Appendix G

Work Plan for the Recommended Corrective Measure Alternative

DRAFT

Gude Landfill
Work Plan for the
Recommended Corrective Measure Alternative
Montgomery County, Maryland

Prepared for:

Department of Environmental Protection
Division of Solid Waste Services
Montgomery County, Maryland

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EA Project No. 1498201

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LIST OF ACRONYMS AND ABBREVIATIONS

ACM	Assessment of Corrective Measures
bgs	Below Ground Surface
BIW	Bioremediation Injection Well
BMP	Best Management Practice
CFR	Code of Federal Regulations
CGI	Combustible Gas Indicator
CMA	Corrective Measure Alternative
COMAR	Code of Maryland Regulations
cVOC	Chlorinated Volatile Organic Compound
DCE	Dichloroethene
DEP	Department of Environmental Protection
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
EA	EA Engineering, Science, and Technology, Inc.
EPA	U.S. Environmental Protection Agency
EVO	Emulsified Vegetable Oil
ft	Foot or Feet
G&SWMP	Groundwater and Surface Water Monitoring Plan
in.	Inch(es)
LEL	Lower Explosive Limit
MCL	Maximum Contaminant Level
MDE	Maryland Department of the Environment
mg/L	Milligram(s) Per Liter (equivalent to parts per million, ppm)
M-NCPPC	Maryland-National Capital Park and Planning Commission
MSDS	Material Safety Data Sheet
NAD	North American Datum
NAVD	North American Vertical Datum
NES	Nature and Extent Study
NTU	Nephelometric Turbidity Unit
ORP	Oxidation-Reduction Potential

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

PCE	Tetrachloroethene
PID	Photo-Ionization Detector
PQL	Practical Quantitation Limit
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
ROI	Radius of Influence
SOP	Standard Operating Procedure
v/v	Volume Per Volume
µg/L	Microgram(s) Per Liter (equivalent to parts per billion, ppb)

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1. PURPOSE

EA Engineering, Science, and Technology, Inc. (EA) has prepared this Work Plan for the Recommended Corrective Measure Alternative (CMA) for the Gude Landfill (the Landfill) located in Montgomery County, Maryland. The Work Plan is intended to accompany the Assessment of Corrective Measures (ACM) Report for the Landfill (EA 2013). The purpose of this report is to present a Work Plan for implementing remediation, conducting additional monitoring, and implementing appropriate controls at the Landfill, along with a general schedule of the planned work.

The following information is included in this Work Plan:

- Brief background and description of historical information presented in the Nature and Extent Study (NES) and Assessment of Corrective Measures (ACM) documents;
- Approach for remediating groundwater maximum contaminant level (MCL) exceedances, landfill gas migration, and non-stormwater discharges;
- Proposed field investigations;
- Methodologies to plan, design, implement, and monitor the recommended CMA technologies; and
- A general proposed schedule of activities for design and implementation of each remedial technology.

A discussion of the remediation approach for the Landfill is presented in the following sections of this Work Plan.

2. BACKGROUND

This section presents a brief background and description of historical information which is presented in detail within the NES (EA 2010) and ACM (EA 2013) documents.

2.1 SITE DESCRIPTION

2.1.1 Site Location and Overview

The Landfill is located at 600 East Gude Drive, Rockville, Maryland 20850. The site has road access at two (2) locations: East Gude Drive and Southlawn Lane.

The Landfill is currently owned and maintained by the County Department of Environmental Protection (DEP). The Landfill was used for the disposal of municipal solid waste and incinerator residues from 1964 to 1982. The Landfill property encompasses approximately one hundred sixty-two (162) acres, of which approximately one hundred forty (140) acres were used for waste disposal. An additional seventeen (17) acres of waste disposal area was delineated on Maryland-National Capital Park and Planning Commission (M-NCPPC) property, beyond the northeastern property boundary of the Landfill. A land exchange is currently in process between the County and M-NCPPC that will transfer ownership of this additional waste disposal area to the County in exchange for a similar area of land without waste to be transferred to M-NCPPC.

2.1.2 Site and Surrounding Area Land Use

The typical ground cover across the Landfill site is open grassy fields with patches of brushy vegetation and trees on most side slopes and along the perimeter borders of the Landfill. The existing landfill gas collection system, including the gas extraction system well heads and gas conveyance piping, is situated above-grade on the Landfill's ground surface. The site also has a limited area on the top of the Landfill that is currently designated for flying model airplanes and a concrete pad near the Southlawn Lane facility entrance road that is used for managing storm-related debris.

The surrounding area and properties adjacent to the Landfill have mixed uses including parkland, industrial property, and residential development. Specifically, the adjacent land areas consist of:

- M-NCPPC land and Crabbs Branch Stream (north by northeast).

- Asphalt and cement production facilities, equipment storage yards, scrap metal recycling facilities, and Southlawn Lane (east by southeast).

- East Gude Drive, Washington Suburban Sanitary Commission (WSSC) property and Southlawn Branch Stream (southwest by south by southeast).

- Transcontinental (Williams Gas)/Columbia Gas natural gas pipeline right-of-way and the community of Derwood Station residential development (west by northwest).

2.1.3 Site History

The Landfill was initially permitted by the County in 1963. The Landfill was subsequently operated and closed under several facility names and refuse disposal permits from 1964 to 1982. The facility name of the Gude-Southlawn Landfill was modified by reference to the Gude Landfill. There is no current refuse disposal permit that is applicable to the Landfill.

The Landfill was constructed and operated prior to modern solid waste management disposal and facility design and closure standards that were implemented by the U.S. Environmental Protection Agency (EPA), under the Resource Conservation and Recovery Act (RCRA). Therefore, the Landfill was not originally constructed with a geosynthetic liner or compacted clay bottom liner, a leachate collection system, a landfill gas collection system, or a stormwater management system. Reportedly, soil was used as daily cover during waste filling, and a two (2) foot (ft) (minimum) final layer of soil was reportedly placed over the waste mass during closure of the Landfill (in 1982) to support the vegetative cover.

Since 1982, the County has voluntarily, or through regulatory mandates, implemented and maintained Best Management Practices (BMPs) for pre-regulatory era landfills to ensure compliance with Code of Maryland Regulations (COMAR) requirements. These BMPs include: soil and vegetative cover system installation, cover system maintenance, leachate seep repairs, landfill gas collection system installation and maintenance, water quality and landfill gas monitoring, and stormwater infrastructure improvements. The County currently maintains an active landfill gas collection system including: flares, a gas-to-energy system, over one hundred (100) gas extraction wells, and horizontal gas conveyance piping. A network of on-site and off-site groundwater monitoring wells; a network of on-site landfill gas monitoring wells; environmental monitoring programs for groundwater, surface water, and landfill gas; and stormwater management infrastructure are also maintained at and for the Landfill site.

2.2 SITE ENVIRONMENTAL SETTING

2.2.1 Topography

The site topography of the Landfill is plateau-like and consists of gentle relief (i.e., slope) along the top of the waste-mass and sharp relief along the perimeter property boundary. The elevation along the top of the plateau gently slopes to the south, with localized mounds and depressions throughout. The side-slope falls sharply from the top of the waste-mass to elevations ranging from fifty-five (55) to ninety (90) ft below the plateau.

A general summary of approximate topographic elevations across the Landfill measured to the toe of slope of the waste mass and/or drainage areas as applicable (including the property with waste encroachment that is owned by M-NCPPC) are provided in the ACM Report.

2.2.2 Geology

The Landfill is located in central Montgomery County, Maryland, within the upland section of the Piedmont Plateau physiographic province (Maryland Geological Survey 1968, Trapp and Horn 1997). The geology in the upland section of the Piedmont Plateau physiographic province primarily consists of metamorphic and igneous rock formations of Paleozoic and Precambrian age. The Piedmont Plateau is underlain by an assortment of phyllite, slate, marble, schist, gneiss, and gabbro formations. Unconsolidated material overlying bedrock is present at the surface in the vicinity of the Landfill site and extends twenty (20) to sixty (60) ft below ground surface (bgs). Based on available groundwater monitoring well construction logs from ATEC Associates Inc. (1988) and more recent boring logs (EA 2010 and 2011), the unconsolidated material consists primarily of silt and clay.

2.2.3 Hydrogeologic Setting

The uplands section of the Piedmont is underlain by three (3) principle types of bedrock aquifers: crystalline-rock and undifferentiated sedimentary-rock aquifers, aquifers in early Mesozoic basins, and carbonate-rock aquifers (Trapp and Horn 1997). The Landfill is underlain by the crystalline rock aquifer that extends over approximately eighty-six (86) percent of the Piedmont Plateau Physiographic Province. At the Landfill, the crystalline rock that comprises the regional aquifer is overlain by unconsolidated material consisting of interbedded silts and clays and saprolite. Recorded logs from on-site and off-site borings for the groundwater monitoring wells correlated well with these general geological descriptions.

Based on information from site boring logs and well gauging, groundwater is present in the unconsolidated material, as well as the bedrock at the Landfill site. The groundwater table is typically present in the unconsolidated material along the perimeter of the Landfill and under the Derwood Station development, at depths ranging from approximately three (3) to sixty (60) ft bgs. Groundwater recharge at the Landfill is variable and is primarily determined by precipitation and runoff. Topographic relief, unconsolidated material, and surface recharge variations created by the Landfill may significantly affect the groundwater flow.

Groundwater flow is highly dependent on the composition and grain size of the sediments, and therefore water likely moves more readily in the unconsolidated material than in the underlying bedrock. Groundwater in the bedrock (typically twenty [20] to sixty [60] ft below grade) is stored in, and moves through, fractures. No documentation of the degree of fracturing or orientation of bedrock fractures at the Landfill is available.

The site topography and the natural cover system (grassy surface and soil layer) of the Landfill make surface water infiltration likely. Some of the infiltrating water likely moves vertically into the bedrock, while a portion also moves laterally along the boundary between the unconsolidated material and the surface of the bedrock and discharges to nearby streams and surface depressions.

Geologic cross-sections of the Landfill area, showing the subsurface geology and the relative depths of unconsolidated material, bedrock, and groundwater, are presented in the ACM Report.

2.2.4 Groundwater Flow

Based on the data collected from new and existing groundwater monitoring wells, including temporary groundwater monitoring wells, and the stream gauge locations (from the NES Amendment No. 1 [EA 2011]), the groundwater flow direction was inferred. The data indicated that groundwater flows in an easterly flow direction across the Landfill site, with minor northerly, northeasterly, and southeasterly flow components. The stream gauge data of surface water elevations were consistent with groundwater table elevations from adjacent groundwater monitoring wells and locations, indicating a hydraulic connection between groundwater and surface water. The above referenced data collection locations and the inferred groundwater flow contours have been overlain on the site topographic map, and are presented in Figure 1-5 of the ACM Report.

2.3 ASSESSMENT OF CORRECTIVE MEASURES

The ACM Report was prepared for the Landfill in accordance with the specific requirements set forth under Title 40 Code of Federal Regulations (CFR) § 258.56 and the general requirements of the Maryland Department of the Environment (MDE) for regulating solid waste disposal facilities under COMAR to recommend a CMA that addresses the following:

- Reported concentrations exceeding MCLs, established by EPA as limits for drinking water, for volatile organic compounds (VOCs) and other groundwater impacts at and beyond the Landfill property boundary per the COMAR 26.08.02. The constituents identified in the NES Amendment No. 1 for the Landfill (EA 2011) as groundwater impacts, based on MCL exceedances in 2011, include cadmium, 1,1-dichloroethene (DCE), cis-1,2-DCE, 1,2-dibromoethane, 1,2-dichloropropane, benzene, methylene chloride, tetrachloroethene (PCE), trichloroethene (TCE), vinyl chloride (VC), and nitrate.

- Intermittent exceedances of the lower explosive limit (LEL) for methane gas at the Landfill property boundary (per COMAR 26.04.07.03B(9)).

- Occurrences of non-stormwater discharges (e.g., leachate seeps) at the Landfill property boundary (per COMAR 26.08.04.08).

2.3.1 Recommended Corrective Measure Alternative

Based on the results of the evaluation presented in the ACM Report, the recommended CMA is Alternative 5, Additional Landfill Gas Collection and Cover System Improvements with Enhanced Bioremediation. This CMA includes the following components:

- Additional Landfill Gas Collection in the Northwest, West, and Southwest Areas.

- Cover System Improvements in the Northwest and West Areas.

- Enhanced Bioremediation in the Northwest, West, Southwest, South, and Southeast Areas.

An improved soil cover system was selected as a corrective measure for the existing side-slopes of the Landfill primarily to decrease the occurrence of leachate seeps. It is anticipated that the additional landfill gas extraction wells would be installed after the cover system improvements, to provide control over gas migration along the property boundary that leads to LEL exceedances. Enhanced Bioremediation was proposed as the primary technology to treat groundwater impacts exceeding MCLs. In addition to these remedial technologies, the ACM Report recommended that approximately seven (7) new groundwater monitoring wells be installed along the property boundary to enable additional monitoring of groundwater impacts during remediation.

Enhanced Bioremediation will be conducted using a phased approach, as described in the ACM Report, starting with a subsurface assessment and a pilot study to determine the optimal parameters for the full-scale system. The subsurface assessment is proposed to include installation of four (4) injection wells, which will be used for testing to characterize the aquifer. The results of these investigations will be used to design a pilot study. Electron donor and pH buffer (and bacterial cultures if required) will be injected into eight (8) pilot injection wells, and the downgradient groundwater will be monitored. A full-scale bioremediation system will then be designed based on the results of the subsurface investigations and pilot studies. Additional subsurface investigations are also planned as the bioremediation system is expanded around the landfill.

3. ENHANCED BIOREMEDIATION

As described in Section 2.3.1, Enhanced Bioremediation will be performed utilizing a phased approach. The phased approach will allow for the optimization of the remedial design and define contingencies in the event Enhanced Bioremediation is not as effective as anticipated for this site.

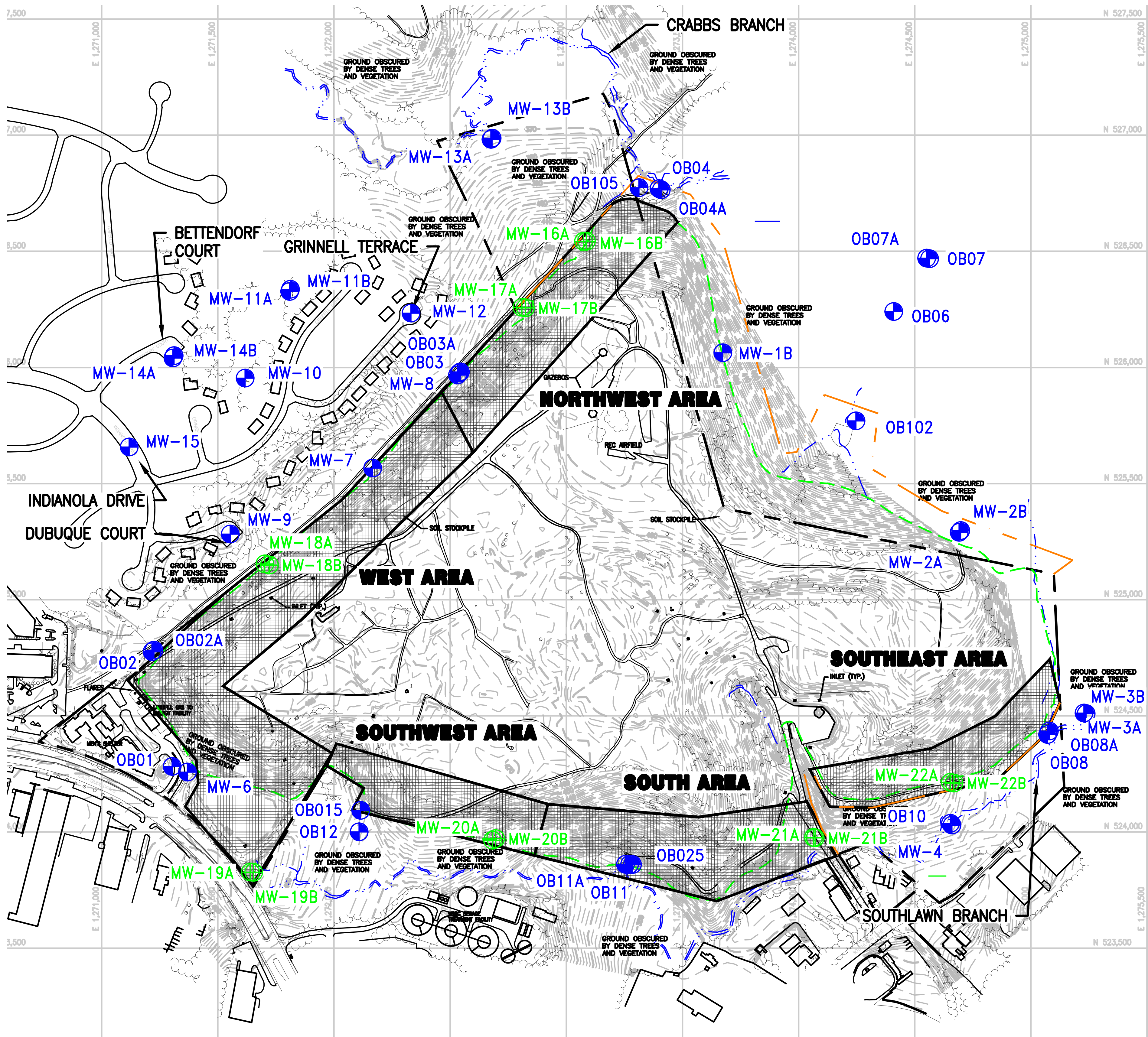
3.1 PRE-INVESTIGATION ACTIVITIES

Prior to initiating investigative activities proposed in this Work Plan, a health and safety plan will be prepared and well permits, construction permits, utility clearance, and right-of-entry for off-site locations will be obtained. A Maryland licensed well driller will obtain well permits for proposed monitoring wells. The well permits will be submitted to EA prior to mobilization to the site for installation of the wells.

EA will contact Miss Utility and will coordinate utility clearance to be conducted by a private utility locator in areas of proposed excavation. The utility contractor will utilize electro-magnetic or other detection methods to sense the presence of subsurface utilities and mark the horizontal location of utilities on the ground surface.

3.2 MONITORING WELL INSTALLATION AND SAMPLING PROGRAM

Current groundwater monitoring well spacing is approximately one thousand (1,000) ft between groundwater monitoring wells. Additional monitoring wells are to be installed to improve groundwater monitoring during implementation of the CMA. A total of seven (7) groundwater monitoring well shallow and deep pairs (fourteen [14] total groundwater monitoring wells) are proposed (**Figure 3-1**), which will result in approximately five hundred (500) ft spacing between wells. Access along the property boundary of the Landfill (where additional groundwater monitoring wells are required) is limited, due to steep slopes and thick vegetation; therefore, site clearing and road construction may be required in association with the well installation activities. The wells will have screened intervals that are twenty (20) to thirty (30) ft long (**Figure 3-2**). The annular space of each well will be packed with #2 morie gravel pack and sealed with bentonite and cement at the surface. The wells will be completed with a steel protective stickup and concrete pads. The new groundwater monitoring wells will be developed by standard surging or pumping techniques until the water is free of sediment.



N

NOTES:

1. TOPOGRAPHY COMPILED BY APPLIED MAPPING SOLUTIONS, INC. USING PHOTOGRAMMETRIC METHODS WITH PHOTOGRAPHY DATED 06/24/09 AND SUPPLEMENTED WITH FIELD SURVEY PERFORMED BY C.C. JOHNSON & MALHOTRA, P.C., OCTOBER 2009.
2. HORIZONTAL DATUM IS NORTH AMERICAN DATUM OF 1983/91 (NAD-83/91). COORDINATE SYSTEM IS MARYLAND STATE PLANE, U.S. SURVEY FEET. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD-88) WITH ELEVATIONS SHOWN IN FEET.
3. TOPOGRAPHY IS APPROXIMATE IN AREAS NOTED "GROUND OBSCURED BY DENSE TREES AND VEGETATION".
4. MONTGOMERY COUNTY IS CURRENTLY IN NEGOTIATIONS WITH M-NCPPC TO EXCHANGE TWO PARCELS OF LAND (LOCATED TO THE NORTH AND SOUTHEAST OF THE GUDE LANDFILL) FOR PROPERTY TO THE NORTHEAST. THE FUTURE PROPERTY BOUNDARY LINE REPRESENTS THE AGREED UPON PROPERTY BOUNDARY FOR THE GUDE LANDFILL FOLLOWING THE PROPERTY EXCHANGE. THE FUTURE PROPERTY BOUNDARY WAS ESTABLISHED WITH PERMANENT PROPERTY BOUNDARY MARKERS AND SURVEYED BY C.C. JOHNSON AND MALHOTRA, P.C. IN MAY 2012.

