MEREDITH STREET STORM DRAIN IMPROVEMENT PROJECT
PRELIMINARY ENGINEERING REPORT

City of Austin
Watershed Protection Department
Watershed Engineering Division

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EXECUTIVE SUMMARY

The Meredith Street Storm Drain Improvements project is a high priority for the Localized Flood Hazard Mitigation (LFHM) program. The purpose of this report is to document the existing conditions in the area and identify possible alternatives for improvement. All alternatives were evaluated to meet the fully developed conditions for the drainage infrastructure.

The serving existing storm drain system, about 750 feet long, is comprised of 15-inch through 18-inch pipes, and has four 5-foot inlets and one 10-foot inlet. The 10-foot inlet discharges directly to the Austin Caverns cave, an underground cave having an entrance at 3605 and 3607 Meredith St. The existing storm drain system was constructed in 1952 and modified to discharge into the Austin Caverns cave in the 1960s. With increased development in the contributing drainage area and some apparent sloughing of the cave walls and/or roof, the cave is no longer able to convey runoff satisfactorily from the storm drain system. The neighborhood has experienced flooding issues since 1996, and has filed associated requests for help via the City's service request system.

Several drainage improvement alternatives were considered (11 total); the following four alternatives were considered to be the most appropriate for potential implementation:

Alternative 1– This alternative includes the rerouting of a nearby NW storm drain system **(Figure 4)** to place that system within the street right-of-way so that it connects to the proposed Meredith SDS with the outfall located on 1804 Rockmoor Ave. (see **Figure 20**). The estimated cost for this alternative is approximately $5,000,000.

Alternative 2 - This alternative focuses on immediate drainage issues and includes boring between the houses located at 1815 and 1901 Rockmoor Ave., with an alignment along Kennelwood Rd. and discharge at the outfall located on 1804 Rockmoor Ave. (see **Figure 21**). The estimated cost for this alternative is approximately $3,900,000.

Alternative 3 - This alternative focuses on immediate drainage issues and includes boring between the houses located at 1813 and 1815 Rockmoor Ave., as well as upgrading the existing 36-inch discharging pipe to a 66-inch pipe from the intersection of Cherry ln and Rockmoor Ave.

to the outfall at 1804 Rockmoor Ave. (see **Figure 22**). The estimated cost for this alternative is approximately $3,600,000.

Alternative 4 – This alternative includes the buyout of private properties at 3605 and 3607 Meredith St. and the construction of a detention pond at this location. This alternative requires upgrading the existing 36-inch discharging pipe to a 66-inch pipe from the intersection of Cherry ln and Rockmoor Ave. to the outfall at 1804 Rockmoor Ave. (see **Figure 23**). The estimated cost for this alternative is approximately $5,000,000.

Alternative 3 is the preferred option; further evaluation by a design consultant is recommended. This alternative provides the benefit of following the natural relief of the land, which helps avoid both bucking grade and very deep construction at the intersection of Meredith St. and Rockmoore Ave. This alternative is also more desirable from environmental point of view (refer to MIP team comments in **Appendix C**).

It is recommended that a more refined analysis of the above alternatives be conducted to confirm that the recommended option is indeed the most suitable option. Additional visual field inspections and topographic surveys should be conducted as needed to prepare a full designe. It is recommended that a public meeting be held early during the design phase of this project to obtain input from all stakeholders involved.

1. INTRODUCTION AND STATEMENT OF NEED

The project area is located in West Austin at the easternmost tip of the Lake Austin Watershed, on Meredith St. between Rockmoor Ave. and Raleigh Ave. (see **Figure 1** for project location map). The subdivisions within the project area were constructed in the 1960s after placing fill material in the excavations of an abandoned quarry and prior to the adoption of current City of Austin design standards for storm drain infrastructure. This project will address six building and yard flooding complaints at the following addresses: 3605-A Meredith St.; 3605-B Meredith St.; 3607 Meredith St., Unit 1; 3607 Meredith St., Unit 2; 1813 Rockmoor Ave.; and 1901 Rockmoor Ave. In addition to addressing flooding issues, the project will provide benefits that meet other mission-related goals of the Watershed Protection Department (WPD).

The existing storm drain system was constructed in 1952; it currently discharges to the Austin Caverns cave at 3605 and 3607 Meredith St. The neighborhood has experienced flooding issues since 1996. Several requests to provide relief from the flooding are documented in the City's service request system.

Figure 1. Meredith St. Location Map

2. PROJECT HISTORY

The first flooding complaint for the area was recorded in 1996; the City has received repeated requests to resolve the flooding issues since that time.

Key events in the history of this drainage system summarized below.

- 1930s – Austin Caverns operates as a commercial attraction
- Early 1950s – Filling and reclamation of abandoned quarry at site
- 1952 –Existing Meredith drainage system constructed
- 1960s – Existing Meredith drainage system directly connected to Austin Caverns and Class V injection well was built to covey runoff undeground
- 1990s –Roadway improvements were made along Meredith St. in the immediate vicinity of the inlet that connects to the cave. The "Drainage Assessment for Austin Caverns" performed by Kast Tec Consulting in 2004 confirmed that fill material from the roadway construction was placed in a manner that blocked drainage to the northern portion of the cave (see **Appendix A**).
- October 1996 – Construction of the planned Walsh Tract Lift Station Relief Interceptor project along Scenic Drive, near Meredith St., was halted due to difficulties with the subsurface conditions. The contractor encountered problems in microtunneling through the base of Edwards Limestone in the vicinity of Lake Austin Boulevard and Bridle Path, approximately 1300 feet southwest of the inlet at 3605 and 3607 Meredith St. The difficulties that led to the abandonment of construction on the interceptor project is a forewarning that subsurface conditions (e.g. the nature of the limestone and the presence of caves in the area) might also present difficulties for any rerouting or extension of the existing storm drain system on Meredith St.
- July 11, 1996 – First recorded flooding complaint is received from residents on Meredith St. City crews cleaned the inlets and flushed the storm drain lines.

- December 1998 – Site visit was conducted to investigate a clogged cave passage at Austin Caverns, located at 3607 Meredith St. Bill Russell, a local caver, asked City of Austin staff (Sylvia Pope, David Johns, Mike Kelly and Roxanne Jackson) to investigate how to open up cave passages at the base of the 23.6-foot deep vertical inlet structure that had become blocked by debris and rock collapse. Residents of the duplexes at 3607 Meredith St. informed City staff about frequent flooding. The complaint was passed on to Mike Newman, Watershed Engineering Division (WED), for consideration as a Capital Improvement Project (CIP).
- April 2000 – Dye trace injection was conducted at Austin Caverns. The dye was never recovered at any of the 26 receptor locations. The most likely outlet was Lake Austin.
- August 28, 2001 – Additional flooding complaints were received and referred to WED.
- November 15, 2001 – Additional flooding complaints were received, and the first Citizen Assistance Form (CAF 11337) was filed.
- May 6, 2002 – CAF 12089 was received. Director Mike Heitz, Mike Newman, and George Oswald of WPD met with the citizen and stated that this area has been identified in the Master Plan for review by the LFHM program.
- June 15, 2004 – CAF 15254 was received. Councilmember Dunkerly, Assistant City Manager Laura Huffman and George Oswald informed the citizen that they do not anticipate funding for this project for 10 or more years. Two additional requests were made by the citizen to: 1) explore cleaning out debris from the cave; and 2) provide advice to impacted homeowners.
- June 2004 – The Texas Commission on Environmental Quality (TCEQ) Injection Well Permit Section sent a letter to City of Austin regarding Class V injection well site. Staff visited Austin Caverns to investigate the current conditions and photographed the interior of the south cave passage from the inlet pipe. Accumulation of debris (sand, leaves, dirt) from surface runoff was visible in the cave passage.
- July 2004 – City staff conducted a site visit with TCEQ Injection Well Permit staff to discuss the Class V injection well status of Austin Caverns. Subsequently, COA applied for Class V injection well status. Sylvia Pope, a hydrogeologist with the City, developed cleanout specifications for the cavern in anticipation of hiring a contractor to do the work.

- September 2004 – A contractor for WPD removed approximately 4.5 cubic yards of debris from Austin Caverns and mapped the accessible portion of the south cave passage (see **Appendix A**, Karst-Tec Consultants report, November 2004).
- 2004 to present – A number of additional complaints have been received from residents in the area. Vactor truck crews periodically attempt to remove leaves and debris where the inlet on Meredith Street connects to Austin Caverns.
- February - March 2011 – The LFHM group conducted field reconnaissance and developed StormCAD (one-dimensional) and InfoWorks (two-dimensional) models of the existing system at the Meredith St. project area, as well as the downstream system along Rockmoor Ave. and Cherry Ln. Potential flooding issues were identified through the modeling and the drainage issues that had been reported in the area were supported by the model results.
- May 2011 – Approximately ½ inch of rainfall produced street and yard flooding in the area immediately downstream of the inlet at 3605 and 3607 Meredith St. Subsequent investigations by the WPD Field Operations Division (FOD) indicated that additional cave-ins of the cavern roof had likely occurred, and that the 18-inch elbow outfalling to the cave was significantly blocked by a large boulder. Impacted residents mentioned past discussions with the City, as well as the possibility of taking their issues to the media if they are not satisfied with the City's response to their concerns.
- January 2012 – Storm event caused flooding of 3607 and 3605 Meredith St. The high watermarks were about 16 inches above the ground surface. Citizens complained again about the ongoing flooding issues.

GIS database flooding complaints received since 1996 are summarized in **Appendix A**.

Structures with reported complaints of building flooding are identifed in **Figure 2.**

Figure 2. Meredith St. Complaints and Existing Storm Drain (Meredith SDS), Not To Scale (NTS)

3. MISSION INTEGRATION

The missions of the WPD are to reduce the impacts of flooding, erosion and water pollution on our community in order to protect lives, property and the environment. As part of the department's goal to integrate the three missions, staff explores ways for every project to incorporate the goals and objectives of each individual mission. The WPD has a specific process that is followed for all CIPs administered by the department. The Mission Integration Prioritization Team (MIPT) helps ensure project integration and assists in developing cost estimates.

In January 2012, the Meredith Street Storm Drain Improvement Project was introduced to the MIPT. A creek walk followed. The creek walk is one of the many steps within the MIPT process that provides the opportunity for MIPT representatives to visit the proposed project site and identify specific problems as they relate to their respective missions. This project is expected to meet nine of the current Watershed Protection Master Plan Goals and Objectives. **Table 1** below identifies the objectives that will be met. The documents prepared for the MIPT process and comments from MIPT members are included in **Appendix C**.

Table 1. WPD Master Plan Objectives Being Met

FC4.	Provide mitigation for flood damage.
FC5.	Prevent the creation of future flood hazards to human life and property.
FC6.	Reduce the depth and frequency of localized flooding for buildings.
FC7.	Reduce the depth and frequency of localized flooding for yards.
FC8.	Reduce the danger of street flooding associated with old storm drains.
FC9.	Reduce standing water in public rights-of-way and drainage easements outside the 100-year floodplain.
WQ1.	In local creeks, achieve or exceed Good Environmental Integrity Index (EII) scores.
WQ2.	In urban creeks, restore baseflow quantity and quality to the maximum extent possible.
WQ3.	In non-urban creeks, preserve the existing baseflow quantity and quality to the maximum extent possible.
FC= Flood Control WQ= Water Quality	

4. EXISTING CONDITIONS

4.1 ONE-DIMENSIONAL STORM DRAIN ANALYSIS

The layout and sizing of the existing storm drain system was based on the available drainage infrastructure GIS (DIG) data for the project area supplemented by construction drawings where available. The system, referred to as the Meredith storm drain system (SDS), is about 750 feet long. The system consists of pipes ranging in diameter from 15inches through 18inches, and has four 5-foot inlets and one 10-foot inlet. The 10-ft inlet is connected directly to Austin Caverns at 3605 and 3607 Meredith St.(refer to **Figure 2**). Because the exact dimensions of Austin Caverns are unknown, the cave was modeled as a deep inlet (a 10-foot inlet with a depth of 25 feet). The inlet locations were confirmed during a July 2011 field survey.

Roads within the project area have curbs and gutters. Observations of the terrain show that when the cave is full, overflowing water travels in the southwesterly direction across the private properties at 3605, 3607 Meredith St. and 1813, 1815 Rockmoor Ave. to Rockmoor Ave., where it is captured partially by two 10-foot inlets that are part of the downstream storm drain system. The downstream system is aligned along Rockmoor Ave., and Cherry Ln., and discharges to Lake Austin at an outfall on the Darcy tract, a private property located at 1804 Rockmoor Ave. (see **Figure 3**). The excess flow appears to cross Rockmoor Ave., and travel to the natural ditch in the northeastern corner of the Darcy tract. The ditch conveys the excess flow Lake Austin.

Figure 3. Existing Storm Drain Systems in Project Area: Meredith SDS (upper) and Cherry SDS (lower), NTS

The downstream storm drain system, mentioned above, was modeled in StormCAD as well. The inlet locations and sizes were confirmed by field survey. The locations and elevations of the remainder of the existing system were based on the City's data records. Both the Meredith SDS (north) and the Cherry SDS (south) are shown in **Figure 4** with detailed descriptions and overflow water paths.

Figure 4. NW Storm Drain System, NTS

Additional information was obtained for the existing storm drain system, referred to as the NW SDS, located northwest of the Meredith St. project area. The system is partially located beneath buildings and aligned through private properties, meaning that future upgrades might involve

relocating the system to the street right–of–way. To resolve localized flood issues in the area, consideration was given to rerouting that system, and tying it to the proposed Meredith system along Rockmoor Ave. All three existing storm drain systems in the area are shown in **Figure 4**. Delineation of the total drainage area (approximately 45 AC) contributing to the three storm drain systems described above was done in ArcGIS with ArcHydro Version 9 Tools. The delineation of total drainage area into subbasins was based on inlet locations and topographic relief. The total drainage area was subdivided into 22 subbasins, as shown in **Figure 5**.

The distribution of total drainage area by the storm drain system is estimated to be:

Meredith SDS = 17 AC

NW SDS= 10.1 AC

Cherry SDS = 17.9 AC

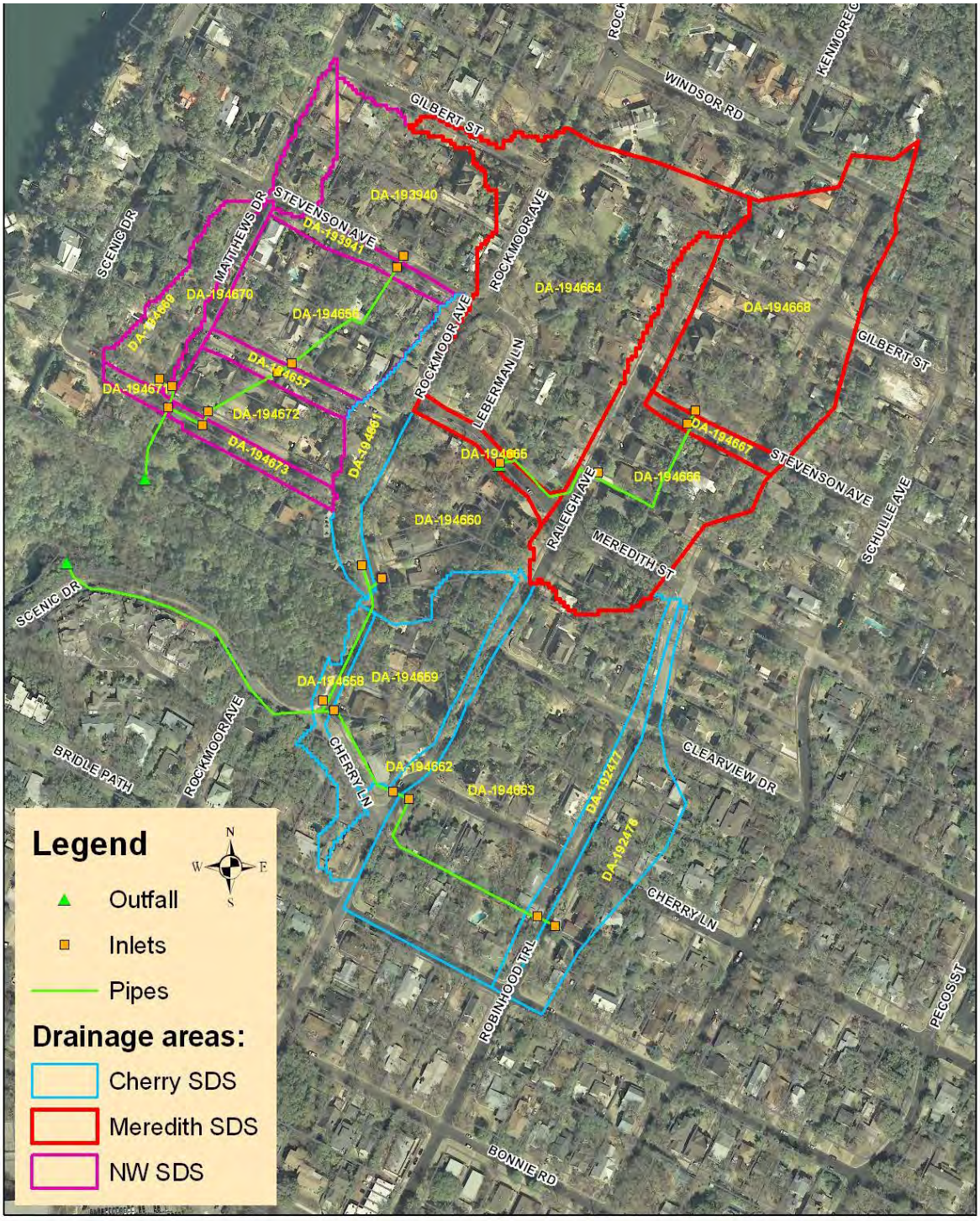


Figure 5. Existing Subbasins, NTS

The Rational Method, as described in the City of Austin's Drainage Criteria Manual (DCM), was used for rainfall-runoff computations in the project area. The Rational Method computes flow through the application of the following equation:

Q = CiA, where

Q = Peak rate of runoff, measured in cubic feet per second (cfs),

C = Runoff coefficient,

i = Average intensity of rainfall in inches per hour,

A = Contributing drainage area to the point of design, measured in acres (AC).

The parameters used in the Rational Method calculations were derived as described in the following subsections.

Runoff coefficients (C) for subbasins were calculated in an Excel spreadsheet based on the existing conditions and impervious cover layers such as Concrete and Asphalt shapefiles in ArcGIS, and formulas defined in the DCM.

Runoff coefficients used in the analysis are summarized in **Table 2**.

Table 2. Runoff coefficients

Design Storm	C average	C min	C max
2-year	0.54	0.47	0.62
10-year	0.6	0.53	0.69
25-year	0.64	0.57	0.73
100-year	0.72	0.65	0.82

Times of Concentration (Tc) flow paths were delineated in ArcMap, and subbasin times of concentration were calculated in an Excel spreadsheet. Sheet flow, where applicable, was assumed to be no longer than 100 feet. For subbasins with a calculated Tc value of less than 5 minutes, the minimum value of 5 minutes specified by the DCM was used.

The minimum Tc of 5 minutes was used for 20 out of 22 subbasins. The maximum calculated Tc was 6.1 minutes for subbasin 194663.. The Tc value for subbasin 194664 was calculated to be 5.6 minutes.

Rainfall Intensity – The rainfall intensities for the analyzed events were calculated in StormCAD using the Austin intensity-duration-frequency (IDF) curve equation. The rainfall intensities for the predominant 5-minute time of concentration are listed below.

2-year storm – 5.76 in/h

10-year storm – 8.57 in/h

25-year storm – 10.1 in/h

100-year storm – 12.5 in/h

Storm Drain System Modeling – The existing-condition storm drainage systems were modeled in StormCAD V8i. The performance of the system was analyzed for the 2-, 10-, 25- and 100-year storm events. Because the extent of clogging was unknown at the time of model development, clogging of the inlet at 3605-3607 Meredith was not accounted for in the one-dimensional analysis.

The tailwater elevations for the Meredith SDS and the NW SDS were assumed to coincide with the pipe crown elevations at the system outfall. For the Cherry SDS which discharges to Lake Austin, the tailwater elevation was set equal to the surface elevation of the lake corresponding to the storm event used in the analysis of the storm drain system. Water surface elevations for the lake are based on studies produced by Halff & Associates in 2005 for the lower Colorado River Authority (LCRA).

The StormCAD results show that the existing storm drain system components are generally undersized. Model runs for the specified design events produced the peak flow rates summarized in **Table 4**.

Table 3. Peak Flows

	Peak Flow Rates at Primary Outfall (cfs)		
Design Storm	Meredith SDS	NW SDS	Cherry SDS
2-year	50.91	29.11	168.37
10-year	87.26	47.47	201.80
25-year	109.87	57.89	223.10
100-year	154.31	77.01	265.88

However, being undersized in general, these three systems currently provide varying levels of service. According to the modeling results, the NW SDS appears to be in compliance with the DCM for the 2-year storm, and can handle the 10-year storm with some inlet ponding and the 25-year storm with inlet ponding and possible flooding of the vacant lot at Kennelwood Dr. The 100-year storm is the biggest issue for this system. The existing condition hydraulic grade lines (HGL) for the NW SDS are shown in **Figures 6** through **9.**

Figure 6. NW Storm Drain System Main Trunk, 2-year storm profile

Figure 7. NW Storm Drain System Main Trunk, 10-year storm profile

Figure 8. NW Storm Drain System Main Trunk, 25-year storm profile

Figure 9. NW Storm Drain System Main Trunk, 100-year storm profile

The Cherry SDS is undersized for all four storm events, starting from the intersection with Rockmoor Ave., where the Rockmoor Ave.laterals intersect the trunk. The system continues to be undersized from this point to the system outfall. Even though the undersized system results in

excess flow in the street, the runoff flows naturally down Cherry Ln. to Lake Austin, causing no issues for the private properties. However, fthe excess flow in the street could cause a traffic hazard on Cherry Ln. The existing condition HGL for the Cherry SDS are shown in **Figures 10** through **13**.

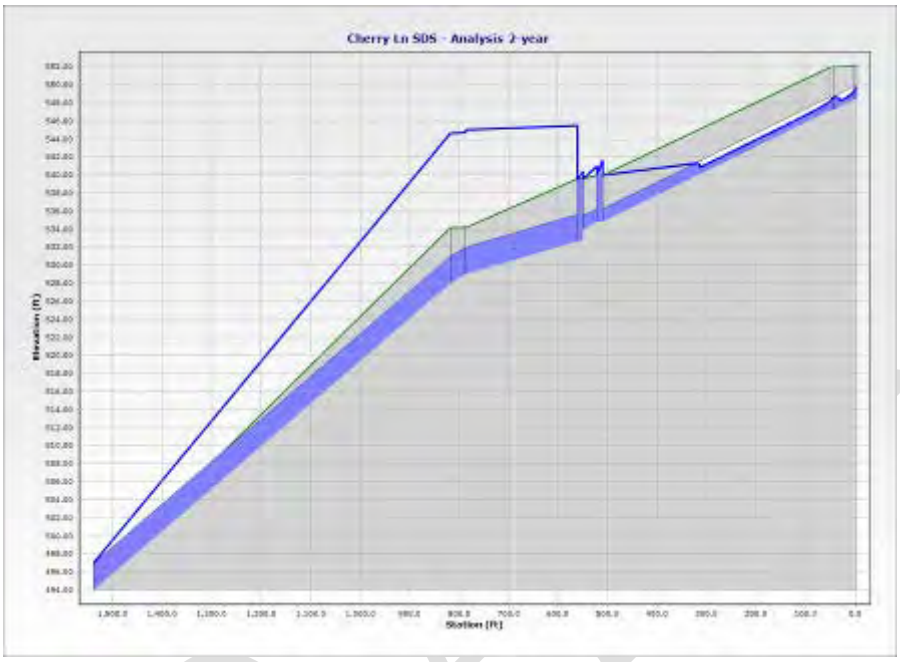


Figure 10. Cherry Storm Drain System Main Trunk, 2-year storm profile

Figure 11. Cherry Storm Drain System Main Trunk, 10-year storm profile

Figure 12. Cherry Storm Drain System Main Trunk, 25-year storm profile

Figure 13. Cherry Storm Drain System Main Trunk, 100-year storm profile

The Meredith SDS is undersized. StormCAD analysis shows flooding issues for all four storm events. The need for improvements to this storm drain system is the driving factor behind this preliminary engineering study. The existing condition hydraulic grade lines for the Meredith

SDS are shown in **Figures 14** through **17**. Starting with the 10-yr event, the inlet cannot pass the incoming flows, resulting in an HGL well above the ground surface. This causes flooding of the properties immediately downstream of the cave (refer to **Figures 14 - 17**). The analysis assumes that the flows are contained within the storm drain system, i.e., the manhole covers are bolted shut and flow does not escape at the downstream inlets.

Escalating flooding issues and numerous flooding complaints at the Meredith SDS service area, together with hydrologic/hydraulic analysis, confirm that this system is significantly undersized, has poor outlet conditions, and requires improvements.

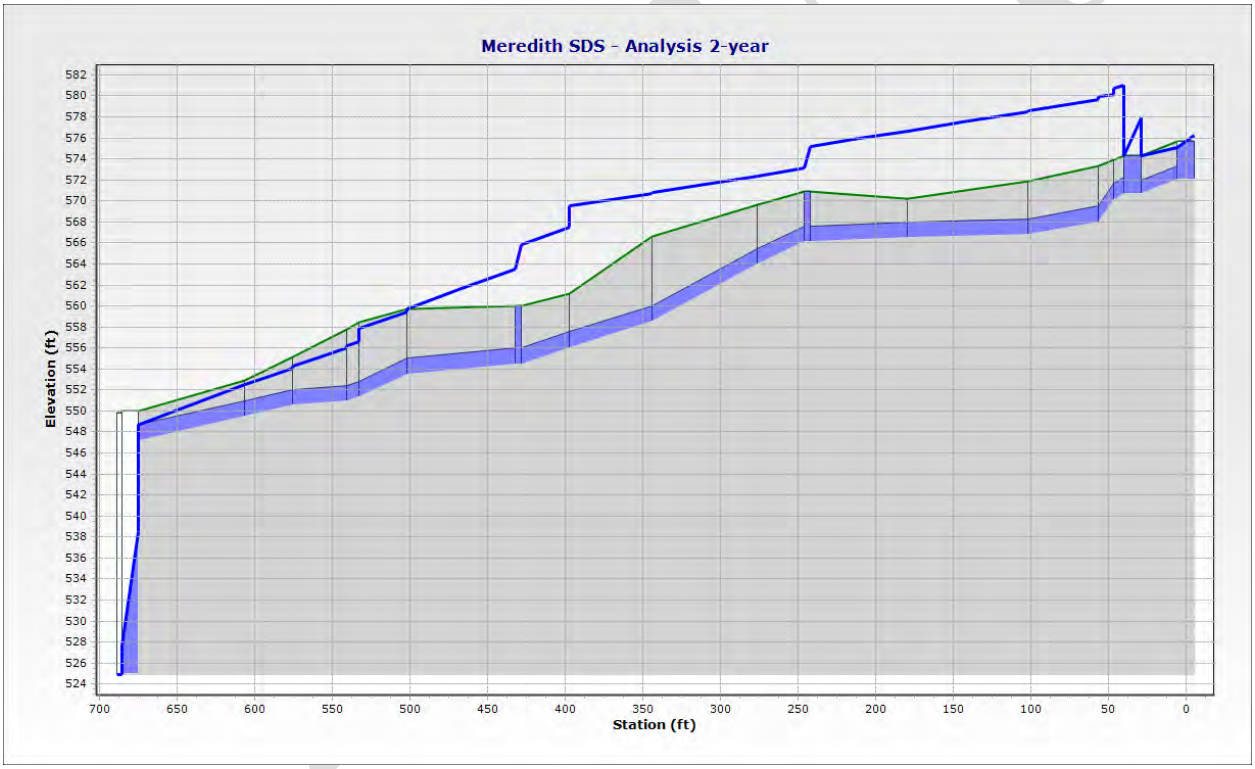


Figure 14. Meredith Storm Drain System Main Trunk, 2-year storm profile

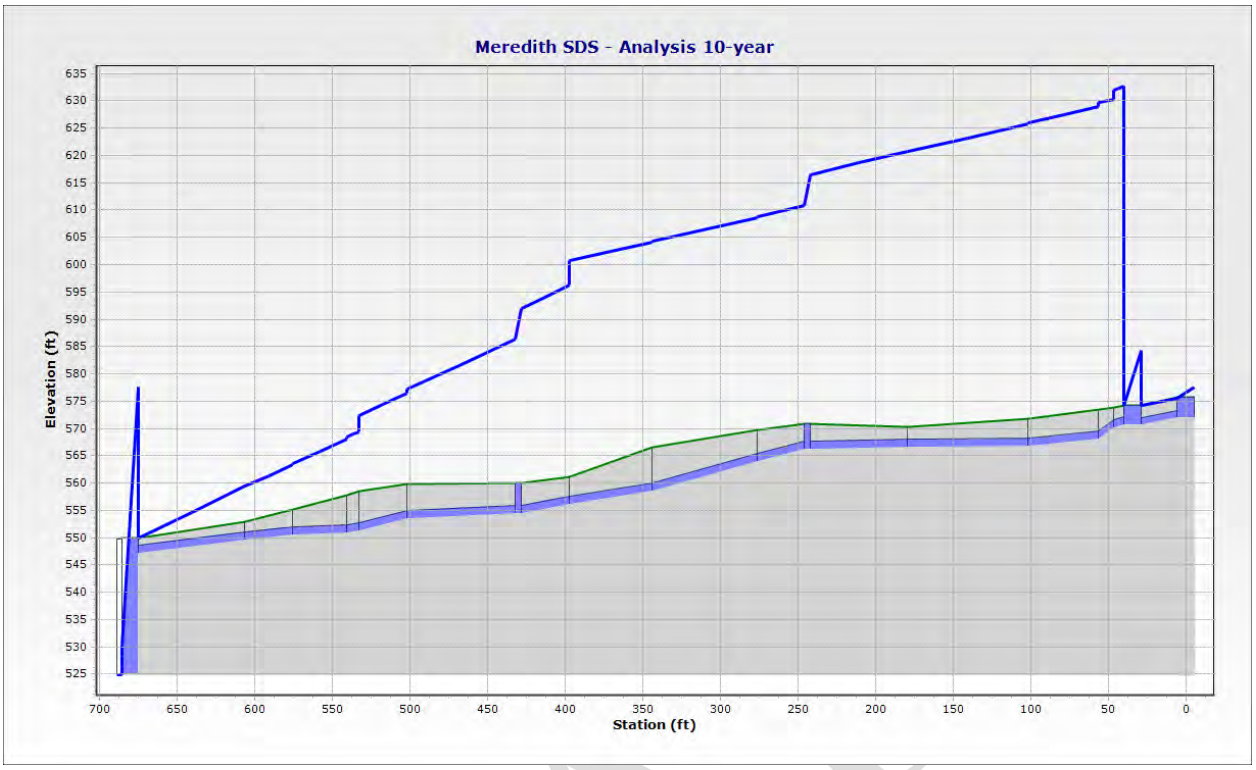


Figure 15. Meredith Storm Drain System Main Trunk, 10-year storm profile

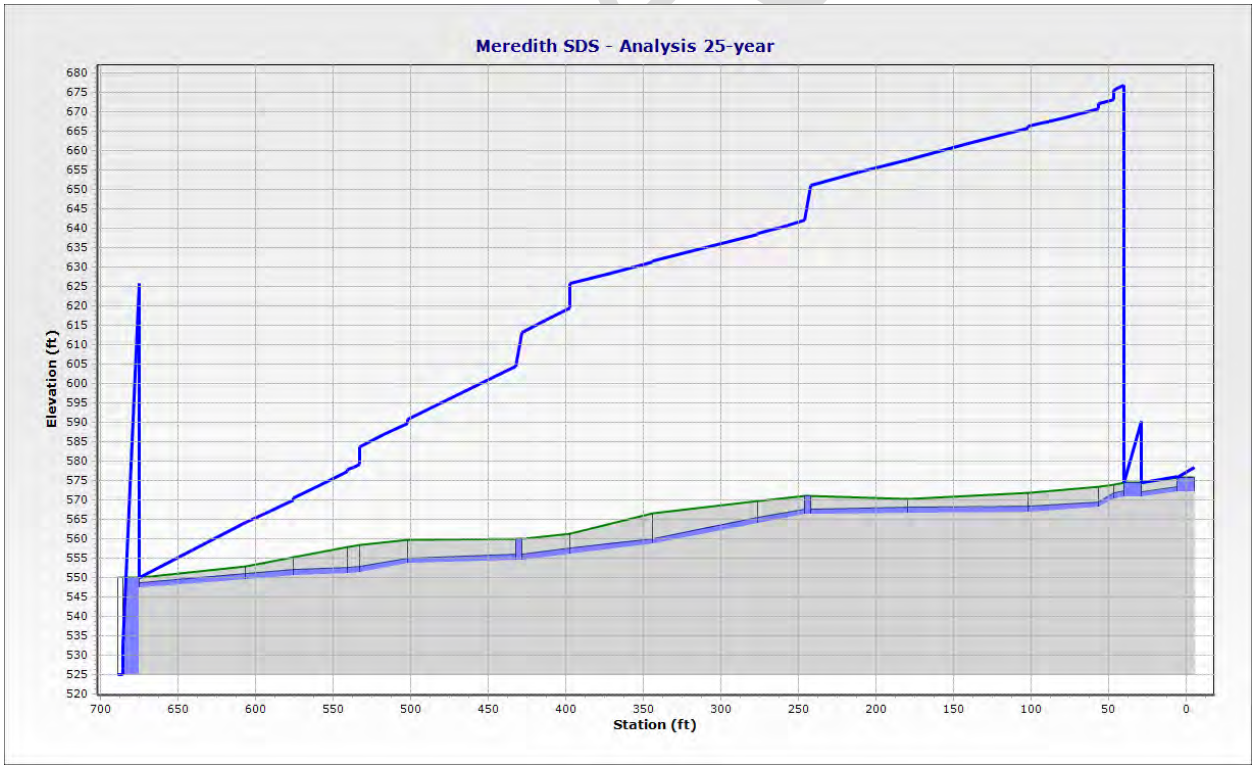


Figure 16. Meredith Storm Drain System Main Trunk, 25-year storm profile

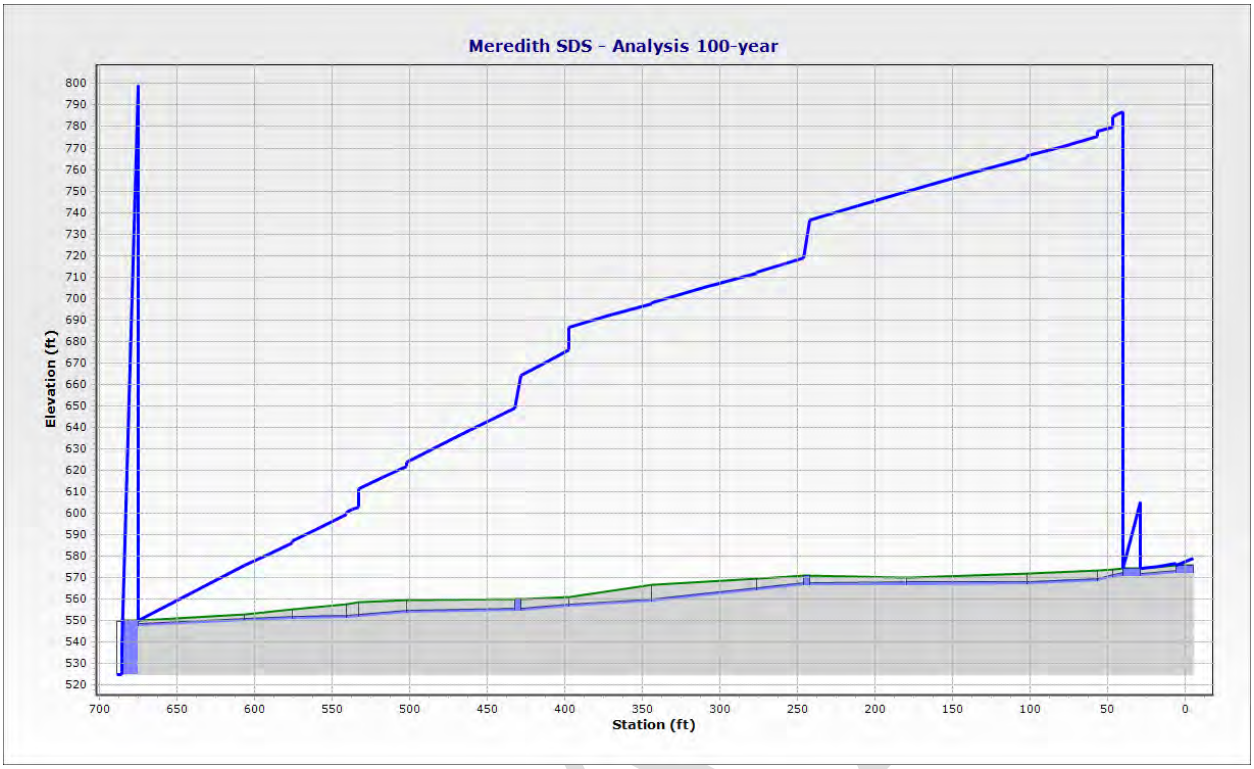


Figure 17. Meredith Storm Drain System Main Trunk, 100-year storm profile

4.2 TWO-DIMENSIONAL ANALYSIS

The existing conditions were analyzed in InfoWorks SD 11.5 to provide a better understanding of the extent of flooding and to identify the pathways taken by the system overflow. 24-hour rainfall distributions were used to model 2-, 10-, 25 and 100-year storms. Floodwater depths during each storm event were estimated using the model results. The results support the observed flood conditions downstream of the cave entrance. The following results were obtained through InfoWorks modeling of the existing system with a clogged inlet at 3605 and 3607 Meredith St.:

100-year storm: 9 houses are flooded with a maximum flood depth of 1.1 feet in the houses

25-year storm: 6 houses are flooded with a maximum flood depth of 0.99 feet in the houses

10-year storm: 3 houses are flooded with a maximum flood depth of 0.84 feet in the houses

2-year storm: 2 houses are flooded with a maximum flood depth of 0.572 feet in the houses

Two-dimensional depth distributions of flood for 2- and 25- year storms are shown in **Figures 1**8 and **19**.

