

Appendix I

Clean Water Nashville Overflow Abatement Program

GUIDANCE FOR DESIGN

GEOTECHNICAL

Version 2.0

April 2014

Table of Contents

Table of Contents.....	i
Section 1 Geotechnical Services.....	1
1.1 Introduction	1
1.2 Definitions.....	1
1.2.1 Personnel Requirements/Qualifications	1
1.2.2 Laboratory Qualifications.....	1
1.2.3 Sub-contractor Qualifications	2
1.3 Site Reconnaissance	2
1.4 Field Services.....	2
1.4.1 Site Safety.....	2
1.4.2 Sample/Test Location Layout.....	2
1.4.3 Utility Clearance.....	3
1.4.4 Site Access.....	3
1.4.5 Right-of-Entry/Owner Notifications.....	3
1.4.6 Permits	3
1.4.7 Drilling and Sampling Procedures	3
1.4.8 Test Pit Procedures.....	4
1.4.9 Other Exploration Procedures.....	4
1.4.10 Property Protection/Site Restoration.....	4
1.5 Sample Handling/Labeling/Storage	5
1.5.1 Soil Samples	5
1.5.2 Rock Core Samples.....	6
1.6 Laboratory Services.....	6
1.6.1 Geotechnical Laboratory Services.....	6
1.6.2 Analytical Laboratory Services.....	6
Section 2 Geotechnical Evaluation and Reporting	7
2.1 <i>Geotechnical Report</i>	7
2.1.1 Geotechnical Considerations.....	7
2.1.2 Geotechnical Recommendations	8
2.2 Data Management.....	9
2.3 Exploration Location Plans	10
2.4 Site and Boring Coordinates	10
2.5 Delivery of Geotechnical Data	10

Section 1

Geotechnical Services

1.1 Introduction

The following section provides specific guidance for geotechnical services on the Clean Water Nashville Overflow Abatement Program (Program). This guidance establishes standard Program protocols and methodologies for delivery of consistent final products. The Designer and its sub-consultants shall adhere to these requirements unless the Designer specifically communicates its reasons for deviating from this guidance to the Project Manager.

1.2 Definitions

Selected definitions pertaining to the Program are provided in the various sections of the *Design Management Manual*. Additional definitions pertaining to this Appendix I are provided below.

AASHTO	American Association of State Highway and Transportation Officials
AMRL	AASHTO Materials Reference Laboratory
ASTM	American Society for Testing and Materials
Exploration Point	Any unique investigation location that is intended to define conditions for an individual discrete location or a vertical column (sample collection point, test borings, rock cores, test pits, piezometers, test wells, direct push sampling point, etc.)
GIS	Geographic Information System
GPS	Global Positioning System
NELAP	National Environmental Laboratory Accreditation Program
OSHA	Occupational Safety and Health Administration

1.2.1 Personnel Requirements/Qualifications

The Designer shall be responsible for any of its Geotechnical sub-consultant's work. This work shall be performed by qualified personnel under the direction and supervision of a Tennessee licensed professional engineer specializing in geotechnical engineering. The licensed engineer's level and type of work experience shall be commensurate with the project type and complexity. The licensed engineer shall verify all sampling and testing are performed per applicable ASTM or other industry standards and for approving all final laboratory data and boring logs. All final work products shall be signed and sealed by the engineer of record in accordance with applicable laws and rules.

1.2.2 Laboratory Qualifications

Geotechnical laboratory testing shall be performed by a laboratory accredited by the AASHTO Materials Reference Laboratory and/or validated by the USACE or other industry-standard agency.

Analytical laboratory testing shall be performed by a laboratory certified by the appropriate state program and/or agency or other industry-standard program or agency (EPA, NELAP, etc.).

Laboratory certifications other than AASHTO, AMRL, USACE, NELAP, or EPA shall be submitted for approval prior to laboratory testing. The Program reserves the right to reject said certifications and require AMRL or USACE certifications at its sole discretion.

1.2.3 Sub-contractor Qualifications

The Geotechnical sub-consultant may use sub-contractors to perform field services not provided in-house including drilling, excavating, utility location, or geophysical exploration. This use must be approved by the Program Management Consultant.