LEGEND

400	10-FT CONTOUR
	2-FT CONTOUR
	CURRENT PROPERTY BOUNDARY
	FUTURE PROPERTY BOUNDARY
	LIMIT OF WASTE
	STREAM
	TREELINE
MW-X/OBX	GROUNDWATER MONITORING WELL
MW-X	PROPOSED GROUNDWATER MONITORING WELL
	APPROXIMATE REMEDIATION AREAS FOR CORRECTIVE MEASURE ALTERNATIVES ANALYSIS

500 250 0 500 1000

GRAPHIC SCALE IN FEET

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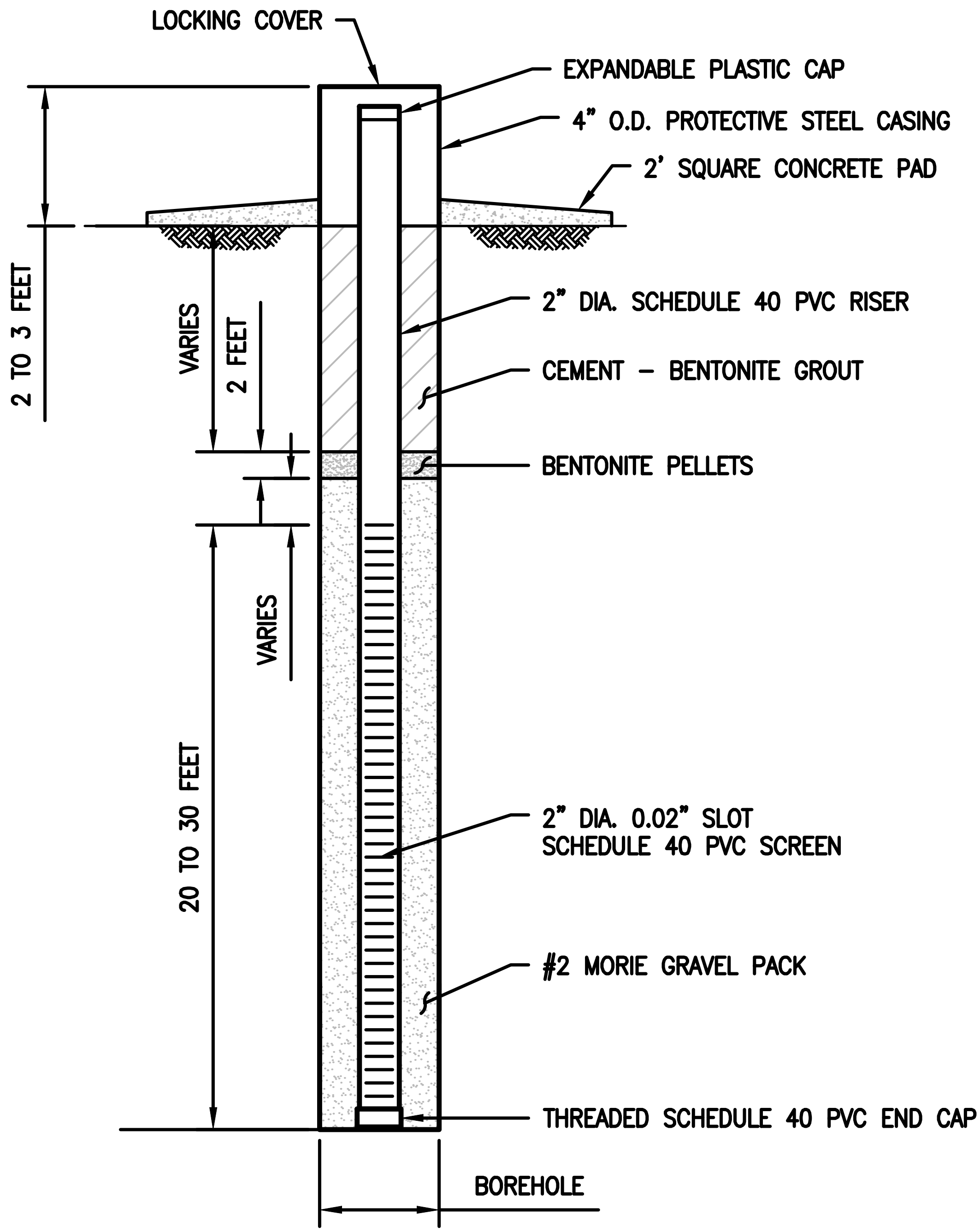
FILE PATH: Q:\PROJECTS\1498201 GUDE PHASE 2 ACM\FIGURES\WORK PLAN\FIG 3-2.DWG [LAYOUT1] 10/14/13

EA ENGINEERING, SCIENCE, AND TECHNOLOGY

GUDE LANDFILL
RECOMMENDED CMA WORK PLAN
MONTGOMERY COUNTY, MARYLAND

FIGURE 3-1
PROPOSED MONITORING WELL LOCATION MAP

DESIGNED BY	DRAWN BY	DATE	PROJECT NO.
PL	JSP	OCT. 2013	14982.01
CHECKED BY	PROJECT MGR.	DRAWING NO.	FIGURE
BR	MJG	–	3-1



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EA ENGINEERING, SCIENCE, AND TECHNOLOGY

GUDE LANDFILL
RECOMMENDED CMA WORK PLAN
MONTGOMERY COUNTY, MARYLAND

FIGURE 3–2
PROPOSED MONITORING WELL DETAIL

PROJECT MGR	DESIGNED BY	DRAWN BY	CHECKED BY	SCALE	DATE	PROJECT NO	FIGURE
MJG	LJO	JAP	BR	–	OCT. 2013	14982.01	3–2

FILE PATH: Q:\PROJECTS\1498201 GUDE PHASE 2 ACM\FIGURES\WORK PLAN\FIG 3–2.DWG [LAYOUT1] 10/10/13

The installation of the groundwater monitoring wells will be completed in accordance with the MDE "Specifications for the Design and Construction of Groundwater Monitoring Wells at Solids Waste Disposal Facilities" included in **Appendix A**. During completion of the monitoring well boreholes, soil sampling will be conducted via continuous split-spoon samples collected until sample refusal is encountered or to a depth of thirty (30) ft bgs (average depth to consolidated rock). The EA Soil Sampling Standard Operating Procedure (SOP) is provided in **Appendix B**. Soil samples will be inspected for geologic classification, and photo-ionization detector (PID) readings will be recorded to assess organic vapor concentrations. The PID will be calibrated daily according to manufacturer specifications. A detailed log of PID calibration results will be maintained by field personnel. A combustible gas indicator (CGI) will be used to monitor the work area for health and safety purposes. The CGI will be calibrated daily according to manufacturer specifications. A detailed log of CGI calibration results will be maintained by field personnel. After well installation is complete, the location and top of casing elevation of each of the groundwater monitoring wells will be surveyed by a licensed surveyor in the State of Maryland. The horizontal survey datum will be North American Datum (NAD) 83, the vertical datum will be (North American Vertical Datum) NAVD 88, and the coordinate system will be Maryland State Plan (feet).

3.2.1 Well Development

Well development of the newly constructed groundwater monitoring wells will occur subsequent to the installation of the new groundwater monitoring wells. The groundwater in the monitoring wells will be developed by overpumping. A two (2)-inch (in.) stainless steel submersible pump, or similar (without a foot or check valve), will be lowered into the well screen and pumped at a rate that exceeds the recharge capacity of the well. The pump will be alternated on and off to allow for backwashing of the borehole with water from the plumbing. A surge block will also be used to agitate and mobilize sediment around the well screen. Pumping and surging will be continued until at least three (3) to five (5) well volumes have been purged and there is low turbidity in the discharge water (less than ten [10] nephelometric turbidity units [NTUs] and clear to the unaided eye). Turbidity, pH, and temperature will be measured and recorded on the Well Development Log for each well. If low turbidity water is not present after two (2) hours, pumping will end. Water produced during well development will be containerized and disposed as referenced in Section 3.2.3.

3.2.2 Well Volume Calculations

Static water level will be measured immediately prior to purging each groundwater monitoring well. After unlocking the well and removing the cap, a decontaminated water level indicator will be placed into the well to measure the depth to the static water level and total depth of the well. The measurement will be recorded to the nearest one-hundredth (0.01) ft and will be measured from a clearly marked reference point at the top of the well casing. The water column height is calculated from the difference between the total well depth measurement and the static water level measurement. The well volume per foot (in gallons) can be equated based on the diameter of the well casing (in inches). The total well volume is determined from the product of the water column height for the well and the well volume per foot (based on the diameter of the well casing).

3.2.3 Groundwater Monitoring and Sampling Program

After the installation and development of the groundwater monitoring wells, groundwater sampling will be conducted at the fourteen (14) new groundwater monitoring wells. Prior to sampling, the wells will be undisturbed for a minimum period of two (2) weeks to allow for equilibration with subsurface conditions. The groundwater monitoring event will consist of groundwater gauging of both the existing and newly installed groundwater monitoring wells and sampling of the new groundwater monitoring wells.

In addition, groundwater and/or perched liquid within the landfill gas extraction wells within the area of the pilot study will be gauged to aid in defining groundwater flow direction in areas where waste is present.

Field activities to be completed during the groundwater sampling events include measurement of water levels and water quality parameters, well purging, and collection of groundwater samples from each well. Well sampling information (including well depth, purge volume, and water quality parameters) will be recorded on Groundwater Sampling Logs.

The monitoring wells will be sampled in accordance with the County’s current approved Groundwater and Surface Water Monitoring Plan (G&SWMP). Sampling will be conducted using the methods described below.

- A physical inspection will be performed and observations will be noted on the Groundwater Sampling Log before sampling begins.

- The static water level in the monitoring well will be determined to the nearest one-hundredth (0.01) ft using a decontaminated water level indicator probe.

- Purging will be accomplished by pumping with a stainless steel submersible pump or by a certified, pre-cleaned bottom-filling Teflon bailer. The volume to be purged is a minimum of three (3) static casing volumes. Purge water will be containerized in fifty-five (55)-gallon drums.

- A minimum of fifteen (15) minutes will be allowed for well recovery before sampling.

- Samples will be collected using dedicated tubing and filling sample containers from the pump discharge, allowing the water to fill the containers by allowing the pump discharge to flow gently down the inside of the container with as little agitation or aeration as possible.

- Temperature, pH, conductivity, turbidity, dissolved oxygen (DO), and oxygen-reduction potential (ORP) will be measured in the field.

Upon completion of sampling, the submersible pump will be removed from the well and the tubing disposed as municipal waste. The necessary entries on the chain-of-custody form will be completed. The labeled and filled sample containers will be immediately placed into an iced cooler with bubble wrap or vermiculite to prevent breakage. At the end of the sampling day, the chain-of-custody form will be placed in a waterproof plastic bag and taped to the inside lid of the cooler. The purge water, containerized in fifty-five (55)-gallon drums will be transported to the leachate treatment plant at the County's Oaks Landfill. Decontamination, sample labeling, chain-of-custody documentation and sampling packing/shipping will be conducted in accordance with the County's current approved G&SWMP. Samples will be submitted for the laboratory analyses shown in **Table 3-1**.

Table 3-1. Monitoring Parameters.

Analyte	**Method**	**PQL**
Volatile Organic Compounds		**(µg/L)**
Acetone	8260B	5
Acrylonitrile	8260B	5
Benzene	8260B	1
Bromochloromethane	8260B	1
Bromodichloromethane	8260B	1
Bromoform	8260B	1
Bromomethane	8260B	1
2-Butanone	8260B	5

Analyte	Method	PQL
Carbon disulfide	8260B	1
Carbon tetrachloride	8260B	1
Chlorobenzene	8260B	1
Chloroethane	8260B	1
Chloroform	8260B	1
Chloromethane	8260B	1
Dibromochloromethane	8260B	1
1,2-Dibromo-3-chloropropane	8260B	1
1,2 – Dibromoethane (EDB)	8260B	1
Dibromomethane	8260B	1
1,2 – Dichlorobenzene	8260B	1
1,4 – Dichlorobenzene	8260B	1
Trans-1,4-dichloro-2-butene	8260B	5
1,1-Dichloroethane	8260B	1
1,2-Dichloroethane	8260B	1
1,1-Dichloroethene	8260B	1
Cis-1,2-Dichloroethene	8260B	1
Trans-1,2-Dichloroethene	8260B	1
Methylene chloride	8260B	1
1,2-Dichloropropane	8260B	1
Trans-1,3-Dichloropropene	8260B	1
Cis-1,3-Dichloropropene	8260B	1
Ethylbenzene	8260B	1
2-Hexanone	8260B	5
Iodomethane	8260B	1
4-Methyl-2-pentanone	8260B	5
Methyl Tertiary Butyl Ether	8260B	2
Styrene	8260B	1
1,1,1,2-Tetrachloroethane	8260B	1
1,1,2,2-Tetrachloroethane	8260B	1
Tetrachloroethene	8260B	1
Toluene	8260B	1
1,1,1-Trichloroethane	8260B	1
1,1,2-Trichloroethane	8260B	1
Trichloroethene	8260B	1
Trichloroflouromethane	8260B	1
1,2,3-Trichloropropane	8260B	1

Analyte	Method	PQL
Vinyl acetate	8260B	1
Vinyl chloride	8260B	1
Xylene	8260B	1
Metals and Indicator Parameters		**(mg/L)**
Total Antimony	EPA 200.8 Rev 5	0.002
Total Arsenic	EPA 200.8 Rev 5	0.002
Total Barium	EPA 200.8 Rev 5	0.01
Total Beryllium	EPA 200.8 Rev 5	0.002
Total Cadmium	EPA 200.8 Rev 5	0.004
Total Chromium	EPA 200.8 Rev 5	0.01
Total Calcium	EPA 200.8 Rev 5	0.08
Total Cobalt	EPA 200.8 Rev 5	0.01
Total Copper	EPA 200.8 Rev 5	0.01
Total Iron	EPA 200.8 Rev 5	0.005
Total Lead	EPA 200.8 Rev 5	0.002
Total Nickel	EPA 200.8 Rev 5	0.011
Total Magnesium	EPA 200.8 Rev 5	0.004
Total Manganese	EPA 200.8 Rev 5	0.01
Total Mercury	EPA 245.2	0.0002
Total Potassium	EPA 200.8 Rev 5	0.39
Total Selenium	EPA 200.8 Rev 5	0.035
Total Silver	EPA 200.8 Rev 5	0.01
Total Sodium	EPA 200.8 Rev 5	0.2
Total Thallium	EPA 200.8 Rev 5	0.002
Total Vanadium	EPA 200.8 Rev 5	0.01
Total Zinc	EPA 200.8 Rev 5	0.01
pH	Field	0.1 (SU)
Alkalinity	EPA 310.2 /SM 2320B	1
Hardness	EPA 200.8 Rev 5	0.5
Chloride	SM 4500Cl-E	0.39
Specific conductance	EPA 120.1	1
Nitrate	SM 4500 NO3-N	0.06
Chemical oxygen demand	EPA 410.4	10
Turbidity	EPA 180.1	0.11 (NTU)
Ammonia	EPA 350.1	1
Sulfate	SM 4500 SO4-D	0.38
Total dissolved solids	SM20-2540 C	10

3.3 PHASE 1 – SUBSURFACE ASSESSMENT

Following the installation of the additional groundwater monitoring wells, a subsurface verification assessment for the Enhanced Bioremediation system is recommended prior to pilot implementation to further assess the site-specific performance of bioremediation in this fractured rock aquifer. The assessment will include installing four (4) bioremediation injection wells (BIWs) (BIW-1 through -4) through the waste material (**Figure 3-3**). Existing monitoring wells MW-8, OB03, and OB03A will be utilized in the assessment to verify aquifer dynamics and groundwater flow for the pilot operation of the bioremediation system.

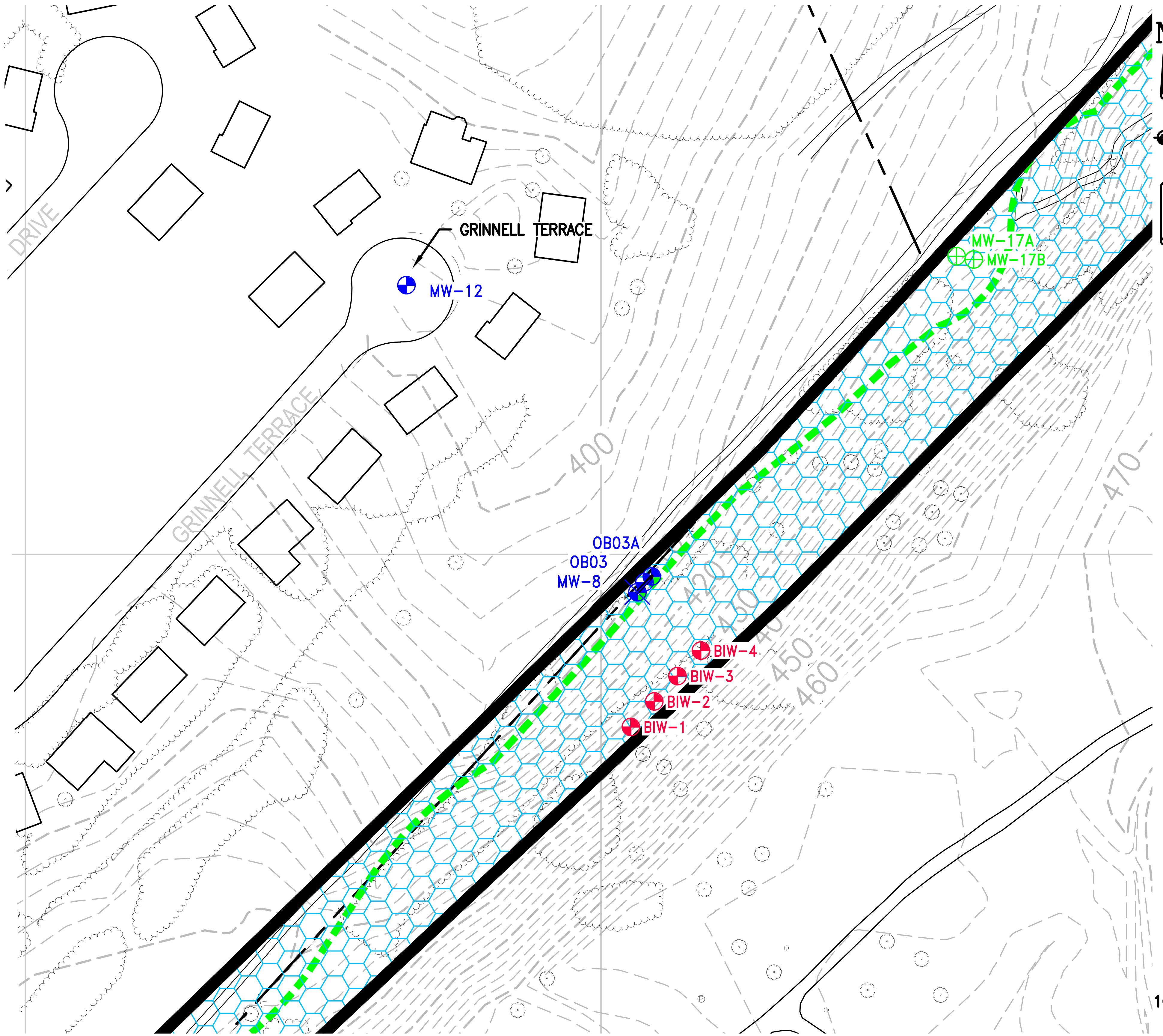
The work related to the field investigations will include:

- Installing BIW-1 through -4;
- Microbial testing;
- Conducting downhole geophysics to confirm bedrock lithology, orientation of bedding planes and fractures, and groundwater flow;
- Conducting groundwater packer testing to assess vertical groundwater quality in major fracture sets; and
- Conducting a groundwater tracer test to verify interconnectivity of the fractures and groundwater flow velocities.

