Village of Shorewood
Advanced Facility Facility Plan

for

Storm Sewer Improvements to Achieve Partial Separation in the "South" Combined Sewer Area

FINAL MARCH 22, 2012

Shorewood

Ruekert·Mielke
engineering solutions for a working world

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Introduction

The Combined Sewer "South Improvements" were proposed in the Village of Shorewood Facility Plan dated March of 2011. The recommended alternative was partial separation of the combined sewers east of Oakland Avenue between Menlo Boulevard and Capitol Drive. Partial or "virtual" separation is achieved by construction of new storm sewers parallel to the existing combined sewer to divert and capture storm water flow from existing catch basins. This alternative was proven to be more cost effective than enlargement of the existing combined trunk sewers shown on Figure 1 and eventual complete separation of the area.

A key component of the plan is construction of a new east/west storm trunk sewer that discharges to the Milwaukee River. This storm sewer would act as the backbone for construction of a grid of new storm sewers to achieve partial separation. Also key are two trunk sewer segments to drain topographic depressions at the intersection of Murray Avenue and Beverly Road and at the intersection of Shorewood Boulevard and Stowell Avenue.
This report is an "Advanced Facility Plan" that included a more detail review of the following components:

- Alternative Locations and Alignments
- Utility Conflicts
- Soils
- Design Flows
- Construction Methods
- Permitting Issues
- Easements
- Project Costs

Alternative Alignments
Three alternative alignments were reviewed for the east/west trunk sewer:

- Beverly Road
- Menlo Boulevard
- Edgewood Avenue

The Beverly Road route was ruled out because it would not allow partial separation of over 50% of the "Combined South" Area, and would not adequately relieve the surcharging in the downstream combined sewers. The Edgewood Avenue route was ruled out because of the lack of space/room in the right-of-way, utility conflicts and expense. The Menlo Boulevard route was verified as the most constructible and cost effective route to achieve partial separation.

Alternate Storm Sewer Profiles
There were two alternate storm sewer profiles that were investigated and evaluated. The two profiles are depicted on Figure 7 in blue and red.
The blue sewer profile is the deeper profile which would allow for construction of a temporary combined sewer overflow at Menlo Boulevard and Prospect Avenue in the event that the Village

did not construct the north trunk sewer segment to pick up to the topographic depression at Shorewood Boulevard at this time.

The shallower red profile could be constructed if the Village planned to also construct the north trunk sewer segment as part of the project. It would pick up the depression on Shorewood Boulevard which would offer immediate overland flooding relief to the residents and minimize the need and effectiveness of temporary combined sewers at either Shorewood Boulevard and Stowell Avenue or Menlo Boulevard and Prospect Avenue.

Recommended Alternative

The recommended Storm Trunk Alternative is shown on Figure 2. The future grid of collector storm sewers is shown on Figure 4.

The recommended plan to construct the storm sewer "backbone" in Menlo Boulevard, Prospect Avenue, Shorewood Boulevard and Murray Avenue will achieve the following goals:

- Goal 1 - will be partially realized by providing "additional basement backup" protection for two inches of rain in one hour. That goal will be fully achieved when the collector storm sewer grid is constructed.
- Goal 4 - will be partially achieved by reducing street flooding in the topographic depressions to provide two feet of freeboard during a three inch per hour rainfall.

Phase 1 of the recommended plan consists of the following storm sewer facilities:

- Menlo Boulevard Segment (Red Profile)
  1755' - 72" storm sewer in tunnel
  155' - 72" storm sewer jacked
  1480' - 72" storm sewer open cut
  Estimated Cost = $7,669,000
- Prospect Avenue/Shorewood Boulevard Segment (Open Cut)
  175' - 60" storm sewer
  275' - 54" storm sewer
  360' - 48" storm sewer
  745' - 38" x 60" and 34" x 53" storm sewer
  250' - 15" to 30" storm sewer
  Estimated Cost = $1,102,000
- Murray Avenue Segment (Open Cut)
  750' - 36" storm sewer
  120' - 15" to 18" storm sewer
  Estimated Cost = $389,000
- Future Storm Sewer Grid
  42" to 12" storm sewer
  Estimated Cost = $4,200,000
- Storm Laterals and Collection System If Desired
  Estimated Cost = $2,521,000
  *Additional cost if full road reconstruction is desired of entire area.
  Estimated Cost = $5,700,000

Phasing Recommendations

- Summer and Fall of 2012
  - Easement Negotiations
  - Initial Permit Contacts
  - Groundwater Monitoring
  - Utility Company Discussions
- Spring of 2013
  - Design Phase
  - Arrange Financing
- Summer of 2014
  - Utility Relocations to Clear Route
  - Obtain Permits, Easements
- Spring of 2015
  - Bid and Construction
- Summer of 2016
  - Complete Construction of Phase 1

CHAPTER 1
INTRODUCTION

The Combined Sewer "South" Improvement Alternatives were proposed in the Village of Shorewood Comprehensive Facility Plan dated March 2011. The recommended alternative was partial separation of the combined sewers between Menlo Boulevard and Capitol Drive east of Oakland Avenue. A key component of this plan was construction of a large storm sewer in Menlo Boulevard between Prospect Avenue and the Milwaukee River and trunk storm sewers in Murray Avenue and Prospect Avenue that would provide a storm sewer outlet for a grid of new storm sewers to allow for partial separation of the area. Because the project is such a large undertaking for the Village, it was decided to conduct a more detailed investigation of the location, feasibility and construction costs of the large storm trunk sewers required for partial separation. This report called an "Advanced Facility Plan" Report will summarize the findings of that investigation and provide a recommendation for the various phases of construction.

The investigation included a detailed review of the following components:

- Alternative Locations
- Underground Utility Locations and Conflicts
- Soil Borings and Geotechnical Conditions
- Design Flows
- Tunnel/Open Cut Constructability Issues
- Potential Permitting Issues
- Easements
- Project Costs

CHAPTER 2
EXISTING COMBINED SEWER AND MIS/INLINE SYSTEM OPERATION

The Village's separate sanitary sewer system and combined sewer system both connect to the Milwaukee Metropolitan Sewerage District (MMSD) Metropolitan Interceptor Sewer (MIS) System that courses along the Milwaukee River on the west side of the Village. The combined sewer system connects to a 39" Special Section (SS) horseshoe shaped MIS at intercepting structure No. IS73 at the intersection of N. Oakland Avenue and E. Edgewood Avenue. This 39" SS MIS also serves a portion of the City of Milwaukee's combined sewer system and the University of Wisconsin, Milwaukee Campus which connects at intercepting structure No. IS74 at the intersection of E. Providence Avenue and N. Bartlet Avenue. The 39" SS MIS runs from N. Oakland Avenue and E. Edgewood Avenue to a 60" MIS in N. Cambridge Avenue and E. Providence Avenue which then flows south to the Jones Island Water Reclamation Facility (WRF). See Figure 1. Peak flow capacity of the 39" SS MIS is limited to about 30 CFS which is adequate to convey base flow, but much less than the capacity of the local combined sewers that connect to it which exceed 800 CFS. This is because the original intent of the MIS system was to intercept only the dry weather base sanitary flows for conveyance to and treatment at the Jones Island WRF. The untreated peak rain flows were diverted directly to the Milwaukee River via a 72" Combined Sewer Overflow (CSO) in E. Edgewood Avenue extended west of N. Oakland Avenue.

In the 1980's, the MMSD constructed the Inline Storage System (ISS) along the major rivers in Milwaukee County and connected the combined sewer overflow pipes at major dropshaft sites to minimize the discharge of untreated over flowing combined sewage to the rivers. These dropshaft sites are equipped with gates that can be closed if the ISS is in danger of filling.

As shown on Figure 1A, Dropshaft NS04 was constructed to pick up the 72" CSO at N. Cambridge Avenue and E. Edgewood Avenue extended. In addition, a 60" combined sewer was also constructed in N. Cambridge, E. Providence, N. Oakland and E. Edgewood Avenues to supplement the capacity of the local Milwaukee sewer system and to deliver excess Milwaukee flows to Dropshaft NS04.

Operation of the ISS is dictated by the Wisconsin Department of Natural Resources (DNR) which requires capture of excess MIS flows from the Separated Sewer Area (SSA) for up to a five-year rainfall event and capture of excess combined sewer flows to limit overflow to the river to no more than six times per year. NS04 only serves the combined sewer areas of Shorewood and Milwaukee. The discharge of its 72" CSO is therefore limited to six times per year although they historically have been averaging between 2 and 3 overflows per year since the ISS went on-line in the 1993.

CHAPTER 3
PARTIAL SEPARATION ALTERNATIVES

The original Facility Plan proposed a solution to solve basement backups in the combined sewer area south of Capitol Drive by upsizing combined sewers or construction of new pipes in the southwest side of the Village combined area and by upsizing the MMSD 72" CSO from Oakland Avenue to the inline Tunnel Dropshaft NS-4. This would be followed by eventual complete separation of the combined sewer system, with the installation of a new parallel storm sewer system.

Additional facility planning conducted in the Spring of 2011 concluded that a partial separation alternative with a new east-west storm trunk sewer outlet on Menlo Boulevard from Prospect Avenue to the Milwaukee River would be more cost effective. The focus of the project was to reduce flow in the combined sewer trunk system. This trunk sewer system was severely overloaded in July of 2010 which resulted in localized flooding and numerous basement backups. The recommended plan was to off-load the combined sewer system by constructing a parallel grid of storm sewers that would capture and reroute the storm water from catch basins now connected to the combined sewers. The existing roof leaders and foundation drains from houses would not initially be connected to the new sewers storm grid. It would also eliminate the need for upsizing the existing combined trunk sewers and upsizing the MIS. Diversion of this flow would reduce peak flows in the combined sewers by as much as 85% and would provide a greatly increased level of protection from flooding. This alternative would provide a major storm sewer outlet to achieve partial separation and eventually allow for complete separation for the area as shown on Figure 2.

There are three east-west routes that were considered for the storm outlets:

- Menlo Boulevard
- Edgewood Avenue
- Beverly Avenue

All the alternatives included "trunk" storm sewers in Murray Avenue and Prospect Avenue to deliver flow to the selected storm outlet.

It was concluded that the outlet should flow to the Milwaukee River because the land generally flows from the east to west and the right-of-way needed from Lake Drive properties to construct a Lake Michigan outlet would be difficult, if not impossible to obtain. The Lake Michigan bluff terrain would also add significant cost to any storm sewer outfall. The three alternative routes are shown on Figure 3.

<u>Edgewood Avenue Alternative:</u>

This alternative would consist of constructing a 78" diameter storm sewer in Edgewood Avenue from Maryland Avenue to the Milwaukee River and major storm trunk sewers parallel to the existing combined sewer north on Murray, Maryland and Prospect Avenue. This alternative, although hydraulically feasible, was ruled out because of ROW limitations. As described in the "Existing MIS/Inline System Operation" section, there is already a 78" combined sewer and a 60" combined sewer in Edgewood Avenue along with multiple other utilities. Plus the disruption of this major arterial roadway along the north side of the UWM Campus would have major social impacts. For these reasons, this route was ruled out.

Menlo Boulevard Alternative:

This alternative consists of constructing a 72" storm sewer in Menlo Boulevard from Prospect Avenue to the Milwaukee River. In the Facility Planning conducted in the Spring of 2011, an alternate route in Menlo Boulevard starting at Murphy Avenue and discharging to Lake Michigan was studied but was ruled out because of cost.

This alternative would consist of 600' of 72" storm sewer in open cut construction from Prospect Avenue to Maryland Avenue, 2000' of 72" storm sewer (1750' in tunnel and 250' in open cut) from Maryland Avenue to Morris Boulevard and 800' of 72" storm sewer in a mixture of open cut and tunnel in Morris Boulevard from Menlo Boulevard to the Milwaukee River outfall.

The advantage of this alternative is that the route avoids the utility and ROW conflicts of the Edgewood Avenue Alternative. It also provides a storm sewer outlet for partial separation of the combined area north of Menlo Boulevard.

Beverly Avenue Alternative:

This alternative consists of constructing a 72" storm sewer in Beverly Avenue from Prospect Avenue to the Milwaukee River. It is very similar to the Menlo Boulevard Alternative in length, size and type of construction. Therefore, the costs were similar to the Menlo Boulevard Alternative. However, by moving the east-west storm sewer route two blocks north, it will only be able to serve 70% of the service area that the Menlo route will serve. This will leave the area between Menlo Boulevard and Beverly Avenue without a storm sewer outlet to use to achieve partial separation. It will also decrease the amount of flow that can be off-loaded from the downstream combined trunk sewers south of Beverly Avenue that have experienced surcharging resulting in basement backups which defeats the purpose of the alternative. For these reasons this alternative was ruled out.

CHAPTER 4
BASIS OF DESIGN

Pollution Control

To meet the requirements of NR 151 of the Wisconsin Administrative Code, the "first flush" of storm water plus flows of up to a six month one hour intensity storm will be captured and conveyed to the MIS for treatment at the Jones Island WWTF. In order to accomplish this under the "partial separation" alternative, junctions at major points along the new trunk sewer system will be equipped with a control structure that will direct low flow to the original combined sewer and direct high flow storm water to the Menlo Storm Trunk Sewer for discharge to the Milwaukee River. This is similar to the configuration that the City of Milwaukee used in 2005 around West Hawley Avenue between West State Street and West Vliet Street. There, the City of Milwaukee relayed an existing storm sewer that was connected to the MIS and directed the base flow back to the MIS and peak flow to an existing CSO downstream of an Inline Tunnel dropshaft to divert the peak storm flow away from the Inline Tunnel.

Peak Flow Control

During the peak flow conditions, like those that would be expected during a 100 year event, the low storm flow would first be directed to the MIS and, as flows increased in the system, the high flows would be directed to the Milwaukee River via the proposed 72" Menlo Storm Sewer. Downstream MIS flow would initially stay in the 39" MIS until flow capacity was exceeded. It would then be diverted at IS-73 and IS-74 sending excess flow to the 72" CSO which would in turn be captured by the Inline Tunnel System at NS-4. As the tunnel filled, capacity would be reserved for the upstream separated sewer area by closing the gate at NS-4 and allowing the combined sewage to discharge to the River via the 72" CSO. Under this alternative, the discharge to the River would be less polluted than that expected in the existing system because the "first flush" would have already been separated out and captured. The peak flow discharged to the River from the new 72" storm outfall and the existing 72" CSO would be relatively unchanged from present conditions based upon historic Inline Tunnel operation. During any rain event exceeding a "two month" to "six month" recurrence interval, the gates to the Inline are to be closed shortly after the major event is predicted in order to reserve capacity in the tunnel for the upstream separated area. For example, operating records from the inline gates during the 7/14/10 event show that the gates were closed 3-1/2 hours after the rain started and during the 7/22/10 event show that the gates were closed 10 hours after the rain started. Under this partial separation alternative, it would result in storm flows finding their way to the River either through the new 72" storm sewer, the existing 72" CSO or from overland flow paths. The Inline system simply will not be operated to store over a 2-month rainfall during major rainfall events from the combined sewer area because it must reserve storage for the separated sewer area. The total of combined flows and separated flows under those conditions fills the Inline System to capacity and requires that the combined sewer dropshaft gates be closed relatively soon after a major event is predicted.

Storm Sewer Flows and Model

The 2011 Facilities Plan generated continuous sewer flow hydrographs using population, land use and meteorological data. A 2.94" - one hour storm event, which equates to a "100-year event", was simulated as the design event. The model was used to evaluate the hydraulic capacity of the combined sewers and also approximate the size of the parallel and "overland flow path" storm sewer grid to achieve partial sewer separation. For preliminary design purposes, the east-west trunk sewer outlet in Menlo Boulevard and the Prospect Avenue and Murray Avenue storm trunk sewers were sized to carry the 2.94" - one hour storm (100-year event) less the 0.66" - one hour storm (six month event) which would be conveyed and treated.

The parallel collector storm sewer grid which is shown on Figure 4 was used to convey the 1.96" - one hour storm (10 year event) without surcharging to the road surface. This 10-year design is standard for the area. The difference in flows between the 10-year and 100-year storms is intended to be conveyed over land between the road curbs without flooding buildings. It is not cost-effective to size a collector storm sewer pipe system for a 100-year storm.

CHAPTER 5
TEMPORARY COMBINED SEWER OVERFLOWS

There are three temporary Combined Sewer Overflows (CSO's) included in the original Facility Plan recommendations:

- Wood Place and Downer Avenue
- Shorewood Boulevard and Stowell Avenue
- Murray Avenue and Beverly Road

These temporary CSO's are located in the low points of topographic depressions along the route of the proposed storm trunk sewers as shown on Figure 4. This is where the combined sewers are shallowest and moderate surcharging causes basement backups.

Since the Facility Plan was published, the costs and benefits of these temporary CSO's were investigated in more detail. The benefit of CSO's would be minimized if the Village proceeds with the partial separation in a timely fashion. As the collector storm grid is constructed and catch basin flows are diverted, the value of the CSO's diminish. The DNR has also stated that a WPDES Permit would also need to be amended which could take two to three years to accomplish

However, if the partial separation project is delayed and temporary relief is to be provided to the residents, then the Wood Place CSO should be constructed first to divert flow out of the combined trunk sewer in Downer Avenue to reduce surcharging downstream in the Shorewood Boulevard combined sewer at the depression near Stowell Avenue. This CSO would contain a manual gate that could be operated to divert the entire flow to a storm sewer for rain events that would exceed 2"/hour. Use of this CSO would be phased out when the storm trunk sewer system was constructed to relieve the depression at Shorewood Boulevard and Stowell Boulevard. A separate detailed design memo was prepared on 12/21/12 that outlines the benefits and options.

The CSO at Shorewood Boulevard and Stowell Boulevard is located at the low point in Shorewood Boulevard where basement backups have occurred. The CSO at Murray Avenue and Beverly Road is located at the low point in Murray Avenue where basement backups have occurred. Both of the CSO's are dependent upon the construction of the major storm trunk sewers in Menlo, Murray and Prospect Avenue which would provide an overflow outlet. They would be active during major rainfall events to prevent basement flooding. Their use would be phased out as the combined sewer area north of Menlo and south of Jarvis Street is partially separated. Catch basins would be connected to the new storm sewers which would offload the flow from the existing combined sewer system and reduce the hydraulic grade line to acceptable levels.

CHAPTER 6
APPLICABILITY OF CHAPTER 13 MMSD RULES AND CITY OF MILWAUKEE PRECEDENT

The MMSD instituted a Surface Water Storm Water Rule in 2001 (Chapter 13) that applies to new development or redevelopment. The intent is for governmental units to "manage the volume, timing and peak flow rate from new impervious surface" and to prevent an increase in the "regional flood". The recommendation in this report does meet the spirit of the Rules. There will be no increase in impervious surface due to this project and there will be no increase in the regional flood. Under both current and planned conditions, peak storm flows above the five-year event and combined sewer flows will be discharging directly to the Milwaukee River because the Inline Storage System (ISS) is reserved for the separate sewer area under those conditions. All flow from this project tributary area will still reach the River regardless of the recurrence interval either through the existing combined sewer overflow, the new storm sewer outfall or from overland flow paths. The new storm sewer outfall will relieve the overland flow situation.

There are two proofs that the regional flood will not be impacted: the timing of the River hydrograph lags behind the peak flow storm hydrograph from this project tributary area and the design of the local sewers and MIS and the operation of the MIS Inline Storage System does not impact the discharge of the 50-year and the 100-year flows to the River from this storm sewer watershed.

1. Hydrograph Timing

   The regional flood is estimated at 14,800 CFS on the Milwaukee River in this downstream most reach. Figure 5 depicts the Milwaukee River watershed which is almost 700 square miles in area compared to the small tributary area of this project of 0.2± square miles in area. The outfall for the new 72" storm sewer will be located within 400' of the existing combined sewer outfall for the area (CSO #009100). The new storm outfall is located in the downstream most reach of the Milwaukee River about 1.5 miles north of the former North Avenue Dam which is the limit of the Harbor Estuary. It is also located about 3.3 miles south of the confluence of Lincoln Creek which causes the last increase in regional flood flows along the River. In fact, there is no change in FEMA Regional Flood Flows on the Milwaukee River from E. Buffalo Street at River Mile 0.99 to Lincoln Creek at River Mile 7.98, a distance of about seven river miles. This supports the conclusion that the River hydrograph peaks hours if not days past this comparatively small watershed that peaks in less than one hour depending on the intensity and duration of the storm. That means that peak flows from this small area would have come and gone by the time peak River flows arrive from miles upstream and the flows would not stack on top of the peak River flow.

2. Design and Operation Impacts

   This area has been built out for many years and the project will not increase the impervious surface or peak runoff from the tributary area.

The existing sewer system that is in place can capture and convey approximately a 5 to 10 year design storm with the excess flowing overland directly to the River. The flow that is captured is conveyed by the combined sewer system to two intercepting structures on the 39" Special Section (SS) MIS which has a capacity of 30 CFS ±. This is enough capacity for the "dry weather flow". The difference between the 5 to 10 year flow and the "dry weather flow" is diverted toward two combined sewer overflow pipes (60" and 72") to the ISS at Dropshaft NS04. At that location, the flows can be diverted to the ISS or to the Milwaukee River through CSO 091. The ISS is operated to capture up to a 1/2-year storm from the Combined Sewer Service Area (CSSA) before diversion gates (DG0811) are closed and the excess overflows to the River.

Therefore, the net result of peak flows discharged to the River will not be changed with the installation of the new storm sewer to allow for partial separation. In summary:

- The base dry weather flows from this limited area in Shorewood plus flows up to a 1/2-year storm will be conveyed in the existing combined sewers to the MIS along with 10 year flows from the City of Milwaukee combined sewers.
- Those flows will attempt to enter the 39" SS MIS with the excess going to the ISS or the River.
- The new storm sewer will capture overland flow to catch basins, deliver the 1/2 year storm to the combined sewer and discharge the remainder to the River.
- Overland flows not captured by the storm sewer will flow directly to the River as it did before, albeit less frequently.
- The end result is that with both the existing and proposed systems, flows in excess of the 1/2 year storm will go to the River and flows less than the 1/2-year storm will go to either the MIS or the ISS until the gates at Dropshaft NS04 are closed.

The City of Milwaukee (City) built a similar project in 2005 which resulted in the separation of a combined sewer area in the City. The City relayed some existing sanitary and storm sewers around W. Hawley Avenue between W. State Street and W. Vliet Street. As part of the sewer project, the separate sanitary and storm sewers were disconnected from the combined sewers. The City worked with the MMSD to allow the low flow of the storm sewer to remain connected to the MIS. The excess storm flow was directed to the Menomonee River via a new 30" storm sewer with a pipe full capacity of 100 CFS.