Drilling sub-contractors shall be experienced and competent in the type of drilling and sampling required for the project in the anticipated geological conditions and directed by a driller who has at least five years' experience with the equipment and procedures necessary to complete the project.

1.3 Site Reconnaissance

During the site reconnaissance, the Designer or the Designer's Geotechnical sub-consultant shall document existing site surface conditions, observe surface indications of the site geology, and note other conditions that may impact site development and the geotechnical conclusions and recommendations. Such conditions that should be documented with photographs in the *Geotechnical Report's* appendix, may include, but are not limited to the following topics:

- Topography
- Vegetation
- Drainage patterns
- Erosion patterns
- Land use/existing (or previous) structures
- Existing fill
- Geology

1.4 Field Services

1.4.1 Site Safety

The Designer and its sub-consultants shall perform all field activities in a safe manner. The Geotechnical sub-consultant shall prepare a site-specific *Health and Safety Plan* prior to commencing field services and perform and document equipment safety inspections daily for the duration of the field services. These documents should be maintained in the Geotechnical sub-consultant's files and provided to the Designer or the Program upon request. Refer to USACE *Safety and Health Requirements Manual* (EM 385-1-1, latest edition), Section 18.G, Machinery and Mechanized Equipment, and Section 18.H, Drilling Equipment, for additional guidance regarding equipment safety.

1.4.2 Sample/Test Location Layout

The Designer or the Designer's Geotechnical sub-consultant shall mark or stake the exploration locations on the site prior to mobilizing the field crew. Such marking or staking shall be based on measuring from known landmarks found on a dimensioned drawing provided by the Designer, measuring from project stakes placed by the Designer, or using a hand-held GPS unit and coordinates provided by the Designer. The Designer may request that the marked stakes be left at the exploration

locations for surveying later by the Designer's surveyor. Surveying horizontal and vertical coordinates of the borings locations may be required on a site-specific basis.

1.4.3 Utility Clearance

The Designer or the Designer's Geotechnical sub-consultant shall contact all utility companies for information and one-call marking regarding underground utilities. For projects at existing facilities, these contacts may include parties designated by the Program Management Team as being knowledgeable about underground utilities and structures. The Designer or Designer's Geotechnical sub-consultant will be required to obtain record drawings and locate utilities at existing MWS facilities if outside the one-call marking jurisdiction. The Designer or the Designer's Geotechnical sub-consultant shall be required to maintain valid utility clearances throughout their work.

1.4.4 Site Access

The Designer or the Designer's Geotechnical sub-consultant is encouraged to visit the site prior to developing a plan for geotechnical activities. Conditions which may require special access considerations, such as soft ground, heavy vegetation, sloping ground, restricted horizontal or vertical clearance, etc., should be noted in the Designer's *Project Work Plan* along with expected dates for this access.

1.4.5 Right-of-Entry/Owner Notifications

For projects at existing MWS facilities, the Designer may assume that right-of-entry will be provided by MWS and that the facilities are secure sites. For projects at existing MWS facilities, the Designer and its sub-consultants will be provided with a facility contact for coordinating site access. For new facility projects such as equalization tanks and pump stations located on property not owned by MWS and being acquired for MWS, the Designer may assume that right-of-entry will be obtained by MWS and be provided to the Designer.

For non-MWS owned property and typically for conveyance projects, no right-of-entry on private property will be provided. The Designer or its sub-consultant shall obtain entry permission and coordinate site work directly with the property owner as may be required on a site-specific basis. This will be coordinated with the Program and the MWS easement section and written entry records will be provided.

1.4.6 Permits

Permit needs will vary on a site-by-site basis for items such as tree removal, erosion and sedimentation control, right-of-way closures, and excavations. The Designer or the Designer's Geotechnical sub-consultant shall consider the need for required permits to complete the project when developing the geotechnical scope. If not expressly disclaimed, it will be assumed that the Geotechnical sub-consultant will obtain and pay for all permits required to complete the geotechnical services and that the related costs are included in the Geotechnical sub-consultant's proposed fee.

1.4.7 Drilling and Sampling Procedures

Unless otherwise stipulated, drilling and sampling will be performed in accordance with current applicable ASTM standards or other recognized industry standards.