3.3.1 Bioremediation Injection Well Installation

All areas where BIWs will be installed must be cleared and made accessible prior to well installation. Some BIWs may be installed on the landfill side-slopes, in order to provide space for biodegradation between the injection wells and the property boundary point of compliance, while also meeting RAOs in an acceptable timeframe. In these cases, benches may be built on the slope of the landfill to accommodate permanent access roads for use during well installation as well as during future injections and monitoring of wells. The BIWs will be installed on the flat surfaces along the sides of the access road. The BIWs would be installed immediately following Cover System Improvements in the pilot testing area.

Based on the monitoring well screen depths at OB03, the groundwater impacted with chlorinated volatile organic compound (cVOC) is present at depths up to one hundred fifty (150) ft bgs;



NOTES:

1. TOPOGRAPHY COMPILED BY APPLIED MAPPING SOLUTIONS, INC. USING PHOTOGRAMMETRIC METHODS WITH PHOTOGRAPHY DATED 06/24/09 AND SUPPLEMENTED WITH FIELD SURVEY PERFORMED BY C.C. JOHNSON & MALHOTRA, P.C., OCTOBER 2009.
2. HORIZONTAL DATUM IS NORTH AMERICAN DATUM OF 1983/91 (NAD-83/91). COORDINATE SYSTEM IS MARYLAND STATE PLANE, U.S. SURVEY FEET. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD-88) WITH ELEVATIONS SHOWN IN FEET.
3. MONTGOMERY COUNTY IS CURRENTLY IN NEGOTIATIONS WITH M-NCPPC TO EXCHANGE TWO PARCELS OF LAND (LOCATED TO THE NORTH AND SOUTHEAST OF THE GUDE LANDFILL) FOR PROPERTY TO THE NORTHEAST. THE FUTURE PROPERTY BOUNDARY LINE REPRESENTS THE AGREED UPON PROPERTY BOUNDARY FOR THE GUDE LANDFILL FOLLOWING THE PROPERTY EXCHANGE. THE FUTURE PROPERTY BOUNDARY WAS ESTABLISHED WITH PERMANENT PROPERTY BOUNDARY MARKERS AND SURVEYED BY C.C. JOHNSON AND MALHOTRA, P.C. IN MAY 2012.
4. MCL = MAXIMUM CONTAMINANT LEVEL. AREAS OF MCL EXCEEDANCES ALONG THE PROPERTY BOUNDARY ARE BASED ON THE OVERALL MCL COMPLIANCE EXTENT MAP" (APRIL AND SEPTEMBER 2011 SAMPLING EVENTS) FROM THE NATURE AND EXTENT STUDY AMENDMENT NO. 1 (2012), WITH MODIFICATIONS TO ALIGN WITH THE PROPOSED FUTURE PROPERTY BOUNDARY.

LEGEND

400	10-FT CONTOUR
	2-FT CONTOUR
	CURRENT PROPERTY BOUNDARY
	FUTURE PROPERTY BOUNDARY
	LIMIT OF WASTE
	STREAM
	TREELINE
MW-X/OBX	GROUNDWATER MONITORING WELL
BIW-X	PROPOSED BIOREMEDIATION INJECTION WELL
MW-X	PROPOSED GROUNDWATER MONITORING WELL
	APPROXIMATE AREAS OF CONCERN FOR GROUNDWATER BASED ON MCL EXCEEDANCES

100 50 0 100 200
GRAPHIC SCALE IN FEET

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EA ENGINEERING, SCIENCE, AND TECHNOLOGY

GUDE LANDFILL
RECOMMENDED CMA WORK PLAN
MONTGOMERY COUNTY, MARYLAND

FIGURE 3-3
PHASE 1 BIOREMEDIATION
INJECTION WELL LOCATION MAP

DESIGNED BY	DRAWN BY	DATE	PROJECT NO.
PL/LJO	JSP	OCT. 2013	14982.01
CHECKED BY	PROJECT MGR.	DRAWING NO.	FIGURE
BR	MJG	-	3-3

FILE PATH: Q:\PROJECTS\1498201 GUDE PHASE 2 ACM\FIGURES\WORK PLAN\FIG 3-3.DWG [LAYOUT1] 10/14/13

therefore, the proposed BIWs will be consistent with that depth. Final well depths of the pilot BIWs will be based on the verification assessment results after consultation with MDE.

Data regarding the subsurface within the landfill footprint is limited and, therefore, there are several conditions which are anticipated. Possible conditions that may be encountered when drilling through the landfill include the following progression from the top of the surface to the bottom of each borehole:

1. Cover soil, waste, overburden, competent bedrock
2. Cover soil, waste, overburden, weathered bedrock (saprolite), competent bedrock
3. Cover soil, waste, competent bedrock
4. Cover soil, waste, weathered bedrock (saprolite), competent bedrock

These subsurface conditions may also vary for each of the areas where Enhanced Bioremediation is to occur. As a result, during the remedial design, several well construction scenarios will be developed to address the groundwater cVOC concentrations within the overburden and bedrock.

For the BIWs, the first well in each area will serve as a pilot borehole that will be drilled through the waste and overburden to a minimum of one (1) foot into competent bedrock. A steel outer casing will be placed into the borehole and advanced to a minimum of one (1) foot into competent bedrock. This outer casing will ensure that waste materials are isolated from the BIWs and that there is no potential for preferential pathways created by the BIWs installed through the waste. The outer casing will be grouted in place via tremie pipe using a neat cement, cement/bentonite, cement/sand, or a thirty (30) percent solids bentonite grout to the ground surface. The grout will be pumped into the annular space between the outer casing and the borehole wall. The size of the outer casing will be of sufficient inside diameter to contain the inner PVC casing, and the required two (2)-inch minimum annular space. The grout will be allowed to cure for a minimum of twenty-four (24) hours before continuing the boring for completion of the BIWs. Waste removed from the well construction will be buried onsite in a location approved by MDE.

After the grout has cured for at least twenty-four (24) hours, a borehole will be drilled through the steel casing and below the casing into competent bedrock using hollow stem, air rotary or mud rotary techniques into the competent bedrock. A qualified geologist will oversee the drilling process, noting and documenting any abrupt changes or anomalies in the air pressure, depth(s) of low or lost circulation, drill-cutting description, and any other pertinent information. The geologist will observe water return and progress of rods to assess the location of water-bearing fractures. Once drilling has reached the target depth, the bit will be lifted slightly off the bottom of the borehole to facilitate drill-cutting removal. Air or mud circulation will cease and the bit will be lowered to the bottom of the borehole to determine total depth. The inner casing will be installed to the appropriate depths with screened intervals located at the target treatment depths below the waste. The detailed design of the potential BIW configurations will be based on the possible subsurface conditions and will be refined based on the first pilot borehole in each area. The BIWs will be designed to treat groundwater within overburden layer and/or within the bedrock depending on the location of the wells and depth of groundwater impacts detected in previous sampling events.

All wells will be installed with a locking and secured protective cover, properly labeled with the MDE-issued well permit tag, and constructed concrete pad around the base of each stick-up well casing. The drill rig and associated reusable equipment used for well installation will be decontaminated prior to each use. Well development will be performed to remove particles of rock (from gravel to clay-size) from water-bearing fractures in the open-rock borehole. The development water will be containerized in fifty-five (55)-gallon drums and will be transported to the leachate treatment plant at the County's Oaks Landfill. BIW horizontal locations and top of casing elevations will be surveyed by a licensed Maryland surveyor.

3.3.2 Microbial Sampling

As cVOC daughter products have been reported in the groundwater samples collected, there is evidence that the microbe *Dehalococcoides* is present at the site, as this species of bacteria is highly specialized for organochlorine respiration. However, the population size and the presence of the VC reductase gene have not been assessed. Groundwater samples from existing groundwater monitoring wells OB03, OB03A, and MW-8 will be collected for molecular analyses to assess whether bioaugmentation is required.

3.3.3 Downhole Geophysical Logging

To further assess the bedrock lithology, orientation of bedding planes and fractures, and groundwater flow within the borehole, downhole geophysical logging will be conducted on the four (4) BIWs and may include:

- Acoustic Televiewer
- Heat-Pulse Flow Meter (ambient)
- Fluid Conductivity/Temperature
- Caliper Log

- Electric Logs
- Natural Gamma
- Single Point Resistance
- 16-64 Normal Resistivity
- Spontaneous Potential

The results of the downhole geophysical investigation will also be used to verify the orientation of the primary groundwater flow direction within the fractures whether they are generally perpendicular to the proposed bioremediation system. If it is observed that the fracture orientation is generally parallel to the proposed bioremediation system orientation, then the bioremediation system design will be modified accordingly. The results of the downhole geophysical logging will also assist in identifying select fracture zones for groundwater sampling using packer assemblies.

3.3.4 Groundwater Packer Testing

Packer tests will be conducted at select fracture intervals in the four (4) initial BIWs to assess the vertical distribution of cVOCs.

Groundwater sampling using packer assemblies will be performed by using a straddle packer apparatus (double packers) to isolate the selected fractures from other fractures. It is anticipated that approximately four (4) to six (6) intervals will be sampled from each of the four (4) BIWs. Therefore, sixteen (16) to twenty-four (24) groundwater samples will be submitted for laboratory analysis of VOCs.

The packer assembly will consist of two (2) pneumatic rubber seals, separated by a ten (10)- to twenty (20)-ft length of perforated steel pipe. The pump will be situated inside the pipe. Groundwater sampling will be accomplished by inflating the packers (rubber seals) with compressed air or nitrogen, isolating a fracture zone from the rest of the borehole, and pumping groundwater from between the seals before collecting a sample for analysis.

Each isolated interval (fracture zone) will be purged until water quality parameters (pH, temperature, specific conductivity, DO, turbidity, and ORP) have stabilized for three (3) consecutive readings, then sampling can begin. Groundwater samples will be collected and analyzed for VOCs by EPA Method 8260B from each packered interval.

The vertical groundwater geochemical profiling results will be used to verify the fractures that will be biased for injections. It is possible that the majority of the contamination is traveling in the overburden or a subset of fracture intervals in the bedrock and these intervals would be isolated for the injections. The results of this sampling will be used to define the approximate depth of the BIWs described in Section 3.4.

3.3.5 Tracer Testing

A conservative tracer test using a bromide solution will be conducted after completion of the packer testing to (1) confirm groundwater flow patterns down-gradient towards groundwater monitoring wells OB03, OB03A, and MW-8; (2) further assess localized groundwater flow direction and velocities for system design; and (3) assess the performance monitoring sampling frequency.

It is assumed that approximately one hundred forty (140) gallons of a concentrated bromide solution will be instantaneously injected into each of the four (4) assessment wells. A target in-well bromide concentration of two hundred (200) milligrams per liter (mg/L) will be attained by mixing the concentrated stock solution with the groundwater in the well. Keeping the quantity of tracer small minimizes the initial disturbance of the natural flow fields (Domenico and Schwartz 1990). The tracer solution will be created on-site by mechanically mixing purged groundwater from the wells and/or potable water with the commercially purchased tracer to the appropriate tracer concentrations.

Prior to introduction of the tracer solution, baseline groundwater quality data will be established at the verification assessment injection wells (BIW-1 through -4) and groundwater monitoring wells OB03, OB03A and MW-8 by collecting groundwater samples for laboratory analysis of bromide (EPA Method 300.0).

Porosity is estimated between one (1) and ten (10) percent in fractured crystalline rock and thirty-five (35) to fifty (50) percent for silt (Fetter 1994). To provide a general groundwater velocity benchmark for comparison and remediation planning purposes, measured groundwater elevations and the linear distance between the wells was utilized to estimate a hydraulic gradient of twenty-two one-thousandths (0.022), an estimated hydraulic conductivity value for silt was assumed to be twenty-eight one-thousandths (0.028) ft/day, and an assumed effective porosity of forty (40) percent for silt, results in an average linear velocity of two one-thousandths (0.002) ft/day. This velocity is likely overly conservative, and a more realistic groundwater velocity for this area likely is in the order of one hundred (100) to three hundred (300) ft/year. Based on the range of the groundwater velocity experienced at a site with similar subsurface conditions (Hernwood Landfill) of one (1) to five (5) ft/day (EA 2012) and the distance between the proposed bioremediation injection wells and groundwater monitoring wells OB03, OB03A, and MW-8 (approximately seventy-five [75] ft), groundwater samples will be collected twice weekly for one (1) month and weekly for an additional two (2) months at the tracer injection wells and the down-gradient monitoring wells OB03, OB03A and MW-8 or until the tracer concentrations begin to decline signifying the tail end of the breakthrough curve.

DO concentrations and ORP (i.e., geochemistry) will be measured and recorded from groundwater present in groundwater monitoring wells OB03, OB03A and MW-8, to further assess existing conditions.

The collection of these data will be used to refine the implementation of the proposed remedial approach. The proposed groundwater sampling schedule for the phases of the remedial action is shown in **Table 3-2**.

Table 3-2. Groundwater Analytical Sampling Table[1]

PHASE:	Phase 1 - Field Investigations				Phase 2 - Pilot Design		Phase 3 - Pilot O&M (3 years - semi-annual)			
TEST TYPE:	K[2]	Geochem[3]	VOC	Bromide	VOCs	Geochem	VOC	K	DHG[4]	DOC[5]
METHOD:	Gene-Trac	Field	8260B	IC 300	8260B	Field	8260B	Gene-Trac	8015B	415.1
Monitoring Wells										
OB03	1	1		17	No Samples	4	6		6	
OB03A	1	1		17		4	6		6	
MW-8	1	1		17		4	6		6	
Bioremediation Wells										
BIW-1			4-6	17		4		3		6
BIW-2			4-6	17		4		3		6
BIW-3			4-6	17		4		3		6
BIW-4			4-6	17		4		3		6
BIW-5					1	4		3		6
BIW-6					1	4		3		6
BIW-7					1	4		3		6
BIW-8					1	4		3		6
Total	4	4	16-24	119	8	60	24	22	24	48

[1] Numbers in the table represent the number of samples per event per analytical parameter.
[2] *Dehalococcoides* – via Gene Trac SiREM analysis.
[3] Geochemistry will be field measured for DO, ORP, and pH.
[4] Dissolved hydrogen gases including ethane, ethene, and methane.
[5] Dissolved organic carbon.

3.4 PHASE 2 – PILOT DESIGN AND INSTALLATION

The additional pilot BIWs will be located within the property line intersecting the groundwater. It is assumed that the wells will be drilled to an approximate depth of one hundred fifty (150) ft to intersect the plume below and immediately adjacent to the waste mass. However, the length and the depth of the additional injections wells may be modified based on the results of the subsurface verification assessment.

The proposed configuration assumes the following:

- Four (4) additional bioremediation injection wells (BIW-5 through BIW-8) through waste and screened in the overburden and bedrock (approximately one hundred fifty (150) ft in depth) at thirty (30)-ft spacing (the pilot bioremediation system will include the four [4] verification assessment wells);

- The BIWs will be installed through the waste mass;

- Groundwater sampling and analysis at the four (4) additional BIWs (BIW-5 through BIW-8) for VOCs;

- A low solubility, slow-release electron donor (emulsified vegetable oil [EVO]) and a slow-release pH buffer will be injected into the BIWs (BIW-1 through BIW-8), which will encourage biological activity in areas around the injection wells, thereby forming a lateral and continuous biologically active treatment zone that intersects the plume;

- VOC-contaminated groundwater that flows through the treatment zone will be biologically reduced to concentrations less than MCLs and ultimately to non-hazardous compounds (i.e., ethene and ethane) under ambient (non-pumping) conditions;

- Bioaugmentation with commercial *Dehalococcoides* cultures (i.e., KB-1®) to ensure complete reduction to concentrations less than MCLs (if required). A secondary injection of EVO and pH buffer will be conducted after bioaugmentation.

The selected electron donor for the bioremediation is an EVO (Material Safety Data Sheet [MSDS] provided in **Appendix C**). Commercially available EVOs have both fast and slow release electron donors and contain both sodium lactate and EVO. The sodium lactate stimulates microbial growth within hours of injection and rapidly produces anaerobic conditions in the subsurface. After the lactate has been consumed, the two (2)- to five (5)-micron low solubility vegetable oil portion is retained on aquifer surfaces and provides molecular hydrogen for a longer period of time.

Currently, the pH of the aquifer (ranging from four and nine-tenths [4.9] to seven [7.0]) is slightly below the ideal pH of six and a half (6.5) for reductive dechlorination. Therefore, pH adjustment and buffering will be necessary to enhance the reductive dechlorination process. Recent remedial actions at other groundwater remediation sites, as well as other remediation sites in acidic aquifers, have shown that pH adjustment can be short lived without continuous addition of pH buffers, due to the short-lived nature of the soluble buffer and the production of volatile fatty acids during the dechlorination process. Therefore, a slow-releasing pH buffer of dissolved and solid-phase magnesium hydroxide (MSDS provided in **Appendix C**) is proposed for the bioremediation system and will be injected simultaneously with the EVO.

The approximate lateral radius of influence (ROI) of each BIW is estimated to be seventeen and a half (17.5) ft. With a proposed well spacing of approximately thirty (30) ft, this ROI will provide some overlap. The approximate ROI was determined using a velocity based assessment of estimated injection rates over the vertical injection profile (determined by the proposed well depth) and overlain on the average groundwater velocity flow field, which is based upon the site specific hydraulic gradient, effective porosity, and hydraulic conductivity. Based on the average most likely ambient groundwater flow velocity (approximately three hundred [300] ft/year), the residence time of groundwater within the treatment zone as proposed would be approximately 37 days. As previously stated, the groundwater flow velocity will be verified during the subsurface verification assessment (Phase 1).

Based upon the detection of dissolved phase COCs in both the overburden and bedrock aquifers at the site, separate estimates for each aquifer condition were completed to approximate the volume of injectate needed for establishment of a treatment zone measuring 30 feet in diameter. The estimation was completed through approximation of effective porosity (30% for silt saprolite and 3% for fractured bedrock) and assumed saturated thicknesses of 15 feet for the overburden condition and 70 feet for the bedrock condition. The estimated volume of injectate needed to establish the proposed treatment zone is approximately 19,000 gallons per overburden well and 11,000 gallons per bedrock well. The injection volume could be modified based on the total depth of cVOC-transmitting fractures observed during the subsurface verification assessment.

EVO provides approximately eighteen one-hundredths (0.180) e^-/gram. The electron demand by the groundwater (including contaminants and other electron acceptors) is approximately forty (40) mg/L of EVO (seven and two-tenths [7.2] me^-/L divided by eighteen one-hundredths [0.180] me^-/mg). The stoichiometric requirement of the EVO calculation is shown in **Table 3-3**.

Table 3-3. EVO Requirement.

Compound	Max Concentration[1]	Units	Molecular Mass (g/mol)	uM concentration	Electrons accepted per mole	u-electron equivalents per liter
PCE	33.23	µg/L	165.8	0.20	8	1.6
TCE	141.41	µg/L	131.5	1.08	6	6.5
1,2-DCE	182.82	µg/L	97	1.88	4	7.5
1,1-DCE	1	µg/L	97	0.01	4	0.0
DO	0.83	mg/L	32	26	4	103.8
Sulfate	72.6	mg/L	62	1171	5	5854.8
Nitrate	14.79	mg/L	96	154	8	1232.5
					Total	7206.7

[1] The max concentration in OB03, OB03A, and MW-8 from 2007 to 2012.

Considering a safety factor of seven (7) for other unidentified electron acceptors, the groundwater electron demand is approximately two hundred eighty (280) mg/L of EVO. The design EVO concentration for field injection is one (1) percent (volume per volume [v/v]). If only electron demand stoichiometry and mass flux of oxidized compounds in the site groundwater are considered, this design concentration should provide sufficient electrons to support bioactivity within the barrier for approximately one (1) year. However, the actual lifespan of the bioremediation injection will also be affected by the solubility and dissolution kinetics, the portion of injected EVO that becomes immobilized (e.g., sorbed to aquifer matrix) in the barrier, and changes of other geochemical conditions (e.g., pH) over time. Electron donor will be replenished, as necessary depending on the results of performance monitoring, to maintain the activity of the bioremediation injection.

