



**LANDFILL GAS MONITORING
PLAN**

CLOSED CONSTRUCTION AND DEMOLITION LANDFILL

Closed Henderson County Landfill, Permit No. 45-01
Henderson County, North Carolina

Submitted To:



Henderson County Solid Waste Division
802 Stoney Mountain Road
Hendersonville, NC 28791 USA

Submitted By: Golder Associates NC, Inc.
5B Oak Branch Drive
Greensboro, NC. 27407 USA

January 2012

0839-650611.500

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January 20, 2012

0839-650611.500

Ms. Jackie Drummond
Department of Environment and Natural Resources
Division of Waste Management
Solid Waste Section
401 Oberlin Road, Suite 150
Raleigh, North Carolina 27605
919-733-4996

**RE: LANDFILL GAS MONITORING PLAN FOR THE CLOSED CONSTRUCTION AND
DEMOLITION LANDFILL
CLOSED HENDERSON COUNTY LANDFILL, PERMIT NO. 45-01
HENDERSON COUNTY, NORTH CAROLINA**

Dear Jackie:

On behalf of Henderson County, Golder Associates NC, Inc. (Golder) is submitting the enclosed *Landfill Gas Monitoring Plan* for the closed construction and demolition landfill at the Henderson County Landfill. *The Landfill Gas Monitoring Plan* has been prepared in accordance with the North Carolina Solid Waste Management Rules 15A NCAC 13B.0544, which require quarterly monitoring of methane gas and other explosive landfill gases to ensure that landfill gas does not exceed the lower explosive limit (LEL) at the facility property boundary or 25 percent of the LEL in facility structures. If you have any questions, please contact the undersigned at 336-852-4903.

Sincerely,

GOLDER ASSOCIATES NC, INC.

A handwritten signature in blue ink, appearing to read 'Dusty Y. Reedy II'.

David "Dusty" Y. Reedy II, P.G.
Senior Project Hydrogeologist

A handwritten signature in blue ink, appearing to read 'Rachel P. Kirkman'.

Rachel P. Kirkman, P.G.
Associate and Senior Geologist

C: Marcus Jones, P.E., Director of Engineering, Henderson County, 100 North King Street, Hendersonville, NC 28792. 828-694-6560. majones@hendersoncountync.org (electronic copy)

Natalie Berry, P.E., Assistant County Engineer, Henderson County Landfill, 802 Stoney Mountain Road, Hendersonville, NC 28791. 828-697-4505. nberry@hendersoncountync.org

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Table of Contents

COVER LETTER

1.0	INTRODUCTION.....	2
1.1	Background	2
1.2	Site Geology.....	2
2.0	LANDFILL GAS MONITORING	2
2.1	Landfill Gas Monitoring Well Locations	2
2.2	Structure and Ambient Sampling	3
2.3	Landfill Gas Monitoring Frequency	3
3.0	LANDFILL GAS SAMPLING PROCEDURES.....	3
3.1	DETECTION EQUIPMENT USED	4
3.2	LANDFILL GAS SAMPLING PROCEDURES.....	4
3.2.1	Landfill Gas Monitoring Well Gas Concentration Measurements	4
3.2.2	Facility Structure Gas Concentration Measurements	5
3.3	WELL DECOMMISSIONING PROCEDURES	5
4.0	RECORD KEEPING AND REPORTING	5
4.1	Landfill Gas Monitoring Form	5
4.2	Sampling Reports.....	6
4.3	Permanent Record Keeping.....	6
6.0	CERTIFICATION.....	7
7.0	REFERENCES.....	7

List of Tables

Table 1 Proposed Landfill Gas Monitoring Well Construction Table

List of Figures

Figure 1 Typical Landfill Gas Monitoring Well Construction Diagram

List of Drawings

Drawing 1 Groundwater Surface Contour Map, September 20-21, 2011
 Drawing 2 Proposed Landfill Gas Monitoring Well Location Map