The Designer's Geotechnical sub-consultant shall provide a full-time field representative (graduate geotechnical engineer or geologist acting under a licensed Geotechnical Engineer's supervision)

during the field exploration. The field representative shall classify and preserve the samples and prepare the field logs. Information to be included on the logs is per ASTM D 1586. Soil samples shall be classified in accordance with the Unified Soil Classification System (reference ASTM D 2487, *Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)*) and described in accordance with ASTM D 2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*.

When performing rock coring, the field representative shall describe the rock formation recovered in each core run and measure and record the percent core recovery and rock quality designation for each core run on the respective field log. Other coring operations information to be included on the field log is per ASTM D 2113.

1.4.8 Test Pit Procedures

Test pits may be appropriate for some projects. The Designer's Geotechnical sub-consultant shall provide a full-time field representative to observe the test pit excavations, document the conditions encountered (including photographs), and perform tests and collect representative samples as appropriate. Soils encountered in the test pits shall be classified in accordance with the Unified Soil Classification System and described in accordance with ASTM D 2488. All test pit activities shall conform to applicable OSHA regulations.

Test Pit Logs shall include, but not be limited to, the following information:

- Project name and number
- Excavation date
- Test pit number
- Inspector's name
- Equipment used
- Surface elevation, if available
- Descriptions of the soil, groundwater, and refusal or termination conditions encountered
- Field test data
- Sample type and depth
- Photograph of the completed test pit - Additional photos may be included, if desired.

1.4.9 Other Exploration Procedures

Other exploration procedures (geophysical surveys, etc.) may be considered by the Designer or the Designer's Geotechnical sub-consultant on a project-specific basis in lieu of or as a supplement to invasive sampling and testing. Other exploration procedures shall conform to ASTM standards or other recognized industry standards.

1.4.10 Property Protection/Site Restoration

The Designer's Geotechnical sub-consultant performing field work shall take all reasonable precautions to prevent visible and concealed damage to property and shall reasonably restore the site to the condition existing prior to the Geotechnical sub-consultant's entry. Such restoration shall include, but not be limited to, backfilling borings, patching slabs and pavements, and repairing lawns and plantings damaged by the exploration equipment. For projects lasting more than one day, open

borings shall be temporarily plugged at the end of each day. At the work's completion, the borings shall be permanently plugged including patching slabs and pavements.

When borings or other exploration points penetrate public roadways or sidewalks, the surface treatment at the boring (or test pit, etc.) shall be repaired in accordance with the appropriate local jurisdiction's requirements.

At a minimum, the Designer's Geotechnical sub-consultant shall backfill all traveled surface penetrations (including test pits) to depth with gravel and finish the surface with materials generally matching those initially encountered or better. The Designer's Geotechnical sub-consultant shall backfill out-of-roadway test pits with the excavated materials unless directed otherwise.

Restoring borings, other exploration points, and/or access corridors on private property shall be performed in accordance with procedures provided by the Designer.

1.5 Sample Handling/Labeling/Storage

1.5.1 Soil Samples

Soil samples shall be preserved and transported in accordance with ASTM D 4220, Standard Practices for Preserving and Transporting Soil Samples.

Bulk soil samples for Proctor compaction and other recompacted tests shall include a properly preserved moisture sample.

Prior to transporting, soil samples will be properly identified with tags, labels, and markings as follows:

- Project name or number or both
- Sampling date
- Sample/boring number
- Sample depth
- Penetration test data, if applicable (ASTM D 1586)

The duration for sample retention by the Designer's Geotechnical sub-consultant will be stipulated in the contract. For samples transferred to MWS for long-term storage, the individual SPT sample containers, i.e., jars or bags, shall be placed in larger lidded containers (boxes or storage totes) which can be stacked.

The larger containers shall be labeled as follows:

- Project name and number
- Boring number for each boring represented in the container (including sample numbers, if split between more than one container)
- Consecutive container count, i.e., Box 1 of 5, Box 2 of 5, etc.

Lidded, stackable containers are not required for long-term storage of thin-walled tube samples. Allowances for long-term upright storage of thin-walled tube samples, if desired by MWS on project-specific basis, will be made by MWS at MWS' cost.

