GROUNDWATER ASSESSMENT
MARSHALL STEAM STATION
DRY ASH LANDFILL
PERMIT NO. 1804

Prepared for:
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Terrell, NC 28682

Prepared by:
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Charlotte, North Carolina

December 21, 2012

REPORT VERIFICATION

PROJECT: **GROUNDWATER ASSESSMENT**
MARSHALL STEAM STATION
DRY ASH LANDFILL
PERMIT NO. 1804

This document has been reviewed for accuracy and quality commensurate with the intended application.

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GROUNDWATER ASSESSMENT
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Section 1
Introduction

The Marshall Steam Station Dry Ash Landfill, Permit No. 1804, is located at the Marshall Steam Station (Marshall) in Catawba County, North Carolina and is owned and operated by Duke Energy Carolinas, LLC (Duke Energy).

In a letter dated November 9, 2011,[1] to Mr. Ed Sullivan, P.E., of Duke Energy, the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Waste Management (DWM) stated that exceedances of groundwater standards established in Title 15A North Carolina Administrative Code (NCAC) Subchapter 2L .0202 Groundwater Quality Standards (2L Standards) were reported in samples collected from groundwater monitoring wells MW-2, MW-3, and MW-5 during the February 8, 2011, monitoring event. This letter is included as Appendix A.

The NCDENR letter stated that manganese was reported at a concentration greater than the 2L Standard in the groundwater sample collected from MW-3 during this event. Monitoring well MW-3 appears to be located at the compliance boundary. NCDENR also stated that industrial landfills are required to comply with the 2L Standards at the compliance boundary in accordance with 15A NCAC 13B .0503 (2)(d)(iv).

The NCDENR letter stated boron and selenium were reported at concentrations greater than their respective 2L Standards in groundwater monitoring well MW-2 and manganese was reported at concentrations greater than the 2L Standard in groundwater monitoring well MW-5. The NCDENR letter stated that monitoring wells MW-2 and MW-5 appear to be located at the review boundary.

NCDENR stated that based on these exceedances, Duke Energy must submit a groundwater assessment work plan to the DWM Solid Waste Section. The assessment work plan, dated February 9, 2012, was prepared by Altamont Environmental Inc. (Altamont) on behalf of Duke Energy and was approved by the DWM on March 23, 2012.

HDR Engineering, Inc. of the Carolinas (HDR) has prepared this assessment on behalf of Duke Energy. This document presents the results of the assessment of groundwater exceedances at groundwater monitoring wells MW-3 and MW-5. Monitoring well MW-2 was found to be located inside of the review boundary and therefore the exceedances do not require assessment.

[1] *North Carolina Department of Environment and Natural Resources. Division of Waste Management. November 9, 2011, Monitoring Well MW-3 Assessment. Duke Energy – Marshall Steam Dry Ash Landfill. DOC ID 15489.*

Section 2
Background

2.1 Site and Landfill Description

The Marshall Dry Ash Landfill is located at Marshall Steam Station. Marshall Steam Station is a four-unit, coal-fired generating facility, located on Lake Norman in Catawba County, North Carolina. It is Duke Energy's second largest coal-burning power plant in the Carolinas and consistently ranks among the most efficient coal facilities in the United States.

The Marshall Dry Ash Landfill consists of two separate disposal areas permitted in December 1983 under NCDENR Solid Waste Permit No. 1804. Placement of flyash began in September 1984 in the area designated as Phase I. Phase I consists of approximately 14.5 acres and approximately 280,000 tons of flyash was placed between September 1984 and March 1986. Placement of ash in this area was completed around March 1986. Placement of ash in Phase II, approximately 46 acres, began around March 1986 and was completed in 1999.

The Marshall Dry Ash Landfill and nearby surrounding area are shown on Figure 1. The landfill is located north of the power plant and south of Island Point Road. The Marshall ash basin is located adjacent the western boundary of the landfill. The ash basin is operated as a water treatment facility and permitted by the National Pollutant Discharge Elimination System (NPDES) program (NPDES Permit #NC0004987). The 46-acre landfill and the 14.5-acre landfill are located on the east side of the Marshall ash basin.

2.2 Site Geology and Hydrogeology

Marshall is located in the Piedmont Physiographic Province of North Carolina within the Kings Mountain Belt. The rocks in the area were formed during the Precambrian era and metamorphosed during the Paleozoic era and consist of schist, gneiss, diorite, and granite. The soils that overlie the bedrock in the area have generally formed from the in-place weathering of the parent bedrock. The fractured bedrock is overlain by a mantle of unconsolidated material known as regolith. The regolith, where present, includes the soil zone, a zone of weathered, decomposed bedrock known as saprolite, and alluvium. Saprolite, the product of chemical and mechanical weathering of the underlying bedrock, is typically composed of clay and coarser granular material up to boulder size, and may reflect the texture of the rock from which it was formed (LeGrand 2004).

Groundwater generally occurs within the residuum and saprolite under unconfined conditions. Often, the heterogeneous nature of the soil results in variable porosities and permeabilities both laterally and vertically. However, low permeability units that would result in confining conditions between the overlying soils and bedrock are generally absent. In the underlying bedrock, groundwater occurs predominately in fractures and joints and flow may occur under either unconfined or confined conditions.