List of Appendices

Appendix A Landfill Gas Monitoring Form

1.0 INTRODUCTION

This *Landfill Gas Monitoring Plan* will serve as guidance for monitoring landfill gas at the closed construction and demolition (C&D) landfill at the closed Henderson County Landfill in Henderson County, North Carolina in accordance with Title 15A of the North Carolina Administrative Code (NCAC) Subchapter 13B.0544. The Henderson County Landfill, which consists of a closed municipal solid waste (MSW) and a closed construction and demolition (C&D) landfill, is maintained by the County under Permit No. 45-01 issued by the North Carolina Department of Environment and Natural Resources (NCDENR). This *Landfill Gas Monitoring Plan* was prepared under the direction of the NCDENR letter dated May 12, 2011, for the closed C&D landfill (i.e., the Plan does not pertain to the closed MSW landfill).

1.1 Background

The location of the facility is shown on the inlay on Drawing 1. As presented, the closed Henderson County Landfill is located approximately 3 miles northwest of the city of Hendersonville, off Stoney Mountain Road. The County maintains an approximately 120-acre landfill facility that consists of a closed, unlined C&D over MSW facility; a closed, C&D facility; a closed, unlined facility formerly operated by the Tennessee Valley Authority (TVA); and an active transfer station. A white goods area, a mulching area, and a customer convenience center are also present on the property.

The facility has been in operation since the 1940s, beginning with the TVA landfill. In January 1998, the MSW facility ceased accepting MSW waste and began placing C&D waste over the MSW waste. After closure of the C&D-over-MSW area, a new C&D landfill began operation on the southeastern portion of the facility property. The C&D-over-MSW area was capped with a modified clay cap. The County ceased accepting waste at the stand-alone C&D landfill on June 30, 2008, and completed closure activities on June 30, 2009.

Landfill gas is monitored on a quarterly basis at the closed MSW landfill in accordance with the existing Transition Plan for the facility. The MSW landfill also has a landfill gas collection system where gas is conveyed by pipeline to an offsite manufacturing facility for beneficial use. Landfill gas has not historically been monitored at the C&D landfill.

The C&D landfill is bounded to the north and east by residential and undeveloped wooded properties, to the south by residential and wooded properties, and to the west by the closed TVA landfill. A recently opened customer convenience center is located adjacent to the C&D landfill to the northeast.

1.2 Site Geology

Geologically, the facility is located within the Chauga Belt of the Blue Ridge Physiographic Province of North Carolina (NCGS, 1985 and 2004). The Chauga Belt is comprised of Cambrian intrusive metamorphic rocks of monzonitic to granodioritic origin. The Chauga Belt is considered a low-grade

metamorphic part of the Inner Piedmont Belt and is bordered to the west by the Brevard thrust fault zone. The facility is underlain primarily by the Henderson Gneiss which is a medium-gray, biotite granite augen composed of microcline, oligoclase, quartz, biotite, and minor amounts of muscovite, epidote, and titanite (Butler and Secor, 1991). The topography of the area is characterized by rolling, rounded hills with broad valleys and moderately steep ravines typically containing streams.

The uppermost groundwater beneath the facility is present in a shallow, unconfined aquifer comprised of partially weathered, fractured, metamorphic intrusive rock. Topographic relief at the site ranges from an elevation of approximately 2590 feet above mean sea level (AMSL) along the eastern property boundary and slopes downward to the southwest to an approximate elevation of 2170 feet AMSL along the western property boundary. As a result of the varying topographic relief at the site, groundwater occurs at depths of ranging from approximately 6 to 55 feet below grade. Depth-to-water measurements obtained during the September 2011 monitoring event were used to prepare a groundwater surface contour map presented as an overlay on Drawing 1. As presented, the groundwater flow in the uppermost aquifer beneath the site is generally toward the southwest.

2.0 LANDFILL GAS MONITORING

The following sections discuss the proposed locations of landfill gas monitoring wells, the monitoring of structures, and the monitoring frequency.

2.1 Landfill Gas Monitoring Well Locations

Three landfill gas monitoring wells (LFG-101, LFG-102, and LFG-103) are proposed to make up the landfill gas monitoring network for the C&D landfill. The installation of a landfill gas monitoring well LFG-102 was proposed in the Assessment Monitoring Work Plan for the closed C&D landfill, which was submitted to NCDENR on September 21, 2011. The proposed locations on these landfill gas monitoring wells are shown on Drawing 2.