The groundwater amendments may also include a pH adjuster − magnesium hydroxide slurry (amended at two one-hundredths (0.02) percent v/v). The magnesium hydroxide will aid in microbial degradation of the groundwater contaminants by modifying the groundwater chemistry to pH neutral and aiding in achieving anaerobic and reducing conditions.

A manifold system equipped with flow and pressure controls will be used for injection at up to six (6) BIWs simultaneously. A proportional pump installed in the manifold system will draw the one (1) percent (v/v) EVO from a supply tank into the main stream. The pH buffer will be added directly to the EVO and mechanically suspended during the injection. To the extent feasible, the make-up water for the injection will be pumped from adjacent BIWs (if not previously treated), sent through the manifold system, amended with EVO and pH buffer, and injected through BIWs. As required, additional make-up water from potable sources may be used. The injection will continue until the total volume of injection fluid has been injected.

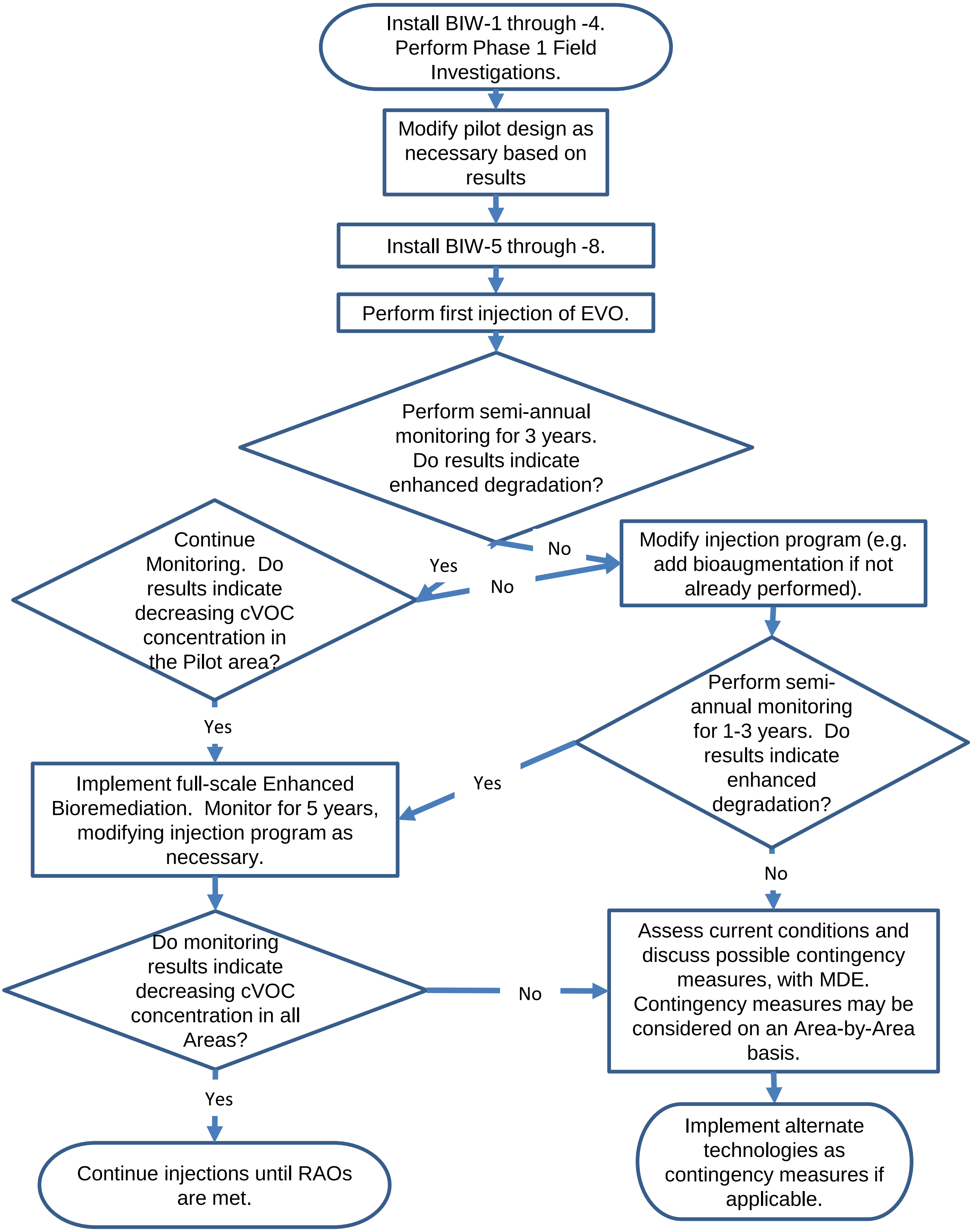
3.5 PHASE 3 – PILOT SYSTEM OPERATION, MAINTENANCE, AND MONITORING

Operations and maintenance for a passive Enhanced Bioremediation approach generally includes bioremediation system "recharges" and groundwater monitoring to assess remediation effectiveness. Based on the current understanding of the groundwater geochemistry and the aquifer characteristics, groundwater monitoring would be required semi-annually for the first three (3) years of the remedy at OB03, OB03A, MW-8, MW-17A, and MW-17B. Semi-annual sampling will be performed at these locations as part of the County's G&SWMP. Groundwater parameters specific to Phase 3 for assessing performance are shown in **Table 3-1**.

Bioremediation system recharging events are expected to occur approximately once a year on average. However, the actual lifespan of the bioremediation system injection will be affected by the solubility and dissolution kinetics, the portion of injected EVO that becomes immobilized (e.g., sorbed to aquifer matrix) in the barrier, and changes of other geochemical conditions (e.g., pH) over time. During the pilot, recharging events may occur more frequently than once per year, to allow better assessment of the optimal frequency. Bioremediation system monitoring (which consists of groundwater sampling for dissolved organic carbon, pH, ORP, and DO) will occur semi-annually during the first three (3) years due to the assumed linear groundwater flow velocity and the current County G&SWMP. The primary function of the injection wells will be to facilitate groundwater treatment. By monitoring the geochemistry and dissolved organic carbon (DOC) concentrations resulting from the EVO and pH adjuster injections over time, assessments will be made for when a recharge event is warranted (i.e., desired anaerobic groundwater geochemistry shifts back and/or DOC concentrations start to return to baseline concentrations). Performance of the groundwater treatment/contaminant reduction will be performed at the down-gradient monitoring wells. While contaminant reduction could be measured at the BIWs, there will be significant potential interferences with the VOC analysis from the higher concentrations of the EVO and pH adjusters near the BIWs. If the remedy is proven effective after the first three (3) years of monitoring, this sampling schedule can be reduced.

Figure 3-4 illustrates a flow diagram which describes the decision process. Following the installation of the pilot design BIWs (BIW-1 through BIW-8) and injection of EVO, monitoring

Figure 3-4 Pilot Design and Full-Scale Remediation Decision Process



cVOC = chlorinated volatile organic compound

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will be performed for up to three (3) years on a semi-annual basis, in conjunction with the current groundwater monitoring program for the site. Upon completion of the monitoring period the groundwater monitoring data will be evaluated to determine if a reduction in cVOC mass has occurred in the pilot design area. Due to the dechlorination process, cVOC concentrations of DCE may increase while PCE and TCE decrease. Therefore, molar concentrations of PCE, TCE, DCE, and VC will be calculated to compare total cVOC concentrations before and after injections. Molar concentrations will be used to remove the mass bias when considering concentrations of compounds with different masses. For example, if one (1) mole of PCE is degraded to one (1) mole of TCE, the total number of moles of cVOCs remaining in the subsurface has not changed, but the mass of PCE is greater than the mass of TCE, so the mass-based concentration (i.e., µg/L) of total cVOCs would be smaller. Therefore, the molar concentration is used as a way to compare the amount of contaminant remaining without a bias due to the different masses of the compounds at different stages of degradation. If monitoring does not indicate a reduction in cVOC concentrations, the injection program will be re-evaluated to determine if bioaugmentation or other modifications to the pilot design can be performed to increase performance. Following the modifications, the pilot design will continue to be monitored.

3.6 PHASE 4 – FULL SCALE REMEDIATION

The full-scale remediation will be performed following the monitoring of the pilot design.
Upon completion of the pilot monitoring period (three [3] to six [6] years], Enhanced Bioremediation will begin to be implemented in additional areas presented in the ACM. Each area will be addressed in a phased approach to address unique subsurface conditions in each area to help ensure each area is appropriately treated. Injections will continue to be performed as needed based on the results of pilot testing and subsequent monitoring, and are anticipated approximately every twelve (12) months on average, until Remedial Action Objectives (RAOs) are met. Injections may be performed more frequently at first, with decreasing frequency as the remediation progresses. The Enhanced Bioremediation system would be phased to first target the Northwest, Southwest, and South Areas, which have the highest concentrations of groundwater impacts. Groundwater data for the West and Southeast Areas would then be reviewed to assess the need for implementation of systems in these areas, and then installation of injection wells would proceed as necessary.

In the event that Enhanced Bioremediation is not effective in any of the areas where it is proposed, other treatment methods would be further evaluated and implemented, if applicable.

3.7 ENHANCED BIOREMEDIATION APPROACH SUMMARY

In summary, the approach is as follows:

- ***Pre-Investigation Activities*** – Develop a health and safety plan, and obtain permits, utility clearance and right-of-entry.

- ***Monitoring Well Installation and Sampling Program*** – Install, develop, and sample additional monitoring wells.

- ***Phase 1 – Subsurface Assessment*** – Phase 1 will be performed prior to pilot implementation to verify aquifer dynamics and groundwater flow and will include:

  - Installing four (4) BIWs (BIW-1 through -4);

  - Microbial testing;

  - Conducting downhole geophysics to confirm bedrock lithology, orientation of bedding planes and fractures, and groundwater flow;

  - Conducting groundwater packer testing to assess vertical groundwater quality in major fracture sets; and

  - Conducting a groundwater tracer test to verify interconnectivity of the fractures and groundwater flow velocities.

- ***Phase 2 – Pilot Design and Installation*** – Phase 2 utilizes the information obtained during Phase 1 to implement the pilot bioremediation system. Work under this phase will include:

  - Installing and surveying of four (4) additional BIWs (BIW-5 through -8);

  - Groundwater sampling and analysis at the four (4) additional BIWs (BIW-5 through -8) for VOCs;

  - Injection of a low solubility, slow-release electron donor (EVO) and a slow-release pH buffer into the BIWs (BIW-1 through -8);

  - Bioaugmentation of BIWs with commercial *Dehalococcoides* cultures (i.e., KB-1®) (if required); and

  - A secondary injection of EVO and pH buffer will be conducted after bioaugmentation (if required).

- ***Phase 3 – Operation, Maintenance, and Monitoring*** – Phase 3 will include the operations and maintenance of the bioremediation system and will include:
  - Recharges of EVO and pH buffer approximately once a year;
  - Molecular analyses and bioaugmentation of BIWs with commercial *Dehalococcoides* cultures (i.e., KB-1®) (if required); and
  - Semi-annual groundwater monitoring of monitoring wells OB03, OB03A, MW-8, MW-17A, and MW-17B for two (2) to three (3) years.
- ***Phase 4 – Full-Scale Remediation***– Phase 4 will include full-scale implementation of Enhanced Bioremediation and will include:
  - Evaluate groundwater monitoring data;
  - Continue semi-annual monitoring and reporting; and
  - Begin phased implementation of Enhanced Bioremediation in each Area.

4. LANDFILL GAS COLLECTION SYSTEM ENHANCEMENTS

The existing landfill gas monitoring network for the Landfill consists of seventeen (17) locations along the perimeter boundaries of the site. Although not part of the landfill gas monitoring network, the County maintains an active gas collection and management system at the Landfill, consisting of over one hundred (100) vertical extraction wells, five (5) dewatering sumps, two (2) enclosed ground flares, and a gas-to-energy facility. Twelve (12) additional landfill gas monitoring wells are currently planned for installation along the eastern border of the Landfill upon completion of the land exchange with M-NCPPC. The gas collection and management system is operated and maintained on a continuous basis by the County's Operations Contractor.

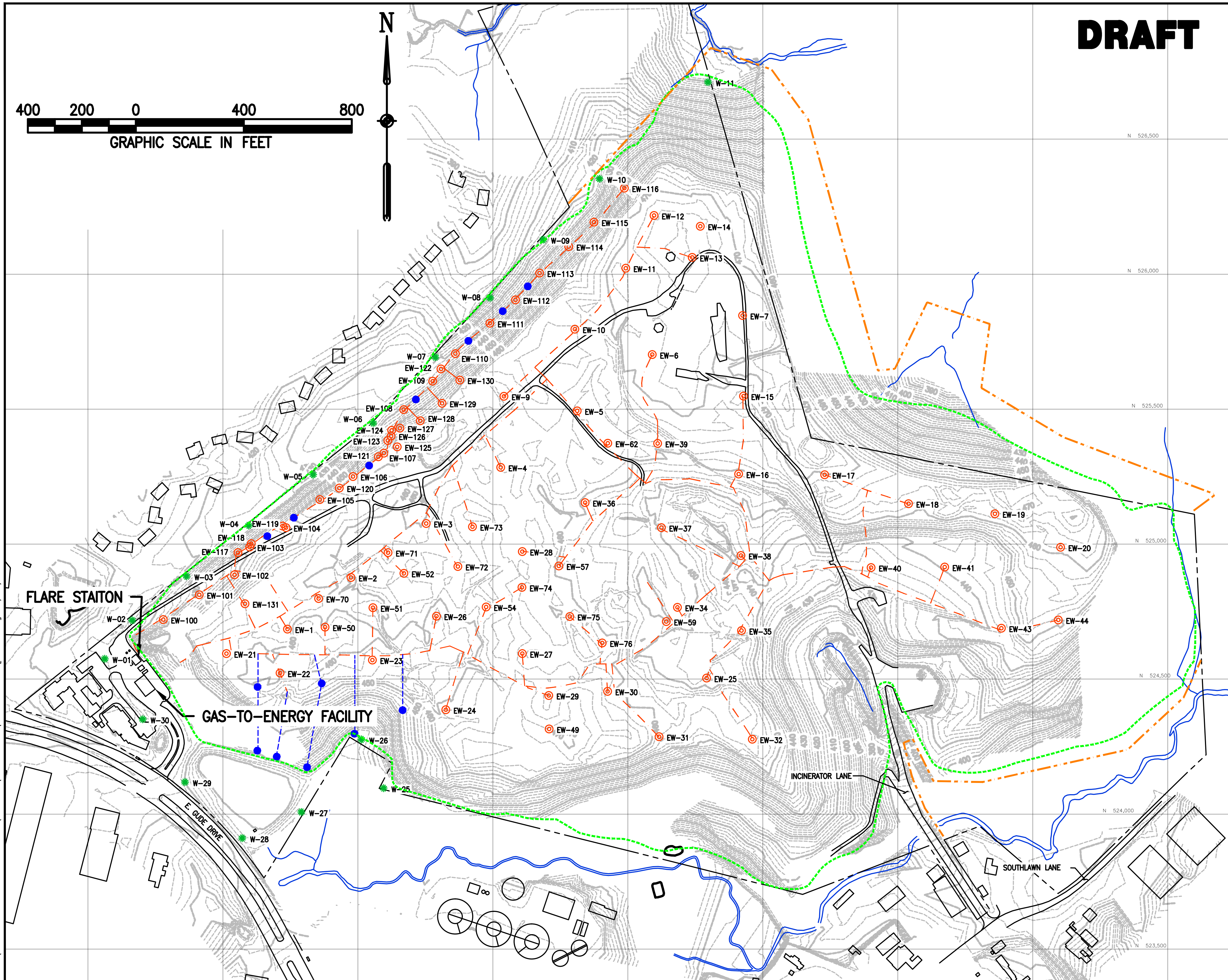
Based on historical landfill gas data collected following the most recent installation of vertical landfill gas extraction wells, additional extraction wells are required to provide direct control over landfill gas migration. The County is actively addressing exceedances and may choose to install additional vertical landfill gas extraction wells prior to implementation of the recommended CMA.

4.1 LANDFILL GAS EXTRACTION WELLS

Exceedances of the LEL have been identified at landfill gas monitoring wells W-04, W-05, W-06, W-07, W-08, and W-28 in the Northwest and West Area defined in the ACM. Additionally, exceedances have been identified in monitoring well W-26 in the corner of the Southwest Area. As a result, additional landfill gas extraction wells will be installed in waste to eliminate landfill gas migration in these areas.

Prior to the design of the landfill gas collection system enhancements, historical data will be reviewed to determine where exceedances are the greatest and the locations of the existing vertical landfill gas extraction wells will be reviewed to determine the horizontal location for placement of additional vertical landfill gas extraction wells. Based on an initial review, possible locations for the addition of vertical landfill gas extraction wells are depicted on **Figure 4-1**.

The depths of the existing landfill gas extraction wells will be compared to the monitoring wells where exceedances have been observed to determine the necessary vertical extent of the proposed landfill gas extraction wells. Extraction wells and remote extraction wells will be constructed to be consistent with the existing landfill gas extraction well construction (**Appendix D**). Landfill gas extraction wells and condensate traps (if necessary) may be installed by the



NOTES:

1. TOPOGRAPHY COMPILED BY APPLIED MAPPING SOLUTIONS, INC. USING PHOTOGRAMMETRIC METHODS WITH PHOTOGRAPHY DATED 06/24/09 AND SUPPLEMENTED WITH FIELD SURVEY PERFORMED BY C.C. JOHNSON & MALHOTRA, P.C., OCTOBER 2009.
2. HORIZONTAL DATUM IS NORTH AMERICAN DATUM OF 1983/91 (NAD-83/91). COORDINATE SYSTEM IS MARYLAND STATE PLANE, U.S. SURVEY FEET. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD-88) WITH ELEVATIONS SHOWN IN FEET.
3. TOPOGRAPHY IS APPROXIMATE IN AREAS NOTED "GROUND OBSCURED BY DENSE TREES AND VEGETATION".
4. MONTGOMERY COUNTY IS CURRENTLY IN NEGOTIATIONS WITH M-NCPPC TO EXCHANGE TWO PARCELS OF LAND (LOCATED TO THE NORTH AND SOUTHEAST OF THE GUDE LANDFILL) FOR PROPERTY TO THE NORTHEAST. THE FUTURE PROPERTY BOUNDARY LINE REPRESENTS THE AGREED UPON PROPERTY BOUNDARY FOR THE GUDE LANDFILL FOLLOWING THE PROPERTY EXCHANGE. THE FUTURE PROPERTY BOUNDARY WAS ESTABLISHED WITH PERMANENT PROPERTY BOUNDARY MARKERS AND SURVEYED BY C.C. JOHNSON AND MALHOTRA, P.C. IN MAY 2012.

LEGEND

- 10-FT CONTOUR (400)
- 2-FT CONTOUR
- PROPERTY BOUNDARY
- ROADS
- STREAM/BODY OF WATER
- LANDFILL GAS EXTRACTION PIPING
- LIMIT OF WASTE
- FUTURE PROPERTY BOUNDARY
- LANDFILL GAS EXTRACTION WELL
- LANDFILL GAS MONITORING WELL (W-07)
- PROPOSED LANDFILL GAS EXTRACTION WELL
- PROPOSED LANDFILL GAS EXTRACTION PIPING

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GUDE LANDFILL
RECOMMENDED CMA WORK PLAN
MONTGOMERY COUNTY, MARYLAND

FIGURE 4-1
PROPOSED LANDFILL GAS EXTRACTION WELL LOCATION MAP

DESIGNED BY	DRAWN BY	DATE	PROJECT NO.
PL/LJO	JAP	OCT. 2013	14982.01
CHECKED BY	PROJECT MGR.	DRAWING NO.	FIGURE
BR	MJG	–	4-1

FILE PATH: Q:\PROJECTS\1498201 GUDE PHASE 2 ACM\FIGURES\WORK PLAN\FIG 4-1.DWG [LAYOUT 1] 10/14/13

County's existing Operations Contractor or another contractor and connected to the existing collection system via above grade piping. The landfill gas extraction wells would be installed following any Cover System Improvements (Section 5).