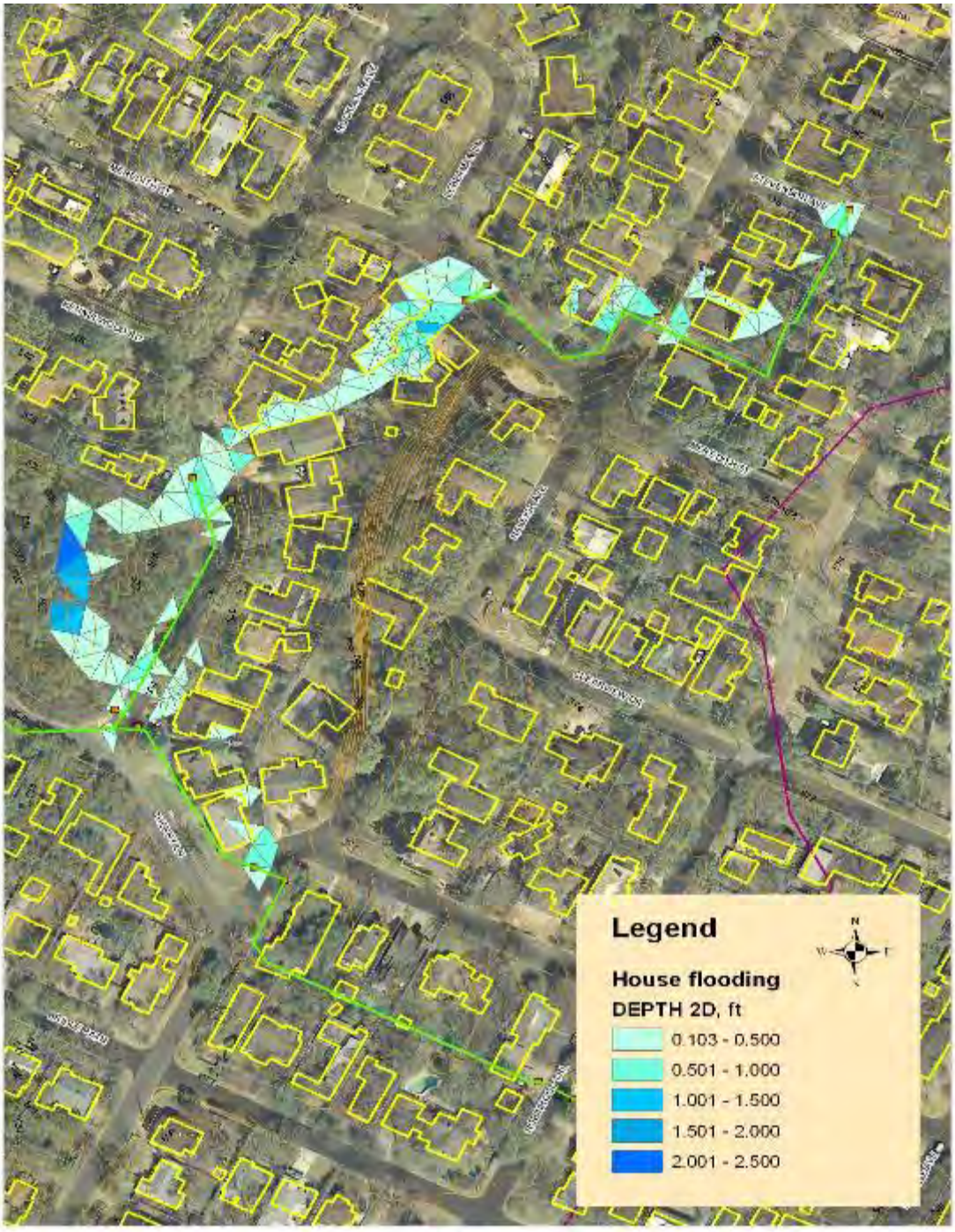


Figure 18. Meredith SDS 2-year Storm Flood, NTS

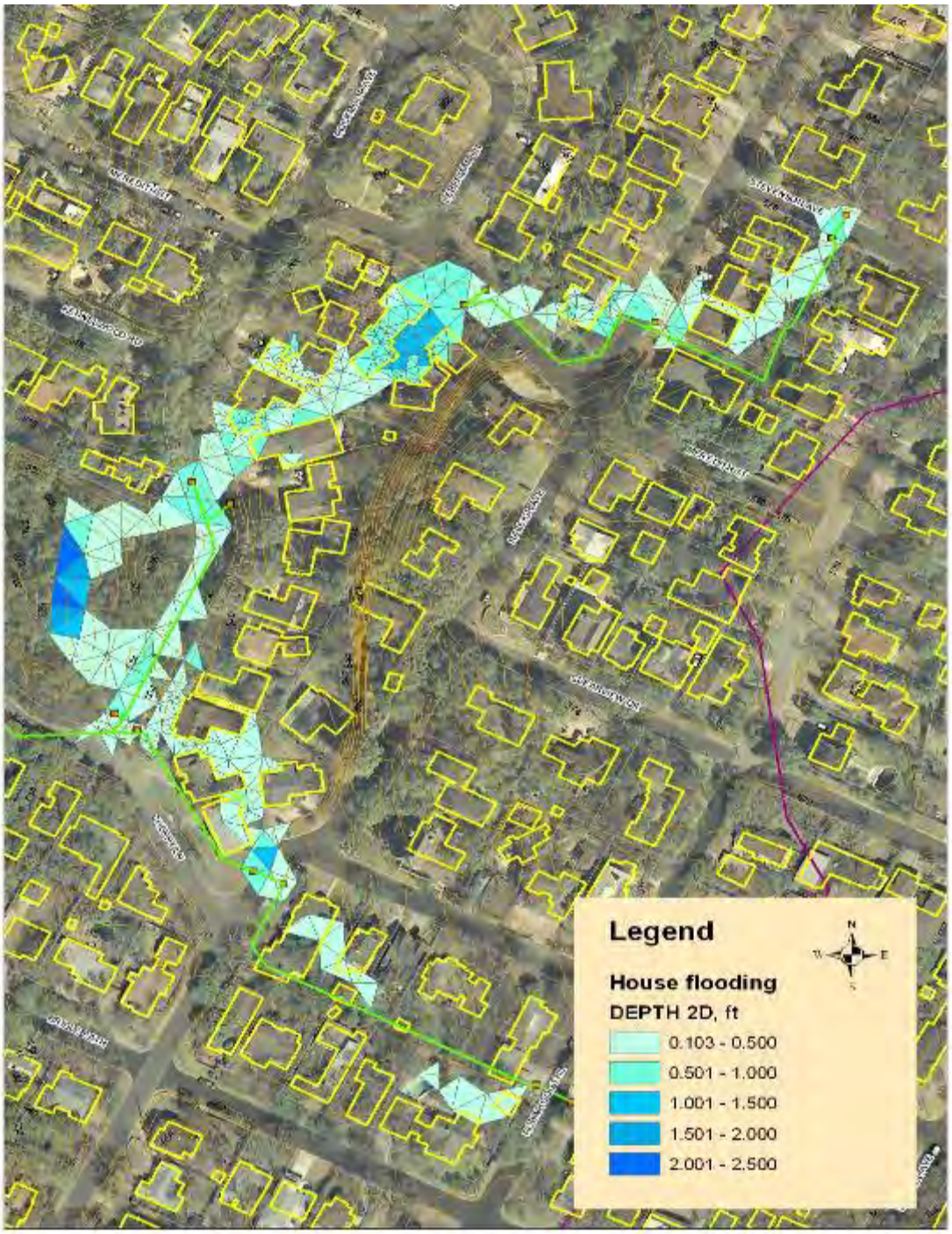


Figure 19. Meredith SDS 25-year storm flood, NTS

Based on the analysis of the existing storm drain systems in the area, the following conclusions are made:

- The analyzed existing storm drain systems do not meet current DCM requirements.

- Even though the Cherry SDS and the NW SDS do not comply with the current DCM requirements, the undersized systems do not cause major flooding issues. With the limited funding and numerous flooding issues in the City of Austin area, upgrades to these two systems will likely be delayed while other systems having a higher priority are improved.
- The InfoWorks model depicts the clogging of the inlet on Meredith based on recent field investigations and shows that the existing Meredith SDS has less than a 2-year level of service. This is less than the level of service indicated by the one-dimensional model, largely due to the differences in clogging assumed for the two methods. Based on the two-dimensional model results, house flooding and extensive yard flooding will occur during the 2-year storm event. The InfoWorks results showed flooding of 3605 and 3607 Meredith St. and extensive flooding of the 1800 block of Rockmoor Ave. The necessity of solving flooding issues for this area has become a priority of the LFHM group.
- The feasibility of tying the NW SDS and/or the Cherry SDS to an upgraded Meredith SDS neds to be further evaluated.

5. CONCEPTUAL ALTERNATIVES ANALYSIS

The StormCAD and InfoWorks storm drain analyses confirm that the capacity of the existing storm drain system at Meredith St. is inadequate and illustrates the need to upgrade the system to prevent the recurrence of severe flooding. If feasible, the upgrades should bring the system into full compliance with DCM standards.

Project location, residential development and terrain presented challengesduring the alternative evaluation. Four alternatives are discussed in this report. However, a total of eleven alternatives were evaluated; theseare shown in **Appendix B**.

Alternative 1. This alternative includes the rerouting of a nearby NW storm drain system **(Figure 4)** to place that system within the street right-of-way so that it connects to the proposed Meredith SDS with the outfall located on 1804 Rockmoor Ave. (see **Figure 20**). Challenges to this alternative include deep construction and bucking of the grade at the Meredith-Rockmoor intersection, and numerous utility conflicts that would require resolution. Additional

improvements will be needed to stabilize erosion at the outfall, and an easement will need to be acquired to convey runoff from the outfall to Lake Austin. The estimated cost for this alternative is approximately $5,000,000.

Figure 20. Alternative 1

Alternative 2. This alternative focuses on immediate drainage issues without upgrading the upstream section of the Meredith SDS where no drainage complaints have been recorded. It includes a boring between the houses at 1815 and 1901 Rockmoor Ave. with alignment along Kennelwood Rd. and discharge at the outfall, located 1804 Rockmoor Ave**. (****refer to Figure 21**). Additional improvements will be needed to stabilize erosion at the outfall, and an easement will need to be acquired to convey runoff from the outfall to Lake Austin. This alternative includes multiple utility conflicts along Kennelwood Rd. that will need to be resolved. The estimated cost for this alternative is approximately $3,900,000.

Figure 21. Alternative 2

Alternative 3. This alternative focuses on immediate drainage issues without upgrading the upstream section of the Meredith SDS where no drainage complaints have been recorded. It includes a boring between the houses at 1813 and 1815 Rockmoor Ave. and involves upgrading the existing 36-inch discharging pipe to a 66-inch pipe from the intersection of Rockmoor Ave.

and Cherry Ln. all the way to the outfall at 1804 Rockmoor Ave. (refer to **Figure 22)**. This alternative would need to include some means of energy dissipation at the outfall that will prevent additional erosion of the soft-bottom substrate and banks of the lake. The estimated cost for this alternative is approximately $3,600,000.

Figure 22. Alternative 3

Alternative 4. This alternative includes the buyout of private properties at 3605 and 3607 Meredith St. and the construction of a detention pond at this location. The preliminary detention pond design followed DCM and Environmental Criteria Manual (ECM) standards. The

conceptual design is that of a concrete-walled detention pond with depth variation of 8.5 to 10 feet. This alternative requires the upgrade of the existing 36-inch discharging pipe to a 66-inch pipe all the way to the outfall on 1804 Rockmoor Ave. (refer to **Figure 23)**. The estimated cost for this alternative is approximately $5,000,000.

Figure 23. Alternative 4

After consultation with the City's hydrogeologist, a decision was made to conduct a geotechnical study of the project area to acquire additional information to be used in selecting a preferred alternative. The geotechnical firm Raba Kistner Consultants Inc. (RKCI) was chosen from the rotation list to perform the geotechnical study for the proposed project area. Work was performed from January through March of 2013. The Raba Kistner report can be found in **Appendix E.**

6. EXISTING UTILITIES

The project was presented at the Austin Utility Location and Coordination Committee (AULCC) meeting on September 8, 2011. Because the final proposed storm drain system route was not determined prior the meeting, the committee members were provided with a map showing only the project boundaries. (refer to **Figure 19**).

The Utility Coordination (UC) tracking number of the project was: **UCC-110908-05-01**. The parties attending the meeting and their responses are listed below:

1. **Austin Energy**

System map of utilities with a quick reference chart was provided with the following comments: *Joe McNair will be your contact for relocation and conflicts: (512) 505-7526 joe.mcnair@austinenergy.com. Both, Aerial on AE and AT&T poles, AE is located at the top, UG varies from 30" to 6' when installed. You will need to pothole for depths.*

2. **Austin Water Utility**

System maps and profiles were provided with the following comments: *Existing 12", 6" and 2" water and 8" and 6" wastewater lines are throughout these proposed sites. See system maps, intersections and profiles. Caution with crossing the existing water, wastewater lines, services, fire lines and manholes. For next review please show water and wastewater lines on your plan and if crossing the proposed storm sewer line then those water and wastewater lines need to show on profiles.* ***Please maintain the 5' horizontal and 2' vertical clearance.***

3. **ACWP (Austin Clean Water Program) –** clear
4. **GAATN** – clear
5. **Grande**

The data sheet was provided with following comments: *Aerial on AE & Att Poles top strand.*

6. ATT Texas

The schema of utility location was provided with the following comments: *Please call for locates before starting construction and pothole for depth at 512-870-4967.*

7. Signals – clear

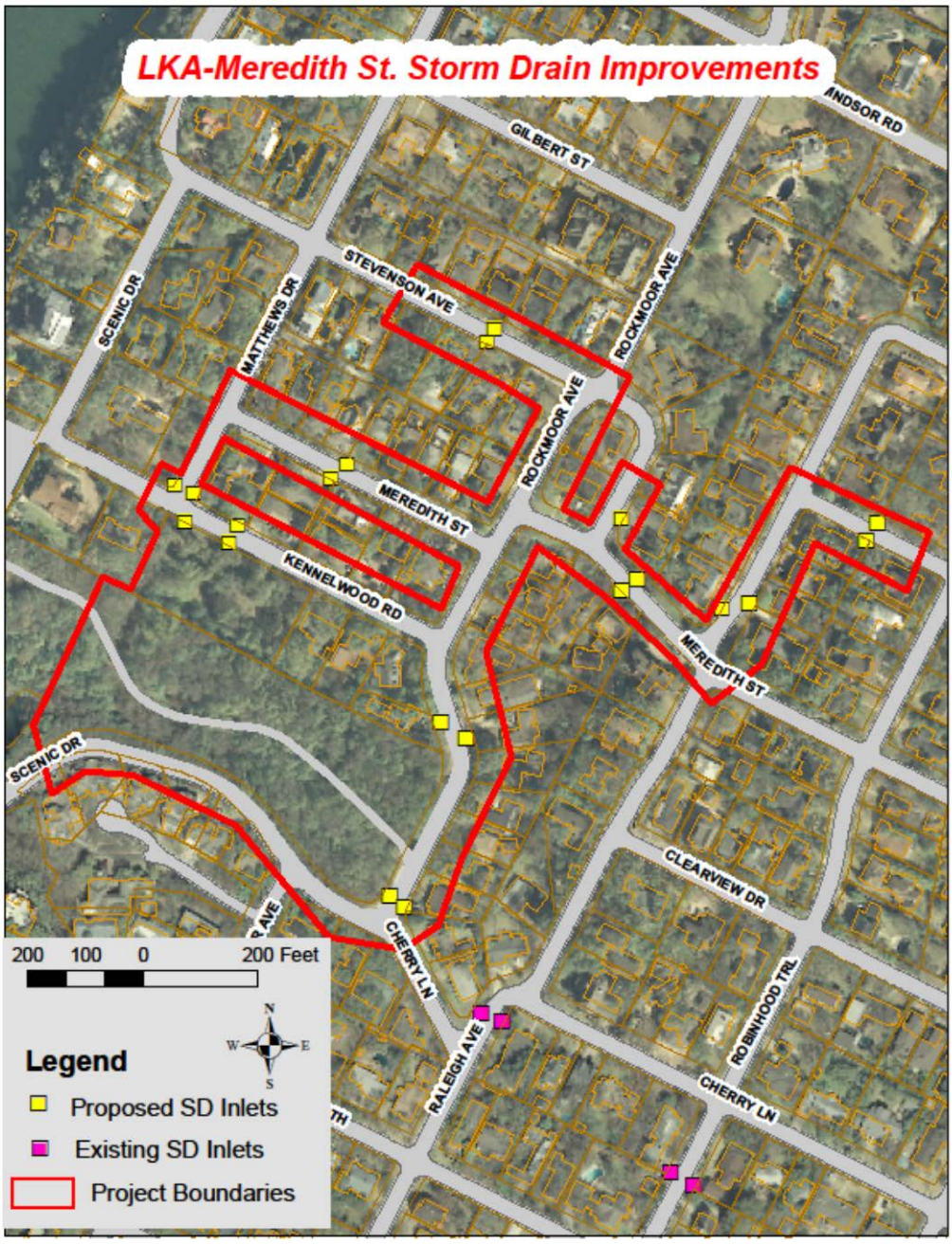


Figure 24. Project Boundaries Map, Provided to AULCC

8. **Street and Bridge Division**

The following comments were provided: *Meredith St. and Leberman Ln. are protected streets in the project area. Streets with trenches in excess of 300' will be treated as protected. Depending upon the actual location of proposed trenches, include the appropriate pavement restoration details for protected streets.*

9. **Tel West Network Services** – clear

10. **Texas Gas Service**

System maps were provided with the following comments: *Underground 18"-36" (typical) utilities in the area. The attached data is not intended as a substitute for the Texas OneCall System. Anyone, excavating anywhere in Texas must call 1-800-DIG-TESS before digging.*

11. **Time Warner Cable**

The data sheet and a map were provided with the following comments: *Aerial facilities on Austin Energy poles, no apparent conflict.*

12. **Verizon Business (MCI)** – clear

13. **Watershed Engineering Division –** in-house PER study.

14. **TW Telecom –** clear

15. **Bluebonnet Elec** – clear

16. **Austin Energy –CW (Chilled Water)** – clear

7. PROJECT SCHEDULE ANALYSIS

A preliminary project schedule has been prepared. The schedule is broken down at a level that is consistent with the standards set by City of Austin. Below are key elements of the schedule for this project:

1. Preliminary Phase – June 2010 to October 2013
2. Design Phase - October 2013 to December 2014
3. Bid/Award/Execution Phase – January 2015 to July 2015
4. Construction Phase – July 2015 to July 2017

5. Post Construction Phase – July 2017 to July 2018

A more detailed project schedule will be required during the design phase.

8. SUMMARY OF RESULTS

After careful review of the modeling results and consideration of the findings in the geotechnical and geophysical reports results, LFHM concluded the following:

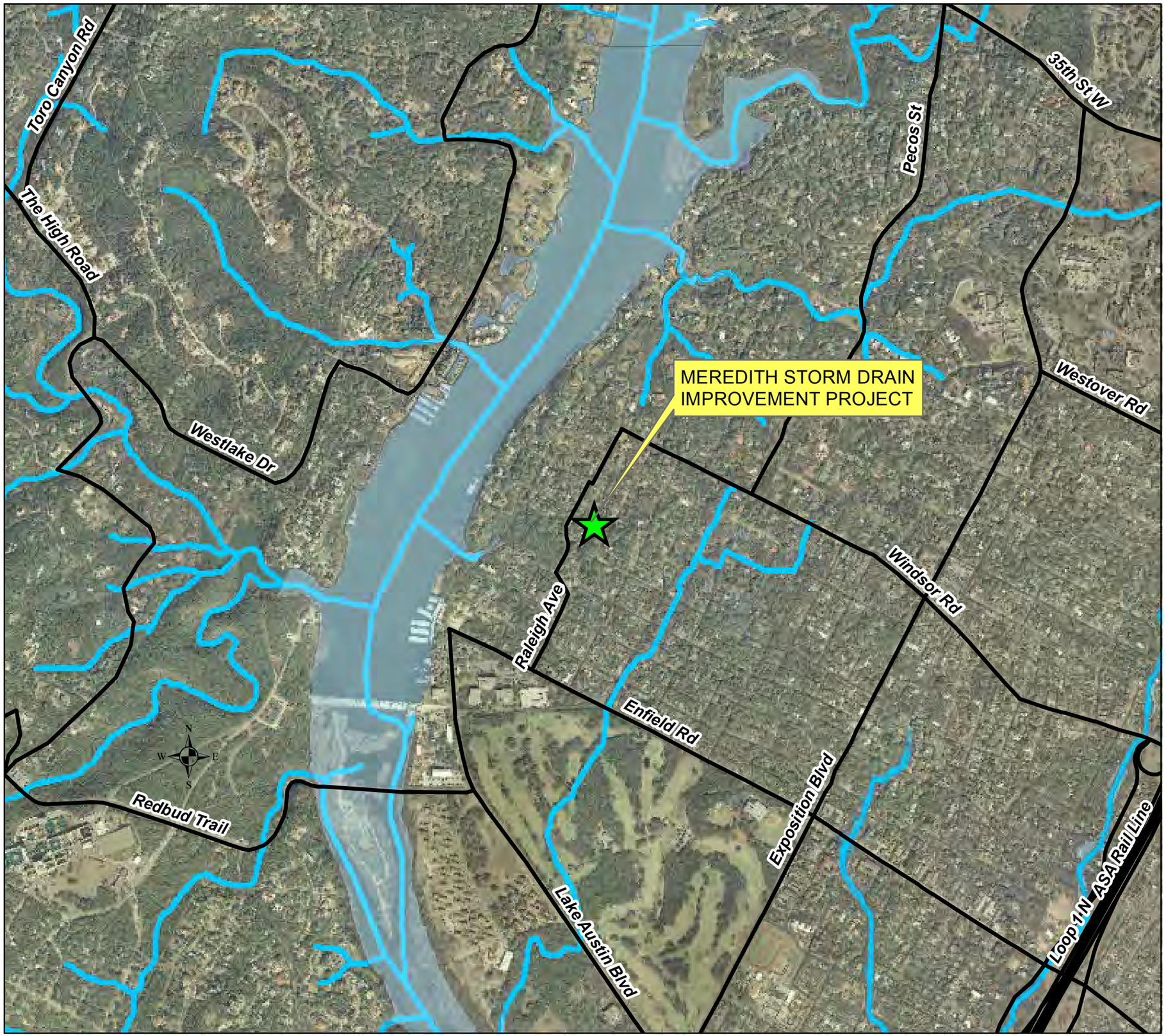
1. All considered alternatives will be susceptible to the presence of karst features in the vicinity of Meredith St. and the potential of encountering voids along the proposed alignments.
2. Alternative 3 (see **Figure 22)** is recommended as the preferred alternative. However, further evaluation by a geotechnical/design consultant is needed before proceeding with final design to know whether this alternative is feasible without undue risks during construction due to the karst features. This alternative includes boring between the houses at 1813 and 1815 Rockmoor Ave., and provides the benefit of following the natural terrain of the area. It allows construction through a fill area that is relatively homogeneous, and avoids deep construction against the grade. If funding is limited, the system upgrade in Rockmooor Ave. and Cherry Lane could be done as a second phase of construction.

MEREDITH STREET LOCALIZED FLOOD HAZARD MITIGATION PRELIMINARY ENGINEERING REPORT

APPENDIX A

PROJECT LOCATION MAP

City of Austin
Watershed Protection Department
Watershed Engineering Division



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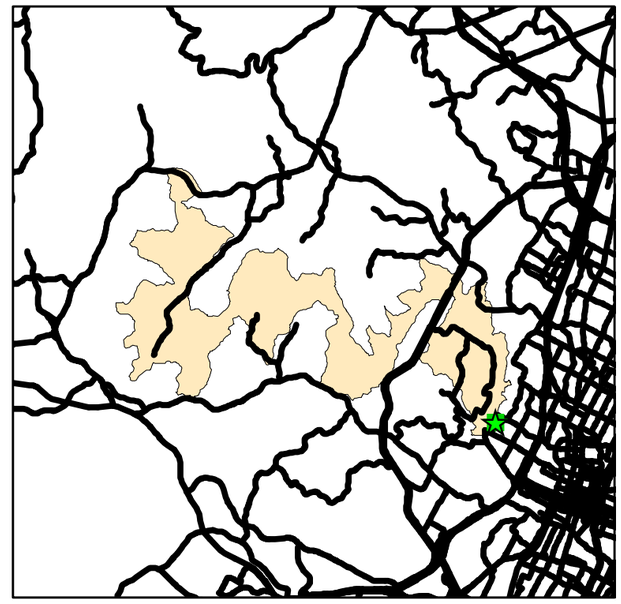
MEREDITH STREET
PROJECT LOCATION MAP



LAKE AUSTIN WATERSHED

1,000 500 0 1,000 Feet


ALTERNATIVE 1
WINDSOR RD
GILBERT ST
STEVENSON AVE
SCENIC DR
MATTHEWS DR
ROCKMOOR AVE
LEBERMAN LN
MEREDITH ST
KENNELWOOD RD
MEREDITH ST
CLEARVIEW DR
ROBINHOOD TRL
CHERRY LN
RALEIGH AVE
CHERRY LN
SCHULLE AVE
200 100 0 200 Feet
Legend
N
W
E
S
Proposed SD
Existing SD


ALTERNATIVE 2
Location of bore
STEVENSON AVE
SCENIC DR
MATTHEWS DR
ROCKMOOR AVE
MEREDITH ST
KENNELWOOD RD
LEBERMAN LN
CHERRY LN
RALEIGH AVE
CLEARVIEW DR
BRIDLE PATH
ROBINHOOD TRL
SCHULLE AVE
200 100 0 200 Feet
Legend
Proposed SD
Existing SD


ALTERNATIVE 3
SCENIC DR
MATTHEWS DR
STEVENSON AVE
ROCKMOOR
ROCKMOOR AVE
LEBERMAN LN
Location of bore
MEREDITH ST
KENNELWOOD RD
STEVENSON AVE
MEREDITH ST
SCENIC DR
CHERRY LN
RALEIGH AVE
CLEARVIEW DR
ROCKMOOR AVE
CHERRY LN
BRIDLE PATH
ROBINHOOD TRL
SCHULLE AVE
200 100 0 200 Feet
Legend
Proposed SD
Existing SD


ALTERNATIVE 4
GILBERT
SCENIC
MATTHEWS
STEVENSON
ROCKMOOR
MEREDITH
KENNELWOOD
LEEBERMAN
Pond
STEVENSON
RALEIGH
MEREDITH
SCENIC
CLEARVIEW
BRIDLE
ROCKMOOR
CHERRY
CHERRY
ROBINHOOD
SCHULLE
200 100 0 200 Feet
N
W
E
S
Legend
Proposed SD
Existing SD


ALTERNATIVE 5
GILBERT
SCENIC DR
MATTHEWS DR
STEVENSON AVE
ROCKMOOR AVE
MEREDITH ST
KENNELWOOD RD
LEBERMAN LN
MEREDITH ST
SCENIC DR
CLEARVIEW DR
BRIDLE PATH
ROCKMOOR AVE
CHERRY LN
RALEIGH AVE
CHERRY LN
ROBINHOOD TRL
SCHULLE AVE
200 100 0 200 Feet
N
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Legend
Proposed SD
Existing SD


ALTERNATIVE 6
GILBERT
SCENIC DR
MATTHEWS DR
STEVENSON AVE
ROCKMOOR AVE
MEREDITH ST
KENNELWOOD RD
LEBERMAN LN
SCENIC DR
CLEARVIEW DR
CHERRY LN
BRIDLE PATH
ROCKMOOR AVE
RALEIGH AVE
CHERRY LN
ROBINHOOD TRL
SCHULLE AVE
200 100 0 200 Feet
N
W
E
S
Legend
Proposed SD
Existing SD


ALTERNATIVE 7
GILBERT
SCENIC DR
MATTHEWS DR
STEVENSON AVE
ROCKMOOR AVE
MEREDITH ST
KENNELWOOD RD
LEBERMAN LN
SCENIC DR
CLEARVIEW DR
CHERRY LN
BRIDLE PATH
ROCKMOOR AVE
RALEIGH AVE
CHERRY LN
ROBINHOOD TRL
SCHULLE AVE
200 100 0 200 Feet
N
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S
Legend
Proposed SD
Existing SD


ALTERNATIVE 8
SCENIC DR
MATTHEWS DR
STEVENSON AVE
ROCKMOOR AVE
MEREDITH ST
KENNELWOOD RD
LEBERMAN LN
MEREDITH ST
SCENIC DR
CLEARVIEW DR
BRIDLE PATH
ROCKMOOR AVE
CHERRY LN
RALEIGH AVE
CHERRY LN
ROBINHOOD TRL
SCHULLE AVE
200 100 0 200 Feet
N
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Legend
Proposed SD
Existing SD


ALTERNATIVE 9
GILBERT
SCENIC DR
MATTHEWS DR
STEVENSON AVE
ROCKMOOR AVE
MEREDITH ST
KENNELWOOD RD
LEBERMAN LN
MEREDITH ST
SCENIC DR
CLEARVIEW DR
C HERRY LN
BRIDLE PATH
ROCKMOOR AVE
RALEIGH AVE
CHERRY LN
ROBINHOOD TRL
SCHULLE AVE
200 100 0 200 Feet
N
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Legend
Proposed SD
Existing SD


ALTERNATIVE 10
GILBERT
SCENIC DR
MATTHEWS DR
STEVENSON AVE
ROCKMOOR AVE
MEREDITH ST
KENNELWOOD RD
LEBERMAN LN
MEREDITH ST
SCENIC DR
CLEARVIEW DR
CHERRY LN
ROCKMOOR AVE
BRIDLE PATH
RALEIGH AVE
CHERRY LN
ROBINHOOD TRL
SCHULLE AVE
200 100 0 200 Feet
N
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Legend
Proposed SD
Existing SD


ALTERNATIVE 11
SCENIC
MATHEWS
STEVENSON
ROCKMOOR
MEREDITH
KENNELWOOD
LEBERMAN
STEVENSON
MEREDITH
SCENIC
RALEIGH
CLEARVIEW
BRIDLE
ROCKMOOR
CHERRY
CHERRY
ROBINHOOD
200 100 0 200 Feet
Legend
N
W
E
S
Proposed SD
Existing SD

MEREDITH STREET LOCALIZED FLOOD HAZARD MITIGATION PRELIMINARY ENGINEERING REPORT

APPENDIX B

ALTERNATIVES WITH COST ESTIMATES

City of Austin
Watershed Protection Department
Watershed Engineering Division

LFHM CIP Unit Prices for Conceptual Estimates

Description	Unit	Unit Price, $	Unit Price, $ *
18-inch pipe	L.F.	$ 200.00	$ 250.00
21-inch pipe	L.F.	$ 210.00	$ 260.00
24-inch pipe	L.F.	$ 225.00	$ 275.00
30-inch pipe	L.F.	$ 250.00	$ 300.00
36-inch pipe	L.F.	$ 300.00	$ 350.00
42-inch pipe	L.F.	$ 400.00	$ 450.00
48-inch pipe	L.F.	$ 525.00	$ 575.00
54-inch pipe	L.F.	$ 550.00	$ 600.00
60-inch pipe	L.F.	$ 600.00	$ 650.00
66-inch pipe	L.F.	$ 650.00	$ 700.00
72-inch pipe	L.F.	$ 700.00	$ 750.00
* Includes cost of structural fill and pavement replacement			
4' X 2'	L.F.	$ 450.00	
4' X 3'	L.F.	$ 525.00	
4' X 4'	L.F.	$ 600.00	
5' X 4'	L.F.	$ 700.00	
6' X 4'	L.F.	$ 800.00	
7' X 4'	L.F.	$ 1,000.00	
5' X 3'	L.F.	$ 600.00	
8'x5' cb	L.F.	$ 1,300.00	
outfalls			
18-inch pipe	EA		$ 25,000.00
24-inch pipe	EA		$ 27,500.00
30-inch pipe	EA		$ 30,000.00
36-inch pipe	EA		$ 35,000.00
42-inch pipe	EA		$ 45,000.00
48-inch pipe	EA		$ 57,500.00
54-inch pipe	EA		$ 60,000.00
60-inch pipe	EA		$ 65,000.00
66-inch pipe	EA		$ 70,000.00
72-inch pipe	EA		$ 75,000.00
Environmental	LS	50000	
Utility Relocation	LS	100000	
Mobilization	% of Base Constr.	10	
Overhead / Profit	% of Base Constr.	10	
Contingency	% of Base Constr.	100	
Eng. (Design & Constr.)	% of Total Constr.	20	
Construction Inspection	% of Total Constr.	10	
City Project Management	% of Total Constr.	5	
Land Acquisition			

CITY OF AUSTIN
WATERSHED PROTECTION AND DEVELOPMENT
West Boldin Creek - Leaning Oak Storm Drain Imrovem
Conceptual Cost Analysis

Item	Description		Quantity	Unit		Unit Price
Storm Drain Improvements						
	Storm Drain					
	Pipes:	18-inch	350	feet	$	250.00
		24-inch	847	feet	$	275.00
		30-inch	409	feet	$	300.00
		36-inch	251	feet	$	350.00
		42-inch	0	feet	$	450.00
		48-inch	895	feet	$	575.00
		54-inch	40	feet	$	600.00
	boxes			feet	$	450.00
		7'x3'	186	feet	$	800.00
		Total Ler	**2978**			
	Inlets:	10-foot Standard Inl	13		$	5,300.00
		15-foot Standard Inl	0		$	7,300.00
		20-foot Standard Inl	3		$	10,600.00
	Manholes	48"	8		$	5,000.00
		60"			$	6,000.00
		72"	5		$	7,000.00
		84"	2		$	10,000.00
		8x5.5	1		$	10,000.00
	Outfall	7'X3'	1		$	100,000.00
MISCELLANEOUS						
	Traffic Control		13	months	$	10,000.00
	Environmental		1	LS	$	50,000.00
	Utility Adjustments		14	LS	$	100,000.00
	SUBTOTAL					
	Mobilization and Demobilizati		10	%	$	3,104,100.00
	Overhead and Profit		10	%	$	3,104,100.00

OPINION OF PROBABLE CONSTRUCTION COST:

Engineering (Design and Const	10	%	$	3,724,920.00
Construction Inspection	10	%	$	3,724,920.00
City Project Management	5	%	$	3,724,920.00
Land Acquisition				

OPINION OF PROBABLE TOTAL PROJECT COST:

REVIEW
ıents Project

	Total
$	87,500.00
$	232,925.00
$	122,700.00
$	87,850.00
$	-
$	514,625.00
$	24,000.00
$	-
$	148,800.00
$	68,900.00
$	-
$	31,800.00
$	40,000.00
$	-
$	35,000.00
$	20,000.00
$	10,000.00
$	100,000.00
$	130,000.00
$	50,000.00
$	1,400,000.00
$	**3,104,100.00**
$	310,410.00
$	310,410.00

$	**3,724,920.00**
$	372,492.00
$	372,492.00
$	186,246.00
$	341,000.00
$	**4,997,150.00**

CITY OF AUST
WATERSHED PROTECTION AND D

Conceptual Cost Ar

Item	Description			Quantity
Storm Drain Improvements				
	Storm Drain			
	Pipes:	18-inch		**0**
		24-inch		**31**
		30-inch		**24**
		36-inch		**21**
		42-inch		**0**
		48-inch	conventional	**880**
		48-inch	JACKING OR BORING STEEL ENCASEMENT PIPE FOR 48 IN. RCP	**180**
		48-inch	PIPE, 48-IN. RCP INSTALLED IN STEEL ENCASEMENT	**180**
		66-inch		
			Total Length:	**1136**
	Inlets:	10-foot Standard Inlet		4
		15-foot Standard Inlet		1
		20-foot Standard Inlet		0
	Manholes	48"		0
		60"		2
		72"		0
		84"		1
	Outfall	48" pipe		1
MISCELLANEOUS				
	Traffic Control			12
	Environmental			10
	Utility Adjustments			8
	SUBTOTAL			
	Mobilization and Demobilization			10
	Overhead and Profit			10
OPINION OF PROBABLE CONSTRUCTION COST:				

Engineering (Design and Construction Phase)	10
Construction Inspection	10
City Project Management	5
Land Acquisition	

OPINION OF PROBABLE TOTAL PROJECT COST:

'IN
EVELOPMENT REVIEW

nalysis

Unit		Unit Price		Total
feet	$	250.00	$	-
feet	$	275.00	$	8,525.00
feet	$	300.00	$	7,200.00
feet	$	350.00	$	7,350.00
feet	$	450.00	$	-
feet	$	575.00	$	506,000.00
	$	1,100.00	$	198,000.00
feet				
	$	250.00	$	45,000.00
feet				
feet	$	700.00	$	-
	$	5,300.00	$	21,200.00
	$	7,300.00	$	7,300.00
	$	10,600.00	$	-
	$	5,000.00	$	-
	$	6,000.00	$	12,000.00
	$	7,000.00	$	-
	$	10,000.00	$	10,000.00
	$	57,500.00	$	57,500.00
months	$	10,000.00	$	120,000.00
LS	$	50,000.00	$	500,000.00
LS	$	100,000.00	$	800,000.00
			$	**2,300,075.00**
%	$	2,300,075.00	$	230,007.50
%	$	2,300,075.00	$	230,007.50
			$	**2,760,090.00**

%	$	2,760,090.00	$	276,009.00
%	$	2,760,090.00	$	276,009.00
%	$	2,760,090.00	$	138,004.50
			$	419,000.00
			$	**3,869,112.50**

CITY OF AUSTIN
WATERSHED PROTECTION AND DEVEL

Conceptual Cost Analysis

Item	Description			Quantity	Unit
Storm Drain Improvements					
	Storm Drain				
	Pipes:	18-inch		**0**	feet
		24-inch		**43**	feet
		30-inch		**25**	feet
		36-inch		**144**	feet
		42-inch		**0**	feet
		48-inch	conventional	**266**	feet
		48-inch	JACKING OR BORING STEEL ENCASEMENT PIPE FOR 48 IN. RCP	**165**	feet
		48-inch	PIPE, 48-IN. RCP INSTALLED IN STEEL ENCASEMENT	**165**	feet
		60-inch		**280**	feet
		66-inch		**724**	feet
			Total Lengt	**1647**	
	Inlets:	10-foot Standard Inlet		5	
		15-foot Standard Inlet		1	
		20-foot Standard Inlet		0	
	Manholes	60"		4	
		72"		2	
		84"		4	
	Outfall	66"-outfall		1	
MISCELLANEOUS					
	Traffic Control			18	months
	Environmental			1	LS
	Utility Adjustments			8	LS
	SUBTOTAL				

Mobilization and Demobilization	10	%
Overhead and Profit	10	%

OPINION OF PROBABLE CONSTRUCTION COST:

Engineering (Design and Constructio	10	%
Construction Inspection	10	%
City Project Management	5	%
Land Acquisition		

OPINION OF PROBABLE TOTAL PROJECT COST:

OPMENT REVIEW

s

	Unit Price		Total	
$	250.00	$	-	
$	275.00	$	11,825.00	
$	300.00	$	7,500.00	
$	350.00	$	50,400.00	
$	450.00	$	-	
$	575.00	$	152,950.00	Total boring
$	1,100.00	$	181,500.00	
$	250.00	$	41,250.00	$ 222,750.00
$	650.00	$	182,000.00	
$	700.00	$	506,800.00	
$	5,300.00	$	26,500.00	
$	7,300.00	$	7,300.00	
$	10,600.00	$	-	
$	6,000.00	$	24,000.00	
$	7,000.00	$	14,000.00	
$	10,000.00	$	40,000.00	
$	70,000.00	$	70,000.00	
$	10,000.00	$	180,000.00	
$	50,000.00	$	50,000.00	
$	100,000.00	$	800,000.00	
		$	**2,346,025.00**	

$	2,346,025.00	$	234,602.50
$	2,346,025.00	$	234,602.50

	$	**2,815,230.00**

$	2,815,230.00	$	281,523.00
$	2,815,230.00	$	281,523.00
$	2,815,230.00	$	140,761.50
		$	78,000.00

	$	**3,597,037.50**

Adress	Prop IDs	cost 2011
3607 Meredith	541241;541242	$351,960.00
3605 Meredith Aand B	117233;715545	$399,274.00
1901 Rockmoor Ave	117225	$390,436.00
1813 Rockmoor Ave	117223	$459,829.00
1815 Rockmoor Ave	117224	$572,191.00
		$2,173,690.00

Short version

3607 Meredith	541241;541242	$351,960.00
3605 Meredith Aand B	117233;715545	$399,274.00
1813 Rockmoor Ave	117223	$459,829.00
		$1,211,063.00

414-C	208	CY
110S-B	3636	CY
Buyouts, relocation, Real estate fees		
Boring between the houses		
SD upgrade	60-inch	**400**
	66-inch	**750**
Inlets:	10-foot Standard Inlet	
	15-foot Standard Inlet	
	20-foot Standard Inlet	
Manholes	60"	
	72"	
Outfall	66	**1**
Traffic Control	7.7	months
Environmental		
Utility Adjustments	2	$100,000
SUBTOTAL:		
Mobilization and Demobilization	10%	
Overhead and Profit	10%	
OPINION OF PROBABLE CONSTRUCTION COST:		
Engineering (Design and Construction Phase)	10%	
Construction Inspection	10%	
City Project Management	5%	

OPINION OF PROBABLE TOTAL PROJECT COST:

as on 2013

$	431,147.00

$	352,082.00
$	431,147.00
$	478,869.00
$	1,262,098.00

			$	600.00	$ 124,800.00	
STREET			$	40.00	$ 145,440.00	
					$ 1,566,458.00	
					$ 222,750.00	the same as Alt-3
feet			$	650.00	$ 260,000.00	
feet			$	700.00	$ 525,000.00	
	4		$	5,300.00	$ 21,200.00	
	1		$	7,300.00	$ 7,300.00	
	1		$	10,600.00	$ 10,600.00	
	4			6000	$ 24,000.00	
	2			7000	$ 14,000.00	
			$	70,000.00	$ 70,000.00	
$	10,000.00				$ 77,000.00	
					$ 50,000.00	
	2			LS	$ 200,000.00	
					$ 3,318,548.00	
					$ 331,854.80	
					$ 331,854.80	
					$ 3,982,257.60	
					$ 398,225.76	
					$ 398,225.76	
					$ 199,112.88	

$ 4,977,822.00

CITY OF AUSTIN
WATERSHED PROTECTION AND DEVELOPMENT REVIEW
West Boldin Creek - Leaning Oak Storm Drain Imrovements Project
Conceptual Cost Analysis

Item	Description		Quantity	Unit		Unit Price		Total
Storm Drain Improvements								
	Storm Drain							
	Pipes:	18-inch	223	feet	$	250.00	$	55,750.00
		24-inch	50	feet	$	275.00	$	13,750.00
		30-inch	372	feet	$	300.00	$	111,600.00
		36-inch	308	feet	$	350.00	$	107,800.00
		42-inch	33	feet	$	450.00	$	14,850.00
		48-inch	717	feet	$	575.00	$	412,275.00
		54-inch	290	feet	$	600.00	$	174,000.00
		60-inch	708	feet	$	650.00	$	460,200.00
		Total Length:	**2701**					
	Inlets:	10-foot Standard Inlet	7		$	5,300.00	$	37,100.00
	Manholes	48"	4		$	5,000.00	$	20,000.00
		60"	4		$	6,000.00	$	24,000.00
		72"	6		$	7,000.00	$	42,000.00
	Outfall	60" pipe	1		$	65,000.00	$	65,000.00
MISCELLANEOUS								
	Traffic Control		11	months	$	10,000.00	$	110,000.00
	Environmental		1	LS	$	50,000.00	$	50,000.00
	Utility Adjustments		1	LS	$	100,000.00	$	100,000.00
	SUBTOTAL						**$**	**1,798,325.00**
	Mobilization and Demobilization		10	%	$	1,798,325.00	$	179,832.50
	Overhead and Profit		10	%	$	1,798,325.00	$	179,832.50
OPINION OF PROBABLE CONSTRUCTION COST:							**$**	**2,157,990.00**
	Engineering (Design and Construction Phase)		10	%	$	2,157,990.00	$	215,799.00
	Construction Inspection		10	%	$	2,157,990.00	$	215,799.00
	City Project Management		5	%	$	2,157,990.00	$	107,899.50
	Land Acquisition						$	48,000.00
OPINION OF PROBABLE TOTAL PROJECT COST:							**$**	**2,745,487.50**

CITY OF AUST
WATERSHED PROTECTION AND DE
West Boldin Creek - Leaning Oak Storm
Conceptual Cost An