Based on topography and physical features, such as streams, potential landfill gas is expected to migrate to the south and southwest, therefore; the landfill gas monitoring wells are proposed to be placed south of the landfill. Landfill gas monitoring well LFG-101 is located near the property boundary of one of two residential properties surrounded by County owned property. The well will be monitored to detect explosive gases that may be migrating from the landfill to this potential receptor. LFG-101 is proposed to be located approximately 500 feet from the C&D waste unit. Well LFG-102 is proposed to be installed next to the newly installed access road to the new convenience center, just north of an unnamed stream. LFG-102 is proposed to be located approximately 300 feet south-southwest of the C&D waste unit. LFG-103 is proposed to be installed along the access road to the top of the C&D landfill, approximately 150 feet south of the waste unit. Landfill gas monitoring wells LFG-102 and LFG-103 could not be located further to the south and closer to the property line due to unpermitted waste recently discovered during the construction of the convenience center access road, south of the proposed well locations.

Relatively little information is known about the depth to bedrock and groundwater at the proposed locations of the landfill gas monitoring wells. Depth to bedrock at each of the locations is assumed to be approximately 55 feet below ground surface, based on available boring logs for groundwater monitoring wells at the facility. Depth to groundwater for each proposed location was estimated using the groundwater surface contours provided on Drawing 1. A summary of depth to bedrock and groundwater estimates along with proposed depths and screened intervals of the proposed landfill gas monitoring wells are provided on Table 1. A diagram of a typical landfill gas monitoring well is provided as Figure 1. The wells are estimated to range between 26 to 55 feet below ground surface, but actual depths will be dependent on field conditions.

The landfill gas monitoring wells will be constructed to a depth equivalent to the top of bedrock unless groundwater is encountered above bedrock. Groundwater is expected to be encountered above bedrock at the locations for LFG-101 and LFG-102. If groundwater is encountered above bedrock, the wells will be installed approximately 5 feet above the static water level to account for seasonal high water level fluctuations. The wells will be constructed of 2-inch PVC with 0.010-inch slotted screen from the bottom of the well up to 5 feet below ground surface. A coarse, clean sand will be used to fill the annular space to approximately 2 feet above the screen. An approximately 2-foot thick bentonite seal will be placed above the sand. The remaining annular space will be filled with a cement mixture. The surface completion of each gas probe will consist of a 3 feet by 3 feet by 0.5 feet concrete well apron and a locking protective casing. The top of the PVC riser will be equipped a well cap with a stopcock valve or quick connect coupling.

2.2 Structure and Ambient Sampling

No on-site structures are present in the vicinity of the closed C&D landfill. Structures in close proximity of the closed MSW landfill are already monitored in conjunction with the MSW landfill's quarterly methane monitoring program. Therefore, there will be no monitoring of structures associated with the quarterly landfill gas sampling of the C&D landfill.

2.3 Landfill Gas Monitoring Frequency

Landfill gas monitoring will be performed on a quarterly basis as required in Title 15A NCAC 13B.0544(d)(2)(B) and in accordance with NCDENR November 2010 Landfill Gas Monitoring Guidance. In the event that the explosive action level or compliance level is exceeded, the monitoring frequency will increase to monthly until three consecutive months have passed without a methane action level or compliance level exceedance, at which time the monitoring frequency will revert to quarterly.

3.0 LANDFILL GAS SAMPLING PROCEDURES

The following sections outline the recommended procedures for performing required landfill gas monitoring well and facility structure monitoring for methane gas.

3.1 DETECTION EQUIPMENT USED

The GEM-2000 Plus is the preferred monitoring device for monitoring landfill gas monitoring wells. Alternatively, a digital or analog manometer combined with a vacuum-pump-equipped monitoring device designed to measure methane gas and hydrogen sulfide concentrations can be used.