4.2 LANDFILL GAS MONITORING

Landfill gas monitoring will be performed in accordance with the approved Landfill Gas Monitoring Plan for the Gude Landfill. Monitoring of the landfill gas monitoring wells will be utilized to evaluate the performance of the Landfill Gas Collection System Enhancements. In the event the installation of the landfill gas extraction wells does not result in eliminating landfill gas migration at the property boundary, the placement of additional extraction wells or other enhancements will be evaluated.

5. SOIL COVER SYSTEM IMPROVEMENTS

The Recommended CMA includes Soil Cover System Improvements along the Northwest and West Area (**Figure 5-1**) to aid in preventing odors, vectors, erosion and sedimentation, stormwater infiltration, fugitive landfill gas emissions, leachate generation, leachate seeps, and exposure to, and of, the in-place waste.

5.1 SOIL PLACEMENT

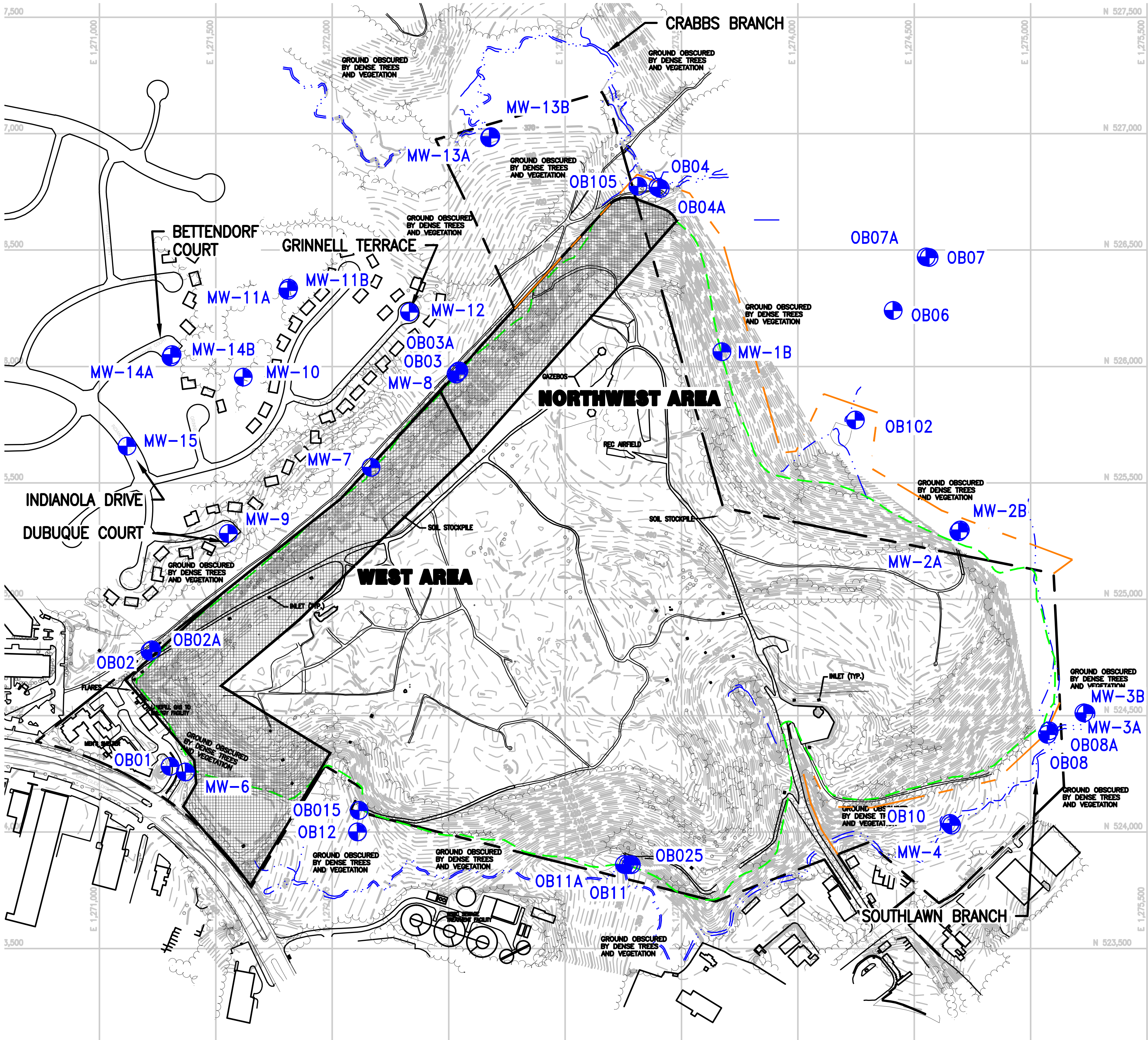
Areas along the Northwest and West Areas will be cleared of trees and re-graded to promote proper site drainage. A two (2)-foot soil cover (**Figure 5-2**) will be the be added, which will include twenty (20) inches of vegetative support soil with a four (4)-inch top layer of topsoil. The areas will then receive vegetative stabilization, similar to a traditional landfill closure cap.

5.2 LEACHATE SEEP REPAIR

Following the clearing of trees and re-grading, any leachate seeps will be addressed during placement of the cover soil. Leachate seeps would be over-excavated to waste, lined with non-woven geotextile, and filled with AASHTO No. 57 stone and three (3) inches of select fill, prior to placement of the Soil Cover System Improvements (**Figure 5-3**). This would promote drainage of the leachate seep back into the waste.

5.3 SOIL COVER SYSTEM IMPROVEMENT MONITORING

The condition of the Soil Cover System Improvements will be monitored visually on a monthly basis by County personnel. Any leachate seep outbreaks will be repaired as detailed in this Work Plan, unless an alternate approach is approved by MDE. Other repairs to the soil cover system may include the placement of additional soil to address settling or re-seeding to address vegetative stabilization.



NOTES:

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LEGEND

- 400 — 10-FT CONTOUR
- 2-FT CONTOUR
- CURRENT PROPERTY BOUNDARY
- FUTURE PROPERTY BOUNDARY
- LIMIT OF WASTE
- STREAM
- TREELINE
- MW-X/OBX — GROUNDWATER MONITORING WELL
- APPROXIMATE REMEDIATION AREAS FOR COVER SYSTEM IMPROVEMENTS

500 250 0 500 1000

GRAPHIC SCALE IN FEET

DRAFT

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FIGURE 5-1
PROPOSED COVER SYSTEM IMPROVEMENTS LOCATION MAP

DESIGNED BY	DRAWN BY	DATE	PROJECT NO.
BTT	JSP	OCT. 2013	14982.01
CHECKED BY	PROJECT MGR.	DRAWING NO.	FIGURE
BR	MJG	–	5-1

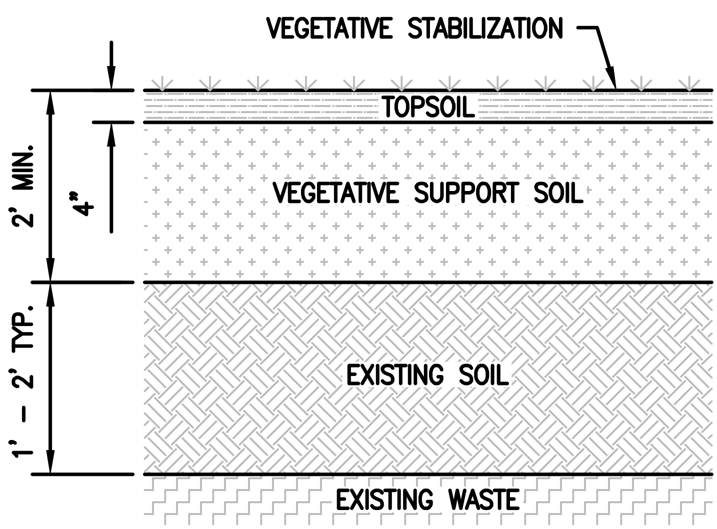

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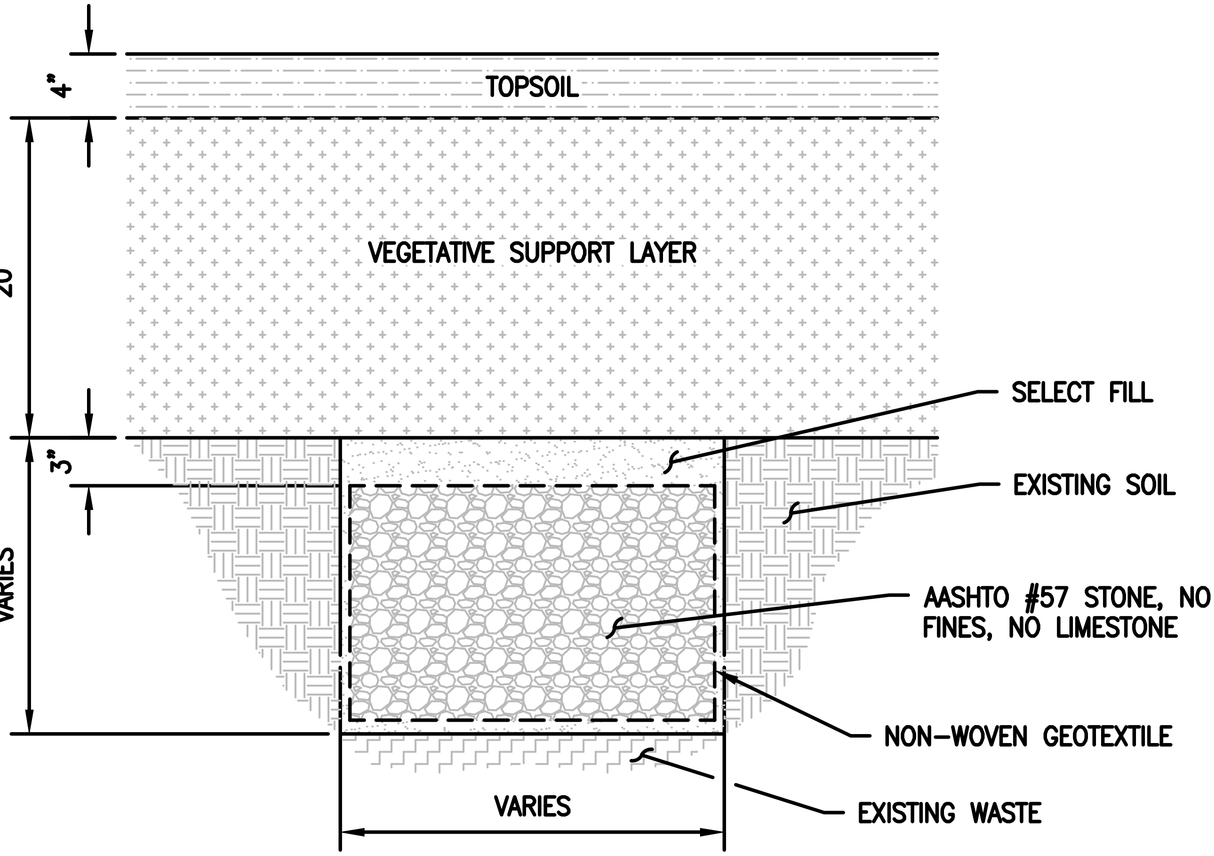
FIGURE 5-2
TYPICAL COVER SYSTEM
IMPROVEMENT CROSS-SECTION

PROJECT MGR	DESIGNED BY	DRAWN BY	CHECKED BY	SCALE	DATE	PROJECT NO	FIGURE
MJG	LJO	JAP	BR	–	OCT. 2013	14982.01	5-2

FILE PATH: Q:\PROJECTS\1498201 GUDE PHASE 2 ACM\FIGURES\WORK PLAN\FIG 5-2.DWG [LAYOUT1] 10/10/13



NOTES:

1. LEACHATE SEEP REPAIRS WILL OCCUR IN AREAS WHERE THERE ARE LOCALIZED LEACHATE OUTBREAKS ONLY.

2. THE LEACHATE SEEP WILL BE EXCAVATED TO WASTE TO ENCOURAGE DRAINAGE OF LEACHATE BACK INTO THE WASTE.

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MONTGOMERY COUNTY, MARYLAND

FIGURE 5-3
TYPICAL LEACHATE SEEP REPAIR CROSS-SECTION

PROJECT MGR	DESIGNED BY	DRAWN BY	CHECKED BY	SCALE	DATE	PROJECT NO	FIGURE
MJG	LJO	JAP	BR	-	OCT. 2013	14982.01	5-3

FILE PATH: Q:\PROJECTS\1498201 GUDE PHASE 2 ACM\FIGURES\WORK PLAN\FIG 5-3.DWG [LAYOUT1] 10/10/13

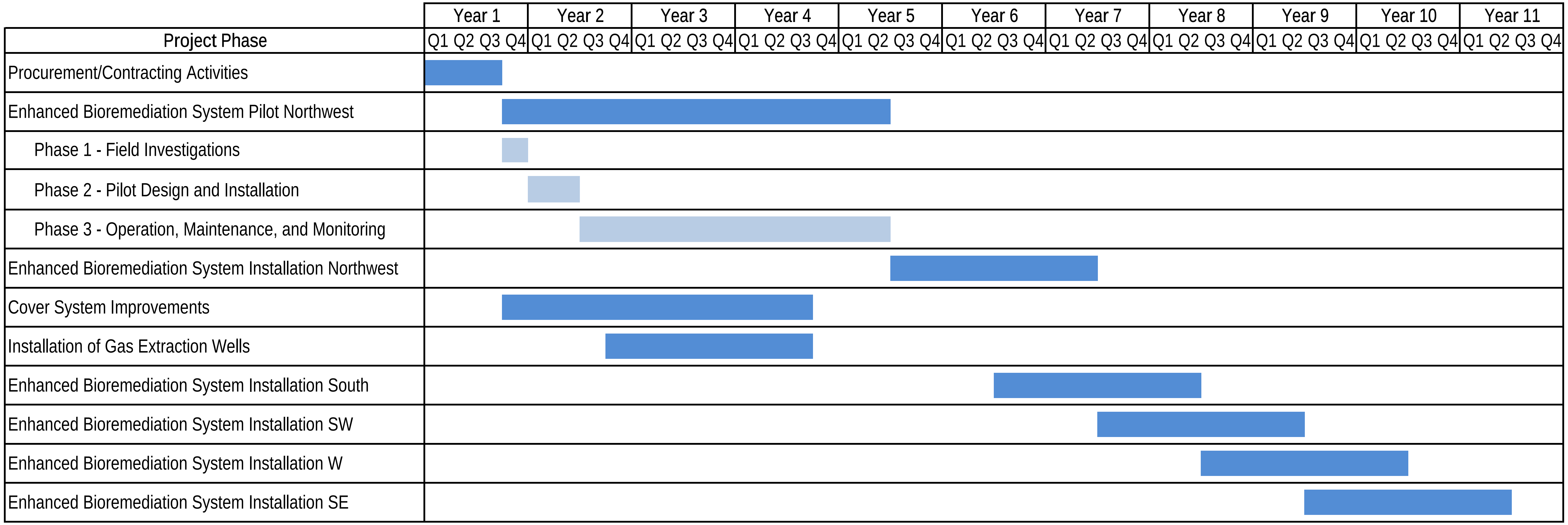
6. MONITORING, REPORTING, AND SCHEDULE

The anticipated schedule for implementation of the recommended CMA is illustrated in Figure 6-1. It is estimated that remedial activities will begin three (3) years after approval of the ACM, based on design, permitting, and contracting requirements. Installation of the Soil Cover System Improvements will be completed within three (3) years following completion of the design. Installation of the landfill gas extraction wells will begin after installation of the cover system in each area, and be completed within two (2) years. The anticipated duration of the pilot test for Enhanced Bioremediation (in the Northwest Area) is approximately four (4) years, including the Phase 1 Field Investigations (3 months), the design and installation of the pilot system (6 months), and operation, maintenance, and monitoring of the pilot system for approximately three (3) years. During this period, the County will submit semi-annual performance reports documenting the results of monitoring and assessing any possible changes required to optimize the system. If substantial challenges are encountered in establishing an effective bioremediation program, it is possible that some extension of the pilot design period would be required to ensure successful full-scale implementation.

Following the pilot design period, assuming it is determined that Enhanced Bioremediation is effective at the Landfill, a full-scale bioremediation system will be installed in the Northwest Area over a period of 6 months to 1 year, followed by an additional year of optimizing the full-scale system. After the Northwest Area, Enhanced Bioremediation systems will be installed in the South and then the Southwest Areas, as these Areas also have consistent MCL exceedances for cVOCs. As in the Northwest, each system is expected to be installed over 6 months to 1 year, followed by a year of optimization. The process of installing bioremediation systems in each Area is expected to begin with field investigations similar to those conducted during the pilot study, to allow a system to be compatible with the local conditions. The timeframe for installation of injection wells may be longer than anticipated if conditions within and below the waste require non-standard well installation procedures. During installation of the systems in the South and Southwest Areas, the need for active remediation in the West and Southeast Areas would be reevaluated, and if determined to be necessary, Enhanced Bioremediation systems would be installed and optimized in these areas next.

Following the initial injections, recharging events in each Area will be performed as determined to be necessary, and semi-annual monitoring events including indicator parameters will be submitted. Note that the schedule is preliminary, based on best estimates at the time of Work Plan development.

Figure 6-1 Anticipated Implementation Schedule



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Appendix A

MDE Specification for the Design and Construction of Groundwater Monitoring Wells at Solid Waste Disposal Facilities

MARYLAND DEPARTMENT OF THE ENVIRONMENT
Waste Management Administration
Solid Waste Program, Suite 605
1800 Washington Boulevard
Baltimore, Maryland 21230-1719

Specifications for the Design and Construction Of Groundwater Monitoring Wells At Solid Waste Disposal Facilities

updated 1/30/09

Wells are defined in COMAR 26.04.04.02.J as "...any hole made in the ground to explore for groundwater, to obtain or monitor groundwater, or to inject water into any underground formation from which groundwater may be produced." This definition includes monitoring wells, piezometers, and any exploratory boring which penetrates the groundwater table. The following general specifications pertain to monitoring wells being installed in the vicinity of sanitary landfills and other solid waste disposal facilities for the purpose of obtaining high-quality samples for chemical analysis. Please note that wells installed for other purposes, such as piezometers installed solely for water level monitoring, wells intended to detect floating gasoline, and wells at petroleum, industrial and Superfund sites are likely to have somewhat different specifications. In <u>all</u> cases, the design of a monitoring system must be approved in advance by the appropriate Waste Management Administration (WAS) project manager.

1. All wells must be installed by a Maryland-licensed well-driller in accordance with all pertinent State and local laws and regulations, and not until this Administration has approved the proposed location and design of each well. A permit to drill each well must be applied for and obtained from the local County Health Department for the county in which the well is to be located prior to well installation.

2. All monitoring well casings and screens must be constructed of 2” to 4" inner-diameter pipe composed of Schedule 40 Polyvinylchloride (PVC), Teflon (PFE), or stainless steel, joined using threaded couplings or an approved alternative. No solvent-welded construction will be approved. No solvents, glues, or lubricants shall be used in the construction of the well, except as specifically approved by the Administration. No reduction fittings may be used in the construction of the well; "telescoped" screen construction is not acceptable. Connections between casing lengths and screen sections may not have protrusions or restricted diameters on the inside of the well casing which could cause a pump or bailer to become lodged in the well.

3. The screened interval of the monitoring well must consist of at least 10 feet but not more than 20 feet of pre-constructed, commercially manufactured well screen of the same material and inner diameter as the main well casing. Slot size of the screen (generally 0.020") shall be selected so that, with the gravel pack, it will preclude clogging and excessive turbidity in the well. The bottom of the screen must be capped.

4. The diameter of the boring into which the casing is set must exceed the diameter of the casing by at least four inches (4") (e.g., a four inch well must be installed in a hole at least eight inches in diameter), so that the gravel pack and grout may be properly placed in the annular space between the casing and the sides of the hole.