2.3 Description of Monitoring System

The groundwater monitoring system at the Marshall Dry Ash Landfill consists of five groundwater monitoring wells and one observation well listed below:

Monitoring Wells:	MW-1
	MW-2
	MW-3
	MW-4
	MW-5
Observation Well:	OB-1

The locations of the monitoring and the observation wells are shown on Figure 2. Monitoring wells MW-2, MW-3, and MW-5 are located adjacent to the 46-acre landfill. Monitoring well MW-1 and observation well OB-1 are located adjacent to the 14.5-acre landfill. Observation well OB-1 is only used to measure groundwater levels.

Monitoring well MW-4 is located upgradient from the 46-acre landfill and is described in the *Post-Closure Ground-Water Monitoring Program Sampling and Analysis Plan*[2] (SAP) as representing upgradient groundwater quality. All of the groundwater monitoring wells are screened to monitor the shallow aquifer.

A portion of the ash basin (groundwater) compliance boundary is also shown on Figure 2. Landfill groundwater monitoring wells MW-1, MW-2, MW-3, and MW-5 are located inside of the ash basin compliance boundary. Landfill groundwater monitoring well MW-4 is located near the ash basin compliance boundary.

2.4 Site Groundwater Flow

Generalized groundwater surface contours for the site are shown on Figure 4. These contours were developed using the groundwater elevations measured in the wells during the August 27, 2012, groundwater sampling event, and by using the approximate surface water elevations for the Marshall ash basin and the adjacent Lake Norman.

The ground surface in the area of the larger landfill slopes from the elevation along Island Point Road (located north of MW-4), approximate elevation 880 feet to 890 feet, downward toward the Marshall ash basin, which has a surface water elevation of approximately 790 feet. Lake Norman is located to the east of the Marshall ash basin. The normal pond elevation of Lake Norman is 760 feet.

Groundwater flow at the site is from areas of higher topography toward the ash basin and on toward Lake Norman. Monitoring well MW-4 is located north of the larger landfill and is at the

[2] Marshall Steam Station Industrial Landfill-Phase II Permit #18-04 *Post-Closure Ground-Water Monitoring Program Sampling and Analysis Plan,* Dated September 20, 1999.

highest topographic elevation in the monitoring well network. Groundwater flow is generally from MW-4 toward the larger landfill and to the ash basin. It is expected that flow would be from the topographically higher region north of MW-3 and MW-5 toward the 46-acre landfill, or in the case of MW-5, toward the inactive portion of ash basin located to the east of the landfill and discharging at the ash basin.

Monitoring well MW-2 is located south of the 46-acre landfill. It is expected that flow would be from the topographical higher region north of MW-2, to the south toward the ash basin.

The water elevation at well MW-3 is approximately the same as the pond elevation of the two adjacent ponded areas. These ponded areas are part of the ash basin drainage area that was cut off from the remainder of the ash basin by construction of the 46-acre landfill.

Monitoring well MW-5 is located on the east side of the larger landfill adjacent to an inactive portion of the ash basin. This inactive portion of the ash basin no longer contains appreciable free water and is filled with ash that was sluiced from the ash basin.

The groundwater flow in the region near the 14.5-acre landfill appears to be from the ash basin (approximate elevation 790 feet) beneath the 14.5-acre landfill and toward the arm of Lake Norman (approximate elevation 760 feet) located east of wells OB-1 and MW-1.

2.5 Groundwater Quality Monitoring

Groundwater monitoring wells MW-1, MW-2, MW-3, and MW-4, and observation well OB-1 were installed in June 1989. The initial semi-annual groundwater sampling was performed at the monitoring wells beginning in August 1989. Monitoring well MW-5 was added to the monitoring well network in May 2000, and initial semi-annual groundwater sampling commenced in August 2000.

In accordance with the SAP for the Marshall Dry Ash Landfill, groundwater monitoring is performed semi-annually in February and August. Sampling results are submitted to NCDENR within 90 days of sampling.

2.6 Monitoring Well Location Update

As part of this assessment, available data was reviewed to determine if the monitoring well locations were correctly displayed on the figures. No survey mapping information was found for well MW-1 and observation well OB-1. Survey mapping information, provided by Duke Energy, was available for wells MW-2, MW-3, MW-4, and MW-5. The state plane coordinates (coordinates) for these wells from the mapping data were reviewed against the coordinate location in the electronic drawing files that were used to develop the figures.

There were differences in the coordinates for wells MW-2, MW-3, MW-4, and MW-5 in the electronic drawing files compared to coordinate locations for the survey mapping information. The differences in the distances between the electronic drawing file coordinates and the survey map coordinates varied but in general the range for the difference was approximately 20 feet to

50 feet. The original surveys for these wells were likely based on an earlier datum (North American Datum 1927) and the newer survey mapping information used in the HDR review was based on a more recent datum (North American Datum 1983). The depicted location of monitoring wells MW-2, MW-3, and MW-4 on Figure 2 and Figure 4 are based on the updated survey information.

2.7 Location of Monitoring Well MW-2

The proposed assessment work plan at the Marshall Dry Ash Landfill included the accurate determination of monitoring well MW-2 top of well casing (TOC), elevation of the well screen, and the ash basin pond elevation. Monitoring well MW-2 was installed on June 28, 1989, as part of the groundwater monitoring system for the permitted landfill. MW-2 is located to the south of the 46-acre landfill, between the landfill and the ash basin (see Figure 2).