Item	Description		Quantity	Unit
Storm Drain Improvements				
	Storm Drain			
	Pipes:	18-inch	250	feet
		24-inch	54	feet
		30-inch	372	feet
		36-inch	316	feet
		42-inch	33	feet
		48-inch	459	feet
		54-inch	290	feet
		60-inch	708	feet
		Total Length:	**2482**	
	Inlets:	10-foot Standard Inlet	7	
	Manholes	48"	6	
		60"	3	
		72"	6	
	Outfall	60" pipe	1	
MISCELLANEOUS				
	Traffic Control		11	months
	Environmental		1	LS
	Utility Adjustments		1	LS
	SUBTOTAL			
	Mobilization and Demobilization		10	%
	Overhead and Profit		10	%
OPINION OF PROBABLE CONSTRUCTION COST:				

Engineering (Design and Constructio	10	%
Construction Inspection	10	%
City Project Management	5	%
Land Acquisition		

OPINION OF PROBABLE TOTAL PROJECT COST:

IN
EVELOPMENT REVIEW
Drain Imrovements Project
alysis

	Unit Price		Total
$	250.00	$	62,500.00
$	275.00	$	14,850.00
$	300.00	$	111,600.00
$	350.00	$	110,600.00
$	450.00	$	14,850.00
$	575.00	$	263,925.00
$	600.00	$	174,000.00
$	650.00	$	460,200.00
$	5,300.00	$	37,100.00
$	5,000.00	$	30,000.00
$	6,000.00	$	18,000.00
$	7,000.00	$	42,000.00
$	65,000.00	$	65,000.00
$	10,000.00	$	110,000.00
$	50,000.00	$	50,000.00
$	100,000.00	$	100,000.00
		$	**1,664,625.00**
$	1,664,625.00	$	166,462.50
$	1,664,625.00	$	166,462.50
		$	**1,997,550.00**

$	1,997,550.00	$	199,755.00
$	1,997,550.00	$	199,755.00
$	1,997,550.00	$	99,877.50
		$	790,500.00
		$	**3,287,437.50**

CITY OF AUSTIN
WATERSHED PROTECTION AND DEVELOPMENT F
West Boldin Creek - Leaning Oak Storm Drain Imrovem
Conceptual Cost Analysis

Item	Description		Quantity	Unit		Unit Price
Storm Drain Improvements						
	Storm Drain	barrels				
	Pipes: 18-inch		154	feet	$	250.00
	24-inch		20	feet	$	275.00
	30-inch		442	feet	$	300.00
	36-inch		270	feet	$	350.00
	42-inch		0	feet	$	450.00
	48-inch		654	feet	$	575.00
	54-inch		303	feet	$	600.00
	boxes 4'x2'			feet	$	450.00
	4'x3'			feet	$	525.00
	6'x3'			feet	$	700.00
	7'x3'			feet	$	800.00
		Total Length:	**1843**			
	Inlets: 10-foot Standard Inlet		7		$	5,300.00
	15-foot Standard Inlet		0		$	7,300.00
	Manholes 48"		4		$	5,000.00
	60"		4		$	6,000.00
	72"		2		$	7,000.00
	Outfall 54"		1		$	60,000.00
MISCELLANEOUS						
	Traffic Control		7.7	months	$	10,000.00
	Environmental		1	LS	$	50,000.00
	Utility Adjustments		1	LS	$	100,000.00
	SUBTOTAL					
	Mobilization and Demobilization		10	%	$	1,211,050.00
	Overhead and Profit		10	%	$	1,211,050.00

OPINION OF PROBABLE CONSTRUCTION COST:

Engineering (Design and Construction	10	%	$	1,453,260.00
Construction Inspection	10	%	$	1,453,260.00
City Project Management	5	%	$	1,453,260.00
Land Acquisition				

OPINION OF PROBABLE TOTAL PROJECT COST:

REVIEW
ents Project

	Total
$	38,500.00
$	5,500.00
$	132,600.00
$	94,500.00
$	-
$	376,050.00
$	181,800.00
$	-
$	-
$	-
$	-
$	37,100.00
$	-
$	20,000.00
$	24,000.00
$	14,000.00
$	60,000.00
$	77,000.00
$	50,000.00
$	100,000.00
$	**1,211,050.00**
$	121,105.00
$	121,105.00

$	**1,453,260.00**
$	145,326.00
$	145,326.00
$	72,663.00
$	421,000.00
$	**2,237,575.00**

CITY OF AUSTIN
WATERSHED PROTECTION AND DEVELOPMENT REVIEW
West Boldin Creek - Leaning Oak Storm Drain Imrovements Project
Conceptual Cost Analysis

Item	Description		Quantity	Unit		Unit Price		Total
Storm Drain Improvements								
	Storm Drain Pipes:	18-inch	162	feet	$	250.00	$	40,500.00
		24-inch	44	feet	$	275.00	$	12,100.00
		30-inch	372	feet	$	300.00	$	111,600.00
		36-inch	234	feet	$	350.00	$	81,900.00
		42-inch	172	feet	$	450.00	$	77,400.00
		48-inch	448	feet	$	575.00	$	257,600.00
		54-inch	285	feet	$	600.00	$	171,000.00
	boxes	4'x2'		feet	$	450.00	$	-
		4'x3'		feet	$	525.00	$	-
		6'x3'		feet	$	700.00	$	-
		7'x3'		feet	$	800.00	$	-
		Total Length:	**1717**					
	Inlets:	10-foot Standard Inlet	7		$	5,300.00	$	37,100.00
		15-foot Standard Inlet	0		$	7,300.00	$	-
	Manholes	48"	5		$	5,000.00	$	25,000.00
		60"	3		$	6,000.00	$	18,000.00
		72"	2		$	7,000.00	$	14,000.00
		8x4			$	10,000.00	$	-
	Outfall	54"	1		$	60,000.00	$	60,000.00
MISCELLANEOUS								
	Traffic Control		7.7	months	$	10,000.00	$	77,000.00
	Environmental		1	LS	$	50,000.00	$	50,000.00
	Utility Adjustments		1	LS	$	100,000.00	$	100,000.00
	SUBTOTAL						**$**	**1,133,200.00**
	Mobilization and Demobilization		10	%	$	1,133,200.00	$	113,320.00
	Overhead and Profit		10	%	$	1,133,200.00	$	113,320.00
OPINION OF PROBABLE CONSTRUCTION COST:							**$**	**1,359,840.00**
	Engineering (Design and Construction Phase)		10	%	$	1,359,840.00	$	135,984.00
	Construction Inspection		10	%	$	1,359,840.00	$	135,984.00
	City Project Management		5	%	$	1,359,840.00	$	67,992.00
	Land Acquisition						$	1,028,000.00
OPINION OF PROBABLE TOTAL PROJECT COST:							**$**	**2,727,800.00**

CITY OF AUSTIN
WATERSHED PROTECTION AND DEVELOPMENT REVIEW
West Boldin Creek - Leaning Oak Storm Drain Imrovements Project
Conceptual Cost Analysis

Item	Description		Quantity	Unit	Unit Price	Total
Storm Drain Improvements						
	Storm Drain					
	Pipes:	18-inch	145		$ 250.00	$ 36,250.00
		24-inch	24		$ 275.00	$ 6,600.00
		30-inch	409		$ 300.00	$ 122,700.00
		36-inch	271		$ 350.00	$ 94,850.00
		42-inch	0		$ 450.00	$ -
		48-inch	636		$ 575.00	$ 365,700.00
	boxes	4'x2'	0	feet	$ 450.00	$ -
		4'x3'	50	feet	$ 525.00	$ 26,250.00
		6'x4'	36	feet	$ 800.00	$ 28,800.00
		7'x4'	302	feet	$ 800.00	$ 241,600.00
		72"x48"	0		$ 800.00	$ -
		Total Length:	**1873**			
	Inlets:	10-foot Standard Inlet	7		$ 5,300.00	$ 37,100.00
		15-foot Standard Inlet	0		$ 7,300.00	$ -
	Manholes	48"	4		$ 5,000.00	$ 20,000.00
	Manholes	60"	3		$ 6,000.00	$ 18,000.00
		7'x5'	1		$ 9,500.00	$ 9,500.00
		8x5	3		$ 10,500.00	$ 31,500.00
	Outfall	7X4	1		$ 90,000.00	$ 90,000.00
MISCELLANEOUS						
	Traffic Control		6.5	months	$ 10,000.00	$ 65,000.00
	Environmental		1	LS	$ 50,000.00	$ 50,000.00
	Utility Adjustments		1	LS	$ 100,000.00	$ 100,000.00
	SUBTOTAL					**$ 1,343,850.00**
	Mobilization and Demobilization		10	%	$ 1,343,850.00	$ 134,385.00
	Overhead and Profit		10	%	$ 1,343,850.00	$ 134,385.00
OPINION OF PROBABLE CONSTRUCTION COST:						**$ 1,612,620.00**
	Engineering (Design and Construction Phase)		10	%	$ 1,612,620.00	$ 161,262.00
	Construction Inspection		10	%	$ 1,612,620.00	$ 161,262.00
	City Project Management		5	%	$ 1,612,620.00	$ 80,631.00
	Land Acquisition					$ 405,000.00
OPINION OF PROBABLE TOTAL PROJECT COST:						**$ 2,420,775.00**

CITY OF AUS
WATERSHED PROTECTION AND
West Boldin Creek - Leaning Oak Stor
Conceptual Cost /

Item	Description		Quantity	Unit
Storm Drain Improvements				
	Storm Drain			
	Pipes:	18-inch	174	feet
		24-inch	28	feet
		30-inch	409	feet
		36-inch	281	feet
		42-inch	0	feet
		48-inch	376	feet
		54-inch	0	feet
	boxes	4'x2'	0	feet
		4'x3'	84	feet
		7'x3'	63	feet
		7'x4'	302	feet
		Total Length:	**1717**	
	Inlets:	10-foot Standard Inlet	7	
		15-foot Standard Inlet	0	
	Manholes	48"	5	
		60"	2	
		8'x4'	1	
		8x5	2	
	Outfall	7X4	1	
MISCELLANEOUS				
	Traffic Control		6.5	months
	Environmental		1	LS
	Utility Adjustments		1	LS
	SUBTOTAL			

Mobilization and Demobilization	10	%
Overhead and Profit	10	%

OPINION OF PROBABLE CONSTRUCTION COST:

Engineering (Design and Construction Pl	10	%
Construction Inspection	10	%
City Project Management	5	%
Land Acquisition		

OPINION OF PROBABLE TOTAL PROJECT COST:

STIN
DEVELOPMENT REVIEW
m Drain Imrovements Project
Analysis

	Unit Price		Total
$	250.00	$	43,500.00
$	275.00	$	7,700.00
$	300.00	$	122,700.00
$	350.00	$	98,350.00
$	450.00	$	-
$	575.00	$	216,200.00
$	600.00	$	-
$	450.00	$	-
$	525.00	$	44,100.00
$	800.00	$	50,400.00
$	1,000.00	$	302,000.00
$	5,300.00	$	37,100.00
$	7,300.00	$	-
$	5,000.00	$	25,000.00
$	6,000.00	$	12,000.00
$	10,000.00	$	10,000.00
$	11,000.00	$	22,000.00
$	90,000.00	$	90,000.00
$	10,000.00	$	65,000.00
$	50,000.00	$	50,000.00
$	100,000.00	$	100,000.00
		$	**1,296,050.00**

$	1,296,050.00	$	129,605.00
$	1,296,050.00	$	129,605.00
		$	**1,555,260.00**
$	1,555,260.00	$	155,526.00
$	1,555,260.00	$	155,526.00
$	1,555,260.00	$	77,763.00
		$	1,148,000.00
		$	**3,092,075.00**

WATERSHED PROTECTION AND

Conceptual Cost A

Item	Description			Quantity
Storm Drain Improvements				
	Storm Drain Pipes:	18-inch		100
		24-inch		0
		30-inch		
		36-inch		210
		42-inch		0
		48-inch	conventional	160
		48-inch	JACKING OR BORING STEEL ENCASEMENT PIPE FOR 48 IN. RCP	850
		48-inch	PIPE, 48-IN. RCP INSTALLED IN STEEL ENCASEMENT	850
		60-inch		0
		66-inch		1060
			Total Length:	2380
	Inlets:	10-foot Standard Inlet		6
		15-foot Standard Inlet		1
		20-foot Standard Inlet		1
	Manholes	60"		7
		72"		3
		84"		0
	Outfall	66"-outfall		1
MISCELLANEOUS				
	Traffic Control			18
	Environmental			1
	Utility Adjustments			8
	SUBTOTAL			
	Mobilization and Demobilization			10
	Overhead and Profit			10
OPINION OF PROBABLE CONSTRUCTION COST:				

Engineering (Design and Construction Phase)	10
Construction Inspection	10
City Project Management	5
Land Acquisition	

OPINION OF PROBABLE TOTAL PROJECT COST:

DEVELOPMENT REVIEW

Analysis

Unit		Unit Price		Total
feet	$	250.00	$	25,000.00
feet	$	275.00	$	-
feet	$	300.00	$	-
feet	$	350.00	$	73,500.00
feet	$	450.00	$	-
feet	$	575.00	$	92,000.00
	$	1,100.00	$	935,000.00
feet				
feet	$	250.00	$	212,500.00
feet	$	650.00	$	-
feet	$	700.00	$	742,000.00
	$	5,300.00	$	31,800.00
	$	7,300.00	$	7,300.00
	$	10,600.00	$	10,600.00
	$	6,000.00	$	42,000.00
	$	7,000.00	$	21,000.00
	$	10,000.00	$	-
	$	70,000.00	$	70,000.00
months	$	10,000.00	$	180,000.00
LS	$	50,000.00	$	50,000.00
LS	$	100,000.00	$	800,000.00
			$	**3,292,700.00**
%	$	-	$	329,270.00
%	$	-	$	329,270.00
			$	**3,951,240.00**

%	$	-	$	395,124.00
%	$	-	$	395,124.00
%	$	-	$	197,562.00
			$	-
			$	**4,939,050.00**

MEREDITH STREET LOCALIZED FLOOD HAZARD MITIGATION PRELIMINARY ENGINEERING REPORT

APPENDIX C

MIP TEAM INFORMATION

City of Austin
Watershed Protection Department
Watershed Engineering Division

MIP team Comments

Comments from: Creek Flood Hazard Mitigation, WED, Johnnie Price, PE:

Any improvements to the storm drain system could possibly adversely affect downstream properties/structures due to potential increases in flows and or changes in timing. This project is located very close to Lake Austin, and the discharge may be placed in such a manner that flows could be directed to Lake Austin without crossing any roadways or other structures before reaching the lake. If this is the case, an impact analysis will not need to be performed.

Although an impact analysis may not need to be performed, some general guidelines will need to be followed:

- any discharge on private property will most likely require a drainage easement which contains the proposed infrastructure and be delineated to the limits of the fully developed flow
- any discharge (fully developed) should be verified not to impact any structures which may be located adjacent to the waterway.
- to negate the need of obtaining a drainage easement on private property for an overland flow/discharge, a reduction in flows would need to shown; this is essentially a creek impact analysis comparing proposed flows to existing flows.

Comments from: Sustainable Stormwater Solutions Section (ERM), Tom Franke, EIT:

WQ1: Please incorporate innovative water quality controls into this project to the maximum extent practicable. Please work with the SSS Section to identify potential locations and evaluate types of innovative controls that are feasible.

Kristin Pipkin, PE:

Existing bank erosion was observed at the stormdrain outfall on property 1804 Rockmoor Avenue. If the recommended alignment for the stormdrain improvements uses this location as a discharge point, bank stabilization will be required at the outfall. Recommended bank stabilization techniques include placing rock riprap along the toe of the bank and regrading the slope at a stable slope. The slope should be protected with an erosion control fabric and planted with native vegetation. The project should extend for approx. 75' downstream of the stormdrain pipe. In addition to the bank stabilization work, rock riprap should be placed at the stormdrain outfall to prevent scouring below the stormdrain pipe. Please work with Stream Restoration Program staff during the preliminary and design phase of the project to develop the most appropriate solution.

Comments from: Water Resources Evaluation Section, ERM, Andrew Clamann:

WB1: I prefer an alternative which does not disturb existing natural vegetation at 1804 Rockmoor (i.e. no tree-removal and no open trenching across the wooded area).

WB2: Of the alternatives reviewed, I would recommend increasing the diameter of the Lake Austin outfall.

WB3: If the outfall at Lake Austin is increased (see WB2), please ensure a method of energy dissipation that will prevent additional erosion of the soft-bottom substrate and banks.

Comments from: Value Engineering, Fang Yu, P.E., Ph.D.

(1) This cave appears to be the (historic) Austin Caverns. Recommend that the City staff performs some research on the history/extent of the cave and determine if there is any historic/environmental concerns that should be addressed as part of the project. Since there may be observations of the cave going back quite a while in time there may be an opportunity to understand the effects of routing stormwater through the cave as well. We believe that understanding the conditions and flow path is critical to the solution of the area flooding

(2) The area consists of hills. Most parts of the area may not be flooded even under less frequent storms. However, there are isolated areas that can be severely flooded. Therefore, the design engineer needs to do a careful modeling and design job to find the most efficient way to solve the issues in the area with minimum cost. So far, we do not have enough information to recommend or offer any alternative solution.

Comments from: Water Resources Evaluation Section, Sylvia Pope, ERM, P.G.

The proposed Meredith Street Stormdrain Improvement Project will be designed to provide flood relief for 6 duplexes located at 3607 Meredith Street, 1813 Rockmoor Drive and 1815 Rockmoor Drive. Flooding occurs when the intensity of rainfall exceeds the capacity of the cave (Austin Caverns) volume. When the stormsewer inlet was built into Austin Caverns in the 1960s, subsidence in this former quarry was creating localized flooding. Over the years; the cave passages have been blocked off by subsidence, block collapse and infill of leaves and sediment. A 1997 WPDRD project to clean debris from the cave and map the cave passages succeeded in clearing a small portion of one cave passage.

In May 1995, Street and Bridge conducted sinkhole repair work in Meredith Street near the stormsewer inlet. Prior to the repair work, cavers reported that erosion of the cave passage was occurring at the base of the standpipe. It's

possible that road base was placed into the sinkhole area and around the inlet to bring the road surface back to level with surrounding pavement. Following the repair work, access to the large cavern room was blocked.

A geotechnical investigation for a nearby wastewater relief interceptor was conducted by Raba-Kistner for the City of Austin in 1997. Ultimately, the microtunneling project was cancelled due to the complex geologic conditions impeding excavation. The report identified alternating layers of clay-filled voids, soft siltstone, hard chert, indurated limestone and brecciated material. A probable fault was located in the vicinity of Lake Austin Boulevard north of Enfield Road, based on interpretation of borehole logs RB-6 and RB-7. Page 2 of Dr. Chock Woodruff's summary (page 5 of the 54-page pdf file) summarizes the complex geologic conditions present. It is recommended that this CIP project include a geotechnical investigation to identify specific subsurface conditions. The scope should include boreholes that extend a minimum of 20 feet below the proposed maximum depth of excavation. This is to detect deeper voids that may pose a concern to structural integrity infrastructure.

In 2000, two attempts were made to trace groundwater flow in the vicinity of Austin Caverns. Dye was not recovered from receptors placed in suspected downgradient water bodies, particularly Lake Austin. Approximately 10,000 gallons of water were used to flush the dye into the aquifer. However, a verbal report of increased dewatering volume from the Ullrich WTP relief main tunneling project was reported during the second dye injection. We suspect that the dye traveled to Lake Austin but it was too dilute to be recovered by receptors.

In July 2004, the Texas Commission on Environmental Quality (TCEQ) Underground Injection Control Program requested that the City of Austin address the flood complaints by residents and establish compliance with the TCEQ's Class V Injection Well rules. The stormdrain inlet at 3607 Meredith Street, Austin, TX was registered as a Class V injection well in July 2004 and is referenced in their database as TNRCC Authorization No. 5X2700057. This qualifies as a Class V injection well because it conveys untreated stormwater to a recharge feature. Any changes to the stormsewer must comply with TCEQ's Class V Injection Well rules. As a result, the conveyance capacity of the cave passages may not be enlarged without providing stormwater treatment prior to injection or the stormwater must be diverted away from the cave. If the proposed CIP project continues to convey any volume of untreated stormwater to Austin Caverns, a permit will have to be approved by the TCEQ Underground Injection Control Program.

In 2002, Charles Brading of WEFOD was considering construction of a small flood relief project and asked for information on Austin Caverns. Information provided to him highlighted four geotechnical concerns: 1) Blockage of the cave passages; 2) Unstable inlet standpipe; 3) Excavation hazards; and 4) Prevention of future collapse. The project was not pursued at that time. A description of these concerns has been described in these comments but additional notes are available to the MIP team.

RECOMMENDATIONS:

1. Conduct a geotechnical investigation that includes boreholes that extend a minimum 20 feet below the estimated maximum depth of excavation and/or tunneling. Additional suggestions for scoping the geotechnical investigation may be provided when a preliminary design option has been selected.
2. If excavation is proposed in the vicinity of the inlet and former Austin Caverns, a geophysical survey may be helpful to determine current cave configuration. Two or three methods should be used to provide a more robust interpretation of subsurface conditions.
3. If any form of tunneling is proposed, I suggest that a tunneling expert be consulted. Dr. Robert Lamb, Austin Water Utility, may provide the names of companies with expertise in this area.
4. Trenching may provide better access for void mitigation, if voids are encountered during construction. A site-specific void mitigation plan should be prepared for trenching activities. This should include provisions for structural analysis of large voids intercepted and for stabilizing the trench if the roadway begins to subside during excavation.
5. Any proposed improvements that will allow untreated stormwater to enter Austin Caverns must be approved by the TCEQ's Underground Injection Control program via a Class V Injection Well permit approval.

Mission Integration Program
MIP Comments

Project: Meredith Street Stormdrain Improvments Project
Mission: Environmental Resources Management – Water Resources Evaluation
Mission Representative: Sylvia Pope
Comment Date: 4/30/2012

Comments:

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In 2002, Charles Brading of WEFOD was considering construction of a small flood relief project and asked for information on Austin Caverns. Information provided to him highlighted four geotechnical concerns: 1). Blockage of the cave passages; 2). Unstable inlet standpipe; 3). Excavation hazards; and 4). Prevention of future collapse. The project was not pursued at that time. A description of these concerns have been described in these comments but additional notes are available to the MIP team.

RECOMMENDATIONS:

1. Conduct a geotechnical investigation that includes boreholes that extend a minimum 20 feet below the estimated maximum depth of excavation and/or tunneling. Additional suggestions for scoping the geotechnical investigation may be provided when a preliminary design option has been selected.
2. If excavation is proposed in the vicinity of the inlet and former Austin Caverns, a geophysical survey may be helpful to determine current cave configuration. Two or three methods should be used to provide a more robust interpretation of subsurface conditions.
3. If any form of tunneling is proposed, I suggest that a tunneling expert be consulted. Dr. Robert Lamb, Austin Water Utility, may provide the names of companies with expertise in this area.
4. Trenching may provide better access for void mitigation, if voids are encountered during construction. A site-specific void mitigation plan should be prepared for trenching activities. This should include provisions for structural analysis of large voids intercepted and for stabilizing the trench if the roadway begins to subside during excavation.

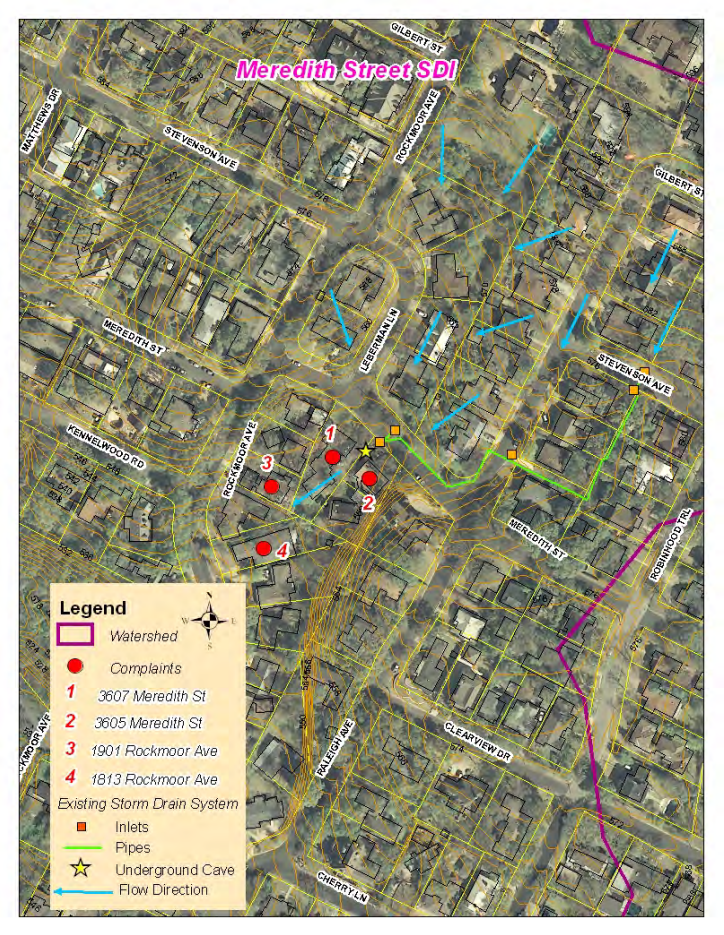
5. Any proposed improvements that will allow untreated stormwater to enter Austin Caverns must be approved by the TCEQ's Underground Injection Control program via a Class V Injection Well permit approval.

CIP 5789.054 Lake Austin – Meredith Street Storm Drain Improvements Project

Angela Todd-Sheremet, PE, PhD

October 18, 2012

• Why we are doing it



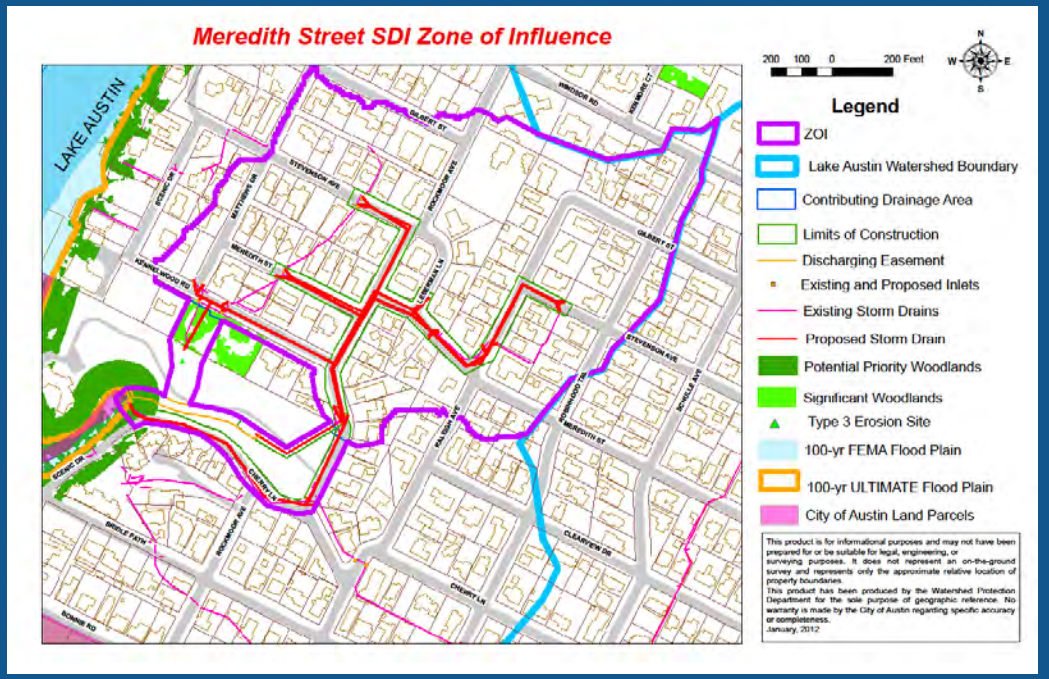
- Why we are doing it

Local Flood Hazard Mitigation – Prioritization Methodology

- **What we have done**

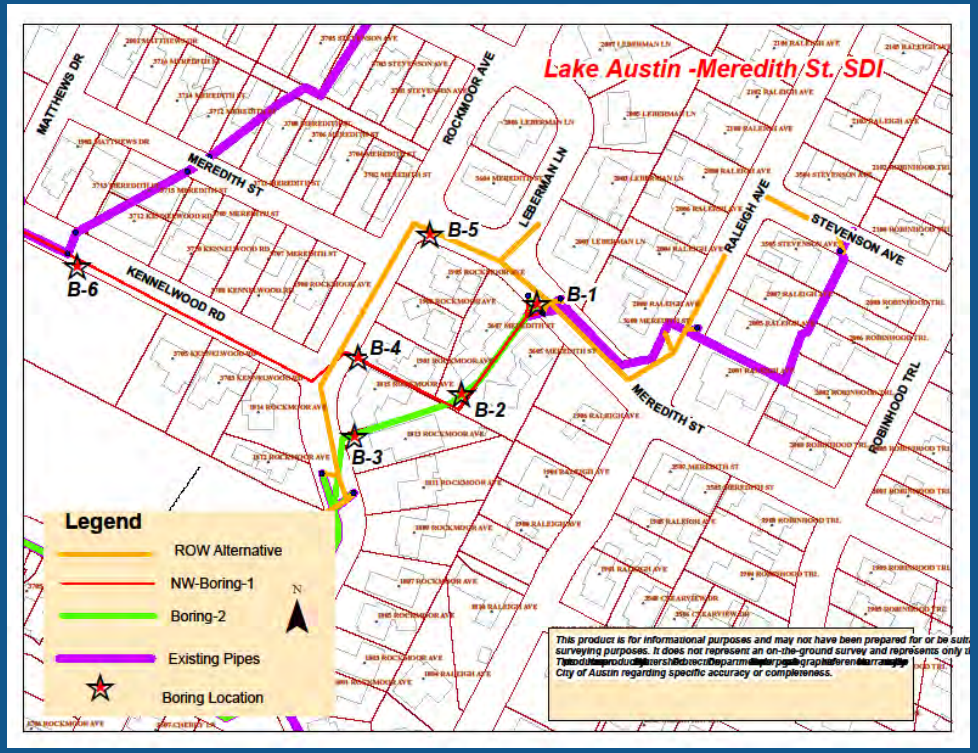
- 1D and 2D analyses of the existing system;
- AULCC;
- 12 alternatives designed including the buyouts;
- Creek Walk .

Local Flood Hazard Mitigation – Prioritization Methodology



- # Reason For Geotechnical/ Geophysical Study

The complex geological conditions



Cost:: $57,380.54

- Expected Benefits

To receive the valuable geotechnical soil and subsurface strata conditions information to answer the question if construction is possible and if it is – to choose the most feasible route.

Please submit your comments by October 29th, 2012

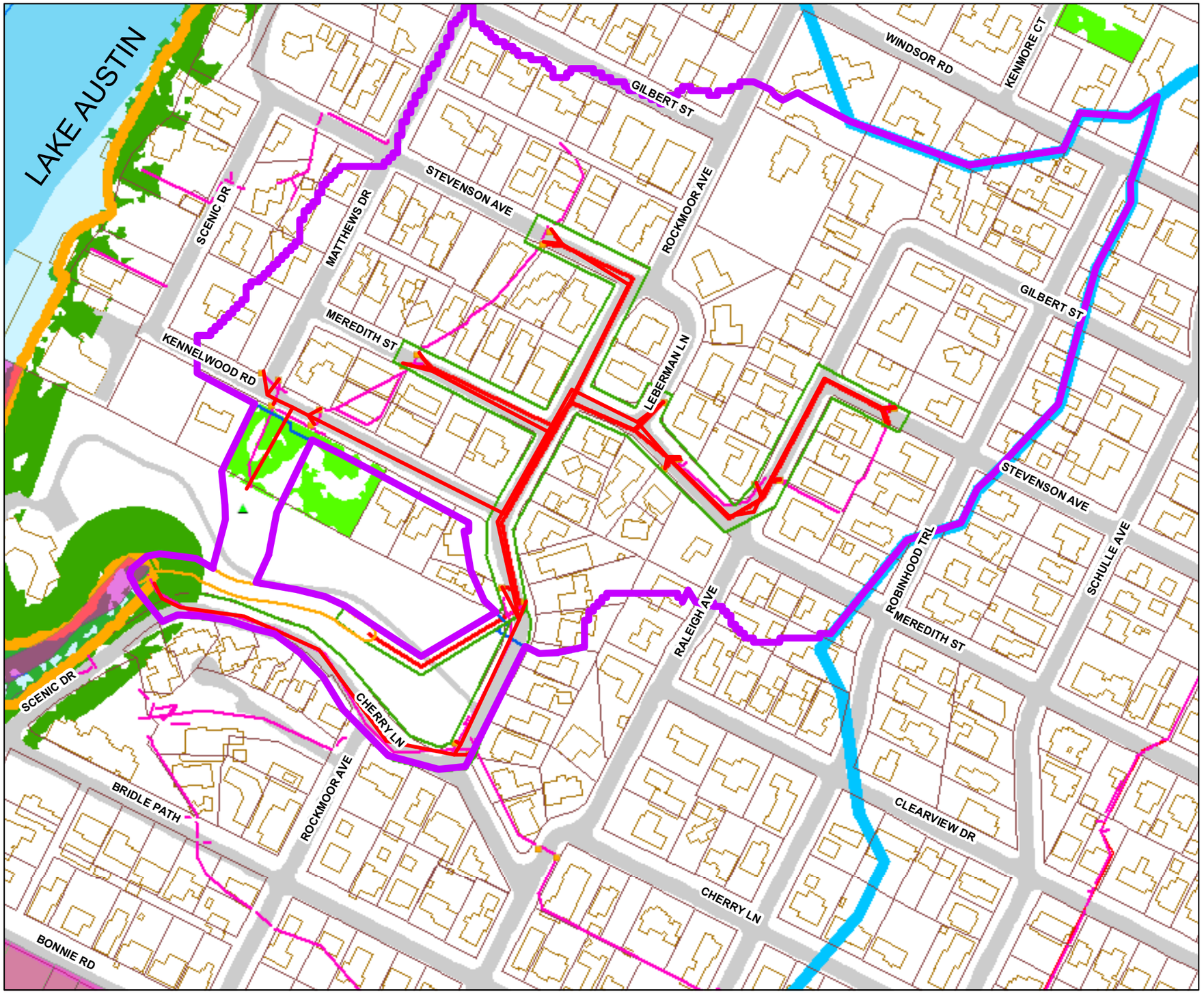
Mission Integration Program
MIP Creekwalk Comments

Project: Meredith Street Stormdrain Improvments Project
Mission: Sustainable Stormwater Solutions - Stream Restoration Program
Mission Representative: Kristin Pipkin
Creekwalk Date: 1/12/2012

Comments:

Existing bank erosion was observed at the stormdrain outfall on property 1804 Rockmoor Avenue. If the recommended alignment for the stormdrain improvements uses this location as a discharge point, bank stabilization will be required at the outfall. Recommended bank stabilization techniques include placing rock riprap along the toe of the bank and regrading the slope at a stable slope. The slope should be protected with an erosion control fabric and planted with native vegetation. The project should extend for approx. 75' downstream of the stormdrain pipe. In addition to the bank stabilization work, rock riprap should be placed at the stormdrain outfall to prevent scouring below the stormdrain pipe. Please work with Stream Restoration Program staff during the preliminary and design phase of the project to develop the most appropriate solution.

Meredith Street SDI Zone of Influence



200 100 0 200 Feet

N
W E
S

Legend

- ZOI
- Lake Austin Watershed Boundary
- Contributing Drainage Area
- Limits of Construction
- Discharging Easement
- Existing and Proposed Inlets
- Existing Storm Drains
- Proposed Storm Drain
- Potential Priority Woodlands
- Significant Woodlands
- Type 3 Erosion Site
- 100-yr FEMA Flood Plain
- 100-yr ULTIMATE Flood Plain
- City of Austin Land Parcels

CIP 5789.054 Lake Austin – Meredith Street
Storm Drain Improvements Project
Mission Integration Process
Problem ID and Summary for Mission Integration

Localized Flood Hazard Mitigation is the lead mission. The site is within Tarrytown, and generally located between Lake Austin to the west and Robinhood Trail to the east, Cherry Lane to the south and Windsor Road to the north (Mapsco #554, Grid #MG-25).

The City of Austin (COA) has received numerous flooding complaints and service requests from local residents near the 3600 block of Meredith Street. City records indicate that that the neighborhood has experienced flooding since 1996. The existing storm drain system was constructed in 1952 and tied to the underground cave at 3607 Meredith St in the 1960's. The cave has a very limited flow capacity, and in the past two years the capacity has been reduced further by roof collapses within the cave. Excess flows that cannot be conveyed by the cave travel through private residential properties. City crews have attempted to clear the storm drain system and cave of debris and collapsed material on several occasions; however, the periodic cleaning provides only temporary relief. A permanent solution is needed. Potentially, the cave could collapse to the extent that there will be no flow capacity or minimal capacity. A storm event in May 2011 rain and consequent flooding prompted a plea by the residents for more productive action by the City on this matter. A decision was made to conduct a feasibility study to alleviate flooding in the area. In July, 2011 the project became a priority of the LFHM group. The drainage studies, feasibility analysis and potential alternatives are summarized in the PER completed by LFHM staff in 2011.

The existing storm drain system that connects to the cave at 3607 Meredith serves a drainage area of approximately 18 acres along Raleigh, Meredith and Stevenson Streets. Existing terrain and area development make it a challenge to provide relief from the flooding problems that the neighborhood has experienced. The existing system generally flows in a southwesterly direction, following the natural drainage path and passing through a number of private residential properties.

Several options are being considered to alleviate the flooding problem. These include potential buyouts of the affected private properties, and various levels of storm drain system improvements. The buy-out option will be costly due to the high value of the properties; WED will need to determine whether this option can be cost-effective. The close proximity of the constructed houses makes the option to upgrade the existing storm drain system along its present route both challenging and risky. Another alternative to reroute the system has been developed to alleviate the Meredith St flooding problem only, i.e., without upgrading lateral systems apart from the area having the most serious flooding problems. Another alternative has been developed to reroute part of the existing drain system located northwest of Meredith Street between Kennelwood Rd and Stevenson Ave. This alternative eliminates a portion of the existing storm drain currently located beneath private homes and which lacks accessibility for maintenance and cleaning

Because the system discharges directly to the lake, an impact analysis was not conducted for the preliminary engineering study. A storm drain easement will likely need to be acquired at 1804 Rockmoor Ave. for all of the alternatives involving improvements to the storm drain system. A final recommendation for alternative selection will be made after the associated costs for each option have been developed and other intangible considerations have been evaluated. .

MEREDITH STREET LOCALIZED FLOOD HAZARD MITIGATION PRELIMINARY ENGINEERING REPORT

APPENDIX D

EXISTING UTILITY INFORMATION

City of Austin
Watershed Protection Department
Watershed Engineering Division

Austin Utility Location & Coordination Committee
Agenda

Meeting scheduled for Thursday September 8, 2011
One Texas Center, 505 Barton Springs Road, 8th floor Conference Room
Time: 2:00 p.m. to 4:00 p.m.

Project Contacts: The projects will be reviewed in the order listed after any announcements are made. Allowing for announcements, there should be ample time for discussion of each project; however, the discussion of each could take as little as 5 minutes or as long as 15 minutes to complete. If you have no representative present when your project comes up, the project will be rotated to the end of the agenda. Please sidebar lengthy discussions with the reviewers, if necessary, until the end of the meeting. The AULCC meeting is scheduled for 2 hours; however, the conference room is reserved until 4:30.

Project Reviewers: Please keep your side discussions and noise level limited so that the meeting can proceed efficiently. Please make yourself available after the meeting for additional discussions, if requested, with the project managers or consultants.

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1 Airport/IH35 **UCC-110908-01-01**

Owner proposes construction of site utilities and streetscape in accordance with Commercial Design Standards on east side of Airport Blvd. from aproximately 45th street to 46th Street and on south side of 46th Street from Airport Blvd. to IH 35 southbound fronatge road. Trench for water, waste water and storm water lines from on-site to existing mainlines at site perimeter and install planting and irrigation per COA Subchapter E Requirements:

Address Range	Street	Cross Street 1	Cross Street 2
4509-4531	Airport Boulevard	45th Street	46th Street
1001-1033	East 46th Street	Airport Boulevard	IH35 SB frontage road

Project Contact (Primary): Gary Bellomy 512-467-7767 or 512-694-8839
Project Manager (Owner's): Gary Bellomy 512-467-7767 or 512-694-8839
Project Engineer: Doucet & Associates, Davood Salek 512-583-2648
Project Contact Email: garyb@landdesignstudio.com

Est. Construction Dates: 11/01/2011 to 03/01/2012 **Plan Dist. Date:** August 25, 2011

Designer: Doucet & Associates **Design Stage:** 95%

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2 Banger's Sausage House & Beer Garden **UCC-110908-02-01**

This project is located at 79 & 81 Rainey Street. The proposed subdivision consists of a cocktail lounge/restaurant. There is no FEMA floodplain located on this site.

Project Contact (Primary): Jerry Perales, PE 512-297-5019
Project Manager (Owner's): Ben Siegel 323-229-2979
Project Engineer: Jerry Perales, PE 512-297-5019
Project Contact Email: jerry.perales@gmail.com

Est. Construction Dates: Start December 2011, End April 2012 **Plan Dist. Date:** August 25, 2011

Designer: Perales Engineering, LLC **Design Stage:** 90%

3 SMCA-CyrusOne Austin Data Center Interconnect **UCC-110908-03-01**

CyrusOne plans to install 3-1.9" HDPE SDR11 within the limits on the streets listed below as well as a route which is a combination of aerial and underground. Projects purpose is to provide a diverse connection between 7401 Ben White Blvd the existing Data Center to the new Data Center located at 7539 Metropolis Dr. Methods of construction will be Aerial Construction which will include Austin Energy Pole attachments and underground placement which will incude a combination of directional drilling as well as trench & place. Project construction timeline will begin on or before 10/24/11 thru 11/11/2011.

