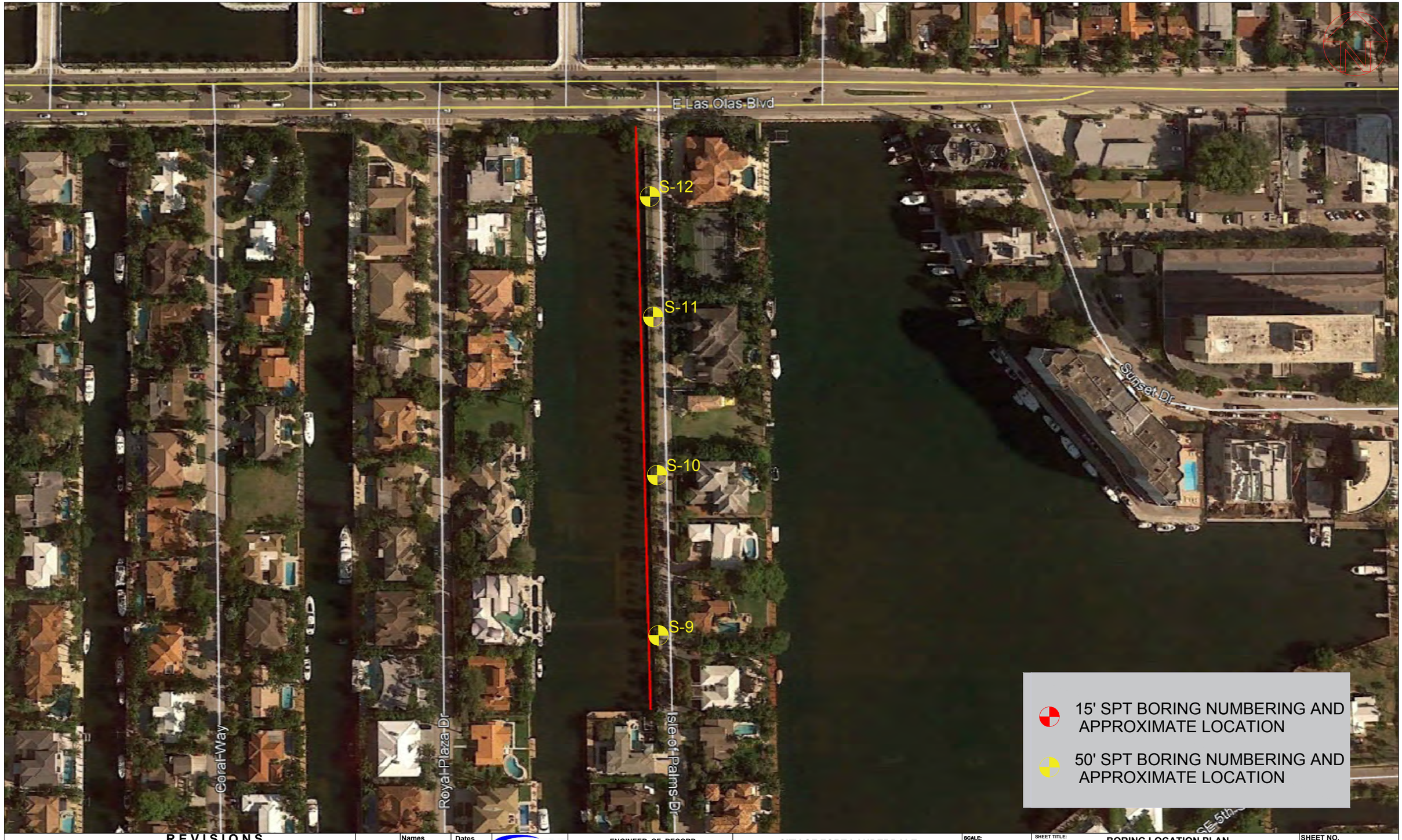
SCALE: HORIZONTAL N.T.S.

SHEET TITLE: BORING LOCATION PLAN (SEAWALL 12, 13 AND 14)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2C

RADISE PROJECT NO: 170901



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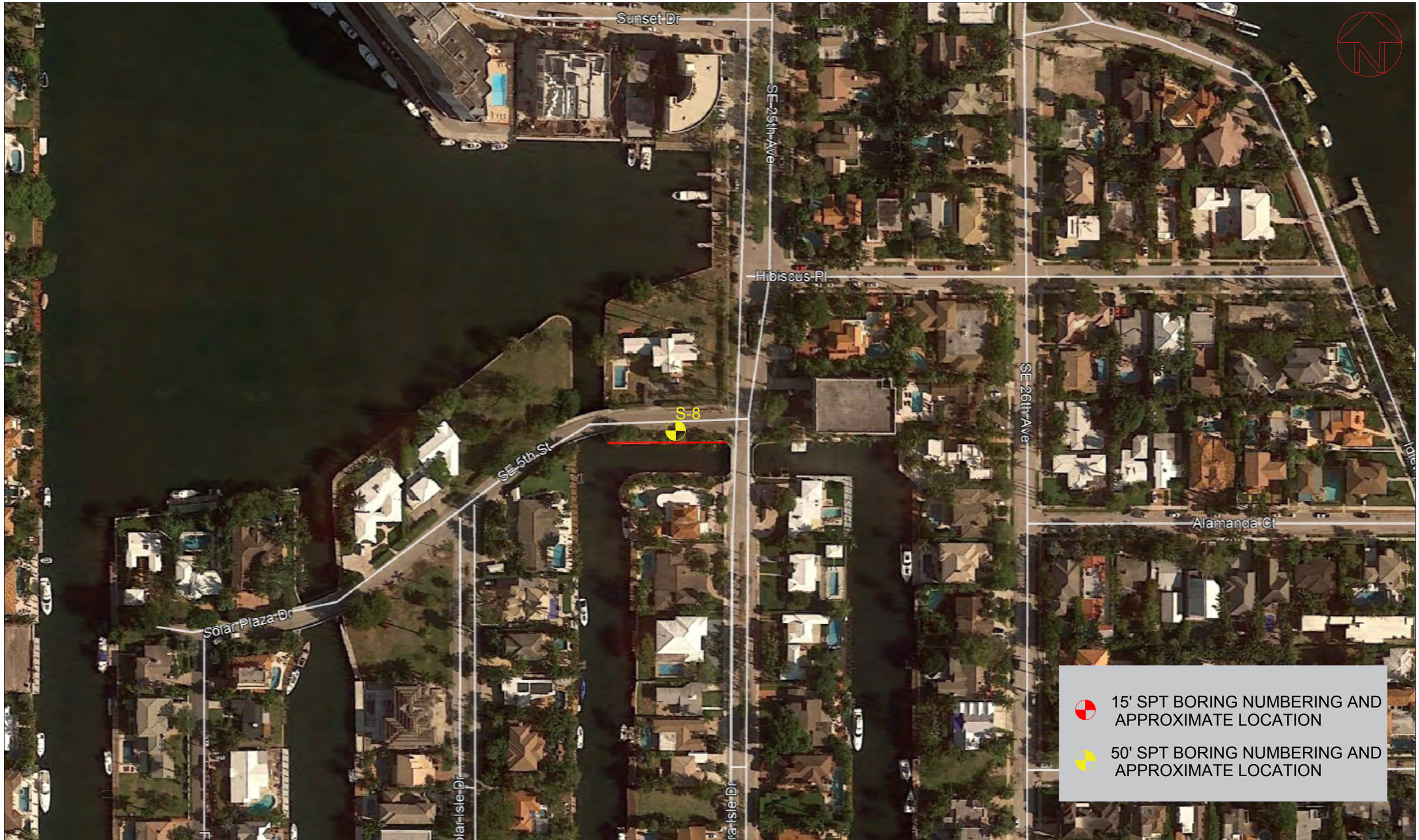
SHEET TITLE: BORING LOCATION PLAN (SEAWALL 15)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2D

RADISE PROJECT NO: 170901



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SCALE: HORIZONTAL N.T.S.

SHEET TITLE: BORING LOCATION PLAN (SEAWALL 17)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

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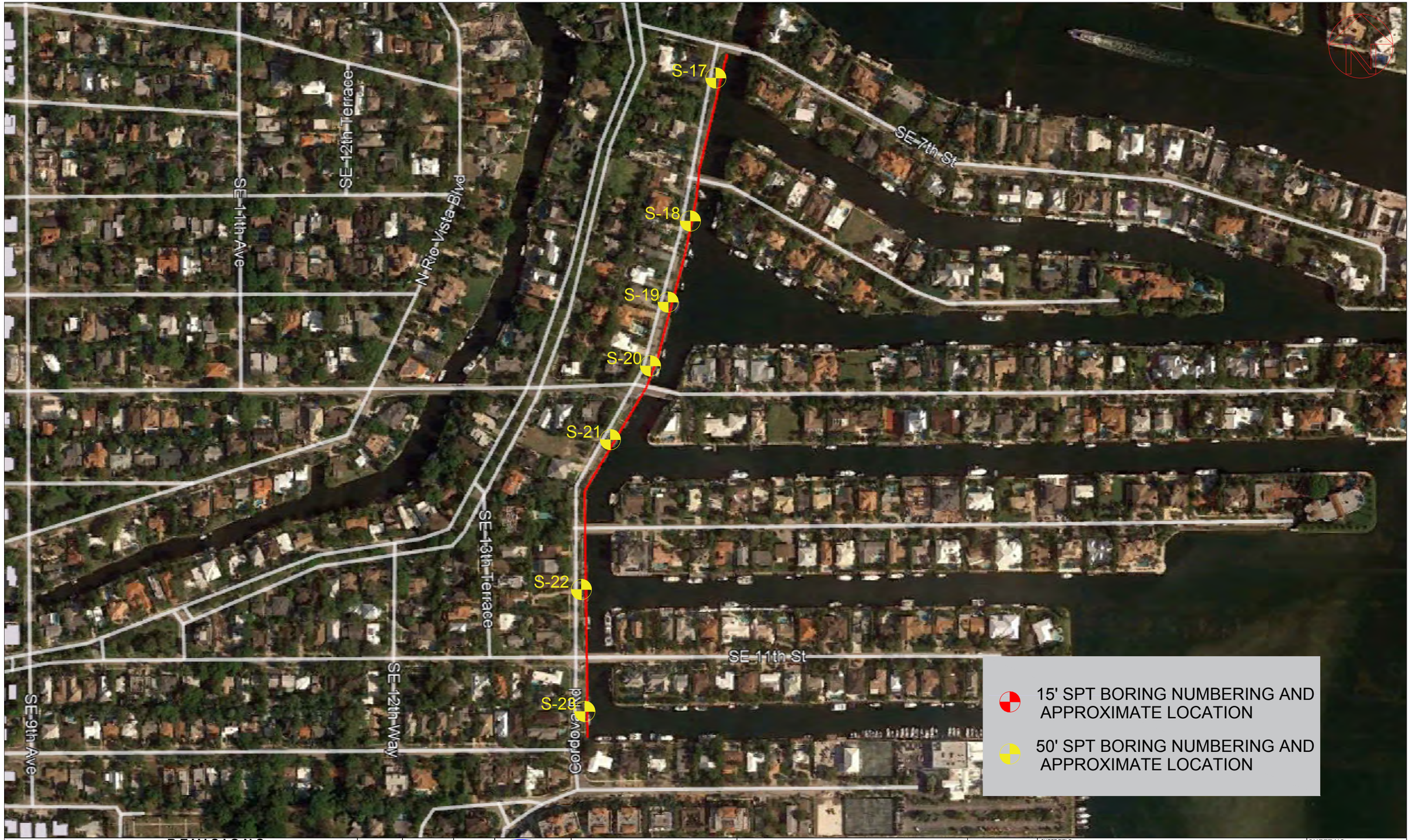

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SHEET TITLE: BORING LOCATION PLAN (SEAWALL 29)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2F