HDR contracted WSP-Sells of Mooresville, North Carolina, to provide professional land surveying services onsite, including the location of monitoring well MW-2, measurement of MW-2 TOC, and the ash basin pond elevation. The field services were completed in July 2012 and the results are depicted on the WSP-Sells *Water Quality Locations, Marshall Steam Station* drawing dated August 6, 2012 (see Appendix C).

Based on the August 6, 2012, survey, monitoring well MW-2 is located approximately 100 feet within the landfill review boundary and approximately 25 feet to 30 feet outside of the edge of waste. The location of monitoring well MW-2 is approximately 43 feet northeast of the previously reported location of this well. Figure 3 shows the location of the previously reported location of this well and the location based on the August 6, 2012, survey.

During a December 7, 2012, telephone conversation between Ms. Elizabeth Werner, Hydrogeologist (NCDENR), and Mr. Bill Miller, P.E. (HDR), the revised location of monitoring well MW-2 was discussed. Ms. Werner stated that due to the actual location of MW-2 being located further within the review boundary than previously thought, the previously reported groundwater exceedances in this well did not require assessment. Therefore, an assessment of the groundwater exceedances in monitoring well MW-2 is not included in this groundwater assessment report.

2.8 Groundwater Quality Exceedances

As noted in the NCDENR letter dated November 9, 2011, exceedances of the 2L Standards were reported for groundwater monitoring wells during the February 8, 2011, monitoring event. After review of the NCDENR letter, representatives from NCDENR, Duke Energy, and Altamont participated in a telephone conversation concerning these exceedances. Participants included Ms. Elizabeth Werner, Hydrogeologist (NCDENR), Mr. Ed Sullivan, P.E. (Duke Energy), and Mr. Bill Miller, P.E. (Altamont). During the conversation, Duke Energy proposed that exceedances reported from groundwater sampling events more recently than noted in the NCDENR letter of November 9, 2011, would also be addressed in the proposed groundwater assessment. NCDENR agreed with this proposal.

Table 1 presents the analytical results for manganese at MW-3 for the sampling events between February 8, 2011, and the most recent event, August 27, 2012.

Table 1 – MW-3 Analytical Results for Manganese

Parameter	February 8, 2011 Analytical Result	August 8, 2011 Analytical Result	February 9, 2012 Analytical Result	August 27, 2012 Analytical Result	Units	15A NCAC 2L Standard
Manganese	**55.80**	**58.18**	**56.20**	**57.10**	µg/L	50

Bold values indicate analytical results at concentrations greater than the 2L Standard.
Values for concentrations are from the Duke Energy MANAGES database.

Table 2 presents the analytical results for manganese at MW-5 for the sampling events between February 8, 2011, and the most recent event, August 27, 2012. Note that for the sampling events performed after February 8, 2011, the analytical results at MW-5 for manganese have been less than the 2L Standard. However, since previous sample results were greater than the 2L Standards, an assessment is provided.

Table 2 – MW-5 Analytical Results for Manganese

Parameter	Well ID	February 8, 2011 Analytical Result	August 8, 2011 Analytical Result	February 9, 2012 Analytical Result	August 27, 2012 Analytical Result	Units	15A NCAC 2L Standard
Manganese	MW-5	**51.90**	13.19	27.40	9.59	µg/L	50

Bold values indicate analytical results at concentrations greater than the 2L Standard.
Values for concentrations are from the Duke Energy MANAGES database.

Section 3
Assessment of Groundwater Exceedances

The assessment of the groundwater exceedances at the Marshall Dry Ash Landfill was performed as stated in the proposed assessment work plan. The assessment was performed for exceedances of the 2L Standards for the well approximately located at the compliance boundary, MW-3; and the well with exceedances near or within the review boundary, MW-5.

3.1 Assessment of Groundwater Exceedances at Monitoring Well MW-3

The NCDENR assessment requirement was based on review of the results in the semi-annual report for the February 8, 2011, sampling event. Exceedances observed at monitoring well MW-3 which occurred after that sampling event are also included in this assessment. Table 1 presents the groundwater exceedances for manganese in monitoring well MW-3.

3.1.1 Review of Site Groundwater Flow and Groundwater Quality Report

Figure 2 presents the sampling locations for the Marshall Dry Ash Landfill. Monitoring well MW-3 was installed on June 29, 1989, as part of the groundwater system for the landfill and is located approximately at the compliance boundary. This well is located to the northeast of the landfill, approximately 70 feet from the edge of waste, and 70 feet south of the Duke Energy property line in this location. The location of the well in relation to the property line and the edge of waste is depicted on Figure 2 of the June 18, 1999, *Duke Power Industrial Landfill Compliance Demonstration* letter report submitted to NCDENR (Appendix A). The well screen in monitoring well MW-3 is located in the saprolite layer to monitor the shallow groundwater. The well construction records are presented in Appendix B.

The 1999 Duke Energy report (Appendix A) describes the investigation performed by Duke Energy to better characterize groundwater flow direction in the vicinity of monitoring well MW-3 using information from the monitoring wells installed in 1989 and from two temporary wells. Figure 2 in the June 18, 1999, report shows the location of temporary wells MSSGP1 and MSSGP2 relative to monitoring well MW-3. The groundwater elevations measured in the wells indicate that the groundwater flow in the vicinity of MW-3 is generally from the north to the south. Groundwater elevation measurements are greatest at MSSGP2 (806.52 feet)[3] followed by MW-3 (805.42) and then MSSGP1 (805.36).

