Geotechnical Engineering Study
Proposed Dos Rios – Phase I Re-rating Project
San Antonio, Texas

ARIAS Job No. 08-2096

ARIAS & ASSOCIATES
Geotechnical • Environmental • Testing

Prepared For
Camp Dresser & McKee Inc.
(CDM)

February 24, 2009

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Geotechnical • Environmental • Testing

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Mr. Greg Swoboda, P.E.
CDM
177 NE Loop 410, Suite 704
San Antonio, Texas 78217

RE: Geotechnical Engineering Study
Proposed Dos Rios – Phase I Re-rating Project
San Antonio, Texas

Dear Mr. Swoboda:

The results of our Geotechnical Engineering Study for the subject project are presented in this report. Our findings and recommendations should be incorporated into the design and construction documents for the proposed plant modifications/improvements associate with the Phase I Re-rating project. Please consult with us as needed during any part of the design or construction process.

In order to help contribute to the success of this project, we recommend that the site work and foundation construction be tested and observed by one of our representatives in accordance with the report recommendations. It is also very important that the geotechnical engineer of record be employed during construction to observe that the site preparation and foundation construction are performed in accordance with the recommendations presented in this report.

Thank you for the opportunity to be of service to you.

Sincerely,
ARIAS & ASSOCIATES INC

Rebecca R. Bennett, M.S., E.I.T.
Geotechnical Project Engineer

Mark J. O'Connor, P.E.
VP – San Antonio Operations

STATE OF TEXAS
MARK J. O'CONNOR
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REGISTERED PROFESSIONAL ENGINEER
2/24/09

cc: 3 above

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INTRODUCTION

The results of a Geotechnical Engineering Study for the proposed Phase I Re-rating Project to be constructed at the San Antonio Water System (SAWS) Dos Rios Water Recycling Center (WRC) in San Antonio, Texas are presented in this report. This project was authorized by means of the *"Standard Form of Agreement Between Engineer (Camp Dresser & McKee Inc.) and Subcontractor (Arias & Associates, Inc.) for Professional Services," dated January 5, 2009.*

SCOPE OF SERVICES

The purpose of this engineering study was to establish foundation engineering properties of the subsurface soil and groundwater conditions present at the site. The scope of the study is to provide geotechnical engineering criteria for use by design engineers in preparing the foundation designs. Our findings and recommendations should be incorporated into the design and construction documents for the proposed development. Environmental studies of any kind were not a part of our scope of work or services.

PROJECT AND SITE DESCRIPTION

The project site is at the SAWS Dos Rios Water Recycling Center located at 3225 Valley Road in San Antonio, Texas. A Vicinity Map of the project site is provided in the enclosures to this report.

We have been informed that the proposed plant modifications and improvements specific to this geotechnical engineering study consist of the

- expansion of the influment flow meter structure (*i.e.*, transit time flow meters),
- expansion of the screen structure, and
- addition of grit classifiers and piping.

The Client-provided site plan showing the configuration of the existing facility elements and the superimposed project elements is provided in the enclosures to this report. We understand that the base of the flow meter structure will be constructed approximately 20 feet below existing grade, the base of the screen structure will be approximately 10 feet below existing grade, the vortex grit removal system will be constructed approximately 12 feet below existing grade, and the grit classifiers will be located at grade. A shallow foundation type (*e.g., mat*) is anticipated for these structures.

Site photographs were taken of the project site in the areas of the proposed project elements. They are provided in the enclosures. The project site in the area of the proposed Transit Time Flow Meters is relatively flat with localized areas of fill mounds. The areas of the proposed step screens are relatively flat and covered with grass. The areas of the proposed vortex grit removal system currently have above and below ground infrastructure and an asphalt-paved road. The site for the proposed grit classifier on the north side of the project area is generally flat with grass cover. The site for the proposed grit classifier on the south side of the project area is at the top of a fill embankment. The general area is covered with grasses and weeds with facility infrastructure and structural canopies in the immediate area.

The locations of the proposed structures are either immediately adjacent to facility structures or generally overlap existing facility elements. Extensive above-and-below ground, SAWS-related infrastructure is present at each project element location.

SOIL BORING AND LABORATORY TESTS

The approximate locations of the test borings and the depth to which they were drilled were specified by the Client. The drilling depths were generally ten feet beyond the expected foundation depth. Because of the extensive below-ground electrical utilities and facility piping at the site, a SAWS representative was present during the drilling operations to specify acceptable drill points within our designated sampling areas and to assist in identifying any potential encroachment into the existing facility infrastructure. The field drilling was conducted on February 6, 2009.

Seven soil test borings were drilled at the approximate locations shown on the Boring Location Plan. The location of Test Boring B-1 corresponds to the area of the proposed Transit Time Flow Meters. This boring was drilled to a depth of approximately 30 feet. The locations of Test Borings B-2 and B-3 correspond to the area of the proposed Step Screens. These borings were drilled to a depth of approximately 20 feet each. The locations of Test Borings B-4 and B-5 correspond to the area of the Vortex Grit Removal System. These borings were drilled to a depth of approximately 22 feet each. The locations of Test Borings B-6 and B-7 correspond to the area of the proposed Grit Classifiers. These borings were drilled to a depth of approximately 20 feet each. All depths are referenced from the existing ground surface at the time of the geotechnical exploration conducted on February 6, 2009. A summary of the boring locations and depths are provided in Table 1.

Table 1. Summary of Test Boring Locations and Depths

Test Boring	Project Element	Depth (ft.)
B-1	Transit Time Flow Meters	30
B-2	Step Screens	20
B-3		20
B-4	Vortex Grit Removal System	22
B-5		22
B-6	Grit Classifiers	20
B-7		20

The geotechnical borehole drilling was done in general accordance with ASTM D1586 and ASTM D1587 procedures for the Split Spoon and Shelby Tube sampling techniques as described in the Appendix. A truck-mounted drill rig using hollow-stem augers together with the sampling tool noted were used to secure the subsurface samples.

Classifications and borehole logging were conducted during the exploration by one our field logging technicians who is under the supervision of our Geotechnical Geologist. Final classifications, as seen on the attached boring logs, were determined in the laboratory based on laboratory and field test results and applicable ASTM procedures.

To provide information on the relative consistency/density of the subsurface material, standard Penetration (N-values) blow counts were recorded during the drilling activities. As a supplement to the field exploration, laboratory testing to determine soil water content, grain size and expansion characteristics was conducted. The laboratory results are reported in the attached test boring logs. Samples were examined, classified and tested both in the field during the drilling and sampling operation and after being received into the laboratory in accordance with the procedures stated in the Appendix of this report. *Once this report is submitted, remaining soil samples recovered from this exploration will be routinely discarded unless requested otherwise*

SUBSURFACE CONDITIONS

Geology

The earth materials underlying the project site have been regionally mapped as alluvial Terrace (Qt) deposits of Pleistocene age over older coastal deposits of the Wilcox Formation of Eocene age. The contact between the alluvial and shallow marine or coastal deposits represents a significant erosional time gap of at least 35 million years. Because the time gap is erosional the contact could be irregular with depth within the project area.

No faults are known to cross through the project area and from a geologic point of view future seismic activity should pose minimal seismic risk to the proposed development.

Site Stratigraphy and Engineering Properties

Our soil classifications, general subsurface profiles and generalized material conditions, provided in the attached boring logs and summarized in Tables 2a and 2b are based upon the soil samples obtained from the seven test borings. The soils consist *primarily* of low to moderately-expansive Clayey Sand (SC), Clay (CL) and/or Clayey Gravel (GC) fill materials overlying expansive Clays (CH), moderately-expansive Sandy Clays (CL) and/or Clayey Gravels (GC).