In addition to the monitoring device(s), the following equipment and documents should be readily available during monitoring events:

- Copy of the facility's *Landfill Gas Monitoring Plan*
- A copy of the Operation Manual(s) for the equipment being used during monitoring
- Blank copies of the Landfill Gas Monitoring Log (a sample Landfill Gas Monitoring Log is provided in Appendix A)
- Calibration gas (if applicable)
- Barometer (if available)
- Personal protection equipment (site specific)
- Necessary keys (site specific)

Gas monitoring equipment should be calibrated daily, prior to use in the field. Generally, one calibration per day is sufficient. In some instances where highly variable concentrations are being observed, it may be necessary to re-calibrate the monitoring device during the work day to ensure that instrument drift is minimal. Instrument drift can be checked with a calibration gas of known concentration. If more than a 3% difference is observed between the instrument reading and the gas standard during an instrument drift check, the unit should be recalibrated.

Field calibration should be performed in accordance with the instrument manufacturer's recommendations using an approved gas standard. Generally, when landfill gas monitoring wells are monitored it is best to calibrate the unit with standard composed of 15% or less methane. Calibration activities should be documented on a calibration log. Gas monitoring equipment should also be calibrated by the manufacturer or supplier in accordance with the recommended schedule for that instrument.

3.2 LANDFILL GAS SAMPLING PROCEDURES

After calibrating the monitoring instrument, record the weather conditions at the site, including the barometric pressure and ambient temperature. The temperature and barometric pressure should be logged at the beginning and ending of each field day. Site-specific barometric pressure readings are preferred. In the event that a barometer is not available, barometric pressure readings from a nearby weather station can be used. Monitoring should be conducted between noon and sunset.

3.2.1 Landfill Gas Monitoring Well Gas Concentration Measurements

Before connecting the monitoring instrument to the landfill gas monitoring well, purge the connector tube for at least one minute prior to taking reading. Connect the instrument tubing to the landfill gas monitoring

well cap fitted with a stopcock valve or quick connect coupling. Open the valve and record the initial reading and then the stabilized reading for methane and hydrogen sulfide. A stable reading is one that does not vary more than 0.5 percent by volume on the instrument's scale. Turn the stopcock valve to the off position and disconnect the tubing. Proceed to the next landfill gas monitoring well and repeat.

3.2.2 Facility Structure Gas Concentration Measurements

Confined spaces, which require a confined space permit to enter, are excluded from these general monitoring requirements. As discussed previously, there are no structures in the vicinity of the C&D landfill. If structures are constructed or installed at the facility (including any temporary structures), the following monitoring plan would apply:

- After entering the designated structure, turn on the gas monitoring device and vacuum pump and traverse the accessible and open area on the first floor of the facility structure while holding the intake hose for the monitoring device at shoulder height. During the traverse, observe the meter for any measurable methane concentrations and record the time and concentration on the monitoring log.
- If measurable methane concentrations are observed in a facility structure, attempts to identify the source of the methane should be made. If the facility structure is elevated and has a crawl space, the crawl space beneath the facility should be monitored from outside of the structure on accessible sides to determine if the methane gas is migrating into the structure from the crawl space. Do not enter a crawl space beneath a structure without proper authorization and sufficient personal protection equipment, including an oxygen monitoring device, since these areas may be considered confined spaces. If the facility structure is constructed on grade, ambient air near the exterior walls at floor level or near cracks in the floor, if exposed, should be monitored to determine if gas is migrating upward along or through the foundation.

3.3 WELL DECOMMISSIONING PROCEDURES

If a landfill gas monitoring well requires decommissioning, an abandonment record shall be submitted to NCDENR within 30 (thirty) days of the decommissioning. The landfill gas monitoring well(s) shall be decommissioned in accordance with 15A NCAC 2C .0113(d) by a certified well driller. The landfill gas monitoring well(s) shall be overdrilled and sealed with grout via tremie-pipe if located in the future waste footprint. The landfill gas monitoring well(s) shall be sealed with grout and all surface completions removed if not located in the future waste footprint. The decommissioning report will be sealed by a North Carolina Licensed/Professional Geologist.