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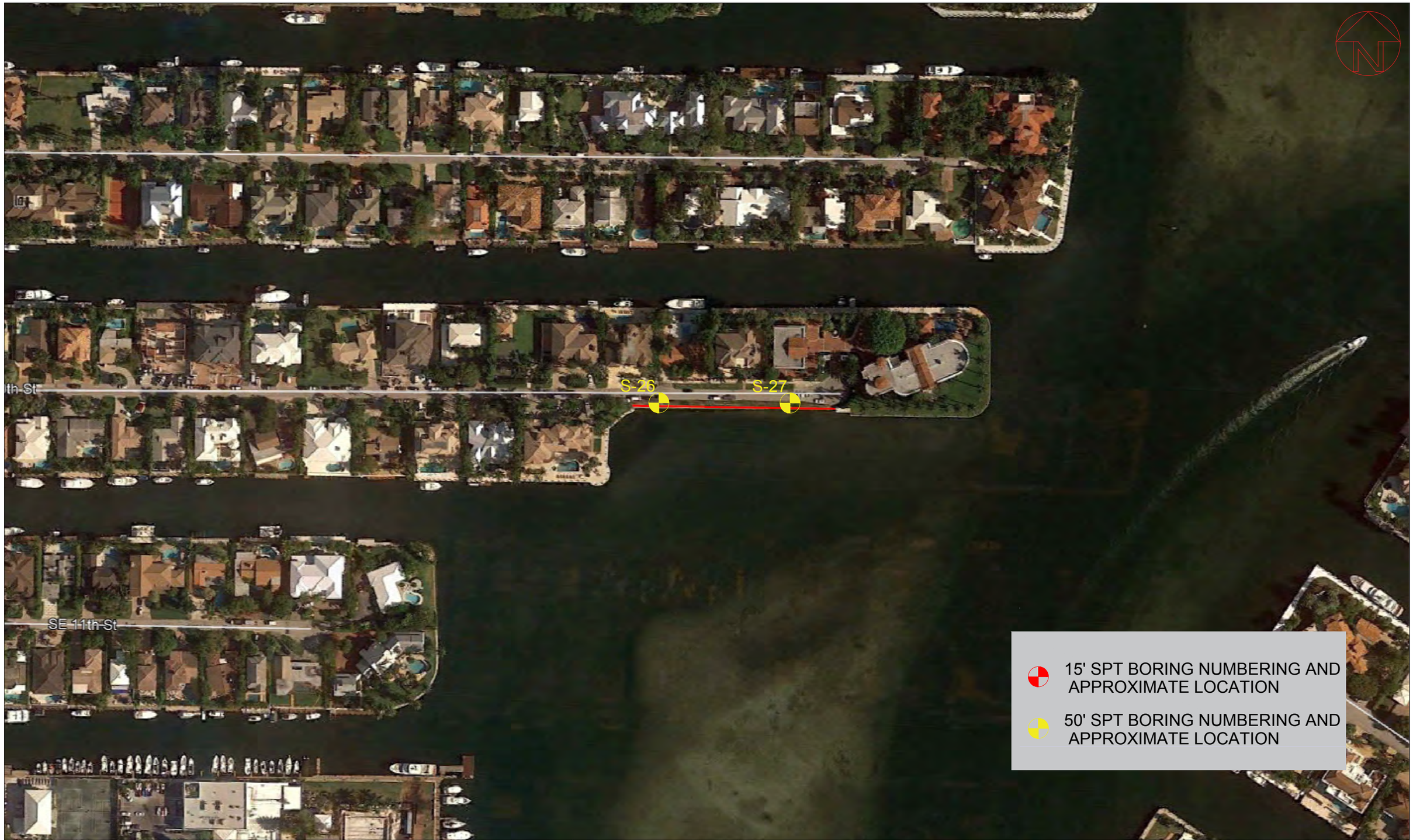

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SHEET TITLE: BORING LOCATION PLAN (SEAWALL 30)
SHEET NO. 2G
PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION
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SCALE: HORIZONTAL N.T.S.

SHEET TITLE: BORING LOCATION PLAN (SEAWALL 32)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2H

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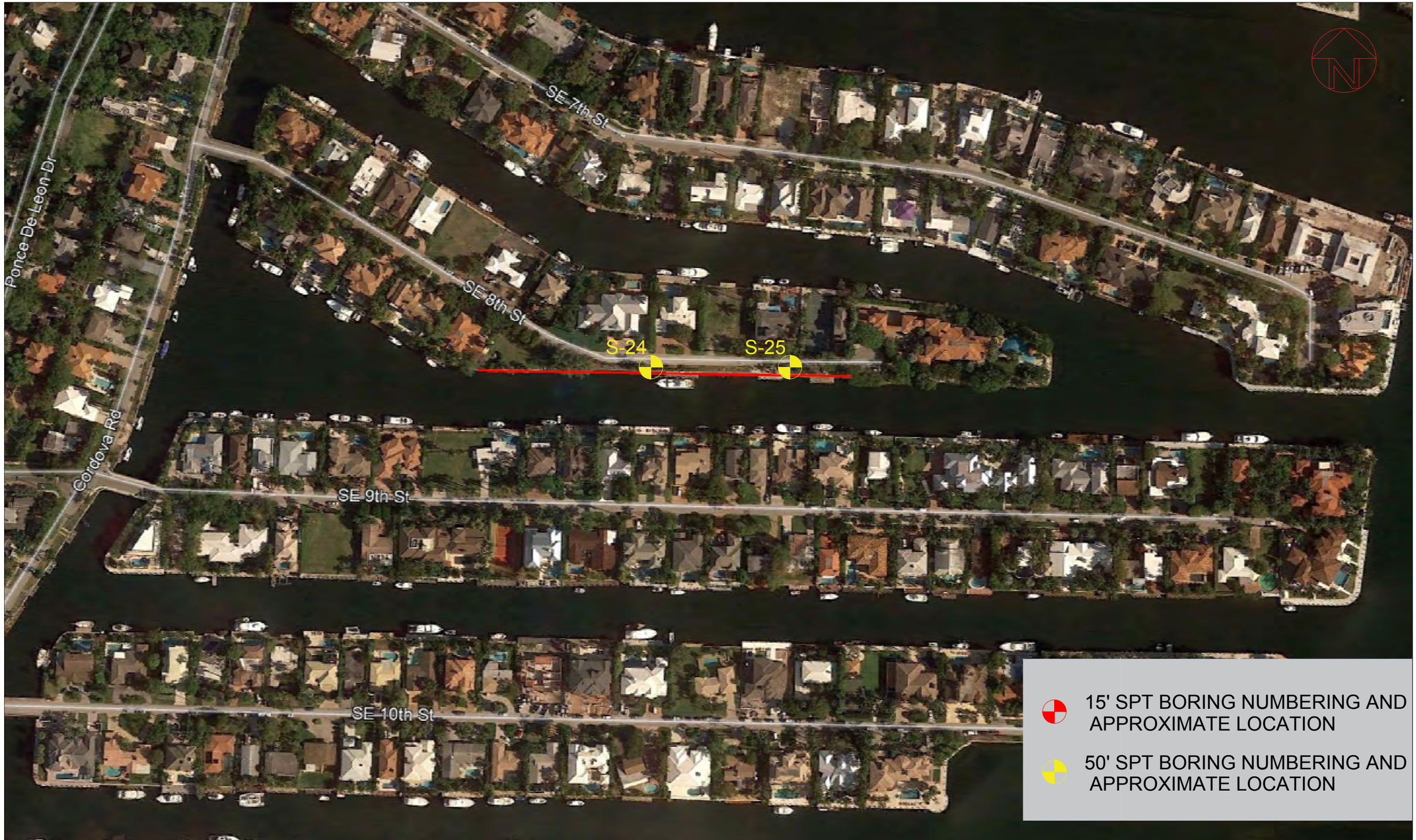
SCALE: HORIZONTAL N.T.S.

SHEET TITLE: BORING LOCATION PLAN (SEAWALL 34)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2I

RADISE PROJECT NO: 170901



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SCALE: HORIZONTAL N.T.S.

SHEET TITLE: BORING LOCATION PLAN (SEAWALL 35)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2J

RADISE PROJECT NO: 170901

15' SPT BORING NUMBERING AND APPROXIMATE LOCATION

50' SPT BORING NUMBERING AND APPROXIMATE LOCATION

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SCALE: VERTICAL N.T.S.

SCALE: HORIZONTAL N.T.S.

SHEET TITLE: BORING LOCATION PLAN (SOUTHEAST ISLES)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2K

RADISE PROJECT NO: 170901

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SCALE: VERTICAL N.T.S.

SCALE: HORIZONTAL N.T.S.

SHEET TITLE: BORING LOCATION PLAN (DORSY RIVERBEND)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2L

RADISE PROJECT NO: 170901

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SCALE: HORIZONTAL N.T.S.

SHEET TITLE: BORING LOCATION PLAN (DURRS)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2M

RADISE PROJECT NO: 170901

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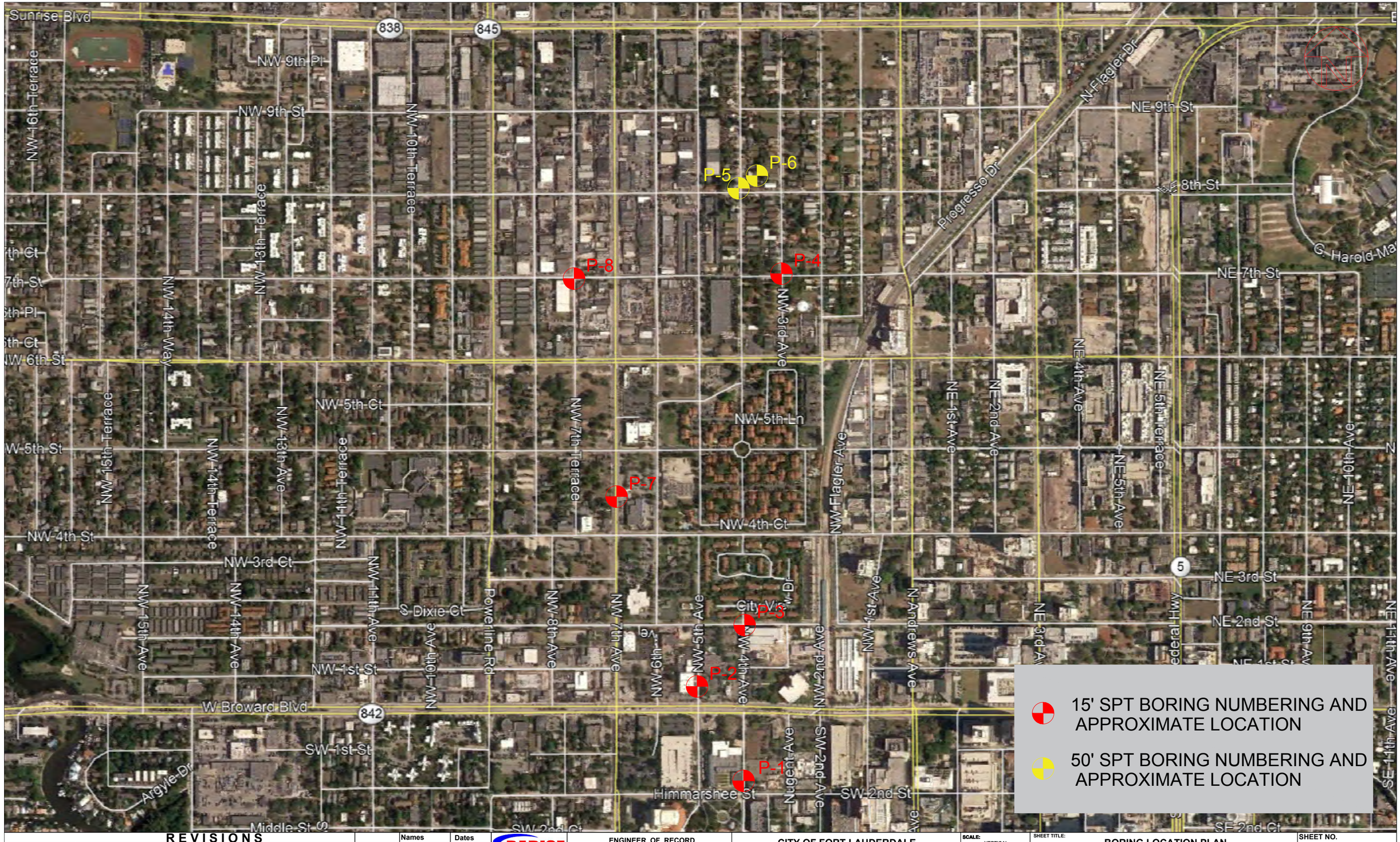
SCALE: HORIZONTAL N.T.S.

SHEET TITLE: BORING LOCATION PLAN (EDGEWOOD)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2N

RADISE PROJECT NO: 170901



REVISIONS							Names	Dates
Date.	By	Descriptions	Date.	By	Descriptions	Drawn by	KA	11/14/17
						Checked by	AB	11/15/17
						Designed by		
						Checked by		
						Approved by		

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CITY OF FORT LAUDERDALE PUBLIC WORKS DEPARTMENT	
COUNTY	CLIENT
BROWARD	HAZEN AND SAWYER

SCALE: VERTICAL N.T.S.