Address Range	Street	Cross Street 1	Cross Street 2
7300-7800	Metro Center Dr	E. Riverside Dr	Metlink Dr.
2800-3188	Metlink Dr	Metro Center Dr	Metropolis Blvd
6600-7800	Metropolis Blvd	Metlink Dr	Burleson RD

Project Contact (Primary): Scott M. Crum (972)489-9376
Project Manager (Owner's): John Mateo (469) 831-2953
Project Engineer: Teo Galvin, PE (281)536-5123
Project Contact Email: scrum@smca-llc.com;John.Mateo@glassandwire.com

Est. Construction Dates: 10/24/2011 to 11/11/2011 **Plan Dist. Date:** August 25, 2011

Designer: Scott M. Crum & Associates **Design Stage:** 50%

---

4 WPD-LKA-Meredith St SDI 5789.054 LKA-Meredith St Storm **UCC-110908-05-01**

WED proposes to Trench and Place approximately 2,500 linear feet of 18-inch through 72 RCP storm drains within the right-of-way of the following streets:

Address Range	Street	Cross Street 1	Cross Street 2
3600-3716	Meredith Street	Raleigh Ave	Matthews Dr
3504-3710	Stevenson Ave	Robinhood Trl	Matthews Dr
3703-3800	Kennelwood Rd	Rockmoor Ave	Matthews Dr
3603-3705	Cherry Ln	Rockmoor Ave	Scenic Dr
1801-2100	Rockmoor Ave	Cherry Ln	Gilbert St
2001-2003	Leberman Ln	Meredith St	Rockmoor Ave
2000-2100	Raleigh Ave	Meredith St	Stevenson Ave

Project Contact (Primary): Angela Todd-Sheremet 974-2382
Project Manager (Owner's): John Driscoll 974-33-83
Project Engineer: Angela Todd-Sheremet 974-2382
Project Contact Email: angela.todd-sheremet@austintexas.gov;john.driscoll@austintexas.gov

Est. Construction Dates: 01/01/2013 to 01/01/2016 **Plan Dist. Date:** September 1, 2011

Designer: Watershed Engineering Division, WPD, COA **Design Stage:** % Preliminary

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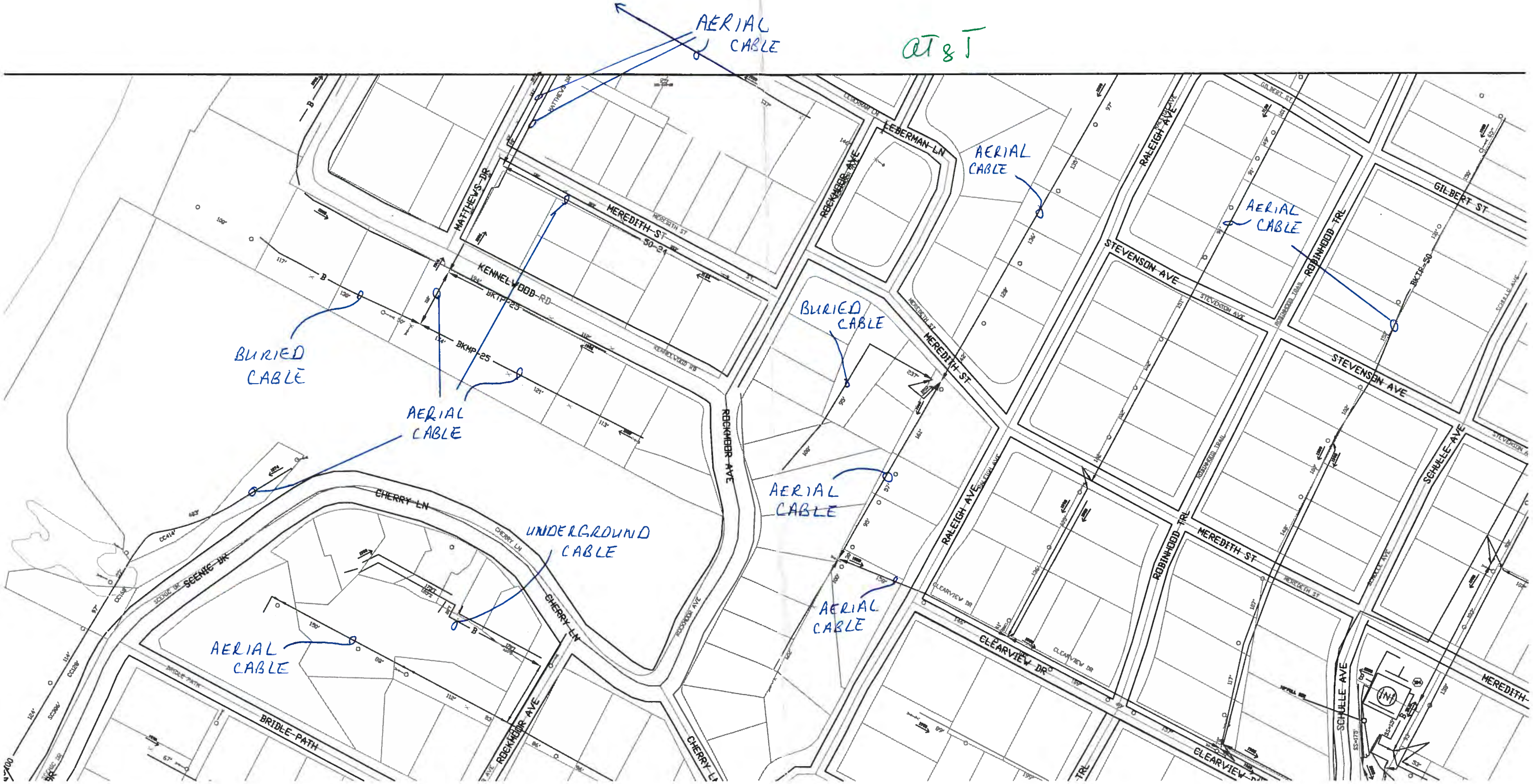
Special Events and Vendors Scheduled

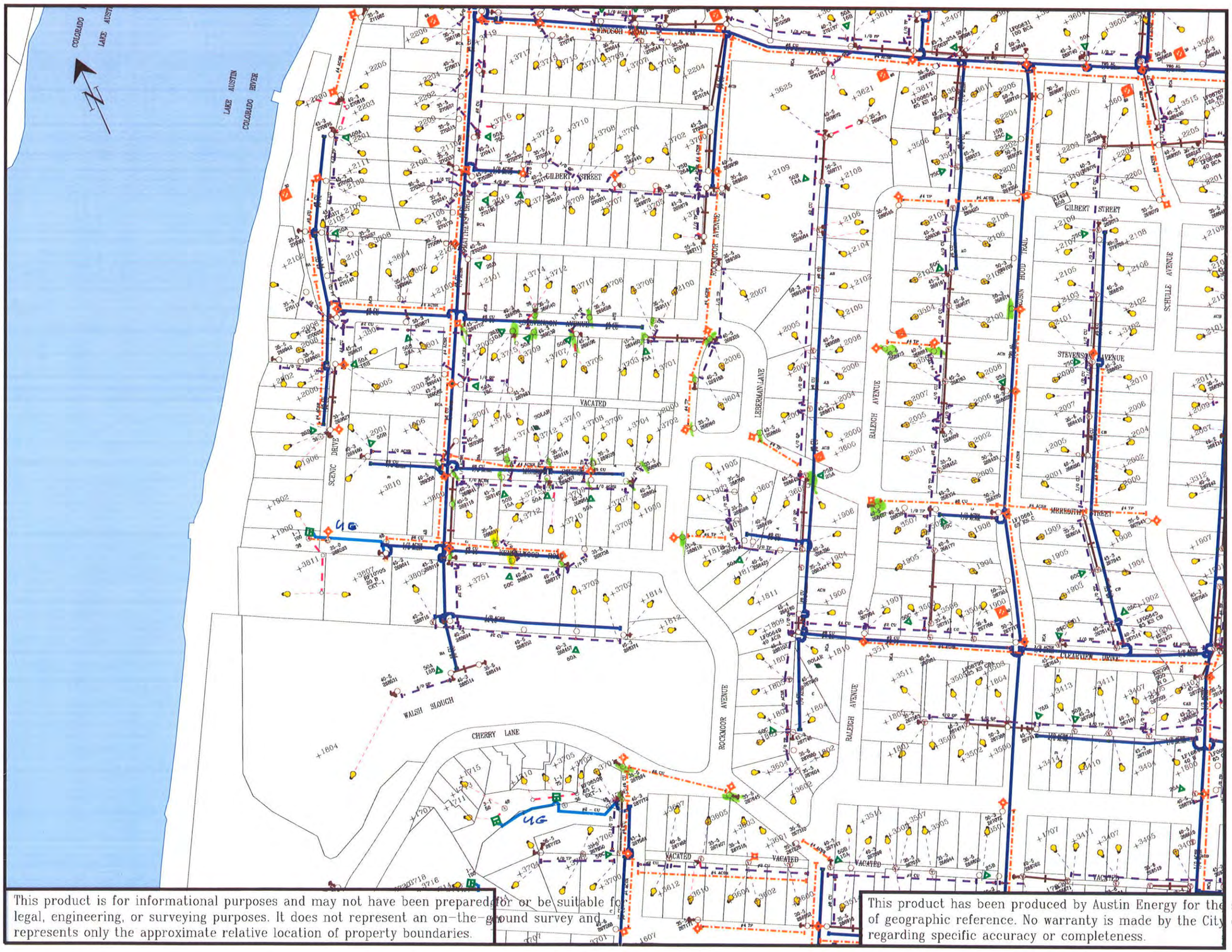
Please be aware of the following Special Events and Vendors scheduled in the project area. Work will not be allowed during the staging and scheduled event time. Coordination with Vendors will need to be in place so their work hours are not effected as well.

10-Sep-11 Pride 5K and Parade
10-Sep-11 SFC Farmers Market
10-Sep-11 Bevo Blvd Celebration
10-Sep-11 ESPN Games, PreGame
16-Sep-11 ACL Music Festival
17-Sep-11 ACL Music Festival
18-Sep-11 ACL Music Festival
17-Sep-11 SFC Farmers Market
24-Sep-11 Pecan St. Festival
25-Sep-11 Pecan St. Festival
24-Sep-11 Stop Child Trafficking
24-Sep-11 SFC Farmers Market
25-Sep-11 Silicon Labs Relay

Oct-11

01-Oct-11 Barkitecture Austin
01-Oct-11 Austin Heart Walk
01-Oct-11 SFC Farmers Market
02-Oct-11 IBM Uptown Classic
02-Oct-11 Be Well Walk
07-Oct-11 Mediterranean Festival
08-Oct-11 Mediterranean Festival
08-Oct-11 NAMI Walk
08-Oct-11 SFC Farmers Market
08-Oct-11 Bicycle Courier Race
09-Oct-11 Bicycle Courier Race


AERIAL CABLE
AT&T
AERIAL CABLE
BURIED CABLE
AERIAL CABLE
BURIED CABLE
AERIAL CABLE
AERIAL CABLE
UNDERGROUND CABLE
AERIAL CABLE
MATTHEWS DR
MEREDITH ST
KENNELWOOD RD
BKTP-25
BKMP-25
LEBERMAN LN
REKHEBER AVE
CHERRY LN
SCENIC DR
BRIDLE PATH
RALEIGH AVE
STEVENSON AVE
ROBINHOOD TRL
GILBERT ST
BKTP-50
SCHULLE AVE
CLEARVIEW DR



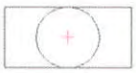
This product is for informational purposes and may not have been prepared for or be suitable fo legal, engineering, or surveying purposes. It does not represent an on-the-ground survey and represents only the approximate relative location of property boundaries.

This product has been produced by Austin Energy for the sole pur of geographic reference. No warranty is made by the City of Austi regarding specific accuracy or completeness.

GIS Objects Quick Reference Chart

Rev 3, November 2003

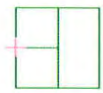
Airswitch	
Anchor	
Attachment	
Capacitor Bank	
Conduit	No Geometry
Conductor (OH Primary)	
Conductor (OH Secondary)	
Conductor (OH Service)	
Conductor (Streetlight)	
Conductor (UG Primary)	
Conductor (UG Secondary)	
Conductor (UG Service)	
Conductor (UG Streetlight)	

Demand Point	
Duct Bank	No Geometry
Fault Indicator	
Fuse Bank	
Generating Station	
Jumper Bank (Primary)	
Jumper Bank (Secondary)	
Jumper Bank (Streetlight)	
Load Break	
Manhole	
OH Guy	
OH Transformer Bank	
Open Locator	N.O. 

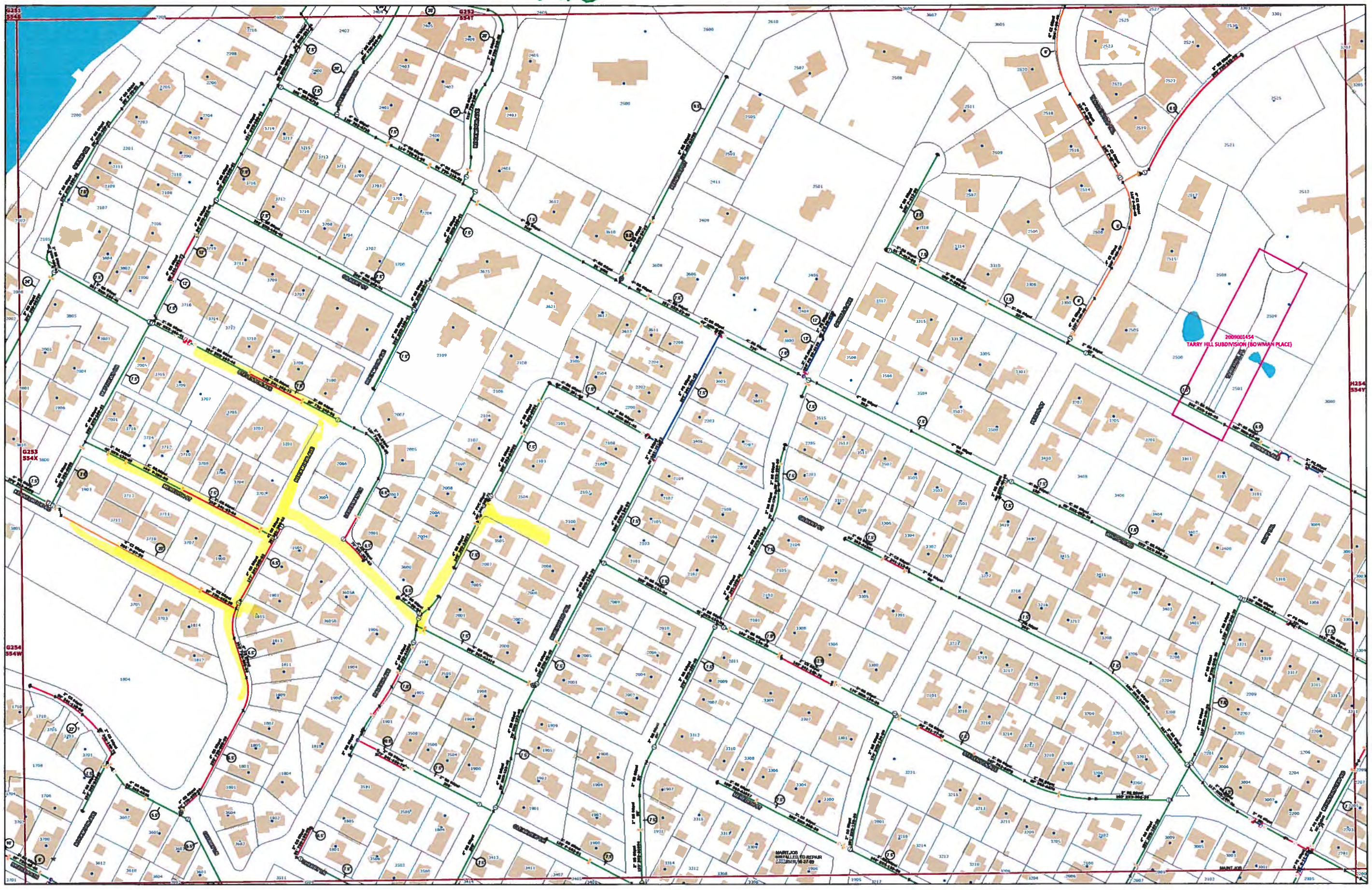
GIS Objects Quick Reference Chart

Rev 3, November 2003

Pedestal	
Pole (Concrete)	
Pole (Foreign)	
Pole (Steel)	
Pole (Wood)	
Primary Meter	
Pull Box	
Recloser Bank	
Regulator Bank	
Relay	
Riser	
Sectionalizer Bank	
Service Box	

Streetlight	
Substation	
Substation Breaker	
Substation Bus	
Substation Transformer Bank	
Switch Bank	
Switchgear Cabinet	
Tower	
Trasformer Secondary Location	
UG Transformer (Submersible)	
UG Transformer Bank	
Vault	

Gas



APPROXIMATE LOCATION OF EXISTING GAS LINES
No blasting within 10 feet of gas lines. Contractor is responsible for any damage to gas lines. Contact 1-800-DIG-TESS at least 48 hours prior to excavating.

Bare Steel
Coated Steel
Polyethylene
Cast Iron
Wrought Iron
PVC
Copper
Unknown
Casing
Insertion
Assignment
Abandoned Gas Pipe
Redline Proposed Work Order
Ball
Gate
Plug
Stop
No Blow Fitting
Unknown
Regulator Station
Emergency Valve
Test Station
Major Meter
3-Way Tee
Short Stop
Service Point
Tie-In
Coupling
Transition
End Cap
Town Border Station
Reducer
Ell
Tee
Map Grid
Property Boundary
Building Outline
Parkland

TEXAS GAS SERVICE
A DIVISION OF ONEOK

oke12725 | 1" = 100' | 4/18/2011

G252
G254 | G253 | H254
G242

GILBERT ST
STEVENSON AV
MEREDITH ST
KENNELWOOD RD
ROCKMOOR AV
LEBERMAN LN
MATTHEWS DR
Time Warner Cable
M:\mg-253.dgn 9/7/2011 3:07:14 PM
AERIAL TIME WARNER CABLE.

CITY OF AUSTIN - WATER DISTRIBUTION SYSTEM

NOTE: THIS MAP IS PRODUCED FOR THE NEEDS OF THE CITY AND NO WARRANTY IS MADE AS TO ITS ACCURACY OR QUALITY.

1:1200 scale maps are available for this grid; additional labels may be visible.

Scale 1:2400

0 100 200 400 600 800 Feet

CITY OF AUSTIN FOUNDED 1839

Austin WATER

Produced by the Water & Wastewater Utility City of Austin, Texas

Main
- In Service, City Maint.
- In Service, Private Maint.
- Proposed
- Abandoned

Hydrant
- Hydrant
- Hydrant Proposed

Operating Valve
- Closed
- Open

Separator
- Attribute Change
- Relabeled By Change
- Material Change
- Ownership Change

Project Separator
- Project Separator

Zone Valve
- Boundary Valve
- Double Check Valve
- Check Valve
- Pressure Reducing Valve
- Pressure Sustaining Valve

Fitting
- Water Connector
- Water Fireline
- Water Plug
- Water Reducer

Control Valve
- Automatic Air Release Valve
- Brain Valve
- Flush Valve
- Hydrant PRV
- Manual Air Release Valve
- Vacuum - Combination ARV
- Vacuum Release Valve

Water Connection
- Water Connection

Meter
- Water Meter

Backflow Preventer
- Backflow Preventer

Inspection Manhole
- Inspection Manhole
- Inspection Manhole with Vault

Brain Manhole
- Brain Manhole

Facilities
- Water Treatment Plant
- Pump Station
- Reservoir
- Sampling Port
- Hydro Tank
- Water Well

Last Update: 07-11-2011

Map Sheet G25

AULCC Reviewer Data Sheet

Data Review Sheet Instructions:

1. Utility Owners, please submit this information by the scheduled meeting date indicated on the plan transmittal sheet. Facility owners not providing the information on the scheduled meeting date may be considered unresponsive and subject to sanctions

   a. Information is due within 35 days for City of Austin projects per City Code. Information not received by the project manager may then be obtained by other means and the costs billed to the facility owner.

   b. Comments not received by the meeting date for license agreements or other private development projects may be interpreted as a "no objection" and an approval granted as a result.

2. Notify the Utility Coordinator of any changes on delivery date before the meeting.

3. For additional space, click the "Additional Comments" tab at the bottom of the worksheet. The spaces provided may not be expanded and are set for the maximum allowable by Excel.

Minutes Sheet is for utility coordinator or project contact use.

Plan Distribution Sheet

Project Name:	**LKA-Meredith St. Storm Drain Improvements**	**UC Tracking #:**	**UCC-110908-05-01**
		Project CIP ID#:	**5789.054**
Meeting Date:	**September 8, 2011**	**License Agreement #:**	**0**

Plan Distribution:

Hard Copies

Note: Hard copies of plan sets are distributed only to those facility owners, depending upon availability, that have regularly attended the weekly AULCC meetings or made regular pickups of the plans. Facility owners to whom hard copies of plans sets are being made available at the AULCC meetings are marked by an (X) below. Utilities that are not marked for plan distribution above must obtain any needed plan sets from the project contact. Utilities not responding will be assumed clear of conflict.

x ROW Mgmt Utility Coord.	x AWU (AULCC Rep)	x PWD - Signal Operations	x ATT TEX	x Time Warner Cable
___ Alpheus Communications	x GAATN	x PWD - Street & Bridge Div	___ Tel West Network Services	x Verizon Business (MCI)
___ Austin Energy (North)	x Grande Communications	___ Qwest Comm.	x Texas Gas Service	___ WPDR - WED
x Austin Energy (South)				
				___ Extra Copies

___ PDF file attached to e-mail distribution

___ Check worksheet tabs below for plans, schematics or other documents

Additional Copies for License Agreements

___ ROW Mgmt License Agr.	___ AWU (Lic.Agreements)	___ NPZD Urban Design	___ PWD - Engineering Services	___ WPDR - Environmental
___ ROW Mgmt Excav. Permits	___ AWU (Tie-backs/Lamb)	___ NPZD Zoning Review	___ PWD - Transportation Div	___ WPDR - Flood Plain
___ Austin Energy (Ch. Water)	___ Capital Metro ROW	___ Pedernales Electric Coop.	___ Research & Regulation	___ WPDR - Planning Review
___ Austin Energy R.O.W.	___ Historical Commission	___ PWD - Chief Engineer		___ WPDR - TASC

Others

Note: Some entities have demonstrated no intent to routinely pick up plans or attend AULCC meetings; however, they and all of the utility owners for which a contact person and e-mail address is available to the utility coordinator, will receive a project transmittal sheet and any electronic attachments that have been made available. Project transmittals are e-mailed by distribution lists set up by geographic region. Some utilities have opted out of receiving project transmittals for projects in certain regions. Utilities for which a recent e-mail address has been available are listed below. Transmittals include the project scope and project contact information.

AboveNet	Bluebonnet Electric Coop.	CITGO Pipeline	McLeod USA	WilTel Communications
AT&T Metro	Broadwing Comm.	CityNet	OnFiber Communications	XO Communications
AT&T Long Distance	Capital Metro Railroads	Enterprise Texas Pipeline	Texas DOT - Permitting	Xspedius Communications
Atmos Energy	Chevron-Texaco	Level 3 Communications	TXU Gas	

Meeting Date: **September 8, 2011** **Meeting Starts:** 2:00 PM

Meeting Location: **8th Floor Conference Room, One Texas Center, 505 Barton Springs Road

AULCC Project Transmittal

Project Name: WPD-LKA-Meredith St SDI 5789.054 LKA-Meredith St Storm Drain Improvements Project

UC Tracking #: UCC-110908-05-01

CIP ID#: 5789.054

Mapsco #: 554 W & X

License Agreement #:

Grid #: MG-25

ROW ID#: 10643790

Meeting Date: September 8, 2011 **Meeting Starts:** 2:00 PM

Meeting Location: **8th Floor Conference Room, One Texas Center, 505 Barton Springs Road

Project Description: WED proposes to Trench and Place approximately 2,500 linear feet of 18-inch through 72 RCP storm drains within the right-of-way of the following streets:

Address Range	*Street*	*Cross Street 1*	*Cross Street 2*
3600-3716	Meredith Street	Raleigh Ave	Matthews Dr
3504-3710	Stevenson Ave	Robinhood Trl	Matthews Dr
3703-3800	Kennelwood Rd	Rockmoor Ave	Matthews Dr
3603-3705	Cherry Ln	Rockmoor Ave	Scenic Dr
1801-2100	Rockmoor Ave	Cherry Ln	Gilbert St
2001-2003	Leberman Ln	Meredith St	Rockmoor Ave
2000-2100	Raleigh Ave	Meredith St	Stevenson Ave

Instructions: Review the plans and provide written comments, record information, system maps, and any other written documentation to indicate horizontal and vertical locations of facilities in possible conflict with the proposed facilities. Also, provide information as to other projects planned by the utility or agency in the area, including schedule and proposed horizontal or vertical locations. Please e-mail the data review sheet (see tab at bottom) as an attachment to the primary project contact and copy the utility coordinator. Use the "additional comments" tab to provide any comments for which their is not space on the data sheet.

Notes: Utility location information for City of Austin projects not received in a timely manner may be obtained from a third party, using potholing or other methods, and billed to the facility owner pursuant to City Code. Delay costs caused by the failure of the facility owner to provide the information or for failure to relocate/adjust the facility prior to construction will also be billed to the facility owner. Comments not received for private party projects & license agreements by the meeting date will interpreted as a "yes" and approval of the project or license agreement may result.

Project Contact (Primary): Angela Todd-Sheremet 974-2382
Project Manager (Owner's): John Driscoll 974-33-83
Project Engineer: Angela Todd-Sheremet 974-2382
Project Contact Email: angela.todd-sheremet@austintexas.gov john.driscoll@austintexas.gov

Est. Construction Dates: 01/01/2013 to 01/01/2016 **Plan Dist. Date:** September 1, 2011

Designer: Watershed Engineering Division, WPD, COA **Design Stage:** % Preliminary

Right-of-way Management Division, Austin Transportation Department
505 Barton Springs Road, Suite 850, (512) 974-7180, fax 974-5617

AULCC: Gregory Pepper, *AULCC@ci.austin.tx.us* **Division Manager:** Jason Redfern, Jason.Redfern@ci.austin.tx.us

AULCC Reviewer Data Sheet

Data Review Instructions are available by clicking on the "Instructions" tab below. Use "additional comments" worksheet where needed (see tabs at bottom). DO NOT CUT & PASTE. Save the file and send the entire file as an attachment to your e-mail to the project contact and copy the utility coordinator. *Required Response

PROJECT INFORMATION

Project Name:	**WPD-LKA-Meredith St SDI 5789.054 LKA-Meredith St Storm Drain Improvements Project**	UC Tracking #:	**UCC-110908-05-01**
License Agreement #:	**0**	Project CIP ID#:	**5789.054**
Meeting Date:	**September 8, 2011**	Design Stage:	**% Preliminary**

***OBJECTION TO LOCATION OR DEPTH OF PROPOSED FACILITIES AS INDICATED? (mark response with an "X") FAILURE TO ENTER A RESPONSE MAY BE INTERPRETED AS "NO".**	YES	
	NO	
	NO, BUT WITH REQUIREMENTS	
	(List requirements below or on "additional comments" sheet)	

FACILITY OWNER INFORMATION

*Utility Name, City Dept. or City Div. providing information:					
*Contact Name		*E-mail Address			
*Phone Number		Fax		Other #	
*Review Submitted by:					

FACILITY INFORMATION

*DO YOU HAVE ANY FACILITIES IN THE CONSTRUCTION AREA? YES OR NO ---->	
*Are you providing System Drawings, Red-lined plans or marked plans to the project manager/design engineer? Yes or No? Via e-mail, standard mail, courier, at meeting?	
* Are your facilities in good condition?	
*Are your facilities scheduled for replacement? If yes, when?	
*Any improvement plans? If yes, when & what type?	
*Are your facilities underground, aerial or both? * If aerial, on whose poles? * If aerial, what position from top? If underground, at what depth of cover? See City Code - "Information Required"	
Assignment of facilities (distance and direction from which ROW line or property line, edge of pavement, back or front of curb, etc.) See City Code - "Information Required"	
Size of underground facility - Height & Width (include any size of any manholes or vaults with orientation to r.o.w.) It is not necessary to provide number of conduit, just the overall dimensions. Use space below. (See City Code - "Information Required")	

Other information pertinent to the project: Start on next line please. Insert extra lines to increase the comments area.

PLACE ADDITIONAL COMMENTS ON SEPARATE SHEET - SEE "ADDITIONAL COMMENTS" TAB AT BOTTOM OF THIS SPREADSHEET.

ADDITIONAL COMMENTS

Project Name:	**WPD-LKA-Meredith St SDI 5789.054 LKA-Meredith St Storm Drain Improvements Project**		
UC Tracking #:	**UCC-110908-05-01**	Project CIP ID #:	**5789.054**
License Agreement #:	0	Other ID #:	
Meeting Date:	**September 8, 2011**	Design Stage:	**% Preliminary**

Comments #1	
Comments #2	
Comments #3	
Comments #4	

Project Name:	**WPD-LKA-Meredith St SDI 5789.054 LKA-Meredith St Storm Drain Improvements Project**	Date:	**September 8, 2011**
UC Tracking #:	**UCC-110908-05-01**	CIP ID #:	**5789.054**
Type of Review:	**% Preliminary**	#:	**0**
Project Manager:	**John Driscoll 974-33-83**		
Engineer:	**Angela Todd-Sheremet 974-2382**		
Project Contact:	**Angela Todd-Sheremet 974-2382**		
Others? (See attendance sheet)	on Date:	**September 8, 2011**	

Project Notes:

Utility	**Austin Energy**	
Rep.	David Henning (North)____ Tony Ferdinando (South)___x_____ Tomme Friar (DAPC) _____ Chuck Purcell _____	
E-mail?	**x**	
Data Sh?	**x**	
Clear?		
Docs?	System Maps ____x____ As-built Plans _____ Marked-up Plans _____ No Apparent Conflict_____	
Utility	**Austin Water Utility**	
Rep.	Vasu Gadhia _____x____ Other _____ **ACWP - CLEAR**	
E-mail?	**x**	Existing 12", 6" and 2" water and 8" and 6" wastewater lines are through out these proposed site. See system maps, intersections and profiles. Caution with crossing the existing water, wastewater lines, services, fire lines and manholes. For next review please show water and wastewater lines on your plan and if crossing the proposed storm sewer line then those water and wastewater lines need to show on profiles. Please maintain the 5' horizontal and 2' vertical clearance.
Data Sh?	**x**	
Clear?		
Docs?	System Maps ____ As-built Plans ____ Marked-up Plans ____ Other _____ No Apparent Conflict_____	
Utility	**GAATN**	
Rep.	Earbie Matheny_____ Other ___ X	
E-mail?	**x**	Carlos.DeMatos@Titus-Systems.com
Data Sh?	**x**	
Clear?	**x**	
Docs?	System Maps _____ As-built Plans _____ Marked-up Plans _____ No Apparent Conflict _____	
Utility	**Grande**	
Rep.	Luis Mata_____x___ Other _____	
E-mail?	**x**	Aerial on AE & Att Poles top strand.
Data Sh?	**x**	
Clear?		
Docs?	System Maps _____ As-built Plans _____ Marked-up Plans _____ No Apparent Conflict _____	
Utility	**ATT Texas**	
Rep.	Denise McCullom _____ Other_x_____	
E-mail?	**x**	MOORE, PATTI [pm2533@att.com] Please call for locates before starting construction and pothole for depth.
Data Sh?		
Clear?		
Docs?	System Maps _____x___ As-built Plans _____ Marked-up Plans _____ No Apparent Conflict _____	
Utility	**Signals**	
Rep.	Chris Dixon ____x_____	
E-mail?		
Data Sh?		
Clear?		
Docs?	System Maps _____ As-built Plans _____ Marked-up Plans _____ No Apparent Conflict _____	
Utility	**Street & Bridge Division**	
Rep.	Binaya Sharma _____ Other ___Duncan, Daren_____	
E-mail?	**x**	Meredith Street and Leberman Ln are protected streets in the project area. Streets with trenches in excess of 300' will be
Data Sh?	**x**	treated as protected. Depending upon the actual location of proposed trenches, include the appropriate pavement restoration

Clear?		details for protected streets.
Docs?	System Maps _____ As-built Plans _____ Marked-up Plans _____ No Apparent Conflict _____	

Project Name:	**WPD-LKA-Meredith St SDI 5789.054 LKA-Meredith St Storm Drain Improvements Project**	Date:	**September 8, 2011**

Utility	**Tel West Network Services**	
Rep.	Antonio Rangel_____ Other ____x_____	
E-mail?		
Data Sh?		
Clear?	x	
Docs?	System Maps _____ As-built Plans _____ Marked-up Plans _____ No Apparent Conflict _____	

Utility	**Texas Gas Service**	
Rep.	Lea Crenshaw_____ Chris Landgraf _____ Other _Karla Merino_____	
E-mail?	x	System Map(s) provided via e-mail, Underground; 18" to 36" (typical) Anyone excavating anywhere in Texas must call 1-800-DIG-TESS before digging.
Data Sh?	x	
Clear?		
Docs?	System Maps __X_____ As-built Plans _____ Marked-up Plans _____ No Apparent Conflicts _____	

Utility	**Time Warner Cable**	
Rep.	Buddy Frazier _____ Aaron Berry_____	
E-mail?	x	Valdes, Frank [frank.valdes@twcable.com]
Data Sh?	x	
Clear?		
Docs?	System Maps _____ As-built Plans _____ Marked-up Plans _____ No Apparent Conflicts _____	

Utility	**Verizon Business (MCI)**	
Rep.	E-Mailed	
E-mail?	x	Verizon (MCI) is clear in this project area
Data Sh?		
Clear?	x	
Docs?	System Maps _____ As-built Plans _____ Marked-up Plans _____ No Apparent Conflicts _____	

Utility	**Watershed Engineering Division**	
Rep.	Reyes Camacho__x_____ Arthur Romero_____	
E-mail?	x	
Data Sh?	x	IN-HOUSE PROJECT; CLEAR
Clear?	x	
Docs?	System Maps _____ As-built Plans _____ Marked-up Plans _____ No Apparent Conflicts_____	

Utility	**TW Telecom**		Utility	**Alpheus**	
Rep.		Mark Peevey__x____ Other	Rep.		Morris Bankhead
E-mail?	X	Laney, David	E-mail?		
Data Sh?	x	[David.Laney@twtelecom.com]	Data Sh?		
Clear?	x		Clear?		
Docs?			Docs?		

Utility	**AT&T Metro**		Utility	**AT&T Legacy**	
Rep.			Rep.		
E-mail?			E-mail?		
Data Sh?			Data Sh?		
Clear?			Clear?		
Docs?			Docs?		

Utility	**Atmos**		Utility	**Austin Energy -CW (Chilled Water)**	
Rep.			Rep.	James Matlock_____ Carol Stewart___X____	
E-mail?			E-mail?	x	
Data Sh?			Data Sh?		
Clear?			Clear?	X	
Docs?			Docs?		CLEAR

Utility	**Bluebonnet Elec.**		Utility	~~**Broadwing**~~	
Rep.	**Miller**		Rep.		
E-mail?	x		E-mail?		
Data Sh?			Data Sh?		
Clear?	x	Carl III Miller	Clear?		
Docs?		[carl.miller@bluebonnet.coop]	Docs?		

Project Name:	**WPD-LKA-Meredith St SDI 5789.054 LKA-Meredith St Storm Drain Improvements Project**	Date:	**September 8, 2011**

Utility	**Cap Metro RxR**	Utility	**Chevron Pipeline**
Rep.		Rep.	
E-mail?		E-mail?	
Data Sh?		Data Sh?	
Clear?		Clear?	
Docs?		Docs?	

Utility	**CITGO Pipeline**	Utility	**CityNet**
Rep.		Rep.	
E-mail?		E-mail?	
Data Sh?		Data Sh?	
Clear?		Clear?	
Docs?		Docs?	

Utility	**Enterprise Pipeline**	Utility	**Kinder Morgan Pipeline**
Rep.		Rep.	
E-mail?		E-mail?	
Data Sh?		Data Sh?	
Clear?		Clear?	
Docs?		Docs?	

Utility	**Koch Pipeline**	Utility	**LCRA**
Rep.		Rep.	**NO RESPONSE**
E-mail?		E-mail?	
Data Sh?		Data Sh?	
Clear?		Clear?	
Docs?		Docs?	

Utility	**Level 3**
Rep.	Jeremy Berger__ Andrew Travino__ PJ Foley___
E-mail?	
Data Sh?	
Clear?	
Docs?	

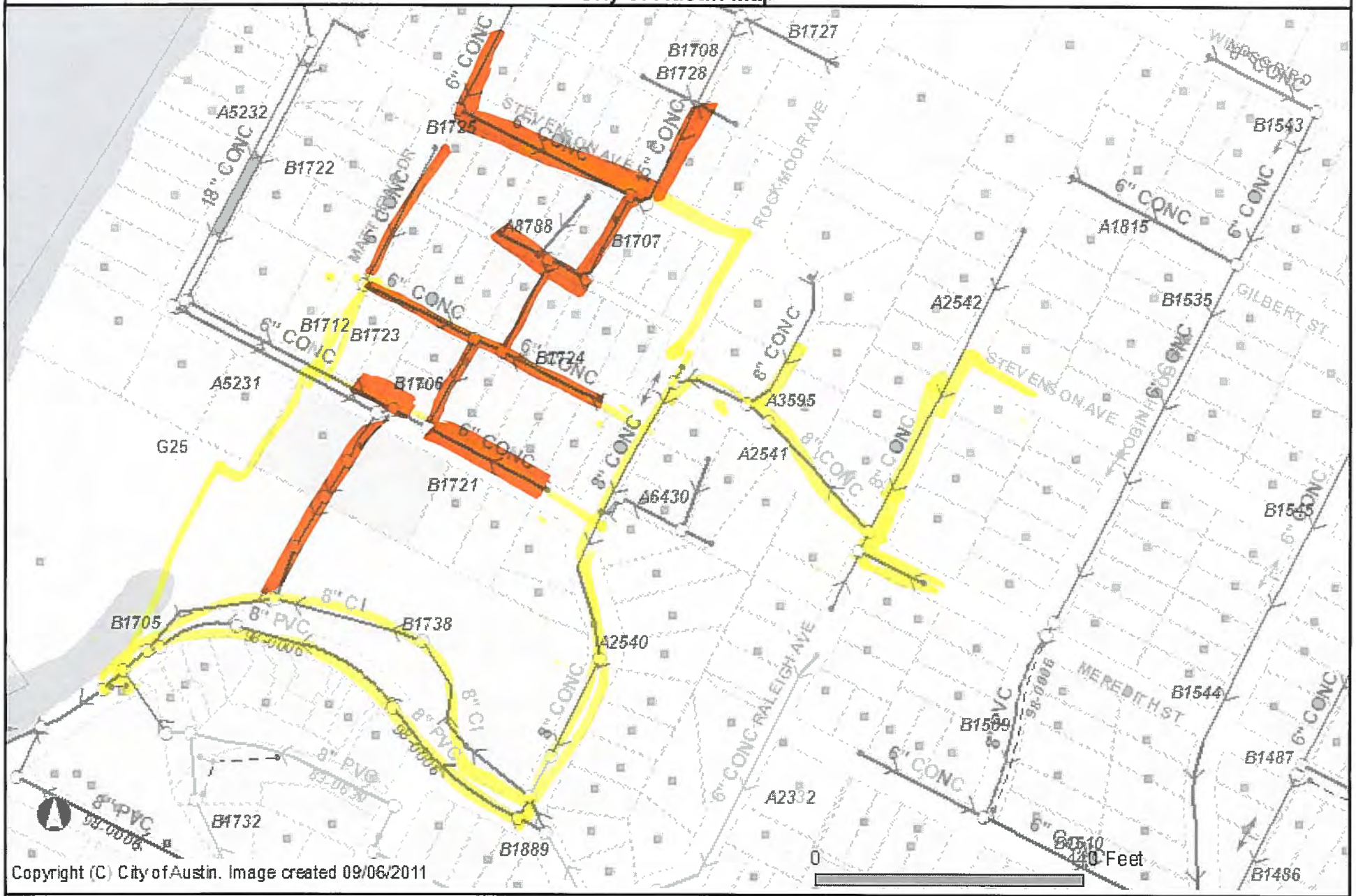
Utility	**~~OnFiber~~**	Utility	**PEC**
Rep.		Rep.	
E-mail?		E-mail?	
Data Sh?		Data Sh?	
Clear?		Clear?	
Docs?		Docs?	

Utility	**Qwest**	Utility	**ONCOR Elec. Delivery**
Rep.	Greg Willis _____	Rep.	
E-mail?		E-mail?	
Data Sh?		Data Sh?	
Clear?		Clear?	
Docs?		Docs?	

Utility	**WilTel**	Utility	**XO Communications**
Rep.		Rep.	Chistopher Jones _____
E-mail?		E-mail?	
Data Sh?		Data Sh?	
Clear?		Clear?	