CHAPTER 7
DESIGN FLOWS

In the Facility Plan, the SWMM Model was used to develop base flows and storm flows representative of the combined sewer area. It also was used to model the existing combined sewer pipe system that connects to the MIS and the Inline Storage System near Edgewood Avenue extended and the Milwaukee River. The hydraulic model was tested with several storm events to determine hydraulic inadequacies in the combined sewer "trunk" system. The recommendation was made to off-load that "trunk sewer" system by partially separating the combined sewer service area (CCSA) south of Capitol Drive. This would be accomplished by diverting the catch basins to a new grid of storm sewers running parallel to the combined sewers. A main east-west- storm trunk sewer in Menlo Boulevard sized for the 2.94 inch/hour (100-year) storm less the 0.66 inch/hour (6 month storm) would outlet into the Milwaukee River. Two other trunk sewers would be extended north in Murray Avenue and Prospect Avenue and Shorewood Boulevard to pick up topographic depressions that pond during major floods. Collector storm sewers sized to convey the 1.96 inch/hour (10 year) storm would form the parallel storm grid that would connect to this truck storm sewer system.

Storm flows at key points that were developed for the trunk storm sewers are listed below.

MH #	Trunk Sewer	Location	2.94"/HR 100-YR (CFS)	1.96"/HR* 10-YR (CFS)	0.66"/HR 6 Month (CFS)	Design Flow (CFS)
10	Menlo	@ Prospect	239		44	195
8		@ Maryland	261		47	213
7		@ Murray	357		65	292
984	Murray	@Beverly	61	36	16	45
998		@ Newton	88	53	19	69
628	Prospect	@Shorewood	128	77	32	96
660		@ Beverly	153	92	36	117
680		@ Newton	194	116	40	154
536	Shorewood	@ Stowell	70	41	22	48

* The 10-year flows are shown for comparison purposes.

CHAPTER 8
ALTERNATIVE ALIGNMENTS AND PROFILES IN MENLO BOULEVARD

Once it was confirmed that the best location for the east-west storm trunk sewer was in Menlo Boulevard with a discharge to the Milwaukee River, several alignments and sewer profiles were investigated.

The location and elevation of key utilities were researched and field surveyed. Preliminary construction drawings were prepared showing property lines, topology (see Figure 6) and a profile with existing utilities. One main obstruction is a 54" Metropolitan Interceptor Sewer (MIS) that needs to be crossed at the intersection of Morris Boulevard and Menlo Boulevard. This pipe along with the option to provide a temporary CSO at the upstream end of the project has a bearing on pipe elevations throughout the project. If it is decided that a temporary CSO is not cost effective because its usefulness would be short-lived, then the upstream end of the pipe at Menlo Boulevard and Prospect Avenue can be raised four feet. This would shallow up the entire project and allow the storm sewer to go over the top of the MIS rather than tunneled underneath.

Profiles were prepared for both elevation options: a shallow storm sewer and a deeper storm sewer. The shallow storm sewer reduced the amount of tunneling by over 600 feet which would be reflected in a less expensive alternative. Figure 7 is a plan and profile for both alternatives.

CHAPTER 9
GEOTECHNICAL INVESTIGATION

A field geotechnical exploration, by PSI, Inc., was conducted along the route to assess the impacts of geotechnical conditions on the two alternatives. The route is shown in detail on Figure 6.

Two alternative depths were identified. One deeper alternative that was tunneled under the MIS at Morris Boulevard and a shallower alternative that could be constructed in open cut over the top of the MIS. Upstream of that location, both pipe alternatives are within four vertical feet of each other.

The complete Geotechnical Report is attached in Appendix A along with individual soil boring logs. The following is a summary narrative of that report:

SITE AND SUBSURFACE CONDITIONS

Subsurface Conditions

The subsurface conditions were explored with fourteen (14) soil test borings. The approximate locations are shown on Figure 6. The borings were drilled to terminal depths varying from 20 to 45 feet below existing grade.

Representative soil samples were obtained from the soil borings. Laboratory testing was conducted on select soil samples to aid in identifying and describing the physical characteristics of the soils and to aid in defining the site soil stratigraphy.

Milwaukee River to Menlo Boulevard

From the east bank of the Milwaukee River to Menlo Boulevard, the proposed pipe will be installed by utilizing cut and cover techniques, with the exception of the portion of the pipe that will extend beneath the existing pedestrian path. Beneath the pedestrian path, pipe jacking techniques will be used.

Beneath the topsoil and pavement structure, old undocumented fill material was observed within each of the Borings except for Boring B-2. The old undocumented fill material was generally observed to extend to approximately 12 to 22 feet beneath the existing grade. The old fill material was generally classified as either silty sand, clayey sand, or sandy clay. The old fill material was observed in a moist to wet condition, with moisture contents in the range of 7% to 24%. The "N-Values" observed within the old fill material were typically observed in the range of 4 to 31 blows per foot (bpf).

Underlying the fill materials within Borings B-1, B-3, B-4, B-5 and B-6, and beneath surficial topsoil observed at Boring B-2, native (interbedded) sand, silt and clay soils were encountered to the terminal depths of the borings.

Menlo Boulevard (Morris Boulevard to Maryland Avenue)

Along Menlo Boulevard and extending from Morris Boulevard to Maryland Avenue, the proposed sewer pipe will be installed by utilizing microtunneling techniques.

Native sand, silt and clay soils were typically observed from the pavement structure to the terminal depths of the borings, with the exception of Boring B-7. Within Boring B-7, old undocumented fill material was observed to extend to a depth of approximately six feet. The old undocumented fill material was classified as sandy clay. The moisture content observed within the sandy clay fill material was 23%, indicating a very moist condition.

Underlying the pavement structure at Borings B-8 through B-11, and beneath the old undocumented fill observed at Boring B-7, native silt, sand and clay soils were observed to extend to the terminal depths of the borings. The upper layers of native sand and silt (typically observed to depths of approximately 20 to 30 feet) were observed in a loose to medium relative soil density, with "N-Values" in the range of 6 to 27 bpf. Beneath the upper deposit of loose to medium native sand and silt to the terminal depths of the borings, the native sand and silt soils were typically observed in a medium to very dense condition, with "N-Values" in the range of 19 to 50+ bpf.

Similar conditions were observed within observed within the native lean clay soils. Within the upper 10 feet, the native lean clay soils were typically observed in a very stiff condition with pocket penetrometer values in the rage of 2-1/2 to 3-1/2 tons per square foot (tsf). Beneath the deposit of very stiff lean clay soils were typically in the range of 9% to 20% indicating a moist soil condition.

Menlo Boulevard (Maryland Avenue to Prospect Avenue)

From Prospect Avenue to Maryland Avenue, the proposed pipe will be installed beneath the existing Menlo Boulevard median by utilizing cut and cover techniques.

Native clay and silty sand was observed from the surficial topsoil to the terminal depths of the borings, with the exception of Boring B-13, in which old fill material was observed to extend to approximately 3 feet below grade. The old fill material was classified as clayey sand. The "N-Value" within the old fill material was observed to be 3 bpf.

Underneath the surficial topsoil material at Borings B-12 and B-14 and beneath the old fill material at Boring B-13, native clay and silty sand was observed to extend to the terminal depths of the borings. The native clay soil was typically classified as lean clay, with the exception of the bottom nine foot thick strata within Boring B-13, which was classified as silty clay. The natural moisture contents within the native clay soils were observed in the range of 10% to 21%, indicating a moist soil condition. The pocket penetrometer values within the native clay soils were observed in the range of 2 to 4-1/2 tons per square foot (tsf), indicating a very stiff to hard soil consistency.

The layers of native silty sand soils which were sporadically observed within the predominate clay matrix were typically observed in a medium to very dense relative soil density, with "N-Values" in the range of 18 to 50+ bpf.

Groundwater Information

Free groundwater was encountered within the borings during or at the completion of drilling operations, at depths ranging from 6± to 39± feet below ground surface. In addition, permanent groundwater monitoring wells were installed at two of the boring locations upon completion of drilling operations (B-6 and B-9).

Fluctuations in the groundwater level should be anticipated throughout the year depending on variations in climatological conditions and other factors not apparent at the time the borings were performed. The possibility of significant groundwater level fluctuation should be considered when developing the design and construction plans for the project.

EVALUATION AND RECOMMENDATIONS

Geotechnical Discussion

Based upon the subsurface conditions encountered at the test borings, there is one primary geotechnical issue that could have an impact during installation of the sanitary sewer; this concern being that groundwater was observed at or above the anticipated installation depth of the new sewer.

Groundwater was encountered within the borings at depths ranging from 6± to 39± feet below existing grade (elevation 586 to 648 feet MSL). Based upon these observations, groundwater-related problems should be anticipated for excavations extending below these depths. For excavations that are only advanced a foot or so below the water level, it is anticipated that it can be handled by simple means such as pumping from sumps or the use of perimeter trenches to collect and discharge the water away from the work area.

However, for excavations that extend below the water table and into a sand or silt deposit (i.e. Borings B-2, B-4, B-6 and B-7); these soils will become "quick" acting as the confining pressure of the overburden soils is removed. In this case, it may be necessary to install trench drains or use other specialized methods, such as deep wells or well points, in order to intercept groundwater and direct water around the excavation. Interceptor trenches must be lined with a geotextile fabric and filled with crushed stone. A qualified dewatering contractor must determine the need for interceptor trenches, and the specific details of the trenches. A qualified dewatering contractor must also determine the width, depth and location of interceptor trenches.

Cut and Cover Recommendations

Based on the information, it appears that excavations required to construct the proposed sanitary sewer from the east bank of the Milwaukee River to Menlo Boulevard, and within the median of Menlo Boulevard from Maryland Avenue to Prospect Avenue will extend to depths of up to 25 feet below the existing round surface. The soils observed at bearing elevation appear to be suitable for support of the proposed sewer line.

Within the borings performed along the proposed sewer pipe path (between the Milwaukee River and Menlo Boulevard), free groundwater was encountered at depths ranging from 6± to 23± feet below existing grade. Based upon these observations, groundwater-related problems should be anticipated for excavations extending below these depths. If water levels do not recede over a period of time, dewatering with sump pumps, wells or well points could be necessary. Moisture seepage into excavations in cohesive soils should be at a slower rate which would generally be controlled by gravity flow and construction sump pumps. Removal of water by pumping from excavations in granular soils (sand and gravel) below the water table could result in a "quick" condition. Water levels must be maintained at least 2 or more feet below the bottom of excavations in sand to prevent seepage forces upward which could reduce subgrade support.

The borings performed along the proposed sewer pipe path within the Menlo Boulevard median (between Maryland Avenue and Prospect Avenue), indicated that free groundwater ranges from 20 to 32 feet below grade. The depth of the proposed excavations within this area will vary from 12 to 25 feet. Therefore, it is possible that groundwater could be controlled by gravity flow and construction sump pumps. It should be noted, however; that discontinuous sand or silt seams could be found during construction, requiring more sophisticated dewater means, such as wells or well points. Dewatering must be anticipated in all excavations which extend below the potentiometric surface, in particular granular soil materials.

Where wet, loose or soft soil conditions are encountered (most likely within the pipe path between the Milwaukee River and Menlo Boulevard), it may be necessary to place a layer of granular bedding material in the bottom of the excavation to develop a stable working surface. A 12-inch layer of cover material should be used to develop the working surface.

Depending upon the depth of the excavations, a sloped or benched excavation may not be feasible. The extent of bracing of open cut excavations will depend upon depth of cut, groundwater conditions, soils encountered, length of time the excavation will be open, area available for excavation and local governing regulations. Predominantly cohesive soils may appear to stand nearly vertical in shallow excavations for short periods of time. However, soil creep, surcharge loads, precipitation, subsurface groundwater seepage, construction activity vibrations and other factors may cause these soils to cave within an unpredictable period of time.

Excavations encountering fill, granular or organic soils may tend to cave or slough readily; the potential for caving soil is even greater if water is present within these layers. Unstable excavation walls may also cause surrounding cohesive soils to become unstable.

If groundwater is encountered, steel sheet piling may be necessary to reduce potential seepage. If sheet piling is necessary, it should extend at least 5 feet below the proposed lowest extent of the excavation to reduce the potential seepage. Toe-depth will also be critical on maintaining an adequate factor of safety relative to stability. If sheet piling is utilized for the project, stability of the shoring unit also must be addressed by a qualified geotechnical Engineer. Sheet piling is not expected to prevent all the groundwater inflow, the rate of flow should be reduced and most likely could be controlled using sump pits and pumps inside the sheeting. Temporary shoring or use of trench boxes will be required to maintain a safe working area in all other areas of the excavation. The contractor should be aware of and follow all applicable regulations governing this type of construction.

Tunneling Recommendations

The storm sewer pipe beneath Menlo Boulevard extending from Morris Boulevard to Maryland will be installed by using microtunneling techniques.

In order to preclude caving of the tunnel roof, prudent care must be taken when tunneling below the existing roadways to provide for the presence of sufficient soil materials above the crown of the excavation. The general rule of thumb when tunneling in un-consolidated material is to provide approximately 1.5 to 3 times the tunnel diameter of soil above the crown of the excavation. Based on this rule and the anticipated pipe diameter (72 inches), the invert elevation should not be above 18 feet below existing grade. Based on the most current plans, the invert elevation within this portion of the project will vary from 22 to 34 feet below existing grade. Adequate support of the tunnel must be maintained at all times.

Based upon the subsurface conditions observed from Borings B-7 through B-11, tunneling installation methods should generally be satisfactory for this site. The soils at and above the anticipated storm sewer invert elevation within the proposed tunneling portion of the project are anticipated to consist of predominately hard/very dense over-consolidated glacial till or hardpan soils.

The tunneling Contractor should select the appropriate microtunnel machine and face support for the proposed boring machine based on the conditions of the project including site geology and subsurface conditions, site and alignment restrictions including items such as the dimension of the access shaft, construction schedule, and local knowledge or past experience with similar projects and similar soil.

The stiff to hard clay soils at this site are generally not anticipated to pose significant resistance during tunneling. However, cobbles or boulders may be encountered within the proposed tunneling reach. When microtunnel machines or hand mining operations are performed, most cobbles and smaller boulders up to approximately 1/3 of the diameter of the boring machine or tunnel can likely be broken by the cutter heads and passed through the face of the microtunnel machine without major impacts. Drilling an access shaft may also be required under extreme circumstances. Where large boulders are encountered near the edge of the tunnel shaft and the surrounding soils are loose or soft, it may be possible for the TBM to push the boulder radially outward into the surrounding soil. However, pushing the boulder radially may cause the tunnel to be shifted from its intended alignment. The removal of cobbles and boulders should be made a part of the contract documents. The removal of boulders up to 1/3 of the tunnel diameter is typically the responsibility of the contractor.

Based on past history in the project area, there is a potential for methane gas to be encountered during tunneling/boring operations. The tunnel excavation should be continuously monitored by the Contractor for methane levels.

Inter-bedded layers of granular soils will likely be encountered while tunneling within the clayey glacial till soils. Special care should be taken to ensure the stability of the unprotected face of the cutting edge within any inter-bedded sand layers encountered. Dewatering may be required to maintain a stable tunneling face within these soils and to prevent substantial groundwater from flowing around the tunnel pipe annulus and into the tunnel. Deep well dewatering methods, installed from the existing ground surface, may be used. The dewatering system(s) chosen, including the type, size, depth and spacing of dewatering wells should be properly designed by an experienced local dewatering contractor utilizing the soil borings performed at the time of construction as well as the available public well information and records in the vicinity of the proposed project. Alternative methods such as the use of breasting boards, grouting or "freezing" may also be used to control running face conditions within these soils.

Surface features must be monitored by the Contractor for settlement caused by ground loss and collapse of the soil above and around the pipe due to alterations of the stresses in the soil. Additional surface ground movement may occur due to running ground conditions at the face of the tunnel or collapse of soil into voids resulting from the removal of boulders at the face. Ground movement associated with tunnel construction is influenced by the methods of construction and the quality of workmanship as well as the subsurface conditions. If pipe-jacking methods are employed, maintaining adequate bentonite pressure in the over cut annulus during installation and permanently grouting the annulus following installation will help to minimized settlements. Dewatering fine sand soil to limit the potential for ground loss association with running round conditions at the face of the excavation will also help minimize surface settlements. If surface settlement exceeds on inch, corrective measures should be undertaken from the ground surface by the Contractor. If the settlement damages any existing surface structures or underground utilities, the use of compaction grouting techniques should be performed as soon as possible to stabilize and restore the damaged structures.

It will be necessary to excavate an entry/receiving pit. The native stiff to hard clay soils should generally be adequate for support of the tunneling equipment, provided they are stable at the time of construction. The approach trench or receiving area should be large enough to accommodate all jacks and blocking and at least on section of the pipe. The tunnel pits or receiving area must be suitably braced. Sheeting and bracing plans should be submitted to the design engineer prior to the excavation of the pits. The soil parameters presented above may be used in the design of the temporary excavation support.

Below Grade Wall Design Considerations

The below grade walls for the entry/receiving pit will be required to resist lateral earth pressures. The actual earth pressure on the walls will vary according to material types and the grade above the top of the wall.

CONSTRUCTION CONSIDERATIONS

PSI should be retained to provide observation and testing of construction activities involved in the foundation, earthwork, and related activities of this project.

Moisture Sensitive Soils/Weather-Related Concerns

The soils encountered at this site are expected to be sensitive to disturbances caused by construction traffic and changes in moisture content. Increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils that become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather.

Areas should be sloped to facilitate removal of collected rainwater, groundwater, or surface runoff. Positive site drainage should be provided to reduce infiltration of surface water into the excavations. The grades should be sloped away from the excavations and surface drainage should be collected and discharged such that water is not permitted to infiltrate back towards the areas of construction.

Drainage and Groundwater Concerns

That portion of the project extending from the Milwaukee River to Menlo Boulevard, shallow groundwater was encountered during drilling operations at a depth of approximately 4 to 21 feet beneath the existing grade. Within this portion of the project, cut and cover methods will be used to install the pipe. The excavation depths within this portion of the project are anticipated to be on the order of 7 to 25 feet below grade. Therefore; difficulty with groundwater seepage is anticipated during excavation from the Milwaukee River to Menlo Boulevard. It is possible for the groundwater table to vary within the depths explored during other timed of the year depending upon climatic conditions (seasonal fluctuation) or for perched water to be present within the existing near-surface fill and organic soils. The Contractor should verify the actual groundwater and seepage conditions at the time of construction activities and propose the groundwater control methods for the Engineer's approval, including disposal of discharge water.

CHAPTER 10
COST ESTIMATES

A preliminary cost estimate was developed for both the deep alternative (Alternative No. 1) and the shallow alternative (Alternative No. 2) based on currently available information. Also included are preliminary estimates for the Prospect Avenue/Shorewood Avenue trunk storm sewer and the Murray Avenue trunk storm sewer which would provide an outlet at the topographic depressions at Shorewood Boulevard and Stowell Avenue and at Murray Avenue and Beverly Avenue. Extension of these trunk sewers would minimize the need for construction of any temporary CSO's.

Final project costs will depend upon actual labor and material costs, bidding conditions, site conditions, implementation schedule and other variable conditions. As a result, final project costs may vary from the preliminary cost estimates in this report. Tables 1 and 2 summarize the estimated costs for Alternative No. 1 (the deep storm sewer alternative) and Alternative No. 2 (the shallow storm sewer alternative). The costs range from $7,974,000 to $7,669,000. This compares well with estimated costs of Alternate No. 2.1.2. - "Virtual Separation Storm Outlet to Milwaukee River" in the Comprehensive Facility Plan by Ruekert & Mielke, Inc. dated March of 2011 which were estimated at $7,770,000.

As footnoted on the cost estimate tables, the costs include trench pavement restoration, but not full street reconstruction. The costs also do not include "hand mining" around three large trees in Menlo Boulevard between Maryland Avenue and Prospect Avenue. These costs could amount to over $120,000 per tree.

Tables 3 and 4 summarize the estimated costs for the Prospect Avenue/Shorewood Boulevard storm trunk sewer of $1,102,000 and the Murray Avenue storm trunk sewer of $389,000. The unit costs for that construction were close to those used in the Facility Plan which were found to be cost effective when compared to other alternatives.

The estimates are based on the following:

- Construction costs are based on anticipated bidding in 2014.
- A contingency of 25 percent is included in the estimated construction cost.
- The capital cost includes an allowance of 15 percent for technical services such as design, construction related services and administrative costs.

CHAPTER 11
PERMITS AND EASEMENTS

There are several permits and agreements that need to be obtained during the final design phase as follows:

- Chapter 30 DNR Permit for a new MS-4 to discharge to the Milwaukee River
- NR 151 sign-off
- NOI to disturb more than one acre of land
- County Park easement to cross under the County Trail (abandoned railroad)
- Temporary construction easements from several property owners
- We Energies facility relocates
- Temporary traffic detours
- Bus route detours
- Temporary parking arrangements

CHAPTER 12
RECOMMENDATION

Facilities Description:

The recommended Alternative is shown in Plan and Profile on Figure 7 as the shallow trunk storm sewer in Menlo Boulevard and Morris Boulevard and the storm trunk sewers in Prospect Avenue/Shorewood Boulevard and Murray Avenue.

If the project moves forward in a timely fashion, there is little benefit to constructing the temporary CSO's which will take several years to permit.

The Menlo Boulevard trunk storm sewer consists of a 72" diameter pipe sized to handle the 2.94 inch/hour 100-year storm less the first flush and storm flow from a six month intensity storm which will remain in the combined sewer system. It will run from Prospect Avenue to the discharge at the Milwaukee River. A portion of the 3400' long sewer is in tunnel (1755') and jacked pipe (155') and the remainder is open-cut. These will be major connection points with the proposed storm sewer grid at Menlo and Prospect, at Menlo and Maryland and at Menlo and Murray.

The Prospect/Shorewood trunk sewer will pick up a topographic depression at Shorewood Boulevard and Stowell Avenue and is sized to convey the 2.94 inch/hour 100-year storm less the first flush and storm flow from a six month intensity storm which will remain in the combined sewer. It consists of pipe ranging in size from 42" low head pipe to 60" diameter pipe. This sewer will initially pick up existing catch basins along the route and will eventually be extended upstream to serve the proposed storm sewer grid.

The Murray trunk storm sewer will pick up a topographic depression at Beverly Avenue and Murray Avenue and is sized to convey the 2.94 inch/hour 100-year storm less the first flush and storm flows from a six month intensity storm which will remain in the combined sewer. It will consist of 36" diameter pipe. The sewer will initially pick up existing catch basins along the route and will eventually be extended upstream to serve the proposed storm sewer grid.

There are some electric and gas utilities that will need to be relocated particularly on Menlo Boulevard near Morris Boulevard. There is also some 8" and 12" diameter sanitary sewer that will need to be moved to accommodate the new large diameter sewers.

On Prospect Avenue between Menlo Boulevard and Newton Avenue, a new parallel sanitary sewer will be necessary to pick up sanitary sewer laterals that will be in conflict with the new storm sewer. There is also a similar requirement at the Morris Boulevard and Menlo Boulevard intersection which will require an outside drop connection to the MIS.

At key points along the trunk sewer route, it is recommended that oversized catch basins be constructed to pick up intersections subject to flooding. This is particularly important in the topographic depressions.

Phasing:

It is recommended that the Menlo Boulevard trunk storm sewer, the Prospect/Shorewood trunk storm sewer and the Murray Avenue trunk storm sewers be constructed at the same time in order to provide relief to the residents located in the topographic depressions. This will minimize the need for the temporary CSO's and save the money for use in extending the storm sewer grid.