Figure 4 shows the groundwater contours from the August 27, 2012, sampling event superimposed on the landfill footprint. These groundwater contours show flow from north of MW-3, through the larger landfill, and towards the ash basin. These groundwater contours are generally consistent with recent depictions of groundwater contours at the site.

Based on data in the 1999 Duke Energy groundwater flow investigation in the vicinity of monitoring well MW-3, the current groundwater contours and the flow direction inferred from

[3] Elevations in this report are based on the North American Vertical Datum of 1988 (NAVD88) datum.

those contours, MW-3 is not located where groundwater flowing from the landfill would flow to the well location.

3.1.2 Evaluate if the Sources of Exceedances are Naturally Occurring or are from Sediment or Other Particulate Matter

The first groundwater sampling event at monitoring well MW-3 was conducted in August 1989. The analytical results for manganese at MW-3 have ranged from a maximum value of 176 micrograms/liter (µg/L) in February 1995 to a minimum of 55.8 µg/L in February 2011 (Figure 5). The August 27, 2012, analytical result for manganese was 57.1 µg/L, which is greater than the 2L Standard of 50 µg/L.

Turbidity values were first measured in the groundwater samples collected from monitoring well MW-3 in August 2001. The values have ranged from 0.73 Nephelometric Turbidity Units (NTUs) in the most recent August 27, 2012, sampling event to a high of 17 NTUs in February 2006. The Environmental Protection Agency (EPA) recommends that when possible, especially when sampling for contaminants that may be biased by the presence of turbidity, the turbidity values in the stabilized well should be less than 10 NTUs (EPA 2000).

Figure 6 shows the historic analytical results for manganese at MW-3 plotted with the measured turbidity values on the secondary axis. A correlation does not appear to exist between the manganese and turbidity results. With the exception of the February 2006 sampling event, the turbidity measurements in the groundwater samples collected from monitoring well MW-3 have been less than 10 NTUs.

Monitoring well MW-4 is located north of the larger landfill and is at the highest topographic elevation in the monitoring well network and is described in the SAP as representing upgradient groundwater quality. Groundwater flow is generally from MW-4 toward the larger landfill and to the ash basin (Figure 4). Manganese concentrations in the groundwater samples collected from MW-4 have ranged from a maximum value of 158 µg/L in February 2004 to a minimum of less than the laboratory reporting limit of 5 µg/L.

Figure 7 shows the historical manganese concentrations measured in the groundwater samples collected from monitoring wells MW-3 and MW-4. The manganese concentrations in both of these wells had an initial concentration of 150 µg/L detected during the August 1989 sampling event. An overall decrease in the manganese concentrations detected in the groundwater samples has been observed in both wells. The manganese concentration in monitoring well MW-4 appears to have stabilized around 30 µg/L and is less than the laboratory reporting limit of 5 µg/L, while the concentration in monitoring well MW-3 appears to have stabilized between 55 µg/L and 75 µg/L.

Although the magnitudes of the manganese concentrations in MW-3 and MW-4 are different, the general trend of decreasing concentrations is similar. Concentrations have decreased from initial high concentrations occurring from 1988 to 1995 and, with the exception of two high readings in MW-4 (February and August 2004), the concentrations have generally stabilized. If the landfill was the source of the manganese exceedances in MW-3, it is likely that the concentrations would have increased as a result of the landfill ash placement.

3.1.3 Conclusion – Assessment of Groundwater Exceedances at MW-3

Based on the direction of site groundwater flow inferred from the generalized groundwater contours and from the information provided in the 1999 Duke Energy report, the groundwater flow in the region around monitoring well MW-3 appears to be from upgradient areas towards the landfill, not from the landfill towards MW-3.

Based on review of the manganese concentrations in MW-3 compared to the concentrations in MW-4 (Figure 7), it appears that the exceedances of the 2L Standards for manganese are caused by naturally occurring conditions and are not related to impacts from the landfill.

3.2 Assessment of Groundwater Exceedances at Monitoring Well MW-5

The analytical results at monitoring well MW-5 for manganese from the sampling performed in August 2011, February 2012, and August 2012 were less than the 2L Standards. However, since previous manganese sample results were in excess of the 2L Standards, the following assessment is provided.

Monitoring well MW-5 is located approximately 100 feet east of the landfill waste boundary and approximately 25 feet west of and within the landfill review boundary.

3.2.1 Review of Site Groundwater Flow

Monitoring well MW-5 was installed on May 22, 2000, as part of the groundwater monitoring system for the landfill. Based on a review of the well installation records provided by Duke Energy (see Appendix B), the well screen was installed at a depth of approximately 18 to 28 feet below ground surface (bgs) and the bottom of the well screen is located 30.71 feet below TOC. The well screen in monitoring well MW-5 is located in the saprolite layer to monitor the shallow groundwater.