Utility	**Abovenet**	Utility	**ZNET**
Rep.	James Nosek ____	Rep.	
E-mail?		E-mail?	
Data Sh?		Data Sh?	
Clear?		Clear?	
Docs?		Docs?	

City of Austin Map



This map has been produced by the City of Austin as a working staff map and is not warranted for any other use. No warranty is made by the City regarding its accuracy or completeness.

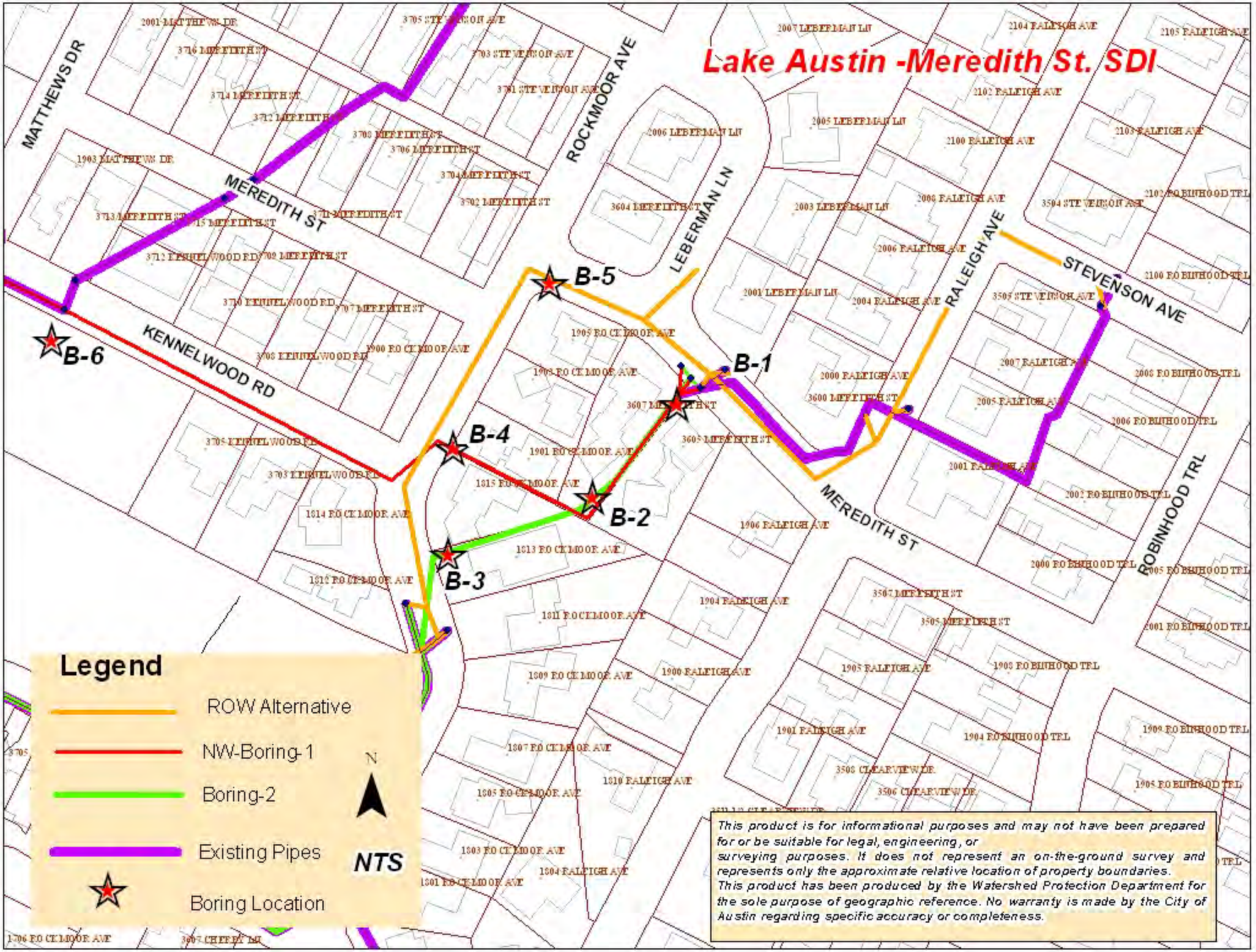
from Vasu.

MEREDITH STREET LOCALIZED FLOOD HAZARD MITIGATION PRELIMINARY ENGINEERING REPORT

APPENDIX E

GEOTECHNICAL DATA
And
GEOPHYSICAL SURVEY REPORT

City of Austin
Watershed Protection Department
Watershed Engineering Division


Lake Austin -Meredith St. SDI
MATTHEWS DR
MEREDITH ST
ROCKMOOR AVE
LEBERMAN LN
RALEIGH AVE
STEVENSON AVE
KENNELWOOD RD
MEREDITH ST
ROBINHOOD TRL
B-1
B-2
B-3
B-4
B-5
B-6
Legend
ROW Alternative
NW-Boring-1
Boring-2
Existing Pipes
Boring Location
N
NTS
This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. It does not represent an on-the-ground survey and represents only the approximate relative location of property boundaries.
This product has been produced by the Watershed Protection Department for the sole purpose of geographic reference. No warranty is made by the City of Austin regarding specific accuracy or completeness.

RABA KISTNER CONSULTANTS

Raba Kistner
Consultants, Inc.
8100 Cameron Road, Suite B-150
Austin, TX 78754
www.rkci.com

P 512 :: 339 :: 1745
F 512 :: 339 :: 6174
TBPE Firm F-3257

[Delivery by US Mail and Email: angela.todd-sheremet@austintexas.gov]

Proposal No.: PAA12-073-00
October 3, 2012 – Revision No. 1

City of Austin
Watershed Engineering Division
Watershed Protection Department
505 Barton Springs Road, Suite 900
Austin, Texas 78704

Attn: Angela Todd-Sheremet, P.E., Ph.D.

Re: Proposed Geotechnical and Geophysical Study
Town Lake – Meredith St. Storm Drain Improvements; FDU: 4850 6307 4138
Austin, Texas

Raba Kistner Consultants, Inc. (RKCI) is pleased to submit this confirming proposal for Geotechnical Engineering and Geophysical Services to the City of Austin for the referenced project. The broad objectives of our study will be to perform soil borings and also perform geophysical field studies along the proposed storm drain alignments within a residential block. Our services will be performed in general accordance to the ***Professional Service Agreement – Comprehensive Materials Testing, Special Testing and Geotechnical Engineering Services 2009-2011 Rotational List*** between **RKCI** and the City of Austin. Described in this letter are:

- our understanding of pertinent project characteristics;
- our proposed scope for field and laboratory study;
- our proposed scope for engineering evaluation and reporting;
- our tentative project schedule; and
- our cost estimate to perform the work.

PROJECT DESCRIPTION

The purpose of our work is to provide geotechnical soil information necessary for the preliminary design of a new storm drain improvement located within the City of Austin. We understand that the current storm drain system is not performing as required to convey storm water runoff away from the area. As such, the residential properties have undergone some flooding. Additionally, we understand voids and possibly caves exist within the vicinity of the proposed storm drain alignment.

The City is considering four alternatives for the route of the proposed storm drain beginning at the inlet in front of 3607 Meredith:

- **Alternate No. 1 -** The storm drain would go west on Meredith to Rockmoor and then south on Rockmoor to Cherry Lane. The storm drain would continue west on Cherry Lane to the location of the existing storm drain outfall.

- **Alternate No. 2. -** The storm drain would go west on Meredith to Rockmoor, south on Rockmoor to the Kennelwood intersection, west on Kennelwood, and then south near the Matthews Drive intersection to a new outfall at the receiving stream.
- **Alternate No. 3 –** The storm drain alignment would go south between 3605 and 3607 Meredith, west between 1901 and 1815 Rockmoor, west along Kennelwood to near the Matthews Drive intersection, and then south to a new outfall at the receiving stream;
- **Alternate No. 4 -** The storm drain alignment would go south between 3605 and 3607 Meredith, southwesterly between 1813 and 1815 Rockmoor, south on Rockmoor and west on Cherry Lane to the location of the existing storm drain outfall.

Our scope of work will be performed in general accordance with the ***Austin Water Utility-Requirements for Geotechnical Investigations for Pipe Line Projects***. We understand that as a part of our scope of work, **RKCI** will be required to prepare the necessary roadway excavation permits, coordinate with utility line locator contractors, and provide traffic control during drilling.

RKCI will subcontract with Landmark Surveying, our right of entry sub consultant, to assist in obtaining right of entry for our drilling rig to access boring locations and/or personnel to perform field studies within private property. If our right of entry efforts are unsuccessful in obtaining right of entry from private owners, **RKCI** will notify the City of Austin to assist us in this matter. By providing right of entry services, **RKCI** does not guarantee that we will be able to obtain right of entry.

RKCI will subcontract with Landmark Surveying, a Professional Land Surveyor, to survey the boring locations. The surveyor will be tasked in providing x and y coordinates of each boring as well as existing ground surface elevations at the boring locations.

During the course of performing our field sampling and testing, it may be necessary to remove and replace fencing to provide access. Additionally, there may be some isolated damage to landscaping in areas where our drill rig traverses private property or due to foot traffic. RKCI will be sensitive to this damage and will attempt to restore the site to near similar conditions. We will include some contingency funds in our fee estimate to address these potential damages.

GEOTECHNICAL FIELD STUDY

As previously mentioned, there are four alternatives for the route of the proposed storm drain line being considered.

To perform the subsurface exploration to address all four storm drain alternatives, RKCI plans on drilling a total of six (6) soil borings. These borings will extend to a depth of about 50 ft below the existing ground surface. Four of the six borings are planned to be drilled within the city street right away. The remaining two borings will be drilled between 3605 and 3607 Meredith.

Based on a cursory review of aerial photography, right of entry access will be necessary to provide access to the boring locations in the backyard of 3605 and 3607 Meredith Ave. This will require permission by all

homeowner's to allow our drill rigs to drive over their property and drill the boring. **RKCI** will include services to obtain right of entry between 3605 Meredith Street, 3607 Meredith Street, 1813 Rockmoor Avenue, 1815 Rockmoor Avenue, and 1901 Rockmoor Avenue. Although no geotechnical borings will be drilled between the residences located 1813, 1815 and 1901 Rockmoor Ave, we will need right of entry to perform geophysical surveys along this corridor.

Samples will be taken using conventional auger, Shelby-tube, and rock coring sampling techniques. Representative portions of all samples will be sealed and packaged for transportation to our laboratory. **RKCI** will photograph intact rock and sediment core samples recovered during geotechnical boring advancement and all recovered core samples will be described by an experienced geologist as to percent recovery, stiffness/density, rock type or soil classification, color, soil structure, weathering, discontinuities, rock quality designation (RQD), and moisture content, as applicable, and will identify carbonate rock features such as clay-filled vugs, calcite-filled fractures and dissolution and/or diagenetic alterations indicating imparted secondary porosity. In addition, **RKCI** will save recovered intact rock core samples for inspection by Watershed Protection Department staff. The samples will be retained up to 3 months after the borings have been drilled. Upon that time, the samples will be discarded. **RKCI** can maintain these samples for longer times however **RKCI** shall be reimbursed the cost to store these samples.

The soil boring in the pavement will be backfilled in accordance to the Public Works Department. **RKCI** will develop a void protocol to be administered during geotechnical boring drilling. If any voids greater than one foot in height or volume are detected by the drilling crew during boring advancement, drilling will stop and **RKCI** will immediately notify the City's Division of Environmental Resource Management-Watershed Protection Department to coordinate and plan additional investigation and/or mitigation procedures to be conducted. It is anticipated that the drill crew will recognize encountering voids by observation of auger-stem drop or loss of hydraulic and/or air pressure, as applicable.

LABORATORY STUDY

Upon completion of the subsurface exploration, the soil samples will be delivered to our laboratory and visual classification will be performed. If necessary to define the strength and classification characteristics of the foundation soils/rock, laboratory tests may be conducted. The testing may include moisture content tests, Atterberg Limits (plasticity tests), grain size analyses, unconfined compressive strength tests slake durability Cerchar Abrasivity Point Load, Brazilian Tensile, Punch Penetration; however, the number and type of tests will be determined based on the subsurface conditions encountered.

GEOPHYSICAL FIELD STUDY

RKCI has consulted with our subconsultant Environmental Geophysical Associates (EGA). Based on discussions with our internal geophysists, our subconsultant EGA, our on-site reconnaissance, and our past experience performing similar studies, it is our opinion that the site only lends us to perform two different geophysical methods, which are 2D Resistivity and Natural Potential (NP) Surveys. The geophysical studies

will be isolated to the two alignments, which are designed to extend between Borings B-1, B-2, and B-4 and from the segment extending from B-1, B-2, and B-3.

2-D Resistivity Method – We will conduct a 1-day DC-electrical resistivity imaging survey along the subject tunneling project segment located within the private residential properties. Resistivity measurements will be collected along at least two arrays located along the proposed storm drain alignments alternatives that traverse the previously mentioned residences. For the purposes of this proposal, it is assumed that the area targeted for investigation will be accessible to **RKCI** personnel and relatively clear of trees, brush, and construction equipment (i.e., parked vehicles, temporary fencing, etc.) that could preclude layout of the resistivity transect and collection of geophysical data.

Data generated as the result of survey activities will be analyzed using computerized methods to produce 2-D profiles or cross-sections depicting subsurface conditions below the array locations. Color-coded profiles will be generated to indicate areas of in-situ rock versus areas of suspected clays or subsurface materials. A primary benefit of the proposed geophysical approach is that it will be possible to evaluate relatively continuous data across the proposed tunneling alignment site. We will coordinate these activities with the subsurface soil boring locations to evaluate/confirm interpreted subsurface conditions.

The results of the ground geophysical survey, together with the supporting field data, will be presented in narrative format with appropriate graphical attachments. Included therein will be the field data with the color-coded electrical resistivity profiles depicting subsurface conditions beneath the proposed tunneling site. The report will also provide an interpretation of the survey results and recommendations for additional activities, if warranted.

Natural Potential (NP) - Natural electrical (NP) currents occur everywhere in the subsurface. In karst investigations, we are concerned with the unchanging or slowly varying direct currents (dc) that give rise to a surface distribution of natural potentials due to the flow of groundwater within permeable materials. Differences of potential are most commonly in the millivolts range and can be detected using a pair of non-polarizing electrodes and a sensitive measuring device (i.e. a voltmeter). Recent flow of groundwater through a conduit is necessary for it to be detected using NP. Positive and negative NP values are attributed to changes in geometry of caves as well as variations in flow conditions. The source of NP anomalies can also be due to changes in topography or changing soil and rock conditions. It should be noted that NP measurements made on the surface are the product of electrical current due to groundwater flow and the subsurface resistivity structure. For this reason, NP data are displayed together with the resistivity data.

We will perform natural potential (NP) surveys along and in the vicinity of the both alignments. The purpose of the NP survey is to create a NP map covering the both segments and the area around them so that we can judge whether the segments have karstic anomalies or not. However, the NP data does not indicate the depth of the voids.

Limitations of Geophysical Work - As electrical methods are sensitive to cultural interference (e.g., metal structures and equipment, buried utilities, overhead electric lines, silt fences, etc.), it will be necessary to

locate resistivity arrays away from such influences to the extent possible. As there are several underground utilities located at the project site, the ability to collect and obtain useful geophysical data will be impacted. Therefore, it should be understood by the Client that there is a possibility that the data collected from the studies may be limited and/or inconclusive.

REPORT DELIVERABLE

The results of the field and laboratory phases of the study will be reviewed by our staff of engineers. The results of our review, together with the supporting field and laboratory data will be presented in written engineering reports to include a Geotechnical Data Report with the information collected using geophysical methods and provide an opinion of the feasibility of performing open-cut and trenchless pipeline construction.

Our report will be submitted for review and comments. Once the final report is approved, **RKCI** will reproduce three (3) spirally-bound copies and one unbound copy.

TENTATIVE PROJECT SCHEDULE

Based on our present workload, we anticipate that we could begin the field exploration phase of this study 7 to 10 working day following receipt of your written authorization, provided permits are available within 5 working days, the site is accessible to our truck-mounted drill rigs and utility locators have completed their tasks. The field exploration of our study is expected to take approximately 5 days, weather permitting, while the laboratory testing phase of the study is expected to take approximately one week to complete. The report will be delivered within 4 to 6 weeks following completion of our field work. We will be pleased to provide the design team with verbal design information as the data becomes available.

It is anticipated that the preliminary written description of geophysical survey activities will be completed and submitted to CLIENT within 5-7 days following completion of field data collection activities.

PROJECT COST

The cost for this scope of services as estimated to be $57,380.54. Refer to the attached cost estimate sheets.

Should unusual soil conditions be encountered in the field that indicates the desirability of significantly broadening the scope of the study, we will contact you to receive authorization before proceeding with any additional work. Additional services will be billed on a unit basis in accordance with the agreed upon standard.

RKCI will invoice the City of Austin no more than once a month for the services rendered. The invoice will include an itemized cost breakdown.

Proposal No.: PAA12-073-00
October 3, 2012 – Revision No.: 1

It should be noted that our study scope and project cost does not include professional time or travel expenses for participation in design team meetings. If these services are required, they will be billed at our standard billing rates for professional time plus expenses.

ACCEPTANCE

We appreciate the opportunity of submitting this proposal and look forward to working with you in the development of this project, which will be carried out in accordance with this letter and the ***Professional Service Agreement – Comprehensive Materials Testing, Special Testing and Geotechnical Engineering Services 2009-2011 Rotational List.***

Please return one signed copy of this letter proposal to provide written authorization for our firm to complete work on the services outlined herein. Our invoices are due and payable upon receipt at P.O. Box 971037, Dallas, Texas 75397-1037. We will be able to schedule the drilling services only after we receive your authorization to proceed.

RKCI considers the data and information contained in this proposal to be proprietary. This statement of qualifications and any information contained herein shall not be disclosed and shall not be duplicated or used in whole or in part of any purpose other than to evaluate this proposal.

Very truly yours,

RABA KISTNER CONSULTANTS, INC.

Gabriel Ornelas, Jr., P.E., PMP
Vice President

GO: tlc

Copies Submitted: Above (2)

Attachments: Cost Breakdown Estimate
Copy of EGA Proposal
Copy of Landmark Surveying Proposal

Accepted
By:

_____
Signature

_____
Typed or Printed Name

_____
Title

_____
Date

COST BREAKDOWN
RKCI GEOTECHNICAL ESTIMATE SHEET

City of Austin
Professional Service Agreement
Comprehensive Materials Testing, Special Testing and Geotechnical Engineering Services
2009-2011 Rotation List

PROPOSAL #: PAA12-073-00 **TITLE:** **Town Lake - Meridith St. Storm Drain Improvements**

CLIENT: City of Austin **CONTACT:** Angela Todd-Sheremet **PHONE #:** 974-2382

DATE: **10/02/12** **PREP.BY:** GO

CONVENTIONAL 50 DEPTH 6
Total= 300 ft

		UNIT	# UNITS	COST/UNIT		TOTAL
DRILLING AND SAMPLING						
	Rig Mobilization	each	1	$310.00		$310.00
	Soil Drilling (min charge per boring)	each	0	$125.00		$0.00
	Soil Drilling (0 to 25 ft)	ft	30	$14.00		$420.00
	Soil Drilling (25 to 35 ft)	ft	0	$16.50		$0.00
	Soil Drilling (35 to 50 ft)	ft	0	$19.00		$0.00
	Rock Coring (0 to 25 ft)	ft	120	$22.50		$2,700.00
	Rock Coring (25 to 35 ft)	ft	60	$24.50		$1,470.00
	Rock Coring (35 to 50 ft)	ft	90	$26.70		$2,403.00
	Asphalt Coring - Field Cut (0 to 6")	each	2	$85.00		$170.00
	Standard penetration tests	each	30	$22.50		$675.00
	Shelby Tube (Thin Wall 3 inch)	each	0	$22.50		$0.00
	Support Truck	day	4	$85.00		$340.00
Outside Services	Allowance Expenses - fence removal, minor irrigation repair,etc.	cost + 5%	1	$1,000.00		$2,000.00
Outside Services	Landscape Repair Allowance	cost + 5%	1	$2,000.00		$1,000.00
					SubTotal	**$11,488.00**
PERFORM GEOPHYSICAL SURVEYS (2-D Resisitivy and Natural Potential)						
Outside Services	Environmental Geophysical Associates	cost + 5%	1	$12,547.50		$12,547.50
	Senior Geologist	hr	10	$105.00		$1,050.00
					SubTotal	**$12,547.50**
PREPARATION OF TRAFFIC CONTROL PLAN AND PURCHASE OF PERMITS						
	Graduate Engineer	hr	0	$80.00		$0.00
	Project Manager	hr	3	$110.00		$330.00
	Senior Engineer	hr	0	$125.00		$0.00
Outside Services	Traffic Control Inspection Fee	cost + 5%	3	$236.25		$708.75
Outside Services	ROW Permit	cost + 5%	3	$36.75		$110.25
Outside Services	Right of Way Usage Charge	cost + 5%	3	$9.45		$28.35
					SubTotal	**$1,177.35**
LOGGING, LOCATION OF BORINGS, AND CORDINATION WITH TRAFFIC CONTROL AND UTILITY LINE LOCATORS						
	Project Engineer	hr	10	$105.00		$1,050.00
	Senior Geologist	hr	40	$105.00		$4,200.00
	Senior Consultant	hr	5	$148.00		$740.00
Outside Services	Traffic Control	cost + 5%	3	$681.98		$2,045.94
					SubTotal	**$8,035.94**
SURVEYING BORINGS AND RIGHT OF ENTRY CORRESPONDENCE						
	Project Engineer	hr	2	$105.00		$210.00
Outside Services	Landmark Surveying, LP	cost + 5%	1	$3,795.75		$3,795.75
					SubTotal	**$4,005.75**
LABORATORY						
	Moisture Content	each	120	$18.00		$2,160.00
	Plasticity Index	each	18	$65.00		$1,170.00
	Minus 200 Sieve	each	9	$42.00		$378.00
	Sieve - Including No. 200 Sieve	each	0	$65.00		$0.00
	Sieve - Including No. 200 Sieve & Hydrometer	each	0	$210.00		$0.00
	Unconfined Compresssion test	each	24	$50.00		$1,200.00
	Triaxial (UU) Multi-Stage	each	0	$155.00		$0.00
	pH, Sulfate, Chloride, Resistivity	each	0	$130.00		$0.00
	Swell Pressure(multi-load)	each	0	$185.00		$0.00
Outside Services	Slake Durability	cost + 5%	12	$270.00		$3,240.00
Outside Services	Cerchar Abrasivity	cost + 5%	12	$130.00		$1,560.00
Outside Services	Point Load	cost + 5%	12	$70.00		$840.00
Outside Services	Brazilian Tensile	cost + 5%	12	$80.00		$960.00
Outside Services	Punch Penetration	cost + 5%	12	$180.00		$2,160.00
					SubTotal	**$13,668.00**
ENGINEERING/REPORTING						
	Senior Consultant/Project Principal	hr	8	$148.00		$1,184.00
	Project Manager	hr	12	$110.00		$1,320.00
	Project Engineer	hr	30	$105.00		$3,150.00
	Graduate Engineer	hr	0	$80.00		$0.00
	Draftsman	hr	8	$48.00		$384.00
	Clerical Support	hr	6	$45.00		$270.00
					SubTotal	**$6,308.00**
					ESTIMATED EXPENSES (Shipping)	**$150.00**
					TOTAL	**$57,380.54**

Environmental **G**eophysics **A**ssociates

2000 Cullen Avenue, #7, Austin, TX · 832-368-4004-Cell
E-mail: ega@pdq.net · Website: www.egatx.com

INTEGRATED GEOPHYSICAL PROPOSAL
LOCATION OF KARSTIC FEATURES
MEREDITH STREET, AUSTIN

Qualifications: EGA has performed scores of successful projects identical to the proposed one. EGA has 18 years of services and the qualifications of EGA for performing surveys are unrivaled in the industry. EGA staff strives for the perfection for each project and take a great pride in our profession. This demonstrated success ensures that the proposed work will be done properly, efficiently and without delay.

1.0 Site Background and Purpose of Geophysical Survey

Environmental Geophysics Associates proposes that 2-D resistivity imaging and natural potential (NP) surveys be conducted at a site located at Meredith Street in Austin.. The purpose of the surveys is to determine whether there are karstic features along two alignments, which are designed to be B1, B2 and B4 and B1, B2 and B3 segments.

2.0 Geophysical Instruments

AGI's Sting R1/Swift Automatic resistivity unit will be utilized in this study. Resistivity imaging is a survey technique, which aims to build up a picture of the electrical properties of the subsurface by passing an electrical current along electrodes and measuring the associated voltages. This technique has been used widely in locating groundwater, determining karstic features, such as caves, sinkhole, and springs. The resistivity unit includes 28 electrodes, two electronic boxes with 2 reels of wire.

Natural electrical currents occur everywhere in the subsurface. In NP investigations we are concerned with the unchanging or slowly varying direct currents (d.c.) that give rise to a surface distribution of natural potentials due to the flow of groundwater within permeable materials. Differences of potential are most commonly in the millivolts range and can be detected using a pair of non-polarizing electrodes and a sensitive measuring device (i.e. a voltmeter). The currents can result from movement of groundwater through fractured zones, subsurface voids, dissolution features, caves, tunnels, etc.

3.0 Field Survey Design

We will perform natural potential (NP) surveys along and in the vicinity of the both alignments. The purpose of the NP survey is to create a NP map covering the both segments and the area around them so that we can judge whether the segments have karstic anomalies or not. The NP data does not indicate the depth of the karstic features.

The second method is the resistivity imaging technique. In this study, we will use a dipole-dipole resistivity technique with 28 electrodes, which is more sensitive to horizontal changes in the subsurface. With this technique we can have a depth exploration as deep as 100 feet, provided that **enough** profile spacing is available.

In order for this fieldwork be successful, we need to have a full access to the back and front yards of the houses that are along the both alignments.

We will also use a Trimble GPS unit during the field work.

The fieldwork will be 2 days.

4.0 Office Work

After the fieldwork is complete, EGA will prepare and submit a geophysical report documenting the fieldwork and subsequent data evaluation. The text portions of the report shall be supported with accompanying maps, and/or profiles as necessary to describe and document the work performed and the conclusions presented. EGA will submit a report within 7 days of completion of the fieldwork. The office work will be about 4 days.

5.0 Cost

The field crew will consist of a senior geophysicist.
Geophysical field surveys can be broken as follows:

1)..Fieldwork..$2,500…x 2 days…….$5,000
2)…Office work….$1,500/day….x 4 day……..$6,000
3)…Mob/demob……..……..N/A
4)..Instrument rental…….950.00
.**TOTAL…….$11,950.00**

Thank you!

Mustafa Saribudak, Ph.D.
Principal Geophysicist-Geologist
Austin, Texas

October 2, 2012

Landmark
SURVEYING, LP

September 27, 2012

Mr. Gabriel Ornelas, P.E., PMP
Raba-Kistner Consultants, Inc.
8100 Cameron Road, Suite B-150
Austin, Texas 78754
Phone: 512-339-1745
Fax: 512-339-6174
E-mail: gornelas@rkci.com

Re: **Town Lake Meredith Street Storm**
City of Austin, Travis County, Texas

Dear **Mr. Gabriel Ornelas**:

We appreciate the opportunity to propose on professional land surveying services you have requested for the Town Lake Meredith Street Storm project based on your e-mail dated September 26, 2012. We understand that you will need horizontal and vertical data on six (6) bore holes as well as Right-of-Entry secured for six (6) property owners. The office and field support for this endeavor is detailed below:

Task 1 - Horizontal and Vertical Control

In order to accomplish the above task Landmark Surveying, LP will need to extend the City of Austin horizontal and vertical control network to the project area via RTK GPS. The control network will be based on the City of Austin Texas Coordinate System of 1983, using NAD '83 horizontal coordinates and NAVD '88 elevations. Since there are no nearby City of Austin vertical controls, Landmark Surveying, LP will rely on RTK GPS redundancy for vertical control.

Task 2 – Locate Six (6) Bore Holes

Landmark will locate up to six (6) bore holes as defined on the attached exhibit provided to Landmark Surveying, LP via e-mail dated September 26, 2012. It is our understanding that Raba Kistner Consultants, Inc. will provide us either a list of addresses where the bore holes are located or a sketch showing the six (6) bore locations. Please note that this estimate is based upon the assumption that all six (6) bores will be drilled, marked and ready to be surveyed at the same time.

Task 3 - Right of Entry and Correspondence:

Right of Entry:

Landmark Surveying, LP will be responsible for obtaining right of entry (R.O.E.) from six (6) affected property owners. This task will entail obtaining Travis County Appraisal ownership information and issuing letters requesting right-of-entry (R.O.E.). The letters will request R.O.E. authorization for not only Landmark Surveying, LP, but

also for Raba-Kistner Consultants, Inc. Landmark Surveying, LP will also attempt to contact the landowner in person if we are unsuccessful by mail. If we are unable to obtain written right-of-entry from a certain landowner (after three attempts) we will notify Raba-Kistner Consultants, Inc. and / or the City of Austin for assistance.

Correspondence with the Project Engineer:
Landmark Surveying, LP anticipate several emails and phone calls to and from your Project Manager prior to and during the project.

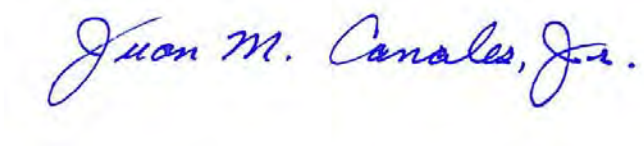
Deliverables:
We will provide an ASCII point file of the bore holes and an AutoCAD drawing of the area affected showing the location of the six (6) bore holes.

Projected Schedule and Fees
As of this date Landmark Surveying, LP expects to perform Task 3 within two (2) to three (3) weeks of written Notice to Proceed. We can perform Task 1 and Task 2 within two (2) weeks of written Notice to Proceed and notification that the six (6) bore holes are ready to be surveyed, weather permitting. The above-described tasks (Tasks 1-3) will be performed on a lump sum basis for a total fee of $ **3,615.00.**

Additional Services, Budget, and Invoicing
Our work is performed on a lump sum basis. A percentage will not be deducted from the final billing for unrequired work. If we exceed the budget for the tasks herein described, you will not be billed for an amount over the not-to-exceed lump sum limit indicated above. Additional services beyond the scope of this estimate will be billed at our standard hourly rates and may exceed the cost estimate provided. Changes to the existing project will constitute additional services and will be billed at our standard hourly rate. Invoices will be directed to you monthly, and payment is due within 10 days of Raba Kistner Consultants, Inc.'s receipt of payment from the City of Austin for the corresponding work. Please note that this proposal is valid for 90 days from the date of this writing. Please find an itemized breakdown of the fees for the above surveying tasks on the following pages.

Respectfully,

Landmark Surveying, LP.
Firm Registration No. 100727-00



Landmark SURVEYING, LP

Juan M. Canales, Jr., R.P.L.S.
Vice President of the General Partner

Town Lake Meredith Street Storm
City of Austin, Travis County, Texas

Tasks 1-3

Service	Max. Hrs.	Labor Rate	Total Cost
Project Principal (R.P.L.S.)	4	$140.00/hr.	$ 560.00
Project Manager (R.P.L.S.)	4	$125.00/hr.	$ 500.00
2-Person Field Crew	16	$130.00/hr.	$ 2,080.00
Survey Technician	5	$ 65.00/hr.	$ 325.00
Clerical	3	$ 50.00/hr.	$ 150.00
		Total	**$ 3,615.00**

RABA KISTNER

MEREDITH STREET STORM DRAIN IMPROVEMENTS

GEOTECHNICAL DATA REPORT

FOR

MEREDITH ST, ROCKMOOR AVE, KENNELWOOD RD, PRIVATE RESIDENTIAL LOTS 3605 & 3607 MEREDITH ST, & 1813, 1815, & 1905 ROCKMOOR AVE AUSTIN, TEXAS

RABA KISTNER CONSULTANTS

Raba Kistner
Consultants, Inc.
8100 Cameron Road, Suite B-150
Austin, TX 78754
www.rkci.com

P 512 :: 339 :: 1745
F 512 :: 339 :: 6174
TBPE Firm F-3257

Project No. AAA12-057-00
June 3, 2013

Angela Todd-Sheremet, P.E., Ph.D.
Watershed Engineering Division & Watershed Protection Department
City of Austin
505 Barton Springs Road, Suite 900
Austin, Texas 78704

RE: Geotechnical Data Report
Meredith Street Storm Drain Improvements - FDU 4850 6307 4138
Meredith St, Rockmoor Ave, Kennelwood Rd, & the Private Residential Lots
At 3605 & 3607 Meredith St, & 1813, 1815, & 1905 Rockmoor Ave
Austin, Travis County, Texas

Dear Ms. Todd-Sheremet:

Raba Kistner Consultants Inc. (RKCI) is pleased to submit the Geotechnical Data Report for the above-referenced project. This study was performed in accordance with **RKCI** Proposal No. PAA12-073-00, dated October 3, 2012 - Revision No. 1. The purpose of this study was to drill borings within the vicinity of the proposed storm drain line alignments, perform laboratory testing to classify and characterize subsurface conditions for the purpose of providing subsurface information for use in determining feasible storm drain alignments. Currently, the City of Austin Watershed Engineering Division & Watershed Protection Department is in the process of preparing a preliminary engineering report.

Additionally, a geophysical field study was performed along two of the proposed storm drain line alignments that are planned to extend through the private residential lots (Refer to the attached Geophysical Field Study Report, dated March 2013).

We appreciate the opportunity to be of service to you on this project. Should you have any questions about the information presented in this report, please call.

Very truly yours,

RABA KISTNER CONSULTANTS, INC.

Yvonne L. Garcia, P.E.
Project Engineer

Gabriel Ornelas, Jr., P.E., PMP
Vice President

YLG/GO: tlc

Attachments
Copies Submitted: Ms. Angela Todd-Sheremet, P.E., Ph.D. - City of Austin (1-Electronic, 3-Bound)
Mr. Steven Penshorn, P.E. (1-Electronic)

GEOTECHNICAL DATA REPORT

For

MEREDITH STREET STORM DRAIN IMPROVEMENTS
MEREDITH ST, ROCKMOOR AVE, KENNELWOOD RD, THE PRIVATE RESIDENTIAL LOTS AT 3605 & 3607 MEREDITH ST, & 1813, 1815, & 1905 ROCKMOOR AVE
AUSTIN, TRAVIS COUNTY, TEXAS

Prepared for

City of Austin Watershed Engineering Division & Watershed Protection Department
505 Barton Springs Road, Suite 900
Austin, Texas 78704

Prepared by

RABA KISTNER CONSULTANTS, INC.
Austin, Texas

PROJECT NO. AAA12-057-00

June 3, 2013

TABLE OF CONTENTS

ATTACHMENTS

INTRODUCTION

RABA KISTNER Consultants, Inc. (RKCI) is pleased to submit the following Geotechnical Data Report for the proposed Meredith Street Storm Drain Improvements project. The Meredith Street Storm Drain Improvements project is located east of Lake Austin within a residential subdivision in Austin, Texas. The subject streets are bounded by Matthews Drive to the west, Raleigh Ave to the east, Cherry Lane to the south and Meredith Street to the North. The proposed storm drain line segments considered along existing streets included in this study are Meredith Street, Rockmoor Avenue, and Kennelwood Road. Proposed storm drain alignments are also being considered to traverse the private residential lots at 3605 & 3607 Meredith as well as 1813, 1815, & 1905 Rockmoor Ave.

The borehole locations were staked in the field by an **RKCI** representative at locations recommended by the City of Austin. Upon completion of drilling operations, the boring locations were surveyed by our sub consultant, Landmark Surveying, and made available to Ms. Angela Todd-Sheremet via electronic file. This report includes a boring location map depicting approximate soil boring locations and geophysical profiles, proposed storm drain alignment option site plans, boring logs presenting subsurface stratigraphy encountered during drilling operations, a geological assessment of the subsurface conditions based on a review of the Geologic Atlas of Texas, and information relative to physical and engineering characteristics of subsurface materials and conditions encountered. No geotechnical recommendations are presented in this data report.

PROJECT DESCRIPTION

The City of Austin Watershed Engineering Division & Watershed Protection Department is evaluating the feasibility of storm drain improvements to a residential subdivision in Austin, Texas. The subject area of improvements referred to herein as Meredith Street Storm Drain Improvements is located east of Lake Austin. Refer to Figure 1 for approximate site location. We understand the current storm drain system for the area does not have the capacity to convey storm water runoff away from the residential homes and some residential properties have undergone flooding.

Based on information provided to us by Ms. Angela Todd-Sheremet, P.E., Ph.D., with the City of Austin Watershed Engineering Division and Watershed Protection Department, the project will consist of the installation of 24-inch and 48-inch storm drain lines and will likely be installed by trenchless construction and/or open cut construction. The horizontal alignments of the storm drain lines relative to existing site elevations are generally anticipated to be approximately less than 15 ft below the existing ground surface; however, due to the abrupt vertical changes in the topography, the depth of the storm drain is likely to be deeper at isolated segments.

We understand four storm drain alignment options our being considered by the city. In general, all four alignments have a common starting point near the storm drain curb inlet on Meredith Street located between the residences at 3605 and 3607 Meredith St. Two of the alternatives will terminate near the intersection of Kennelwood Rd and Matthews Drive, the other two alignment options will terminate near the intersection of Rockmoor Ave and Cherry Lane. Two of the four proposed alignments being considered also will traverse residential lots rather than traveling around the southeast intersection of Meredith St

and Rockmoor Ave. Each of the proposed alignments has been designated as Proposed Alignment Option No. 1, No. 2, No. 3 and No. 4 (Refer to Figures 2a, 2b, 2c, and 2d for a graphical depiction of the proposed storm drain alignments.

Proposed Alignment Option No. 1 The proposed storm drain will extend west on Meredith Street to Rockmoor Avenue. The alignment will then travel south on Rockmoor Avenue to where the alignment intersects Cherry Lane. It's understood that the alignment of the proposed storm drain will continue west on Cherry Lane to the location of an existing storm drain outfall. Based on preliminary information provided by Ms. Todd-Sheremet, we understand horizontal pipe alignments elevations will likely range from elevation 540 to 550 ft near the inlet and from elevations 518 to 528 ft near the storm drain outfall.

Proposed Alignment Option No. 2 The proposed storm drain will extend west on Meredith Street to Rockmoor Drive and then south on Rockmoor Drive to its intersection with Kennelwood Road. The proposed storm drain alignment will continue west on Kennelwood Road until approaching Matthews Drive and then south to a new outfall at the receiving stream. We understand horizontal pipe alignments elevations will likely range from elevation 540 to 550 ft near the inlet and from elevation 515 to 523 ft near the outfall.

Proposed Alignment Option No. 3 The proposed storm drain will extend south within the private residential lots between the residences located at 3605 and 3607 Meredith St and then west between the residences located at 1815 and 1901 Rockmoor Avenue. The storm drain alignment will then travel west along Kennelwood Road to near the Matthews Drive intersection, and then south to a new outfall at the receiving stream. We understand horizontal pipe alignments elevations will likely range from elevation 540 to 550 ft near the inlet and from elevation 515 to 523 ft near the outfall.

Proposed Alignment Option No. 4 The proposed storm drain will extend south within the private residential lots between the residences located at 3605 and 3607 Meredith St and then southwesterly between the residences at 1813 and 1815 Rockmoor Avenue. The storm drain line will continue south on Rockmoor Ave and then west on Cherry Lane to the location of an existing storm drain outfall. We understand horizontal pipe alignments will likely range from elevation 540 to 550 ft near the inlet and from elevation 493 to 506 ft near the outfall.

PURPOSE

The Geotechnical Data Report's primary purpose is to present the geological, geotechnical, groundwater and laboratory testing data collected during **RKCI's** subsurface investigation and laboratory testing programs. Based on this information, Raba Kistner will provide general recommendations as it pertains to subsurface conditions for the design team's use in determining the best feasible alignment to consider. Six borings were drilled in the vicinity of the proposed alignments of the Meredith Street Storm Drain Improvements project. The drilling operations, which include sampling, relative strength testing, and laboratory testing of specified soil samples were also performed as part of the investigation. In addition, a review of the available preliminary project information and the geological conditions in the vicinity of these borings was made to prepare the geotechnical data report.

LIMITATIONS

This geotechnical data report has been prepared in accordance with accepted Geotechnical Engineering practices in the region of central Texas and for the use of the City of Austin Watershed Engineering Division & Watershed Protection Department (CLIENT) and its representatives for design purposes. This report may not contain sufficient information for purposes of other parties or other uses.

The information submitted in this report is based on the data obtained from six borings drilled at this site, the geophysical study, our understanding of the preliminary project information provided to us, and the assumption that site grading will remain as during our field study. If the project information described in this report is incorrect, is altered, or if new information is available, we should be retained to review and modify our report.

This report may not reflect the actual variations of the subsurface conditions across the site. The nature and extent of variations across the site may not become evident until construction commences. As such, the subsurface information depicted in the boring logs, which may be seen in the attachments, contain subsurface information specific to the location where the boring was drilled and the conditions at the time drilling operations occurred. Additionally, the construction process itself may also alter subsurface conditions. If variations appear evident at the time of construction, it may be necessary to reevaluate our recommendations after performing on-site observations and tests to establish the engineering impact of the variations.

The scope of our Geotechnical Engineering Study does not include an environmental assessment of the air, soil, rock, or water conditions either on or adjacent to the site. No environmental opinions are presented in this report.