Table 2a. Generalized Material Stratigraphy

<table>
<tr><th rowspan="2">Depth (feet)</th><th rowspan="2">Description</th><th>MC range</th><th>PI range</th><th>#200 range</th><th>PP range</th><th>N range</th></tr>
<tr><th>MC avg.</th><th>PI avg.</th><th>#200 avg.</th><th>PP avg.</th><th>N avg.</th></tr>
<tr><td colspan="7">Test Boring B-1– General Location of the Transit Time Flow Meters</td></tr>
<tr><td rowspan="2">Stratum 1A
0 to 6.5</td><td rowspan="2">Fill Materials:
CLAY(CL), some Sand, trace Gravel, brown, in a very hard condition
and
Clayey SAND(SC), some Gravel, reddish-brown, in a dense condition</td><td>5 – 8</td><td>--</td><td>--</td><td>--</td><td>44 – 78</td></tr>
<tr><td>6</td><td>26</td><td>41</td><td>--</td><td>57</td></tr>
<tr><td rowspan="2">Stratum 2A
6.5 to 12</td><td rowspan="2">CLAY(CH), some Sand, brown to light brown, in a very hard to hard condition with depth</td><td>14 – 22</td><td>37 – 38</td><td>--</td><td>--</td><td>43 – 51</td></tr>
<tr><td>17</td><td>38</td><td>--</td><td>--</td><td>47</td></tr>
<tr><td rowspan="2">Stratum 3A
12 to 30</td><td rowspan="2">Sandy CLAY(CL), trace Gravel, tan, in a very stiff condition with depth</td><td>13 – 16</td><td>--</td><td>65 – 68</td><td>2.8 – 5.5</td><td>22 – 24</td></tr>
<tr><td>15</td><td>21</td><td>67</td><td>4</td><td>23</td></tr>
<tr><td colspan="7">Test Borings B-2 & B-3 –General Location of the Proposed Step Screens</td></tr>
<tr><td rowspan="2">Stratum 1B
0 to 5</td><td rowspan="2">Fill Material: CLAY(CL), some Sand, trace Gravel, brown, in a very hard condition
and
Sandy CLAY(CL) or Clayey SAND(SC), some Gravel, tan, in a very hard / very dense condition</td><td>4 – 9</td><td>16 – 26</td><td>--</td><td>--</td><td>50/6" - **50/4"</td></tr>
<tr><td>6</td><td>21</td><td>49</td><td>--</td><td>>50/6"</td></tr>
<tr><td rowspan="2">Stratum 2B
5 to 20</td><td rowspan="2">CLAY(CL), with Sand, trace Gravel, tan, in a very hard condition
and
Sandy CLAY(CL), trace Gravel, tan, in a hard to very hard condition</td><td>7 – 20</td><td>21 – 33</td><td>65 – 99</td><td>--</td><td>31 – 64</td></tr>
<tr><td>12</td><td>28</td><td>78</td><td>--</td><td>51</td></tr>
</table>

Where:

Depth - Soil stratum depth (ft.) from existing ground surface at the time of geotechnical investigation
MC – Moisture Content, %
PI - Plasticity Index associated with the fraction of this soil passing the #200 Sieve
#200 - Percent passing #200 sieve, %
PP – Pocket Penetrometer value, tsf
N - Standard Penetration Test (SPT) value, blows per foot
**** -** Standard Penetration Test (SPT) blow count during the seating operation

Table 2b. Generalized Subsurface Profile and Material Conditions

Depth (feet)	Description	MC range / MC avg.	PI range / PI avg.	#200 range / #200 avg.	N range / N avg.
Test Borings B-4 & B-5– General Location of the Proposed Vortex Grit Removal System					
Stratum 1C 0 to 5	***Fill Materials:*** ***Sandy CLAY(CL),*** *trace Gravel, tan, in a hard condition* *and* ***CLAY(CH),*** *gray-brown, in a very stiff condition*	3 – 18	19 – 42	--	27 – 38
		9	**27**	**--**	**33**
Stratum 2C 5 to 16	***Clayey GRAVEL(GC),*** with Sand, tan, in a dense condition (possible Fill Materials)	3 – 14	--	15 – 34	25 - **50/6"
		7	**--**	**27**	**80**
Stratum 3C 16 to 21	***Clayey GRAVEL(GC),*** with Sand, in a medium dense to very dense condition	4 – 12	--	26 – 41	50/6" - **50/4"
		8	**9**	**33**	**>50/6"**
Test Boring B-6 – General Location of the Proposed Grit Classifier – north					
Stratum 1D 0 to 5.5	***Fill Materials:*** ***CLAY(CL),*** trace Sand and Gravel, brown, in a very hard condition and ***Sandy CLAY(CL),*** with Gravel, in a very hard condition	4 – 11	--	--	69 – 50/6"
		8	**29**	**48**	**84**
Stratum 2D 5.5 to18.5	***Clayey GRAVEL(GC)***, with Sand, tan in a very dense condition	3 – 8	--	34 – 34	56 - **50/6"
		5	**--**	**28**	**50/6"**
Stratum 3D 18.5 to 20	***Sandy CLAY(CL),*** *some Gravel, tan, in a stiff condition*	--	-	--	--
		9	**17**	**--**	**14**
Test Boring B-7 – General Location of the Proposed Grit Classifier – south					
Stratum 1E 0 to 6.5	***Fill Materials:*** ***Clayey GRAVEL(GC),*** *with Sand, tan, in a very dense condition* *and* ***CLAY(CH),*** *with Sand, some Gravel, brown, in a very hard condition*	2 – 14	--	--	35 - 45
		7	**--**	**<64**	**40**
Stratum 2E 6.5 to 12	**CLAY(CH),** trace Sand and Gravel, brown to light brown, in a hard condition	17 – 21	38 – 41	--	35 – 43
		19	**40**	**91**	**39**
Stratum 3F 12 to 20	***CLAY(CL),*** *some Sand, trace Gravel, light brown, in a very stiff condition*	--	26 – 33	--	--
		16	**30**	**86**	**22**

Groundwater

A dry soil sampling method was used to obtain the soil samples at the project site. Groundwater was observed only within Test Borings B-5 during the drilling operation at a depth of approximately ***19.5 feet*** below the existing pavement surface. After a several day delay the depth to groundwater was again measured in B-5. At this time groundwater was observed at a depth of approximately 17 feet and the borehole had collapsed at a depth of approximately 18 feet 7 inches. Groundwater was not encountered within the B-1 through B-4, B-6 and B-7 test borings. The anticipated depth of each project element and the observed depth-to-groundwater (if present) is summarized in Table 3.

Table 3. Summary of the Groundwater Observations at the Boring Locations and the Excavation Depth of the Project Elements

Test Boring	Project Element	Depth of Boring (ft.)	Depth of Project Element (ft.)	Depth to Observed Groundwater (ft.)
B-1	Transit Time Flow Meters	30	20	dry boring
B-2	Step Screens	20	10	dry boring
B-3		20	10	dry boring
B-4	Vortex Grit Removal System	22	12	dry boring
B-5		22	12	**17**
B-6	Grit Classifiers	20	0 (at grade)	dry boring
B-7		20	0 (at grade)	dry boring

Due to the proximity of the SAWS Dos Rios Facility to the Medina River, groundwater in the area is generally associated with the natural water table. It should be noted, however, that while clay soils are generally not conducive to the presence of groundwater, pockets or seams of gravels, sands, and/or silts can store and transmit "perched" groundwater flow or seepage. Also, seams of more permeable type coarse-fraction materials can transmit "perched" groundwater into intercepting utility backfills.

It should be noted that water the elevation in open excavations may require several hours to several days to stabilize depending on the permeability of the soil. Also, the groundwater level at this site may be subject to seasonal conditions, recent rainfall, drought or temperature affects.

Upon completion of the drilling and exploration activities the drill holes were backfilled with excavated material and the site cleaned as required.

Variations

Subsurface material and conditions may vary between the locations at this site. Transition boundaries or contacts noted on the boring log to separate material types are approximate.

Actual contacts may be gradual and vary at different locations. If conditions encountered during construction indicate more variation than established as a result of this study, we should be contacted to evaluate the significance of the changed conditions relative to our recommendations.

ENGINEERING ANALYSIS AND DISCUSSION

The type of foundation most appropriate for a given structure depends on several factors: the function of the structure and the loads it may carry, the subsurface conditions, and the cost of the foundation in comparison with the cost of the superstructure. In addition, the performance criteria for the structure are significant relative to the foundation system selected.

Both shallow and deep foundation types are used in this area on expansive, granular, and fill-type materials. A shallow foundation type such as a mat or isolated footing foundations is a cost-effective foundation system when relatively non-expansive soil is present and the structural loads are small to moderate.

Recommended Foundation Types

Considering the function of the structures and the observed subsurface soils and conditions at the site, a mat foundation type is considered a suitable foundation for the proposed at-grade Grit Classifiers.

Appropriate geotechnical bearing, trench/shoring parameters will be required for the construction of the proposed below-grade project elements which include the Transit Time Flow Meters, Step Screens, and Vortex Grit Removal System.

Soil Shrink-Swell Potential Due to Expansive Soils

The expansive soils found at this site are capable of swelling and shrinking in volume dependent on potentially changing soil water content conditions during or after construction. The term swelling soils implies not only the tendency to increase in volume when water is available, but also to decrease in volume or shrink if water is removed. Shrinkage is merely the reverse process of swelling.