WSP-Sells surveyed the monitoring well MW-5 TOC and surface water drainage located to the west of MW-5, between the well and the 46-acre landfill (see Appendix C) in July 2012. Based on the surveyed TOC elevation (822.99 feet) and the measured depth to the bottom of the well screen (30.71 feet), the well screen in monitoring well MW-5 is located between the elevations of 792.28 feet and 802.28 feet.[4]

During the August 27, 2012, groundwater sampling event, the depth to groundwater in monitoring well MW-5 was gauged at 26.47 feet below the TOC, which is equivalent to an elevation of 796.52 feet. The WSP-Sells elevation of the surface water drainage feature located

[4] Differences in vertical elevations of TOC between existing information and the recent survey information were observed. However, these differences were minor and the existing TOC elevations are used in this report.

between MW-5 and the 46-acre landfill ranged from 801.29 feet to 798.24 feet, with an elevation of 799.14 feet at a location approximately perpendicular to monitoring well MW-5.

Based on the groundwater elevation measured in monitoring well MW-5 (796.52 feet) and the water level measured in the drainage feature (799.14 feet) perpendicular to the well, the surface water drainage feature located between the larger landfill and monitoring well MW-5 appears to be ephemeral (stream channel above the water table).

The groundwater flow across the site (Figure 4) during the August 2012 monitoring event in the vicinity of monitoring well MW-5 has been determined to be to the south and southeast. Groundwater contour elevations depicted on Figure 4 are based on existing TOC information. The groundwater contours on Figure 4 are generally consistent with historical depictions of groundwater contours in the vicinity of the landfill. Based on the observed water level in the well and the location of the well relative to the larger landfill, the groundwater in MW-5 has the potential to be influenced by the 46-acre landfill.

3.2.2 Evaluate if the Sources of Exceedances are Naturally Occurring or are from Sediment or Other Particulate Matter

Turbidity values were first measured in the groundwater samples collected from monitoring well MW-5 in August 2001. The values have ranged from a minimum of 0.65 NTUs in August 2002 to a maximum of 17 NTUs in February 2006.

Figure 9 shows the historical analytical results for manganese at MW-5 plotted with the measured turbidity values on the secondary axis. A correlation does not appear to exist between the manganese concentrations in MW-5 and turbidity measurements.

Monitoring well MW-4 is located north of the 46-acre landfill and is described in the SAP as representing upgradient groundwater quality. Manganese concentrations in the groundwater samples collected from MW-4 have ranged from a maximum value of 158 µg/L in February 2004 to a minimum concentration of less than the laboratory reporting limit of 5 µg/L .

Figure 9 shows the historical manganese concentrations detected in the groundwater samples collected from monitoring wells MW-4 and MW-5. Note that monitoring well MW-5 was not installed until May 2000 and groundwater analytical data does not exist until August 2000 for this monitoring well. The manganese concentrations measured in these wells have been generally within the same range of concentrations with notable exceptions for MW-4 in 1989 and 2004 and for MW-5 from 2008 to 2009.

HDR is not aware of any condition that would have caused the increase in manganese concentrations in MW-4 measured during the August 2003, February 2004, and August 2004 sampling events. HDR reviewed the turbidity data for MW-4 and did not see a correlation between the increase and decrease in manganese concentrations and the turbidity measurements.

Duke Energy provided information to HDR that in 2007-2008, a surface water drainage pipe conveying stormwater collected from the landfill cover experienced a failure in a connecting band. This failure resulted in the erosion of a portion of the soil cover for the landfill. The area was repaired and the soil cover was re-established. It is possible that the elevated manganese concentrations during that period were associated with impacts from erosion due to the pipe failure. Duke Energy stated that the pipe failure and erosion occurred on the east side of the landfill. The surface water drainage on the east side of the landfill would drain into the surface water drainage feature located approximately between MW-3 and MW-5.

3.2.3 Conclusion – Assessment of Groundwater Exceedances at MW-5

Based on the direction of site groundwater flow and the monitoring well location, MW-5 has the potential to be influenced by the 46-acre landfill. However, the concentrations of manganese in the groundwater samples collected from MW-5 are generally within the same range as background samples collected from monitoring well MW-4, and are likely the result of naturally-occurring manganese and are not caused by impacts from the landfill.