5. For wells set into bedrock, and for any well greater than 50 feet deep, at least three (3) centralizers must be installed to center the well casing in the annular space, with one at the screen and the others spaced evenly along the well casing. The centralizers shall be composed of the same material as the casing and screen, or other inert material approved by the Administration.

6. The annular space of all wells shall be packed with sterilized pea gravel or coarse sand of a size compatible with the selected screen slot size from the base of the well to a level three feet (3') above the top of the screen. The gravel or sand pack used must be selected so that it prevents fine-grained sediment in the screened formation from clogging the slots in the screen or causing excessive turbidity in the well, and it must have a permeability at least approximately equal to or higher than the permeability of the monitored formation. Two feet (2') of finer sand must be placed on top of the gravel or sand pack to prevent the migration of bentonite and/or other grout components vertically down into the gravel pack and screen. Two feet (2') of bentonite pellets must be placed above the fine sand, to prevent the entry of grout into the gravel pack, and to act as a long-term barrier to liquid which might seep down the formation/grout interface. Two (2) hours should be allowed for hydration of the bentonite prior to grout emplacement.

All materials used to construct the well, including the gravel pack, seal, and grout, must be clean, sterilized, new materials - cuttings may not be placed back in the hole, as this can cause cross-contamination of the well from shallower contaminated zones or surface contaminants. Also, the gravel and sand must be composed of quartz or a similar inert mineral; limestone, marble, shale or other rock chips containing soluble minerals may not be used. If in doubt as to the consistency of the proposed materials, submit a sample to the Administration's project manager. If any wastes, contaminated soils or contaminated liquids are produced during the drilling process, they must be disposed of properly. If the gravel pack is emplaced with auger flights or temporary casing still in the hole, the augers or casing must be backed out by increments as the gravel pack is emplaced to insure that the gravel pack sets properly without bridging and without displacing the well casing when the casing or augers are extracted.

7. The annular space of all wells must be pressure-grouted with Portland cement or a Portland cement/10% bentonite slurry from the top of the pelletized bentonite seal to the surface. The grout must be installed by means of a tremie pipe inserted into the annular space of the well to a point just above the bentonite seal, and should not be installed until the two-foot (2') bentonite seal has had two (2) hours to hydrate. Under certain circumstances, a 100%-bentonite slurry or a > 10% bentonite-enriched cement may be specified as the grouting material. If bentonite clay is the approved grouting material, the well must be developed **before** grouting, and the groundwater tested prior to bentonite use. A 100% bentonite slurry may not be used for grout where it will come into contact with groundwater having a pH below 5.0 or a Total Dissolved Solids concentration of greater than 1000 mg/l.

8. After the grout has set up, some additional grout may have to be added to replace grout volume lost due to shrinkage. Regardless of the type of grout used, the top three feet must be composed of Portland cement or an acceptable concrete. All wells must be provided with a means of protection from tampering, vandalism, and accidental damage. At a minimum, all wells must be provided with a steel outer casing with a diameter at least 2" greater than the main casing anchored three feet (3') into the cement grout, with a hinged, locking steel cap which allows access to the main casing inside only when open. Alternative protective devices may be proposed. It is recommended that any proposed method should not entail sliding parts which would require periodic lubrication, such as threaded steel pipe, as this can foul sampling equipment and coat the inside of the well rendering it useless for water quality sampling.

At the ground surface, a concrete form must be provided during grout installation for the construction of a square concrete pad at least 18"x18" centered around the well, which shall extend from three inches above to three inches below the undisturbed ground surface. The height of the protective casing shall be two feet (2') above the top of the cement pad plus or minus no more than two inches (2"), unless otherwise approved. The top of the PVC casing inside must be provided with a removable cap that fits just under the locking protective steel cap, and be accessible for cap removal with normal tools. The Waste Management Administration must be provided with such keys or other special devices required for access to the wells for sampling. The Administration may approve other access control arrangements provided that access to the wells for sampling by Administration personnel on demand is assured.

High-traffic areas such as maintenance areas and parking lots may require special installations such as concrete posts set around the well to prevent damage by vehicles. Such barriers should be painted a highly visible color, and should be spaced so as to protect the well but still allow a vehicle to back up to it for sampling and repairs. Also, some installations such as gas stations may require ground-level or low-profile anti-vandalism caps; leak-proof metal caps are commercially available for these locations. These should be carefully marked so that inexperienced personnel do not mistake them for the fuel-fill ports of underground storage tanks. Also, low-profile caps are not recommended for most landfill applications, as they make relocating the well for sampling more difficult; however, they may be appropriate in paved areas.

9. After the grout has thoroughly cured or set up, all wells must be developed to insure that a satisfactory hydraulic connection exists between the well and the monitored formation. Development must consist of alternating mechanical- and/or air-surging techniques with pumping, to remove fine materials that may remain in the well, gravel pack, and the formation nearest the well which would otherwise threaten sample quality. Jetting or other techniques may be employed where necessary to speed this process, particularly when the drilling method used to install the wells was the mud-rotary method, or a variant. Wells shall be developed so that the water produced has a measured turbidity of 10 NTUs (Nephelometric Turbidity Units) or less.

10. Following development, all wells must undergo a pump test of not less than one (1) hour in order to determine the yield of the well. Yield must be reported on the completion reports. If wells are developed using high-pressure air development techniques, the air compressors must be of the oilless variety and/or have sufficient carbon filtration to remove any chance that oil vapor will be introduced into the well.

11. All wells must be properly tagged, with the well construction permit number and monitoring well designation (e.g., MW-2D, etc.) clearly visible from the outside of the well, and flagged or otherwise made visible so that they can be located for sampling and avoided by on-site heavy equipment. The inner plastic casing should be carefully sealed prior to any spray-painting or any other work on the protective casing which could introduce contaminants into the well.

12. Well completion reports must be fully completed for each well installed, and a copy of the well completion reports forms submitted to the County Health Department must be forwarded to this Administration within thirty (30) days of well completion. A project summary describing the installation procedure must accompany the copies of the

completion reports, and must contain an accurate map depicting the precise location of all wells installed at the site in relation to known landmarks; a detailed description of the construction of the wells installed including casing, screen, gravel pack and grout intervals; the elevation of the top of the concrete pad installed at the base of the protective outer well casing; the top-of-casing elevation; and both the static and pumping water levels to the nearest one-hundredth of a foot.

13. The well driller or the supervising engineer or geologist must notify this Administration via telephone at least three (3) work days prior to initiation of drilling at any waste disposal site, so that representatives may be present to observe the well installation. Failure to notify WAS may result in rejection of the well or system as an acceptable monitoring point.

14. All regulatory requirements must be met concerning the application for, permitting of, construction of and completion of all monitoring wells. Wells not constructed in accordance with the regulations (COMAR 26.04.04 of the Annotated Code of Maryland) and these specifications will not be accepted by this Administration unless a variance was obtained prior to or during well construction. Also, drilling at waste disposal sites may generate contaminated soils or liquids which must be collected and disposed of in a safe and legal manner. This may entail sampling for TCLP or other characterization tests, particularly when wastes may have been encountered during drilling.

15. It is recognized that geologic conditions at a site may require that changes to these general specifications be made in order that the monitoring system installed is adequate for monitoring the intended geologic formations, while not creating an additional hazard to groundwater quality. The specific reason for installing the well - e.g., looking for "floaters" like gasoline, dissolved compounds like landfill leachate, or "sinkers" like some chlorinated solvents ("DNAPLs")- will also control the specific design requirements of the well. Variances from the specifications described may be sought from the WAS project manager coordinating the well installation. Also, the Administration may require additional or more stringent construction specifications for any well where site conditions warrant it.

16. Any wells which are to be abandoned, and which are located at or near a solid waste disposal facility, must be abandoned so that the appropriate section of the Well Drilling regulations addressing abandonment is carefully followed. Casing must be removed, drilled out, or thoroughly split or pierced, and the entire well and gravel pack completely filled with Portland cement grout from the base of the former boring to the ground surface.

17. Placement of wells through refuse should be avoided. If it is impossible to site an accessible well at a place which is not on fill and still adequately monitor the facility, then the boring must be drilled or reamed out to at least a twelve inch (12") diameter into the next confining layer below the waste or where no clay layers occur to a depth at least five feet below the lowest occurrence of waste, and a steel casing of at least an eight inch internal diameter (8" I.D.) grouted in place with Portland cement or a mixture of Portland cement and bentonite as discussed above. After the grout has cured, drilling may commence in the boring at the previous diameter inside the steel pipe. The annular space between the steel outer casing and the 4" main well casing is to be grouted normally upon completion of the drilling. Alternative designs of an equally protective nature may be proposed. **Construction details of wells to be placed through waste MUST be approved by this Administration in advance, and a variance obtained for this construction in the well construction permit.**

18. For sites not located in the Coastal Plain physiographic province, or which are located along the Fall Line where bedrock is encountered at shallow depths, if groundwater is found in a boring above the bedrock/saprolite interface, two wells must be installed at that location in near proximity to each other, although not in the same boring. One well is to be screened in the weathered zone above the bedrock as defined by auger refusal, and the other is to be screened in a productive bedrock zone. If water is not found above bedrock, then the first productive zone or zones encountered that cumulatively produce at least 1 gallon per minute should be screened.

For sites on the Coastal Plain, the occurrence of noncontinuous confining layers or clay lenses on the site may require the installation of similar well clusters. This is typically required where clays greater than one foot thick are observed within 50 feet of the ground surface, where a lower zone is thought to be uncontaminated but needs to be evaluated, or where a plume of mixed contaminants (e.g., "floaters" and "sinkers") might be separating into different levels of the aquifer. In some cases such clusters may have to consist of 3 or 4 wells, each screened at different levels. Each well in a cluster must be installed in an individual boring; multiple casing installation in one boring is not acceptable.

19. Except for wells installed at petroleum product distribution facilities (e.g., gas stations), no well should be set less than fifteen feet (15') into the saturated zone without consultation and approval by the WAS project manager. Significant confining layers (e.g., sedimentary clays > 1 foot thick, fire-clay below coal seams, etc.) should not be penetrated without similar approval.

Also, wells generally should not be overdrilled to a depth greater than 5' below the elevation at which the screen is to be set, to avoid cross-contamination of deeper zones and averaging of hydraulic pressure across the open interval. When overdrilling is required, as in cases where a site is being investigated for the first time, the hole should be grouted with Portland cement up to the bottom of the selected screened interval and the grout allowed to fully cure before the screen is set. The well should also be developed with particular care to avoid residual cement contamination in subsequent water samples.

20. Unless the geological setting is well defined, continuous core-sampling (in rock) or split-spoon or Shelby-tube sampling (in sediments and soils) should be performed so that the correct location of the screen can be verified during drilling. The anticipated zone in which the screen should be set should be established and approved by the Administration prior to drilling. If conditions are not sufficiently well defined to permit absolute identification of the conditions to be encountered beforehand, then a protocol for choosing the proper zone should be established in advance. In the case of shallow monitoring wells, generally the first zone or zones which cumulatively yield 1 gallon per minute or more should be screened.

21. All monitoring wells must be accessible to 4-wheel drive vehicles. Any mounds of dirt, vegetation, etc., must be removed or bridged, and any stormwater control devices, fences or other necessary restrictions to access be constructed so that access to the wells is possible upon reasonable request without prior notice. All-weather access roads to the wells must be maintained in a serviceable condition.

22. These standards generally apply to the installation of piezometers installed strictly for water level exploration and monitoring; however, the following variances are typically allowed for piezometers:

a) Casing diameters less than 4";

b) Boring diameters less than 8";

c) Screened intervals less than 10'; and

d) Solvent-welded plastic casing above the water table.

These details should be discussed with and approved in advance by with the WAS project manager.

23. Alternative designs may be requested, but a demonstration that the requested changes will provide equal or superior performance must be submitted to MDE, and approved prior to implementation, or the monitoring system will not be deemed to be acceptable to MDE. Examples include the use of narrow diameter wells for use with low-flow sampling systems.

24. Where a conflict exists between these specifications and the more general well construction requirements of COMAR 26.04.04, a variance for the required construction may be obtained from the local County Health Department. Questions concerning this matter may be referred to the WAS project manager or facility inspector, or to the Solid Waste Program at (410)-537-3424.

Project Manager....____________________....(410)-___-_____

EMD:emd

Tuesday, February 09, 2010

Appendix B

Standard Operating Procedure No. 025 for Soil Sampling

Standard Operating Procedure No. 025
for
Soil Sampling

Prepared by

EA Engineering, Science, and Technology, Inc.
11019 McCormick Road
Hunt Valley, Maryland 21031

Revision 0
August 2007

CONTENTS

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to delineate protocols for sampling surface and subsurface soils. Soil samples give an indication of the area and depth of site contamination, so a representative sample is very important.

2. MATERIALS

The following materials may be required:

Bucket auger or push tube sampler	Split-spoon, Shelby tube, or core barrel sampler
Drill rig and associated equipment	Stainless steel bowl
Personal protective equipment as required by the Health and Safety Plan	Stainless steel spoon, trowel, knife, spatula (as needed)

3. PROCEDURE

3.1 SUBSURFACE SAMPLES

Don personal protective equipment. Collect split-spoon, core barrel, or Shelby Tube samples during drilling. Upon opening sampler, or extruding sample, immediately screen soil for volatile organic compounds using either a photoionization detector or flame ionization detector. If sampling for volatile organic compounds, determining the area of highest concentration, use a stainless steel knife, trowel, or laboratory spatula to peel and sample this area. Log the sample in the Field Logbook while it is still in the sampler. Peel and transfer the remaining sample in a decontaminated stainless steel bowl. Mix thoroughly with a decontaminated stainless steel spoon or trowel. Place the sample into the required number of sample jars. Preserve samples as required. Discard any remaining sample into the drums being used for collection of cuttings. Decon sampling implements. All borings will be abandoned.

NOTE: If sample recoveries are poor, it may be necessary to composite samples before placing them in jars. In this case, the procedure will be the same, except that two split-spoon samples will be mixed together. The Field Logbook should clearly state that the samples have been composited, which samples were composited, and why the compositing was done.

Samples taken for geotechnical analysis will be undisturbed samples, collected using a thin-walled (Shelby tube) sampler.

3.2 SURFICIAL SOIL SAMPLES

Don personal protective equipment. Remove vegetative mat. Collect a sample from under the vegetative mat with a stainless steel trowel, push tube sampler, or bucket auger. If a representative sample is desired over the depth of a shallow hole or if several shallow samples are to be taken to represent an area, composite as follows:

- As each sample is collected, place a standard volume in a stainless steel bowl.
- After all samples from each hole or area are in the bucket, homogenize the sample thoroughly with a decontaminated stainless steel spoon or spatula.

If no compositing is to occur, place sample directly into the sample jars. Place the leftover soil in the auger borings and holes left by sampling. If necessary, add clean sand to bring the subsampling areas back to original grade. Replace the vegetative mat over the disturbed areas. Samples for volatile organic compounds will not be composited. A separate sample will be taken from a central location of the area being composited and transferred directly from the sampler to the sample container. Preserve samples as required. Decon sampling implements.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

Refer to the Health and Safety Plan.

Soil samples will not include vegetative matter, rocks, or pebbles, unless the latter are part of the overall soil matrix.

6. REFERENCES

American Society for Testing and Materials (ASTM). Method D1586-84, Penetration Test and Split-Barrel Sampling of Soils.

ASTM. Method D1587-83, Thin Walled Sampling of Soils.

Department of the Army, Office of the Chief of Engineers. 1972. Engineer Manual 1110-2-1907 Soil Sampling. 31 March.

Appendix C

Injectate Material Safety Data Sheet

MODIFIED MATERIAL SAFETY DATA SHEET: USA

Remediation and Natural Attenuation Services Incorporated
6712 West River Road
Brooklyn Center, MN 55430

Product Information: 763-585-6191 Issue Date: March 28, 2002

Section 1: IDENTIFICATION

1.1 Product Name: Newman Zone
1.2 Product Type: Inedible Industrial Nutrient for Microbial Organisms
1.3 Hazard Rating: Health: 1 Fire: 1 Reactivity: 1
1.4 Formula: Proprietary

Substances Subject to SARA 313 Reporting Are Indicated by "#"

It is our opinion that the above named product does not meet the definition of "hazardous Chemical" as defined in the OSHA "Hazard Communication Standard" regulation 29 CFR 1910.1200. This material Safety Data Sheet is provided as general information for health and safety guidelines.

Section 2: INGREDIENTS/COMPOSITION

	CAS No.	%	PEL (mg/m^3)	TWA (mg/m^3)
Soybean Oil (food grade)	8001-22-7	45	15(Mist)	10(Mist)
Sodium-L-Lactate	867-56-1	4		
Food Additives/Emulsifiers/Preservatives	(Proprietary)	<10		
Water		<45		

EMERGENCY ONLY, 24-HOUR SERVICE: CHEMTREC: 1-800-424-9300

Section 3: PHYSICAL AND CHEMICAL CHARACTERISTICS

This section completed per formulation ingredient data unless stated.

- Solubility: Dispersible in water (product)
- PH: 6 (product)
- Specific Gravity: 0.98 (product)
- Boiling Point: NA
- Vapor Pressure: NA
- Vapor Density: NA
- Percent Volatile By Volume (%): NA
- Evaporation Rate: NA
- Viscosity: 23.6 cps @ 68°F (Brookfield)(product)
- Product Appearance and Odor: Light yellow-cream colored liquid, vegetable oil odor.

==

Section 4: FIRE AND EXPLOSION HAZARDS

This section completed per formulation ingredient data unless stated.

4.1 Special Fire Hazards: Product - none, does not support combustion.

Flash Point: >540 degrees F (Pure Soybean Oil Closed Cup).
Flammable Limits
LEL ND
UEL ND

4.2 Fire Fighting Methods: Use method appropriate for surrounding fire.

4.3 Extinguishing Media: Dry Chemical or CO_2 Preferable; water may cause spattering or spreading.

==

Section 5: HEALTH HAZARD DATA

5.1 THIS PRODUCT IS NEITHER INTENDED NOR MANUFACTURED FOR HUMAN OR ANIMAL CONSUMPTION AND SHOULD NOT BE USED FOR FOOD OR FEEDSTUFFS.

5.2 Effects of Overexposure: NA

5.3 Emergency and First Aid Procedures: If inhaled, remove from contaminated atmosphere. For eye contact immediately flush eyes with large amounts of water. Ensure rinsing entire surface of eye & under lid. For skin contact wash affected areas thoroughly with soap and water. Seek medical help for persistent irritation.

5.4 Hydrolyzed soy protein has been identified by the United States Food and Drug Administration as a food allergen. Symptoms include swelling of the lips, stomach cramps, vomiting, diarrhea, skin hives, rashes, eczema and breathing problems.

5.5 Occupational Exposure Limits [8-hour time weighted averages (TWA)]:

	CAS No.	mg/m^3 OSHA PEL/ACGIH TLV
Soybean Oil (food grade)	8001-22-7	15(Mist)/10(Mist)

==

Section 6: REACTIVITY DATA

This section completed per formulation ingredient data unless stated.

6.1 Stability: Stable under normal conditions.

6.2 Conditions to Avoid: NA

6.3 Incompatibilities: None known

6.4 Hazardous Decomposition Products: Product - None identified. Ingredients - Carbon oxides. Biological decomposition (spoilage) may result in offensive odors.

6.5 Hazardous Polymerization; None known

===

Section 7: SPILL OR LEAK PROCEDURES

This section completed per formulation ingredient data unless stated.

7.1 Spill Response: Water dispersible. Same as for vegetable oil spills: isolate spill, prevent from entering waterways, and sewer systems. Sorb or remove spilled materials as soon as possible. Oils and specific quantities of oils may be reportable under federal, state, or local regulations.

7.2 Waste Disposal Method: This product is not hazardous, however, wastes must be disposed in accordance with local, state or federal regulations. Consult with local sewer authority, or solid waste facility prior to disposition.

===

Section 8: SPECIAL PRECAUTIONS

No protective equipment is necessary under normal use conditions.

8.1 Eyes: If splashing may occur, eye protection recommended.
8.3 Skin: Wear impervious gloves for prolonged or repeated exposure.
8.4 Respiratory: Avoid breathing mists of this product

===

Section 9: TRANSPORTATION PRECAUTIONS

This section completed per formulation ingredient data unless stated.