Land Requirements:

Negotiations should begin with Milwaukee County parks to obtain an easement under the bike trail and several property owners should be contacted to obtain temporary construction easements.

Utility Contacts:

We Energies should be contacted as soon as preliminary plans are available to discuss utility relocates.

The MMSD should be contacted regarding the need to modify the MIS manhole at Morris Boulevard.

Groundwater Monitoring:

Groundwater monitors were installed at two locations along the Menlo Boulevard trunk sewer route. These monitors must be read monthly to establish information that will be needed to properly design the deep tunnel dropshafts.

City of Milwaukee Flooding Study Task Force:

The City of Milwaukee created a Flood Study Task Force (FSTF) on July 27, 2010. The FSTF met nine times in 2011 and published its recommendations to the City Council on June 10, 1911. One of the recommendations was to "work with the Village of Shorewood and MMSD to develop an official policy regarding targeted separation of the combined sewers in areas where timing and volume generate a high risk of inflow-induced backups and where limited utility connections and accessible outlet allow for separation to be cost effective."

This alternative will provide a significant reduction to combined sewer flows in Edgewood Avenue which borders the City of Milwaukee. Discussions should be held with the City of encourage them to take steps to prevent any increase in flood flows from their development to the combined sewers in Edgewood Avenue and to consider taking steps to reduce flows by partially separating their portion of the tributary area.

TABLE 1

Village of Shorewood Combined Area South - Cost Estimate
February 23, 2012

ALTERNATIVE 1

Item No.	Description	Unit	Quantity	Unit $	Total
1	72-inch RCP Storm Sewer Open Cut w/Spoil Backfill (10 Feet Deep)	LF	100.00	$450.00	$45,000.00
2	72-inch RCP Storm Sewer Open Cut w/Granular Backfill (10 Feet Deep)	LF	85.00	$600.00	$51,000.00
3	72-inch RCP Storm Sewer Open Cut w/Spoil Backfill (20 Feet Deep)	LF	370.00	$630.00	$233,100.00
4	72-inch RCP Storm Sewer Open Cut w/Granular Backfill (20 Feet Deep)	LF	15.00	$830.00	$12,450.00
5	72-inch RCP Storm Sewer Open Cut w/Spoil Backfill (25 Feet Deep)	LF	215.00	$700.00	$150,500.00
6	72-inch RCP End Section w/Grate	EA	1.00	$5,400.00	$5,400.00
7	72-inch RCP Storm Sewer (Tunneled)	LF	2535.00	$1,200.00	$3,042,000.00
8	120-inch Storm Manhole	VF	39.00	$1,800.00	$70,200.00
9	Tunnel Shaft w/Manhole	VF	151.00	$13,300.00	$2,008,300.00
10	12" Sanitary Sewer Relay	LF	120.00	$150.00	$18,000.00
11	Veolia Dewatering	LS	1.00	$50,000.00	$50,000.00
12	Trench Restoration	LF	100.00	$100.00	$10,000.00

Total Preliminary Estimated Construction Cost:		$5,695,950.00
15% Engineering Services:	$	854,392.50
25% Contingency:	$	1,423,987.50
Total Preliminary Estimated Project Cost:	$	7,974,330.00

* Costs include trench restoration in the street
* Hand mining under trees would add $1500 per lineal foot or $120000 per tree

Village of Shorewood Combined Area South - Cost Estimate
February 23, 2012

ALTERNATIVE 2

Item No.	Description	Unit	Quantity	Unit $	Total
1	72-inch RCP Storm Sewer Open Cut w/Spoil Backfill (10 Feet Deep)	LF	100.00	$450.00	$45,000.00
2	72-inch RCP Storm Sewer Open Cut w/Granular Backfill (10 Feet Deep)	LF	85.00	$600.00	$51,000.00
3	72-inch RCP Storm Sewer Open Cut w/Spoil Backfill (15 Feet Deep)	LF	290.00	$550.00	$159,500.00
4	72-inch RCP Storm Sewer Open Cut w/Granular Backfill (15 Feet Deep)	LF	435.00	$750.00	$326,250.00
6	72-inch RCP Storm Sewer Open Cut w/Granular Backfill (20 Feet Deep)	LF	305.00	$830.00	$253,150.00
7	72-inch RCP Storm Sewer Open Cut w/Spoil Backfill (25 Feet Deep)	LF	265.00	$700.00	$185,500.00
8	72-inch RCP End Section w/Grate	EA	1.00	$5,400.00	$5,400.00
9	72-inch RCP Storm Sewer (Jacked)	LF	155.00	$2,000.00	$310,000.00
10	72-inch RCP Storm Sewer (Tunneled)	LF	1755.00	$1,200.00	$2,106,000.00
11	120-inch Storm Manhole	VF	121.00	$1,800.00	$217,800.00
12	MIS Manhole O/D	EA	1.00	$40,000.00	$40,000.00
13	Tunnel Shaft w/Manhole	VF	120.00	$13,300.00	$1,596,000.00
14	Jacking Shaft	EA	2.00	$12,500.00	$25,000.00
15	8" Sanitary Sewer Relay	LF	300.00	$120.00	$36,000.00
16	12" Sanitary Sewer Relay	LF	120.00	$150.00	$18,000.00
17	Veolia Dewatering	LS	1.00	$50,000.00	$50,000.00
18	Trench Restoration	LF	530.00	$100.00	$53,000.00
				Total Preliminary Estimated Construction Cost:	**$5,477,600.00**
				15% Engineering Services:	**$821,640.00**
				25% Contingency:	**$1,369,400.00**
				Total Preliminary Estimated Project Cost:	**$7,668,640.00**

* Costs include trench restoration in the street
* Full street reconstruction would add approxiamately $130000
* Hand mining under trees would add $1500 per lineal foot or $120000 per tree

TABLE 3

Village of Shorewood Combined Area South - Cost Estimate
February 23, 2012

Prospect Storm Sewer

Item No.	Description	Unit	Quantity	Unit $	Total
1	12-inch RCP CL V Storm Sewer w/Granular Backfill	LF	500.00	$55.00	$27,500.00
2	15-inch RCP CL IV Storm Sewer w/Granular Backfill	LF	30.00	$60.00	$1,800.00
3	24-inch RCP CL III Storm Sewer w/Granular Backfill	LF	120.00	$95.00	$11,400.00
4	30-inch RCP CL III Storm Sewer w/Granular Backfill	LF	100.00	$130.00	$13,000.00
5	34X53-inch RCP Storm Sewer w/Granular Backfill	LF	325.00	$250.00	$81,250.00
6	38X60-inch RCP Storm Sewer w/Granular Backfill	LF	420.00	$325.00	$136,500.00
7	48-inch RCP Storm Sewer w/Granular Backfill	LF	360.00	$250.00	$90,000.00
8	54-inch RCP Storm Sewer w/Granular Backfill	LF	275.00	$325.00	$89,375.00
9	60-inch RCP Storm Sewer w/Granular Backfill	LF	175.00	$380.00	$66,500.00
10	84-inch Storm Manhole	VF	25.00	$800.00	$20,000.00
11	96-inch Storm Manhole	VF	18.00	$1,000.00	$18,000.00
12	108-inch Storm Manhole	VF	24.00	$1,250.00	$30,000.00
13	Catch Basin w/Grate	EA	18.00	$1,500.00	$27,000.00
14	Pavement Restoration	LF	1750.00	$100.00	$175,000.00

Total Preliminary Estimated Construction Cost:	$787,325.00
15% Engineering Services:	$118,098.75
25% Contingency:	$196,831.25
Total Preliminary Estimated Project Cost:	$1,102,255.00

TABLE 4

Village of Shorewood Combined Area South - Cost Estimate
February 23, 2012

Murray Storm Sewer

Item No.	Description	Unit	Quantity	Unit $	Total
1	12-inch RCP CL V Storm Sewer w/Granular Backfill	LF	500.00	$55.00	$27,500.00
2	15-inch RCP CL IV Storm Sewer w/Granular Backfill	LF	80.00	$60.00	$4,800.00
3	18-inch RCP CL III Storm Sewer w/Granular Backfill	LF	40.00	$70.00	$2,800.00
4	36-inch RCP Storm Sewer w/Granular Backfill (10 Feet Deep)	LF	750.00	$170.00	$127,500.00
5	60-inch Storm Manhole	VF	50.00	$450.00	$22,500.00
6	Catch Basin w/Grate	EA	12.00	$1,500.00	$18,000.00
7	Pavement Restoration	LF	750.00	$100.00	$75,000.00

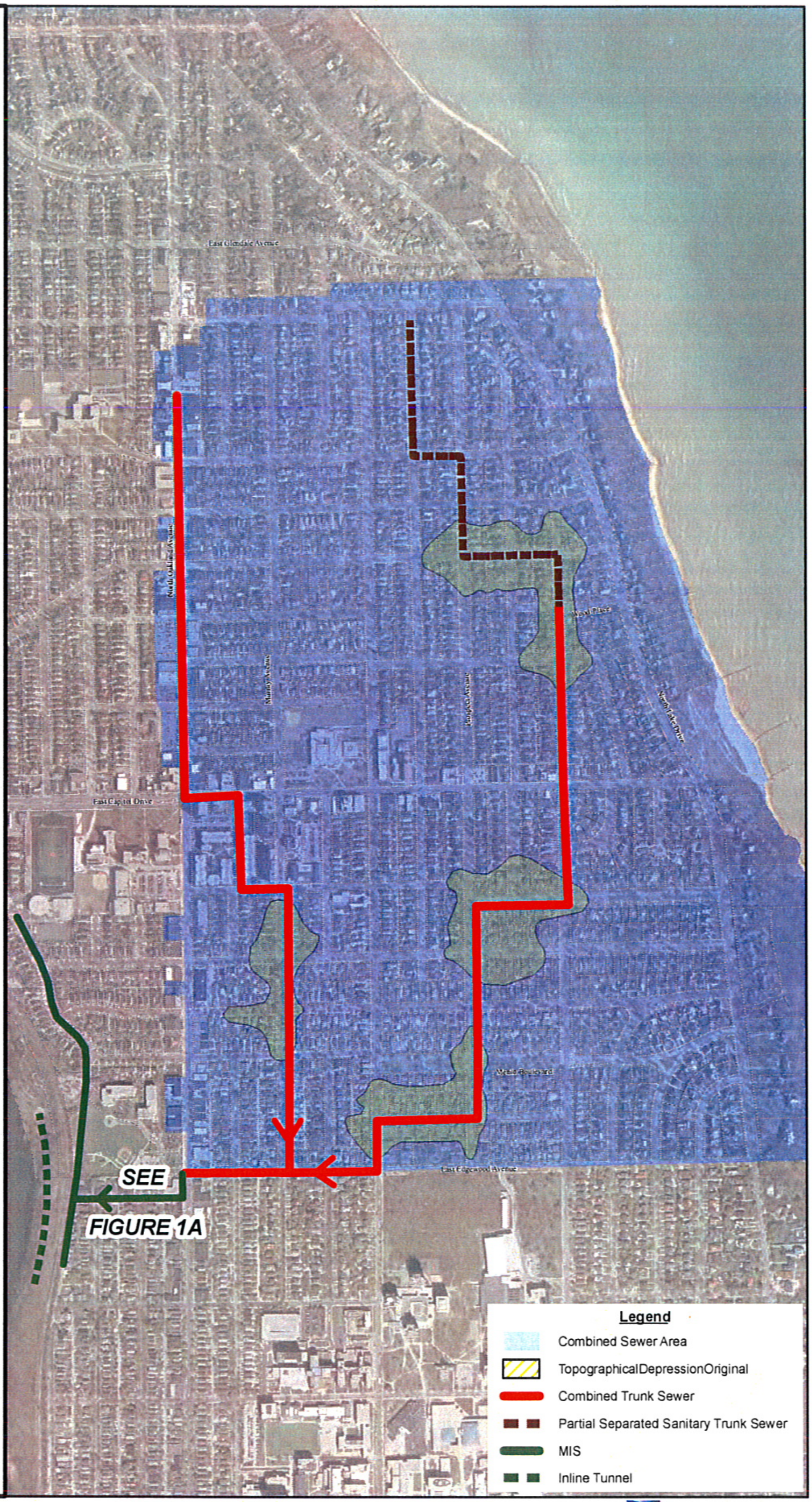
Total Preliminary Estimated Construction Cost:	$278,100.00
15% Engineering Services:	$41,715.00
25% Contingency:	$69,525.00
Total Preliminary Estimated Project Cost:	$389,340.00

Village of Shorewood

FIGURE 1

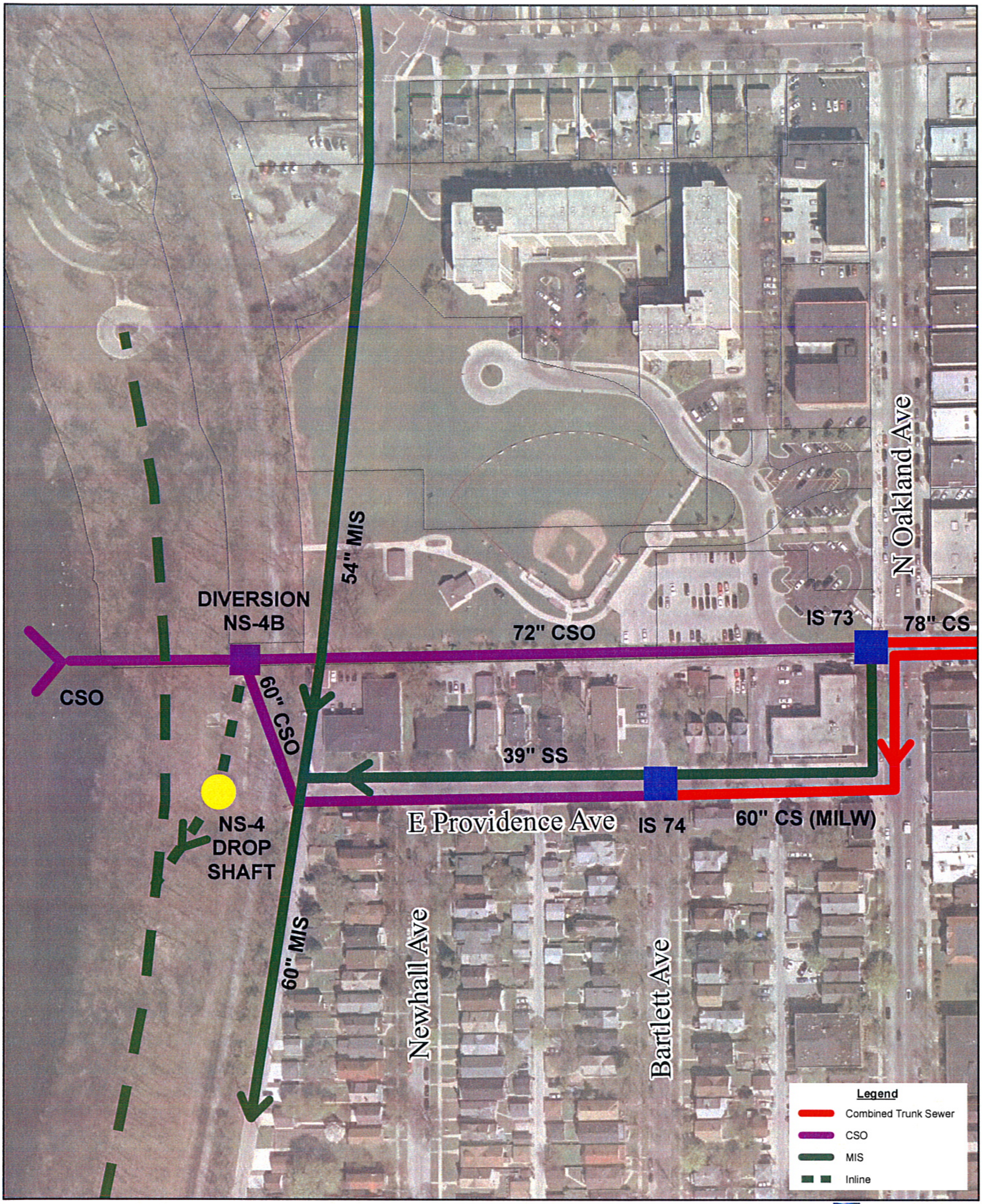
VILLAGE OF SHOREWOOD

COMBINED SEWER AREA



Ruekert·Mielke
engineering solutions for a working world

FIGURE 1A



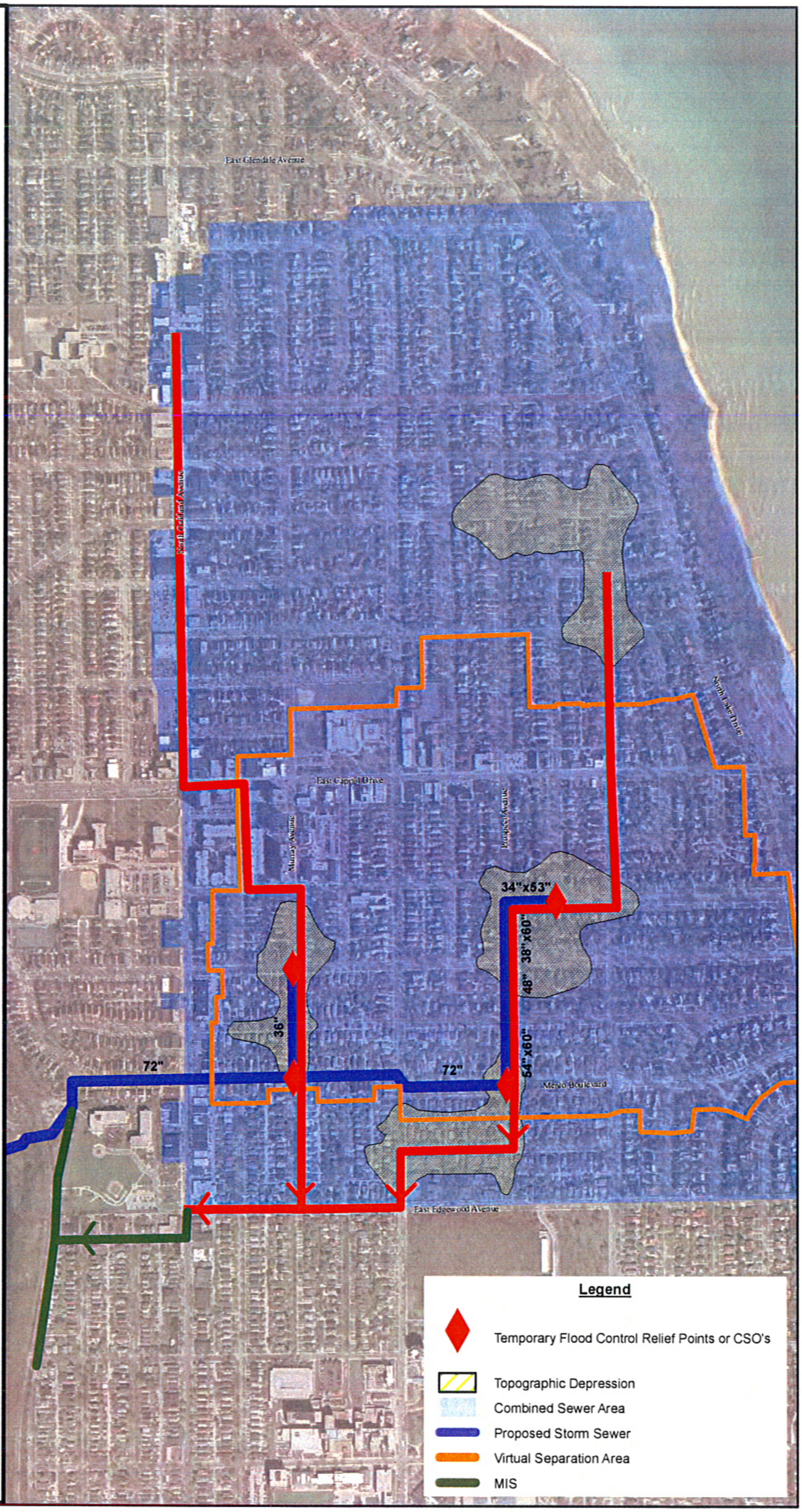
Ruekert·Mielke
engineering solutions for a working world

FIGURE 2

Village of Shorewood

HYDRAULIC IMPROVEMENT BY CONSTRUCTION OF STORM SEWER OUTLETS

Virtual separation of the combined area between Menlo Boulevard and Capital Drive and construction of combined sewer overflows on Prospect Avenue, Murray Avenue and east Wood Place eliminates the need for combined sewer improvements south of east Jarvis Street and MIS improvements in Edgewood Avenue.