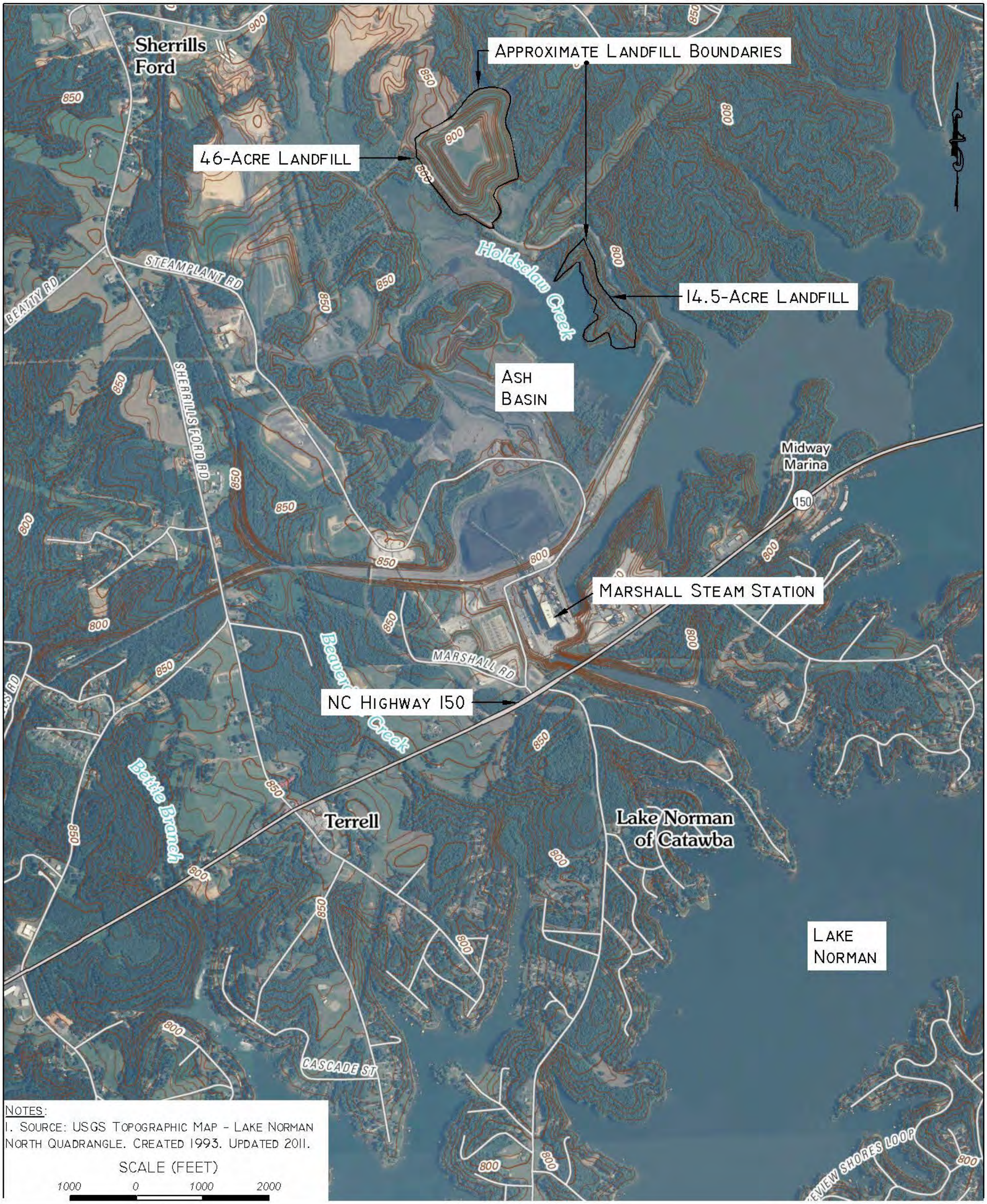
As described earlier in this section, the analytical results at monitoring well MW-5 for manganese from the sampling performed in August 2011, February 2012, and August 2012 were less than the 2L Standards.

Section 4
References

A Master Conceptual Model for Hydrogeological Site Characterization in the Piedmont and Mountain Region of North Carolina. LeGrand, Harry E. Sr., 2004

Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, Ground Water Forum Issue Paper, Douglas Yeskis and Bernard Zavala, EPA 542-S-02-001, Office of Solid Waste and Emergency Response, May 2002.

FIGURES



Notes:
1. Source: USGS Topographic Map - Lake Norman North Quadrangle. Created 1993. Updated 2011.