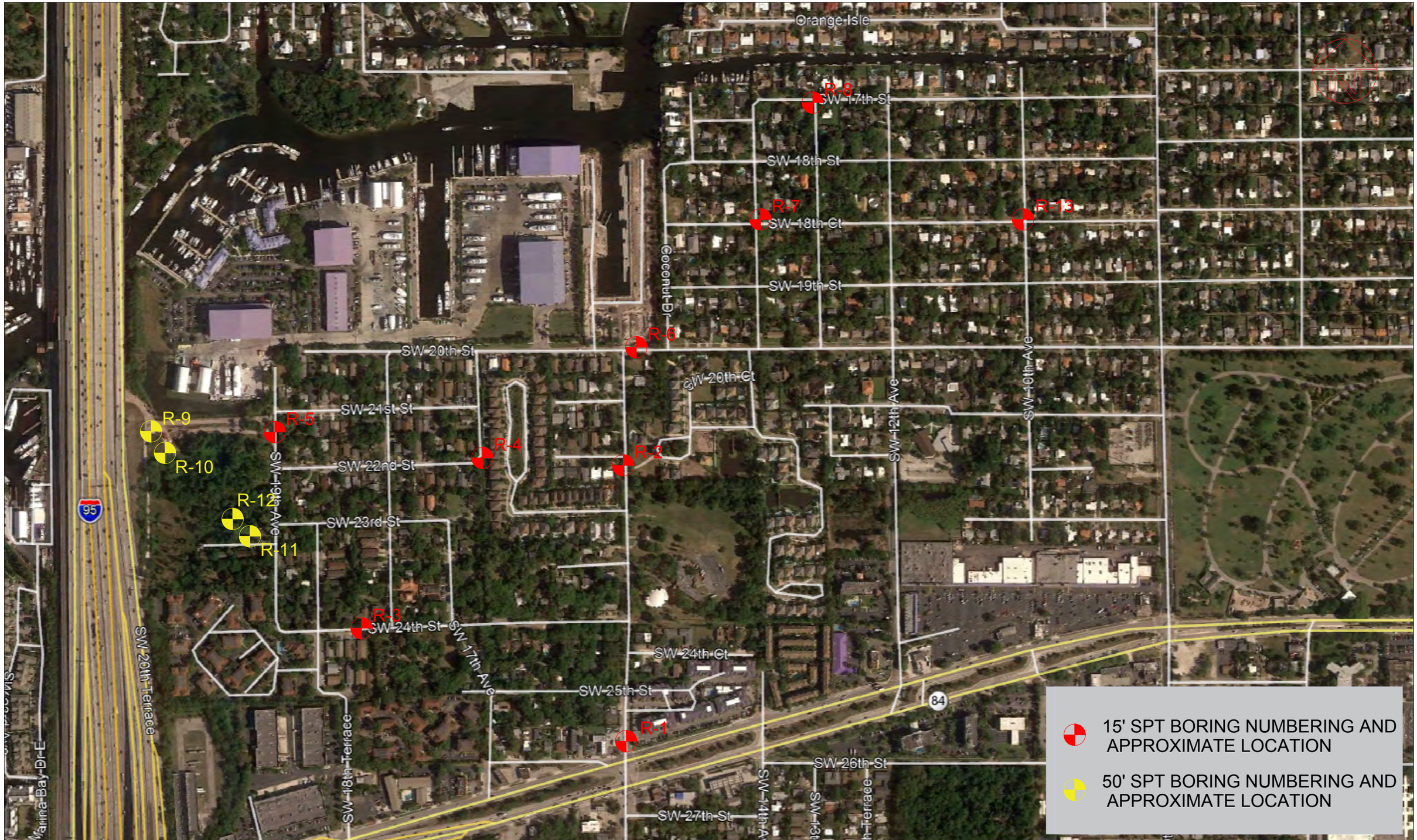
SCALE: HORIZONTAL N.T.S.

SHEET TITLE: BORING LOCATION PLAN (PROGRESSO)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2O

RADISE PROJECT NO: 170901



REVISIONS

Date.	By	Descriptions	Date.	By	Descriptions

	Names	Dates
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BROWARD	HAZEN AND SAWYER

SCALE: VERTICAL N.T.S.

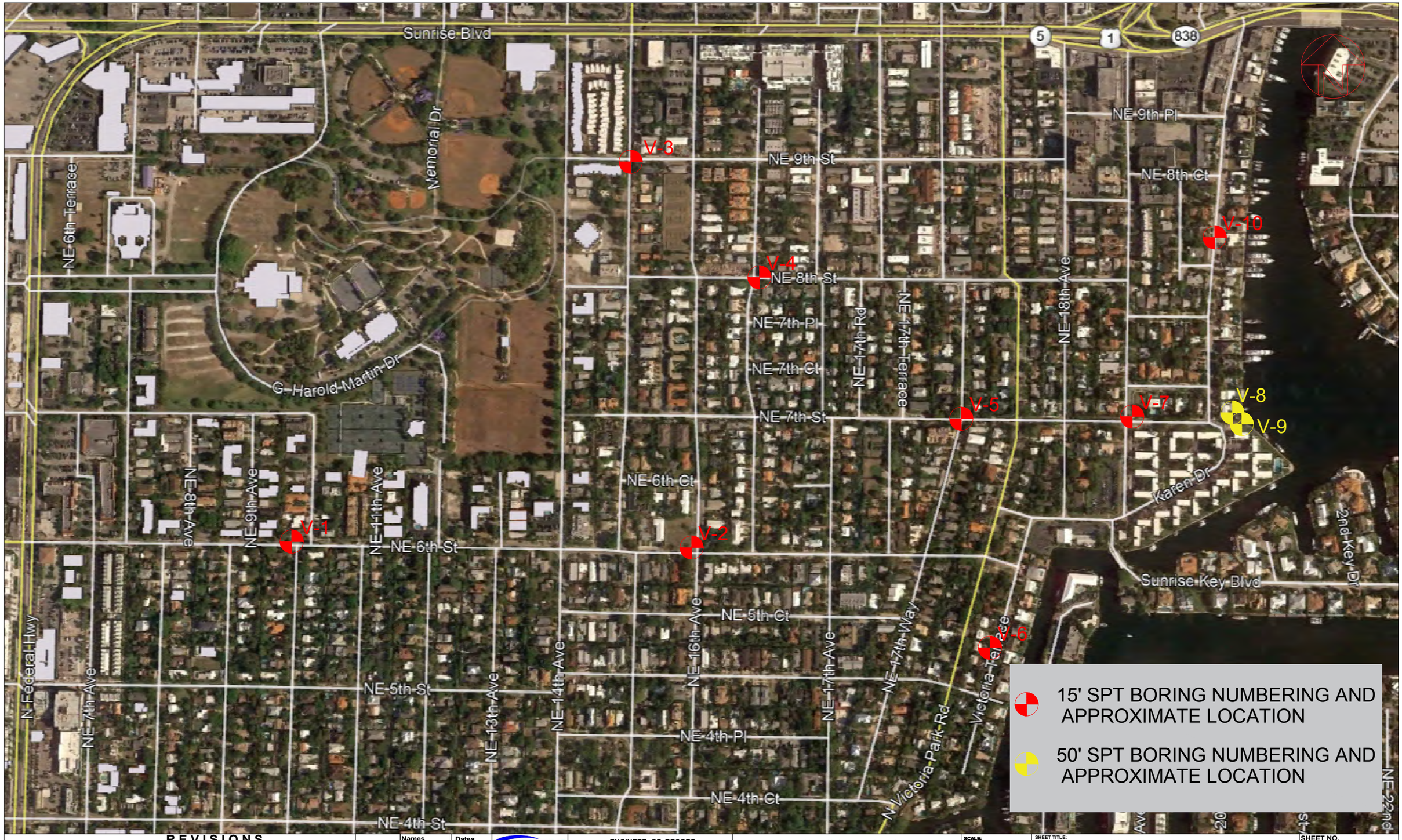
SCALE: HORIZONTAL N.T.S.

SHEET TITLE: BORING LOCATION PLAN (RIVER OAKS)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2P

RADISE PROJECT NO: 170901



REVISIONS					
Date.	By	Descriptions	Date.	By	Descriptions

	Names	Dates
Drawn by	KA	11/14/17
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CITY OF FORT LAUDERDALE
PUBLIC WORKS DEPARTMENT

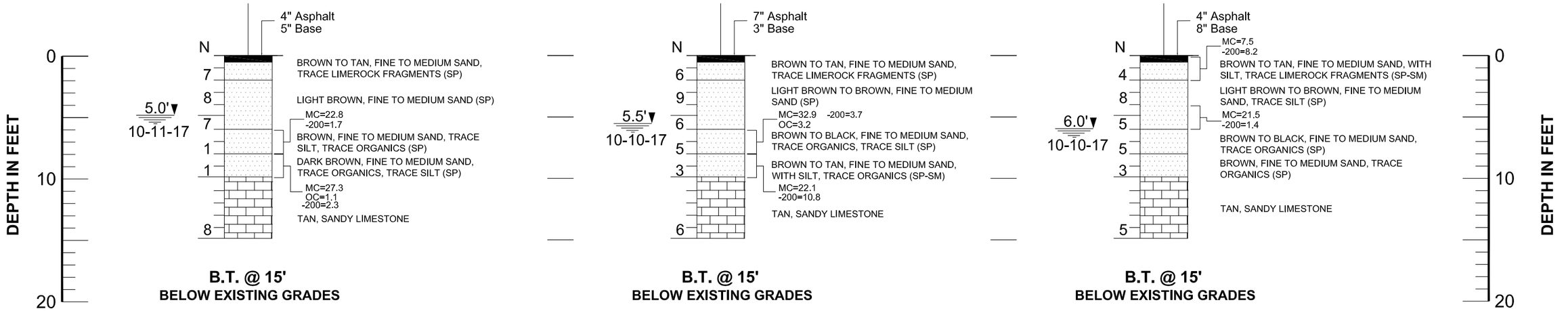
COUNTY	CLIENT
BROWARD	HAZEN AND SAWYER

SCALE: VERTICAL N.T.S.
SCALE: HORIZONTAL N.T.S.

SHEET TITLE: BORING LOCATION PLAN (VICTORIA PARK)
PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 2Q
RADISE PROJECT NO: 170901

	D-1	D-2	D-3
BORING NO.	D-1	D-2	D-3
ELEVATION (NAVD 88):	N/A	N/A	N/A
LATITUDE:	26.1345°	26.1327°	26.1307°
LONGITUDE:	-80.1653°	-80.1639°	-80.1671°
DATE:	10/11/2017	10/10/2017	10/10/2017
DRILLER:	T. FICKLING	T. FICKLING	T. FICKLING
RIG:	CME 45	CME 45	CME 45



LEGEND

- ASPHALT AND BASE
- LIMESTONE
- SAND
- GRAVEL
- SILTY SAND
- ORGANIC MATERIAL
- 5.0' ▼ / 10-11-17 — GROUNDWATER DEPTH IN FEET AND DRILLING DATE
- N — STANDARD PENETRATION RESISTANCE- BLOWS PER FOOT USING AUTOMATIC HAMMER

SP, SP-SM, SM	UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL (ASTM D 2488)
D-1	STANDARD PENETRATION TEST (SPT) BORING AND NUMBER
MC	MOISTURE CONTENT (%)
-200	AMOUNT PASSING US STANDARD # 200 SIEVE (%)
OC	ORGANIC CONTENTS (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
B.T. @ 15'	BORING TERMINATED AT 15 FEET BELOW THE EXISTING GROUND SURFACE

NOTES

(1) BORINGS WERE DRILLED ON OCTOBER, 2017 USING A CENTRAL MINING EQUIPMENT MODEL 45 (CME 45) AUTOMATIC HAMMER DRILL RIG.

(2) STRATA BOUNDARIES ARE APPROXIMATE AND REPRESENT SOIL AND REPRESENT SOIL STRATA AT EACH TEST HOLE LOCATION ONLY. SOIL TRANSITIONS MAY BE MORE GRADUAL THAN IMPLIED.

(3) GROUNDWATER LEVELS SHOWN ON THE SUBSURFACE PROFILES REPRESENT GROUNDWATER SURFACES ON THE DATES SHOWN. GROUNDWATER LEVELS WILL FLUCTUATE THROUGHOUT THE YEAR.

(4) LONGITUDE AND LATITUDE COORDINATES WERE MEASURED IN THE FIELD USING A HAND HELD GPS UNIT.

(5) ELEVATIONS WERE NOT AVAILABLE

(6) AFTER COMPLETION OF DRILLING BOREHOLES WERE BACK FILLED WITH GROUT.