Several methods such as the AASHTO or TXDOT methods are available to estimate possible soil shrink-swell movements. These methods provide an estimate of potential vertical rise, PVR. These methods use the liquid limits, plasticity indices, and existing water contents for soils in the seasonally active zone, estimated to be about fifteen feet in most parts of San Antonio, Texas. A summary of the estimated values of PVR at the boring locations are provided in Table 4.

Our PVR estimate for this site as calculated from the *existing ground surface* was evaluated to be approximately ***1 to 2¼ inches*** based on dry soil moisture conditions which are predominant in the San Antonio, Texas area. This amount of soil movement for shrink-swell can be experienced by the expansive soils upon typical changes in soil moisture contents. Soil movements greater than these estimated values can result if the expansive soils are subjected to isolated soil moisture content changes, such as flooding, poor drainage, or a leaking irrigation system or if soil moisture changes occur at greater depths than the determined seasonally active zone. Actual soil movement depends on the degree of moisture content change, which may occur.

Table 4. Summary of the Estimated Value of PVR at the Boring Locations
As calculated from the existing ground surface elevation

Test Boring	Estimated PVR
B-1	2¾"
B-2	1¾"
B-3	2½"
B-4	1"
B-5	2"
B-6	1¾"
B-7	2¼"

BELOW-GRADE STRUCTURES:
Transit Time Flow Meters, Step Screens, Vortex Grit Removal System

Excavation Dewatering

We understand that the Transit Time Flow Meters structure will be located approximately 20 feet below existing grade, the Step Screens will be located approximately 10 feet below existing grade, and the Vortex Grit Removal System will be located approximately 12 feet below existing grade. (The Grit Classifiers will be located at grade.)

Based upon the field and laboratory information obtained from the soils observed at the general location of the proposed Transit Time Flow Meters structure (*i.e.*, Test Boring B-1), the excavation for the proposed flow meters is anticipated to penetrate the

- Stratum 1A Clays and Clayey Sand fill materials in either a *very hard or dense* condition,
- Stratum 2A Clays in a *very hard to hard* condition, and
- Stratum 3a Sandy Clays in a *very stiff* condition.

See Table 2a for the stratigraphic description at this location. Groundwater was not encountered in this vicinity of the site and should drought conditions continue in the San Antonio area, it is not anticipated to be encountered during construction to a depth of 20 feet.

Based upon the field and laboratory information obtained from the soils observed at the general location of the proposed Step Screens (*i.e.*, Test Borings B-2 and B-3), the excavations for the proposed step screens are anticipated to penetrate the

- Stratum 1B Clay, Sandy Clay, and Clayey Sand fill materials in a very hard or very dense condition and
- Stratum 2B Clays and Sandy Clays in a very hard condition.

See Table 2b for the stratigraphic descriptions at these locations. Likewise, groundwater is not anticipated to be encountered to the construction depth of 10 feet.

Based upon the field and laboratory information obtained from the soils observed at the general location of the proposed Vortex Grit Removal System (*i.e.*, Test Borings B-4 and B-5), the excavations for the proposed vortex grit removal structures are anticipated to penetrate the:

- Stratum 1C Sandy Clay and Clay fill materials in a hard or very stiff condition and
- Stratum 2C Clayey Gravels in a dense condition.

See Table 2b for the stratigraphic descriptions at these locations. Likewise, groundwater is not anticipated to be encountered to the construction depth of 12 feet.

As a cautionary note, though perched groundwater is not anticipated to the depth of the below-grade structures, depending upon localized precipitation in the area at the time of construction the groundwater level may rise or, with drought, drop. If groundwater is encountered sumps and pumps are generally effective in removing such water. However, studies to indicate the groundwater inflow rates are not within the scope of this investigation. If large quantities of water are encountered well points may be required. Subsequent to the dewatering measures, a lean-concrete mud mat placed in the bottom of the excavation should be considered to protect the supporting materials from the weather during form and rebar placement and to provide a good working platform. It is recommended that an Arias & Associates representative be present to visually inspect the condition of the excavation before construction of the proposed project elements begins.

Allowable Bearing Pressure

Transit Time Flow Meters

We understand that the flow meters will extend to a depth of 20 feet below the ground surface. These structures, therefore, are anticipated to be founded within the Stratum 3A sandy clays and above the groundwater table. Based on the results of our boring, the net allowable bearing pressure for the Stratum 3A very stiff sandy clay soils encountered at the site is ***2,500 psf.*** This includes a factor safety of 3.0.

Step Screens

We understand that each of the strep screen structures will extend to a depth of 10 feet below the ground surface. These structures, therefore, are anticipated to be founded within the Stratum 2B very hard clays, and above the groundwater table. Based on the results of our boring, the net allowable bearing pressure for the Stratum 2B soils encountered at the site is ***3,250 psf.*** This includes a factor safety of 3.0.

Vortex Grit Removal System

We understand that each of the vortex grit removal system will extend to a depth of 12 feet below the ground surface. These structures, therefore, are anticipated to be founded within the Stratum 2C very dense clayey gravels, and above the groundwater table. Based on the results of our boring, the net allowable bearing pressure for the Stratum 2C soils encountered at the site is ***3,250 psf.*** This includes a factor safety of 3.0.

General

Excavation equipment may disturb the bearing soils and loose pockets can occur at the bearing level that was not disclosed by the borings. For this reason, it is recommended that the bottom of the excavations be compacted prior to form and rebar placement. The upper six (6) inches of subgrade soil should be compacted to achieve a density of no less than 95 percent of the maximum dry density as determined by ASTM designation (D-698). Hand operated type compaction equipment should be utilized.

Compacted select fill consisting of well-graded, free-draining gravel should be placed beneath the foundation and behind the vertical walls of the Transit Time Flow Meters, Step Screens and Vortex Grit Removal System. We recommend that the select fill consist of 1-inch clean TxDOT concrete gravel Grade #5 (ASTM C-33 #67). A minimum of 6 inches of this clean gravel should be placed beneath each foundation slab. A minimum of 12 inches of this material should surround the sides of the below-grade structures. If the width of the backfill exceeds 18 inches, then plate compaction should be performed in maximum 1 foot lifts. Care should be taken to not over-compact the backfill placed behind fixed walls. Compacted select fill should be place behind the below-grade walls to grade. A representative of Arias & Associates should observe the backfill and compaction processes.

The backfill material placed between the cut slopes of the excavation and the select fill placed adjacent to the below-grade walls of the Transit Time Flow Meters, Step Screens, and Vortex Grit Removal System may consist of the natural soils removed during the excavation operation. These materials should be placed in 9-inch loose lifts and compacted to achieve a density of no less than 95 percent of the maximum dry density as determined by ASTM designation (D-698). The compacted material should be benched into the cut slope to develop an integral connection between the *in situ* material and the re-placed soils. A representative of Arias & Associates should observe the backfill and compaction processes.

Lateral Earth Pressures

It is assumed that the below grade walls of the proposed Transit Time Flow Meters, Step Screens, and Vortex Grit Removal System will be formed on both sides and that soil backfill will be utilized on the backside of the walls. For below-grade walls retained both at the top and bottom, soil pressures approaching an at-rest condition should be used. Equivalent fluid pressures of 45 pounds per cubic foot per foot of wall height are recommended. This value does not include a hydrostatic component. If provisions to prevent accumulations of water behind the walls are not provided, the walls should be designed to resist the full hydrostatic head in addition to the external earth pressures as stated above. Water stops are recommended between the walls, floors and any other areas where joints may exist.