SCALE (FEET)
1000 0 1000 2000

HDR
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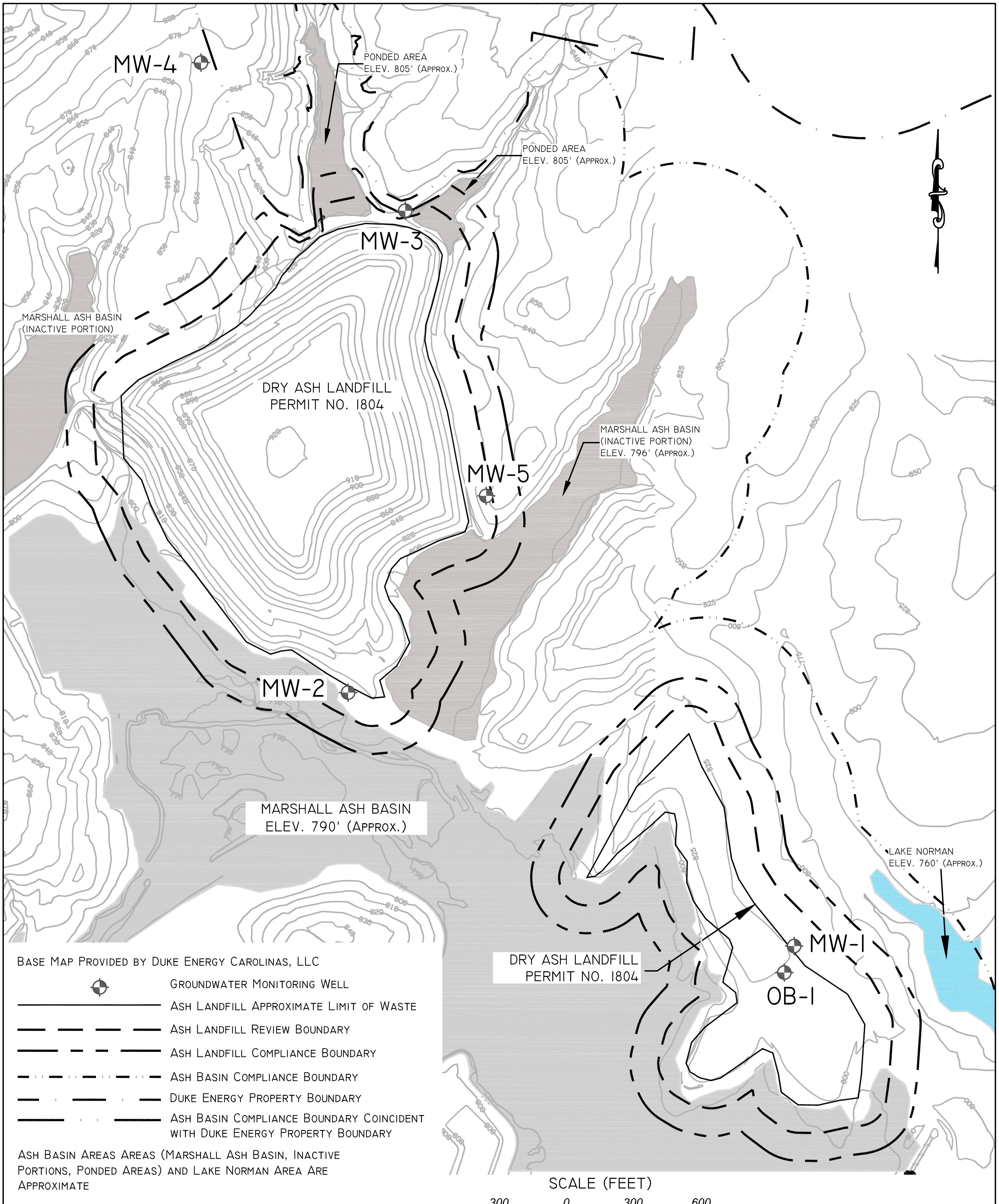
SITE LOCATION MAP
MARSHALL STEAM STATION
DRY ASH LANDFILL
PERMIT NO. 1804

DATE
December 21, 2012

FIGURE
1



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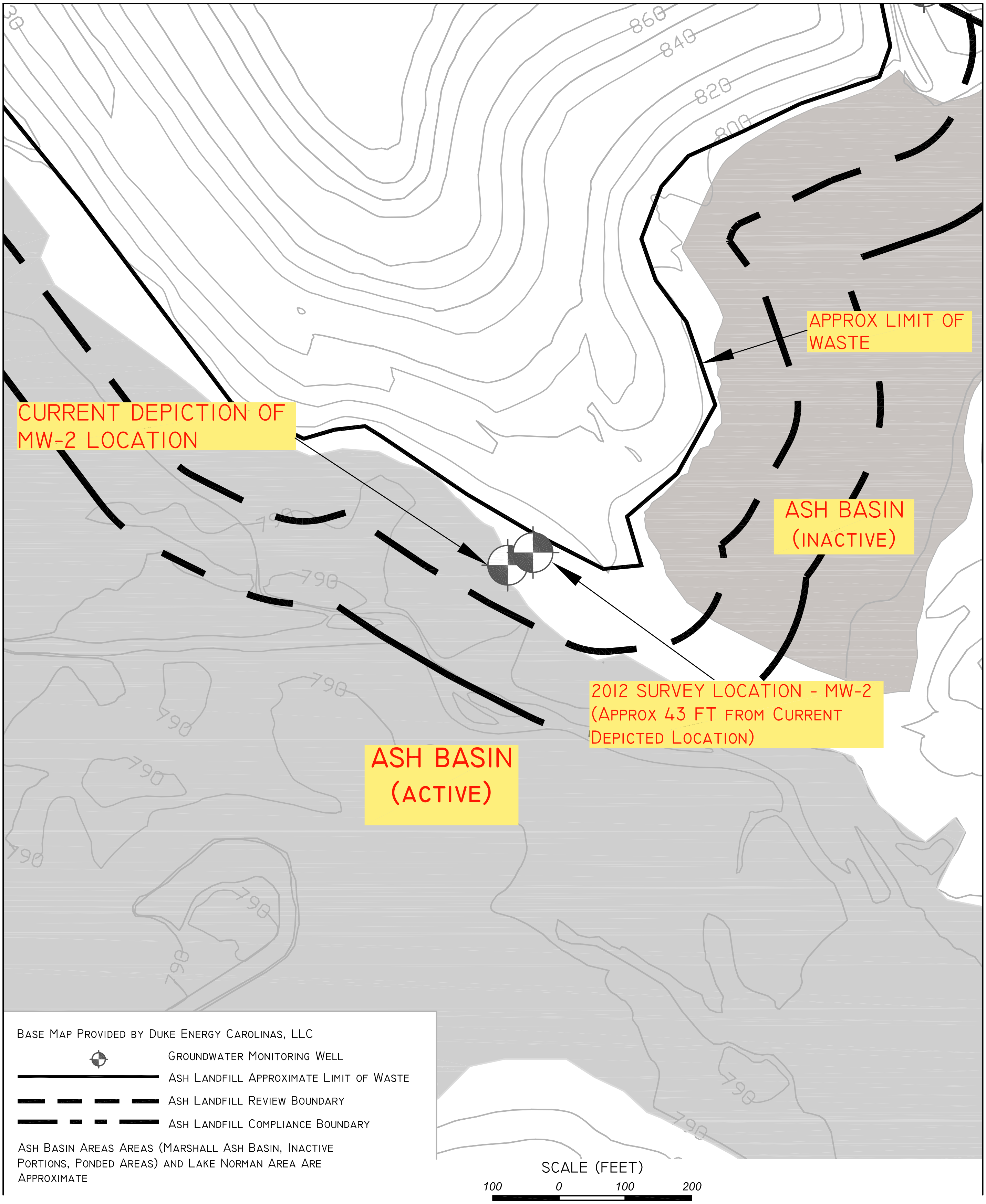
SAMPLE LOCATIONS
MARSHALL STEAM STATION
DRY ASH LANDFILL
PERMIT NO. 1804