BORINGS AND LABORATORY TESTS

Subsurface conditions at the site were evaluated by six borings drilled at the approximate locations shown on the Boring Location Map, Figure 1. The borehole locations were staked in the field by an **RKCI** representative and are based on boring locations as recommended by the City of Austin. Once drilling operations were completed, the boring locations were surveyed by Landmark Surveying and were made available to Ms. Todd-Sheremet via electronic file. The top of boring elevations surveyed are as shown in the following table:

Boring No.	Top of Boring Elevation (MSL)
B-1	551.39 ft
B-2	548.59 ft
B-3	537.94 ft
B-4	552.03 ft
B-5	549.29 ft
B-6	532.03 ft

Drilling operations were directed and logged under direct supervision of an **RKCI** representative. The thickness of the asphalt and flexible base were measured and the subsurface stratigraphy was documented at each boring location. The borings were advanced to approximate depths of 50 to 55 ft below the existing ground surface using a truck-mounted drilling rig. Upon completion of drilling, all boreholes were backfilled with auger cuttings, bentonite and capped with a cold patch in accordance with City of Austin backfill procedures. During drilling operations the following samples were collected:

Type of Sample	Number Collected
Split-Spoon (with Standard Penetration Test)	56
Nx Rock Core	162 ft

Each sample was visually classified in the laboratory by a member of our Geotechnical Engineering staff. The geotechnical engineering properties of the strata were evaluated by the following tests:

Type of Test	Number Conducted
Natural Moisture Content	56
Atterberg Limits	12
Percent Passing a No. 200 Sieve	5
Unconfined Compression (rock)	7

The results of all laboratory tests are presented in graphical or numerical form on the boring logs illustrated on Figures 3 through 8. A key to classification terms and symbols used on the logs is presented on Figure 9. The results of the laboratory and field testing are also tabulated on Figure 10 for ease of reference. A photograph log illustrating the samples retrieved from Nx coring at each of the cored bore locations are attached to this report as an Appendix.

Standard Penetration Test (SPT) N-values are also noted on the boring logs and Figure 10. SPT N-value refers to the number of blows a 30-inch free falling 140-lb hammer penetrates 12 inches into the subsurface materials. Where hard or dense materials were encountered, the tests were terminated at 50 blows even if one foot of penetration had not been achieved. When all 50 blows fall within the first 6 inches (seating blows), refusal "ref" for 6 inches or less will be noted.

The Recovery (REC) presented on the logs is the total length of the recovered material divided by the attempted run length during coring activities, presented as a percentage. The Rock Quality Designation (RQD) is the sum of the length of all the pieces recovered measuring 4 inches or more divided by the attempted run length during coring activities, presented as a percentage.

Samples will be retained in our laboratory for 30 days after submittal of this report. Other arrangements may be provided at the request of the Client.

GENERAL SITE CONDITIONS

Geology

A review of the *Geologic Atlas of Texas, Austin Sheet*, indicates that this site is naturally underlain by soils/rock (limestone) of the Fredericksburg Group, particularly the Edwards Limestone Formation. The presence of the Georgetown formation overlying the Edwards is also likely. The geological atlas also indicates that upper Colorado River terrace deposits may be encountered along the northern boundaries of the subject site.

Edwards Limestone is generally considered hard induration and typically contains harder zones/seams of chert and dolomite. Edwards limestone also typically contains karstic features in the form of open and/or clay-filled vugs, voids, and/or solution cavities that form as a result of solution movement through fractures in the rock mass. This formation also contains dolomite, chert, and can exhibit "honeycombed" features.

Georgetown Limestone is comprised of limestone and marl, but mostly limestone. The limestone can also contain karstic features similar to the Edwards Limestone.

Upper Colorado River terrace deposits are stream bed deposits typically consists of clays, sands, silts, and gravels. Such deposits can contain point bars, cutbanks, oxbows, and abandoned channel segments associated with variations in stream bed activity. As a result, soil profiles in terrace deposit areas may vary greatly over relatively short distances. Key geotechnical engineering concerns for development supported on this formation are the expansive nature of the clays, the consistency or relative density of the deposits, and the absence/presence as well as thickness of potentially water-bearing gravels.

Based on a review of online publication data, the proposed alignments of the storm drain improvements are situated in the vicinity of known cavern locations and past rock quarry/fill borrow pits. We understand that a cave has been documented to exist beneath the current Meredith Street and was periodically explored by the public. Sometime in the early 1950's, several of the cave entrances were sealed off.

Additionally, we understand that subsequent fill was placed to restore a rock quarry borrow site or fill in a low lying area prior to construction of the residential homes in the subject areas being considered. Based upon a review of historical contour elevation maps, there is indication that a depression likely associated with rock quarry activities was present. A contour map dating to the early 1950's indicated an isolated depression of approximately 10 to 15 ft located where the current residences of 3605 and 3607 Meredith Street are located. This depression may have increased in dimension overtime until the quarry operation ceased and the excavation restored. The highly horizontal and vertical fractured nature of the rock may have also been mechanically fractured due to nearby blasting.

Subsurface Stratigraphy

The subsurface stratigraphy at this site can be described by four generalized strata. Each stratum has been designated by grouping soils that possess similar physical and engineering characteristics. The boring logs should be consulted for more stratigraphic information. The lines designating the interfaces between strata on the boring logs represent approximate boundaries. Transitions between strata may be gradual.

Stratum I (fill material) generally consists of loose to medium dense, brown clayey gravel (GC) material, with traces of sand, cobbles and boulder fill. Plasticity indices (PI) of samples collected in this stratum range from 14 to 33. Measured moisture contents range from 5 to 14 percent. SPT N-values generally range from 6 to 31 blows per foot. An SPT N-value of refusal for 2 inches was obtaining in this stratum, indicating the free falling hammer could have been bouncing on oversized rock and/or boulder fill. At Boring B-1, a void was encountered at an approximate depth of 3 to 4 ft below the ground surface also indicating the potential presence of nesting as a result of oversized rock and/or boulder fill. Approximately 26 to 43 percent of the fines passing a No. 200 sieve. This stratum was only encountered in Borings B-1 and B-2 and extended to approximate depths below the ground surface of 10 ft and 22 ft, respectively.

Stratum II consists of hard, gravelly, dark brown fat (CH) clay, with limestone fragments. These clays are classified as highly plastic based on a measured PI of 42 and a measured moisture contents of 21 percent. An SPT N-value of 40 blows per foot of penetration was measured in this stratum. The Stratum II clays were only encountered within the upper 2 ft of Boring B-4.

Stratum III consists of stiff to hard, tan lean (CL) clay, with traces of limestone fragments and intermittent limestone seams and calcareous deposits. This material may be classified as a very soft, decomposed limestone based on the ability to crumble the material by hand as well as obtain samples with a Shelby tube. Decomposed refers to the weathered nature of the material. These clays are classified as low to moderately plastic based on PI's ranging from 5 to 16. Measured moisture contents range from 4 to 30 percent. SPT N-values in stiff to very stiff material encountered in the stratum range from 8 blows to 39 blows per foot of penetration. In harder zones with intermittent limestone seams, SPT N-values typically range from refusal for 1 inch of penetration to 50 blows for 9 inches of penetration. Approximately 73 percent of the fines passed a No. 200 sieve. This stratum was encountered at Borings B-2, B-3, B-4 and B-6. At Borings B-3, B-4 and B-6 this stratum extended to depths ranging from about 5 to 15 ft below the ground surface. At Boring B-2, the Stratum III clays extended to a depth of about 34 ft.

Stratum IV generally consists of very hard, vuggy, moderately to slightly weathered, tan limestone with clay layers and seams. During Nx coring operations, the presence of karst features such as voids were encountered in the rock formation. Refer to Boring Logs B-1, B-3, and B-4 for approximate size and depths of voids encountered in our borings. SPT N values generally range from 50 blows for 3 inches to refusal for 1 inch of penetration. Unconfined compression tests performed on selected rock core samples yield strength values ranging from 192 to 490 tsf. The REC of the core runs range from about 12 to 100 percent, while the RQD generally ranges from 0 to 49 percent. All borings were terminated in this stratum.

ANTICIPATED SUBSURFACE CONDITIONS ALONG PROPOSED ALIGNMENTS

Proposed Alignment Option No. 1 - Boring Nos. B-1, B-3, and B-4

Based on our subsurface explorations conducted in the vicinity of proposed storm drain Alignment Option No. 1 and the preliminary depths in which the storm drain is proposed to be installed, we anticipate the following:

- Along the alignment depicted between Borings B-1, B-3, and B-4, we anticipate moderately weathered to slightly weathered, highly to intensely fractured Stratum IV limestone to be encountered at the proposed horizontal pipe alignment elevations. This segment of the proposed storm drain alignment is anticipated to encounter vuggy limestone, intermittent clay pockets, weathered seams, and voids in the limestone formation. Void thicknesses of up to 1 ft were measured.
- Based on the results of the geophysical study and the subsurface conditions encountered at Boring B-1, it is also anticipated that karst features, such as voids and possibly caves will be encountered in the vicinity of the existing storm drain inlet on Meredith Street. It is also likely that borrow pit restoration fill in the upper 10 to 15 ft relative to the existing surface will be encountered. These fills could consist of a combination of clayey gravel mixed with cobbles and boulders.

Proposed Alignment Option No. 2 - Boring Nos. B-1, B-4, B-5 and B-6

Based on our subsurface boring explorations conducted in the vicinity of the proposed storm drain Alignment Option No. 2 and the preliminary depth in which the storm drain is proposed to be installed, we anticipate the following:

- Along the alignment depicted between Borings B-1, B-4, and B-5, subsurface conditions will likely consist of moderately weathered highly fractured limestone of the Edwards Group (Ked). This segment of the proposed storm drain alignment is anticipated to encounter vuggy limestone, intermittent weathered seams, and voids. Voids in the limestone formation of approximately 1 ft thick were measured in our soil borings. As stated previously, karst features and restoration fill will be encountered in the vicinity of Boring B-1.
- At Boring B-6, the subsurface conditions will likely consist of very stiff to hard, lean tan clay (decomposed limestone) within the upper 15 ft and moderately weathered and highly fractured limestone. The moderately weathered and highly fractured limestone will also contain voids and intermittent clay seams and pockets. Seams of chert are also likely to be encountered.

Proposed Alignment Option No. 3 - Boring Nos. B-1, B-2, and B-4

Based on our subsurface boring explorations conducted in the vicinity of the proposed storm drain Alignment Option No. 3 and the preliminary depth in which the storm drain is proposed to be installed, we anticipate the following:

- From Borings B-1 to B-2, subsurface conditions in the upper 20 to 25 ft will likely consists of quarry restoration fills comprised mainly of clayey gravel with limestone fragments, cobbles, and possible boulders. We anticipate a layer of lean gravelly clays underlying the fills and above the tan limestone rock encountered at about 35 ft. The limestone formation can be described as hard, moderately weathered, and highly fractured. Based on the results of the geophysical study, it is also anticipated that karst features, such as voids and possibly caves will be encountered in the vicinity of the existing storm drain inlet on Meredith Street.
- From Boring B-2 to B-4, the subsurface conditions will likely consist of the conditions described between Borings B-1 to B-2 and abruptly transition to hard, moderately weathered and highly fractured limestone rock. Based on the results of the geophysical survey, it is anticipated that an abrupt change in the subsurface conditions associated with "faulting" may likely occur at approximately 60 to 100 ft from Rockmoore Ave along the geophysical profile line G-2. The faulting and/or abrupt change in geophysical profiling may be associated with previous rock quarry activities in the area. It's possible that the faulting described in the geophysical report is a rough delineation of the limits of the rock quarry excavation. Therefore, the fault could be depicting the contact between the native limestone cuts of the quarry operation and the subsequent fills placed to restore the quarry.
- From Borings B-4 to B-6, subsurface conditions are similar to what has been described on Kennelwood Rd along that segment of the Proposed Alignment Option No. 2.

Proposed Alignment Option No. 4 - Boring Nos. B-1, B-2, and B-3

Based on our soil borings conducted in the vicinity of the Proposed Segment No. 4 storm water alignment, we anticipate the following

- Similar subsurface conditions as described along the segment for Proposed Alignment Option No. 3 from Boring B-1 to B-2.
- From Boring B-2 to B-3, the transitioning between quarry restoration fills and rock quarry limitations also appears to be evident. It is likely that the proposed alignment will transition from the fills located at Boring B-2 to the weathered, highly fractured limestone depicted in Boring B-3.

GROUNDWATER

Groundwater was not observed in the borings either during or immediately upon completion of the drilling operations. It is possible for groundwater to exist beneath this site at shallow depths on a transient basis, particularly following periods of precipitation. Fluctuations in groundwater levels occur due to variation in rainfall and surface water run-off. The construction process itself may also cause variations in the groundwater level.

INTERPRETATION OF GEOPHYSICAL SURVEY DATA

Raba Kistner commissioned Environmental Geophysics Associates (EGA) to perform a geophysical Survey. The report dated March 2013 is attached to this report as an appendix. EGA performed surveys

utilizing two geophysical methods including resistivity and natural potential. The methods as well as the results of their survey can be further understood by reviewing the attached report.

In general two profiles, Profiles G-1 and G-2, located at the approximate locations depicted in Figure 1 were performed to geologically characterize the site and karstic features underlying the site to approximate depths of 45 to 60 ft below the existing ground surfaces. The use of geophysical survey was prudent due to supplement the limited number of soil borings able to be performed within the accessible areas of the residential lots and the anticipated presence of karst features, such as caves in the vicinity, was also factored in utilizing geophysics. Geophysical studies are beneficial as they are capable of providing a continuous mapping of the subsurface conditions as opposed to a soil boring that can only obtain subsurface information at a discreet location. With this said, a geophysical survey should always be calibrated by soil borings. We have often found that anomalies detected by the geophysical survey require additional soil borings in the area to further understand the significance of the anomaly. It should be noted that although some soil borings were obtained along the geophysical profiles, there were anomalies that could warrant additional soil borings to fully characterize them. Unfortunately, some of these areas occur at locations of the private residence that are not accessible to a drill truck.

A summary of the interpretation of the geophysical survey data presented in the Geophysical Report is as follows:

- Karstic features and possibly cave chambers are likely beneath Meredith Street and extending into the private residences located at 3605 and 3607 Meredith.
- There is the presence of quarry restoration fill along geophysical profile G-1 and G-2. The depth of the fill encountered in the geophysical survey closely corresponds to the depth of fill encountered in Borings B-1 and B-2.
- There is apparent faulting along the geophysical profiles G-1 and G-2 located on either side of 1815 Rockmoor Ave. This faulting represents an abrupt transition between the deep fills to a natural limestone formation. This faulting could represent limits of a quarry excavation cut.
- A karst feature, possibly a hard resistive rock chunk, was also encountered along the profile G-1 about 50 ft from the street.

Although much information was gathered and interpreted from this geophysical survey, the subsurface conditions exhibit somewhat “chaotic” results. This is probably associated to the past quarry operation, restoration fill operations, and the presence of karst conditions all occurring within a relatively small area. To gain additional understanding of the conditions, additional soil boring calibration data would be beneficial assuming that accessibility could be gained.

GENERAL COMMENTS

From a geotechnical standpoint, we believe that all storm drain alignments are feasible for construction either by trenching or trenchless techniques. Based on the data collected, Proposed Alignment Options No. 3 and 4 will experience similar challenges. Both will have to deal with the restored fills existing along the majority of the alignment located in the residential lots. Both will likely encounter geological

transitions that could abruptly transition from deep fills to the Edward Limestone. On the advantage side, the presence of borrow fill could be conducive for open-cut trenching methods assuming the depth of the pipe alignment is relatively shallow.

All alignment options will be challenged with the karst features located in the vicinity of Meredith Street and the potential of encountering voids intermittently along the proposed alignments. During construction, the presence of voids and caves will require void mitigation, which could likely be extensive and result in construction cost overruns and scheduled delays. Trenchless methods will also affected by voids.

RECOMMENDATIONS FOR ADDITIONAL INFORMATION

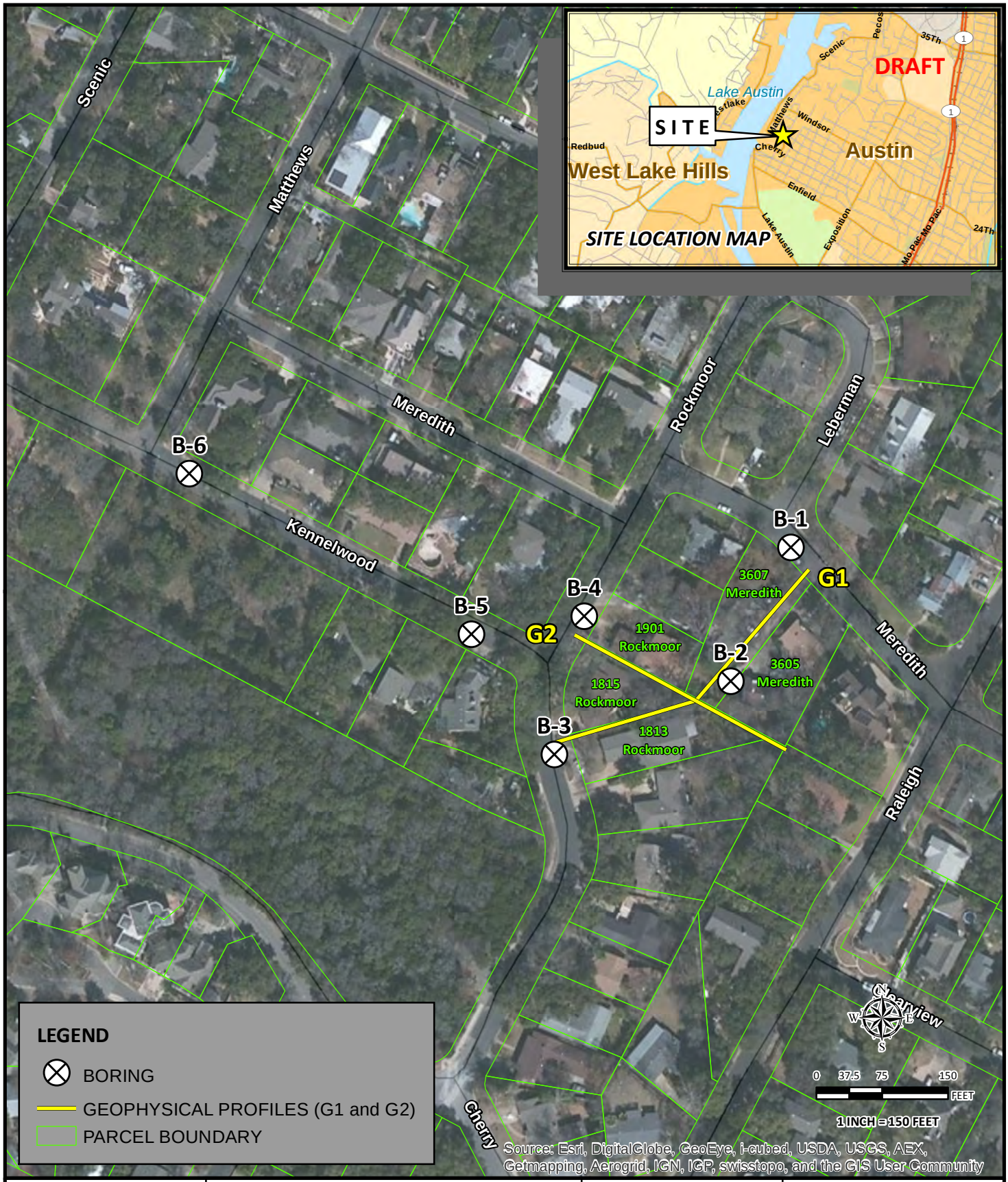
Although the geophysical survey identified anomalies thought to be caves beneath Meredith St, Soil Boring B-1 did not replicate those findings. Given that all storm drain alignments will originate where karst features likely exist, we recommend additional soil borings in the vicinity of the probably karst region and an additional geophysical survey along Meredith St extending from about Raleigh Ave to Leberman Lane.

* * * * * * * * * * * * * * * * * *

The following figures are attached and complete this report:

Figure 1	Boring Location Map
Figure 2A, 2B, 2C, & 2D	Proposed Tunnel Alignment Options
Figures 3 through 8	Logs of Borings
Figure 9	Key to Terms and Symbols
Figure 10	Results of Soil Analyses
Figure 11	Generalized Subsurface Profiles - Alignment Option No. 1
Figure 12	Generalized Subsurface Profiles - Alignment Option No. 2
Figure 13	Generalized Subsurface Profiles - Alignment Option No. 3
Figure 14	Generalized Subsurface Profiles - Alignment Option No. 4
Appendix A	Geophysical Survey Report
Appendix B	Photographs of Rock Cores

ATTACHMENTS



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BORING LOCATION MAP & GEOPHYSICAL PROFILES

MEREDITH ST STORM DRAIN IMPROVEMENTS
AUSTIN, TEXAS

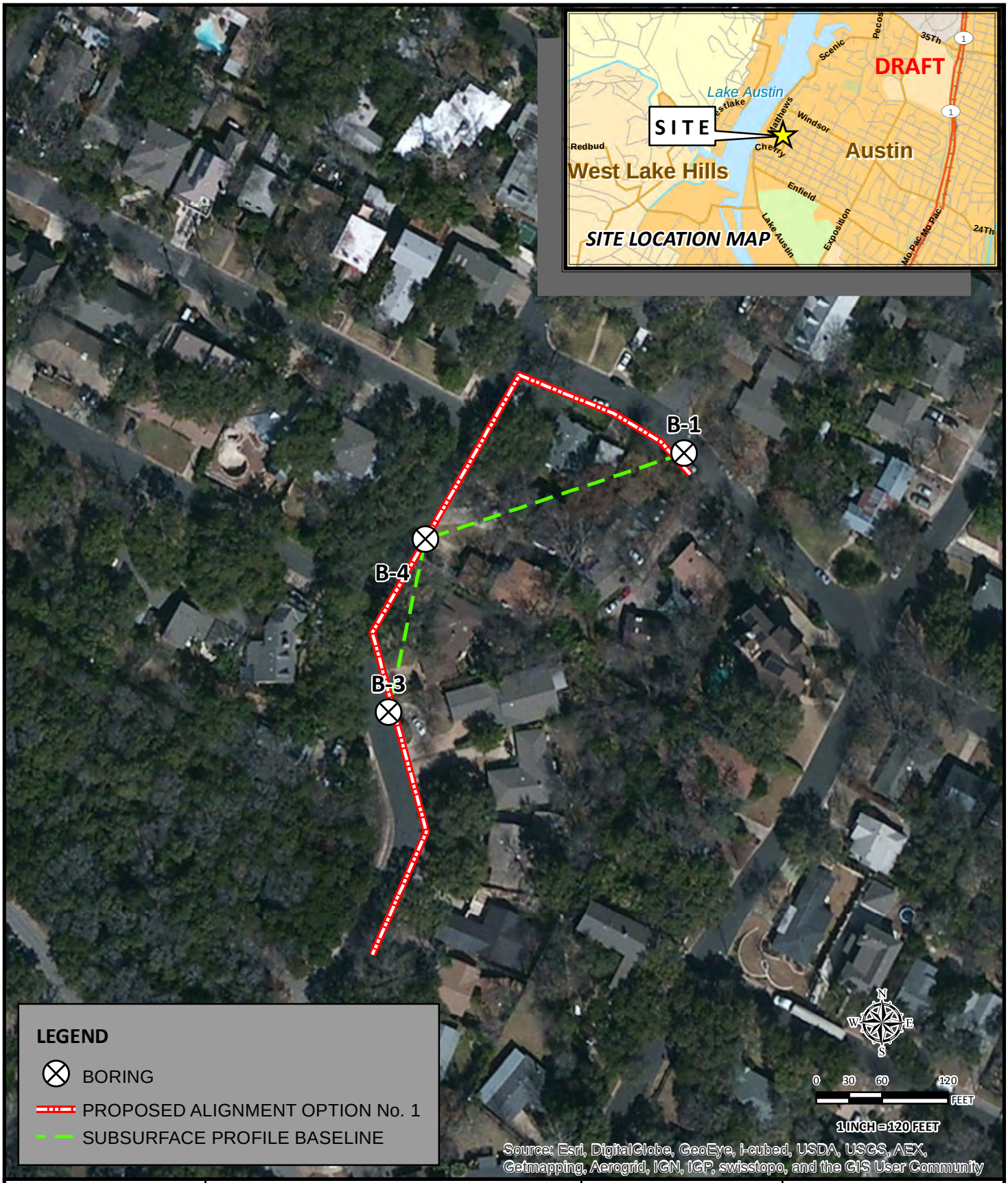
REVISIONS:

No.	DATE	DESCRIPTION

PROJECT No.: AAA12-057-00	
ISSUE DATE:	06/03/2013
DRAWN BY:	CCL
CHECKED BY:	YLG
REVIEWED BY:	GO

FIGURE 1

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes



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PROPOSED ALIGNMENT OPTION No.1

MEREDITH ST STORM DRAIN IMPROVEMENTS
AUSTIN, TEXAS

REVISIONS:

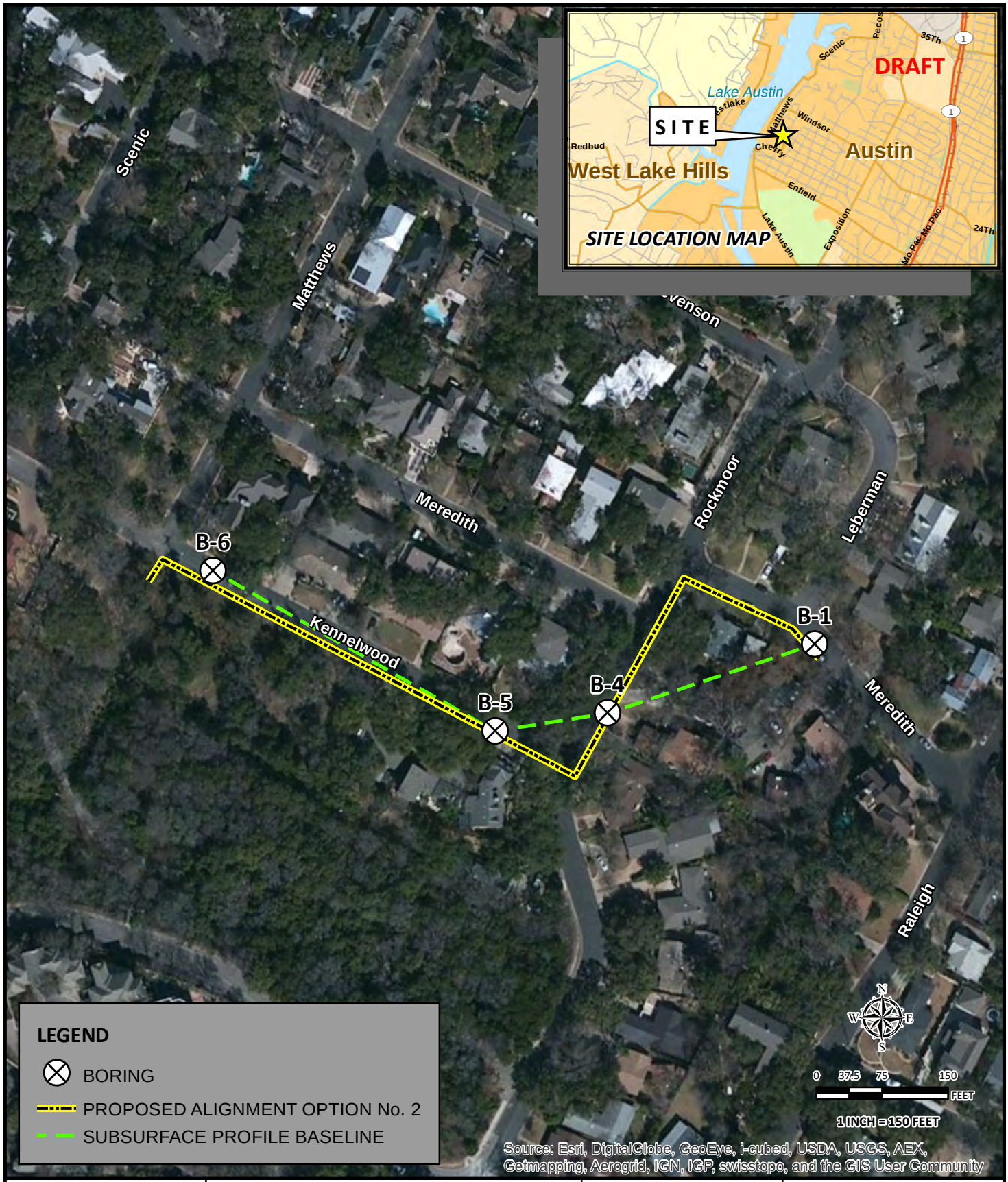
No.	DATE	DESCRIPTION

PROJECT No.: AAA12-057-00	
ISSUE DATE:	05/03/2013
DRAWN BY:	CCL
CHECKED BY:	YLG
REVIEWED BY:	GO

FIGURE

2A

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes



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PROPOSED ALIGNMENT OPTION No.2

MEREDITH ST STORM DRAIN IMPROVEMENTS
AUSTIN, TEXAS

REVISIONS:

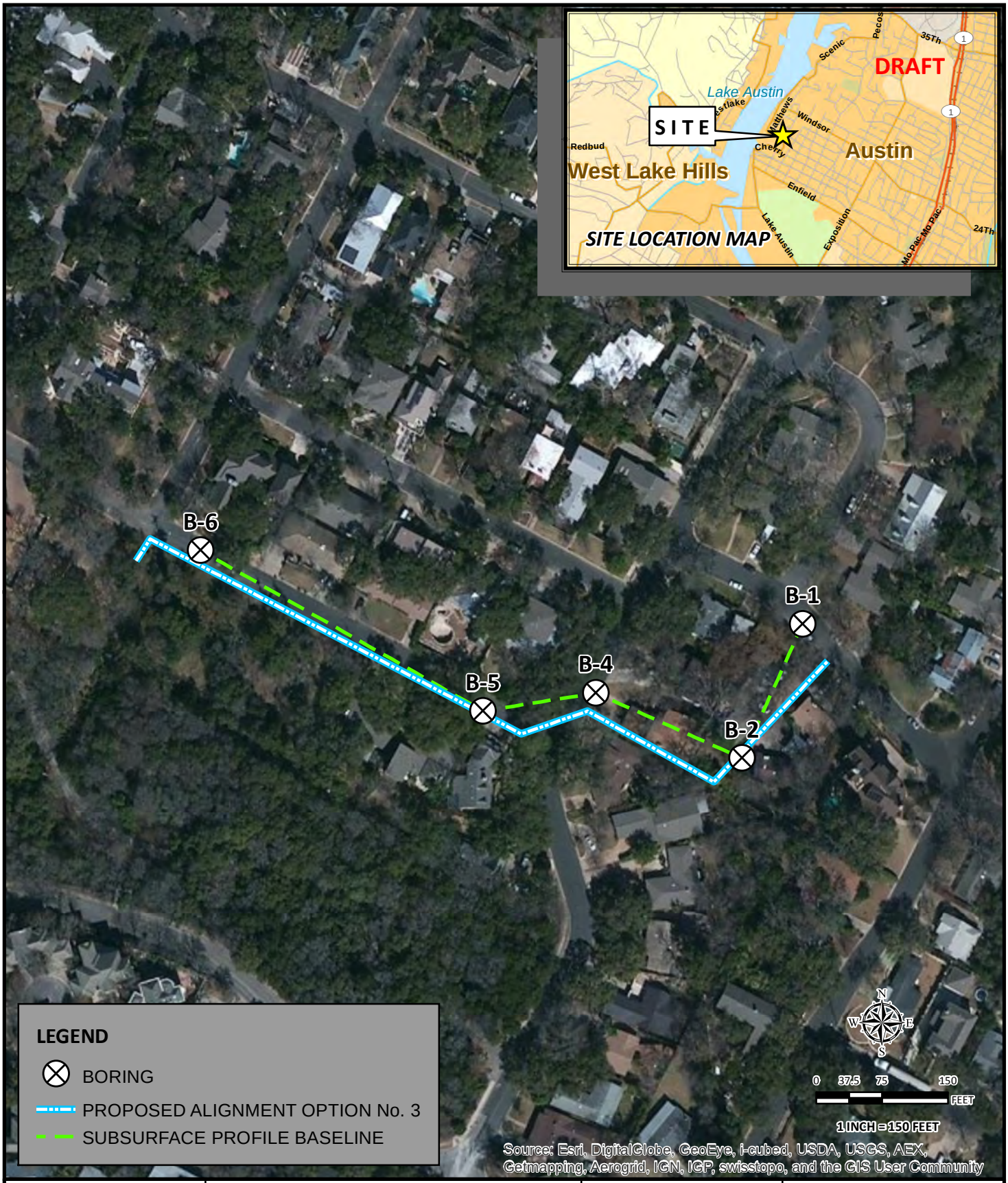
No.	DATE	DESCRIPTION

PROJECT No.: AAA12-057-00	
ISSUE DATE:	05/03/2013
DRAWN BY:	CCL
CHECKED BY:	YLG
REVIEWED BY:	GO

FIGURE

2B

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes



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PROPOSED ALIGNMENT OPTION No.3

MEREDITH ST STORM DRAIN IMPROVEMENTS
AUSTIN, TEXAS

REVISIONS:

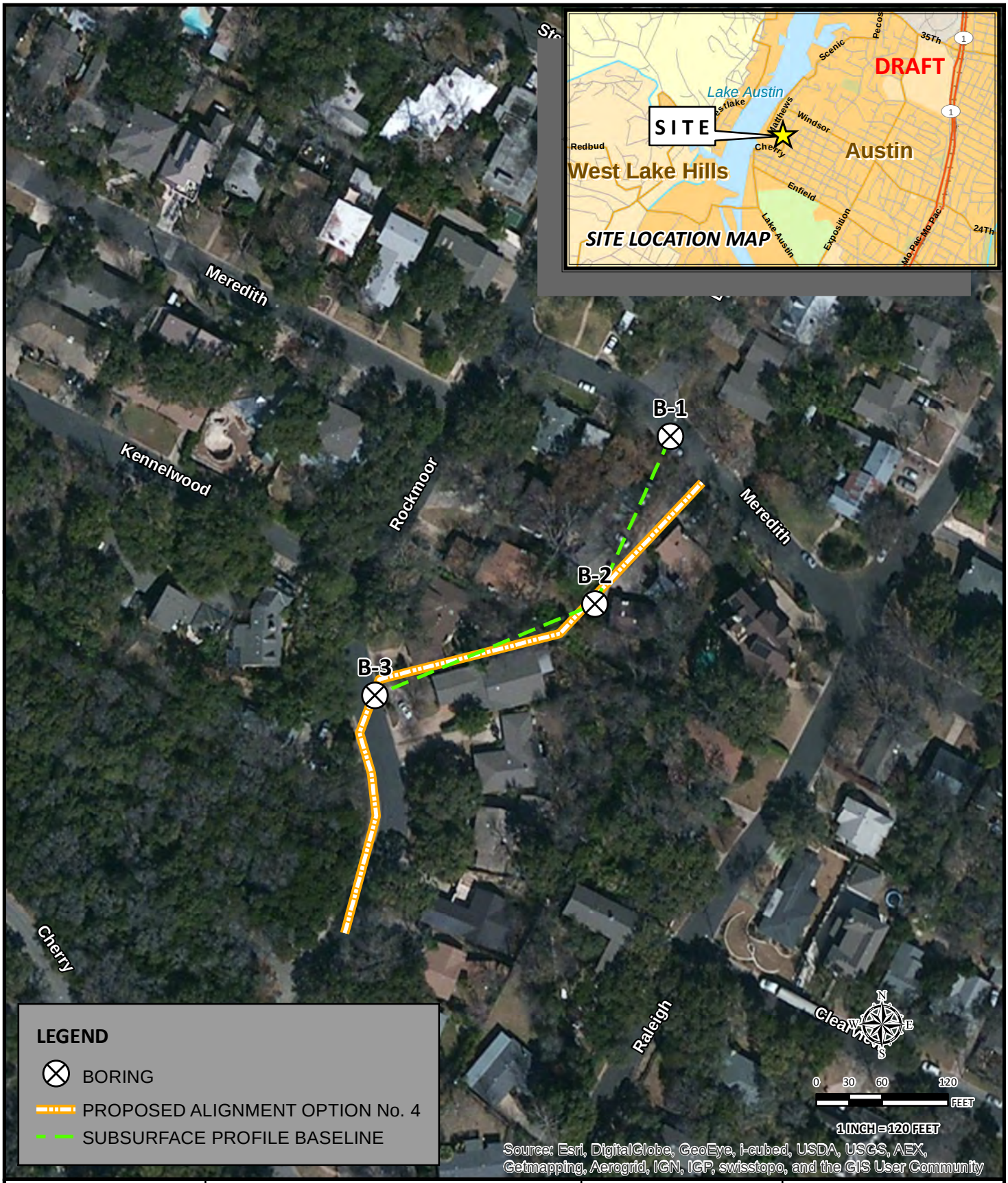
No.	DATE	DESCRIPTION

PROJECT No.: AAA12-057-00	
ISSUE DATE:	05/03/2013
DRAWN BY:	CCL
CHECKED BY:	YLG
REVIEWED BY:	GO

FIGURE

2C

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes



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PROPOSED ALIGNMENT OPTION No.4

MEREDITH ST STORM DRAIN IMPROVEMENTS
AUSTIN, TEXAS

REVISIONS:

No.	DATE	DESCRIPTION

PROJECT No.: AAA12-057-00	
ISSUE DATE:	05/03/2013
DRAWN BY:	CCL
CHECKED BY:	YLG
REVIEWED BY:	GO

FIGURE

2D

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

LOG OF BORING NO. B-1

Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRAFT

DRILLING METHOD: Air Rotary & Air Core

LOCATION: N 30.29934; W 97.77901

SURFACE ELEVATION: 551.39 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (3 inches)				
	BASE (9 inches)				
	FILL: CLAYEY GRAVEL (GC), Medium Dense to Loose, Brown, with traces of sand, cobbles and boulders	24		33	27
	- void, 3 to 4 ft (possible nesting)	ref/2"			
5		6		30	
		7			43
10	**LIMESTONE,** Hard, Moderately to Slightly Weathered, Highly Fractured, Tan (Edwards Group, Ked)				
	REC: 44% **RQD: 0%**				
	- void from 14 to 15 ft				
15		50/4"			
	REC: 95% **RQD: 18%**				
	- 4 to 6 in thick void at about 17 ft				
20	- 4 to 6 in thick void at about 20 ft				
	REC: 57% **RQD: 7%**		142		
	- 4 to 6 in thick void at about 22.5 ft				
25	**REC: 85%** **RQD: 17%**				
30	**REC: 85%** **RQD: 0%**				
35		ref/1"	111		
	REC: 77% **RQD: 26%**				

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT: 10 20 30 40 50 60 70 80

273.00

216.00

DEPTH DRILLED:	50.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA12-057-00
DATE DRILLED:	2/13/2013	**DATE MEASURED:**	2/13/2013	**FIGURE:**	3a

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-1

Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRAFT

DRILLING METHOD: Air Rotary & Air Core

LOCATION: N 30.29934; W 97.77901

SURFACE ELEVATION: 551.39 ft

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT^2 (0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70 80)	PLASTICITY INDEX	% -200
45			**LIMESTONE,** Hard, Moderately to Slightly Weathered, Highly Fractured, Tan (Edwards Group, Ked) *(continued)* **REC: 80%** **RQD: 0%**					
				ref/5"		●		
50			**REC: 78%** **RQD: 7%**					
55			NOTES: 1. Groundwater not encountered during drilling operations. 2. Borehole backfilled with auger cuttings, bentonite, concrete and asphalt.					
60								
65								
70								
75								

DEPTH DRILLED:	50.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA12-057-00
DATE DRILLED:	2/13/2013	**DATE MEASURED:**	2/13/2013	**FIGURE:**	3b

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-2

Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRAFT

DRILLING METHOD: Air Rotary & Air Core

LOCATION: N 30.29896; W 97.77920

SURFACE ELEVATION: 548.59 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (2 inches)				
	BASE (14 inches)				
	FILL: CLAYEY GRAVEL (GC), Medium Dense, Brown, with limestone fragments and tan gravelly clay seams and pockets	6			
		16		14	
5		24			
		18			26
		31			
10					
		17		30	41
15					
		19			
20	- void from about 21.5 to 22 ft				
	CLAY (CL), Gravelly, Lean, Very Stiff to Hard, Tan with sand and calcareous deposits (decomposed limestone)	23			
25					
	- chert, 28 to 30 ft	39		6	
30					
		ref/6"			
	LIMESTONE, Hard, Moderately Weathered, Highly Fractured, Tan (Edwards Group, Ked)				
35	**REC: 67%** **RQD: 0%**				

SHEAR STRENGTH, TONS/FT²

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT

10 20 30 40 50 60 70 80

DEPTH DRILLED:	55.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA12-057-00
DATE DRILLED:	2/12/2013	**DATE MEASURED:**	2/12/2013	**FIGURE:**	4a

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-2

Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRAFT

DRILLING METHOD: Air Rotary & Air Core

LOCATION: N 30.29896; W 97.77920

SURFACE ELEVATION: 548.59 ft

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT²	PLASTICITY INDEX	% -200
			LIMESTONE, Hard, Moderately Weathered, Highly Fractured, Tan (Edwards Group, Ked) *(continued)* - severely weathered above 40 ft **REC: 67%** **RQD: 22%**	50/3"				
45			**REC: 100%** **RQD: 37%**		156	490.00		
50			- gray with chert seams below 50 ft **REC: 93%** **RQD: 37%**					
55			NOTES: 1. Groundwater not encountered during drilling operations. 2. Borehole backfilled with auger cuttings, bentonite, concrete and asphalt.					
60								
65								
70								
75								