Trench Shoring

Lateral earth pressure for design of shoring can use the following soil design parameters for short term conditions:

Table 5. Trench Shoring Parameters for Short Term Conditions

Stratum	Description	γ_e	C	φ	k_a
	Propose Transit Time Flow Meters (Test Boring B-1)				
1A 0 to 6.5 ft.	*CLAY(CL) & Clayey SAND(SC)*	115	2,000	0	0.35
2A 6.5 to 12 ft.	*CLAY(CH)*	120	2,000	0	0.35
3A 12 to 30 ft.	*Sandy CLAY(CL)*	120	1,500	0	0.35
	Proposed Step Screens (Test Borings B-2 & B-3)				
1B 0 to 5 ft.	*CLAY(CL) & Sandy CLAY(CL)*	120	2,000	0	0.35
2B 5 to 20 ft.	*CLAY(CL) & Sandy CLAY(CL)*	120	1,500	0	0.35
	Proposed Vortex Grit Removal Systems (Test Borings B-4 & B-5)				
1C 0 to 5 ft.	*Sandy CLAY(CL) & CLAY(CH)*	120	1,500	0	0.35
2C 5 to 16 ft.	*Clayey GRAVEL(GC)*	120	0	32	0.4
3C 16 to 21 ft.	*Clayey GRAVEL(GC)*	58	0	32	0.4
	Proposed Grit Classifier - north (Test Boring B-6)				
1D 0 to 5.5 ft.	*CLAY(CL) & Sandy CLAY(CL)*	115	2,000	0	0.35
2D 5.5 to 18.5 ft.	*Clayey GRAVEL(GC)*	120	0	32	0.4
3D 18.5 to 20 ft.	*Sandy CLAY(CL)*	120	1,000	0	0.35
	Proposed Grit Classifier - south (Test Boring B-7)				
1E 0 to 3 ft.	*Clayey GRAVEL(GC)*	120	0	30	0.4
1E 3 to 6.5 ft.	*CLAY(CH)*	120	1,500	0	0.35
2E 6.5 to 12 ft.	*CLAY(CH)*	120	1,500	0	0.35
3E 12 to 20 ft.	*CLAY(CL)*	120	1,000	0	0.35

where:
γ_e = effective soil unit weight, pcf
C = undrained soil shear strength, psf
φ = angle of internal friction, deg.
k_a = coefficient of active earth pressure

Lateral earth pressures on the trench shoring can be calculated considering a rectangular pressure diagram having a magnitude of:

$$(\gamma)(H)(k_a)$$

where γ and k_a are provided above and H is the depth of excavation in feet. Any surcharge loads including equipment loads, and soil stockpiles and hydrostatic pressures should be added to this value as required.

Trench-Excavations

The contractor should be aware that slope height, slope inclination, or excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, or federal safety regulations, *e.g.,* OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, dated October 31, 1989. Such regulations are strictly enforced and, if they are not followed, the Owner, Contractor, and/or earthwork and utility subcontractors could be liable for substantial penalties.

The soils encountered during our field investigation within the vicinity of the proposed Transit Time Flow Meters, Step Screens, Vortex Grit Removal System and Grit Classifiers consist of clayey sands (SC), sandy clays (CL), clays (CH-CL), clayey gravels (GC). The OSHA classification for these soil types is Type "C". The maximum allowable slope for a Type "C" soil is 1.5H:1V (34 degrees). Also, all materials below the water table must be classified as Type "C" soils.

For excavations less than 20 feet deep, the maximum allowable slope for Type "C" soils is 1.5H:1V (34°). ***It must be noted that layered slopes cannot be steeper at the top than the underlying slope and that all materials other than stable rock below the water table must be classified as Type "C" soils.*** The OSHA publication should be referenced for layered soil conditions, benching, etc.

Appropriate trench excavation methods will depend on the various soil and groundwater conditions encountered. We emphasize that undisclosed soil conditions may be present at locations and depths other than those encountered in our borings. Consequently, flatter slopes and dewatering techniques may be required in these areas.

The soils to be penetrated by excavations may vary across the site. Our soil classification is based solely on the materials encountered in seven borings placed within the approximate areas of the project elements. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, we recommend that Arias & Associates, Inc. be contacted immediately to evaluate the conditions encountered.

Trenches less than 5 feet deep are generally not required to be sloped back or braced following federal OSHA requirements for excavations. Sides of temporarily vertical excavations less than 5 feet deep may stay open for short periods of time, however, the soils that will be encountered in trench excavations are subject to random caving and sloughing. If side slopes begin to slough, the sides should be either braced or be sloped back to at least 1V: 1H.

If any excavation, including a utility trench, is extended to a depth of more than twenty (20) feet, it will be necessary to have the side slopes designed by a professional engineer registered in Texas. As a safety measure, it is recommended that all vehicles and soil piles be kept a minimum lateral distance from the crest of the slope equal to no less than the slope height.

Specific surcharge loads such as traffic, heavy cranes, earth stockpiles, pipe stacks, etc., should be considered by the Trench Safety Engineer. It is also important to consider any vibratory loads such as heavy truck traffic.

It is required by OSHA that the excavations be carefully monitored by a competent person making daily construction inspections. These inspections are required to verify that the excavations are constructed in accordance with the intent of OSHA regulations and the Trench Safety Design. If deeper excavations are necessary or if actual soil conditions vary from the borings, the trench safety design may have to be revised. It is especially important for the inspector to observe the effects of changed weather conditions, surcharge loadings, and cuts into adjacent backfills of existing utilities. The flow of water into the base and sides of the excavation and the presence of any surface slope cracks should also be carefully monitored.

Subgrade Considerations

The bottoms of trench excavations should expose strong competent soils, and should be dry and free of loose, soft, or disturbed soil. If fill soils are encountered at the base of trench excavations, their competency should be verified through probing and density testing. Soft, wet, weak, or deleterious materials should be over-excavated to expose strong competent soils. At locations where soft or weak soils extend for some depth, over-excavation to stronger soils may prove infeasible and/or uneconomical. In the event of encountering these areas of deep soft or weak soils, we recommend that the bottom of the trench be over-excavated by one to two feet, and replaced with an open-graded aggregate (such as a uniform gradation of gravel between 0.5 to 2.0 inches). This aggregate will allow for drainage of water, as well as providing a stable working platform.

We recommend good surface drainage away from excavations be established to prevent surface runoff from flooding excavations. The proposed below-grade structures should be constructed and backfilled as soon after excavation as possible.

AT-GRADE STRUCTURES:
Grit Classifiers

Mat Foundation

After performing the site improvement measures outlined in "Site Preparation" section of this report which include stripping at least the top 6-inches of existing material, compaction of the subgrade, and placement of compacted structural fill, a mat foundation for each of the proposed grit classifiers can be designed for a net allowable soil bearing pressure of ***2,000 psf*** for the 1 to 5 foot depth.

Depending on seasonal weather conditions, excavations may allow groundwater. Depending on the volume of water encountered, conventional sump and pumping methods should allow for the base of the excavations to remain sufficiently dry to allow for concrete placement.

Excavation equipment may disturb the bearing soils and loose pockets can occur at the bearing levels that were not disclosed by the borings. For this reason, it is recommended that the bottoms of the excavations be compacted prior to form and rebar placement. The upper six (6) inches should be compacted to achieve a density of no less than 95 percent of the maximum dry density as determined by ASTM designation (D-698). Hand operated type compaction equipment should be utilized.

In order to minimize the effects of any slight differential movement that may occur due to variations in the character of the supporting soils, it is recommended that the mats be suitably reinforced to make them as rigid as possible. It may be advantageous to use a "turned down" perimeter beam. In addition, a lean concrete mud mat placed in the bottom of the mat excavation should be considered to protect the supporting soils from the weather during form and rebar placement.

Uplift and Lateral Loads for Mat Foundation– Grit Classifiers

The mats maybe subject to uplift and lateral loads. Lateral loads can be resisted by a uniform allowable passive pressure of **1,000 psf** acting on the side of the foundations. Allowable uplift resistance can be conservatively taken as the dead weight of the footing/mat plus the weight of the soil above the concrete.

CONSTRUCTION CRITERIA

Site Preparation – Proposed Below-Grade Structures (Transit Time Flow Meters, Step Screens, Vortex Grit Removal System)

The following site preparation recommendations are provided in the area of the below-grade structures to include the Transit Time Flow Meters, and Step Screens, Vortex Grit Removal System. If groundwater is encountered sumps and pumps are generally effective in removing such water. Large-scale dewatering with well points may be required depending upon the depth-to-groundwater at the time of construction.

Table 6. Recommended Site Preparation and Earthwork in the Below-Grade Structures

Depth of Excavation	20 feet – Flow Meter Structure 10 feet – Screen Structures 12 feet – Vortex Grit Removal System
Undercut Extent	3 feet beyond perimeter of foundation
After Undercut compact the subgrade	Min. 95% of the max. Standard Proctor (ASTM D-698) within 0 to +3% of optimum moisture content
Select Fill Placed Beneath the Foundation	6 inches minimum
Select Fill Placed Behind the Sub-surface Vertical Walls	12 inches minimum
Structural Select Fill Type	TxDOT Item 247, Type A or B, Grade 1 or 2.
Maximum Structural Select Fill Loose Lift Thickness (in)	9 inches
Structural Select Fill Compaction Requirement	Min. 95% of the max. Standard Proctor (ASTM D-698) within -1 to +3% of optimum moisture content

Exposed subgrade from excavations or grading operations should be compacted to achieve a density of no less than 95 percent of the maximum dry density as determined by ASTM designation (D-698). Hand operated type compaction equipment should be utilized immediately adjacent to the outer walls of the proposed Transit Time Flow Meters, Step Screens, and Vortex Grit Removal Systems structures.