1.5.2 Rock Core Samples

Rock core samples shall be preserved and transported in accordance with ASTM D 2113. The core boxes shall be properly identified with tags, labels, and markings prior to transporting them.

The core box tops shall include the following information:

- Project name and number
- Sampling date
- Boring number
- Core run number
- Depth interval of core run
- Percent recovery and rock quality designation
- Box number and box count for each boring, i.e., box 1 of 3, etc.

The duration for sample retention by the Designer's Geotechnical sub-consultant will be stipulated in the contract, but in no case shall samples be retained for a period of less than one year.

1.6 Laboratory Services

1.6.1 Geotechnical Laboratory Services

Geotechnical laboratory services shall conform to ASTM methods or other widely accepted industry standards such as those published by AASHTO or USACE. A copy of the laboratories QA/QC procedures and chain-of-custody documentation shall be made available to the Program Quality Manager from the Designer upon request.

1.6.2 Analytical Laboratory Services

Selected chemical or other laboratory testing, such as corrosivity-related testing, may be performed by an analytical laboratory sub-contracted to the Designer or the Designer's Geotechnical sub-consultant. The testing should conform to USEPA methods or other widely accepted industry standards. A copy of the laboratories QA/QC procedures and chain-of-custody documentation shall be made available to the Program Quality Manager from the Designer upon request.

Section 2

Geotechnical Evaluation and Reporting

2.1 Geotechnical Report

The *Geotechnical Report* provided by the Designer or the Designer's Geotechnical sub-consultant shall be sealed by a Tennessee licensed professional engineer specializing in geotechnical engineering. The detailed structure and formatting for the *Geotechnical Report* is not specified herein.

However, the *Geotechnical Report* shall include discussion/presentation of the following items:

- Exploration's purpose and scope
- Pertinent project information
- Site geology/geologic hazards
- Site surface conditions
- Subsurface conditions including stratigraphy and groundwater
- Geotechnical considerations, i.e., site-specific geotechnical concerns for design and construction
- Geotechnical recommendations
- Appendices/supporting documents
- Site location plan
- Exploration location plan
- Prepared to a conventional scale or giving dimensioned locations of borings/test pits
- Boring logs
- Chart illustrating soil and rock classification criteria and the terminology and symbols used on the boring/test pit logs
- Laboratory test results – tabular and/or graphical, as appropriate
- Site photographs

The following additional supporting documents may be appropriate on a site-specific basis:

- Test pit logs
- Groundwater well logs
- Subsurface fence diagrams
- Photographs – rock core
- Geophysical or other sub-consultant report(s)
- Other documents/figures

2.1.1 Geotechnical Considerations

The Designer or the Designer's Geotechnical sub-consultant shall evaluate the data and information gathered during the exploration considering the proposed project's requirements and present a

discussion about site-specific geotechnical considerations for design and construction. Those considerations not applicable to a particular project shall be so noted in the report.

The *Geotechnical Report* shall address the applicable considerations listed below for every project.

- Undocumented fill
- Soft, loose, or otherwise potentially unstable soils (including unstable slopes)
- High plasticity clays/elastic silts
- Compressible soils
- Liquefiable soils
- Difficult excavation (debris fill, rock fill, hard soils, etc.)
- Deep excavations (sloping/shoring/sheeting/bracing/underpinning)
- Shallow rock
- Irregular top of rock
- Rock excavation
- Geologic hazards (caves, sinkholes, and other karst voids)
- Suitable foundation types
- Excessive predicted settlement
- Corrosive conditions (concrete and/or steel)
- Seasonal variations in groundwater levels
- High groundwater or design storm event (dewatering – temporary/permanent)
- Potential effects of weather and construction equipment on soil subgrades
- Other site-specific and/or project specific considerations as appropriate

2.1.2 Geotechnical Recommendations

The geotechnical recommendations necessary for design and construction will vary with project specifics. The Designer shall consider the following and provide recommendations in the *Geotechnical Report* as appropriate:

- Foundations
 - Bearing depth/elevation
 - Design recommendations
 - Compression loads
 - Tension loads
 - Lateral loads
 - Seismic loads
 - Minimum embedment for frost protection
 - Estimated foundation performance, i.e., settlement
 - Construction recommendations
- Foundation stability, i.e., work platform
- Slabs-on-grade
- Hydrostatic uplift