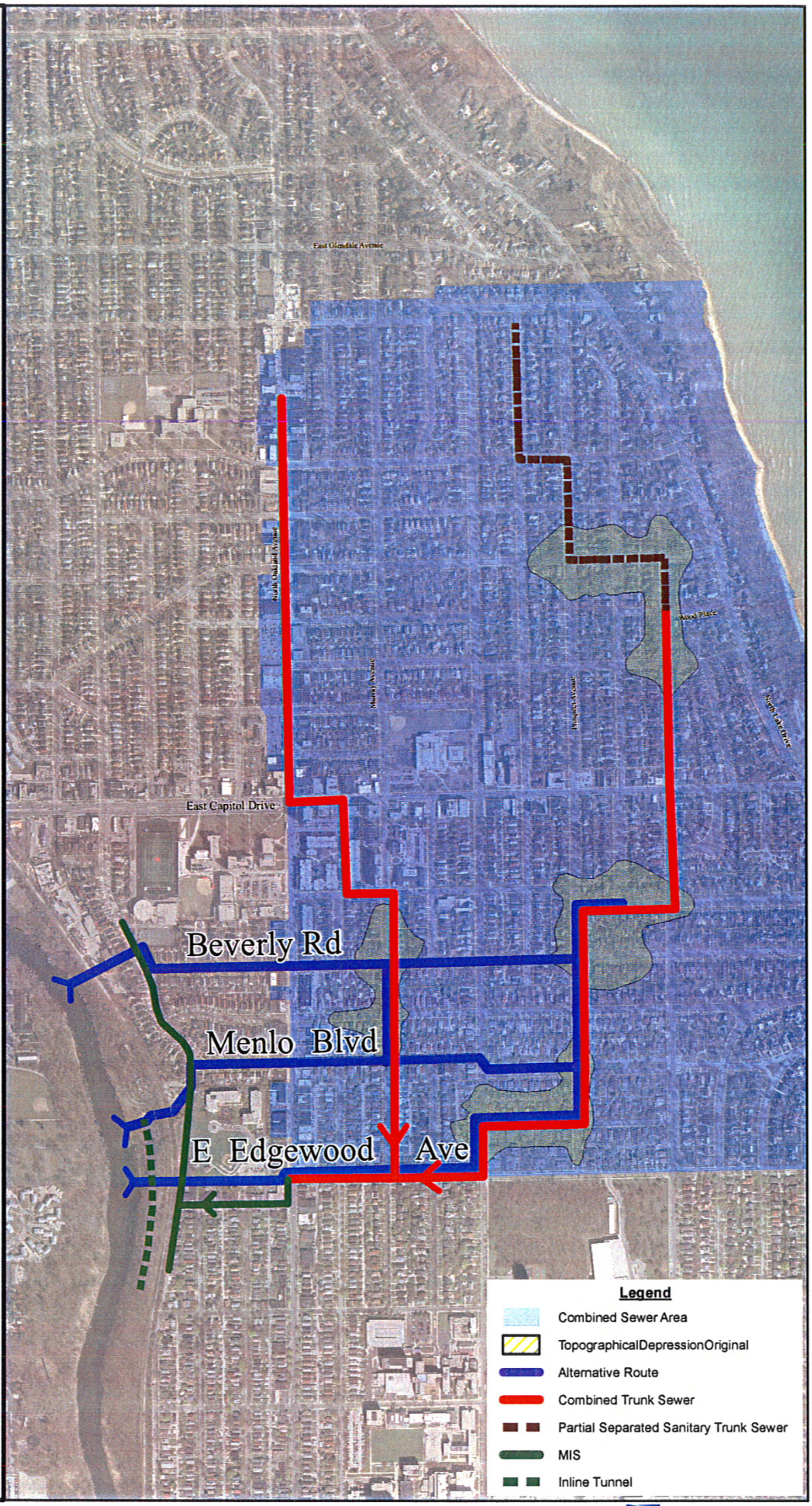


Ruekert·Mielke
engineering solutions for a working world

FIGURE 3

VILLAGE OF SHOREWOOD

COMBINED SEWER AREA ALTERNATIVE STORM TRUNK SEWER ROUTES



Ruekert·Mielke
engineering solutions for a working world

FIGURE 4

ADVANCED FACILITY PLAN

REFINED ALTERNATIVE

RELIEF OF COMBINED SEWER FLOWS BY STORM SEWER CONSTRUCTION

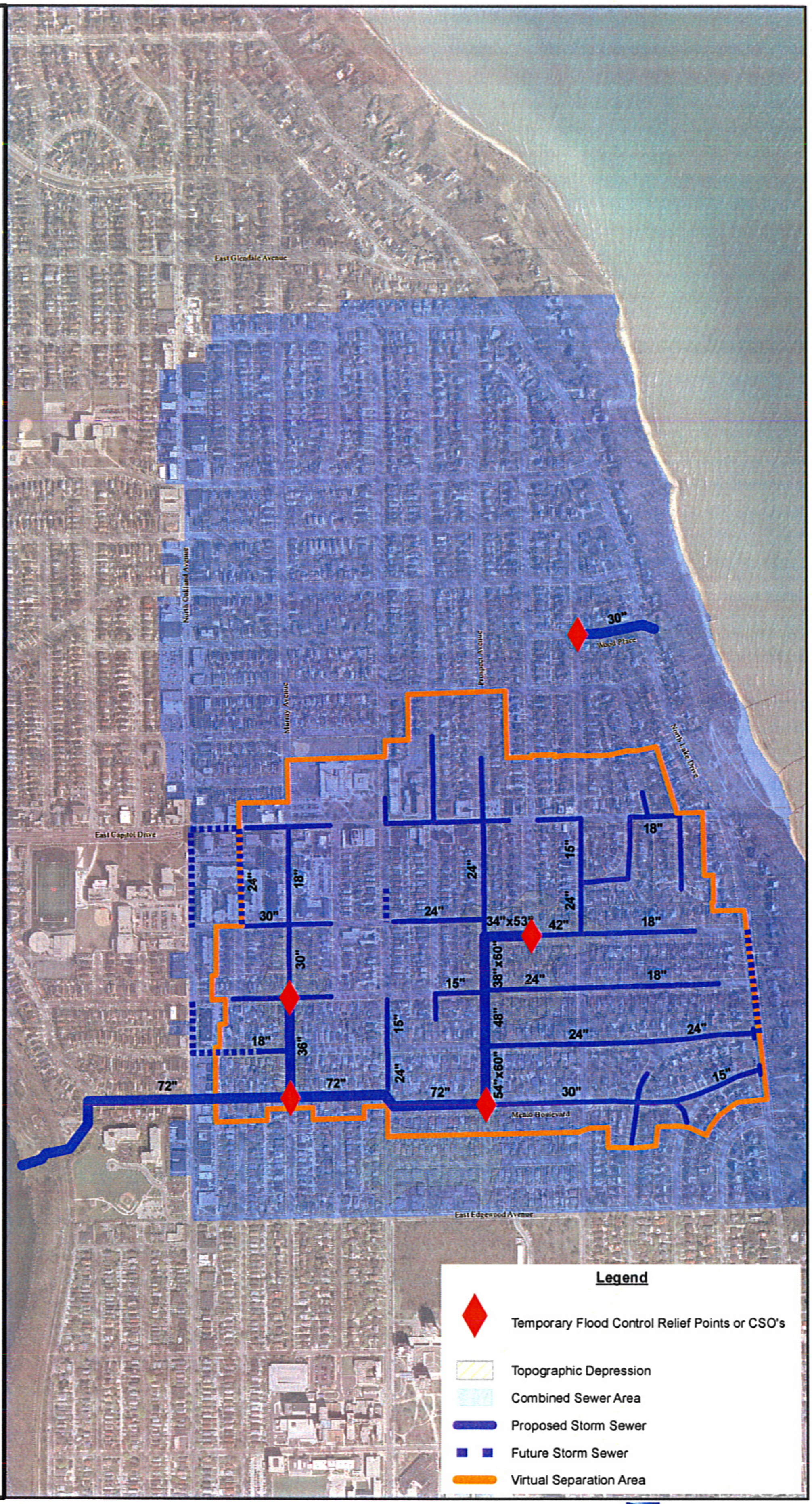
AKA

VIRTUAL SEPARATION

The Village is proposing to construct new storm outfall at Menlo and the Milwaukee River to capture street runoff from the south east corner of the combined area. The "first flush" stormwater will be directed to the original combined sewer for treatment of suspended solids.

This separation eliminates the need to improve the MMSD MIS west of Oakland Avenue.

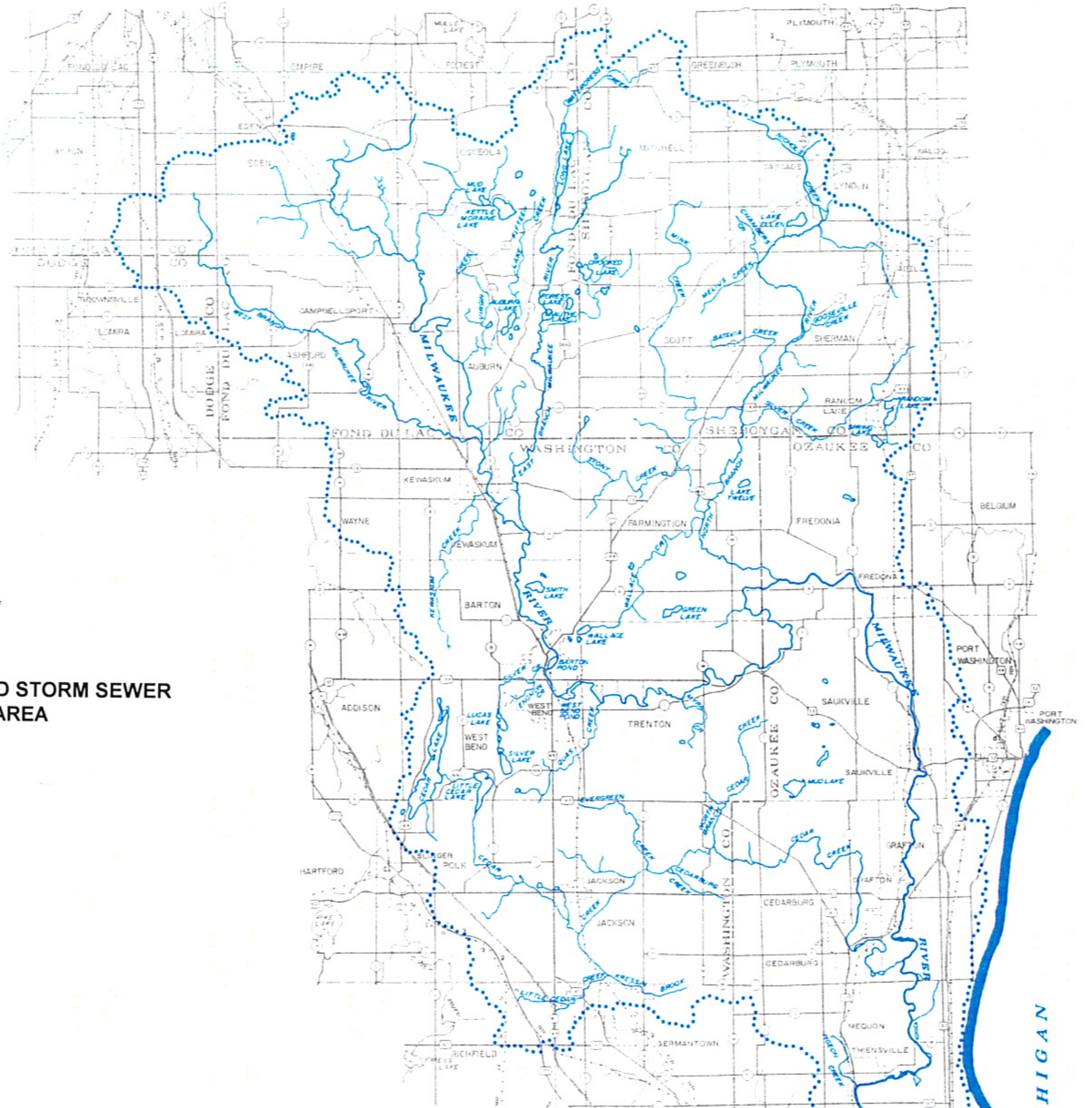
Storm sewers sized to handle 2" rain/hr w/o surcharge and 3" rain/hr w/o surface flooding.

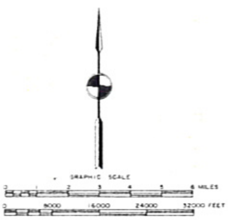


Ruekert·Mielke
engineering solutions for a working world

FIGURE 5

THE MILWAUKEE RIVER WATERSHED

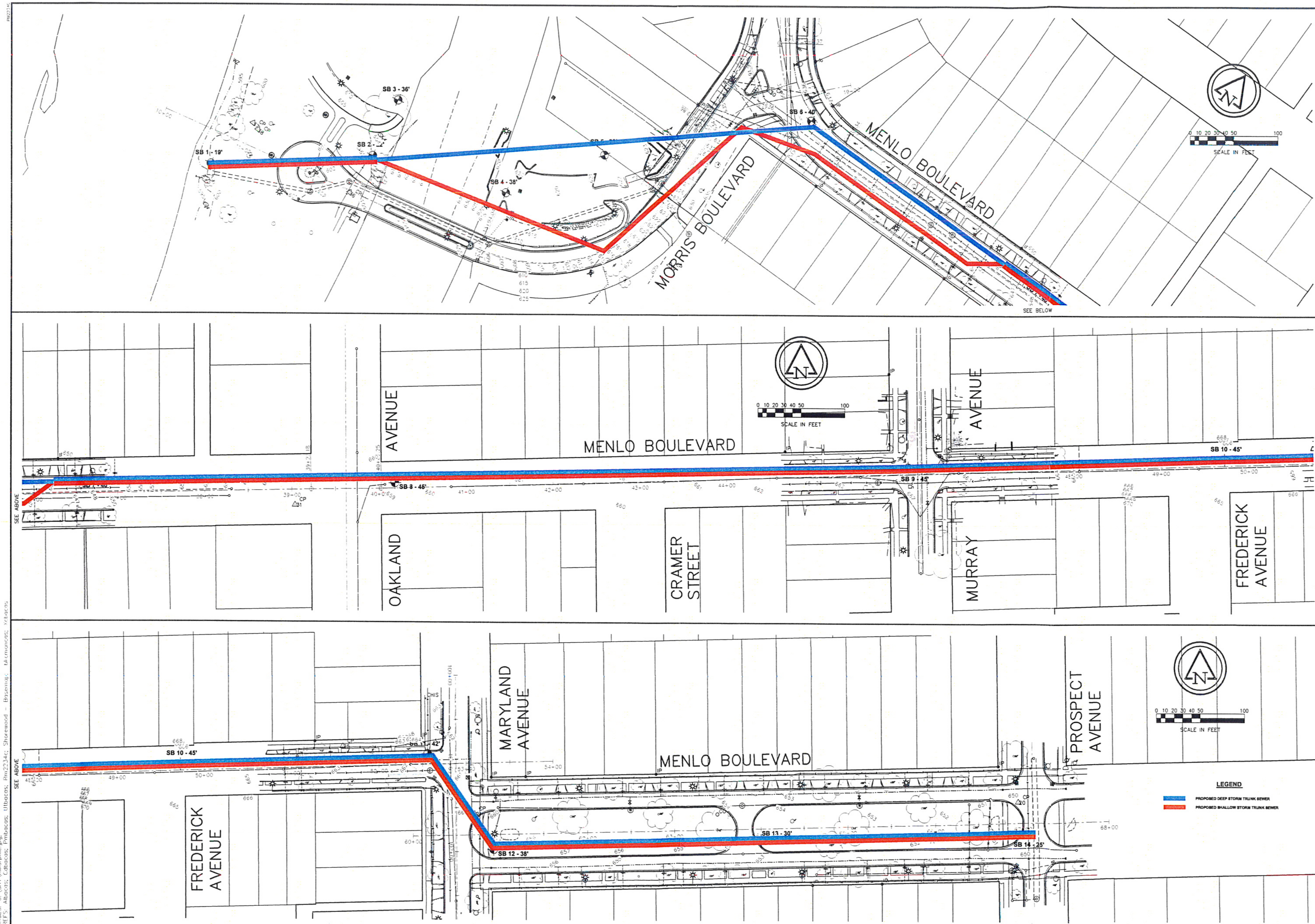




SHOREWOOD STORM SEWER TRIBUTARY AREA

The Milwaukee River watershed is a natural surface water drainage basin about 693 square miles in extent, of which about 62 percent, or 430 square miles, are located within the jurisdiction of the seven-county Southeastern Wisconsin Planning Region. The remaining 38 percent, or about 264 square miles, are located in Dodge, Fond du Lac, and Sheboygan Counties. A sound approach to the growing environmental and developmental problems of the watershed requires that the entire watershed, including the headwater protions beyond the geographic boundaries of the Region, be included in the comprehensive planning program.

Source: SEWRPC.



Ruekert·Mielke
engineering solutions for a working world
W233 N2080 Ridgeview Parkway • Waukesha, WI 53188-1020
(262) 542-5733 • Fax: (262) 542-5631 • www.ruekert-mielke.com

REVISIONS

TOWN: 7N RANGE: 22E SECTION(s): 9 NE

COMBINED AREA SOUTH

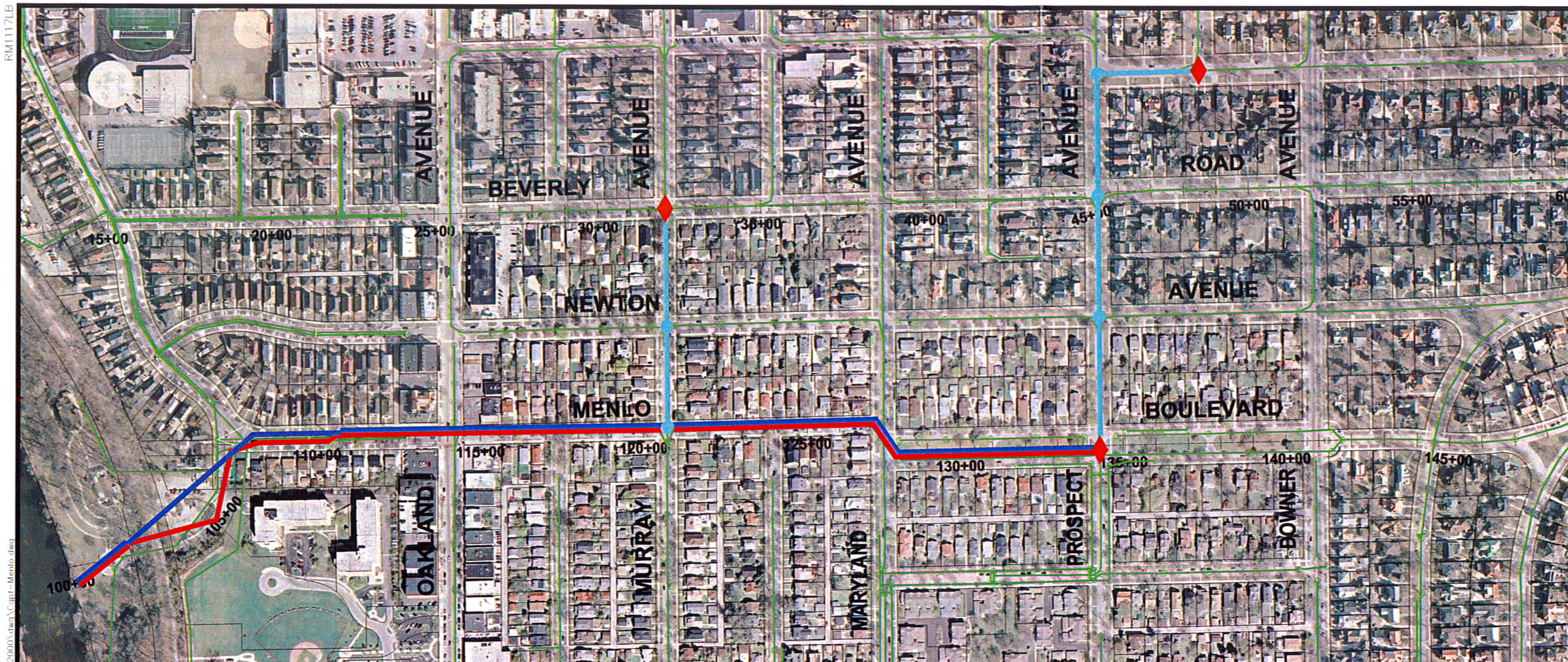
FIGURE 6
ALTERNATIVE ALIGNMENTS
VILLAGE OF SHOREWOOD
MILWAUKEE COUNTY, WISCONSIN

DESIGNED BY: RJB
DRAFTED BY: PJR
CHECKED BY:
DATE: FEBRUARY 2012
FILE NO. 8122005.200

SHEET NO.

Feb 27, 2012 2:04pm PLOTTED BY: Akrueger SAVED BY: Akrueger

Shorewood



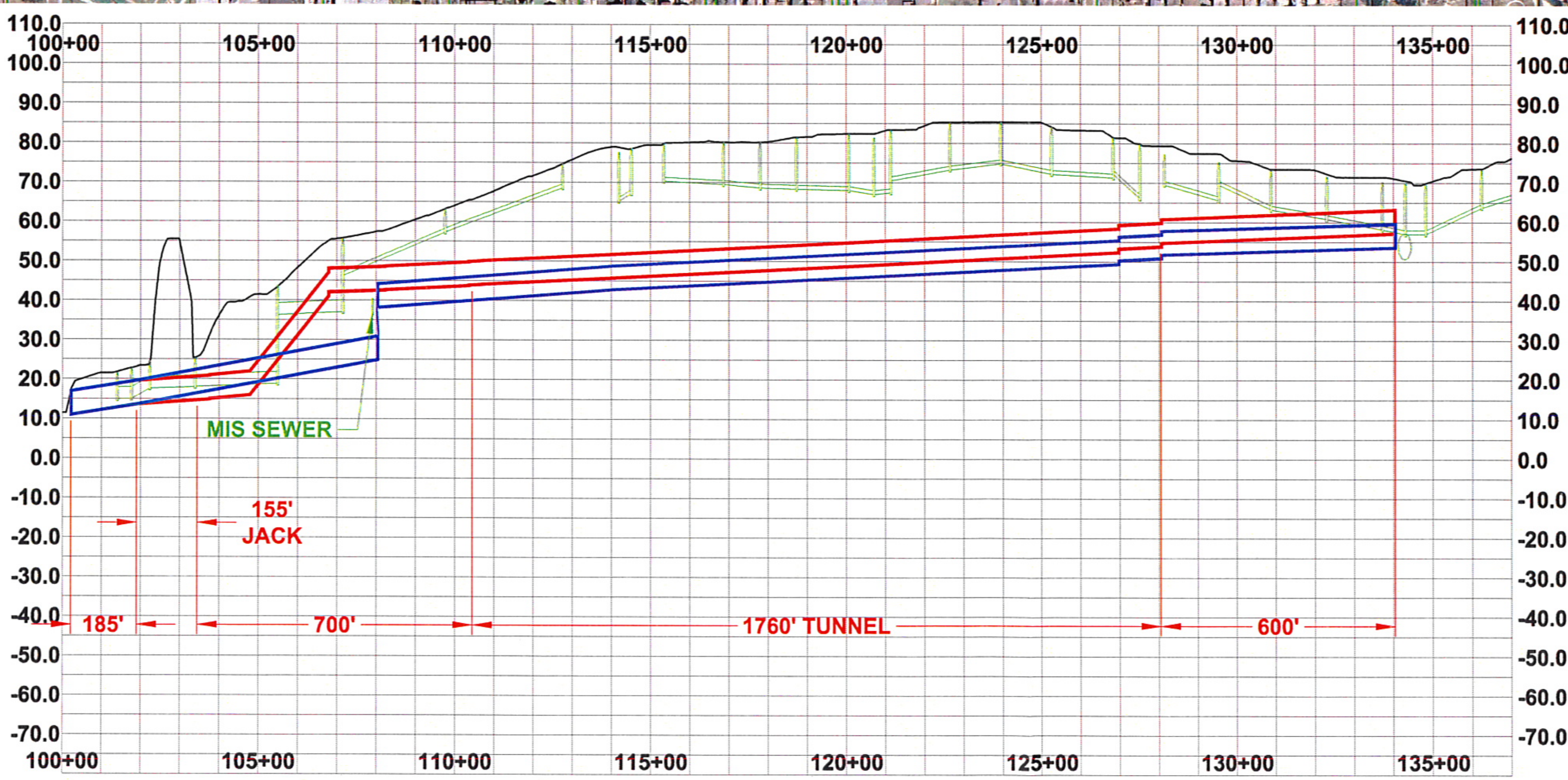


FIGURE 7

MENLO BOULEVARD STORM SEWER ALTERNATIVE

VILLAGE OF SHOREWOOD
MILWAUKEE COUNTY, WISCONSIN

LEGEND

- EXISTING SEWERS
- PROPOSED DEEP STORM TRUNK SEWER
- PROPOSED SHALLOW STORM TRUNK SEWER
- PROPOSED TRUNK STORM SEWER EXTENSION
- POTENTIAL FLOOD RELIEF POINT OR COMBINED SEWER OVERFLOW

N
W E
S

0 100 200 400 800
SCALE IN FEET

DATE: FEBRUARY 2012

SOURCE:
BASEMAP SOURCE:

Ruekert·Mielke
engineering solutions for a working world

APPENDIX A

Geotechnical Report
and
Soil Boring Logs

Information To Build On
Engineering • Consulting • Testing

GEOTECHNICAL ENGINEERING SERVICES REPORT

For the

Proposed Menlo Boulevard Storm Sewer
Milwaukee River to Prospect Avenue
Village of Shorewood, Wisconsin

Prepared for:

Village of Shorewood
3801 N. Morris Boulevard
Shorewood, WI 53211

Prepared by:

Professional Service Industries, Inc.
W237 N2878 Woodgate Road
Suite 2
Pewaukee, Wisconsin 53072
Phone (262) 347-0898
Fax (262) 347-2256

PSI Report Number: 0052525

March 1, 2012

Kenneth R. Wojtanowski, E.I.T.
Staff Engineer
Geotechnical Services

Mark J. Carlson, P.E.
Senior Vice President/
Chief Engineer

psi Information To Build On
Engineering • Consulting • Testing

March 1, 2012

Village of Shorewood
3801 N. Morris Boulevard
Shorewood, WI 53211

Attn: Mr. M. Chris Swartz
Village Manager

Re: Geotechnical Engineering Services Report
Proposed Menlo Boulevard Storm Sewer
Milwaukee River to Prospect Avenue
Village of Shorewood, Wisconsin
PSI Report No. 0052525

Dear Mr. Swartz:

Professional Service Industries, Inc. (PSI) is pleased to transmit our Geotechnical Engineering Services Report for the proposed Menlo Boulevard Storm Sewer in the Village of Shorewood, Wisconsin. This report includes the results of field and laboratory testing, recommendations for the installation of the storm sewer, as well as general site development.