SHEAR STRENGTH, TONS/FT²: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH DRILLED:	55.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA12-057-00
DATE DRILLED:	2/12/2013	**DATE MEASURED:**	2/12/2013	**FIGURE:**	4b

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-3

Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRAFT

DRILLING METHOD: Air Rotary & Air Core

LOCATION: N 30.29879; W 97.77996

SURFACE ELEVATION: 537.94 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
0	**ASPHALT** (2 inches)				
	BASE (8 inches)				
	CLAY (CL), Lean, Stiff to Very Stiff, Tan, with calcareous deposits and trace limestone fragments	8			
		26		16	
		ref/3"			
5	**LIMESTONE,** Hard to Very Hard, Moderately Weathered, Highly Fractured, Tan, with intermittent chert seams (Edwards Group, Ked) **REC: 80% RQD: 42%**				
10	**REC: 62% RQD: 25%**		152		
	- 6-inch void at about 13 ft				
15	- severely weathered seams, 15 to 20 ft				
	REC: 85% RQD: 13%				
20	**REC: 67% RQD: 0%**				
25		ref/1.5"			
	REC: 99% RQD: 0%				
30		ref/1"			
	REC: 92% RQD: 49%				
35	- highly weathered seams, vuggy below 35 ft				
	REC: 47% RQD: 7%		155		

SHEAR STRENGTH, TONS/FT^2

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT

10 20 30 40 50 60 70 80

414.00

265.00

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	50.1 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA12-057-00
DATE DRILLED:	2/12/2013	**DATE MEASURED:**	2/12/2013	**FIGURE:**	5a

LOG OF BORING NO. B-3

Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRAFT

DRILLING METHOD: Air Rotary & Air Core

LOCATION: N 30.29879; W 97.77996

SURFACE ELEVATION: 537.94 ft

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT^2	PLASTICITY INDEX	% -200
45			**LIMESTONE,** Hard to Very Hard, Moderately Weathered, Highly Fractured, Tan, with intermittent chert seams (Edwards Group, Ked) *(continued)* **REC: 43%** **RQD: 7%**					
			REC: 80% **RQD: 0%**					
50				ref/1"				
55			NOTES: 1. Groundwater not encountered during drilling operations. 2. Borehole backfilled with auger cuttings, bentonite, concrete and asphalt.					
60								
65								
70								
75								

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH DRILLED:	50.1 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA12-057-00
DATE DRILLED:	2/12/2013	**DATE MEASURED:**	2/12/2013	**FIGURE:**	5b

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-4

Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRAFT

DRILLING METHOD: Air Rotary & Air Core

LOCATION: N 30.29916; W 97.77979

SURFACE ELEVATION: 552.03 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0)	PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70 80)	PLASTICITY INDEX	% -200
0	**ASPHALT** (2 inches)						
	BASE (10 inches)						
	CLAY (CH), Fat, Gravelly, Hard, Dark Brown, with limestone fragments	40				42	
	CLAY (CL), Lean, Hard, Tan, with gravel and calcareous deposits (decomposed limestone)	23					
5		50/4"					
		50/11.5"				8	
		ref/6"					73
10							
		ref/2"					
15	**LIMESTONE,** Hard, Moderately Weathered, Highly Fractured, Tan (Edwards Group, Ked)						
	REC: 100% **RQD: 7%**						
20	**REC: 87%** **RQD: 0%**						
25		50/8.5"					
	REC: 100% **RQD: 28%** - with intermittent 3 to 4 inch voids from 28 to 40 ft						
30	- vuggy, 30 to 40 ft						
	REC: 22% **RQD: 0%**						
35		23					
	REC: 33% **RQD: 0%**						

DEPTH DRILLED:	50.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA12-057-00
DATE DRILLED:	2/11/2013	**DATE MEASURED:**	2/11/2013	**FIGURE:**	6a

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-4

Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRAFT

DRILLING METHOD: Air Rotary & Air Core

LOCATION: N 30.29916; W 97.77979

SURFACE ELEVATION: 552.03 ft

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT²	PLASTICITY INDEX	% -200
45			**LIMESTONE,** Hard, Moderately Weathered, Highly Fractured, Tan (Edwards Group, Ked) *(continued)* - tan clay layer at 40 ft **REC: 86%** **RQD: 18%**	50/7"	118	192.00		
50			- intermittent 3 to 4 in void from 45 to 50 ft **REC: 38%** **RQD: 10%**					
55			NOTES: 1. Groundwater not encountered during drilling operations. 2. Borehole backfilled with auger cuttings, bentonite, concrete and asphalt.					
60								
65								
70								
75								

SHEAR STRENGTH, TONS/FT²: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
PLASTIC LIMIT · WATER CONTENT · LIQUID LIMIT
10 20 30 40 50 60 70 80

DEPTH DRILLED:	50.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA12-057-00
DATE DRILLED:	2/11/2013	**DATE MEASURED:**	2/11/2013	**FIGURE:**	6b

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-5

Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRAFT

DRILLING METHOD: Air Rotary & Air Core

LOCATION: N 30.29907; W 97.78018

SURFACE ELEVATION: 549.29 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (2 inches)				
	BASE (8 inches)	50/10.5"			
	LIMESTONE, Moderately Hard, Intensely to Highly Weathered, Highly Fractured, Tan, with intermittent clay seams (Edwards Group, Ked)	ref/6"		6	
5		50/2.5"			
	REC: 12% **RQD: 0%**				
10		ref/1"			
	REC: 17% **RQD: 0%**				
15					
	REC: 0% **RQD: 0%**				
20		ref/1.5"			
	REC: 42% **RQD: 0%**				
25		ref/1"			
	REC: 30% **RQD: 0%**				
30		ref/2"			
	LIMESTONE, Hard, Moderate to Slightly Weathered, Highly Fractured, Tan, with clay seams (Edwards Group, Ked) **REC: 70%** **RQD: 0%**				
35		ref/3"			
	REC: 53% **RQD: 0%**				

SHEAR STRENGTH, TONS/FT^2: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT: 10 20 30 40 50 60 70 80

DEPTH DRILLED:	50.8 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA12-057-00
DATE DRILLED:	2/8/2013	**DATE MEASURED:**	2/8/2013	**FIGURE:**	7a

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-5

Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRAFT

DRILLING METHOD: Air Rotary & Air Core

LOCATION: N 30.29907; W 97.78018

SURFACE ELEVATION: 549.29 ft

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70 80)	PLASTICITY INDEX	% -200
			LIMESTONE, Hard, Moderate to Slightly Weathered, Highly Fractured, Tan, with clay seams (Edwards Group, Ked) *(continued)* **REC: 45% RQD: 0%**	ref/1"				
45			- with calcite deposits and reddish-brown clay filled vugs below 45 ft **REC: 43% RQD: 0%**	ref/4.5"				
50				50/3"				
55								
60								
65								
70								
75								

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings, bentonite, concrete and asphalt.

DEPTH DRILLED:	50.8 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA12-057-00
DATE DRILLED:	2/8/2013	**DATE MEASURED:**	2/8/2013	**FIGURE:**	7b

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-6

Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRAFT

DRILLING METHOD: Air Rotary & Air Core

LOCATION: N 30.29961; W 97.78113

SURFACE ELEVATION: 532.03 ft

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT, (2 inches)				
	BASE, (10 inches)				
	CLAY, Lean, Hard, Tan, with calcareous deposits, with traces of limestone fragments and intermittent limestone seams (decomposed limestone)	25			
		30		5	
5		50/9.5"			
		ref/1"			
		50/9"		9	
10					
		34			
15	**LIMESTONE,** Moderately Hard, Intensely to Highly Weathered, Highly Fractured, Tan, with intermittent clay pockets and seams (Edwards Group, Ked)				
		18		34	
20					
		50/6"			
25					
		ref/5"			
30	- limestone seams, 31 to 33 ft				
	- gray chert below about 33 ft				
	- limestone seams at 35 to 44 ft	45			
35					
		40			

SHEAR STRENGTH, TONS/FT²

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT

10 20 30 40 50 60 70 80

DEPTH DRILLED:	50.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA12-057-00
DATE DRILLED:	2/12/2013	**DATE MEASURED:**	2/12/2013	**FIGURE:**	8a

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. B-6

Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRAFT

DRILLING METHOD: Air Rotary & Air Core

LOCATION: N 30.29961; W 97.78113

SURFACE ELEVATION: 532.03 ft

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	SHEAR STRENGTH, TONS/FT² (0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0)	PLASTICITY INDEX	% -200
			LIMESTONE, Moderately Hard, Intensely to Highly Weathered, Highly Fractured, Tan, with intermittent clay pockets and seams (Edwards Group, Ked) *(continued)*					
				ref/1.5"		●		
45			**LIMESTONE,** Very Hard, Vuggy, Tan, with reddish brown clay filled vugs (Edwards Group, Ked) **REC: 90%** **RQD: 25%**		155	484.00 ⊗		
50								
55								
60								
65								
70								
75								

PLASTIC LIMIT ⊗ WATER CONTENT ● LIQUID LIMIT ⊗ (10 20 30 40 50 60 70 80)

NOTES:
1. Groundwater not encountered during drilling operations.
2. Borehole backfilled with auger cuttings, bentonite, concrete and asphalt.

DEPTH DRILLED:	50.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	AAA12-057-00
DATE DRILLED:	2/12/2013	**DATE MEASURED:**	2/12/2013	**FIGURE:**	8b

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

KEY TO TERMS AND SYMBOLS

DRAFT

MATERIAL TYPES

SOIL TERMS


CALCAREOUS


CALICHE


CLAY


CLAYEY


GRAVEL


GRAVELLY


PEAT


SAND


SANDY


SILT


SILTY


FILL

ROCK TERMS


CHALK


CLAYSTONE


CLAY-SHALE


CONGLOMERATE


DOLOMITE


IGNEOUS


LIMESTONE


MARL


METAMORPHIC


SANDSTONE


SHALE


SILTSTONE

OTHER


ASPHALT


BASE


CONCRETE/CEMENT


BRICKS / PAVERS


WASTE


NO INFORMATION

WELL CONSTRUCTION AND PLUGGING MATERIALS


BLANK PIPE


SCREEN


BENTONITE


CEMENT GROUT


BENTONITE & CUTTINGS


CONCRETE/CEMENT


CUTTINGS


GRAVEL


SAND


VOLCLAY

SAMPLE TYPES

AIR ROTARY

GRAB SAMPLE

CORE

GEOPROBE SAMPLER

ROTOSONIC -DAMAGED

MUD ROTARY

NO RECOVERY

NX CORE

PITCHER

ROTOSONIC -INTACT

SHELBY TUBE

SPLIT BARREL

SPLIT SPOON

TEXAS CONE PENETROMETER

DISTURBED

STRENGTH TEST TYPES

POCKET PENETROMETER

TORVANE

UNCONFINED COMPRESSION

TRIAXIAL COMPRESSION UNCONSOLIDATED-UNDRAINED

TRIAXIAL COMPRESSION CONSOLIDATED-UNDRAINED

NOTE: VALUES SYMBOLIZED ON BORING LOGS REPRESENT SHEAR STRENGTHS UNLESS OTHERWISE NOTED

PROJECT NO. AAA12-057-00

RABA KISTNER

REVISED 04/2012

FIGURE 9a

KEY TO TERMS AND SYMBOLS (CONT'D)

DRAFT

TERMINOLOGY

Terms used in this report to describe soils with regard to their consistency or conditions are in general accordance with the discussion presented in Article 45 of SOILS MECHANICS IN ENGINEERING PRACTICE, Terzaghi and Peck, John Wiley & Sons, Inc., 1967, using the most reliable information available from the field and laboratory investigations. Terms used for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in American Society for Testing and Materials D2487-06 and D2488-00, Volume 04.08, Soil and Rock; Dimension Stone; Geosynthetics; 2005.

The depths shown on the boring logs are not exact, and have been estimated to the nearest half-foot. Depth measurements may be presented in a manner that implies greater precision in depth measurement, i.e 6.71 meters. The reader should understand and interpret this information only within the stated half-foot tolerance on depth measurements.

RELATIVE DENSITY

Penetration Resistance Blows per ft	Relative Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
> 50	Very Dense

COHESIVE STRENGTH

Resistance Blows per ft	Consistency	Cohesion TSF
0 - 2	Very Soft	0 - 0.125
2 - 4	Soft	0.125 - 0.25
4 - 8	Firm	0.25 - 0.5
8 - 15	Stiff	0.5 - 1.0
15 - 30	Very Stiff	1.0 - 2.0
> 30	Hard	> 2.0

PLASTICITY

Plasticity Index	Degree of Plasticity
0 - 5	None
5 - 10	Low
10 - 20	Moderate
20 - 40	Plastic
> 40	Highly Plastic

ABBREVIATIONS

B = Benzene
T = Toluene
E = Ethylbenzene
X = Total Xylenes
BTEX = Total BTEX
TPH = Total Petroleum Hydrocarbons
ND = Not Detected
NA = Not Analyzed
NR = Not Recorded/No Recovery
OVA = Organic Vapor Analyzer
ppm = Parts Per Million

Qam, Qas, Qal = Quaternary Alluvium
Qat = Low Terrace Deposits
Qbc = Beaumont Formation
Qt = Fluviatile Terrace Deposits
Qao = Seymour Formation
Qle = Leona Formation
Q-Tu = Uvalde Gravel
Ewi = Wilcox Formation
Emi = Midway Group
Mc = Catahoula Formation
El = Laredo Formation
Kknm = Navarro Group and Marlbrook Marl
Kpg = Pecan Gap Chalk
Kau = Austin Chalk

Kef = Eagle Ford Shale
Kbu = Buda Limestone
Kdr = Del Rio Clay
Kft = Fort Terrett Member
Kgt = Georgetown Formation
Kep = Person Formation
Kek = Kainer Formation
Kes = Escondido Formation
Kew = Walnut Formation
Kgr = Glen Rose Formation
Kgru = Upper Glen Rose Formation
Kgrl = Lower Glen Rose Formation
Kh = Hensell Sand

KEY TO TERMS AND SYMBOLS (CONT'D)

DRAFT

TERMINOLOGY

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.
Carbonate	Having more than 50% carbonate content.

SAMPLING METHODS

RELATIVELY UNDISTURBED SAMPLING

Cohesive soil samples are to be collected using three-inch thin-walled tubes in general accordance with the Standard Practice for Thin-Walled Tube Sampling of Soils (ASTM D1587) and granular soil samples are to be collected using two-inch split-barrel samplers in general accordance with the Standard Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586). Cohesive soil samples may be extruded on-site when appropriate handling and storage techniques maintain sample integrity and moisture content.

STANDARD PENETRATION TEST (SPT)

A 2-in.-OD, 1-3/8-in.-ID split spoon sampler is driven 1.5 ft into undisturbed soil with a 140-pound hammer free falling 30 in. After the sampler is seated 6 in. into undisturbed soil, the number of blows required to drive the sampler the last 12 in. is the Standard Penetration Resistance or "N" value, which is recorded as blows per foot as described below.

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

NOTE: To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

DRAFT

FILE NAME: AAA12-057-00 MEREDITH (BORING LOGS).GPJ 6/3/2013

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-1	1.0 to 2.5	24	10	50	17	33	GC				
	2.5 to 2.7	ref/2"	5						27		
	3.0 to 4.0										
	6.5 to 8.0	6	14	49	19	30	GC				
	8.5 to 10.0	7	10						43		
	12.0 to 15.0										
	15.0 to 15.8	50/4"	4								
	15.8 to 20.0										
	20.0 to 25.0							142		273.00	UC
	25.0 to 30.0										
	30.0 to 35.0										
	35.0 to 35.1	ref/1"	4					111		216.00	UC
	35.1 to 40.0										
	40.0 to 45.0										
	45.0 to 45.4	ref/5"	6								
	45.4 to 50.0										
B-2	1.0 to 2.5	6	9								
	2.5 to 4.0	16	5	27	13	14	GC				
	4.5 to 6.0	24	9								
	6.5 to 8.0	18	6						26		
	8.5 to 10.0	31	8								
	13.5 to 15.0	17	13	47	17	30	SC		41		
	18.5 to 20.0	19	10								
	23.5 to 25.0	23	7								
	28.5 to 30.0	39	7	23	17	6	CL				
	33.5 to 34.0	ref/6"	30								
	35.0 to 40.0										
	40.0 to 40.8	50/3"	4								
	40.8 to 45.0										
	45.0 to 50.0							156		490.00	UC
	50.0 to 55.0										
B-3	1.0 to 2.5	8	23								
	2.5 to 4.0	26	22	44	28	16	CL				
	4.5 to 4.8	ref/3"	3								
	5.0 to 10.0										
	10.0 to 15.0							152		414.00	UC
	15.0 to 20.0										
	20.0 to 25.0										
	25.0 to 25.1	ref/1.5"	2								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. AAA12-057-00

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

DRAFT

FILE NAME: AAA12-057-00 MEREDITH (BORING LOGS).GPJ 6/3/2013

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-3	25.1 to 30.0										
	30.0 to 30.1	ref/1"	3								
	30.1 to 35.0										
	35.0 to 40.0							155		265.00	UC
	40.0 to 45.0										
	45.0 to 50.0										
	50.0 to 50.1	ref/1"	4								
B-4	1.0 to 2.5	40	21	64	22	42	CH				
	2.5 to 4.0	23	11								
	4.5 to 5.4	50/4"	14								
	6.5 to 8.0	50/11.5"	8	28	20	8	CL				
	8.5 to 9.0	ref/6"	11						73		
	13.5 to 13.7	ref/2"	6								
	15.0 to 20.0										
	20.0 to 25.0										
	25.0 to 26.2	50/8.5"	4								
	26.2 to 30.0										
	30.0 to 35.0										
	35.0 to 36.5	23	2								
	36.5 to 40.0										
	40.0 to 41.1	50/7"	29					118		192.00	UC
	41.1 to 45.0										
	45.0 to 50.0										
B-5	1.0 to 2.4	50/10.5"	6								
	2.5 to 3.0	ref/6"	4	27	21	6	CL				
	4.5 to 5.2	50/2.5"	4								
	5.0 to 10.0										
	10.0 to 10.1	ref/1"	3								
	10.1 to 15.0										
	15.0 to 20.0										
	20.0 to 20.1	ref/1.5"	4								
	20.1 to 25.0										
	25.0 to 25.1	ref/1"	2								
	25.1 to 30.0										
	30.0 to 30.2	ref/2"	1								
	30.2 to 35.0										
	35.0 to 35.3	ref/3"	3								
	35.3 to 40.0										
	40.0 to 40.1	ref/1"	2								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. AAA12-057-00

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Meredith Street Storm Drain Improvements
Meredith St, Rockmoor Ave, Kennelwood Rd and Cherry Ln
Austin, Texas

DRAFT

FILE NAME: AAA12-057-00 MEREDITH (BORING LOGS).GPJ 6/3/2013

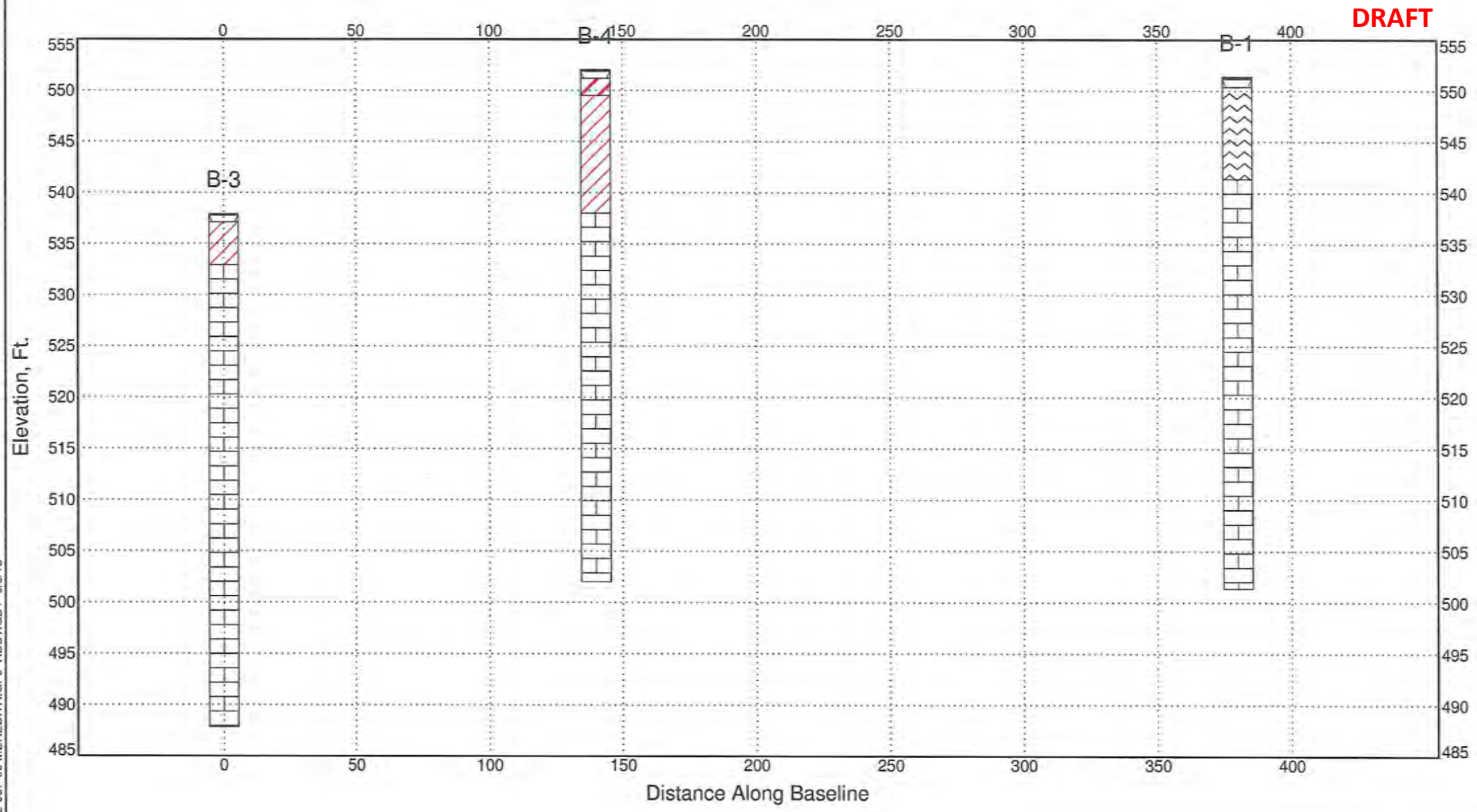
Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
B-5	40.1 to 45.0										
	45.0 to 45.4	ref/4.5"	1								
	45.4 to 50.0										
	50.0 to 50.8	50/3"	1								
B-6	1.0 to 2.5	25	11								
	2.5 to 4.0	30	14	28	23	5	CL				
	4.5 to 5.8	50/9.5"	16								
	6.5 to 6.6	ref/1"	4								
	8.5 to 9.8	50/9"	11	25	16	9	CL				
	13.5 to 15.0	34	6								
	18.5 to 20.0	18	17	50	16	34	CH				
	23.5 to 24.5	50/6"	11								
	28.5 to 28.9	ref/5"	4								
	33.5 to 35.0	45	24								
	38.5 to 40.0	40	3								
	43.5 to 43.6	ref/1.5"	4								
	45.0 to 50.0							155		484.00	UC

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. AAA12-057-00

DRAFT



GENERAL NOTES

1. See Figure 1 and 2A for approximate location of borings.
2. Soil stratigraphy has been determined at boring locations only. Actual conditions may differ from the profile shown here.
3. See Figure 9a for classifications and symbols used on this profile.
4. Top of boring elevations provided by Landmark Surveying.
5. Distances between borings are not to scale.

GENERALIZED SUBSURFACE PROFILE

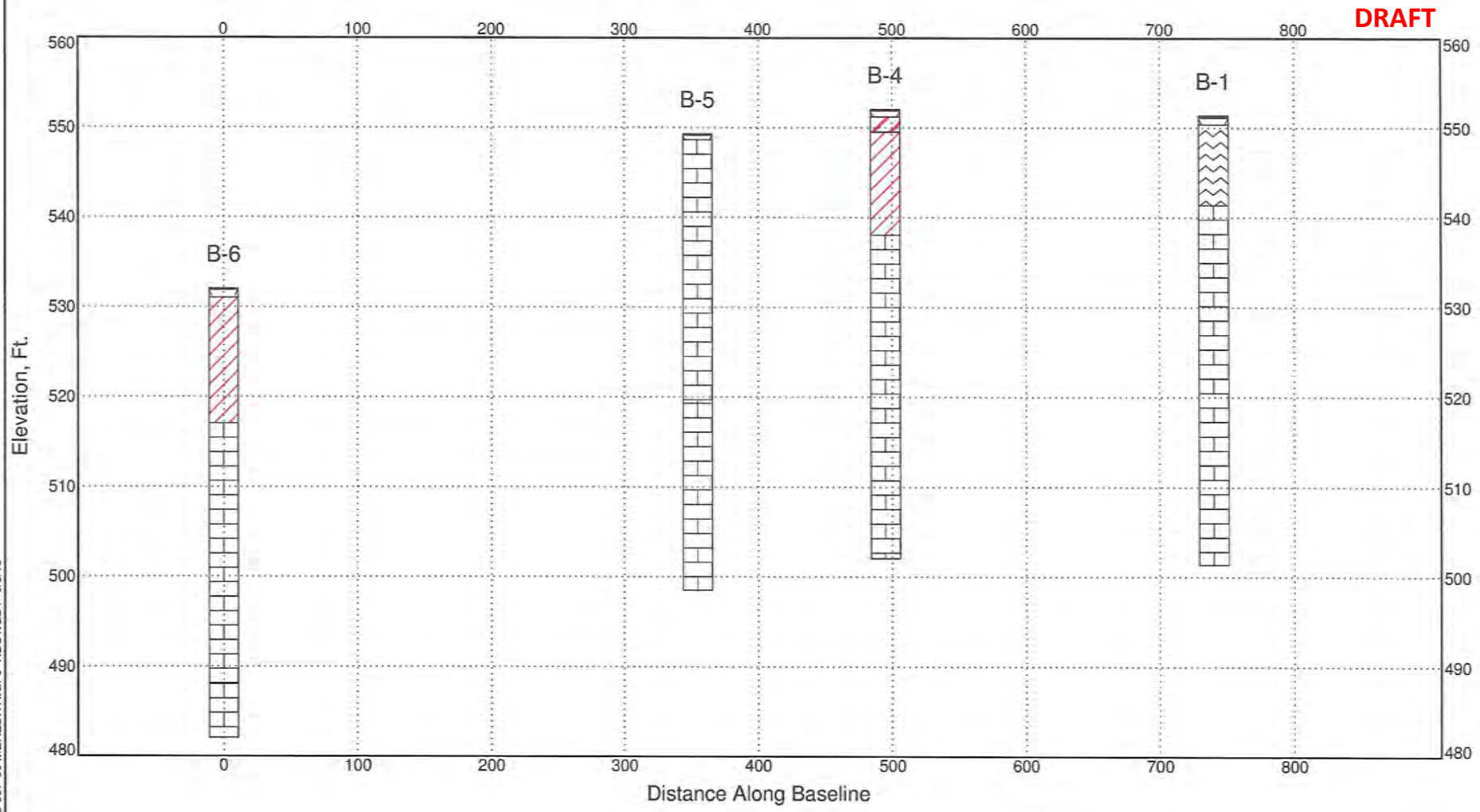
Meredith Street Storm Drain Improvements

Proposed Alignment Option No. 1

PROJECT #	DATE	PLATE
AAA12-057-00	June 3, 2013	11

HCFCDFENCE FENCE DIAGRAMS 6.3.13. AAA12-057-00 MEREDITH.GPJ HBC1.GDT 6/3/13

DRAFT



GENERAL NOTES

1. See Figure 1 and 2B for approximate location of borings.
2. Soil stratigraphy has been determined at boring locations only. Actual conditions may differ from the profile shown here.
3. See Figure 9a for classifications and symbols used on this profile.
4. Top of boring elevations provided by Landmark Surveying.
5. Distances between borings are not to scale.

GENERALIZED SUBSURFACE PROFILE

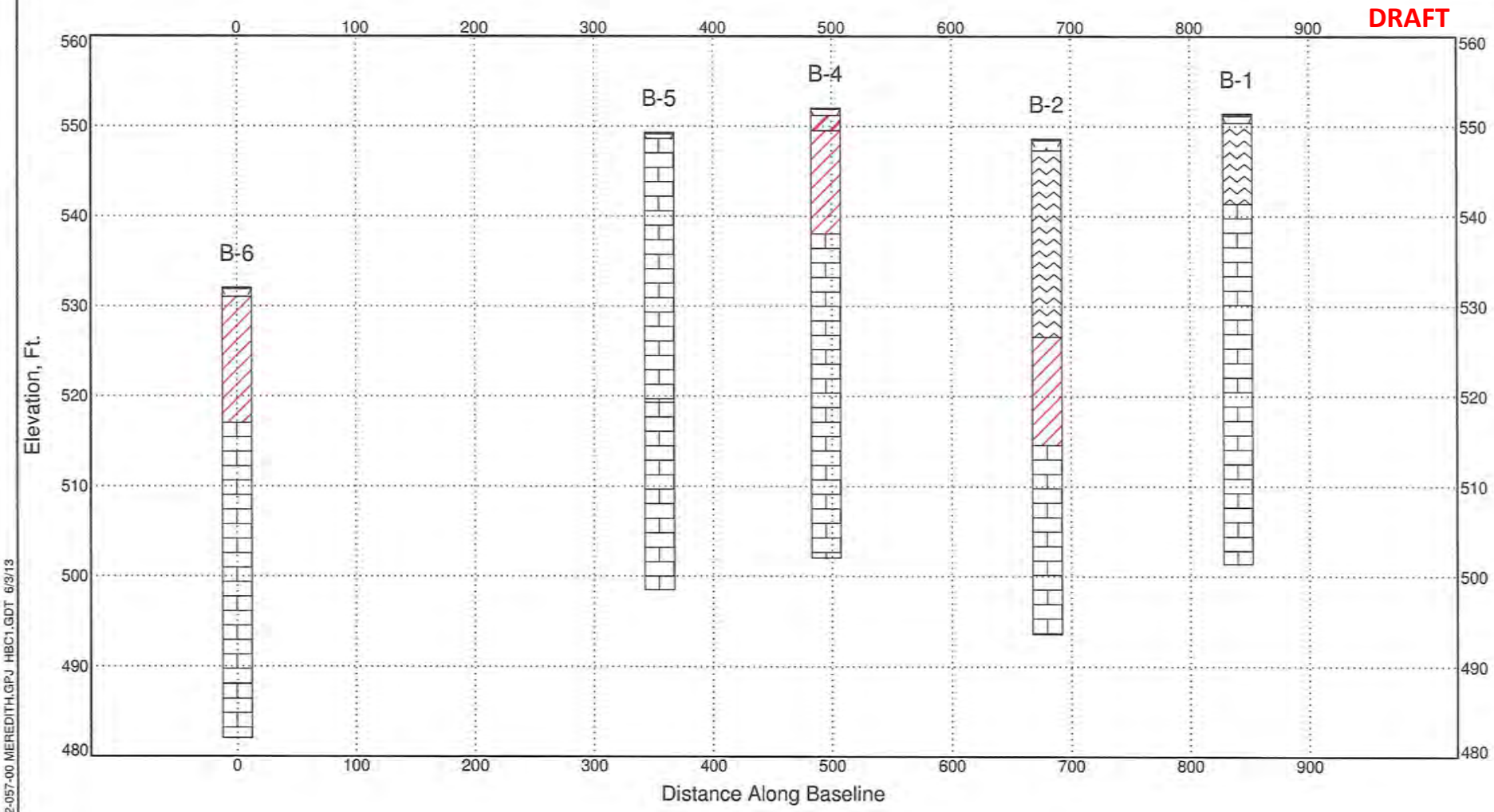
Meredith Street Storm Drain Improvements

Proposed Alignment Option No. 2

PROJECT #	DATE	PLATE
AAA12-057-00	June 3, 2013	12

HCFCDFENCE FENCE DIAGRAMS 6.3.13. AAA12-057-00 MEREDITH.GPJ HBC1.GDT 6/3/13

DRAFT



GENERAL NOTES

1. See Figure 1 and 2C for approximate location of borings.
2. Soil stratigraphy has been determined at boring locations only. Actual conditions may differ from the profile shown here.
3. See Figure 9a for classifications and symbols used on this profile.
4. Top of boring elevations provided by Landmark Surveying.
5. Distances between borings are not to scale.

GENERALIZED SUBSURFACE PROFILE

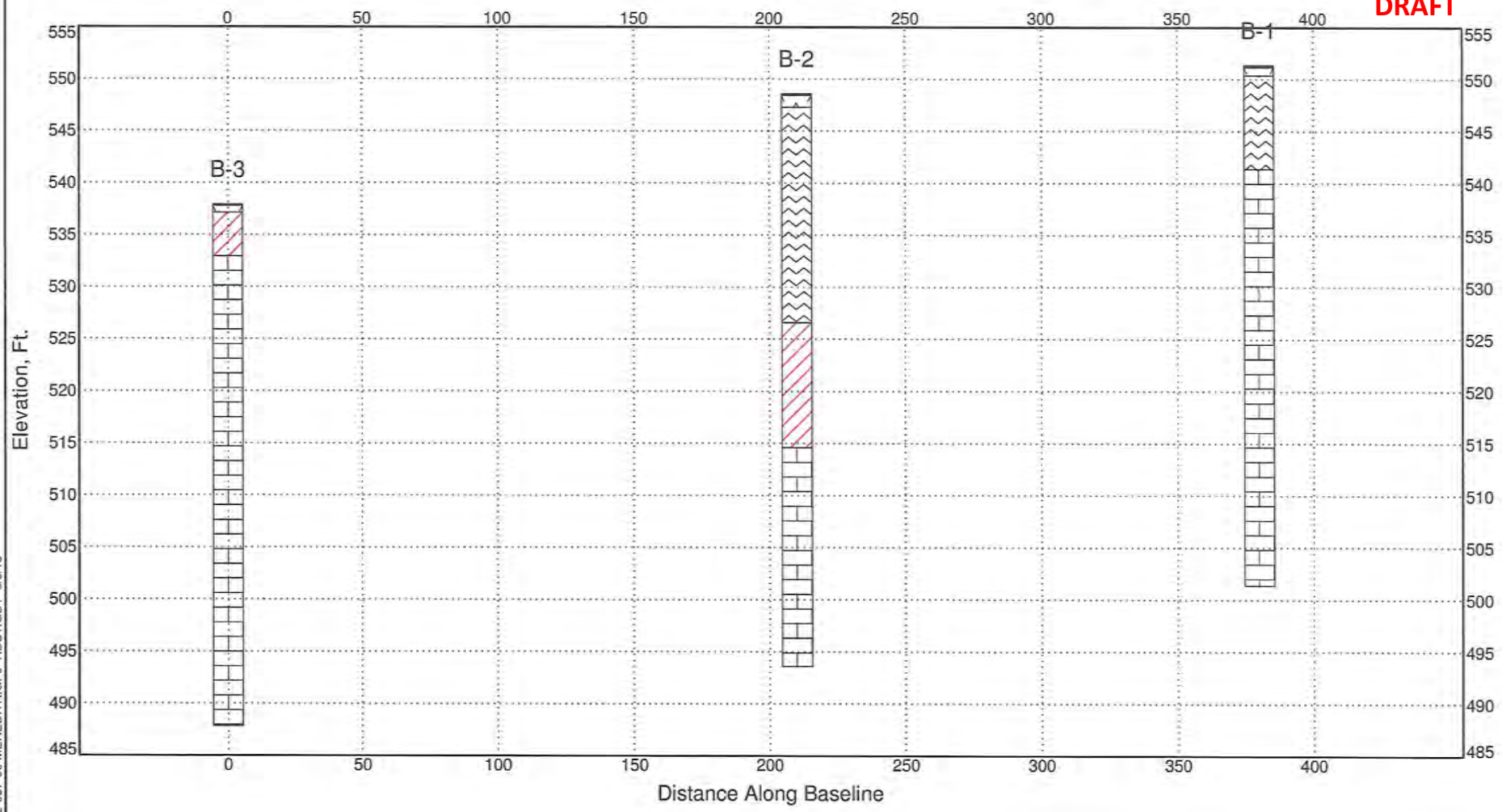
Meredith Street Storm Drain Improvements

Proposed Alignment Option No. 3

PROJECT #	DATE	PLATE
AAA12-057-00	June 3, 2013	13

HCFCDFENCE FENCE DIAGRAMS 6.3.13. AAA12-057-00 MEREDITH.GPJ HBC1.GDT 6/3/13

DRAFT



GENERAL NOTES

1. See Figure 1 and 2D for approximate location of borings.
2. Soil stratigraphy has been determined at boring locations only. Actual conditions may differ from the profile shown here.
3. See Figure 9a for classifications and symbols used on this profile.
4. Top of boring elevations provided by Landmark Surveying.
5. Distances between borings are not to scale.

GENERALIZED SUBSURFACE PROFILE

Meredith Street Storm Drain Improvements

Proposed Alignment Option No. 4

PROJECT #	DATE	PLATE
AAA12-057-00	June 3, 2013	14

HCFCDFENCE FENCE DIAGRAMS 6.3.13. AAA12-057-00 MEREDITH.GPJ HBC1.GDT 6/3/13

APPENDIX A – GEOPHYSICAL SURVEY REPORT

DRAFT

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Geophysical Survey Report
Meredith Street and Rockmoor Avenue
Edwards Aquifer Recharge Zone
Austin, Texas

March, 2013

Prepared for:
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EXECUTIVE SUMMARY

Environmental Geophysics Associates (EGA) was retained by **Raba Kistner Consultants, Inc**. to perform geophysical surveys (resistivity and natural potential) at a neighborhood site situated between Meredith Street and Rockmoor Avenue in the southwest Austin, Texas.

Resistivity and NP results obtained from two profiles (profiles G1 and G2) provided significant information on the geological characterization of the site and karstic features. The resistivity data along profile G1 indicated a chaotic structure where low resistivity (fill based on soil boring), medium resistivity (Georgetown Limestone), and high resistivity (Edwards Limestone) units are exposed. The inhomogeneous structure of the resistivity data is probably due to the fact that the site used to be a quarry where blasting of rocks and refilling of the quarry was a random practice. The top of the Edwards Limestone showed an irregular geometry along profile G1, which is probably caused by the blasting and cave development within the Limestone. Presence of low and high NP data along the resistivity data supports this interpretation. It should be noted that the first segment (A) of profile G1 also indicates a significant fracture or fault.

The resistivity data along profile G2 provide a significant low resistivity zone, where Del Rio Clay appears to be sandwiched between Georgetown Limestone. This low resistive zone could be caused by a major fault and correlates well with the low NP anomaly.

In summary, locations of the karstic anomalies were marked on a site map and provided in Figure 16.

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Figure 7. Resistivity data along the segment A of profile G1. Locations of the wood fence and borehole location of B-3 are given for references.

Figure 8. Resistivity data along segments B and C. Locations of the wood fence, borehole location B-2, drainage present along the profile and the width of Meredith Street are shown for reference purposes.

Figure 9. Resistivity data along profile G2. Borehole location B-4 on Rockmoor Avenue, yard gate and wood fence are shown for reference purposes. A low resistivity zone between the yard gate and the wood fence appears to be significant.

Figure 10. Natural potential (NP) data along segment A of profile G1. Note the locations of B-3 and wood fence for reference purposes. The NP data does not indicate any karstic feature such as cave; but do show significant smooth variation. This type of anomaly is usually indicative of lithologic change, a fault which juxtaposes two different hydrologic units.

Figure 11. NP data along the combined segments of B and C of profile G1. Note the presence of high and low NP values along the profile. Both high and low NP values could be caused by karstic features.

Figure 12. NP data along profile G2. Locations of B-4 yard gate, wood fence are shown for reference purposes. A smooth low NP anomaly is characteristic of this profile, which may indicate a lithologic change, a zone of infiltration of water, along the profile.

Figure 13. Correlation of resistivity and NP data along segment A of profile G1.

Figure 14. Correlation of resistivity and NP data along segments of B and C of profile G1. Low NP values do not correspond to any significant resistivity anomalies in the top 35 feet below the surface. It is possible that the sources of these NP anomalies may be deeper.

Figure 15. Correlation of resistivity and NP data along profile G2.

Figure 16. Site map showing locations of geophysical anomalies.

1.0 Site Location and Background

Environmental Geophysics Associates (EGA) was retained by **Raba Kistner Consultants, Inc**. to perform geophysical surveys (resistivity and natural potential) at a ıe in the

Figure 1. Site map showing Meredith Street and Rockmoor Avenue and borehole locations (Raba Kistner Consultants, Inc.). Borehole locations B-1 through B-5 approximately defines the boundaries of the quarry operation that took place in early 1900s. Sinkholes and caves were observed during the quarrying of the Edwards Limestone. Edwards Limestone, Georgetown Limestone and Del Rio Clay still outcrop in and around the site.

A quarry for the Edwards Limestone was operated at the site in early 1900s, during which a cave was discovered. This cave was later referred to be Austin Caverns, and was a tour cave. It was later blasted just and filled over. Part of the cave was reopened to provide a place to channel street runoff, and a manhole can still be used to enter the south section on Meredith Street. This is not adequate capacity however, and at times it back water up and floods some houses (Neighbors at 3607 Meredith Street, Pers. Comm., 2013).