4.0 RECORD KEEPING AND REPORTING

Quarterly gas monitoring results shall be maintained by the facility operator for the life of the facility operation, closure, and post-closure care periods.

4.1 Landfill Gas Monitoring Form

The date, time, location, sampling personnel, equipment, atmospheric temperature, reported barometric pressure, general weather conditions at the time of sampling, and the concentration of methane and

hydrogen sulfide shall be recorded on the Landfill Gas Monitoring Field Log. An example Landfill Gas Monitoring Form is provided in Appendix A.

4.2 Sampling Reports

A letter report that includes the Landfill Gas Monitoring Form and a map showing the monitoring locations will be prepared after each monitoring event. Monitoring records will be kept on site in the facility files. In the event that explosive gas concentrations are detected in excess of allowable limits in the compliance monitoring points, a report will also be provided to the NCDENR within 5 days of the exceedance as described below.

4.3 Permanent Record Keeping

A copy of each quarterly report shall be retained on-site as part of the permanent operating record for the facility.

5.0 CONTINGENCY PLAN

Pursuant to the 15A NCAC 13B, the compliance levels for landfill gas monitoring are 25% of the lower explosive limit (LEL) for methane and other explosive gasses (1.25% methane by volume) in facility structures (excluding gas control or recovery system components) and 100% of the LEL (5% methane by volume) for methane at the facility boundary. If either of these compliance levels is exceeded, the operator shall:

- Take all immediate steps necessary to protect public health and safety, including those required by the contingency plan. The contingency plan for this facility is as follows:
 - Evacuating all personnel from any facility structure(s) exceeding the safe LEL levels
 - Notifying local fire officials of the exceedance if there are habitable structures within 1,000 feet of the property boundary
 - Isolating the effective area and post signs around the affected area indicating the potential health and safety risk
 - Posting signs in the affected area indicating a "No Smoking" area
 - Appropriate safety training for all personnel entering in the isolated area
- Notify NCDENR in a written statement within five working days of learning that action levels have been exceeded, and indicate what has been done or is planned to be done to resolve the problem.
- Begin initial remediation actions, which may include the following activities:
 - Additional temporary gas monitoring probe installations and sampling to determine the extent of the gas migration
 - Increased monitoring of probes, structures, and any identified preferred flow pathways to verify concentrations and to protect human health
- Within 60 days of detection, implement a remediation plan for the explosive gas releases and submit it to NCDENR for amendment of the facility permit

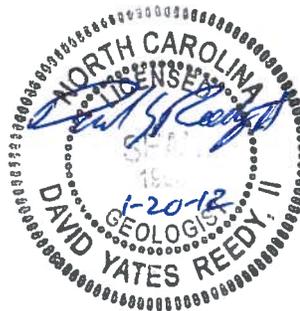
The *Landfill Gas Remediation Plan* shall describe the nature and extent of the problem and the proposed remedy. The plan shall include an implementation schedule specifying timeframes for implementing the corrective actions, an evaluation of the effectiveness of such corrective actions, and milestones for proceeding in implementation of additional corrective actions, if necessary to re-establish compliance. Gas control systems proposed in a *Landfill Gas Remediation Plan* shall be designed to:

- Prevent methane accumulation in on-site structures
- Prevent methane compliance level exceedances at the facility boundary
- Provide for the collection, treatment, and destruction/disposal of decomposition gases and condensate
- Comply with Clean Air Act requirements, as applicable

6.0 CERTIFICATION

The *Landfill Gas Monitoring Plan* for the C&D landfill at this facility has been prepared by a qualified geologist who is licensed to practice in the State of North Carolina. The plan has been prepared based on first-hand knowledge of site conditions and familiarity with North Carolina solid waste rules and industry standard protocol. This certification is made in accordance with North Carolina Solid Waste Regulations, indicating this *Landfill Gas Monitoring Plan* should provide early detection of any release of hazardous constituents to the uppermost aquifer, so as to be protective of public health and the environment. No other warranties, expressed or implied, are made.

Signed 
Printed David Y. Reedy II
Date 1-20-12



Not valid unless this document bears the seal of the above mentioned licensed professional.