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE BLOWS/FOOT
VERY LOOSE	LESS THAN 3
LOOSE	3 - 8
MEDIUM	8 - 24
DENSE	24 - 40
VERY DENSE	GREATER THAN 40

STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.375 INCH
SPOON OUTSIDE DIA.	2.0 INCHES
AVG. HAMMER DROP	30 INCHES
HAMMER WEIGHT	140 POUNDS

REVISIONS							Names	Dates
Date.	By	Descriptions	Date.	By	Descriptions	Drawn by	KA	11/07/17
						Checked by	AB	11/07/17
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						Checked by		
						Approved by		

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CITY OF FORT LAUDERDALE
PUBLIC WORKS DEPARTMENT

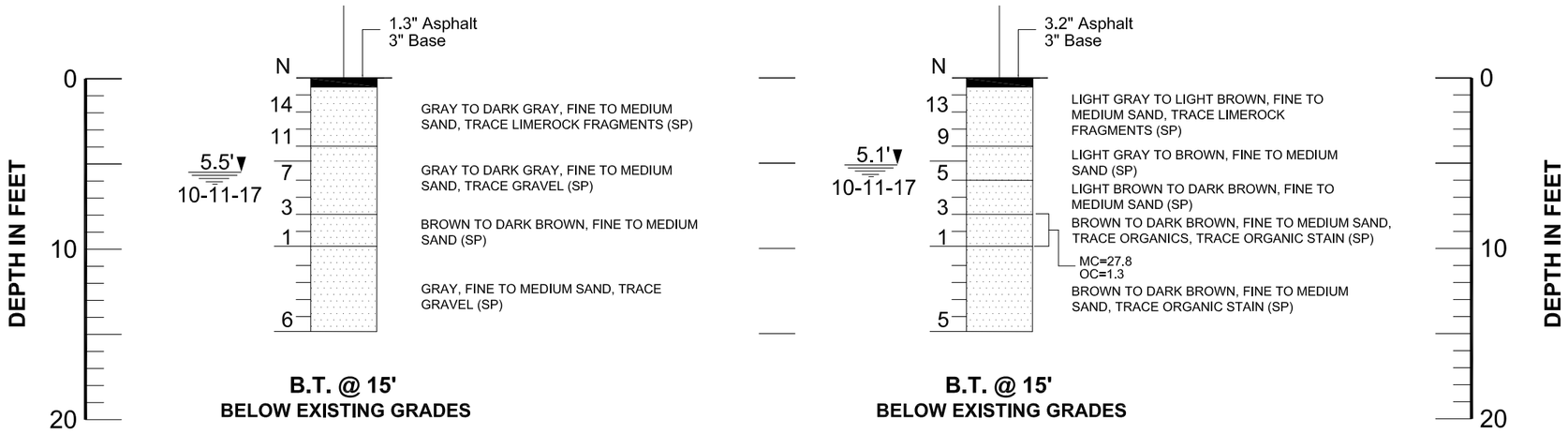
COUNTY	CLIENT
BROWARD	HAZEN AND SAWYER

SCALE: VERTICAL N.T.S.
SCALE: HORIZONTAL N.T.S.

SHEET TITLE: SUBSURFACE PROFILES (DURRS)
PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 3A
RADISE PROJECT NO: 170901

	D-4	D-5
BORING NO.	D-4	D-5
ELEVATION (NAVD 88):	N/A	N/A
LATITUDE:	26.1328°	26.1297°
LONGITUDE:	-80.1590°	-80.1613°
DATE:	10/11/2017	10/11/2017
DRILLER:	T. FICKLING	T. FICKLING
RIG:	CME 45	CME 45



LEGEND

- ASPHALT AND BASE
- LIMESTONE
- SAND
- GRAVEL
- SILTY SAND
- ORGANIC MATERIAL
- 5.0' / 10-11-17 — GROUNDWATER DEPTH IN FEET AND DRILLING DATE
- N — STANDARD PENETRATION RESISTANCE- BLOWS PER FOOT USING AUTOMATIC HAMMER

SP, SP-SM, SM	UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL (ASTM D 2488)
D-1	STANDARD PENETRATION TEST (SPT) BORING AND NUMBER
MC	MOISTURE CONTENT (%)
-200	AMOUNT PASSING US STANDARD # 200 SIEVE (%)
OC	ORGANIC CONTENTS (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
B.T. @ 15'	BORING TERMINATED AT 15 FEET BELOW THE EXISTING GROUND SURFACE

NOTES

(1) BORINGS WERE DRILLED ON OCTOBER, 2017 USING A CENTRAL MINING EQUIPMENT MODEL 45 (CME 45) AUTOMATIC HAMMER DRILL RIG.

(2) STRATA BOUNDARIES ARE APPROXIMATE AND REPRESENT SOIL AND REPRESENT SOIL STRATA AT EACH TEST HOLE LOCATION ONLY. SOIL TRANSITIONS MAY BE MORE GRADUAL THAN IMPLIED.

(3) GROUNDWATER LEVELS SHOWN ON THE SUBSURFACE PROFILES REPRESENT GROUNDWATER SURFACES ON THE DATES SHOWN. GROUNDWATER LEVELS WILL FLUCTUATE THROUGHOUT THE YEAR.

(4) LONGITUDE AND LATITUDE COORDINATES WERE MEASURED IN THE FIELD USING A HAND HELD GPS UNIT.

(5) ELEVATIONS WERE NOT AVAILABLE

(6) AFTER COMPLETION OF DRILLING BOREHOLES WERE BACK FILLED WITH GROUT.

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE BLOWS/FOOT
VERY LOOSE	LESS THAN 3
LOOSE	3 - 8
MEDIUM	8 - 24
DENSE	24 - 40
VERY DENSE	GREATER THAN 40

STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.375 INCH
SPOON OUTSIDE DIA.	2.0 INCHES
AVG. HAMMER DROP	30 INCHES
HAMMER WEIGHT	140 POUNDS

REVISIONS							Names	Dates
Date.	By	Descriptions	Date.	By	Descriptions	Drawn by	KA	11/09/17
						Checked by	AB	11/09/17
						Designed by		
						Checked by		
						Approved by		

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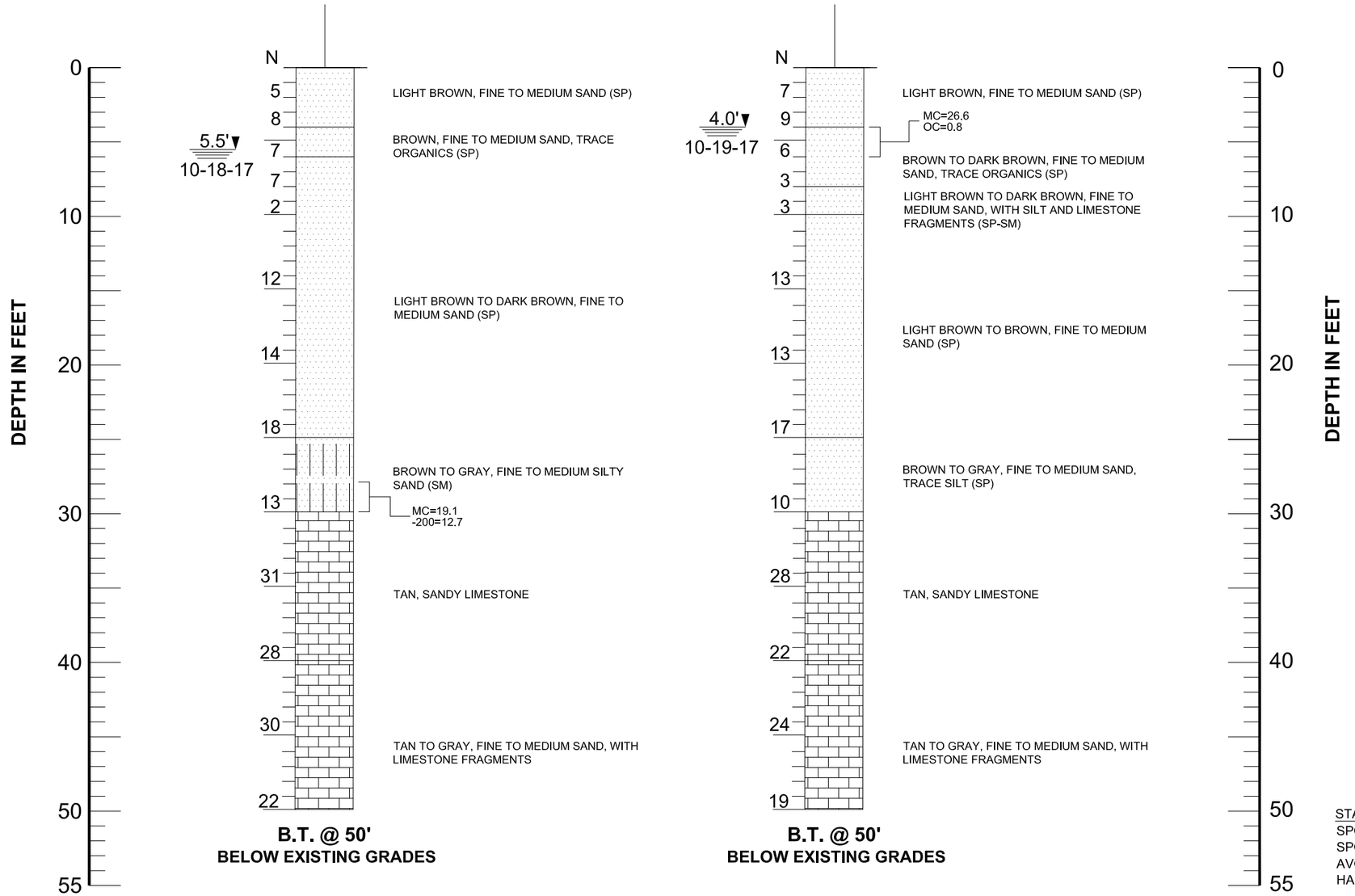
CITY OF FORT LAUDERDALE PUBLIC WORKS DEPARTMENT		SCALE: VERTICAL N.T.S.	SHEET TITLE: SUBSURFACE PROFILES (DRRUS)	SHEET NO. 3B
COUNTY	CLIENT	SCALE: HORIZONTAL N.T.S.	PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION	RADISE PROJECT NO: 170901
BROWARD	HAZEN AND SAWYER			

	DR-1	DR-2
BORING NO.	DR-1	DR-2
ELEVATION (NAVD 88):	N/A	N/A
LATITUDE:	26.1278°	26.1279°
LONGITUDE:	-80.1621°	-80.1619°
DATE:	10/18/2017	10/19/2017
DRILLER:	R. RAMSEWACK	R. RAMSEWACK
RIG:	CME 45	CME 45



LEGEND

SAND	SHELLY SAND
SILTY SAND	LIMESTONE
ORGANIC MATERIAL	GRAVEL

5.5' ▼ 10-18-17	GROUNDWATER DEPTH IN FEET AND DRILLING DATE
N	STANDARD PENETRATION RESISTANCE- BLOWS PER FOOT USING AUTOMATIC HAMMER
SP, SP-SM, SM	UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL (ASTM D 2488)
DR-1	STANDARD PENETRATION TEST (SPT) BORING AND NUMBER
MC	MOISTURE CONTENT (%)
-200	AMOUNT PASSING US STANDARD # 200 SIEVE
OC	ORGANIC CONTENTS (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
B.T. @ 50'	BORING TERMINATED AT 50 FEET BELOW THE EXISTING GROUND SURFACE

NOTES

(1) BORINGS WERE DRILLED ON OCTOBER, 2017 USING A CENTRAL MINING EQUIPMENT MODEL 45 (CME 45) AUTOMATIC HAMMER DRILL RIG.

(2) STRATA BOUNDARIES ARE APPROXIMATE AND REPRESENT SOIL AND REPRESENT SOIL STRATA AT EACH TEST HOLE LOCATION ONLY. SOIL TRANSITIONS MAY BE MORE GRADUAL THAN IMPLIED.

(3) GROUNDWATER LEVELS SHOWN ON THE SUBSURFACE PROFILES REPRESENT GROUNDWATER SURFACES ON THE DATES SHOWN. GROUNDWATER LEVELS WILL FLUCTUATE THROUGHOUT THE YEAR.

(4) LONGITUDE AND LATITUDE COORDINATES WERE MEASURED IN THE FIELD USING A HAND HELD GPS UNIT.

(5) ELEVATIONS WERE NOT AVAILABLE

(6) AFTER COMPLETION OF DRILLING BOREHOLES WERE BACK FILLED WITH GROUT.

STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.375 INCH
SPOON OUTSIDE DIA.	2.0 INCHES
AVG. HAMMER DROP	30 INCHES
HAMMER WEIGHT	140 POUNDS

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE BLOWS/FOOT
VERY LOOSE	LESS THAN 3
LOOSE	3 - 8
MEDIUM	8 - 24
DENSE	24 - 40
VERY DENSE	GREATER THAN 40

REVISIONS

Date.	By	Descriptions	Date.	By	Descriptions

	Names	Dates
Drawn by	ML	10/26/17
Checked by	AB	10/26/17
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CITY OF FORT LAUDERDALE
PUBLIC WORKS DEPARTMENT

COUNTY	CLIENT
BROWARD	HAZEN AND SAWYER

SCALE: VERTICAL N.T.S.