PSI appreciates the opportunity to perform this Geotechnical Study and looks forward to continuing our participation during the design and construction phases of this project. If you have questions pertaining to this report, or if PSI may be of further service, please contact us at your convenience.

Respectfully submitted,

PROFESSIONAL SERVICE INDUSTRIES, INC.

Electronic Copy
Kenneth R. Wojtanowski, E.I.T.
Staff Engineer
Geotechnical Services

Electronic Copy
Mark J. Carlson, P.E.
Senior Vice President/
Chief Engineer

1-Client
1-Mr. Russell Barry, P.E.-Ruekert & Mielke, Inc.
1-Mr. Mike Campbell, P.E.-Ruekert & Mielke, Inc.

PSI • W237 N2878 Woodgate Road, Suite 2 • Pewaukee, Wisconsin 53072 • 262-347-0898 • Fax 262-347-2256 • www.psiusa.com

TABLE OF CONTENTS

PROJECT INFORMATION

Project Authorization

The following Table summarizes (in chronological order) the project authorization history for the services performed and represented in this report by Professional Service Industries, Inc. (PSI):

DOCUMENT AND REFERENCE NUMBER	DATE	SOURCE OF REQUEST	AUTHOR OR AGENT & TITLE
Request for Proposal	12/5/2011	Ruekert & Mielke, Inc.	Mr. Russell Barry, P.E.
PSI Proposal Number: PO-052-59198R2	12/21/2011	PSI	Mr. David Barndt, P.E. Mr. Paul Koszarek, P.E.
Notice to Proceed	1/11/2012	Village of Shorewood	Mr. M. Chris Swartz

Project Description

PSI understands that the proposed sewer project includes the construction of a 72 inch diameter reinforced concrete storm sewer pipe extending from the Milwaukee River to Prospect Avenue in the Village of Shorewood, Wisconsin. The following Table lists the information provided for this project:

DESCRIPTION OF MATERIAL	PROVIDER/SOURCE	DATE
Proposed Soil Boring Locations	Mr. Russell Barry, P.E. Ruekert & Mielke, Inc.	11/2011
Combined Area South (Revised)	Mr. Mike Campbell, P.E. Ruekert & Mielke, Inc.	10/2011

The proposed storm sewer pipe will begin near the east bank of the Milwaukee River, within Hubbard Park. The proposed invert elevation of the storm sewer near the Milwaukee River bank is approximately 591 feet MSL. Extending from the Milwaukee River, the sewer pipe will run east to Morris Boulevard, where it will change direction following Morris Boulevard to the north. The pipe will subsequently follow Morris Boulevard to the north until it intersects with Menlo Boulevard. Reportedly, this portion of the pipe (i.e. from the Milwaukee River to Menlo Boulevard) will be installed utilizing cut and cover excavating techniques with the exception of the portion of the pipe that extends beneath the elevated pedestrian path within Hubbard Park. Also, the stretch of pipe that extends beneath the pedestrian path will be installed utilizing pipe jacking techniques.

From Morris Boulevard, the sewer pipe will extend east along Menlo Boulevard to the intersection with Maryland Avenue. Within this portion of the project, the storm sewer will be installed by utilizing microtunneling techniques. Subsequently, the pipe will continue to extend east from Maryland Avenue to Prospect Avenue at which locale, the new storm sewer will connect with existing storm sewer pipes. Within this portion of the project (i.e. from Maryland Avenue to Prospect Avenue), the pipe will be installed using cut and cover excavating techniques. The invert elevation at the eastern termination of the project is planned at 638 feet MSL.

The geotechnical recommendations presented in this report are based on the available project information and the subsurface materials described in this report. If the noted information is incorrect, please inform PSI in writing so that we may amend the recommendations presented in this report if appropriate and if desired by the client. PSI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

Purpose and Scope of Services

The purpose of this geotechnical engineering study was to explore the subsurface conditions at the site and provide general recommendations and construction considerations for installation of the new sewer pipe. PSI's scope-of-services included drilling a total of fourteen (14) soil test borings, select laboratory testing, and preparation of this geotechnical report. This report includes the following:

- Descriptions of the existing pavement sections at the boring locations;
- A discussion of subsurface conditions encountered including pertinent soil properties;
- General suitability of the soils within the project area for the planned construction;
- Anticipated construction conditions that may be encountered;
- Site preparation information including the need for excavation below subgrade (EBS), placement and compaction of engineered fill, control of groundwater, and improvement of unstable soil;
- Comments and recommendations relating to other observed geotechnical conditions which could impact construction;

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air on or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes.

SITE AND SUBSURFACE CONDITIONS

Subsurface Conditions

The subsurface conditions were explored with fourteen (14) soil test borings. The approximate locations are shown on the attached Boring Location Plans (presented in the Appendix of this report). The borings were located in the field by PSI based on the boring location plans provided by Ruekert & Mielke, Inc. The borings were drilled to terminal depths varying from 20 to 45 feet below existing grade. The borings were advanced utilizing hollow-stem auger drilling methods. Soil samples were routinely obtained during the drilling process at 2 ½ foot intervals up to a depth of 10 feet, and every 5 feet thereafter. In addition, continuous sampling was performed in a ten foot zone at each boring location, beginning approximately five feet above the pipe, and ending approximately 5 feet below the bottom of the proposed pipe. Drilling and sampling techniques were accomplished generally in accordance with ASTM procedures.

Representative soil samples were obtained from the soil borings and were returned to PSI's laboratory where they were visually classified using the Unified Soil Classification System (USCS) as a guideline. Further, we conducted limited laboratory testing on select soil samples to aid in identifying and describing the physical characteristics of the soils and to aid in defining the site soil stratigraphy. The results of the field exploration and laboratory tests were used in our engineering analysis and in the formulation of our engineering recommendations.

The Borings were completed collinear to the route of the proposed storm sewer. The following Table contains the location, the zone in which continuous sampling was performed, the depths, and the elevations at each boring location.

BORING	GENERAL LOCATION OF BORING	ZONE OF CONTINUOUS SAMPLING (FEET BELOW THE EXISTING GRADE)	TERMINAL DEPTH OF BORING (FEET)	APPROXIMATE ELEVATION OF BORING (FEET MSL)
B-01	Hubbard Park	4-14	20	599
B-02	Hubbard Park	7-17	25	603
B-03	Hubbard Park	21-31	40	618
B-04	Hubbard Park	23-33	40	620
B-05	Hubbard Park	23-33	40	622
B-06	Menlo Boulevard	25-35	40	637
B-07	Menlo Boulevard	25-35	40	647
B-08	Menlo Boulevard	30-40	45	660
B-09	Menlo Boulevard	30-40	45	662
B-10	Menlo Boulevard	30-40	45	665
B-11	Menlo Boulevard	27-37	45	662
B-12	Menlo Boulevard	23-33	40	659
B-13	Menlo Boulevard	15-25	30	654
B-14	Menlo Boulevard	10-20	25	651

Milwaukee River to Menlo Boulevard

From the east bank of the Milwaukee River to Menlo Boulevard, the proposed pipe will reportedly be installed by utilizing cut and cover techniques, with the exception of the portion of the pipe that will extend beneath the existing pedestrian path. Beneath the pedestrian path, pipe jacking techniques will be used. The invert elevation within this portion of the project will vary from 591 feet MSL (near the east bank of the Milwaukee River) to 624 feet MSL (near the intersection of Morris Boulevard and Menlo Boulevard). The following Table indicates the pavement or topsoil thickness, the invert elevation, and the type of material encountered within about the ten (10) foot sewer envelope which was continuously sampled at each boring location:

BORING NO.	EXISTING ASPHALT PAVEMENT THICKNESS (IN)	EXISTING BASE COURSE THICKNESS (IN)	EXISTING TOPSOIL THICKNESS (IN)	INVERT ELEVATION (FEET MSL)	GENERAL SOIL TYPES OBSERVED WITHIN THE 10 FOOT SEWER ENVELOPE
B-1	N/A	N/A	14	592	Fill (Clayey Sand, Sandy Clay, Organic Silt) to Lean Clay
B-2	N/A	N/A	14	593	Poorly Graded Fine Sand to Clayey Silt
B-3	N/A	N/A	10	N/A	Clayey Silt
B-4	4	5	N/A	595	Silty Fine Sand, trace Gravel and Clay
B-5	4	7	N/A	N/A	Silty Fine Sand, trace Gravel and Clay
B-6	5	7	N/A	623	Silty Fine Sand, trace Gravel and Clay

NOTE: Borings B-3 and B-5 were completed within an alternate route of the proposed sewer pipe.

Beneath the topsoil and pavement structure (as indicated in the above Table), old undocumented fill material was observed within each of the Borings except for Boring B-2. The old undocumented fill material was generally observed to extend to approximately 12 to 22 feet beneath the existing grade. The old fill material was generally classified as either silty sand, clayey sand, or sandy clay. The aforementioned old fill material was observed in a moist to wet condition, with moisture contents in the range of 7% to 24%. The "N-Values" observed within the old fill material were typically observed in the range of 4 to 31 blows per foot (bpf).

It should be noted that organic deposits were encountered within two (2) of the borings. At Boring B-1, a layer of organic silt was observed from approximately eight (8) to ten (10) feet beneath the existing grade. The organic silt soil was observed in a very moist condition, with a natural moisture content of 43%. At Boring B-5, a layer of buried topsoil was also encountered from approximately 13 to 15 feet. The buried topsoil was observed in a very moist condition, with an in-situ moisture content of 31%.

Underlying the fill materials within Borings B-1, B-3, B-4, B-5 and B-6, and beneath the surficial topsoil observed at Boring B-2, native (interbedded) sand, silt and clay soils were encountered to the terminal depths of the borings. The native lean clay soil was typically observed in a moist condition with natural moisture contents in the range of 14% to 17%. The pocket penetrometer values observed on the native lean clay soils were in the range of 2½ to 4½ tons per square foot (tsf), thereby indicating a very stiff to hard soil consistency.

The upper layers of native sand and silt (typically observed to depths of approximately 11 to 12 feet) were observed in a very loose to medium relative soil density, with "N-Values" in the range of 3 to 17 bpf. Extending from approximately 11 feet to the terminal depths of the borings, the native sand and silt soils were observed in a medium to very dense condition, with "N-Values" in the range of 19 to 50+ bpf.

Menlo Boulevard (Morris Boulevard to Maryland Avenue)

Along Menlo Boulevard and extending from Morris Boulevard to Maryland Avenue, the proposed sewer pipe will reportedly be installed by utilizing microtunneling techniques. The invert elevation within this portion of the project will vary from 624 feet MSL (near the intersection of Menlo Boulevard and Morris Boulevard) to 634 feet MSL (near the intersection of Menlo Boulevard and Maryland Avenue). The following Table indicates the pavement thickness, the invert elevation, and the type of material encountered within about the ten (10) foot sewer envelope which was continuously sampled at each boring location:

BORING NO.	EXISTING ASPHALT PAVEMENT THICKNESS (IN)	EXISTING CONCRETE PAVEMENT THICKNESS (IN)	EXISTING BASE COURSE THICKNESS (IN)	INVERT ELEVATION (FEET MSL)	GENERAL SOIL TYPES OBSERVED WITHIN THE 10 FOOT SEWER ENVELOPE
B-7	7	N/A	6	625	Silty Fine Sand
B-8	6	N/A	8	626	Sandy Lean Clay
B-9	4	6	6	629	Lean Clay
B-10	13	N/A	6	631	Lean Clay to Silty Sand
B-11	9	N/A	5	633	Lean Clay to Silty Clay

Native sand, silt and clay soils were typically observed from the pavement structure (as indicated in the above Table) to the terminal depths of the borings, with the exception of Boring B-7. Within Boring B-7, old undocumented fill material was observed to extend to a depth of approximately six feet. The old undocumented fill material was classified as sandy clay. The moisture content observed within the sandy clay fill material was 23%, indicating a very moist condition.

Underlying the pavement structure at Borings B-8 through B-11, and beneath the old undocumented fill observed at Boring B-7, native silt, sand and clay soils were observed to extend to the terminal depths of the borings. The upper layers of native sand and silt (typically observed to depths of approximately 20 to 30 feet) were observed in a loose to medium relative soil density, with "N-Values" in the range of 6 to 27 bpf. Beneath the upper deposit of loose to medium native sand and silt to the terminal depths of the borings, the native sand and silt soils were typically observed in a medium to very dense condition, with "N-Values" in the range of 19 to 50+ bpf.

Similar conditions were observed within the native lean clay soils. Within the upper 10 feet, the native lean clay soils were typically observed in a very stiff condition with pocket penetrometer values in the range of 2½ to 3½ tons per square foot (tsf). Beneath the deposit of very stiff lean clay soils, the native lean clay was observed in a hard condition, with pocket penetrometer values of 4½ tons per square foot (tsf). The moisture contents within the native lean clay soils were typically in the range of 9% to 20%, indicating a moist soil condition.

Menlo Boulevard (Maryland Avenue to Prospect Avenue)

From Prospect Avenue to Maryland Avenue, the proposed pipe will reportedly be installed beneath the existing Menlo Boulevard median by utilizing cut and cover techniques. The invert elevation within this portion of the project will vary from 634 feet MSL (near the intersection of Menlo Boulevard and Maryland Avenue) to 639 feet MSL (near the intersection of Menlo Boulevard and Prospect Avenue). The following Table indicates the topsoil thickness, the invert elevation, and the type of material encountered within about the ten (10) foot sewer envelope which was continuously sampled at each boring location:

BORING NO.	EXISTING TOPSOIL THICKNESS (IN)	INVERT ELEVATION (FEET MSL)	GENERAL SOIL TYPES OBSERVED WITHIN THE 10 FOOT SEWER ENVELOPE
B-12	10	634	Lean Clay to Silty fine Sand
B-13	10	636	Lean Clay to Silty Sand to Silty Clay
B-14	8	639	Lean Clay to Silty Sand

Native clay and silty sand was observed from the surficial topsoil (as indicated in the above Table) to the terminal depths of the borings, with the exception of Boring B-13, in which old fill material was observed to extend to approximately 3 feet below grade. The old fill material was classified as clayey sand. The "N-Value" within the old fill material was observed to be 3 bpf.

Underneath the surficial topsoil material at Borings B-12 and B-14 and beneath the old fill material at Boring B-13, native clay and silty sand was observed to extend to the terminal depths of the borings. The native clay soil was typically classified as lean clay, with the exception of the bottom nine foot thick strata within Boring B-13, which was classified as silty clay. The natural moisture contents within the native clay soils were observed in the range of 10% to 21%, indicating a moist soil condition. The pocket penetrometer values within the native clay soils were observed in the range of 2 to 4 ½ tons per square foot (tsf), indicating a very stiff to hard soil consistency.

The layers of native silty sand soils which were sporadically observed within the predominate clay matrix were typically observed in a medium to very dense relative soil density, with "N-Values" in the range of 18 to 50+ bpf.

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the appendix should be reviewed for specific information at individual boring locations. These records include soil descriptions, stratifications, penetration resistances, locations of the samples and laboratory test data. The stratification shown on the boring logs represents the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. The stratification represents the approximate boundary between subsurface materials and the actual transition may be gradual. Water level information obtained during field operations is also shown on the boring logs. The samples that were not discarded during classification or altered by laboratory testing will be retained for 60 days from the date of this report and then will be discarded.

Groundwater Information

Free groundwater was encountered within the borings during or at the completion of drilling operations, at depths ranging from 6± to 39± feet below ground surface. In addition, permanent groundwater monitoring wells were installed at two of the boring locations upon completion of drilling operations (B-6 and B-9). The following Table presents the depth where free groundwater was observed at completion of drilling operations, 24 hours after completion of drilling operations, and the groundwater level observed on February 17, 2012 at the two (2) aforementioned monitoring well locations:

Boring	Depth Groundwater Level Observed at Completion of Drilling(ft)*	Depth Groundwater Level Observed 24 Hours After Completion of Drilling(ft)*	Depth of Groundwater Observed on 2/17/2012 (ft)*	Elevation of Highest Groundwater Level Observed (feet MSL)
B-1	13	18	N/A	586
B-2	6	8	N/A	597
B-3	N/O	4	N/A	614
B-4	N/O	15	N/A	605
B-5	21	14	N/A	608
B-6	N/O	10	6	631
B-7	16	N/A	N/A	631
B-8	31	N/A	N/A	629
B-9	N/O	N/A	14	648
B-10	39	N/A	N/A	626
B-11	37	N/A	N/A	625
B-12	N/O	N/A	N/A	N/O
B-13	N/O	N/A	N/A	N/O
B-14	N/O	N/A	N/A	N/O

*-As Measured Beneath the Existing Grade
N/O=Not Observed
N/A-Reading Not Taken

Fluctuations in the groundwater level should be anticipated throughout the year depending on variations in climatological conditions and other factors not apparent at the time the borings were performed. The possibility of significant groundwater level fluctuation should be considered when developing the design and construction plans for the project. PSI recommends that the Contractor determine the actual groundwater levels at the site at the time of the construction activities.

EVALUATION AND RECOMMENDATIONS

Geotechnical Discussion

Based upon the subsurface conditions encountered at the test borings and PSI's understanding of project, there is one primary geotechnical issue that could have an impact during installation of the sanitary sewer; this concern being that groundwater was observed at or above the anticipated installation depth of the new sewer.

Groundwater was encountered within the borings at depths ranging from 6± to 39± feet below existing grade (elevation 586 to 648 feet MSL). Based upon these observations, groundwater-related problems should be anticipated for excavations extending below these depths. For excavations that are only advanced a foot or so below the water level, it is anticipated that it can be handled by simple means such as pumping from sumps or the use of perimeter trenches to collect and discharge the water away from the work area.

However, for excavations that extend below the water table and into a sand or silt deposit (i.e. Borings B-2, B-4, B-6 and B-7), these soils will become "quick" acting as the confining pressure of the overburden soils is removed. In this case, it may be necessary to install trench drains or use other specialized methods, such as deep wells or well points, in order to intercept groundwater and direct water around the excavation. Interceptor trenches must be lined with a geotextile fabric and filled with crushed stone. A qualified dewatering contractor must determine the need for interceptor trenches, and the specific details of the trenches. A qualified dewatering contractor must also determine the width, depth and location of interceptor trenches. PSI recommends that the dewatering contractor determine the actual groundwater levels at the site at the time of the construction activities. **Dewatering must be anticipated in all excavations which extend below the potentiometric surface, in particular granular soil materials.**

Cut and Cover Recommendations

Based on the information provided to PSI, it appears that excavations required to construct the proposed sanitary sewer from the east bank of the Milwaukee River to Menlo Boulevard, and within the median of Menlo Boulevard from Maryland Avenue to Prospect Avenue will extend to depths of up to 25 feet below the existing ground surface. The soils observed at bearing elevation appear to be suitable for support of the proposed sewer line.

Within the borings performed along the proposed sewer pipe path (between the Milwaukee River and Menlo Boulevard), free groundwater was encountered at depths ranging from 6± to 23± feet below existing grade. Based upon these observations, groundwater-related problems should be anticipated for excavations extending below these depths. If water levels do not recede over a period of time, dewatering with sump pumps, wells or well points could be necessary. Moisture seepage into excavations in cohesive soils should be at a slower rate which would generally be controlled by gravity flow and construction sump pumps. Removal of water by pumping from excavations in granular soils (sand and gravel) below the water table could result in a "quick" condition. Water levels must be maintained at least 2 or more feet below the bottom of excavations in sand to prevent seepage forces upward which could reduce subgrade support.

The borings performed along the proposed sewer pipe path within the Menlo Boulevard median (between Maryland Avenue and Prospect Avenue), indicated that free groundwater ranges from 20 to 32 feet below grade. The depth of the proposed excavations within this area will vary from 12 to 25 feet. Therefore, it is possible that groundwater could be controlled by gravity flow and construction sump pumps. It should be noted, however; that discontinuous sand or silt seams could be found during construction, requiring more sophisticated dewatering means, such as wells or well points. **Dewatering must be anticipated in all excavations which extend below the potentiometric surface, in particular granular soil materials.**

Where wet, loose or soft soil conditions are encountered (most likely within the pipe path between the Milwaukee River and Menlo Boulevard), it may be necessary to place a layer of granular bedding material in the bottom of the excavation to develop a stable working surface. The granular bedding material must meet section 8.43.2 of the Standard Specifications for Sewer and Water Construction, Sixth Edition (SSSWC). A 12-inch layer of cover material should be used to develop the working surface. The cover material must meet Section 8.43.3 of the SSSWC. The bedding and cover layers should be placed in relatively uniform horizontal lifts. The bedding and cover materials should be compacted to a minimum in-place density of 95 percent of the maximum dry density as obtained by the standard Proctor test (ASTM D 698), as specified in Section 2.6.14(b)1 of the SSSWC.

The new backfill materials which will overly the cover and bedding materials must meet Section 8.43.4 of the SSSWC for granular backfill, Section 8.43.5 for excavated material, or Section 8.43.6 for crushed stone backfill. If excavated material is to be used, the standard specifications state that the material used as backfill shall consist of loam, clay or other materials which in the judgment of the engineer are suitable for backfilling. Excavated backfill materials should be free of organic, frozen, or other deleterious materials, have a maximum particle less than 3 inches, and have a liquid limit less than 45 and plasticity index less than 25 and greater than 11. Other soils with Atterberg limits outside those recommended should be reviewed by the geotechnical for their intended use. If a fine-grained soil is used for backfill, close moisture content control will be required to achieve the recommended degree of compaction.