9.1 Transportation Considerations: This product is not classified as dangerous in the meaning of transport regulations. Shippers and transporters may need to meet packaging and transportation requirements for certain oils and respective quantities under CFR 49 Part 130.

The above information is believed to be correct with respect to the formula used to manufacture the product in the country of origin. As data, standards, and regulations change, and conditions of use and handling are beyond our control, NO WARRANTY, EXPRESS OR IMPLIED, IS MADE AS TO THE COMPLETENESS OR CONTINUING ACCURACY OF THIS INFORMATION.

****
SECTION I PRODUCT IDENTIFICATION
****

PRODUCT NAME: MAGNESIUM HYDROXIDE SOLUTION

MSDS #: P14725V

DATE ISSUED: 04/17/2000

SUPERSEDES: 08/08/1997

ISSUED BY: 008497

REVIEWED DATE: 07/16/2004

This MSDS has been reviewed on 07/16/2004, and is current as of the DATE ISSUED above.

SECTION I Chemical Product And Company Identification

Product Name: Magnesium Hydroxide Solution
Hi-Chem Mag-50

CAS NUMBER: 1309-42-8

Distributed by:
Univar USA Inc.
17425 NE Union Hill Road
Redmond, WA 98052
425-889-3400

Section II Composition/Information On Ingredients

Chemical Name	CAS Number	%	Exposure Limits (TWAs) in Air ACGIH TLV	OSHA PEL	STEL
Magnesium Hydroxide	1309-42-8	51-65	10 mg/m3 (total dust) 5 mg/m3 (respirable dust)	15 mg/m3 (total dust)	N/A

Section III Hazard Identification

ROUTES OF EXPOSURE: N/A

SUMMARY OF ACUTE HEALTH HAZARDS The product presents a very low health risk. Magnesium hydroxide is a general purpose food additive. Dust generated from the dried product is classified as a nuisance dust.

INGESTION: Ingestion is unlikely. If ingested in sufficient quantity, may cause gastrointestinal disturbances. Symptoms may include irritation, nausea, vomiting, abdominal pain and diarrhea.

INHALATION: May irritate the respiratory tract on prolonged or repeated contact. May aggravate preexisting respiratory conditions.

SKIN: Repeated or prolonged contact may cause irritation

EYES: May irritate or injure eyes.

SUMMARY OF CHRONIC HEALTH HAZARDS: The excessive inhalation above (TLV) of mineral dust, over long periods of time, may cause industrial bronchitis, reduce breathing capacity, and lead to increased susceptibility to other lung disease.

SIGNS AND SYMPTOMS OF EXPOSURE: N/A
EFFECTS OF OVEREXPOSURE: N/A

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: Dust from the dried product may aggravate pre-existing chronic lung conditions such as, but not limited to, bronchitis, emphysema, and asthma.

NOTES TO PHYSICIANS: N/A

Section IV First Aid Measures

INGESTION: Low toxicity. Give 1-2 glasses of water and seek immediate medical attention. Never give anything of mouth to an unconscious person. Leave decision to induce vomiting for medical personnel, since some particles may be aspirated into the lungs.

INHALATION: Move to fresh air; if discomfort persists, get medical attention.

SKIN: Wash with soap and water

EYES: Irrigate immediately with plenty of water. Obtain medical attention if necessary.

Section V Fire Fighting Measures

FLASH POINT: N/A
AUTOIGNITION TEMPERATURE: N/A
LOWER EXPLOSIVE LIMIT: N/A
UPPER EXPLOSIVE LIMIT: N/A
UNUSUAL FIRE AND EXPLOSION HAZARDS: N/A
EXTINGUISHING MEDIA: N/A
SPECIAL FIREFIGHTING PROCEDURES:
FIREFIGHTERS SHOULD WEAR NIOSH-APPROVED, POSITIVE PRESSURE, SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING WHEN APPROPRIATE.

Section VI Accidental Release Measures

Dike the spilled liquid, and either pump back into original container or cover with clay-type substance for absorption.

Section VII Handling and Storage

Store at ambient temperature. Prevent possible eye and skin contact by wearing protective clothing and equipment.

Section VIII Exposure Controls/Personal Protection

RESPIRATORY PROTECTION: Respirator approved by NIOSH/MSHA are adequate for contaminate concentrations encountered.
VENTILATION: N/A
PROTECTIVE CLOTHING: Gloves are recommended, rubber gloves re recommended when repeated or prolonged contact is likely.

EYE PROTECTION: Safety glasses are recommended.
OTHER PROTECTIVE CLOTHING OR EQUIPMENT: N/A
WORK/HYGIENIC PRACTICES: Avoid contact with the eyes and skin.

Section IX Physical and Chemical Properties

PHYSICAL STATE:	Milky liquid
MELTING POINT/RANGE:	N/A
pH:	10-11
BOILING POINT/RANGE:	212 DEG F, 100 DEG C
APPEARANCE/COLOR ODOR:	White - Off white, No odor
SOLUBILITY IN WATER:	NIL

SPECIFIC GRAVITY (Water = 1): 1.4-1.5
VAPOR DENSITY (Air = 1): N/A
VAPOR PRESSURE (mmHg): N/A
MOLECULAR WEIGHT: N/A
% OF SOLUTION: 48-51 51-55 61-65
% VOLATILES: 49-52 45-49 35-39

Section X Stability and Reactivity

STABILITY: Stable HAZARDOUS POLYMERIZATION: Will Not Occur

CONDITIONS TO AVOID: N/A

MATERIALS TO AVOID: Acids and maleic anhydride Magnesium hydroxide is soluble in aqueous acids generating heat.

HAZARDOUS DECOMPOSITION PRODUCTS: HEAT AND STEAM

Section XI Toxicological Information

N/A

Section XII Ecological Information

N/A

Section XIII disposal Considerations

May be disposed of in a secured sanitary landfill. Disposal must be done in accordance with Local, State, and Federal regulations.

Section XIV Transport Information

DOT Proper Shipping Name: N/A
DOT Hazard Class/I.D. No: N/A

Section XV Regulatory Information

Reportable Quantity: N/A
NFPA Rating: Health - 1; Fire - 0; Reactivity - 0
0 = Insignificant 1 = Slight 2 = Moderate 3 = High 4 = Extreme
Carcinogenicity Lists: No NTP: No IARC Monograph: No OSHA Regulated: No

Section XVI Other information

SYNONYMS/ COMMON NAMES: Brucite
CHEMICAL FAMILY TYPE: Magnesium Hydroxide

------------------------- FOR ADDITIONAL INFORMATION -------------------------
CONTACT: MSDS COORDINATOR UNIVAR USA INC.
DURING BUSINESS HOURS, PACIFIC TIME (425)889-3400
----------------------------------- NOTICE -----------------------------------

DO NOT USE INGREDIENT INFORMATION AND/OR INGREDIENT PERCENTAGES IN THIS MSDS AS A PRODUCT SPECIFICATION. FOR PRODUCT SPECIFICATION INFORMATION REFER TO A PRODUCT SPECIFICATION SHEET AND/OR A CERTIFICATE OF ANALYSIS. THESE CAN BE OBTAINED FROM YOUR LOCAL UNIVAR SALES OFFICE.

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*** END OF MSDS ***

Manufacturer Name and Address JRW Bioremediation, LLC **14321 W. 96th Terrace** **Lenexa, KS 66215** **Emergency Phone: 913-438-5544**	**Material Safety Data Sheet** **CHITOREM™ chitin complex**

1 Product Identification

Trade name: **CHITOREM chitin complex**

2 Composition

Chitin Chemical names: protein carbonate	beta-(1,4)-2-acetamido-2-deoxy-D-glucose
Source	crab shell

3 Physical/Chemical Characteristics

Appearance and odor	Crab meal has a mixed light brownish color of granular and flaked particles, with a crab odor
Solubility	Insoluble in water, alcohols, and most acids
Chemical formula	$C_8H_{13}NO_5$ (chitin)
Density	+/- 25 lbs./CF

4 Toxicological Data

Acute oral, LD50 (mice)	> 10 g / kg

5 Fire & Explosion Hazard Data

Flash Point	NA
Flammability	Keep away from oxidizing agents and avoid open flames. Product may ignite at temperatures In excess of 400° F.
Unusual Fire and Explosion Hazards	Depending on moisture content, and particle size, airborne dust of chitin might explode in the presence of an ignition source. It is comparable to flour and wood dust. Dust explosion limits unknown
Fire Fighting Media	Use water, dry chemicals, carbon dioxide, sand, or foam.

6 Health Hazards Information

Acute Health Effects - Signs and Symptoms of Exposure, Emergency and First Aid Procedures	EYE CONTACT: Chitin powder may cause mechanical irritation. Treat powder in eye as foreign object. Flush with water to remove. SKIN CONTACT: The powder can cause irritation or rash. Seek medical help if it persists. INHALATION: Chitin may aggravate preexisting respiratory conditions or allergies. It may accumulate on linings of the nose and lungs resulting in dryness and coughing. Remove to fresh air. Get medical help if persistent irritation or breathing difficulties occur. INGESTION: Not likely to be hazardous by ingestion.
Potential Chronic Health Effects	There is no known effect from chronic exposure to this product.
Carcinogenicity	Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA

7 Personal Protective Equipment

Respiratory protection	A NIOSH/MSHA-approved respirator is recommended when the dust is airborne
Protective gloves	Not required. However cloth or plastic gloves are recommended to minimize potential mechanical irritation from handling.
Eye protection	Goggles are recommended when there is a high level of airborne dust.
Other protective clothing	Not needed

8 Regulatory

TSCA	Listed on the TSCA inventory
SARA Section 302	Does not have an RQ or TPQ
SARA Section 313	Not reportable under Section 313
Clean Air Act	This material does not contain any hazardous air pollutants.
Clean Water Act	Not listed as Hazardous Substance, Priority Pollutant or Toxic Pollutant
OSHA	Not considered hazardous
DOT	Shipping name: Chitin Class: 50, Not regulated

9 Storage, Handling and Disposal

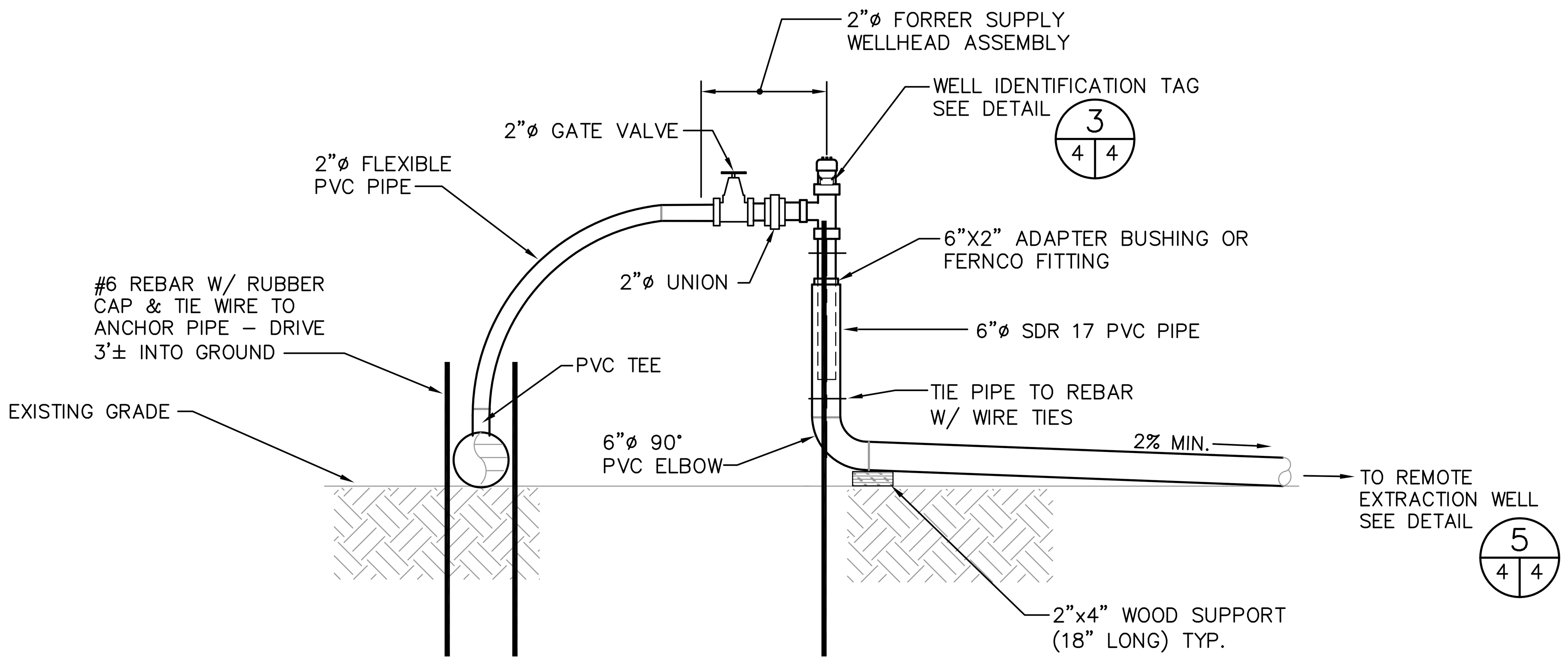
Storage	Store in a cool, dry place away from open flames and strong oxidizers.
For spills of Chitin	The material may be vacuumed or collected for recovery or disposal.
Waste disposal method	Land disposal is acceptable. The material is biodegradable. Follow local, state, and federal regulations.

Work / hygiene practices	Follow good hygienic and housekeeping practices. Clean up areas where Chitin dust settles to avoid excessive accumulation of this combustible material. Minimize blow down, sweeping, or other practices that generate high airborne dust concentrations. Wash to remove dust after use.

Prepared by: P.L.	**Revision Date:** 11/28/2005

Appendix D

As-Built Details



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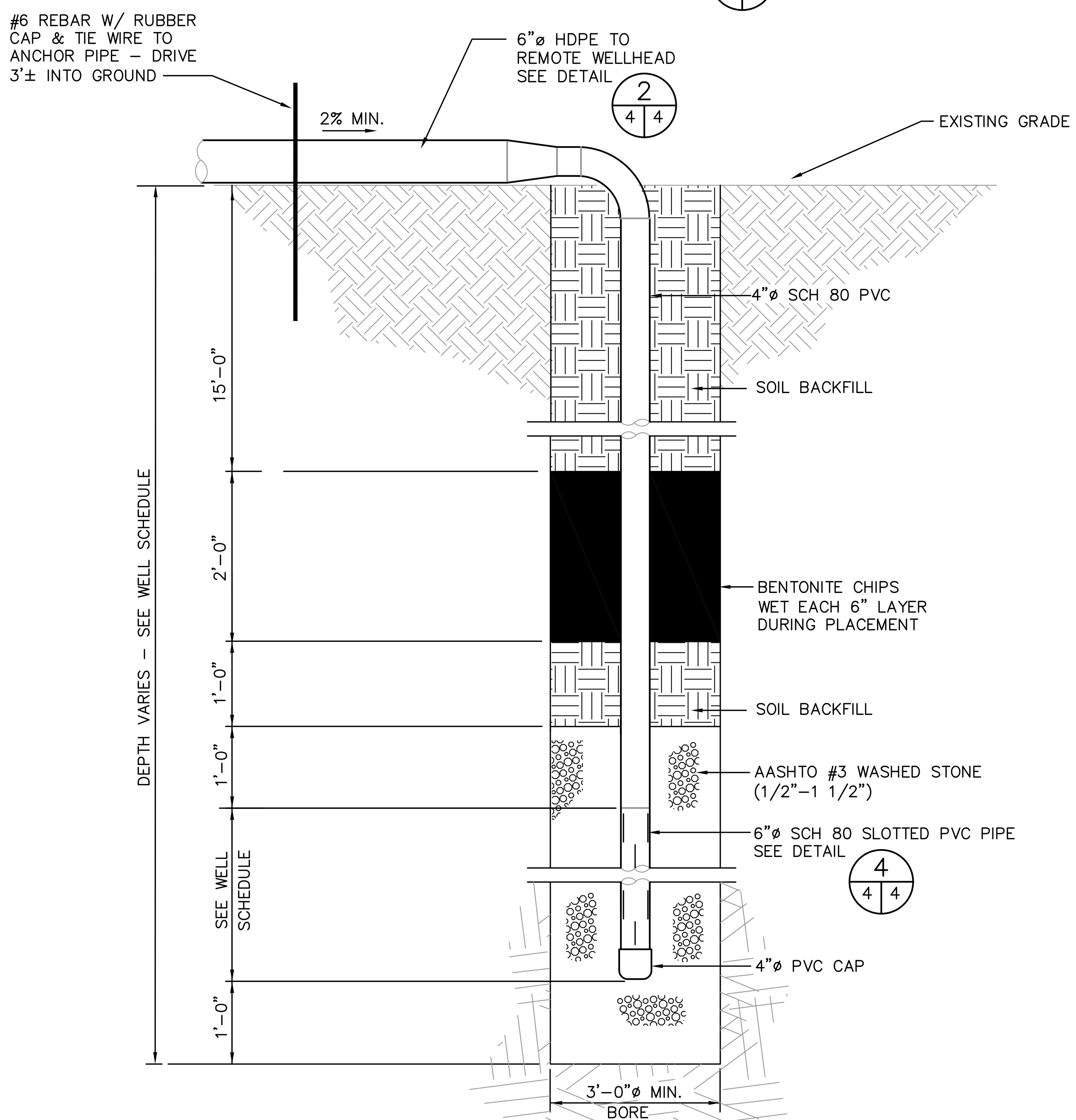

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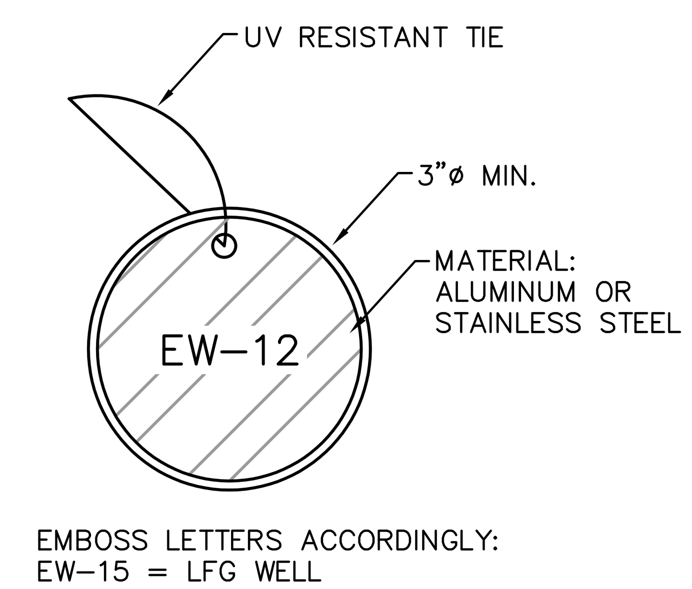
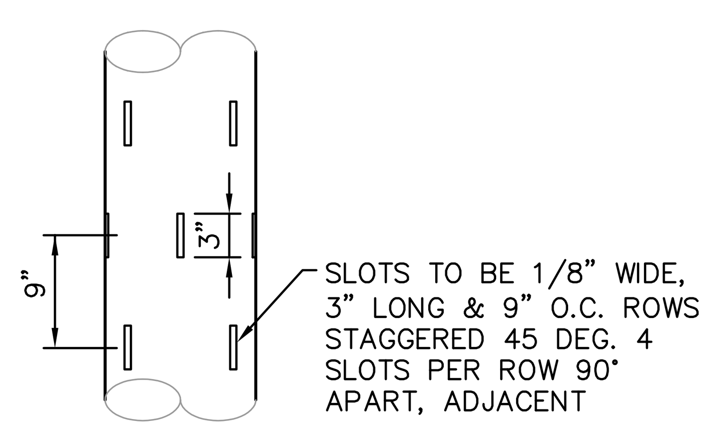
N.T.S.