The backfill material placed between the cut slopes of the excavation and the select fill placed adjacent to the below-grade walls may consist of the natural soils removed during the excavation operation. These materials should be placed in 9-inch loose lifts and compacted to achieve a density of no less than 95 percent of the maximum dry density as determined by ASTM designation (D-698). The compacted material should be benched into the cut slope to develop an integral connection between the *in situ* material and the re-placed soils.

We recommend that one of our representatives be scheduled to observe that the site preparation operations including the backfill and compaction processes are performed in accordance with our recommendations.

If existing structures are discovered during excavation, we should be informed immediately to determine the impact of those structures on our recommendations.

Site Preparation – Grit Classifiers

The following site preparation and earthwork recommendations are provided to maintain a PVR of 1" or less in the area of the proposed Grit Classifiers.

Table 6. Recommended Site Preparation and Earthwork in the Grit Classifier Areas

Earthwork	Mat Foundation Type*
Min. Undercut Depth (ft)	6 inches
Min. Select Structural Fill Thickness (ft)	1 foot
Undercut Extent	3' beyond perimeter of foundation
After Undercut compact the subgrade	Min. 95% of the max. Standard Proctor (ASTM D-698) within 0 to +3% of optimum moisture content
Structural Select Fill Type	TxDOT Item 247, Type A or B, Grade 1 or 2.
Maximum Structural Select Fill Loose Lift Thickness (in)	9"
Structural Select Fill Compaction Requirement	Min. 95% of the max. Standard Proctor (ASTM D-698) within -1 to +3% of optimum moisture content

- *Strip away existing asphalt, concrete, topsoil, grass, organics, and deleterious debris as needed, and dispose outside of the foundation areas. Undercut to the required depth and extent as noted in the table above. Additional excavation may be required to accommodate the required select fill thickness. Additional excavation may also be necessary due to encountering deleterious materials such as concrete or undesirable soft and wet subgrade conditions. The site representative of the geotechnical engineer should observe undercutting operations. Unless passing density reports are provided for a specific area, existing fill soils found during the excavation should be considered as uncertified and removed to suitable natural soils.*

- *Exposed subgrade from excavations or grading operations should be compacted to 95% minimum of standard proctor density within 0 to +3 of the optimum moisture content.*

- *Select fill should be placed for the Grit Classifier structures as required to raise the foundation for drainage purposes and accommodate the required select fill thickness.*

- *Select fill used for the Grit Classifier mat foundations should meet the plasticity, grain size and compaction requirements as outlined in the above table. The select fill should be free of organics, trash, rubble or other deleterious materials. Pit run borrow fills should be tested to confirm compliance with the above plasticity requirements on a daily basis. We suggest that the select fill consist of crushed limestone base material meeting the requirements of TxDOT Item 247, Type A or B, Grade 1 or 2. This will provide a good all-weather working surface for construction. The select fill should be tested to the specifications as indicated above.*

- *Voids created as a result of demolition and removal of existing structures should be replaced with select fill placed and compacted as outlined above.*

- *At least one density test should be conducted per 5,000 square feet of building pad per lift of prepared fill and subgrade or a minimum of three density tests should be taken per lift within the building pad area*

Drainage

Good positive drainage during and after construction is very important to minimize expansive soil volume changes that can detrimentally affect the performance of the planned development. Proper attention to surface and subsurface drainage details during the design and construction phase of development can prevent many potential soil shrink-swell related problems during and following the completion of the project.

Earthwork and Foundation Acceptance

Exposure to the environment may weaken the soils at the bearing level if the excavation remains open for long periods of time. Therefore, it is recommended that all excavations be extended to final grade and constructed as soon as possible in order to minimize potential damage to bearing materials. If bearing materials are exposed to severe drying or wetting, the unsuitable material must be re-conditioned or removed as appropriate. The bearing level should be free of loose soil, ponded water or debris and should be observed by the geotechnical engineer or his representative.

Foundation concrete associated with a mat foundation should not be placed on soils that have been disturbed by rainfall or seepage. If the bearing soils are softened by surface water intrusion during exposure or by desiccation, the unsuitable soils must be removed from the foundation excavation and replaced with compacted select fill prior to placement of concrete.

Subgrade preparation and fill placement operations should be monitored by the soil engineer or his representative. As a guideline, at least one in-place density test should be performed for each 5,000 sq. ft. of compacted surface per lift or a minimum of three tests per lift. Any areas not meeting the required compaction should be recompacted and retested until compliance is met.

Quality Control

As Geotechnical Engineer of record, we should be engaged to observe and evaluate the foundation installation and earthwork for site subgrade improvement activities to determine that the actual bearing materials are consistent with those encountered during the field exploration and to monitor and test the select fill placement and subgrade preparation. It is also important that we be given the opportunity to review the design and construction documents. The purpose of this review is to check to see if our recommendations are properly interpreted into the project plans and specifications.

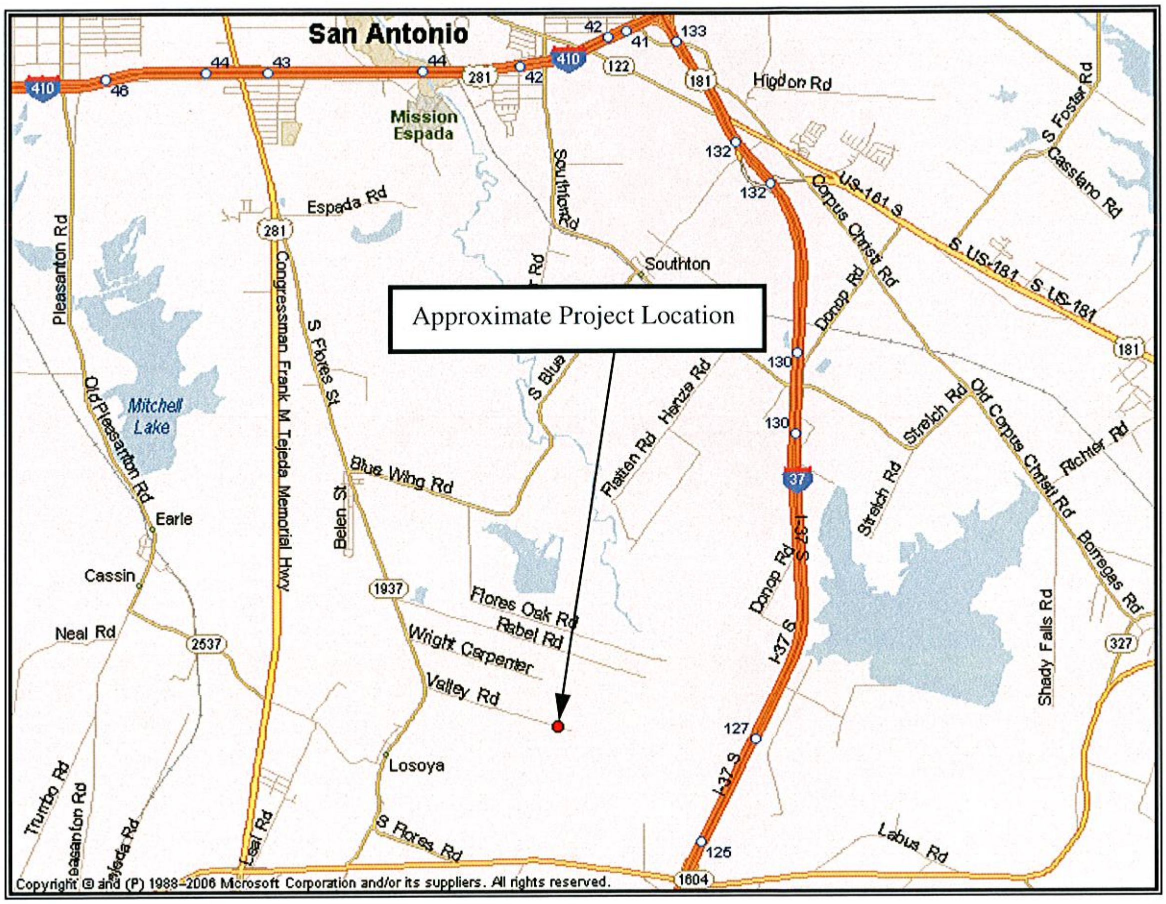
GENERAL COMMENTS

This report was prepared for this project exclusively for the use of CDM, Inc., and their design team. If the development plans change relative to propose Phase I Re-rating project element layouts or sizes, or if different subsurface conditions are encountered, we should be informed and retained to ascertain the impact of these changes on our recommendations. We cannot be responsible for the potential impact of these changes if we are not informed.