7.0 REFERENCES

Butler, J.R., and D.T. Secor, Jr., 1991. The Central Piedmont (Chapter 4) in J.W. Horton, Jr. and V.A. Zullo, eds., *The Geology of the Carolinas* (Carolina Geological Society Fiftieth Anniversary Volume): The University of Tennessee Press, pp. 2, 4, 24, 36, 44-45.

North Carolina Department of Environment and Natural Resources, November 2010. *Landfill Gas Monitoring Guidance*.

North Carolina Geologic Survey, 1985. Geologic Map of North Carolina

North Carolina Geologic Survey, 2004. Modified from 1991 Generalized Geologic Map (digital representation)

TABLE

TABLE 1

**Proposed Landfill Gas Monitoring Well Construction Table
Henderson County Closed C&D Landfill, Permit No. 45-01**

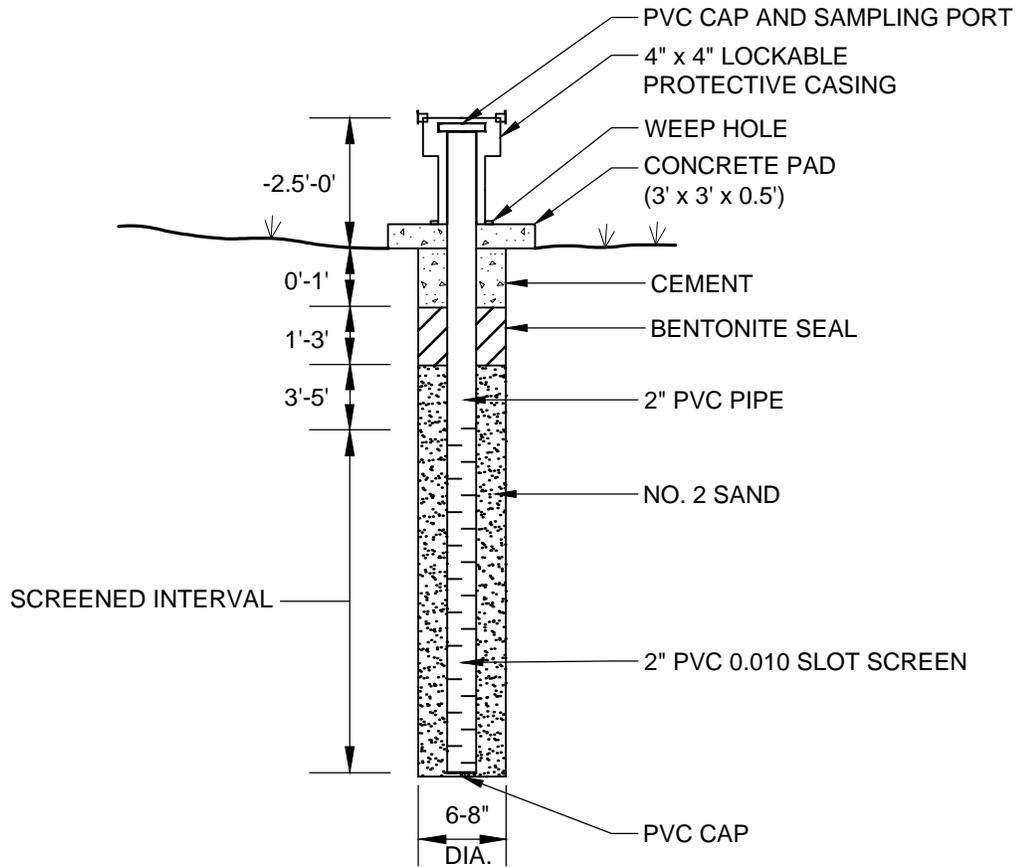
Well Identification	Ground Surface Elevation (feet AMSL)	Well Diameter (inches)	Well Depth (feet bgs)	Screened Interval (feet bgs)	Screened Interval (feet AMSL)	Depth To Bedrock (feet bgs)	Depth To Groundwater (feet bgs)
LFG-101	2255	2	26	5 - 26	2250 - 2229	55	31
LFG-102	2285	2	46	5 - 46	2280 - 2239	55	51
LFG-103	2325	2	55	5 - 55	2320 - 2270	55	83