SCALE: HORIZONTAL N.T.S.

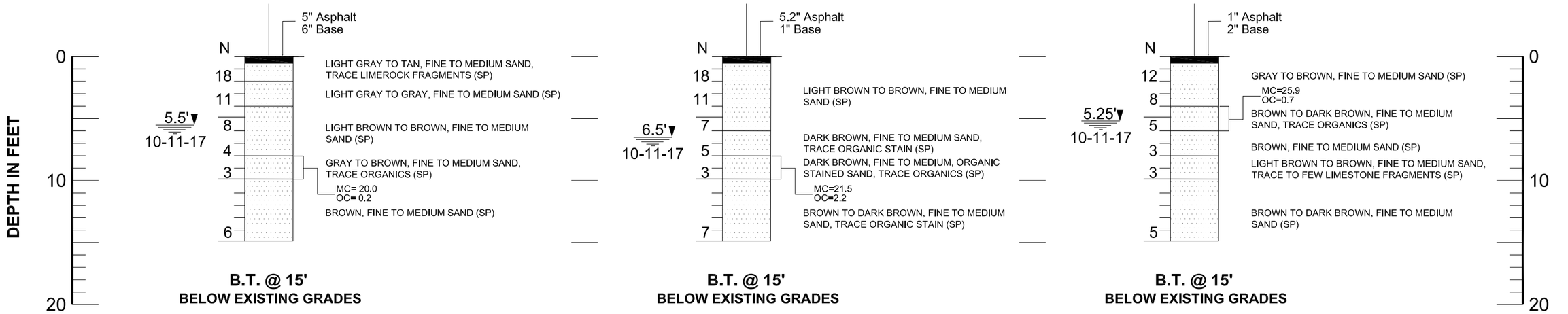
SHEET TITLE: SUBSURFACE PROFILES (DORSEY RIVERBEND)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 4A

RADISE PROJECT NO: 170901

	DR-3	DR-4	DR-5
BORING NO.	DR-3	DR-4	DR-5
ELEVATION (NAVD 88):	N/A	N/A	N/A
LATITUDE:	26.1256°	26.1256°	26.1288°
LONGITUDE:	-80.1617°	-80.1658°	-80.1660°
DATE:	10/11/2017	10/11/2017	10/11/2017
DRILLER:	T. FICKLING	T. FICKLING	T. FICKLING
RIG:	CME 45	CME 45	CME 45



LEGEND

- ASPHALT AND BASE
- SAND
- SILTY SAND
- LIMESTONE
- GRAVEL
- ORGANIC MATERIAL
- 5.5' / 10-11-17 — GROUNDWATER DEPTH IN FEET AND DRILLING DATE
- N — STANDARD PENETRATION RESISTANCE-BLOWS PER FOOT USING AUTOMATIC HAMMER

SP, SP-SM, SM	UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL (ASTM D 2488)
DR-1	STANDARD PENETRATION TEST (SPT) BORING AND NUMBER
MC	MOISTURE CONTENT (%)
-200	AMOUNT PASSING US STANDARD # 200 SIEVE (%)
OC	ORGANIC CONTENTS (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
B.T. @ 15'	BORING TERMINATED AT 15 FEET BELOW THE EXISTING GROUND SURFACE

NOTES

(1) BORINGS WERE DRILLED ON OCTOBER, 2017 USING A CENTRAL MINING EQUIPMENT MODEL 45 (CME 45) AUTOMATIC HAMMER DRILL RIG.

(2) STRATA BOUNDARIES ARE APPROXIMATE AND REPRESENT SOIL AND REPRESENT SOIL STRATA AT EACH TEST HOLE LOCATION ONLY. SOIL TRANSITIONS MAY BE MORE GRADUAL THAN IMPLIED.

(3) GROUNDWATER LEVELS SHOWN ON THE SUBSURFACE PROFILES REPRESENT GROUNDWATER SURFACES ON THE DATES SHOWN. GROUNDWATER LEVELS WILL FLUCTUATE THROUGHOUT THE YEAR.

(4) LONGITUDE AND LATITUDE COORDINATES WERE MEASURED IN THE FIELD USING A HAND HELD GPS UNIT.

(5) ELEVATIONS WERE NOT AVAILABLE

(6) AFTER COMPLETION OF DRILLING BOREHOLES WERE BACK FILLED WITH GROUT.

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE BLOWS/FOOT
VERY LOOSE	LESS THAN 3
LOOSE	3 - 8
MEDIUM	8 - 24
DENSE	24 - 40
VERY DENSE	GREATER THAN 40

STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.375 INCH
SPOON OUTSIDE DIA.	2.0 INCHES
AVG. HAMMER DROP	30 INCHES
HAMMER WEIGHT	140 POUNDS

REVISIONS

Date.	By	Descriptions	Date.	By	Descriptions

	Names	Dates
Drawn by	KA	11/09/17
Checked by	AB	11/09/17
Designed by		
Checked by		
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CITY OF FORT LAUDERDALE
PUBLIC WORKS DEPARTMENT

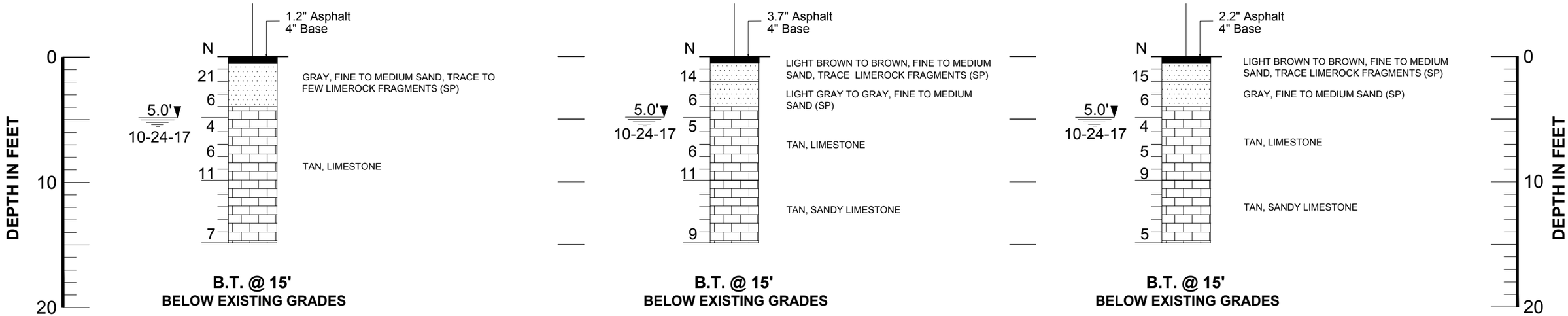
COUNTY	CLIENT
BROWARD	HAZEN AND SAWYER

SCALE: VERTICAL N.T.S.
SCALE: HORIZONTAL N.T.S.

SHEET TITLE: SUBSURFACE PROFILES (DORSEY RIVERBEND)
PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 4B
RADISE PROJECT NO: 170901

	E-1	E-2	E-3
BORING NO.			
ELEVATION (NAVD 88):	N/A	N/A	N/A
LATITUDE:	26.0845°	26.0864°	26.0881°
LONGITUDE:	-80.1607°	-80.1607°	-80.1607°
DATE:	10/24/2017	10/24/2017	10/24/2017
DRILLER:	T. FICKLING	T. FICKLING	T. FICKLING
RIG:	CME 45	CME 45	CME 45



LEGEND

- ASPHALT AND BASE
- LIMESTONE
- SAND
- GRAVEL
- SILTY SAND
- ORGANIC MATERIAL
- 5.0' / 10-24-17 — GROUNDWATER DEPTH IN FEET AND DRILLING DATE
- N — STANDARD PENETRATION RESISTANCE- BLOWS PER FOOT USING AUTOMATIC HAMMER

SP, SP-SM, PT	UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL (ASTM D 2488)
E-1	STANDARD PENETRATION TEST (SPT) BORING AND NUMBER
MC	MOISTURE CONTENT (%)
-200	AMOUNT PASSING US STANDARD # 200 SIEVE (%)
OC	ORGANIC CONTENTS (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
B.T. @ 15'	BORING TERMINATED AT 15 FEET BELOW THE EXISTING GROUND SURFACE

NOTES

(1) BORINGS WERE DRILLED ON OCTOBER, 2017 USING A CENTRAL MINING EQUIPMENT MODEL 45 (CME 45) AUTOMATIC HAMMER DRILL RIG.

(2) STRATA BOUNDARIES ARE APPROXIMATE AND REPRESENT SOIL AND REPRESENT SOIL STRATA AT EACH TEST HOLE LOCATION ONLY. SOIL TRANSITIONS MAY BE MORE GRADUAL THAN IMPLIED.

(3) GROUNDWATER LEVELS SHOWN ON THE SUBSURFACE PROFILES REPRESENT GROUNDWATER SURFACES ON THE DATES SHOWN. GROUNDWATER LEVELS WILL FLUCTUATE THROUGHOUT THE YEAR.

(4) LONGITUDE AND LATITUDE COORDINATES WERE MEASURED IN THE FIELD USING A HAND HELD GPS UNIT.

(5) ELEVATIONS WERE NOT AVAILABLE

(6) AFTER COMPLETION OF DRILLING BOREHOLES WERE BACK FILLED WITH GROUT.

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE BLOWS/FOOT
VERY LOOSE	LESS THAN 3
LOOSE	3 - 8
MEDIUM	8 - 24
DENSE	24 - 40
VERY DENSE	GREATER THAN 40

STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.375 INCH
SPOON OUTSIDE DIA.	2.0 INCHES
AVG. HAMMER DROP	30 INCHES
HAMMER WEIGHT	140 POUNDS

REVISIONS

Date.	By	Descriptions	Date.	By	Descriptions

	Names	Dates
Drawn by	KA	11/06/17
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CITY OF FORT LAUDERDALE
PUBLIC WORKS DEPARTMENT

COUNTY	CLIENT
BROWARD	HAZEN AND SAWYER

SCALE: VERTICAL N.T.S.
SCALE: HORIZONTAL N.T.S.

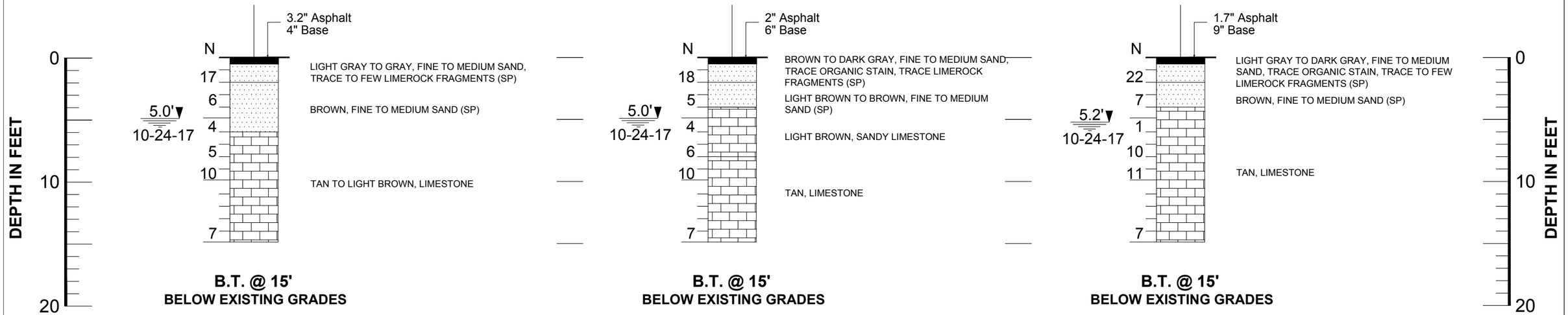
SHEET TITLE: SUBSURFACE PROFILES (EDGEWOOD)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 5A

RADISE PROJECT NO: 170901

	E-4	E-5	E-6
BORING NO.			
ELEVATION (NAVD 88):	N/A	N/A	N/A
LATITUDE:	26.0873°	26.0855°	26.0888°
LONGITUDE:	-80.1595°	-80.1595°	-80.1588°
DATE:	10/24/2017	10/24/2017	10/24/2017
DRILLER:	T. FICKLING	T. FICKLING	T. FICKLING
RIG:	CME 45	CME 45	CME 45



LEGEND

- ASPHALT AND BASE
- LIMESTONE
- SAND
- GRAVEL
- SILTY SAND
- ORGANIC MATERIAL
- 5.0' / 10-24-17 — GROUNDWATER DEPTH IN FEET AND DRILLING DATE
- N — STANDARD PENETRATION RESISTANCE- BLOWS PER FOOT USING AUTOMATIC HAMMER

SP, SP-SM, PT	UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL (ASTM D 2488)
E-1	STANDARD PENETRATION TEST (SPT) BORING AND NUMBER
MC	MOISTURE CONTENT (%)
-200	AMOUNT PASSING US STANDARD # 200 SIEVE (%)
OC	ORGANIC CONTENTS (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
B.T. @ 15'	BORING TERMINATED AT 15 FEET BELOW THE EXISTING GROUND SURFACE

NOTES

(1) BORINGS WERE DRILLED ON OCTOBER, 2017 USING A CENTRAL MINING EQUIPMENT MODEL 45 (CME 45) AUTOMATIC HAMMER DRILL RIG.