The materials to be penetrated by excavations may vary significantly across the site. Our classification is based solely on the materials encountered in eight widely-spaced test borings, drilled to a depth of approximately 20 feet, 22 feet, or 30 feet. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, we recommend that Arias & Associates, Inc. be contacted immediately to evaluate the conditions encountered.

This report has been prepared in accordance with generally accepted geotechnical engineering practice with a degree of care and skill ordinarily exercised by reputable geotechnical engineers practicing in this area.

VICINITY MAP



Proposed SAWS Dos Rios Water Recycling Center
Phase I Rerating Project
San Antonio, Texas

ARIAS & ASSOCIATES, INC. **A&A File No.: 08-2096**

Representative Photographs of Project Area

Site Photo 1 – Vicinity of Test Boring B-1

Site Photo 2 – Vicinity of Test Boring B-2 (looking northeast)

Site Photo 3 – Vicinity of Test Boring B-2

Site Photo 4 – Vicinity of Test Boring B-3

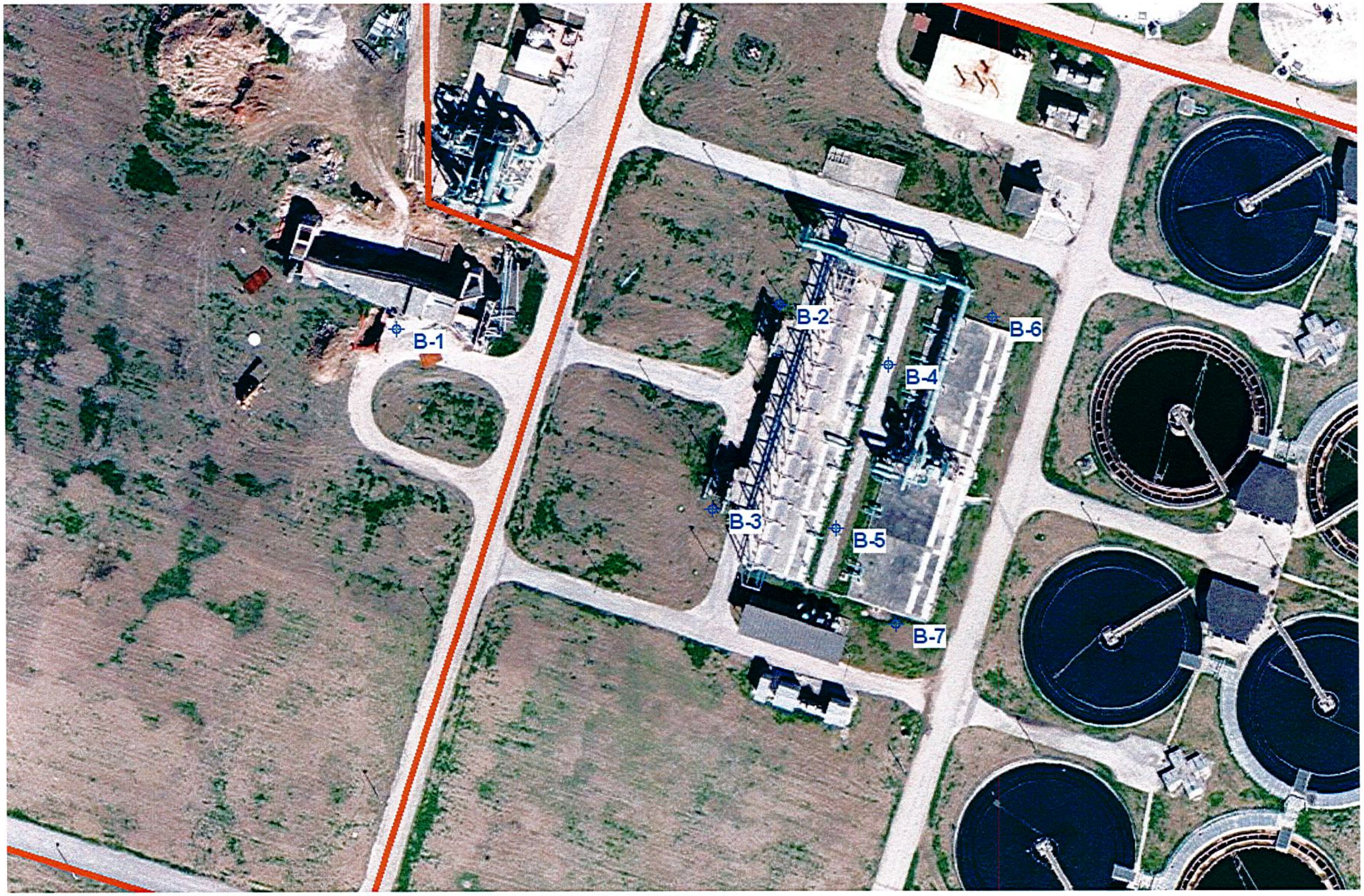
Site Photo 5 – Vicinity of Test Boring B-4 (looking south)

Site Photo 6 – Vicinity of Test Boring B-5 (looking south)

Site Photo 7 – Vicinity of Test Boring B-6

Site Photo 8 – Vicinity of Test Boring B-7

BORING LOCATION PLAN



NOTE: Drawing is not to scale. Locations are approximate.

Boring Log No. B-1

Address: **3225 Valley Road**
San Antonio, Texas
Location:

Project: **Dos Rios - Phase I Re-rating Project**
Logged By: **ME** Elev.:
Sampling Date: **2/6/09**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200	pF
FILL: CLAY (CL), some Sand, trace Gravel, brown, very hard		1: SS	5	15	41	26		78		4.9
FILL: Clayey SAND (SC), some Gravel, reddish brown, dense		2: SS	8					50		4.2
	5	3: SS	6					44	41	4.4
CLAY (CH), some Sand, trace calcareous deposits, brown to light brown, very hard to hard		4: SS	14	17	55	38		51		4.2
		5: SS	15					46		4.0
	10	6: SS	22	17	54	37		43		4.0
Sandy CLAY (CL), trace Gravel and calcareous deposits, tan, very stiff										
	15	7: ST	14				5.50		68	3.6
	20	8: ST	15				2.75			3.9
	25	9: SS	16	13	34	21		22		
	30	10: SS	13					24	65	
Completion Depth: 30.0 ft.										

Groundwater During Drilling: None Observed

- Grab Bag Sample (GB)
- Shelby Tube Sample (ST)
- Split Spoon Sample (SS)
- Water encountered during drilling
- Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
ST = Shelby Tube Sample
SS = Split Spoon Sample
WC = Water Content (%)
N = SPT Blow Counts
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)
-200 = % Passing #200 Sieve
pF = Soil Suction

BORING LOG REVISED 08-2096.GPJ ARIAS.GDT 2/24/09

Boring Log No. B-2

Address: **3225 Valley Road**
San Antonio, Texas
Location:

Project: **Dos Rios - Phase I Re-rating Project**
Logged By: **ME** Elev.:
Sampling Date: **2/6/09**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
FILL: CLAY (CL), some Sand, trace Gravel, brown, very hard		1: SS	6				50/6"	
Sandy CLAY (CL), trace Gravel and calcareous deposits, tan, very hard to hard		2: SS	9	14	36	22	**50/4"	
	5	3: SS	8				31	
-very hard to hard		4: SS	7	13	34	21	55	
	10	5: SS	8				46	66
-very hard to hard		6: SS	10				56	
	15	7: SS	10				39	65
	20	8: SS					46	
Completion Depth: 20.0 ft.								

Groundwater During Drilling: None Observed

- ☒ Grab Bag Sample (GB)
- ■ Shelby Tube Sample (ST)
- Split Spoon Sample (SS)
- ▽ Water encountered during drilling
- ▼ Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
SS = Split Spoon Sample
WC = Water Content (%)
N = SPT Blow Counts
** = Blow Counts During Seating Penetration
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
-200 = % Passing #200 Sieve

BORING LOG REVISED 08-2096.GPJ ARIAS.GDT 2/24/09

Arias & Associates, Inc.