2.0 Site Geology

The site lies within the Edwards Recharge Zone and the Balcones Fault Zone (BFZ). The BFZ is a fault-line scarp, and consists of normal faults, which dip toward the east and southeast. The BFZ's most prominent fault is the Mount Bonnell fault, which composes the northernmost part of the fault zone with a throw of near 600 feet. The Lower Cretaceous Glen Rose Formation is at the surface to the west of the MBF, while east of the fault zone younger rocks of Edwards Aquifer are at the surface.

The Edwards Aquifer units (Georgetown Limestone, Edwards limestone), and the overlying Del Rio Clay outcrop in the vicinity of the site. Partly covering these bedrock units, and extending across much of the neighborhood, is Quaternary terrace deposits (clay and gravel).

3.0 Purpose of Geophysical Surveys and Survey Design

We performed resistivity imaging (2D resistivity profiling), and natural potential (NP) surveys at the site. Locations of the geophysical profiles are shown in Figure 2. The purpose of the surveys was to: 1) locate karstic features (void, cave, fault and fracture); 2) characterize the subsurface geology along the geophysical profiles. We run two geophysical profiles (G1 and G2) across the site.

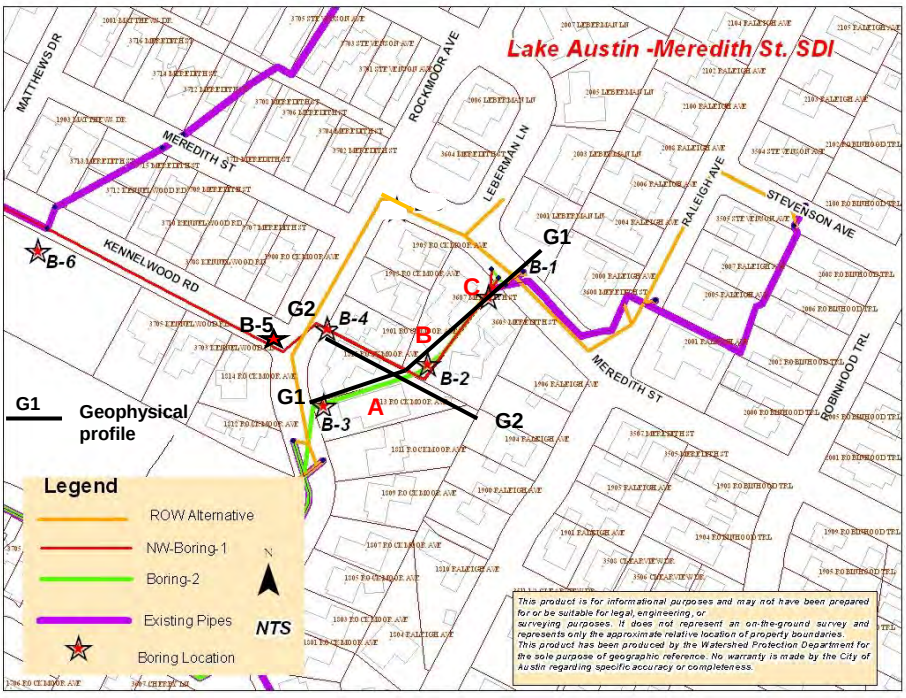


Figure 2. Site map showing locations of two geophysical profiles (G1 and G2) at the site. Profile G1 consists of three segments (A, B and C). Note that profile G1 crosses Meredith Street. Borehole locations B-1 through B-6 are already drilled by Raba Kistner Consultants, Inc.

Geophysical profile G1 starts from Rockmoor Avenue in the south, where the borehole location B-3 is located, crosses the borehole location B2 and Meredith Street. The geophysical data were collected in three segments, as A, B and C along this profile. A detailed schematic site map of this profile is given in Figure 3. Geophysical profile G2 starts near the borehole B-4 on Rockmoor Avenue and terminates at the backyard of 3605 B Meredith Street.

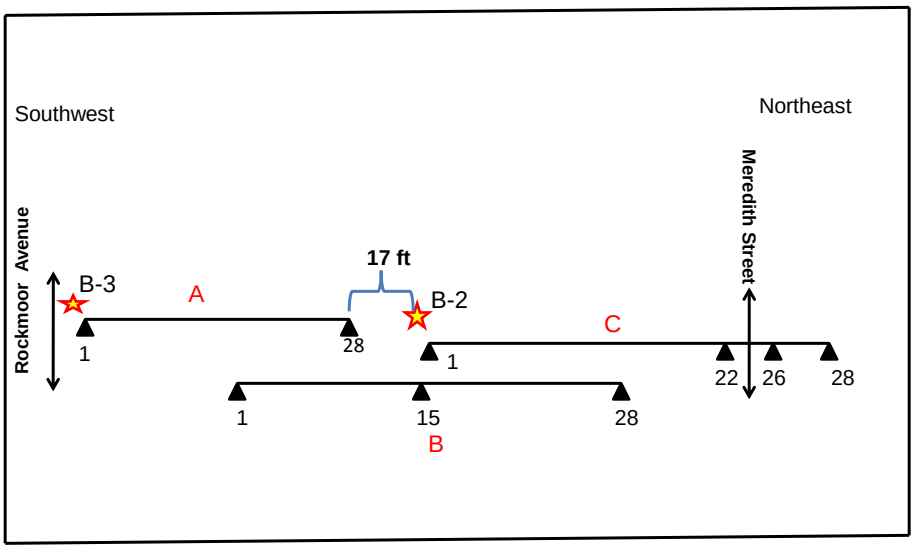


Figure 3. A detailed site map of geophysical profile G1. Geophysical data was presented as segment A and combination of segments B and C in the report.

4.0 Geophysical Methods

4.1 Resistivity Imaging Method

Resistivity imaging is a survey technique, which aims to build up a picture of the electrical properties of the subsurface by passing an electrical current along electrodes and measuring the associated voltages. This technique has been used widely in locating karstic features, such as caves, voids and faults, in karstic areas.

In this study, we used Advanced Geosciences Inc., (AGI)'s SuperSting R1 resistivity meter with dipole-dipole resistivity technique, which is more sensitive to horizontal changes in the subsurface with respect to other available resistivity arrays, and provides a 2-D electrical image of the near-surface geology.

We used 2 resistivity cables, each cable having 14 electrodes with varying electrode spacing; i.e., 7 to 9 feet. After the initial section of resistivity data was collected, the entire 28 electrodes moved down half-way (14 electrodes) ahead of the survey line. This process was continued until all data along the desired length were collected. We used a generator to drill holes into the driveway of 3607 Meredith Street and on the Street itself. Photographs of the field surveys are attached to this report (Appendix A).

Appropriate quality assurance/quality control procedures such as testing contact resistance before data collection was performed for each segment of each profile. Contact resistance measures the resistance to current flow at electrodes caused by imperfect electrical contact with the earth. Poor data quality or anomalous data can result from high or highly variable electrode contact resistance along a profile. To decrease the effect of contact resistance along each profile, we used a saltwater solution to each electrode before the contact test was performed.

Resistivity imaging data are processed and inverted using the AGI 2D Earth Imager software, and converted into the resistivity data and presented as a colored 2-D resistivity image of subsurface (i.e. a vertical cross section of the distribution of subsurface resistivity). Such a display section indicates high and low resistivity areas and the structural configuration of the subsurface geology. High resistivity is displayed by red and low resistivity is displayed by blue colors. Medium resist ivies are presented by the green color.

Resistivity values of clay units (for example, Del Rio Clay) range between 1 and 15 Ohm-meter whereas Edwards limestone units vary between 200 and higher values (10,000) of Ohm-meter, depending on the weathering and/or presence of karstic features. Georgetown Limestone usually is characterized with medium resistivity values of 50 and 300 Ohm.meter, depending on the weathering conditions.

4.1.1 Theory of Dipole-Dipole Resistivity Array Method

Many electrode configurations are used in geophysics to measure subsurface resistivity. A common factor in these configurations is a set of current input electrodes usually labeled A and B and a set of voltage measurement electrodes usually labeled as M and N. The dipole-dipole method places the A and B electrodes to one side with a spacing between them denoted as "a". The M and N electrode pair with equal a-spacing are placed collinearly a distance "na" away from A and B. A distance equal to an integer multiple of a is denoted "na". Figure 4 shows the basic dipole-dipole electrode configuration.

As measurements are taken at various n's, that is, the pairs of electrodes are moved apart, a sounding is obtained. If the electrodes are moved across the surface, a profile of comparative values is generated. Thus the dipole-dipole method produces a combination sounding-profiling set of data if measurements are taken at various values of n along a profile. Basic dipole-dipole configuration with four electrodes is shown in Figure 4.

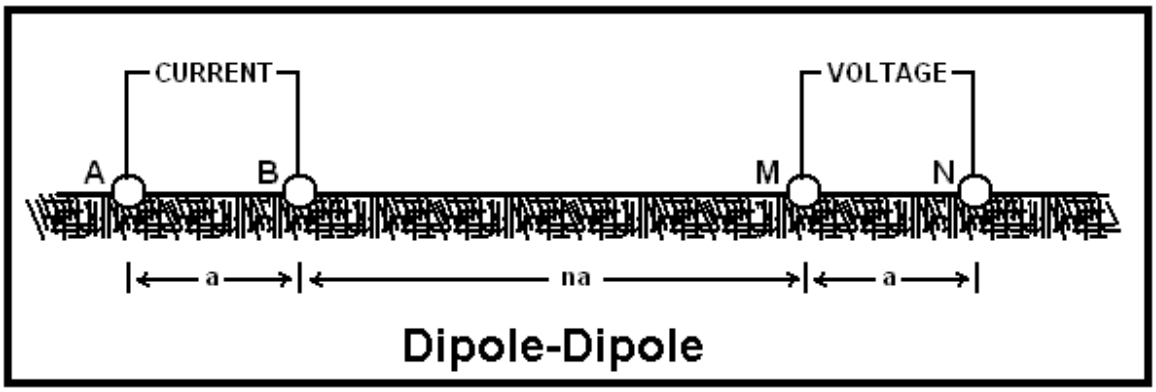


Figure 4. Basic dipole-dipole array configuration with four electrodes.

In this study, a pair of current and voltage electrodes are selected automatically using the SuperSting/Swift electrode system. A command file for dipole-dipole array was selected and used for the entire study area. Figure 5 shows an example of such array and distribution of apparent resistivity values.

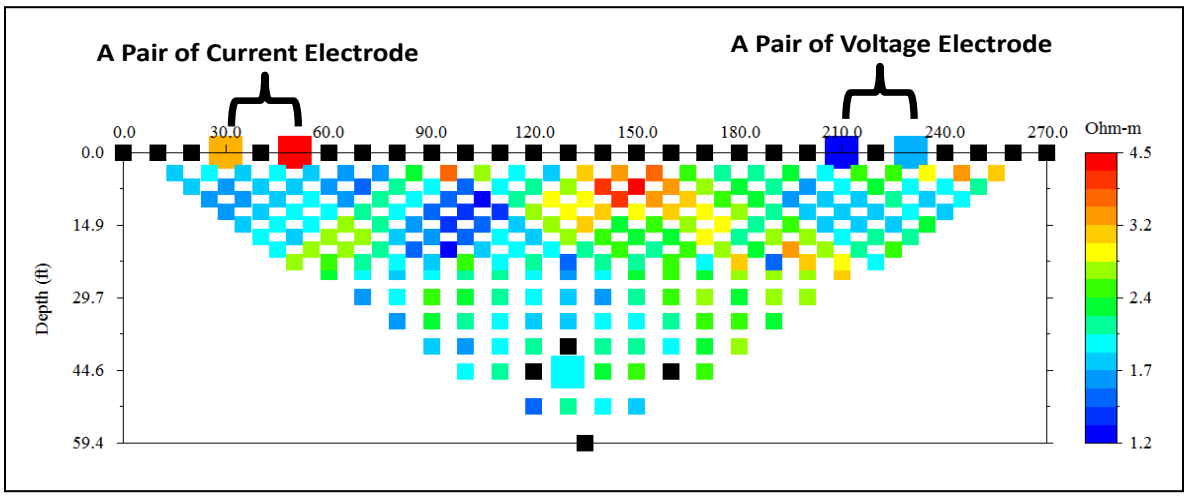


Figure 5. Dipole-dipole configuration of surface apparent resistivity data with 28 electrodes with 10-ft electrode spacing which yields 50 feet depth exploration.

4.2 Natural Potential Method (NP)

Natural electrical (NP) currents occur everywhere in the subsurface. In karstic investigations, we are concerned with the slowly varying direct currents (DC) that give rise to a surface distribution of natural potentials due to the flow of groundwater within permeable and/or conduit materials. Differences of potential are most commonly in the millivolt range and can be detected using a pair of non-polarizing electrodes and a sensitive measuring device (i.e., a voltmeter). It should be noted that water movement should be present within or surrounding a cave in order to determine a void or cave location (Figure 6). Positive and negative NP values are attributed to changes in the flow conditions and the resistivity distribution of the subsurface. The source of NP anomalies can be also due to changes in topography, soils, and geologic conditions. NP measurements made on the surface are the product of electrical current due to groundwater flow and the subsurface resistivity structure. NP anomalies do not provide information on the depth of their sources.

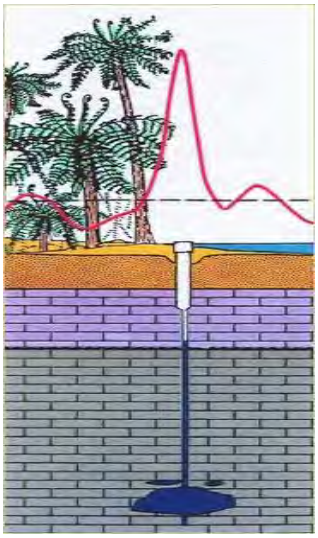


Figure 6. A schematic limestone section showing a cave and a corresponding positive NP anomaly. Polarity of NP anomalies (+/-) depends on the resistivity/conductivity of the geologic environment and hydrogeologic conditions. NP anomalies are also created by lithologic changes in the subsurface. There is no depth information inferred from these NP anomalies.

5.0 Interpretation of Resistivity Data

5.1. Profile G1

An inverted resistivity profile of segment A along profile G1 is given in Figure 7. Approximate locations of the wood fence and the borehole location B-3 are shown for reference purposes. The resistivity data along this segment shows a chaotic structure: medium resistivity values, shown with green color, appear to have mixed with low (blue in color) and high (red in color) resistivity values. In addition, the drastic resistivity variations between stations 84 and 112 feet at the depth of about 35 feet indicate a fracture zone or fault. The highest resistivity anomaly, up to 10,000 Ohm.m, is shown with the letter X. This anomaly either is caused by a resistive limestone unit or a karstic feature (void or cave).

It should be noted that the site in general was used to be a quarry and random blasting and refilling was practiced quite often.

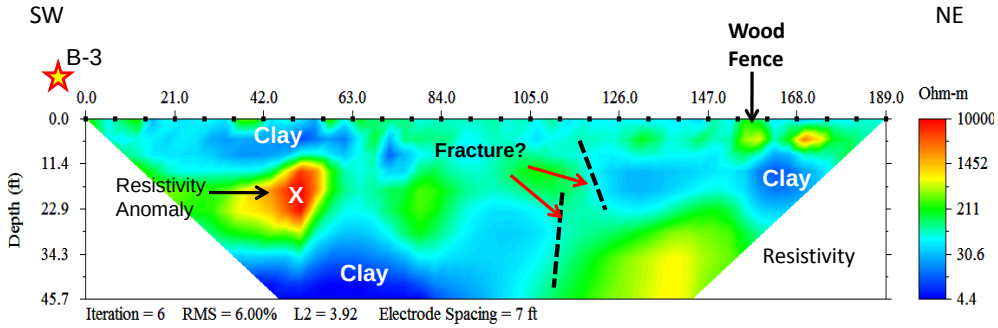


Figure 7. Resistivity data along the segment A of profile G1. Locations of the wood fence and borehole location of B-3 are given for references.

Segments B and C for the resistivity profile G1 were combined together and are shown in Figure 8. Locations of the wood fence, which is also given in Figure 7, borehole location B-2, a drainage feeding the supposed cave system and Meredith Street are shown on the resistivity profile for reference purposes.

The resistivity data shows, as on segment A (Figure 7), a chaotic structure: low (blue in color) and medium (green in color) resistivity values appear to mingle with each other. In addition, underlying these low and medium resistivity values, is a relatively high resistive unit, shown with yellow/orange and red colors. The contact between the high (Edwards Limestone) and medium resistivity values (Georgetown Limestone) are highly irregular, which may indicate the results of quarrying (i.e., blasting) and/or cave occurrence.

A typical cave geometry defined by the resistivity data is shown between stations 315 and 370 feet, which is located between the drainage and Meredith Street on Figure 8.

It should be reminded that caves do also occur in the Georgetown Limestone, and can be represented with low and medium resistivity values because of weathering, filled clay materials, etc.

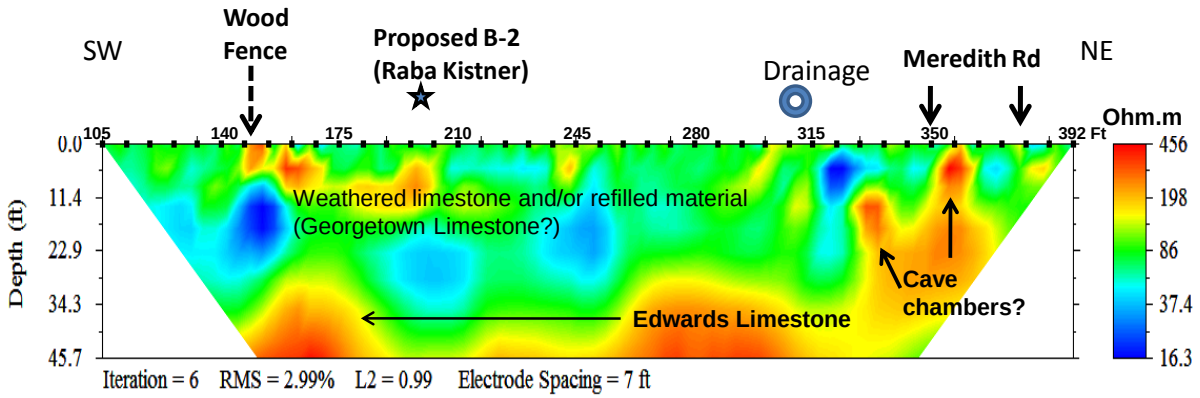


Figure 8. Resistivity data along segments B and C. Locations of the wood fence, borehole location B-2, drainage present along the profile and the width of Meredith Street are shown for reference purposes.

5.2 Profile G2

An inverted resistivity profile across the profile G2 (see Figure 2) is given in Figure 9. Locations of borehole B-4 on Rockmoor Avenue, yard gate and wood fence of the house, and the backyard of 3605 B Meredith Street are shown for reference purposes. In addition, the intersection of profile G1 with the profile G2 is also marked.

The resistivity data indicates a significant resistivity variation between stations 65 and 110 feet where a low resistivity section (light and dark blue in color) sandwiches itself between medium (green in color) and high (red in color) resistivity values. Light and dark blue colors have resistivity values between 5 and 33 Ohm-meter, which indicate clayey material (Del Rio Clay?). Resistivity values of the green color range between 100 and 500 Ohm-meter, which may indicate weathered and fresh limestone (Georgetown?).

It is known that the City of Austin is considering the construction project along this resistivity profile as an alternative. Presence of the fault and clayey soil determined by the resistivity survey needs to be considered and weighed against such an option.

We have observed very similar resistivity anomalies across Del Rio Clay and Georgetown Limestone where major known faults are involved (Antioch Fault Zone in Onion Creek).

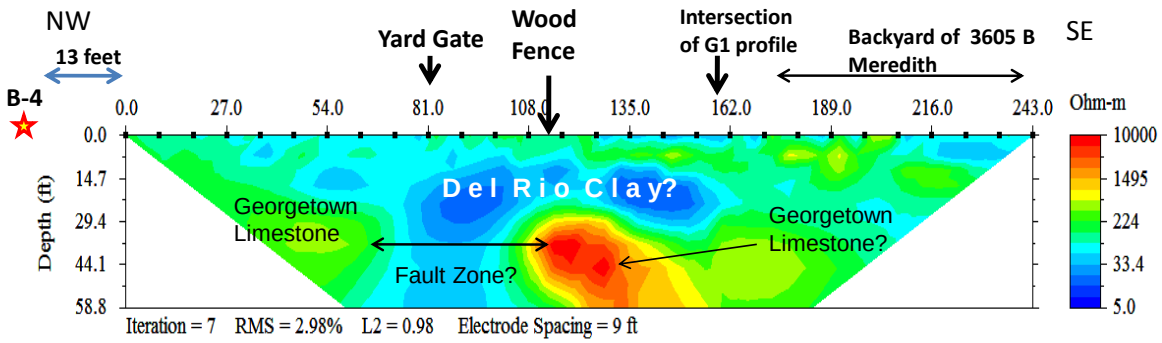


Figure 9. Resistivity data along profile G2. Borehole location B-4 on Rockmoor Avenue, yard gate and wood fence are shown for reference purposes. A low resistivity zone between the yard gate and the wood fence could be caused by a fault or fault zone.

6.0 Interpretation of Natural Potential (NP) Data

6.1 Profile G1

An NP profile between borehole B-3 location and borehole B-2 (segment A of Figure 2 and Figure 3) is given in Figure 10. The profile starts with high NP values (i.e., 80 milivolt (mV)) and smoothly reduces to about zero (0 mV) at the end of the profile. The breaking inflection station for this NP profile is at about station 100 feet. The source for this anomaly could be due to change in rock type, resistivity, etc. It is important to note that the NP data does not indicate any local NP anomaly, which is indicative of any karst feature.

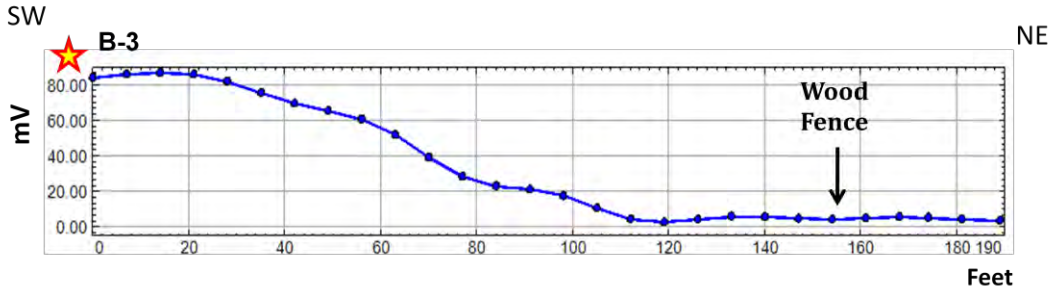


Figure 10. Natural potential (NP) data along segment A of profile G1. Note the locations of B-3 and wood fence for reference purposes. The NP data does not indicate any karstic feature such as cave; but do show significant smooth variation. This type of anomaly is usually indicative of lithologic change, a fault which juxtaposes two different hydrologic units.

Figure 11 shows the NP data along the combined segments of B and C of profile G1. Locations of the wood fence, borehole location B-2, drainage for the driveway and the width of the Meredith Street are given for reference purposes. Locations of high (positive) and low (negative) NP values are marked in Figure 11.

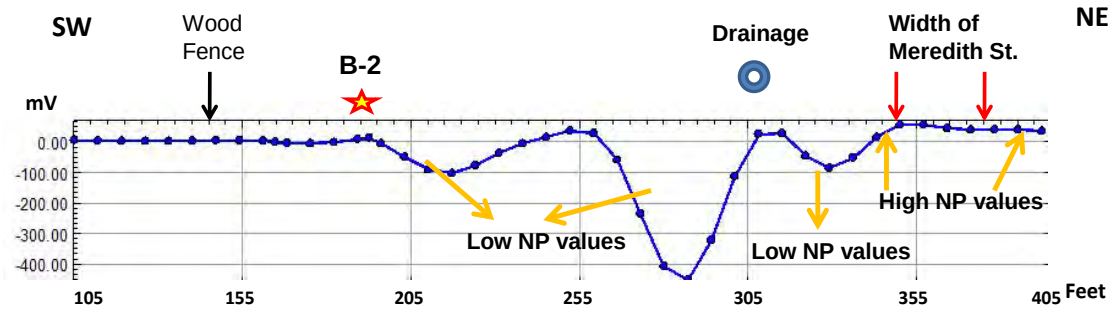


Figure 11. NP data along the combined segments of B and C of profile G1. Note the presence of high and low NP values along the profile. Both high and low NP values could be caused by karstic features.

6.2 Profile G2

NP data along profile G2 is shown in Figure 12. The NP data indicates a smooth low NP anomaly developing between stations 0 and 200 feet. However, the lowest NP value is at about station 100 feet. Between stations 100 and 140 feet, there is very local high NP anomaly. The smooth-varying low NP anomaly could be caused by a lithologic change (a presence of fault) and a zone of infiltrating groundwater; and the local high NP anomaly may be caused by a karstic feature.

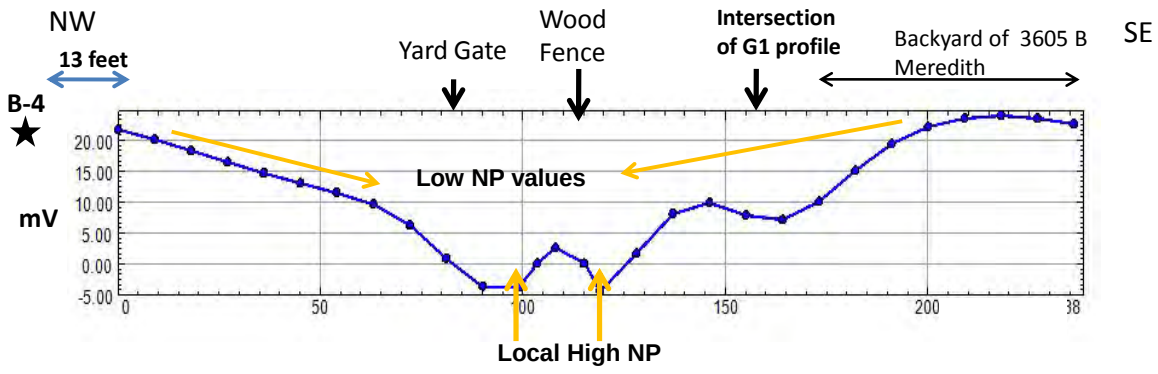


Figure 12. NP data along profile G2. Locations of B-4 yard gate, wood fence are shown for reference purposes. A smooth low NP anomaly is characteristic of this profile, which may indicate a lithologic change, a zone of infiltration of water, along the profile. And the local high NP anomaly could be due to a karstic feature.

7.0 Correlation of Resistivity and NP Data

7.1 Profile G1

Correlation of resistivity and NP data along segment A of profile G1 is given in Figure 13. Note the topographic variations of the low resistivity unit (clay?) between stations 21 and 110 feet at a depth 30 feet. Source causing this irregular topography could be karstic development on the medium resistivity values, which are presented by the green color. A significant fracture or fault could be present at about station 105 feet where the high NP anomaly starts developing.

The distribution of the resistivity values along the profile does not make much sense. The irregular topography between medium and low resistivity values could have been caused

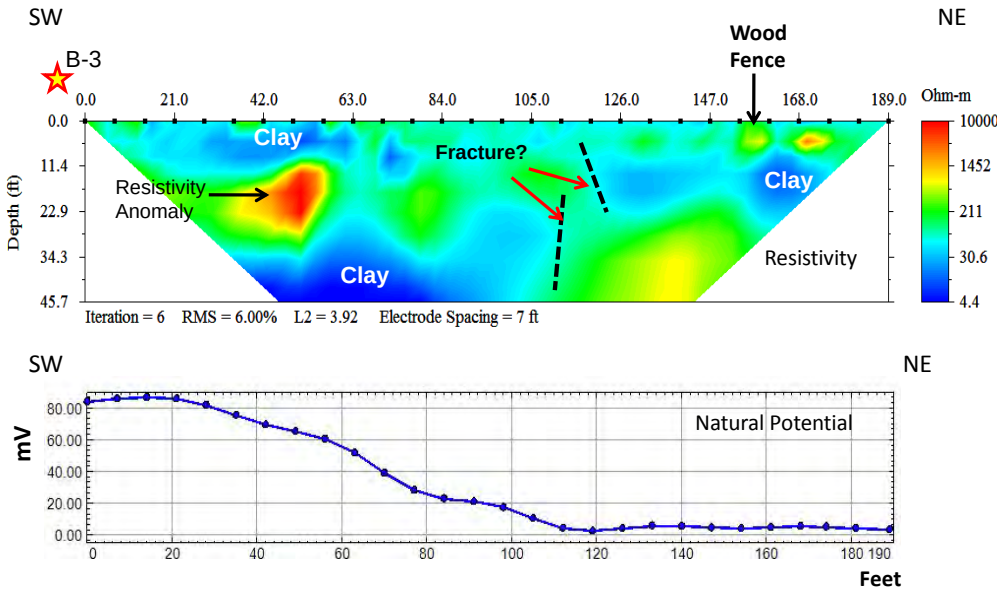


Figure 13. Correlation of resistivity and NP data along segment A of profile G1.

The rest of the profile of G1, which consists of segments of B and C, is shown in Figure 14. High and low NP values are dominant between the borehole location B-2 and Meredith Street where resistivity data indicate low resistivity and high resistivity anomalies. It is likely that there are karstic feature along this profile.

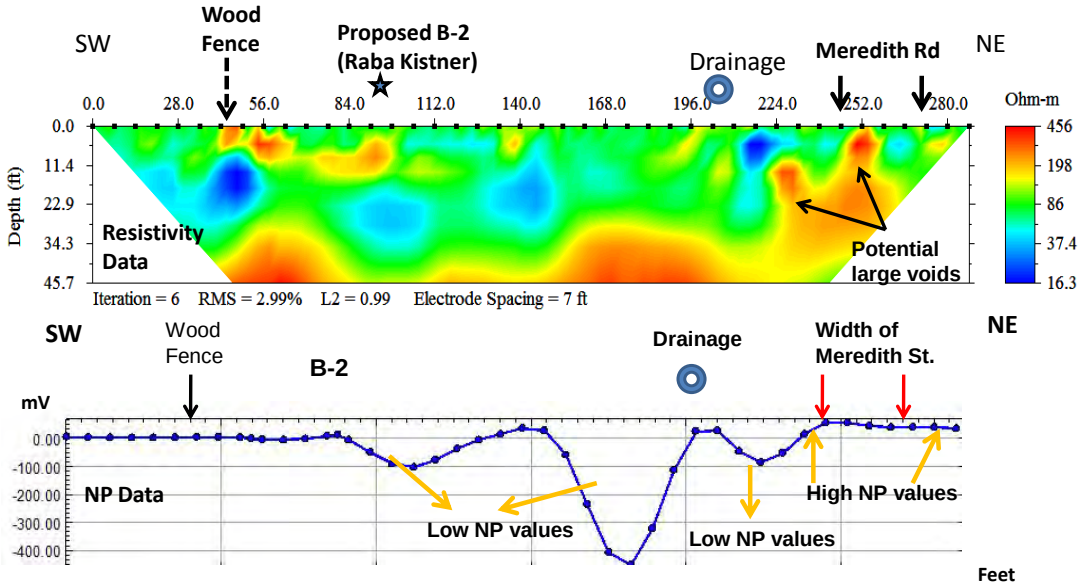


Figure 14. Correlation of resistivity and NP data along segments of B and C of profile G1. Low NP values do not correspond to any significant resistivity anomalies in the top 35 feet below the surface. It is possible that the sources of these NP anomalies may be deeper.

7.2 Profile G2

Correlation of resistivity and NP data along profile G2 is shown in Figure 15. A low resistivity zone observed between yard gate and the wood fence corresponds to a low NP anomaly. This NP anomaly is probably caused by the infiltration of the surface water through the low resistivity zone.

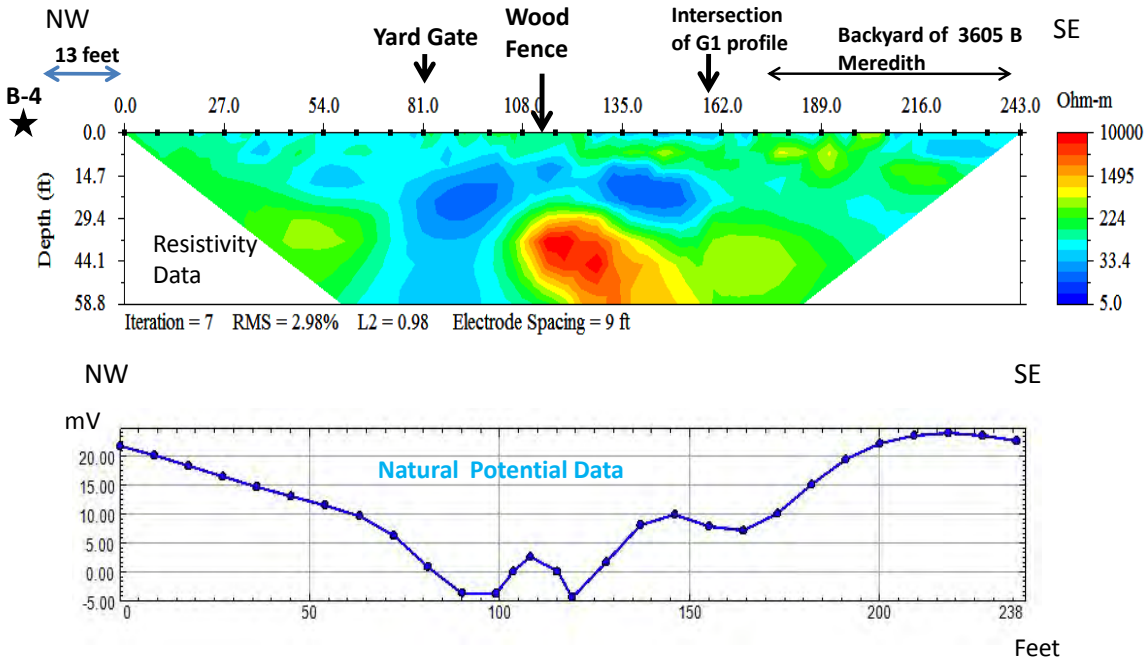


Figure 15. Correlation of resistivity and NP data along profile G2. See text above.

8.0 Discussion/Conclusion

Resistivity and NP results obtained from two profiles (profiles G1 and G2) provided significant information on the geological characterization of the site and karstic features. The resistivity data along profile G1 indicated a chaotic structure where low resistivity (Del Rio Clay?), medium resistivity (Georgetown Limestone), and high resistivity (Edwards Limestone) units are exposed. The inhomogeneous structure of the resistivity data is probably due to the fact that the site used to be a quarry where blasting of rocks and refilling of the quarry was a random practice. The top of the Edwards Limestone showed an irregular geometry along profile G1, which is probably caused by the blasting and cave development within the Limestone. Presence of low and high NP data along the resistivity data supports this interpretation. It should be noted that the first segment (A) of profile G1 also indicates a significant fracture or fault.

The resistivity data along profile G2 provide a significant low resistivity zone, where Del Rio Clay appears to be sandwiched between Georgetown Limestone. This low resistive zone could be caused by a major fault and correlates well with the low NP anomaly.

In summary, locations of the karstic anomalies were marked on a site map and provided in Figure 16.

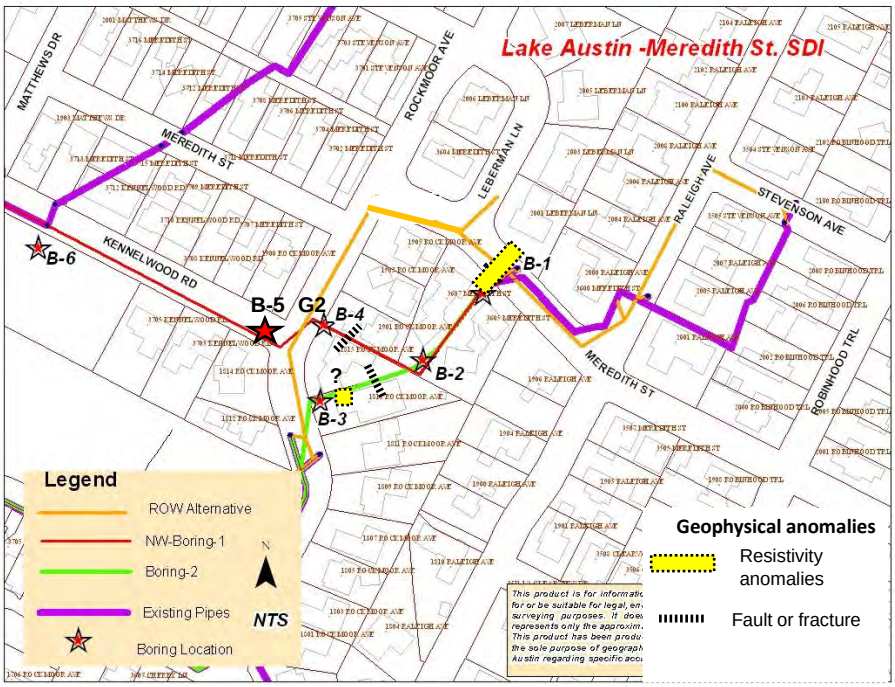


Figure 16. Site map showing locations of potential geophysical anomalies.

APPENDIX A

Survey Photographs

Picture 1. Resistivity survey along profile G1 on segments B and C. The road and asphalt driveway were drilled using a generator to insert the electrodes.

Picture 2. Natural potential survey along the segments of B and C of profile G1. A slim NP electrode was used in the holes that were drilled using a generator.

Picture 3. Taking resistivity survey along profile G2. The recording rechsistivity unit was set in the backyard of 3605 B Meredith Street. There are rocks outcropping to the east, which appear to be Georgetown Limestone.

APPENDIX B – PHOTOGRAPHS OF ROCK CORES

Photograph 1 – Boring B-1 – Depth 0'-20'

Photograph 2 – Boring B-1 – Depths 20'-30'

Photograph 3 – B0ring B-1 – Depths 30’-40’

Photograph 4 – Boring B-1 – Depths 40’-50’

Photograph 5 – Boring B-2 – Depth 0'-40'

Photograph 6 – Boring B-2 – Depths 40.8'-50'

Photograph 7 – Boring B-2 – Depths 50'-55'

Photograph 8 – No flash

Photograph 9 – Boring B-3 – Depth 0'-15'

Photograph 10 – Boring B-3 – Depths 15'-25'

Photograph 11 – Blurry

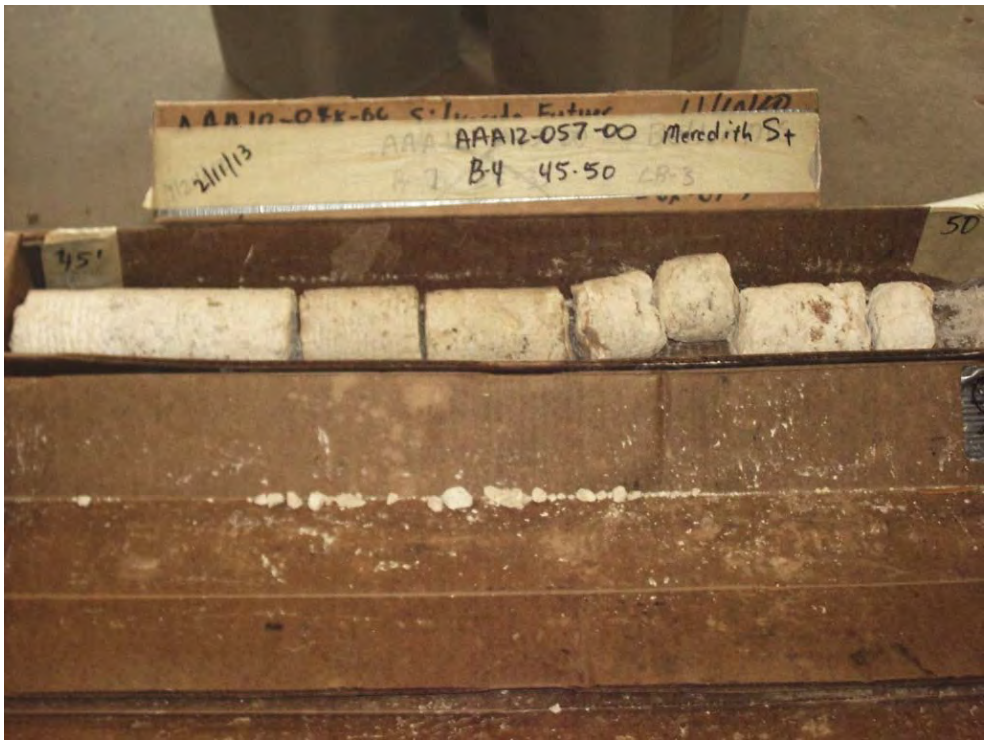
Photograph 12 – Boring B-3 – Depths 25’-35’

Photograph 13 – Boring B-3 – Depths 35'-50'

Photograph 14 – Boring B-4 – Depths 0'-20'

Photograph 15 – Boring B-4 – Depths 20'–30'

Photograph 16 – Boring B-4 – Depths 30'–45'



Photograph 17 – Boring B-4 – Depths 45'–50'

Photograph 18 – Boring B-5 – Depths 0'–30'

Photograph 19 – Boring B-5 – Depths 30'–45'

Photograph 20 – Boring B-5 – Depths 45'-50'

Photograph 21 – Boring B-6 – Depths 0'-50'