Based PSI's soil borings data, the existing clay, silt and sand soils (with the exception of the buried topsoil and organic silt material observed within Borings B-1 and B-5) should be suitable for use as trench backfill material if they meet the above guidelines and the project specifications. The suitability of off-site soils for use as fill should be evaluated prior to its use as fill. Section 2.6.14(b)1 of the SSSWC states that if the backfill material is granular or crushed stone, then the backfill should be compacted to a minimum in-place density of 95 percent of the maximum laboratory density as determined in accordance with the standard Proctor test (ASTM D 698). If excavated materials removed from the trench are to be used as backfill, then they should be compacted according to Section 2.6.14(b)2 of the SSSWC which states that they should be compacted so as to result in a density equal to 100% of the density of the existing adjacent material in the trench.

Trench backfill should be placed in maximum lifts of 18 inches of loose material and should be compacted within the range of two percentage points below to two percentage points above the optimum moisture content value as determined in accordance with the standard Proctor test (ASTM D 698). The first lift of backfill material over the cover material should be approximately 2 feet thick. Smaller lifts may be required if the minimum specified compacted density is not being obtained. If water must be added, it should be uniformly applied and thoroughly mixed into the soil by disking or scarifying. Each lift of compacted engineered fill should be tested by a representative of the geotechnical engineer prior to placement of subsequent lifts.

Depending upon the depth of the excavations, a sloped or benched excavation may not be feasible. The extent of bracing of open cut excavations will depend upon depth of cut, groundwater conditions, soils encountered, length of time the excavation will be open, area available for excavation and local governing regulations. Predominantly cohesive soils may appear to stand nearly vertical in shallow excavations for short periods of time. However, soil creep, surcharge loads, precipitation, subsurface groundwater seepage, construction activity vibrations and other factors may cause these soils to cave within an unpredictable period of time.

Excavations encountering fill, granular or organic soils may tend to cave or slough readily; the potential for caving soil is even greater if water is present within these layers. Unstable excavation walls may also cause surrounding cohesive soils to become unstable.

If groundwater is encountered, steel sheet piling may be necessary to reduce potential seepage. If sheet piling is necessary it should extend at least 5 feet below the proposed lowest extent of the excavation to reduce the potential seepage. Toe-depth will also be critical on maintaining an adequate factor of safety relative to stability. If sheet piling is utilized for the project, stability of the shoring unit also must be addressed by a qualified geotechnical Engineer. Sheet piling is not expected to prevent all the groundwater inflow, the rate of flow should be reduced and most likely could be controlled using sump pits and pumps inside the sheeting. Temporary shoring or use of trench boxes will be required to maintain a safe working area in all other areas of the excavation. The contractor should be aware of and follow all applicable regulations governing this type of construction.

Tunneling Recommendations

The storm sewer pipe beneath Menlo Boulevard extending from Morris Boulevard to Maryland Avenue will reportedly be installed by using microtunneling techniques. The proposed invert elevation along this stretch will vary from 624 to 634 feet MSL. The total length of the microtunneling portion of the project is approximately 1,900 feet.

In order to preclude caving of the tunnel roof, prudent care must be taken when tunneling below the existing roadways to provide for the presence of sufficient soil materials above the crown of the excavation. The general rule of thumb when tunneling in un-consolidated material is to provide approximately 1.5 to 3 times the tunnel diameter of soil above the crown of the excavation. Based on this rule and the anticipated pipe diameter (72 inches), the invert elevation should not be above 18 feet below existing grade. Based on the most current plans, the invert elevation within this portion of the project will vary from 22 to 34 feet below existing grade. Adequate support of the tunnel must be maintained at all times.

Based upon the subsurface conditions observed from Borings B-7 through B-11, tunneling installation methods should generally be satisfactory for this site. The soils at and above the anticipated storm sewer invert elevation within the proposed tunneling portion of the project are anticipated to consist of predominately hard/very dense over-consolidated glacial till or hardpan soils.

PSI recommends that the Tunneling Contractor select the appropriate microtunnel machine and face support for the proposed boring machine based on the conditions of the project including site geology and subsurface conditions, site and alignment restrictions including items such as the dimension of the access shaft, construction schedule, and local knowledge or past experience with similar projects and similar soil.

The stiff to hard clay soils at this site are generally not anticipated to pose significant resistance during tunneling. However, cobbles or boulders may be encountered within the proposed tunneling reach. Where microtunnel machines or hand mining operations are performed, most cobbles and smaller boulders up to approximately 1/3 of the diameter of the boring machine or tunnel can likely be broken by the cutter heads and passed through the face of the microtunnel machine without major impacts. Drilling an access shaft may also be required under extreme circumstances. Where large boulders are encountered near the edge of the tunnel shaft and the surrounding soils are loose or soft, it may be possible for the TBM to push the boulder radially outward into the surrounding soil. However, pushing the boulder radially may cause the tunnel to be shifted from its intended alignment. The removal of cobbles and boulders should be made a part of the contract documents. The removal of boulders up to 1/3 of the tunnel diameter is typically the responsibility of the contractor.

Based on past history in the project area, there is a potential for methane gas to be encountered during tunneling/boring operations. PSI recommends that the tunnel excavation be continuously monitored by the Contractor for methane levels.

PSI recommends that the proposed tunneling reach be installed without interruptions to the installation process as much as possible, especially where constructed in cohesive soils. During boring, the pore pressures within the surrounding soil are increased and when the tunneling or boring operation is halted, the pore pressures relax. This process may cause the casing to "freeze" in-place making it very difficult to further advance the casing following an interruption in the installation process.

Inter-bedded layers of granular soils will likely be encountered while tunneling within the clayey glacial till soils. Special care should be taken to ensure the stability of the unprotected face at the cutting edge within any inter-bedded sand layers encountered. Dewatering may be required to maintain a stable tunneling face within these soils and to prevent substantial groundwater from flowing around the tunnel pipe annulus and into the tunnel. Deep well dewatering methods, installed from the existing ground surface, may be used. The dewatering system(s) chosen, including the type, size, depth and spacing of dewatering wells should be properly designed by an experienced local dewatering contractor utilizing the soil borings performed at the time of construction as well as the available public well information and records in the vicinity of the proposed project. Alternative methods such as the use of breasting boards, grouting or "freezing" may also be used to control running face conditions within these soils.

Surface features must be monitored by the Contractor for settlement caused by ground loss and collapse of the soil above and around the pipe due to alterations of the stresses in the soil. Additional surface ground movement may occur due to running ground conditions at the face of the tunnel or collapse of soil into voids resulting from the removal of boulders at the face. Ground movement associated with tunnel construction is influenced by the methods of construction and the quality of workmanship as well as the subsurface conditions. If pipe-jacking methods are employed, maintaining adequate bentonite pressure in the over cut annulus during installation and permanently grouting the annulus following installation will help to minimize settlements. Dewatering fine sand soil to limit the potential for ground loss associated with running ground conditions at the face of the excavation will also help minimize surface settlements. If surface settlement exceeds one inch, corrective measures should be undertaken from the ground surface by the Contractor. If the settlement damages any existing surface structures or underground utilities, the use of compaction grouting techniques should be performed as soon as possible to stabilize and restore the damaged structures.

It will be necessary to excavate an entry/receiving pit. The native stiff to hard clay soils should generally be adequate for support of the tunneling equipment, provided they are stable at the time of construction. The approach trench or receiving area should be large enough to accommodate all jacks and blocking and at least on section of the pipe. The tunnel pits or receiving area must also be suitably braced. Sheeting and bracing plans should be submitted to the design engineer prior to the excavation of the pits. The soil parameters presented above may be used in the design of the temporary excavation support.

Below Grade Wall Design Considerations

The below grade walls for the entry/receiving pit will be required to resist lateral earth pressures. The actual earth pressure on the walls will vary according to material types and the grade above the top of the wall. If the below grade wall is restrained from movement in each direction, the at-rest condition applies. However, if the wall is not restrained, then the active pressures would be applicable. Based on the material types observed within the soil Borings, the following design parameters are recommended:

PARAMETER	RECOMMENDED VALUE[3]
In-situ Unit Weight	135 pcf
"Active" Coefficient of Lateral Earth Pressure, K_a	0.33
"Active" Equivalent Fluid Pressure	45 psf/ft of depth above water table 24 psf/ft below water table
Coefficient of "Passive" Pressure, K_p[1]	3.0
"Passive" Equivalent Fluid Pressure	405 psf/ft of depth above water table 220 psf/ft below water table
"At-Rest" Coefficient of Lateral Earth Pressure, K_o	0.50
"At-Rest" Equivalent Fluid Pressure	68 psf/ft of depth above water table 36 psf/ft below water table
Coefficient of Sliding	0.45

Notes:
1. Ultimate passive pressure typically requires large strains to be fully mobilized, therefore, PSI recommends using 50% or less of the ultimate passive pressure to limit the strain on the structure.
2. The values in the Table are ultimate values and do not include a factor of safety

The above values do not include the influence of foundation or surface loads in or adjacent to the wall. For walls adjacent to roadways, a car load of 250 psf should be added to the weight of the overburden soil to determine the appropriate equivalent fluid pressure acting on the wall. The magnitude of this and other surcharge loads, acting within the zone that begins at the base of a new foundation and extends upward and outward at a 1H: 1V ratio can be determined by multiplying the load by the appropriate lateral earth pressure coefficient.

Passive resistance should be neglected to a depth of four feet below exterior grade due to seasonal softening from freeze-thaw. In addition, the passive earth pressure values given above are based upon the structure being placed in direct contact with the naturally deposited soils.

Seismic Site Class

The 2006 International Building Code requires a site class for the calculation of earthquake design forces. This class is a function of soils type (i.e. depth of soil and strata types). Based on the estimated density of the soils observed within the boring locations, Site Class "C" is recommended. The USGS-NEHRP probabilistic ground motion values near Latitude 43.084225°N and Longitude 87.885890°W are as follows:

PERIOD (SECONDS)	2% PROBABILITY OF EVENT IN 50 YEARS (% G)	SITE COEFFICIENT F_A	SITE COEFFICIENT F_V
PGA	4.9	N/A	N/A
0.2 (S_S)	10.5	1.2	N/A
1.0 (S_1)	4.4	N/A	1.7

The Site Coefficients, F_a and F_v were interpolated from IBC 2006 Tables 1613.5.3(1) and 1613.5.3(2) as a function of the site classification and the mapped spectral Response acceleration at the short (S_s) and 1 second (S_1) periods.

CONSTRUCTION CONSIDERATIONS

PSI should be retained to provide observation and testing of construction activities involved in the foundation, earthwork, and related activities of this project. PSI will not accept any responsibility for any conditions that deviated from those described in this report, nor for the performance of the foundation or pavement if we are not engaged to also provide construction observation and testing for this project.

Moisture Sensitive Soils/Weather-Related Concerns

The soils encountered at this site are expected to be sensitive to disturbances caused by construction traffic and changes in moisture content. Increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils that become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather.

Areas should be sloped to facilitate removal of collected rainwater, groundwater, or surface runoff. Positive site drainage should be provided to reduce infiltration of surface water into the excavations. The grades should be sloped away from the excavations and surface drainage should be collected and discharged such that water is not permitted to infiltrate back towards the areas of construction.

Drainage and Groundwater Concerns

That portion of the project extending from the Milwaukee River to Menlo Boulevard, shallow groundwater was encountered during drilling operations at a depth of approximately 4 to 21 feet beneath the existing grade. Within this portion of the project, cut and cover methods will be used to install the pipe. The excavation depths within this portion of the project are anticipated to be on the order of 7 to 25 feet below grade. Therefore; difficulty with groundwater seepage is anticipated during excavation from the

Milwaukee River to Menlo Boulevard. It is possible for the groundwater table to vary within the depths explored during other timed of the year depending upon climactic conditions (seasonal fluctuation) or for perched water to be present within the existing near-surface fill and organic soils. PSI recommends that the Contractor verify the actual groundwater and seepage conditions at the time of construction activities and propose the groundwater control methods for the Engineer's approval, including disposal of discharge water.

Excavations

It is mandated that excavations, whether they be for utility trenches, basement excavations or footing excavations, be constructed in accordance with current Occupational Safety and Health Administration (OSHA) guidelines to protect workers and others during construction. PSI recommends that these regulations be strictly enforced; otherwise, workers could be in danger and the owner(s) and the contractor(s) could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

PSI is providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations.

Utilities Trenching and Backfilling

Excavation for utility trenches shall be performed in accordance with OSHA regulations as stated in 29 CFR Part 1926. It should be noted that utility trench excavations have the potential to degrade the properties of the adjacent fill materials. Utility trench walls that are allowed to move laterally can lead to reduced bearing capacity and increased settlement of adjacent structural elements and overlying slabs.

Backfill for utility trenches is as important as the original subgrade preparation or structural fill placed to support either a foundation or slab. Therefore, it is imperative that the backfill for utility trenches be placed to meet the project specifications for the structural fill of this project. Unless otherwise specified, the backfill for the utility trenches should be placed in 4 to 6 inch loose lifts and compacted to a minimum of 95% of the maximum dry density achieved by the modified Proctor test. The backfill soil should be moisture conditioned to be within 3% of the optimum moisture content as determined by the modified Proctor test. Up to 4 inches of bedding material placed directly under the pipes or conduits placed in the utility trench can be compacted to the 90% compaction criteria with respect to the modified Proctor. Compaction testing should be performed for every 200 cubic yards of backfill placed or each lift within 200 linear feet of trench, whichever is less. Backfill of utility trenches should not be performed with water standing in the trench. If granular material is used for the backfill of the utility trench, the granular material should have a gradation that will filter protect the backfill material from the adjacent soils. If this gradation is not available, a geosynthetic non-woven filter fabric should be used to reduce the potential for the migration of fines into the backfill material. Granular backfill material shall be compacted to meet the above compaction criteria. The geotechnical engineer can also specify a relative density specification for clean granular materials. The granular backfill material should be compacted to achieve a relative density greater than 75% or as specified by the geotechnical engineer for the specific material used.

GEOTECHNICAL RISK

The concept of risk is an important aspect of the geotechnical evaluation. The primary reason for this is that the analytical methods used to develop geotechnical recommendations do not comprise an exact science. The analytical tools which geotechnical engineers use are generally empirical and must be used in conjunction with engineering judgment and experience. Therefore, the solutions and recommendations presented in the geotechnical evaluation should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soils and the proposed structure will perform as planned. The engineering recommendations presented in the preceding section constitutes PSI's professional estimate of those measures that are necessary for the proposed structure to perform according to the proposed design based on the information generated and referenced during this evaluation, and PSI's experience in working with these conditions.

REPORT LIMITATIONS

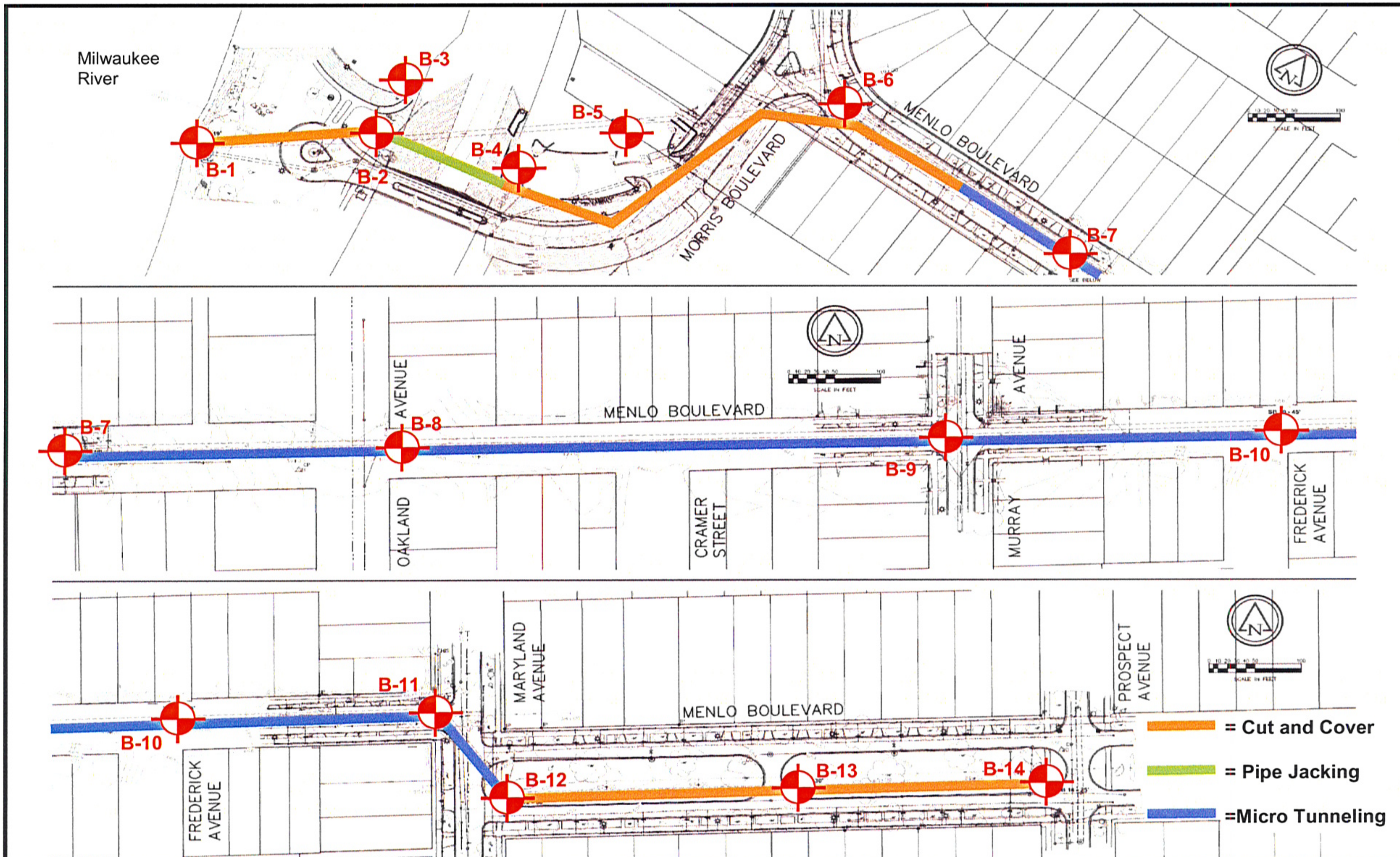
PSI's recommendations are based on the available subsurface information obtained by PSI and design details furnished by others. If there are any revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI must be notified immediately to determine if changes in the recommendations are required. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the project.

PSI warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans and specifications are complete, PSI must be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At this time, it may be necessary to submit supplementary recommendations. This report has been prepared for the exclusive use by Ruekert & Mielke, Inc. for the proposed Menlo Boulevard Storm Sewer to be located in the Village of Shorewood, Wisconsin.

APPENDIX

BORING LOCATION PLAN
LOG OF BORINGS
LABORATORY TEST RESULTS
GENERAL NOTES



psi *Information To Build On*

Engineering • Consulting • Testing

W237 N2878 Woodgate Road, Suite 2
Pewaukee, Wisconsin 53072

Project Name:	Proposed Menlo Boulevard Storm Sewer
Project Location:	Milwaukee River to Prospect Avenue Village of Shorewood, Wisconsin
PSI Project # :	0052525

Boring Location Plan

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

LOG OF BORING B-01

PSI Job No.: 0052525
Project: Proposed Menlo Boulevard Storm Sewer
Location: Milwaukee River to Prospect Ave.
Shorewood, WI

Drilling Method: Hollow Stem Auger
Sampling Method: 2-in SS
Hammer Type: Automatic
Boring Location: Hubbard Park

WATER LEVELS

While Drilling	Not Obsvd.
Upon Completion	13 Ft.
After 24 Hrs.	18 Ft.

Station: N/A
Offset: N/A

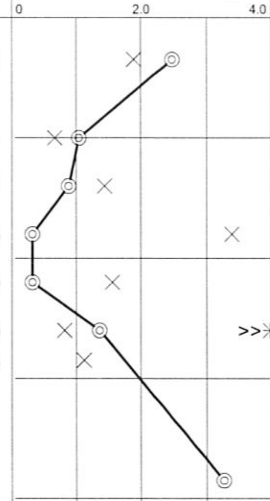
Surface Elev.: 599 ft

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	0			Topsoil (14" Thick)	Fill			
		1	10	Fill, Black Silty Fine Sand, Trace Gravel, Possible Foundry Sand, Moist	Fill	9-10-21 N=31	24	
595	5	2	6	Fill, Gray Clayey Fine Sand with Concrete Rubble, Moist	Fill	8-9-4 N=13	8	
		3	6	Fill, Brown Mixed Gray Sandy Lean Clay, Very Moist	Fill	6-7-4 N=11	18	
590	10	4	8	Fill, Dark Gray Organic Silt with Concrete Rubble, Very Moist	Fill	3-2-2 N=4	43	
		5	6	Fill, Brown Mixed Dark Brown Sandy Clay with Gravel, Very Moist	Fill	2-1-3 N=4	20	
585	15	6	16	Brown Lean Clay, Trace Sand, Moist, Hard	CL	4-8-9 N=17	10 / 14	>> Qp
580	20	7	16			9-20-21 N=41		

End of Boring at 20'

Cave in at 15.5'

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0



Completion Depth: 20.0 ft
Date Boring Started: 1/24/12
Date Boring Completed: 1/24/12
Logged By: TB
Drilling Contractor: PSI, Inc.

Sample Types: Auger Cutting, Split-Spoon, Rock Core, Shelby Tube, Hand Auger, Calif. Sampler, Texas Cone

Latitude: 43.084225°N°
Longitude: 87.885890°W°
Drill Rig: Freightliner
Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

LOG OF BORING B-02

Sheet 1 of 1

PSI Job No.: 0052525
Project: Proposed Menlo Boulevard Storm Sewer
Location: Milwaukee River to Prospect Ave.
Shorewood, WI

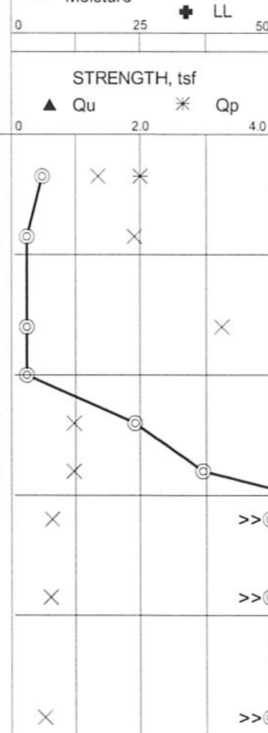
Drilling Method: Hollow Stem Auger
Sampling Method: 2-in SS
Hammer Type: Automatic
Boring Location: Hubbard Park

WATER LEVELS
- While Drilling: 8 Ft.
- Upon Completion: 6 Ft.
- After 24 Hrs.: 8 Ft.