Job No.: 08SA-2096

Boring Log No. B-3

Address: **3225 Valley Road**	Project: **Dos Rios - Phase I Re-rating Project**
San Antonio, Texas	Logged By: **ME** Elev.:
Location:	Sampling Date: **2/6/09**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
CLAY (CL), some Sand, trace Gravel, brown, very hard		1: SS	4	15	41	26	50/6"	
Clayey SAND (SC), some Gravel, trace calcareous deposits, tan, very dense		2: SS	5	12	28	16	**50/5"	49
CLAY (CL), some Sand, trace Gravel and calcareous deposits, tan, very hard to hard	5	3: SS	11				64	
		4: SS	12				64	82
	10	5: SS	14	15	45	30	52	
		6: SS	13				51	
	15	7: SS	19	16	49	33	48	
-trace Sand, very hard	20	8: SS	20				56	99
Completion Depth: 20.0 ft.								

Groundwater During Drilling: None Observed

- Grab Bag Sample (GB)
- Shelby Tube Sample (ST)
- Split Spoon Sample (SS)
- Water encountered during drilling
- Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
SS = Split Spoon Sample
WC = Water Content (%)
N = SPT Blow Counts
** = Blow Counts During Seating Penetration
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
-200 = % Passing #200 Sieve

BORING LOG REVISED 08-2096.GPJ ARIAS.GDT 2/24/09

Arias & Associates, Inc.

Job No.: 08SA-2096

Boring Log No. B-4

Address: **3225 Valley Road**
San Antonio, Texas
Location:

Project: **Dos Rios - Phase I Re-rating Project**
Logged By: **ME** Elev.:
Sampling Date: **2/6/09**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
3" ASPHALT								
FILL: 1" BASE (Clayey GRAVEL(GC) with sand, tan								
FILL: Sandy CLAY (CL), trace Gravel, tan, hard		1: GB	5 8	11	30	19		26
		2: SS	7				27	
	5	3: SS	14				50/6"	29
Clayey GRAVEL (GC), with Sand, tan, very dense (Possible Fill Material)								
		4: SS	5				65	24
		5: SS	4				**50/6"	
	10							
		6: SS	4				**50/6"	37
	15	7: SS	6				72	
Clayey GRAVEL (GC), with Sand, tan, very dense								
		8: SS	8	13	22	9	**50/4"	41
	20							
		9: SS	4				50/6"	26
Completion Depth: 22 ft.								

Groundwater During Drilling: None Observed

- ☒ Grab Bag Sample (GB)
- ■ Shelby Tube Sample (ST)
- ▮ Split Spoon Sample (SS)
- ▽ Water encountered during drilling
- ▼ Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
SS = Split Spoon Sample
GB = Grab Bag Sample
WC = Water Content (%)
N = SPT Blow Counts
** = Blow Counts During Seating Penetration
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
-200 = % Passing #200 Sieve

Arias & Associates, Inc.

Job No.: 08SA-2096

Boring Log No. B-5

Address: **3225 Valley Road**
San Antonio, Texas
Location:

Project: **Dos Rios - Phase I Re-rating Project**
Logged By: **ME** Elev.:
Sampling Date: **2/6/09**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
3" ASPHALT								
FILL: 10" BASE (Clayey GRAVEL(GC) with sand, tan		1: GB	3					
FILL: CLAY (CH), gray brown			18	14	56	42		
FILL: Sandy CLAY (CL), trace Gravel, tan, hard		2: SS	9	11	30	19	38	
Clayey GRAVEL (GC), with Sand, tan, dense to very dense (Possible Fill Material)	5	3: SS	10				31	24
		4: SS	12				80	34
		5: SS	6				73	
	10	6: SS	3				**50/3"	15
-medium dense to very dense	15	7: SS	4				25	
Clayey GRAVEL (GC), with Sand, tan, medium dense to very dense		8: SS	10				**50/6"	32
	20	9: SS	12				**50/4"	
Completion Depth: 22 ft.								

Groundwater During Drilling: Observed at 19.5 ft.

- Grab Bag Sample (GB)
- Shelby Tube Sample (ST)
- Split Spoon Sample (SS)
- Water encountered during drilling
- Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
SS = Split Spoon Sample
GB = Grab Bag Sample
WC = Water Content (%)
N = SPT Blow Counts
** = Blow Counts During Seating Penetration
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
-200 = % Passing #200 Sieve

BORING LOG REVISED 08-2096.GPJ ARIAS.GDT 2/24/09

Arias & Associates, Inc.

Job No.: 08SA-2096

Boring Log No. B-6

Address: **3225 Valley Road**
San Antonio, Texas
Location:

Project: **Dos Rios - Phase I Re-rating Project**
Logged By: **ME** Elev.:
Sampling Date: **2/6/09**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
FILL: CLAY (CL), trace Sand and Gravel, brown, very hard		1: SS	8	16	45	29	70/10"	
FILL: Sandy CLAY (CL), with Gravel, reddish brown, very hard		2: SS	4				50/6"	48
	5	3: SS	11	12	41	29	63/11"	
Clayey GRAVEL (GC), with Sand, tan, very dense		4: SS	4				**50/6"	25
		5: SS	8				50/4"	
	10	6: SS	3				**50/6"	34
	15	7: SS	3				56	24
Sandy CLAY (CL), some Gravel, tan, stiff		8: SS	9	11	28	17	14	
	20							
Completion Depth: 20.0 ft.								

Groundwater During Drilling: None Observed

- ☒ Grab Bag Sample (GB)
- ■ Shelby Tube Sample (ST)
- Split Spoon Sample (SS)
- ▽ Water encountered during drilling
- ▼ Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
SS = Split Spoon Sample
WC = Water Content (%)
N = SPT Blow Counts
** = Blow Counts During Seating Penetration
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
-200 = % Passing #200 Sieve

BORING LOG REVISED 08-2096.GPJ ARIAS.GDT 2/24/09

Arias & Associates, Inc.

Job No.: 08SA-2096

Boring Log No. B-7

Address: **3225 Valley Road** **San Antonio, Texas**	Project: **Dos Rios - Phase I Re-rating Project**
Location:	Logged By: **ME** Elev.:
	Sampling Date: **2/6/09**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200
FILL: Clayey GRAVEL (GC), with Sand, tan, very dense		1: SS	4					45	
		2: SS	2					50/0"	
FILL: CLAY (CL), with Sand, some Gravel, brown, hard	5	3: SS	14					35	64
CLAY (CH), trace Sand and Gravel, brown to light brown, hard		4: SS	17	15	56	41		43	
	10	5: SS	21					35	91
		6: ST	20	17	55	38	7.25		
CLAY (CL), some Sand, trace Gravel, light brown, very stiff	15	7: ST	16	15	41	26	5.25		
	20	8: SS	16	16	49	33		22	86
Completion Depth: 20.0 ft.									

Groundwater During Drilling: None Observed

- Grab Bag Sample (GB)
- Shelby Tube Sample (ST)
- Split Spoon Sample (SS)
- Water encountered during drilling
- Delayed water reading