(2) STRATA BOUNDARIES ARE APPROXIMATE AND REPRESENT SOIL AND REPRESENT SOIL STRATA AT EACH TEST HOLE LOCATION ONLY. SOIL TRANSITIONS MAY BE MORE GRADUAL THAN IMPLIED.

(3) GROUNDWATER LEVELS SHOWN ON THE SUBSURFACE PROFILES REPRESENT GROUNDWATER SURFACES ON THE DATES SHOWN. GROUNDWATER LEVELS WILL FLUCTUATE THROUGHOUT THE YEAR.

(4) LONGITUDE AND LATITUDE COORDINATES WERE MEASURED IN THE FIELD USING A HAND HELD GPS UNIT.

(5) ELEVATIONS WERE NOT AVAILABLE

(6) AFTER COMPLETION OF DRILLING BOREHOLES WERE BACK FILLED WITH GROUT.

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE BLOWS/FOOT
VERY LOOSE	LESS THAN 3
LOOSE	3 - 8
MEDIUM	8 - 24
DENSE	24 - 40
VERY DENSE	GREATER THAN 40

STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.375 INCH
SPOON OUTSIDE DIA.	2.0 INCHES
AVG. HAMMER DROP	30 INCHES
HAMMER WEIGHT	140 POUNDS

REVISIONS

Date.	By	Descriptions	Date.	By	Descriptions

	Names	Dates
Drawn by	KA	11/06/17
Checked by	AB	11/06/17
Designed by		
Checked by		
Approved by		

RADISE — Infrastructure Engineers & Software Developers
LICENSE NO. - 8901

ENGINEER OF RECORD
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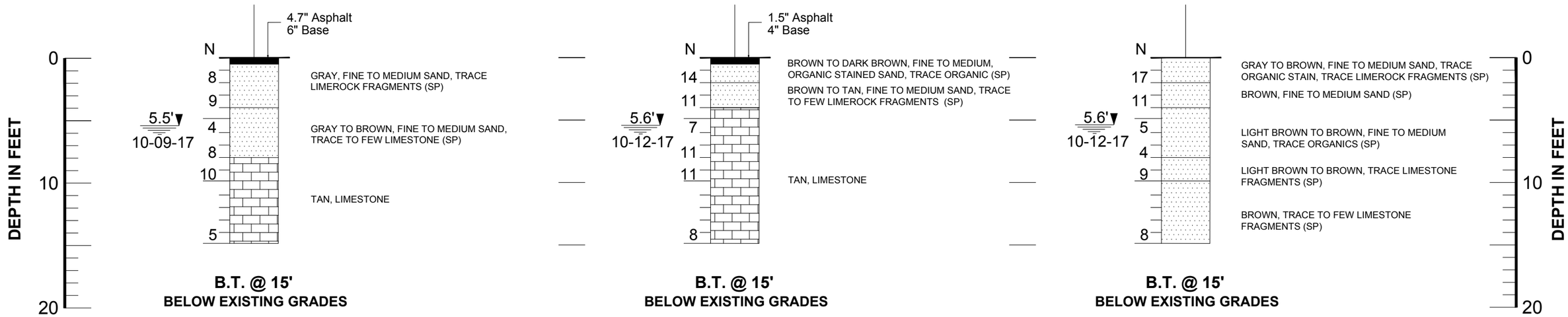
4152 West Blue Heron Boulevard, Suite 1114
Riviera Beach, Florida. 33404
TEL 561-841-0103 FAX 561-841-0104
URL : http:// www.radise.net

CITY OF FORT LAUDERDALE PUBLIC WORKS DEPARTMENT		SCALE: VERTICAL N.T.S.	SHEET TITLE: SUBSURFACE PROFILES (EDGEWOOD)	SHEET NO. 5B
COUNTY: BROWARD	CLIENT: HAZEN AND SAWYER	SCALE: HORIZONTAL N.T.S.	PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION	RADISE PROJECT NO: 170901

	E-7	E-8	E-9
BORING NO.			
ELEVATION (NAVD 88):	N/A	N/A	N/A
LATITUDE:	26.0888°	26.0861°	26.0880°
LONGITUDE:	-80.1548°	-80.1567°	-80.1560°
DATE:	10/09/2017	10/12/2017	10/12/2017
DRILLER:	T. FICKLING	T. FICKLING	T. FICKLING
RIG:	CME 45	CME 45	CME 45



LEGEND

- ASPHALT AND BASE
- LIMESTONE
- SAND
- GRAVEL
- SILTY SAND
- ORGANIC MATERIAL
- 5.0' ▼ / 10-24-17 — GROUNDWATER DEPTH IN FEET AND DRILLING DATE
- N — STANDARD PENETRATION RESISTANCE- BLOWS PER FOOT USING AUTOMATIC HAMMER

SP, SP-SM, PT	UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL (ASTM D 2488)
E-1	STANDARD PENETRATION TEST (SPT) BORING AND NUMBER
MC	MOISTURE CONTENT (%)
-200	AMOUNT PASSING US STANDARD # 200 SIEVE (%)
OC	ORGANIC CONTENTS (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
B.T. @ 15'	BORING TERMINATED AT 15 FEET BELOW THE EXISTING GROUND SURFACE

NOTES

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(3) GROUNDWATER LEVELS SHOWN ON THE SUBSURFACE PROFILES REPRESENT GROUNDWATER SURFACES ON THE DATES SHOWN. GROUNDWATER LEVELS WILL FLUCTUATE THROUGHOUT THE YEAR.

(4) LONGITUDE AND LATITUDE COORDINATES WERE MEASURED IN THE FIELD USING A HAND HELD GPS UNIT.

(5) ELEVATIONS WERE NOT AVAILABLE

(6) AFTER COMPLETION OF DRILLING BOREHOLES WERE BACK FILLED WITH GROUT.

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE BLOWS/FOOT
VERY LOOSE	LESS THAN 3
LOOSE	3 - 8
MEDIUM	8 - 24
DENSE	24 - 40
VERY DENSE	GREATER THAN 40

STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.375 INCH
SPOON OUTSIDE DIA.	2.0 INCHES
AVG. HAMMER DROP	30 INCHES
HAMMER WEIGHT	140 POUNDS

REVISIONS

Date.	By	Descriptions	Date.	By	Descriptions

	Names	Dates
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Checked by	AB	11/06/17
Designed by		
Checked by		
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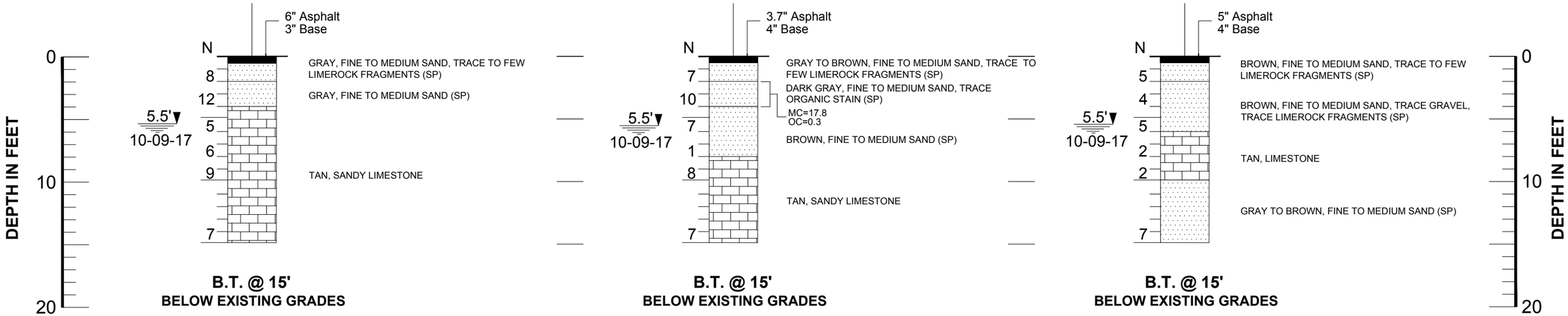
CITY OF FORT LAUDERDALE PUBLIC WORKS DEPARTMENT		SCALE: VERTICAL N.T.S.	SHEET TITLE: SUBSURFACE PROFILES (EDGEWOOD)	SHEET NO. 5C
COUNTY: BROWARD	CLIENT: HAZEN AND SAWYER	SCALE: HORIZONTAL N.T.S.	PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION	RADISE PROJECT NO: 170901

	E-10	E-11	E-12
BORING NO.	E-10	E-11	E-12
ELEVATION (NAVD 88):	N/A	N/A	N/A
LATITUDE:	26.0870°	26.0874°	26.0889°
LONGITUDE:	-80.1528°	-80.1507°	-80.1507°
DATE:	10/09/2017	10/09/2017	10/09/2017
DRILLER:	T. FICKLING	T. FICKLING	T. FICKLING
RIG:	CME 45	CME 45	CME 45



LEGEND

- ASPHALT AND BASE
- LIMESTONE
- SAND
- GRAVEL
- SILTY SAND
- ORGANIC MATERIAL
- 5.0' / 10-24-17 — GROUNDWATER DEPTH IN FEET AND DRILLING DATE
- N — STANDARD PENETRATION RESISTANCE- BLOWS PER FOOT USING AUTOMATIC HAMMER

SP, SP-SM, PT	UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL (ASTM D 2488)
E-1	STANDARD PENETRATION TEST (SPT) BORING AND NUMBER
MC	MOISTURE CONTENT (%)
-200	AMOUNT PASSING US STANDARD # 200 SIEVE (%)
OC	ORGANIC CONTENTS (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
B.T. @ 15'	BORING TERMINATED AT 15 FEET BELOW THE EXISTING GROUND SURFACE

NOTES

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(6) AFTER COMPLETION OF DRILLING BOREHOLES WERE BACK FILLED WITH GROUT.

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE BLOWS/FOOT
VERY LOOSE	LESS THAN 3
LOOSE	3 - 8
MEDIUM	8 - 24
DENSE	24 - 40
VERY DENSE	GREATER THAN 40

STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.375 INCH
SPOON OUTSIDE DIA.	2.0 INCHES
AVG. HAMMER DROP	30 INCHES
HAMMER WEIGHT	140 POUNDS

REVISIONS

Date.	By	Descriptions	Date.	By	Descriptions

	Names	Dates
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Checked by	AB	11/06/17
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CITY OF FORT LAUDERDALE
PUBLIC WORKS DEPARTMENT

COUNTY	CLIENT
BROWARD	HAZEN AND SAWYER

SCALE: VERTICAL N.T.S.
SCALE: HORIZONTAL N.T.S.