IDENTIFICATION TAG DETAIL 3 4 4
N.T.S



SLOTTED PIPE DETAIL 4 4 4
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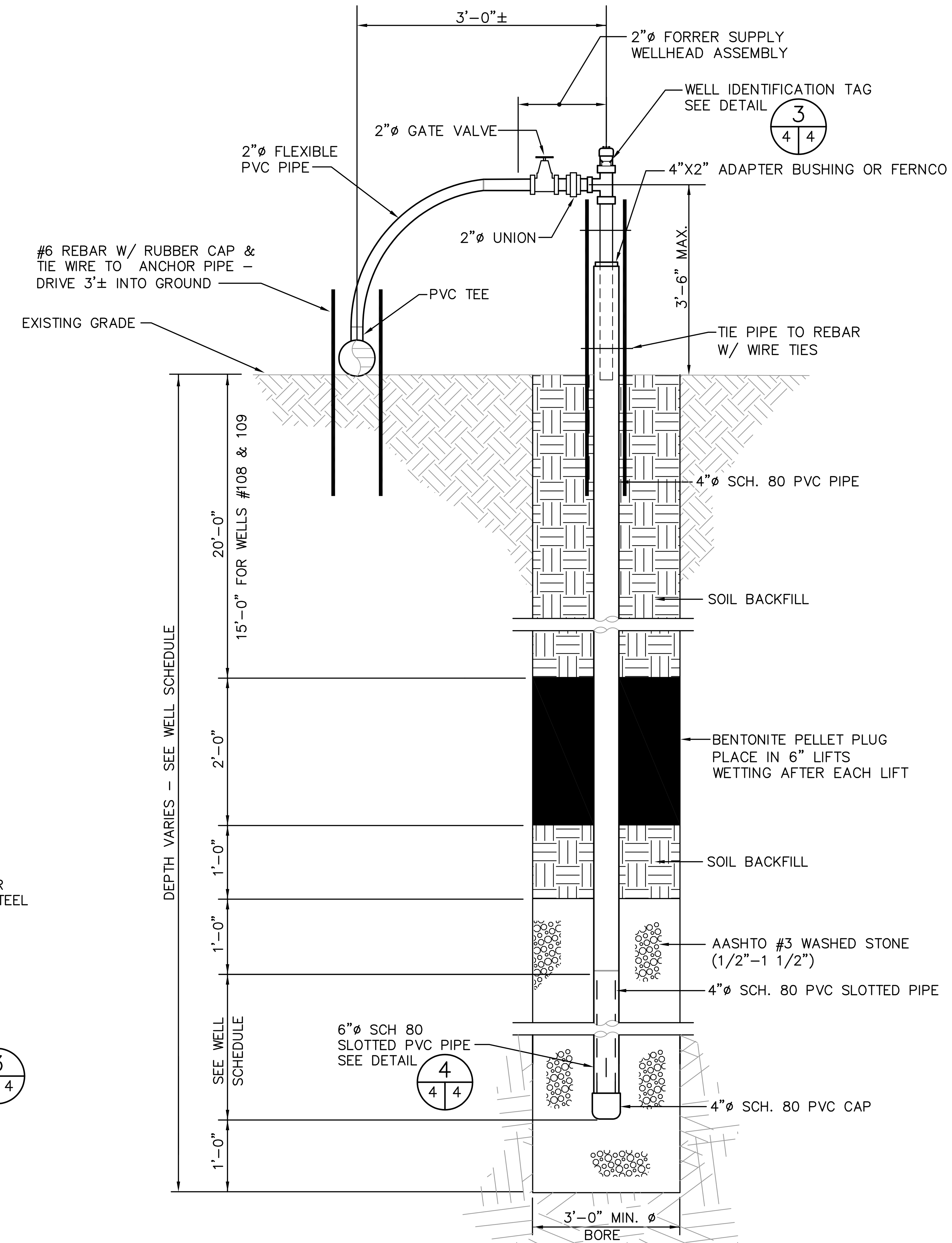


EXTRACTION WELL DETAIL 1 2,3 4
SCALE: 1"=1'–0"

DETAILS AS–BUILT

DATE	REVISION	NO.
		1
		2
		3
		4
		5

SHEET TITLE
LFG SYSTEM DETAILS (1)

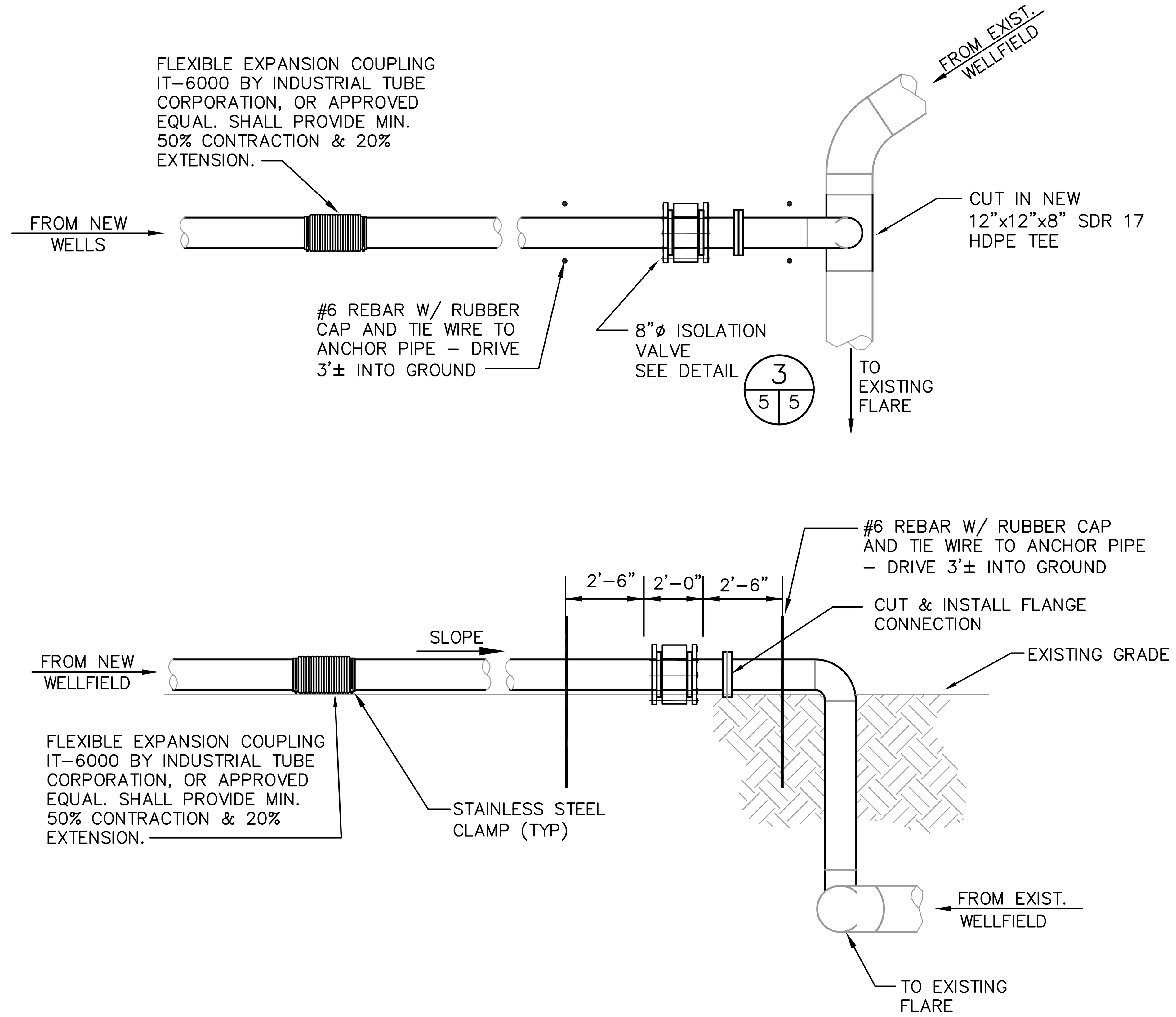
PROJECT TITLE
GUDE LANDFILL
LANDFILL GAS SYSTEM

CLIENT
MONTGOMERY COUNTY
DPWT/DSWS
16101 FREDERICK ROAD
DERWOOD, MARYLAND 20855

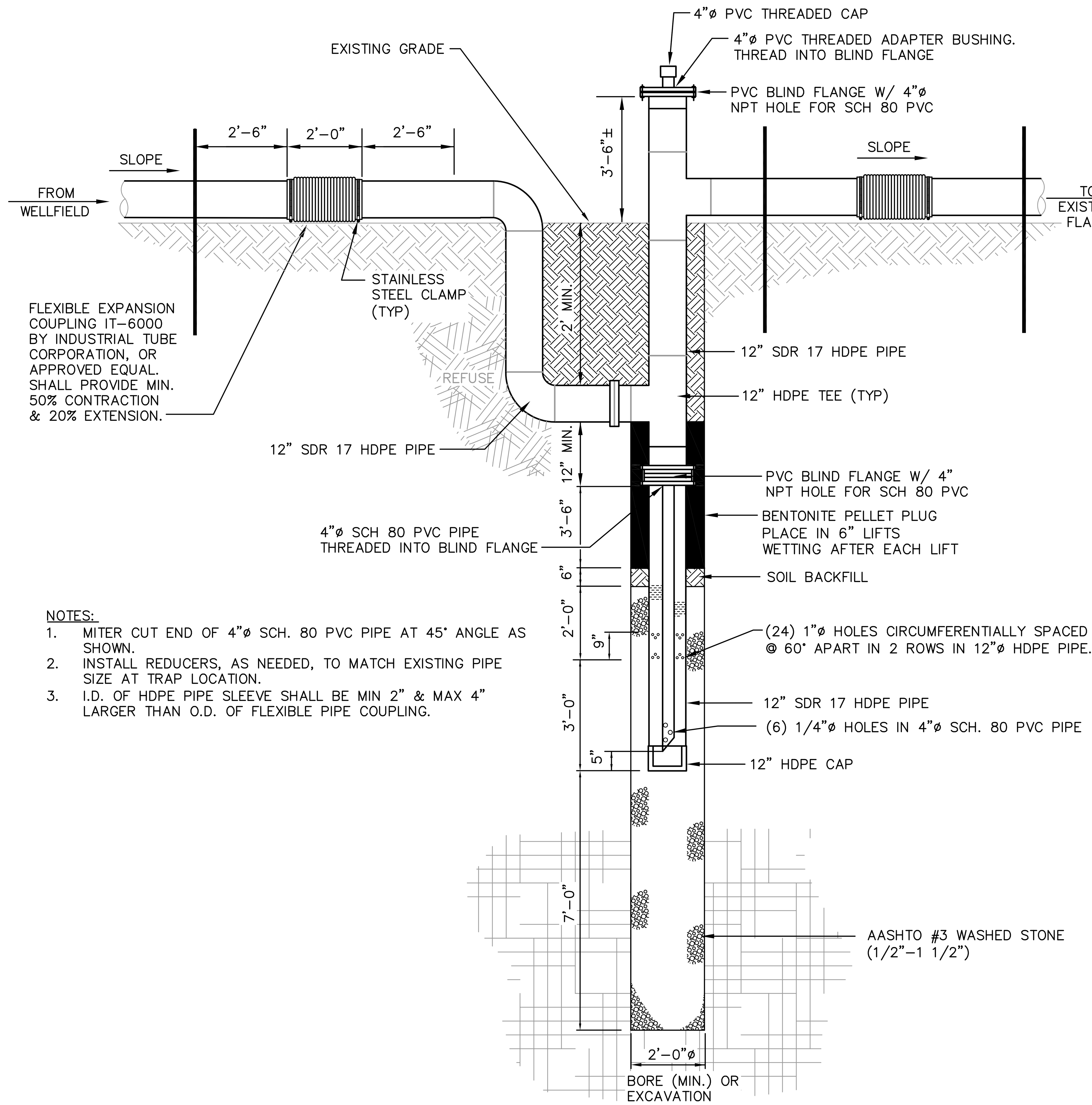
SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS, INC.
11260 ROGER BACON DRIVE, RESTON, VA 20190
PH. (703) 471-6150 FAX. (703) 471-6676

PROJ. NO. 02203039.07 | DWN. BY: MAK/DJD | Q/A RVW BY: MAK
DSN. BY: MAK | CHK. BY: MAK | APP. BY: MAK

CADD FILE: 4–5 DETAILS
DATE: 9.18.08
SCALE: AS SHOWN
DRAWING NO. **4** of **5**



TIE IN NEW HEADER TO EXISTING DETAIL (2, 3|5)
N.T.S.

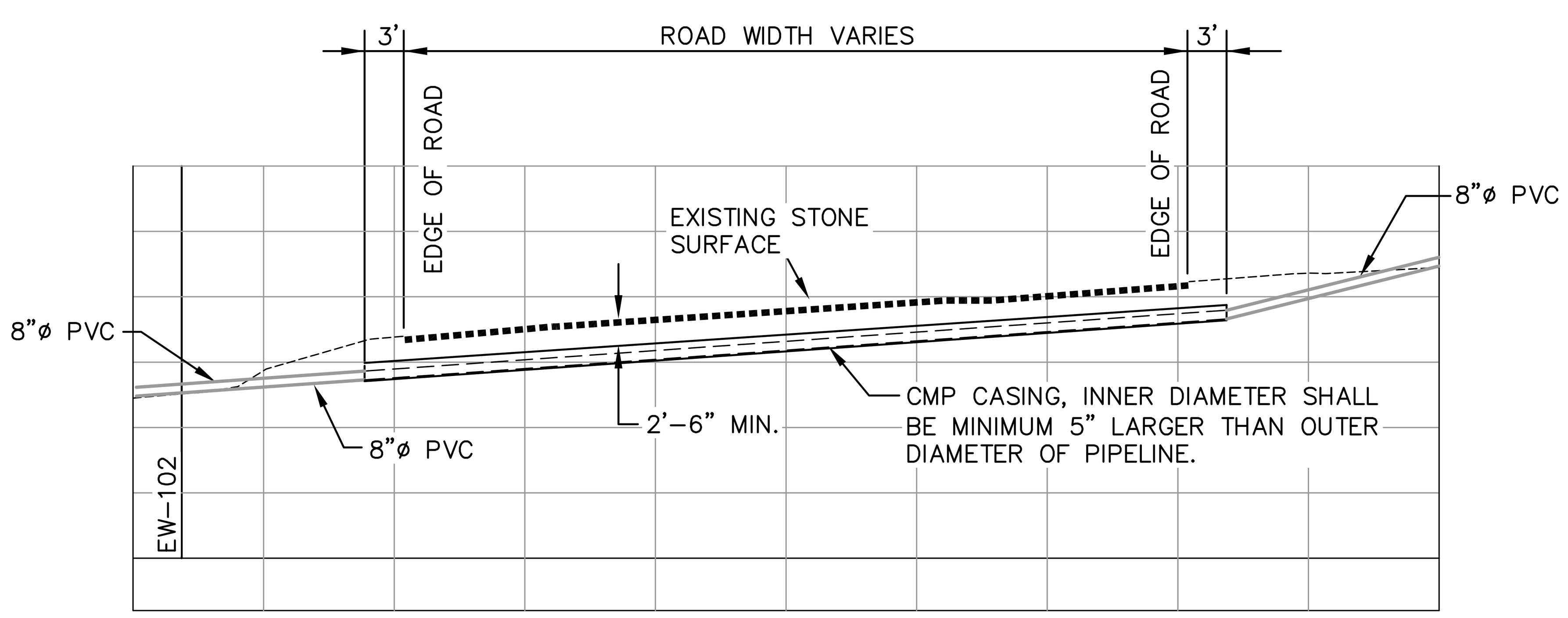


NOTES:

1. MITER CUT END OF 4"ø SCH. 80 PVC PIPE AT 45° ANGLE AS SHOWN.
2. INSTALL REDUCERS, AS NEEDED, TO MATCH EXISTING PIPE SIZE AT TRAP LOCATION.
3. I.D. OF HDPE PIPE SLEEVE SHALL BE MIN 2" & MAX 4" LARGER THAN O.D. OF FLEXIBLE PIPE COUPLING.

SELF DRAINING CONDENSATE TRAP (1, 2,3|5)
N.T.S.

NOTE:
CONTRACTOR SHALL RESTORE ACCESS ROAD TO MATCH ORIGINAL CONDITIONS.



ROAD CROSSING DETAIL (4, 3|5)
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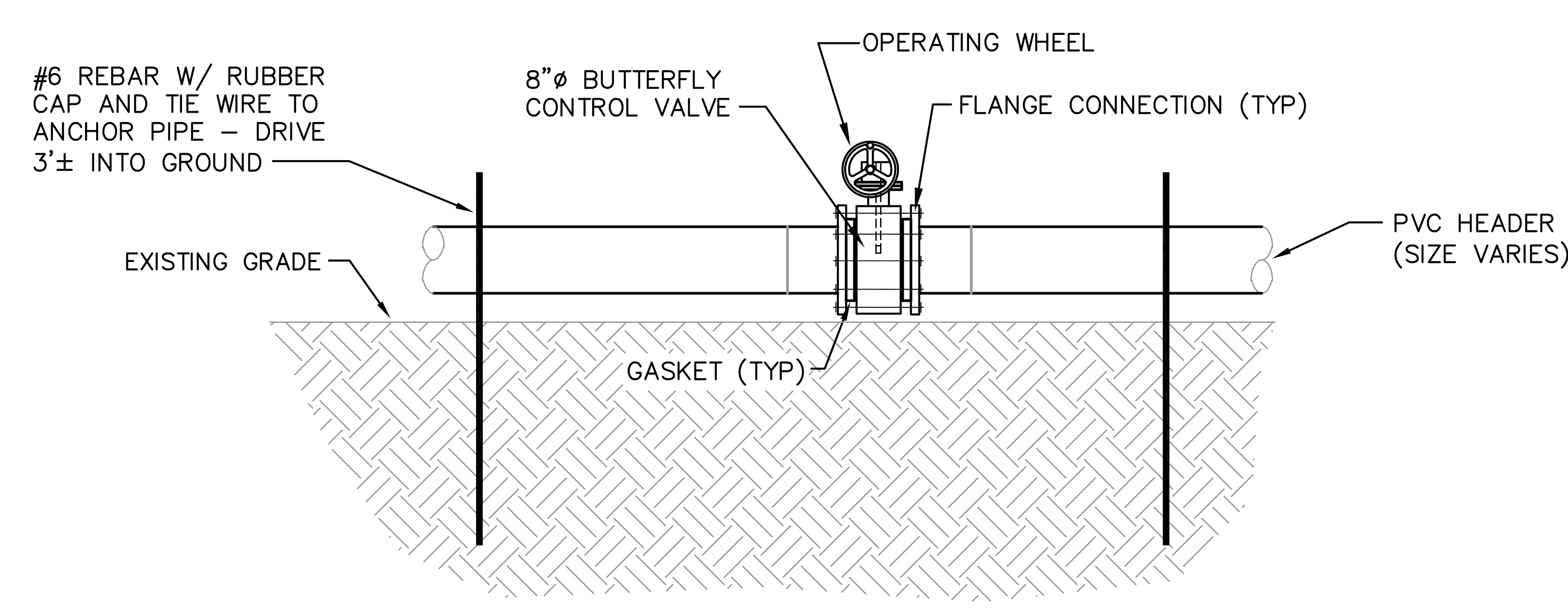

ABOVEGROUND ISOLATION VALVE DETAIL (3, 2,3,4|5)
N.T.S.

DETAILS AS-BUILT

NO.	REVISION	DATE

SHEET TITLE: LFG SYSTEM DETAILS (2)

PROJECT TITLE: GUDE LANDFILL LANDFILL GAS SYSTEM

CLIENT: MONTGOMERY COUNTY DPWT/DSWS 16101 FREDERICK ROAD DERWOOD, MARYLAND 20855

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS, INC.
11260 ROGER BACON DRIVE - RESTON, VA 20190
PH. (703) 471-6150 FAX (703) 471-6676

PROJ. NO. 02203039.07 | DSN. BY: MAK | DWN. BY: MAK/DJD | CHK. BY: MAK | Q/A RVW BY: MAK | APP. BY: MAK

CADD FILE: 4-5 DETAILS

DATE: 9.18.08

SCALE: N.T.S.

DRAWING NO. 5 of 5