Station: N/A
Offset: N/A
Surface Elev.: 603 ft

Elevation (feet)	Depth, (feet)	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
603	0				Topsoil (14" Thick)	OL			
		Split-Spoon	1	14	Gray Mottled Rust Brown Lean Clay, Trace Root Structure, Moist, Stiff	CL	4-3-3 N=6	17	
600	5	Split-Spoon	2	12	Dark Brown Mottled Rust Brown Clayey Fine Sand, Wet, Very Loose	SC	1-1-2 N=3	24	
595		Split-Spoon	3	14	Dark Gray Poorly Graded Fine Sand, Trace Roots, Wet, Very Loose	SP	1-2-1 N=3	41	
	10	Split-Spoon	4	0			3-2-1 N=3		
		Split-Spoon	5	16	Gray Clayey Silt with Sand with Gravel, Moist, Medium	ML	18-13-11 N=24	12	
590		Split-Spoon	6	16			11-13-24 N=37	12	
	15	Split-Spoon	7	16			39-32-42 N=74	8	
585	20	Split-Spoon	8	14			5-24-27 N=51	8	
580	25	Split-Spoon	9	12			50/5"	7	
					End of Boring at 25'				
					Cave in at 8'				

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
STRENGTH, tsf ▲ Qu ✳ Qp



Completion Depth: 25.0 ft
Date Boring Started: 1/24/12
Date Boring Completed: 1/24/12
Logged By: TB
Drilling Contractor: PSI, Inc.

Sample Types: Auger Cutting, Split-Spoon, Rock Core, Shelby Tube, Hand Auger, Calif. Sampler, Texas Cone

Latitude: 43.084225°N
Longitude: 87.885890°W
Drill Rig: Freightliner
Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

LOG OF BORING B-03

PSI Job No.:	0052525	Drilling Method:	Hollow Stem Auger
Project:	Proposed Menlo Boulevard Storm Sewer	Sampling Method:	2-in SS
Location:	Milwaukee River to Prospect Ave. Shorewood, WI	Hammer Type:	Automatic
		Boring Location:	Hubbard Park

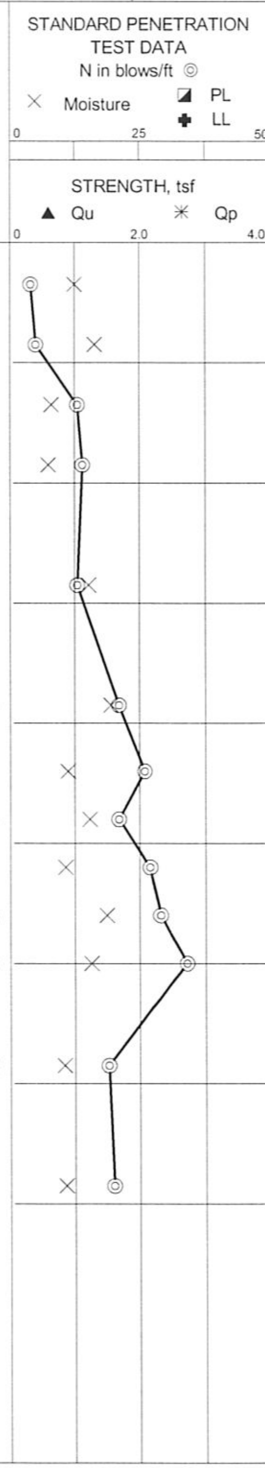
WATER LEVELS

While Drilling	Not Obsvd.
Upon Completion	Not Obsvd.
After 24 Hrs.	4 Ft.

Station: N/A
Offset: N/A

Surface Elev.: 618 ft

Elevation (feet)	Depth, (feet)	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
618	0				Topsoil (10" Thick)	Fill			
		Split-Spoon	1	12	Fill, Brown Silty Fine Sand, Trace Gravel, Roots and Concrete Rubble, Moist		3-2-2 N=4	12	
615									
	5	Split-Spoon	2	10		Fill	1-2-3 N=5	16	
		Split-Spoon	3	12			7-7-6 N=13	8	
610					Fill, Dark Brown Silty Fine Sand with Gravel and Brick, Moist				
	10	Split-Spoon	4	10		Fill	5-6-8 N=14	7	
605					Fill, Brown Silty Sand with Clay and Gravel, Moist				
	15	Split-Spoon	5	8		Fill	3-4-9 N=13	15	
					Gray Clayey Silt, Very Moist, Medium to Dense				
600									
	20	Split-Spoon	6	14			7-9-12 N=21	19	
595		Split-Spoon	7	10			30-15-11 N=26	11	
	25	Split-Spoon	8	12			11-9-12 N=21	15	
		Split-Spoon	9	4			16-14-13 N=27	11	
590		Split-Spoon	10	16		ML	12-11-18 N=29	19	
	30	Split-Spoon	11	16			17-17-17 N=34	16	
585	35	Split-Spoon	12	14			7-9-10 N=19	10	
580									
	40	Split-Spoon	13	14			4-8-12 N=20	11	
					End of Boring at 40'				
					Cave in at 30'				



Completion Depth:	40.0 ft	Latitude:	43.084225°N°
Date Boring Started:	1/24/12	Longitude:	87.885890°W°
Date Boring Completed:	1/24/12	Drill Rig:	Freightliner
Logged By:	TB	Remarks:	
Drilling Contractor:	PSI, Inc.		

Sample Types: Auger Cutting, Split-Spoon, Rock Core, Shelby Tube, Hand Auger, Calif. Sampler, Texas Cone

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

LOG OF BORING B-04

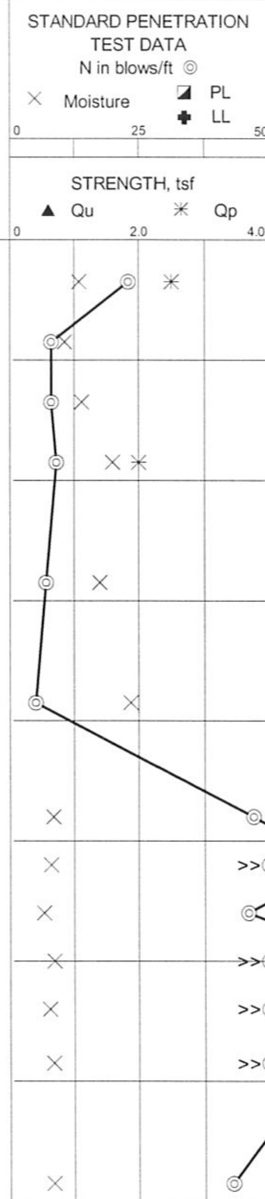
PSI Job No.: 0052525
Project: Proposed Menlo Boulevard Storm Sewer
Location: Milwaukee River to Prospect Ave.
Shorewood, WI

Drilling Method: Hollow Stem Auger
Sampling Method: 2-in SS
Hammer Type: Automatic
Boring Location: Hubbard Park

WATER LEVELS	
While Drilling	Not Obsvd.
Upon Completion	Not Obsvd.
After 24 Hrs.	15 Ft.

Station: N/A
Offset: N/A
Surface Elev.: 620 ft

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	0			Asphalt (4" Thick)	Pvmt			
				Base Course (5" Thick)	Base			
		1	16	Fill, Brown Mixed Dark Brown Sandy Clay, Trace Gravel, Moist	Fill	24-10-13 N=23	13	
615	5	2	8	Fill, Brown Silty Sand with Gravel, Trace Asphalt and Concrete, Moist	Fill	8-5-3 N=8	11	
		3	10			7-4-4 N=8	14	
610	10	4	8	Fill, Brown Mixed Dark Brown Sandy Clay, Trace Gravel, Moist	Fill	4-4-5 N=9	20	
605	15	5	10	Fill, Brown Silty Sand with Gravel, Trace Brick, Moist	Fill	4-4-3 N=7	17	
600	20	6	18	Fill, Brown Mixed Dark Brown Clayey Fine Sand, Trace Gravel, Wet	Fill	1-1-4 N=5	23	
595	25	7	14	Gray Silty Fine Sand, trace Gravel and Clay, Moist, Dense to Very Dense	SM	18-19-28 N=47	8	
		8	16			34-32-31 N=63	8	
		9	16			19-19-27 N=46	7	40% Fines
590	30	10	10			23-26-43 N=69	9	
		11	16			24-32-34 N=66	8	
585	35	12	8			50/5"	8	
				Gray Silty Fine Sand, Trace Gravel, Wet, Very Dense	SM			
580	40	13	14			15-19-24 N=43	8	
				End of Boring at 40'				



Completion Depth: 40.0 ft
Date Boring Started: 1/25/12
Date Boring Completed: 1/25/12
Logged By: TB
Drilling Contractor: PSI, Inc.

Sample Types: Auger Cutting, Split-Spoon, Rock Core, Shelby Tube, Hand Auger, Calif. Sampler, Texas Cone

Latitude: 43.084225°N°
Longitude: 87.885890°W°
Drill Rig: Freightliner
Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

LOG OF BORING B-05

Sheet 1 of 1

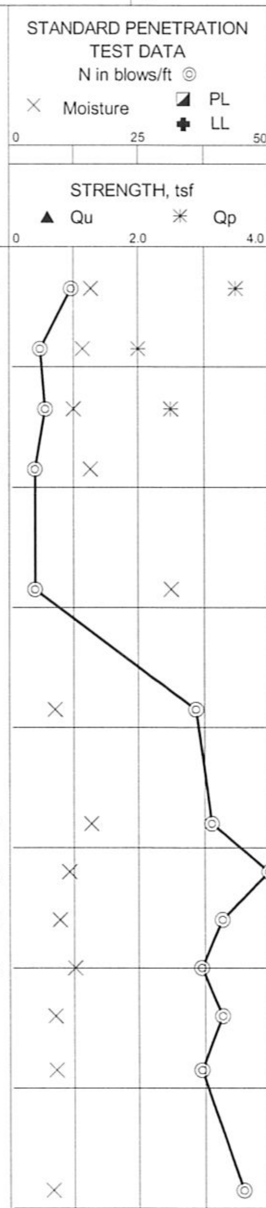
PSI Job No.:	0052525	Drilling Method:	Hollow Stem Auger
Project:	Proposed Menlo Boulevard Storm Sewer	Sampling Method:	2-in SS
Location:	Milwaukee River to Prospect Ave. Shorewood, WI	Hammer Type:	Automatic
		Boring Location:	Hubbard Park

WATER LEVELS

While Drilling	23 Ft.
Upon Completion	21 Ft.
After 24 Hrs.	14 Ft.

Station: N/A
Offset: N/A
Surface Elev.: 622 ft

Depth, (feet)	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %
0				Asphalt (4" Thick)	Pvmt		
				Base Course (7" Thick)	Base		
	Split-Spoon	1	10	Fill, Brown Mixed Dark Brown Sandy Clay, Trace Gravel, Moist		4-6-6 N=12	16
	Split-Spoon	2	10		Fill	3-3-3 N=6	14
	Split-Spoon	3	4			3-3-4 N=7	12
	Split-Spoon	4	8	Fill, Tan Mixed Olive Brown Clayey Sand, Trace Gravel, Moist	Fill	2-3-2 N=5	16
	Split-Spoon	5	10	Buried Topsoil, Dark Brown Organic Lean Clay, Very Moist	Topsoil	2-2-3 N=5	31
				Gray Silty Fine Sand, trace Gravel and Clay, Moist to Wet, Dense			
	Split-Spoon	6	16			12-17-19 N=36	9
	Split-Spoon	7	16			14-18-21 N=39	16
	Split-Spoon	8	16			15-24-26 N=50	12
	Split-Spoon	9	16		SM	13-15-26 N=41	10
	Split-Spoon	10	16			10-13-24 N=37	13
	Split-Spoon	11	16			20-19-22 N=41	9
	Split-Spoon	12	16			11-17-20 N=37	9
	Split-Spoon	13	16			17-19-26 N=45	8
40				End of Boring at 40'			
				Cave in at 28'			



Additional Remarks

		Sample Types:		
Completion Depth:	40.0 ft	Auger Cutting	Shelby Tube	Latitude: 43.084225°N°
Date Boring Started:	1/26/12	Split-Spoon	Hand Auger	Longitude: 87.885890°W°
Date Boring Completed:	1/26/12	Rock Core	Calif. Sampler	Drill Rig: Freightliner
Logged By:	TB		Texas Cone	Remarks:
Drilling Contractor:	PSI, Inc.			

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

LOG OF BORING B-06

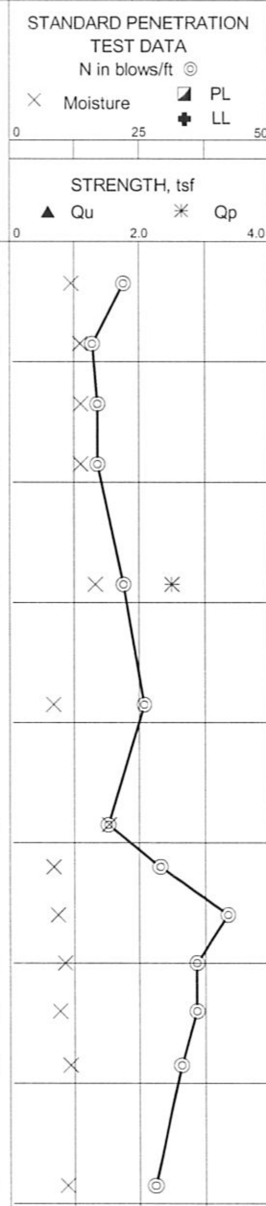
PSI Job No.: 0052525
Project: Proposed Menlo Boulevard Storm Sewer
Location: Milwaukee River to Prospect Ave. Shorewood, WI

Drilling Method: Hollow Stem Auger
Sampling Method: 2-in SS
Hammer Type: Automatic
Boring Location: Menlo Boulevard

WATER LEVELS
- While Drilling: 23 Ft.
- Upon Completion: Not Obsvd.
- After 24 Hrs.: 10 Ft.

Station: N/A
Offset: N/A
Surface Elev.: 637 ft

Depth (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %
0			Asphalt (5" Thick)	Pvmt		
			Base Course (7" Thick)	Base		
	1	14	Fill, Brown Silty Sand with Gravel, Trace Slag, Moist	Fill	9-11-11 N=22	12
	2	10	Fill, Dark Brown Silty Fine Sand, Moist	Fill	4-10-6 N=16	14
	3	14	Fill, Rust Brown Silty Sand with Gravel, Moist	Fill	4-10-7 N=17	14
	4	14	Brown Silty Fine Sand, Trace Gravel, Moist	SM	4-9-8 N=17	14
	5	6	Brown Mottled Gray Lean Clay, Trace Sand, Moist, Very Stiff	CL	6-9-13 N=22	17
	6	16	Gray Silty Fine Sand, trace Gravel and Clay, Moist to Wet, Medium to Dense	SM	9-11-15 N=26	8
	7	16			6-9-10 N=19	19
	8	16			7-9-20 N=29	8
	9	16			20-20-22 N=42	9
	10	16			14-18-18 N=36	11
	11	16			17-16-20 N=36	10
	12	16			11-15-18 N=33	12
	13	16	Gray Silty Sand with Gravel, Wet, Medium	SM	7-8-20 N=28	11
40			End of Boring at 40'			



Additional Remarks

Completion Depth: 40.0 ft
Date Boring Started: 1/27/12
Date Boring Completed: 1/27/12
Logged By: TB
Drilling Contractor: PSI, Inc.

Sample Types: Auger Cutting, Split-Spoon, Rock Core, Shelby Tube, Hand Auger, Calif. Sampler, Texas Cone

Latitude: 43.084225°N
Longitude: 87.885890°W
Drill Rig: Freightliner
Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

LOG OF BORING B-07

Sheet 1 of 1

PSI Job No.: 0052525
Project: Proposed Menlo Boulevard Storm Sewer
Location: Milwaukee River to Prospect Ave.
Shorewood, WI

Drilling Method: Hollow Stem Auger
Sampling Method: 2-in SS
Hammer Type: Automatic
Boring Location: Menlo Boulevard

WATER LEVELS

While Drilling	27 Ft.
Upon Completion	16 Ft.
After 24 Hrs.	N/A

Station: N/A
Offset: N/A

Surface Elev.: 647 ft

Sample No.	Recovery (inches)	Material Description	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
		Asphalt (7" Thick)	Pvmt			
		Base Course (6" Thick)	Base			
1	15	Fill, Brown Sandy Clay, Trace Gravel, Moist	Fill	3-3-3 N=6	15	
2	15			2-2-2 N=4	23	
3	18	Brown Mottled Dark Brown Silty Fine Sand, Moist, Loose	SM	4-4-3 N=7	19	
4	18	Brown Silty Sand with Gravel, Moist, Loose to Medium	SM	3-2-4 N=6	18	
5	18			8-15-13 N=28	12	
6	18	Gray Clayey Silt, Trace Sand and Gravel, Moist, Medium	ML	9-8-9 N=17	8	
7	18	Gray Silty Fine Sand, Trace Gravel, Wet, Dense	SM	8-15-21 N=36	9	
8	24			25-35-50/6"	14	22% Fines
9	12			50/6"	18	
10	12	Gray Silty Fine Sand, trace Gravel and Clay, Wet, Very Dense	SM	50/6"	8	
11	24			29-30-32 N=62	8	
12	18			15-50/6"	16	
13	6			50/6"	12	

End of Boring at 40'

Cave in at 23'

Completion Depth: 40.0 ft
Date Boring Started: 1/30/12
Date Boring Completed: 1/30/12
Logged By: DZ
Drilling Contractor: PSI, Inc.

Sample Types: Auger Cutting, Split-Spoon, Rock Core, Shelby Tube, Hand Auger, Calif. Sampler, Texas Cone

Latitude: 43.084225°N
Longitude: 87.885890°W
Drill Rig: Freightliner
Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

LOG OF BORING B-08

Sheet 1 of 1

PSI Job No.:	0052525	Drilling Method:	Hollow Stem Auger
Project:	Proposed Menlo Boulevard Storm Sewer	Sampling Method:	2-in SS
Location:	Milwaukee River to Prospect Ave. Shorewood, WI	Hammer Type:	Automatic
		Boring Location:	Menlo Boulevard

WATER LEVELS	
While Drilling	43 Ft.
Upon Completion	31 Ft.
After 24 Hrs.	N/A

Station: N/A
Offset: N/A
Surface Elev.: 660 ft

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
660	0			Asphalt (6" Thick)	Pvmt			
				Base Course (8" Thick)	Base			
		1	18	Gray Sandy Lean Clay, Moist, Very Stiff		2-4-4 N=8	11	
655	5	2	18		CL	3-4-4 N=8	12	
		3	18			5-5-8 N=13	10	
		4	18	Gray Sandy Lean Clay with Gravel, Moist, Hard		8-8-13 N=21	9	
650	10							
645	15	5	18			6-8-9 N=17	10	
640	20	6	18			12-11-14 N=25	9	
635	25	7	18		CL	14-14-25 N=39	15	
630	30	8	18			14-20-30 N=50	11	
		9	24			16-28-44 N=72	16	LL = 40 PL = 15
		10	24			12-19-29 N=48	16	
625	35	11	24			13-21-35 N=56	14	
		12	3			30-43-50/4"	14	
620	40	13	24			19-16-39 N=55	13	
				Gray Clayey Sand with Gravel, Wet, Very Dense	SC			
615	45	14	9			50/3"	12	
				End of Boring at 45'				
				Cave in at 39.5'				

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0

Completion Depth:	45.0 ft
Date Boring Started:	1/27/12
Date Boring Completed:	1/27/12
Logged By:	DZ
Drilling Contractor:	PSI, Inc.

Sample Types: Auger Cutting, Split-Spoon, Rock Core, Shelby Tube, Hand Auger, Calif. Sampler, Texas Cone

Latitude: 43.084225°N
Longitude: 87.885890°W
Drill Rig: Freightliner
Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

LOG OF BORING B-09

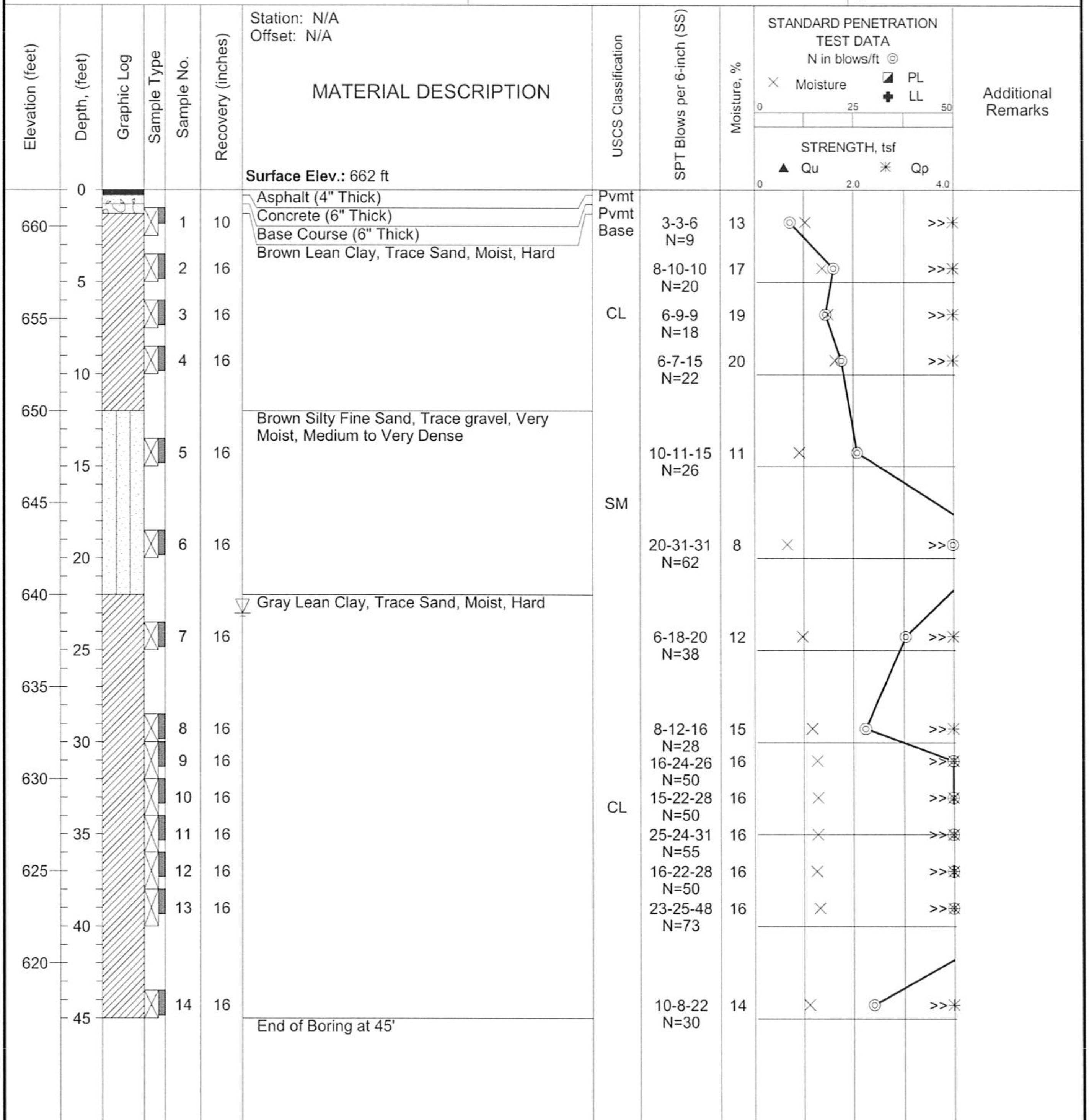
PSI Job No.: 0052525
Project: Proposed Menlo Boulevard Storm Sewer
Location: Milwaukee River to Prospect Ave.
Shorewood, WI

Drilling Method: Hollow Stem Auger
Sampling Method: 2-in SS
Hammer Type: Automatic
Boring Location: Menlo Boulevard

WATER LEVELS
- While Drilling: 23 Ft.
- Upon Completion: Not Obsvd.
- After 24 Hrs.: N/A

Station: N/A
Offset: N/A
Surface Elev.: 662 ft

Sample No.	Sample Type	Recovery (inches)	Material Description	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %
			Asphalt (4" Thick)	Pvmt		
			Concrete (6" Thick)	Pvmt		
			Base Course (6" Thick)	Base		
1	Split-Spoon	10	Brown Lean Clay, Trace Sand, Moist, Hard	CL	3-3-6 N=9	13
2	Split-Spoon	16			8-10-10 N=20	17
3	Split-Spoon	16			6-9-9 N=18	19
4	Split-Spoon	16			6-7-15 N=22	20
5	Split-Spoon	16	Brown Silty Fine Sand, Trace gravel, Very Moist, Medium to Very Dense	SM	10-11-15 N=26	11
6	Split-Spoon	16			20-31-31 N=62	8
7	Split-Spoon	16	Gray Lean Clay, Trace Sand, Moist, Hard	CL	6-18-20 N=38	12
8	Split-Spoon	16			8-12-16 N=28	15
9	Split-Spoon	16			16-24-26 N=50	16
10	Split-Spoon	16			15-22-28 N=50	16
11	Split-Spoon	16			25-24-31 N=55	16
12	Split-Spoon	16			16-22-28 N=50	16
13	Split-Spoon	16			23-25-48 N=73	16
14	Split-Spoon	16			10-8-22 N=30	14
			End of Boring at 45'			



Completion Depth: 45.0 ft
Date Boring Started: 1/27/12
Date Boring Completed: 1/27/12
Logged By: TB
Drilling Contractor: PSI, Inc.