Refer to Appendix for Additional Information

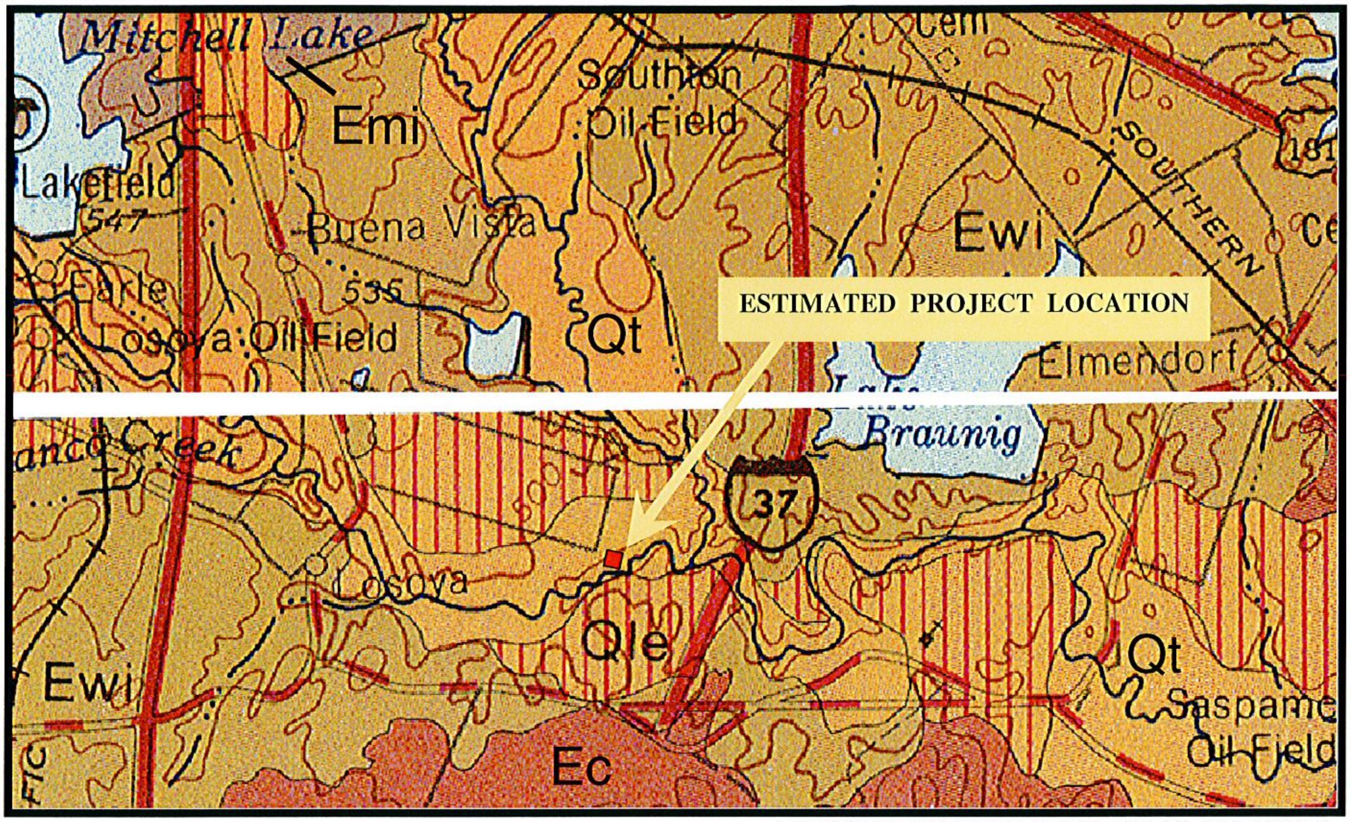
SN = Sample Type and No.
ST = Shelby Tube Sample
SS = Split Spoon Sample
WC = Water Content (%)
N = SPT Blow Counts
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)
-200 = % Passing #200 Sieve

KEY TO CLASSIFICATION SYMBOLS USED ON BORING LOGS

MAJOR DIVISIONS			GROUP SYMBOLS	DESCRIPTIONS
COARSE-GRAINED SOILS More Than Half of Material LARGER Than No. 200 Sieve size	GRAVELS More Than Half of Coarse Fraction is LARGER Than No. 4 Sieve Size	Clean Gravels (Little or no Fines)	GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or no Fines
			GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or no Fines
		Gravels With Fines (Appreciable Amount of Fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS More Than Half of Coarse Fraction is SMALLER Than No. 4 Sieve Size	Clean Sands (Little or no Fines)	SW	Well-Graded Sands, Gravelly Sands, Little or no Fines
			SP	Poorly-Graded Sands, Gravelly Sands, Little or no Fines
		Sands With Fines (Appreciable Amount of Fines)	SM	Silty Sands, Sand-Silt Mixtures
			SC	Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS More Than Half of Material is SMALLER Than No. 200 Sieve Size	SILTS & CLAYS	Liquid Limit Less Than 50	ML	Inorganic Silts & Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
	SILTS & CLAYS	Liquid Limit Greater Than 50	MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils, Elastic Silts
			CH	Inorganic Clays of High Plasticity, Fat Clays
FORMATIONAL MATERIALS	SANDSTONE			Massive Sandstones, Sandstones with Gravel Clasts
	MARLSTONE			Indurated Argillaceous Limestones
	LIMESTONE			Massive or Weakly Bedded Limestones
	CLAYSTONE			Mudstone or Massive Claystones
	CHALK			Massive or Poorly Bedded Chalk Deposits
	MARINE CLAYS			Cretaceous Clay Deposits
	GROUNDWATER		▼	Indicates Final Observed Groundwater Level
			▽	Indicates Initial Observed Groundwater Location

Arias & Associates, Inc.

GEOLOGIC MAP



PORTION OF GEOLOGIC ATLAS OF TEXAS

LEGEND

Symbol	Name	Age
Qt	Alluvial Terrace Deposits	Quaternary Period / Pleistocene Epoch
Qle	Leona Formation (Alluvium)	Quaternary Period / Pleistocene Epoch
Ec	Carrizo Sand Formation	Tertiary Period / Eocene Epoch
Ewi	Wilcox Formation	Tertiary Period / Eocene Epoch
Emi	Midway Formation	Tertiary Period / Eocene Epoch
U / D	Fault Segment with Indication of Relative Movement	

Proposed SAWS Dos Rios Water Recycling Center
Phase I Rerating Project
Valley Road
San Antonio, Texas

APPENDIX
Laboratory and Field Test Procedures

Soil Classification Per ASTM D2487-93
This soil testing standard was used for classifying soils according to the Unified Soil Classification System. The soil classifications of the earth materials encountered are as noted in the attached boring logs.

Soil Water Content Per ASTM D2216-92
This test determines the water content of soil or rock expressed as a percentage of the solid mass of the soil. The test results are listed under **MC** in the attached boring logs.

Soil Liquid Limit Per ASTM D4318-93
The soil Liquid Limit identifies the upper limit soil water content at which the soil changes from a moldable (plastic) physical state to a liquid state. The Liquid Limit water content is expressed as a percentage of the solid mass of the soil. The test results are listed under **LL** in the attached boring logs.

Soil Plastic Limit Per ASTM D4318-93
The soil Plastic Limit identifies a lower limit soil water content at which the soil changes from a moldable (plastic) physical state to a non-moldable (semi-solid) physical state. The Plastic Limit water content is expressed as a percentage of the solid mass of the soil. The test results are listed under **PL** in the attached boring logs.

Plasticity Index Per ASTM D4318-93
This is the numeric difference between the Liquid Limit and Plastic Limit. This index also defines the range of water content over which the soil-water system acts as a moldable (plastic) material. Higher Plasticity Index (PI) values indicate that the soil has a greater ability to change in soil volume or shrink and swell with lower or higher water contents, respectively. The test results are listed under **PI** in the attached boring logs.

Standard Penetration Test (SPT) and Split Spoon Sampler (SS) per ASTM D 1586
This is the standard test method for both the penetration test and split-barrel (spoon) sampling of soils. This sampling method is used for soils or rock too hard for sampling using Shelby Tubes. The method involves penetration of a split spoon sampler into the soil or rock through successive blows of a 140 pound hammer in a prescribed manner.

Blow Counts (N) per ASTM D 1586
This is the number of blows required to drive a Split Spoon Sampler by means of a 140 pound hammer for a distance of 12 inches in accordance with the variables stated in the test procedures.

Shelby Tube (ST) per ASTM D 1587
This procedure is for using a thin-walled metal tube to recover relatively undisturbed soil samples suitable for laboratory tests of physical properties.

Rock Core per ASTM D 2113
This procedure is for using diamond core drilling equipment to obtain core samples of rock and some soils that are too hard to sample by soil-sampling methods.

Dry Density (DD) per ASTM D 2937
This procedure is for the determination of in-place density of soil. The test results are measured in pounds per cubic foot, pcf.

Unconfined Compression Test (UC) per ASTM D 2166
This test method covers the determination of the unconfined compressive strength of cohesive soil in the undisturbed, remolded, or compacted condition, using strain-controlled application of the axial load.

Minus No. 200 Sieve per ASTM D 1140
This test method covers determination of the amount of material finer than a Number 200 sieve by washing. The results are stated as a percent of the total dry weight of the sample.

Pocket Penetrometer (PP): This test method is an accepted modification of ASTM D 1558 test method for establishing the moisture-penetration resistance relationships of fine-grained soils. The test results are measured in tons per square foot, tsf. The strength values provided by this method should be considered qualitatively.

Rock Quality Designation (RQD) : The measure of the quality of a rock mass defined by adding intact rock core pieces greater than four inches in length by the total length of core advance per ASTM 6032.

Recovery Ratio (REC): The Recovery Ratio is equal to the total length of core recovered divided by the total length of core advance.

Boring Logs: This is a summary of the above described information at each boring location.