- Below-grade construction
 - Lateral earth pressures (static plus increase for seismic)
 - Wall backfill – compaction and other construction considerations
 - Wall drainage
- Slope stability
- Excavation sloping/shoring/sheeting/bracing/underpinning
- Excavation dewatering
- Cofferdams
- Subgrade Stabilization
- Permanent dewatering (foundations, slabs, pavements)
- Corrosion protection/mitigation
- Pavement section thickness
- Subgrade modulus for designing pavements by others
- Berm/levee evaluation
- Construction recommendations
 - Site preparation (including demolition if applicable)
 - Subgrade protection (weather, construction equipment)
 - Subgrade stabilization, including undercutting
 - Engineered fill
 - Material requirements
 - Placement and compaction requirements
 - Cut and fill slopes
 - Temporary groundwater control
 - Rock excavation – depth, methods
 - General construction recommendations
- Other site-specific and/or project specific considerations as appropriate

2.2 Data Management

Hard copies and electronic copies of reports and logs shall be delivered in accordance with this document. Additional requirements outlined in this Section are provided to facilitate MWS data management through populating a GIS database.

The GIS database is anticipated to include the following geotechnical information:

- Reports (*Geotechnical Reports, Geophysical Survey Reports, etc.*) will be linked to a site or survey area.
- Logs (boring logs, test pit logs, field testing reports, well and piezometer installation diagrams) will be linked to the respective individual exploration point location.

2.3 Exploration Location Plans

A plan graphically depicting boring and other exploration point locations (test pits, piezometers, wells, field testing, etc.) in relation to existing topographic and planimetric features shall be included in the *Geotechnical Report*. The topographic survey drawings developed by the Designer may be used as the basis for the plan. If a site survey is not readily available for a given site, the Designer or the Designer's Geotechnical sub-consultant should use the most recent digital aerial photography available from the Metropolitan Planning Commission as the basis for the boring location plan or other exploration point location plan. Each exploration location shall be identified using a symbol set unique to the plan set along with a unique identifier such as boring number, test pit number, etc. The plan must also identify the approximate site boundaries represented by the *Geotechnical Report*, but is not expected to meet Boundary Survey standards as prepared by a licensed Land Surveyor unless so stated in the project-specific contract.

The geophysical survey plan depicting the locations for site boundaries, arrays, or other survey units should be prepared using a base figure as noted above.

2.4 Site and Boring Coordinates

Latitude and longitude for all geotechnical exploration point locations (borings, test pits, field testing, etc.) and for the approximate centroid of exploration areas (such as the site represented by the *Geotechnical Report* or the geophysical survey area(s)) must be determined to the nearest meter using a GPS unit capable of sub-meter accuracy, traditional surveying, or other approved methods. All latitude and longitude coordinates are to be determined in accordance with the applicable standards addressed in other Manual sections.

2.5 Delivery of Geotechnical Data

Geotechnical data will be delivered in an electronic format to help manage the geotechnical information collected by the design team. The deliverables for a geotechnical exploration project are as follows:

2.5.1 *Geotechnical Report*

Hard copies and a PDF copy of the complete *Geotechnical Report* including text and all supporting documents (plans, logs, laboratory data, etc.) shall be provided per contract requirements. Sub-contractor reports completed as part of the geotechnical exploration may be included as an appendix to the *Geotechnical Report*.

A PDF copy of complete sub-contractor reports (such as *Geophysical Survey Reports*) shall be provided in addition to any reports provided as appendices to *Geotechnical Reports* as applicable.

2.5.2 Logs

Individual PDF files for each log (in addition to the logs included as part of the PDF report file) shall be submitted.

An Excel spreadsheet presenting the attribute data listed including file names for the individual PDF log files, and the latitude and longitude (in decimal degrees) for the site's approximate centroid, the *Geotechnical Report* date, and the PDF file name for the *Geotechnical Report* shall be provided.

2.5.3 Plans

When design or construction plans are contractually required, the plans shall be prepared in accordance with the CADD standards in this *Design Management Manual*.

Other deliverables may be required on a project-specific basis.