Sample Types: Auger Cutting, Split-Spoon, Rock Core, Shelby Tube, Hand Auger, Calif. Sampler, Texas Cone

Latitude: 43.084225°N°
Longitude: 87.885890°W°
Drill Rig: Freightliner
Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

LOG OF BORING B-10

PSI Job No.: 0052525
Project: Proposed Menlo Boulevard Storm Sewer
Location: Milwaukee River to Prospect Ave.
Shorewood, WI

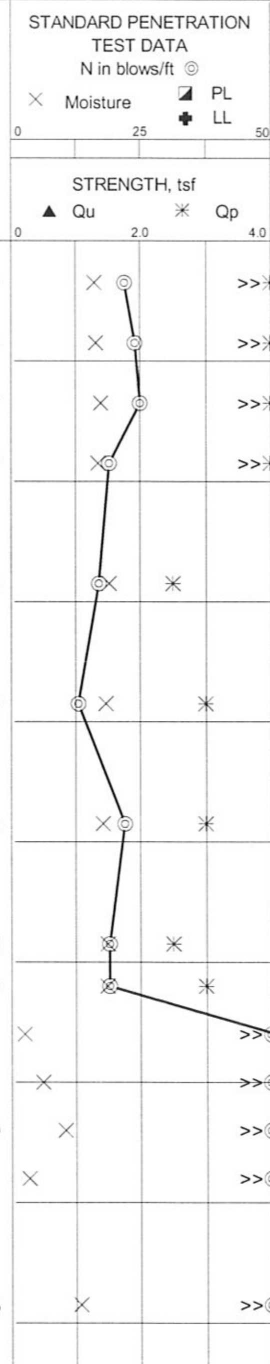
Drilling Method: Hollow Stem Auger
Sampling Method: 2-in SS
Hammer Type: Automatic
Boring Location: Menlo Boulevard

WATER LEVELS
- While Drilling: 43 Ft.
- Upon Completion: 39 Ft.
- After 24 Hrs.: N/A

Station: N/A
Offset: N/A

Surface Elev.: 665 ft

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	Material Description	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
665	0			Asphalt (13" Thick)	Pvmt			
				Base Course (6" Thick)	Base			
		1	18	Brown Mottled Gray Lean Clay, Trace Sand, Moist, Hard	CL	7-9-13 N=22	16	
660	5	2	18			7-10-14 N=24	16	
		3	18			7-10-15 N=25	17	
655	10	4	18			7-8-11 N=19	17	
				Gray Lean Clay, Trace Sand, Moist, Very Stiff	CL			
650	15	5	18			7-7-10 N=17	19	
645	20	6	18			4-6-7 N=13	18	
640	25	7	18			9-8-14 N=22	18	
635	30	8	24			7-9-10 N=19	19	
		9	24			6-9-10 N=19	19	
		10	24	Gray Silty Sand with Gravel, Moist, Very Dense to Wet	SM	3-11-40 N=51	3	
630	35	11	24			40-31-48 N=79	6	9% Fines
		12	3			50/3"	10	
		13	3			50/3"	3	
625	40							
620	45	14	18			16-22-32 N=54	13	
				End of Boring at 45'				



Completion Depth: 45.0 ft
Date Boring Started: 1/27/12
Date Boring Completed: 1/27/12
Logged By: DZ
Drilling Contractor: PSI, Inc.

Sample Types: Auger Cutting, Split-Spoon, Rock Core, Shelby Tube, Hand Auger, Calif. Sampler, Texas Cone

Latitude: 43.084225°N°
Longitude: 87.885890°W°
Drill Rig: Freightliner
Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

LOG OF BORING B-11

Sheet 1 of 1

PSI Job No.:	0052525	Drilling Method:	Hollow Stem Auger
Project:	Proposed Menlo Boulevard Storm Sewer	Sampling Method:	2-in SS
Location:	Milwaukee River to Prospect Ave. Shorewood, WI	Hammer Type:	Automatic
		Boring Location:	Menlo Boulevard

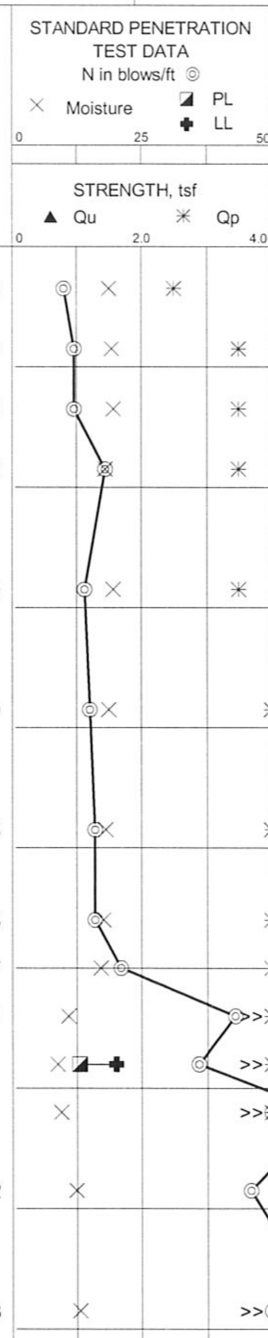
WATER LEVELS

While Drilling	39.5 Ft.
Upon Completion	37 Ft.
After 24 Hrs.	N/A

Station: N/A
Offset: N/A

Surface Elev.: 662 ft

Sample No.	Recovery (inches)	Material Description	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
		Asphalt (9" Thick)	Pvmt			
		Base Course (5" Thick)	Base			
1	15	Brown Lean Clay, Trace Sand, Moist, Very Stiff	CL	3-4-6 N=10	19	
2	18			2-5-7 N=12	19	
3	18			6-3-9 N=12	20	
4	18	Gray Lean Clay, Trace Sand, Moist, Very Stiff to Hard	CL	6-8-10 N=18	18	
5	18			5-6-8 N=14	20	
6	18			5-6-9 N=15	19	
7	18			7-7-9 N=16	18	
8	24			4-6-10 N=16	18	
9	24			5-9-12 N=21	17	
10	24	Gray Sandy Silty Clay, Trace Gravel, Moist, Hard	CL-ML	33-17-26 N=43	11	
11	24			27-18-18 N=36	9	LL = 20 PL = 13
12	9			50/3"	9	
13	18	Gray Silty Sand with Gravel, Wet, Dense to Very Dense	SM	15-23-23 N=46	12	
14	19			10-30-30 N=60	13	
		End of Boring at 45'				
		Cave in at 38'				



Completion Depth:	45.0 ft	Latitude:	43.084225°N°
Date Boring Started:	1/27/12	Longitude:	87.885890°W°
Date Boring Completed:	1/27/12	Drill Rig:	Freightliner
Logged By:	DZ	Remarks:	
Drilling Contractor:	PSI, Inc.		

Sample Types: Auger Cutting, Split-Spoon, Rock Core, Shelby Tube, Hand Auger, Calif. Sampler, Texas Cone

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

LOG OF BORING B-12

PSI Job No.:	0052525
Project:	Proposed Menlo Boulevard Storm Sewer
Location:	Milwaukee River to Prospect Ave. Shorewood, WI
Drilling Method:	Hollow Stem Auger
Sampling Method:	2-in SS
Hammer Type:	Automatic
Boring Location:	Menlo Boulevard Median

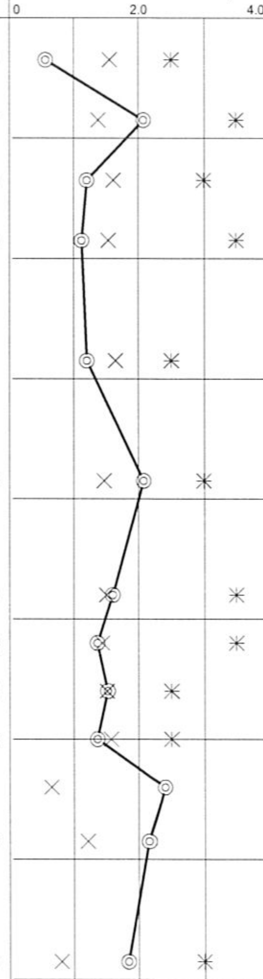
WATER LEVELS

While Drilling	32.5 Ft.
Upon Completion	Not Obsvd.
After 24 Hrs.	N/A

Station: N/A
Offset: N/A
Surface Elev.: 659 ft

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	Material Description	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
659	0			Topsoil (10" Thick)	OL			
		1	15	Brown Mottled Gray Lean Clay, Trace Sand, Moist, Very Stiff		3-3-4 N=7	19	
655	5	2	18		CL	9-12-14 N=26	17	
		3	18			5-6-9 N=15	20	
650	10	4	18	Gray Lean Clay, Trace Sand, Moist, Very Stiff		5-6-8 N=14	19	
645	15	5	18			5-5-10 N=15	21	
640	20	6	18		CL	6-8-13 N=26	18	
635	25	7	18			6-8-12 N=20	19	
		8	18			5-7-10 N=17	18	
630		9	18			5-7-12 N=19	19	
	30	10	18			5-7-10 N=17	20	
		11	18	Gray Silty Sand with Gravel, Wet, Dense	SM	14-19-11 N=30	8	
625	35	12	18	Gray Silty Fine Sand, Wet, Medium	SM	11-13-14 N=27	15	
620		13	18	Gray Lean Clay, Trace Sand and Gravel, Very Moist, Very Stiff	CL	5-8-15 N=23	10	
	40			End of Boring at 40'				
				Cave in at 24'				

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
▲ Qu ✳ Qp
STRENGTH, tsf



Completion Depth:	40.0 ft
Date Boring Started:	1/26/12
Date Boring Completed:	1/26/12
Logged By:	DZ
Drilling Contractor:	PSI, Inc.

Sample Types: Auger Cutting, Split-Spoon, Rock Core, Shelby Tube, Hand Auger, Calif. Sampler, Texas Cone

Latitude: 43.084225°N°
Longitude: 87.885890°W°
Drill Rig: Freightliner
Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

LOG OF BORING B-13

PSI Job No.:	0052525	Drilling Method:	Hollow Stem Auger
Project:	Proposed Menlo Boulevard Storm Sewer	Sampling Method:	2-in SS
Location:	Milwaukee River to Prospect Ave. Shorewood, WI	Hammer Type:	Automatic
		Boring Location:	Menlo Boulevard Median

WATER LEVELS

While Drilling	20.5 Ft.
Upon Completion	Not Obsvd.
After 24 Hrs.	N/A

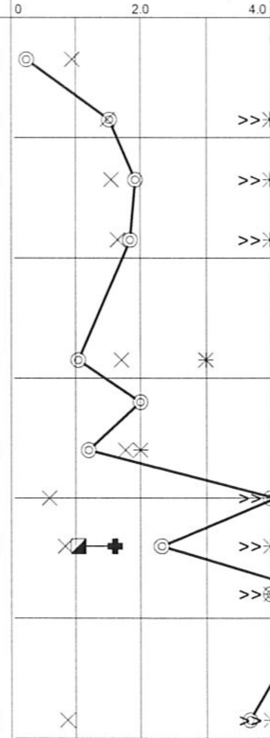
Station: N/A
Offset: N/A
Surface Elev.: 654 ft

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	0			Topsoil (10" Thick)	Fill			
		1	15	Fill, Dark Brown Clayey Fine Sand, Moist	Fill	2-1-2 N=3	12	
650	5	2	18	Brown Mottled Gray Lean Clay, Trace Sand, Moist, Hard	CL	5-8-11 N=19	19	
		3	2			2-13-11 N=24	19	
645	10	4	18			8-10-13 N=23	21	
640	15	5	18	Gray Lean Clay, Trace Sand, Moist, Very Stiff	CL	7-6-7 N=13	21	
		6	0			8-10-15 N=25		
		7	18			4-7-8 N=15	22	
635	20	8	18	Brown Silty Sand with Gravel, Wet, Medium	SM	20-20-31 N=51	7	
		9	18	Gray Sandy Silty Clay, Trace Gravel, Moist, Hard	CL-ML	9-13-16 N=29	10	LL = 20 PL = 13
630	25	10	1			50/4"		
625	30	11	18			12-17-29 N=46	11	

End of Boring at 30'

Cave in at 27'

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0



Completion Depth:	30.0 ft	Latitude:	43.084225°N°
Date Boring Started:	1/26/12	Longitude:	87.885890°W°
Date Boring Completed:	1/26/12	Drill Rig:	Freightliner
Logged By:	DZ	Remarks:	
Drilling Contractor:	PSI, Inc.		

Sample Types: Auger Cutting, Split-Spoon, Rock Core, Shelby Tube, Hand Auger, Calif. Sampler, Texas Cone

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

LOG OF BORING B-14

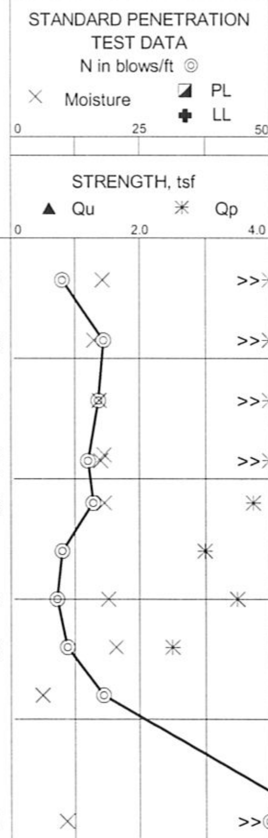
PSI Job No.: 0052525
Project: Proposed Menlo Boulevard Storm Sewer
Location: Milwaukee River to Prospect Ave.
Shorewood, WI

Drilling Method: Hollow Stem Auger
Sampling Method: 2-in SS
Hammer Type: Automatic
Boring Location: Menlo Boulevard Median

WATER LEVELS	
While Drilling	Not Obsvd.
Upon Completion	Not Obsvd.
After 24 Hrs.	N/A

Station: N/A
Offset: N/A
Surface Elev.: 651 ft

Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %
0			Topsoil (8" Thick)	OL		
	1	12	Brown Mottled Gray Lean Clay, Trace Sand, Moist, Hard		3-5-5 N=10	18
	2	15		CL	9-9-9 N=18	16
	3	18			3-7-10 N=17	17
	4	18	Gray Lean Clay, Trace Sand, Moist, Hard to Very Stiff		5-6-9 N=15	18 / 17
	5	18			4-6-10 N=16	18
	6	18		CL	4-4-6 N=10	
	7	18			3-4-5 N=9	19
	8	18			4-5-6 N=11	20
	9	12	Gray Silty Sand with Gravel, Moist, Medium		3-10-8 N=18	6
				SM		
	10	18			15-14	11
25			End of Boring at 25'			
			Cave in at 23.5'			



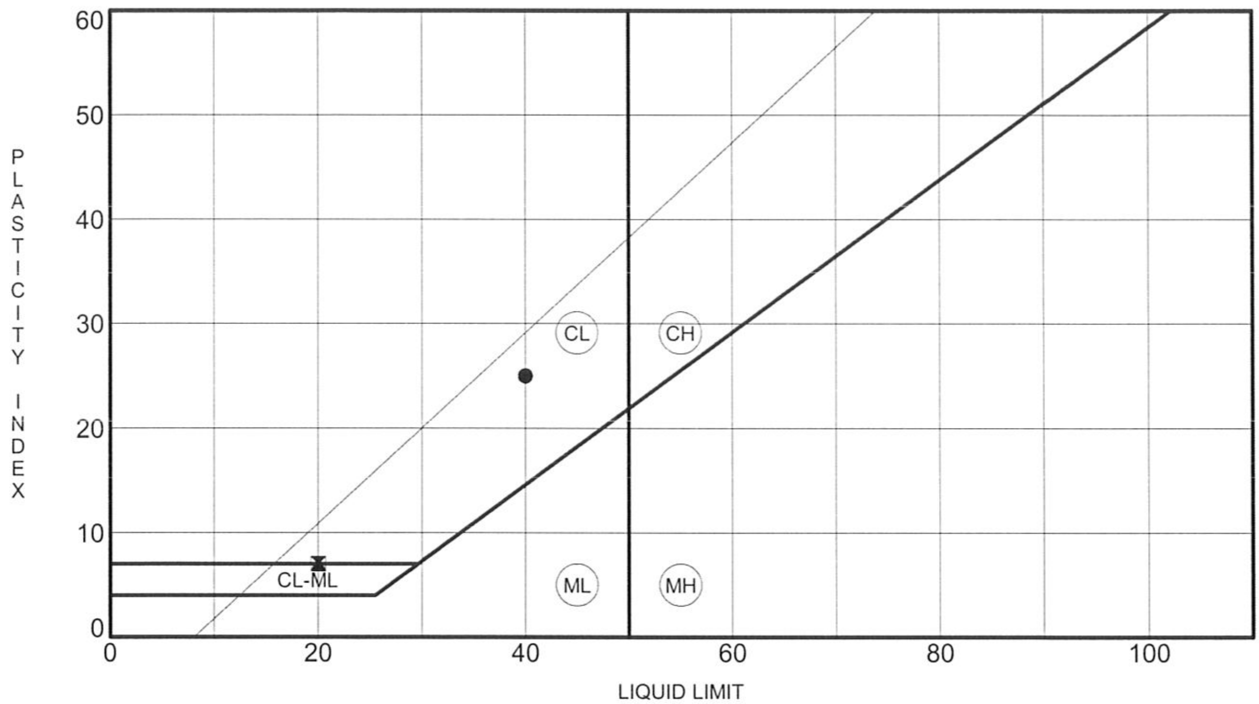
Additional Remarks

Completion Depth: 25.0 ft
Date Boring Started: 1/26/12
Date Boring Completed: 1/26/12
Logged By: DZ
Drilling Contractor: PSI, Inc.

Sample Types: Auger Cutting, Split-Spoon, Rock Core, Shelby Tube, Hand Auger, Calif. Sampler, Texas Cone

Latitude: 43.084225°N°
Longitude: 87.885890°W°
Drill Rig: Freightliner
Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.



	Boring	Depth (ft)	LL	PL	PI	Fines	Classification (*Visual)
●	**B-08**	**31.0**	**40**	**15**	**25**		
⧗	**B-11**	**34.0**	**20**	**13**	**7**		
▲	**B-13**	**22.0**	**20**	**13**	**7**		

Professional Service Industries, Inc.
W237 N2878 Woodgate Road, Suite 2
Pewaukee, WI 53072
Telephone: (262) 347-0898
Fax: (262) 347-2256

ATTERBERG LIMIT RESULTS

PSI Job No.: 0052525
Project: Proposed Menlo Boulevard Storm Sewer
Location: Milwaukee River to Prospect Ave.
Shorewood, WI

GENERAL NOTES

SAMPLE IDENTIFICATION

The Unified Soil Classification System is used to identify the soil unless otherwise noted.

SOIL PROPERTY SYMBOLS

N:	Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch O.D. split-spoon.
Qu:	Unconfined compressive strength, tsf.
Qp:	Penetrometer value, index value of unconfined compressive strength, tsf.
Mc:	Water content, %.
PL:	Plastic limit, %.
LL:	Liquid Limit, %.
PI:	Plasticity Index.
γd:	Natural dry density, pcf.
▼	Groundwater level observed at time noted after completion of boring.

DRILLING AND SAMPLING SYMBOLS

SS:	Split-Spoon – 1 3/8" I.D., 2" O.D., except where noted.
ST:	Shelby Tube – 3" O.D., except where noted.
AU:	Auger Sample.
DB:	Diamond Bit.
CB:	Carbide Bit.
WS:	Washed Sample.

RELATIVE DENSITY AND CONSISTENCY CLASSIFICATION (Terzaghi & Peck, 1948)

TERM (COHESIONLESS SOILS)	STANDARD PENETRATION RESISTANCE
Very Loose	0 – 4
Loose	4 – 10
Medium	10 – 30
Dense	30 – 50
Very Dense	Over 50

TERM (COHESIVE SOILS)	Qu – (TSF)
Very Soft	0 – 0.25
Soft	0.25 – 0.50
Medium	0.50 – 1.00
Stiff	1.00 – 2.00
Very Stiff	2.00 – 4.00
Hard	4.00+

PARTICLE SIZE (ASTM D2487 AND D422)

Boulders	≥ 12 in. (300mm)
Cobbles	< 12 in.(300mm) to 3 in. (75mm)
Gravel	< 3 in. (75mm) to 4.75mm (#4 sieve)
Coarse Sand	<4.75mm (#4 sieve) to 2mm (#10 sieve)
Medium Sand	<2mm (10 sieve) to 425μm (#40 sieve)
Fine Sand	<425μm (#40 sieve) to 75μm (#200 sieve)
Silt	<75μm (#200 sieve) to 5μm
Clay	<5μm