Notes:

feet AMSL = feet above mean sea level

feet bgs = feet below ground surface

FIGURE



NOTE

1. PLACE PEA GRAVEL IN ANNULAR SPACE BETWEEN PVC STICK UP AND PROTECTIVE CASING.
2. THE LANDFILL GAS MONITORING WELL WILL BE CONSTRUCTED AT THE TOP OF BEDROCK UNLESS GROUNDWATER IS ENCOUNTERED ABOVE BEDROCK.
3. IF GROUNDWATER IS ENCOUNTERED ABOVE BEDROCK, THE LANDFILL GAS MONITORING WELL WILL BE INSTALLED APPROXIMATELY 5 FEET ABOVE THE STATIC WATER LEVEL TO ACCOUNT FOR SEASONAL HIGH WATER LEVEL FLUCTUATIONS.

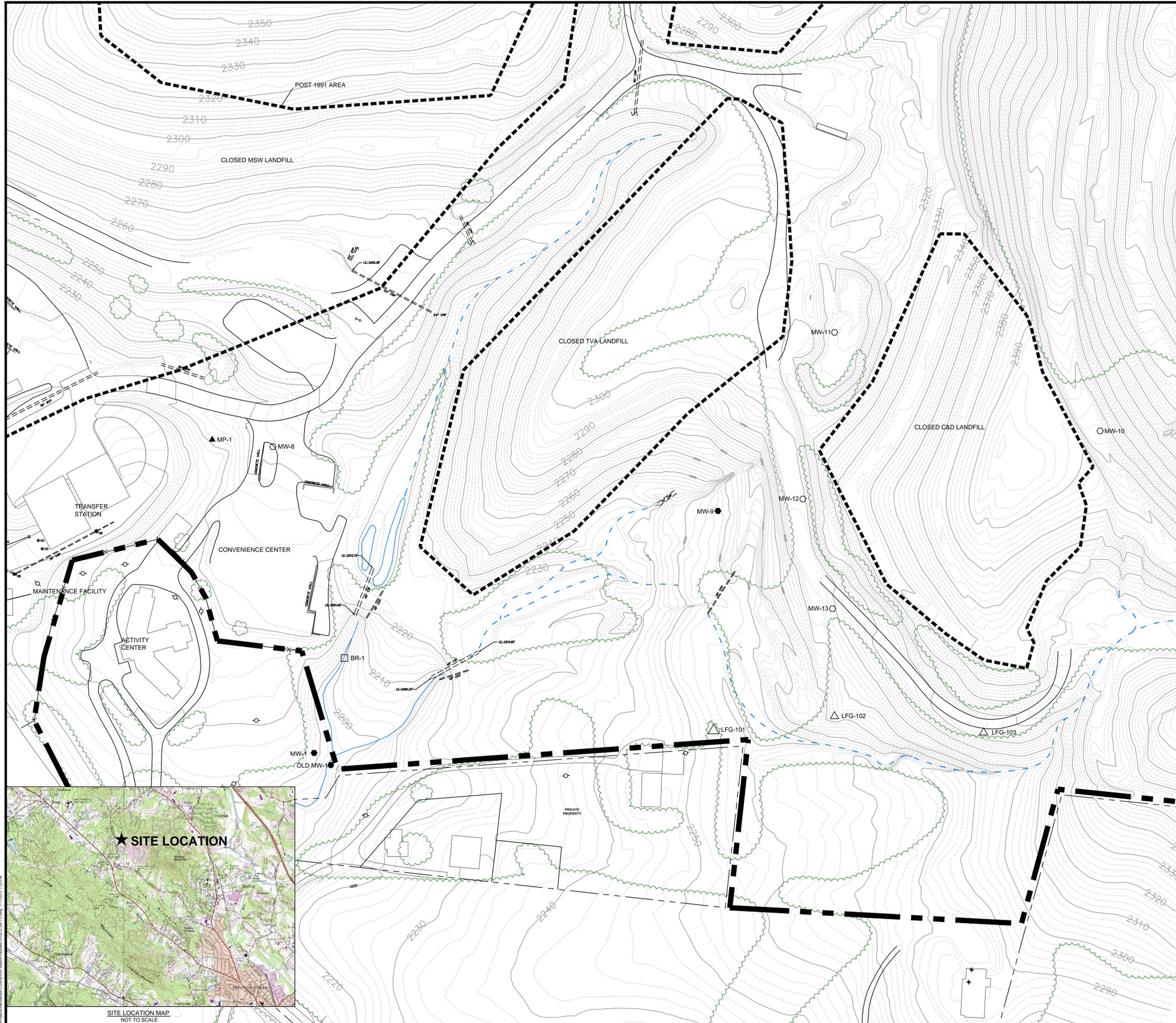
REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RW
PROJECT						
HENDERSON COUNTY C&D LANDFILL						
TITLE						
TYPICAL LANDFILL GAS MONITORING WELL CONSTRUCTION DIAGRAM						
PROJECT No.		0839-6506		FILE No. Figure 1(13-12)		
DESIGN	DYR	1/4/12		SCALE	N.T.S	REV. -
CADD	LKB	1/4/12				
CHECK						
REVIEW						