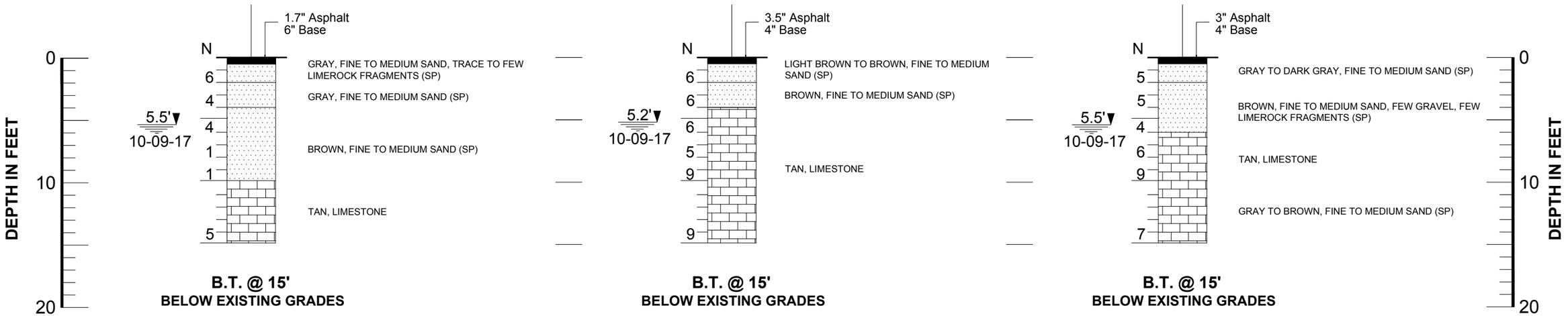
SHEET TITLE: SUBSURFACE PROFILES (EDGEWOOD)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 5D

RADISE PROJECT NO: 170901

	E-13	E-14	E-15
BORING NO.			
ELEVATION (NAVD 88):	N/A	N/A	N/A
LATITUDE:	26.0899°	26.0907°	26.0868°
LONGITUDE:	-80.1528°	-80.1401°	-80.1391°
DATE:	10/09/2017	10/09/2017	10/09/2017
DRILLER:	T. FICKLING	T. FICKLING	T. FICKLING
RIG:	CME 45	CME 45	CME 45



LEGEND

- ASPHALT AND BASE
- LIMESTONE
- SAND
- GRAVEL
- SILTY SAND
- ORGANIC MATERIAL
- 5.0' / 10-24-17 — GROUNDWATER DEPTH IN FEET AND DRILLING DATE
- N — STANDARD PENETRATION RESISTANCE- BLOWS PER FOOT USING AUTOMATIC HAMMER

SP, SP-SM, PT	UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL (ASTM D 2488)
E-1	STANDARD PENETRATION TEST (SPT) BORING AND NUMBER
MC	MOISTURE CONTENT (%)
-200	AMOUNT PASSING US STANDARD # 200 SIEVE (%)
OC	ORGANIC CONTENTS (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
B.T. @ 15'	BORING TERMINATED AT 15 FEET BELOW THE EXISTING GROUND SURFACE

NOTES

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GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE BLOWS/FOOT
VERY LOOSE	LESS THAN 3
LOOSE	3 - 8
MEDIUM	8 - 24
DENSE	24 - 40
VERY DENSE	GREATER THAN 40

STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.375 INCH
SPOON OUTSIDE DIA.	2.0 INCHES
AVG. HAMMER DROP	30 INCHES
HAMMER WEIGHT	140 POUNDS

REVISIONS

Date.	By	Descriptions	Date.	By	Descriptions

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Checked by	AB	11/06/17
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CITY OF FORT LAUDERDALE
PUBLIC WORKS DEPARTMENT

COUNTY	CLIENT
BROWARD	HAZEN AND SAWYER

SCALE: VERTICAL N.T.S.
SCALE: HORIZONTAL N.T.S.

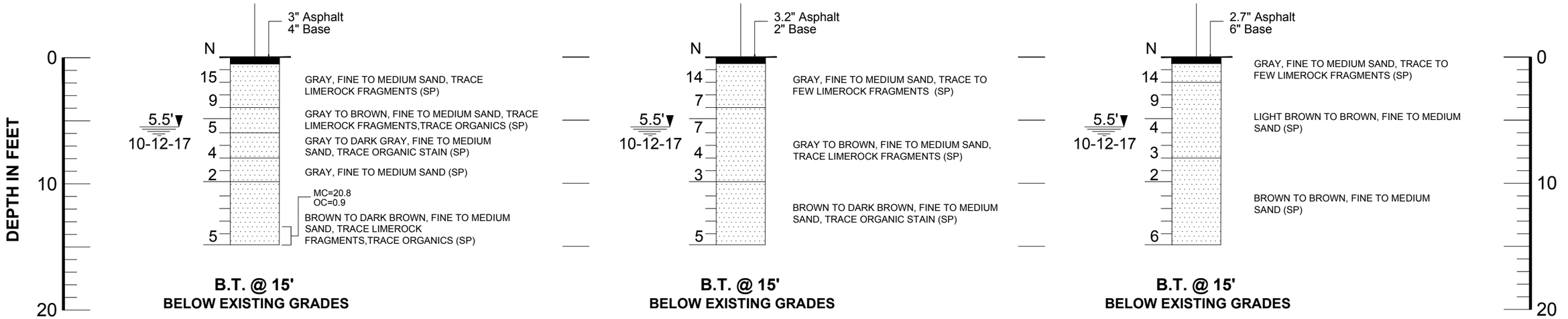
SHEET TITLE: SUBSURFACE PROFILES (EDGEWOOD)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 5E

RADISE PROJECT NO: 170901

	P-1	P-2	P-3
BORING NO.	P-1	P-2	P-3
ELEVATION (NAVD 88):	N/A	N/A	N/A
LATITUDE:	26.1207°	26.1223°	26.1239°
LONGITUDE:	-80.1474°	-80.1485°	-80.1475°
DATE:	10/12/2017	10/12/2017	10/12/2017
DRILLER:	T. FICKLING	T. FICKLING	T. FICKLING
RIG:	CME 45	CME 45	CME 45



LEGEND

- ASPHALT AND BASE
- LIMESTONE
- SAND
- GRAVEL
- SILTY SAND
- ORGANIC MATERIAL
- 5.5' ▼ / 10-12-17 — GROUNDWATER DEPTH IN FEET AND DRILLING DATE
- N — STANDARD PENETRATION RESISTANCE- BLOWS PER FOOT USING AUTOMATIC HAMMER

SP, SP-SM, PT	UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL (ASTM D 2488)
P-1	STANDARD PENETRATION TEST (SPT) BORING AND NUMBER
MC	MOISTURE CONTENT (%)
-200	AMOUNT PASSING US STANDARD # 200 SIEVE (%)
OC	ORGANIC CONTENTS (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
B.T. @ 15'	BORING TERMINATED AT 15 FEET BELOW THE EXISTING GROUND SURFACE

NOTES

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GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE BLOWS/FOOT
VERY LOOSE	LESS THAN 3
LOOSE	3 - 8
MEDIUM	8 - 24
DENSE	24 - 40
VERY DENSE	GREATER THAN 40

STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.375 INCH
SPOON OUTSIDE DIA.	2.0 INCHES
AVG. HAMMER DROP	30 INCHES
HAMMER WEIGHT	140 POUNDS

REVISIONS

Date.	By	Descriptions	Date.	By	Descriptions

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CITY OF FORT LAUDERDALE
PUBLIC WORKS DEPARTMENT

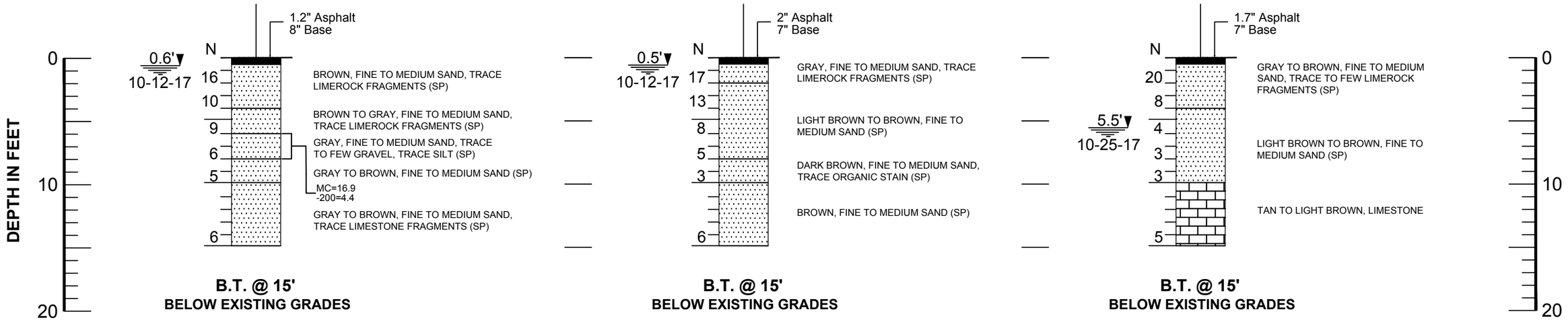
COUNTY	CLIENT
BROWARD	HAZEN AND SAWYER

SCALE: VERTICAL N.T.S.
SCALE: HORIZONTAL N.T.S.

SHEET TITLE: SUBSURFACE PROFILES (PROGRESSO)
PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 6A
RADISE PROJECT NO: 170901

	P-4	P-7	P-8
BORING NO.			
ELEVATION (NAVD 88):	N/A	N/A	N/A
LATITUDE:	26.1315°	26.1266°	26.1312°
LONGITUDE:	-80.1469°	-80.1506°	-80.1517°
DATE:	10/12/2017	10/12/2017	10/25/2017
DRILLER:	T. FICKLING	T. FICKLING	T. FICKLING
RIG:	CME 45	CME 45	CME 45



LEGEND

- ASPHALT AND BASE
- LIMESTONE
- SAND
- GRAVEL
- SILTY SAND
- ORGANIC MATERIAL
- 5.5' / 10-12-17 — GROUNDWATER DEPTH IN FEET AND DRILLING DATE
- N — STANDARD PENETRATION RESISTANCE- BLOWS PER FOOT USING AUTOMATIC HAMMER

SP, SP-SM, PT	UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL (ASTM D 2488)
P-1	STANDARD PENETRATION TEST (SPT) BORING AND NUMBER
MC	MOISTURE CONTENT (%)
-200	AMOUNT PASSING US STANDARD # 200 SIEVE (%)
OC	ORGANIC CONTENTS (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
B.T. @ 15'	BORING TERMINATED AT 15 FEET BELOW THE EXISTING GROUND SURFACE

NOTES

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(5) ELEVATIONS WERE NOT AVAILABLE

(6) AFTER COMPLETION OF DRILLING BOREHOLES WERE BACK FILLED WITH GROUT.

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE BLOWS/FOOT
VERY LOOSE	LESS THAN 3
LOOSE	3 - 8
MEDIUM	8 - 24
DENSE	24 - 40
VERY DENSE	GREATER THAN 40

STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.375 INCH
SPOON OUTSIDE DIA.	2.0 INCHES
AVG. HAMMER DROP	30 INCHES
HAMMER WEIGHT	140 POUNDS

REVISIONS						Names	Dates
Date.	By	Descriptions	Date.	By	Descriptions	Drawn by	KA 11/09/17
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						Approved by	

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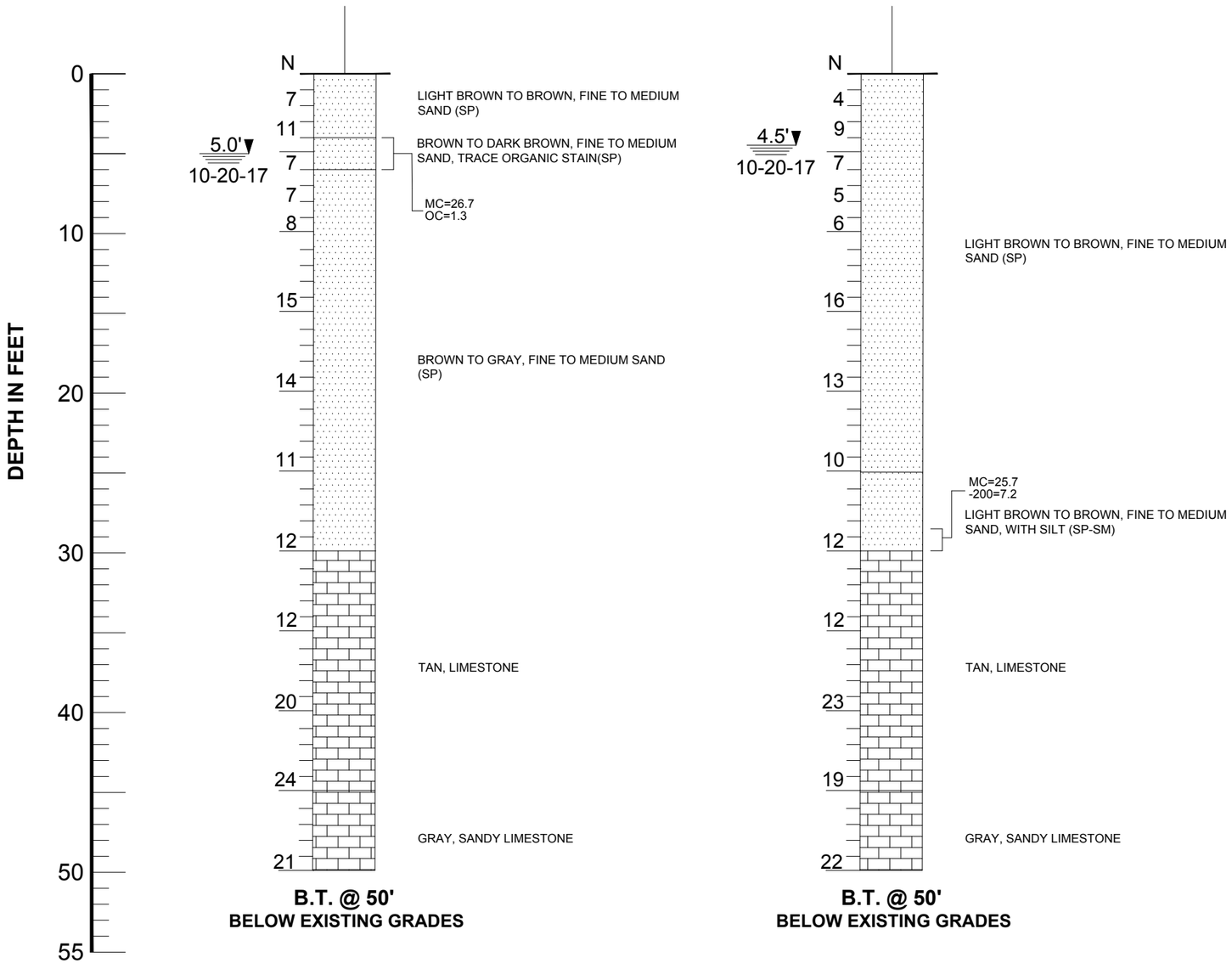
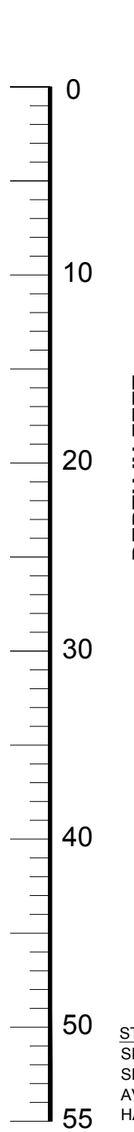
CITY OF FORT LAUDERDALE PUBLIC WORKS DEPARTMENT		SCALE: VERTICAL N.T.S.	SHEET TITLE: SUBSURFACE PROFILES (PROGRESSO)	SHEET NO. 6B
COUNTY: BROWARD	CLIENT: HAZEN AND SAWYER	SCALE: HORIZONTAL N.T.S.	PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION	RADISE PROJECT NO: 170901