FIGURE 1

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DRAWINGS

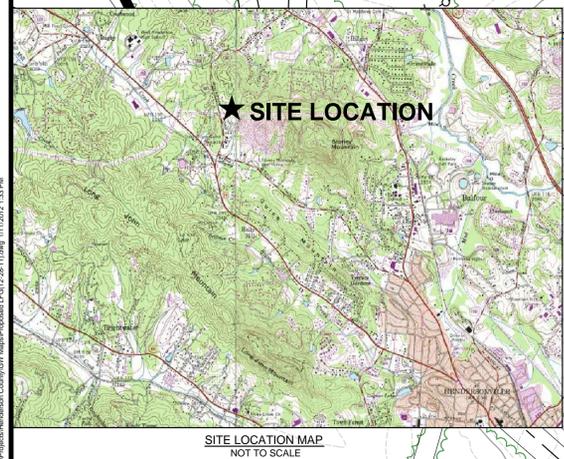


LEGEND

	EXISTING 10 FT. CONTOUR
	EXISTING 2 FT. CONTOUR
	PROPERTY LINE
	LIMITS OF WASTE
	STREAM
	TREELINE
	EXISTING ROAD
	TOPOGRAPHIC DIVIDING LINE (SEE NOTE 9)
	MW-8 MONITORING WELL AND IDENTIFICATION
	MW-1 NON COMPLIANCE MONITORING WELL AND IDENTIFICATION
	MP-6 METHANE MONITORING PROBE AND IDENTIFICATION
	BR-1 SURFACE WATER MONITORING POINT AND IDENTIFICATION
	LFG-101 PROPOSED LANDFILL GAS MONITORING WELL

- NOTES**
1. TOPOGRAPHIC CONTOUR INTERVAL = 2 FEET
 2. APPROVED WATER QUALITY MONITORING WELL NETWORK FOR THE C&D LANDFILL INCLUDES: MW-10, MW-11, MW-12, AND MW-13.
 3. COORDINATE SYSTEM IS N.C. STATE PLANE GRID.

- REFERENCES**
1. BASE MAP PROVIDED BY CAMP DRESSER & McKEE FROM PREVIOUS WATER QUALITY MONITORING REPORTS.



REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RW

PROJECT: HENDERSON COUNTY CLOSED MSW AND C&D LANDFILL PERMIT # 45-01

TITLE: **PROPOSED LANDFILL GAS MONITORING WELL LOCATION MAP**

PROJECT No.	FILE No.
DESIGN	SCALE AS SHOWN
CADD	REV.
CHECK	
REVIEW	

DWG. 2



X:\Projects\Henderson County\DWG\Map\Proposed LFG12-26-11.dwg 11/12/2011 1:33 PM

APPENDIX A
LANDFILL GAS MONITORING FORM

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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South America	+ 55 21 3095 9500

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