	P-5	P-6
BORING NO.		
ELEVATION (NAVD 88):	N/A	N/A
LATITUDE:	26.1332°	26.1335°
LONGITUDE:	-80.1479°	-80.1476°
DATE:	10/20/2017	10/20/2017
DRILLER:	R. RAMSEWACK	R. RAMSEWACK
RIG:	CME 45	CME 45





LEGEND

SAND
SILT
ORGANIC MATERIAL
SHELLY SAND
LIMESTONE
GRAVEL

5.0' ▼ 10-20-17	GROUNDWATER DEPTH IN FEET AND DRILLING DATE
N	STANDARD PENETRATION RESISTANCE- BLOWS PER FOOT USING AUTOMATIC HAMMER
SP, SP-SM, PT	UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL (ASTM D 2488)
P-5	STANDARD PENETRATION TEST (SPT) BORING AND NUMBER
MC	MOISTURE CONTENT (%)
-200	AMOUNT PASSING US STANDARD # 200 SIEVE
OC	ORGANIC CONTENTS (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
B.T. @ 50'	BORING TERMINATED AT 50 FEET BELOW THE EXISTING GROUND SURFACE

NOTES

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(6) AFTER COMPLETION OF DRILLING BOREHOLES WERE BACK FILLED WITH GROUT.

STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.375 INCH
SPOON OUTSIDE DIA.	2.0 INCHES
AVG. HAMMER DROP	30 INCHES
HAMMER WEIGHT	140 POUNDS

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE BLOWS/FOOT
VERY LOOSE	LESS THAN 3
LOOSE	3 - 8
MEDIUM	8 - 24
DENSE	24 - 40
VERY DENSE	GREATER THAN 40

REVISIONS							Names	Dates
Date.	By	Descriptions	Date.	By	Descriptions	Drawn by	ML	10/13/17
						Checked by	AB	10/13/17
						Designed by		
						Checked by		
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RADISE International
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Riviera Beach, Florida. 33404
TEL 561-841-0103 FAX 561-841-0104
URL : http:// www.radise.net

CITY OF FORT LAUDERDALE PUBLIC WORKS DEPARTMENT	
COUNTY	CLIENT
BROWARD	HAZEN AND SAWYER

SCALE: VERTICAL N.T.S.
SCALE: HORIZONTAL N.T.S.

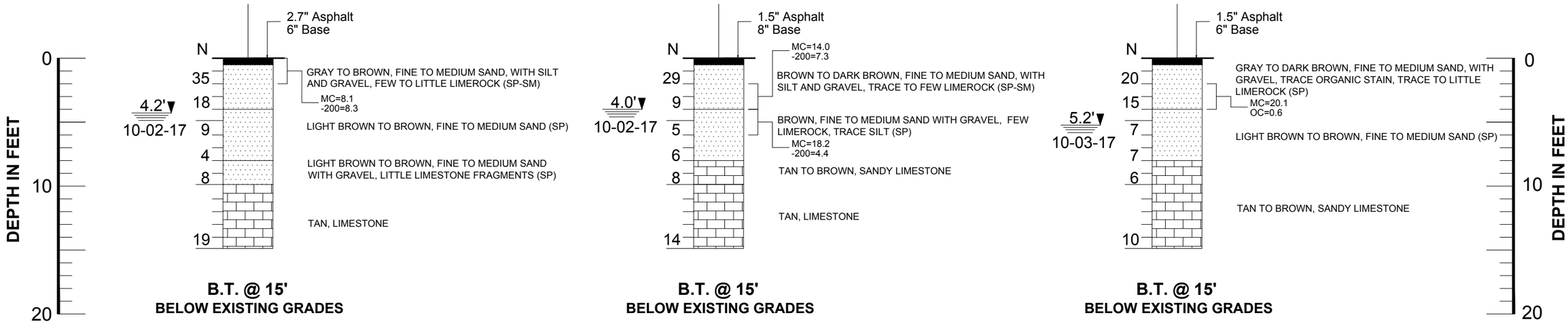
SHEET TITLE: SUBSURFACE PROFILES (PROGRESSO)

PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 6C

RADISE PROJECT NO: 170901

	R-1	R-2	R-3
BORING NO.	R-1	R-2	R-3
ELEVATION (NAVD 88):	N/A	N/A	N/A
LATITUDE:	26.0909°	26.0945°	26.0924°
LONGITUDE:	-80.1608°	-80.1609°	-80.1648°
DATE:	10/02/2017	10/02/2017	10/03/2017
DRILLER:	P. RAMSEWACK	P. RAMSEWACK	P. RAMSEWACK
RIG:	CME 45	CME 45	CME 45



LEGEND

- ASPHALT AND BASE
- LIMESTONE
- SAND
- GRAVEL
- SILTY SAND
- ORGANIC MATERIAL
- 4.2' / 10-02-17 — GROUNDWATER DEPTH IN FEET AND DRILLING DATE
- N — STANDARD PENETRATION RESISTANCE- BLOWS PER FOOT USING AUTOMATIC HAMMER

SP, SP-SM, PT	UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL (ASTM D 2488)
R-1	STANDARD PENETRATION TEST (SPT) BORING AND NUMBER
MC	MOISTURE CONTENT (%)
-200	AMOUNT PASSING US STANDARD # 200 SIEVE (%)
OC	ORGANIC CONTENTS (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
B.T. @ 15'	BORING TERMINATED AT 15 FEET BELOW THE EXISTING GROUND SURFACE

NOTES

(1) BORING WERE DRILLED ON OCTOBER, 2017 USING A CENTRAL MINING EQUIPMENT MODEL 45 (CME 45) AUTOMATIC HAMMER DRILL RIG.

(2) STRATA BOUNDARIES ARE APPROXIMATE AND REPRESENT SOIL AND REPRESENT SOIL STRATA AT EACH TEST HOLE LOCATION ONLY. SOIL TRANSITIONS MAY BE MORE GRADUAL THAN IMPLIED.

(3) GROUNDWATER LEVELS SHOWN ON THE SUBSURFACE PROFILES REPRESENT GROUNDWATER SURFACES ON THE DATES SHOWN. GROUNDWATER LEVELS WILL FLUCTUATE THROUGHOUT THE YEAR.

(4) LONGITUDE AND LATITUDE COORDINATES WERE MEASURED IN THE FIELD USING A HAND HELD GPS UNIT.

(5) ELEVATIONS WERE NOT AVAILABLE

(6) AFTER COMPLETION OF DRILLING BOREHOLES WERE BACK FILLED WITH GROUT.

GRANULAR MATERIALS

RELATIVE DENSITY	AUTOMATIC HAMMER SPT N-VALUE BLOWS/FOOT
VERY LOOSE	LESS THAN 3
LOOSE	3 - 8
MEDIUM	8 - 24
DENSE	24 - 40
VERY DENSE	GREATER THAN 40

STANDARD PENETRATION TEST DATA

SPOON INSIDE DIA.	1.375 INCH
SPOON OUTSIDE DIA.	2.0 INCHES
AVG. HAMMER DROP	30 INCHES
HAMMER WEIGHT	140 POUNDS

REVISIONS					
Date.	By	Descriptions	Date.	By	Descriptions

	Names	Dates
Drawn by	KA	11/09/17
Checked by	AB	11/09/17
Designed by		
Checked by		
Approved by		

RADISE Infrastructure Engineers & Software Developers
LICENSE NO. - 8901

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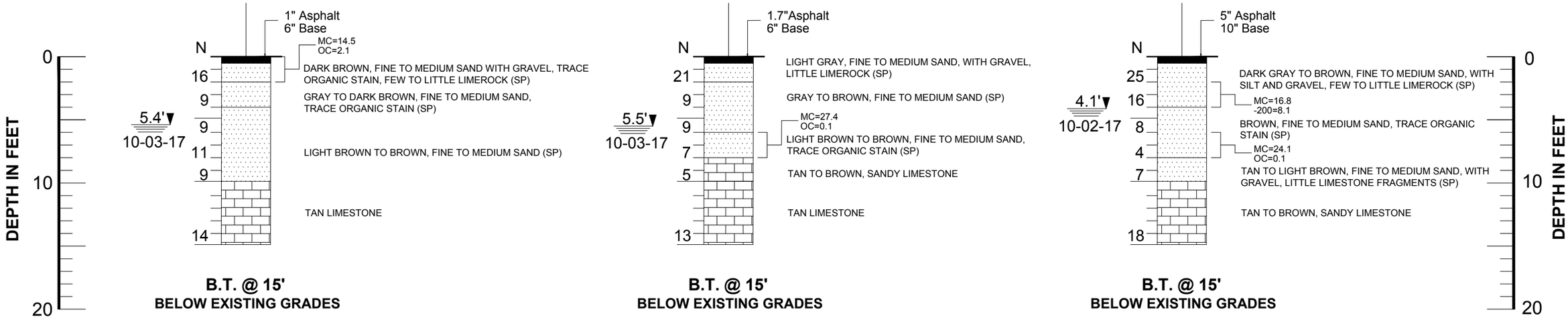
SCALE: VERTICAL N.T.S.
SCALE: HORIZONTAL N.T.S.

SHEET TITLE: SUBSURFACE PROFILES (RIVER OAKS)
PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 7A
RADISE PROJECT NO: 170901

	R-4	R-5	R-6
BORING NO.	R-4	R-5	R-6
ELEVATION (NAVD 88):	N/A	N/A	N/A
LATITUDE:	26.0946°	26.0950°	26.0961°
LONGITUDE:	-80.1630°	-80.1661°	-80.1608°
DATE:	10/03/2017	10/03/2017	10/02/2017
DRILLER:	P. RAMSEWACK	T. FICKLING	T. FICKLING
RIG:	CME 45	CME 45	CME 45



LEGEND

- ASPHALT AND BASE
- LIMESTONE
- SAND
- GRAVEL
- SILTY SAND
- ORGANIC MATERIAL
- 4.2' / 10-02-17 — GROUNDWATER DEPTH IN FEET AND DRILLING DATE
- N — STANDARD PENETRATION RESISTANCE- BLOWS PER FOOT USING AUTOMATIC HAMMER

SP, SP-SM, PT	UNIFIED SOIL CLASSIFICATION SYSTEM GROUP SYMBOL (ASTM D 2488)
R-1	STANDARD PENETRATION TEST (SPT) BORING AND NUMBER
MC	MOISTURE CONTENT (%)
-200	AMOUNT PASSING US STANDARD # 200 SIEVE (%)
OC	ORGANIC CONTENTS (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)
B.T. @ 15'	BORING TERMINATED AT 15 FEET BELOW THE EXISTING GROUND SURFACE

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Date.	By	Descriptions	Date.	By	Descriptions

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BROWARD	HAZEN AND SAWYER

SCALE: VERTICAL N.T.S.
SCALE: HORIZONTAL N.T.S.

SHEET TITLE: SUBSURFACE PROFILES (RIVER OAKS)
PROJECT NAME: STORMWATER MASTER PLAN MODELING AND DESIGN IMPLEMENTATION

SHEET NO. 7B
RADISE PROJECT NO: 170901