DATE
December 21, 2012

FIGURE
2



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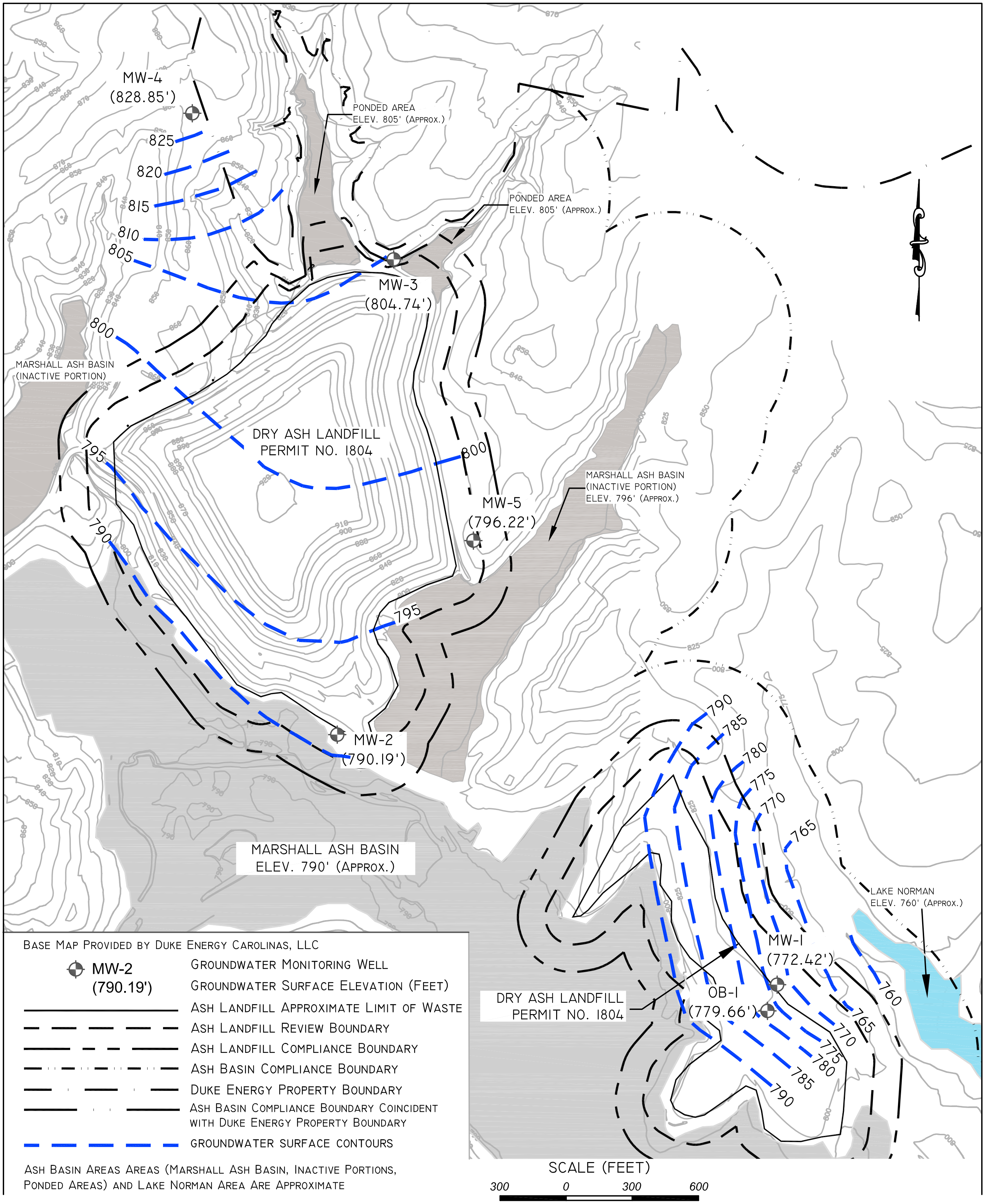
MONITORING WELL 2 LOCATION
MARSHALL STEAM STATION
DRY ASH LANDFILL
PERMIT NO. 1804

DATE
December 21, 2012

FIGURE
3



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GENERALIZED GROUNDWATER SURFACE CONTOURS AUGUST 27, 2012
MARSHALL STEAM STATION
DRY ASH LANDFILL
PERMIT NO. 1804

DATE
December 21, 2012

FIGURE
4

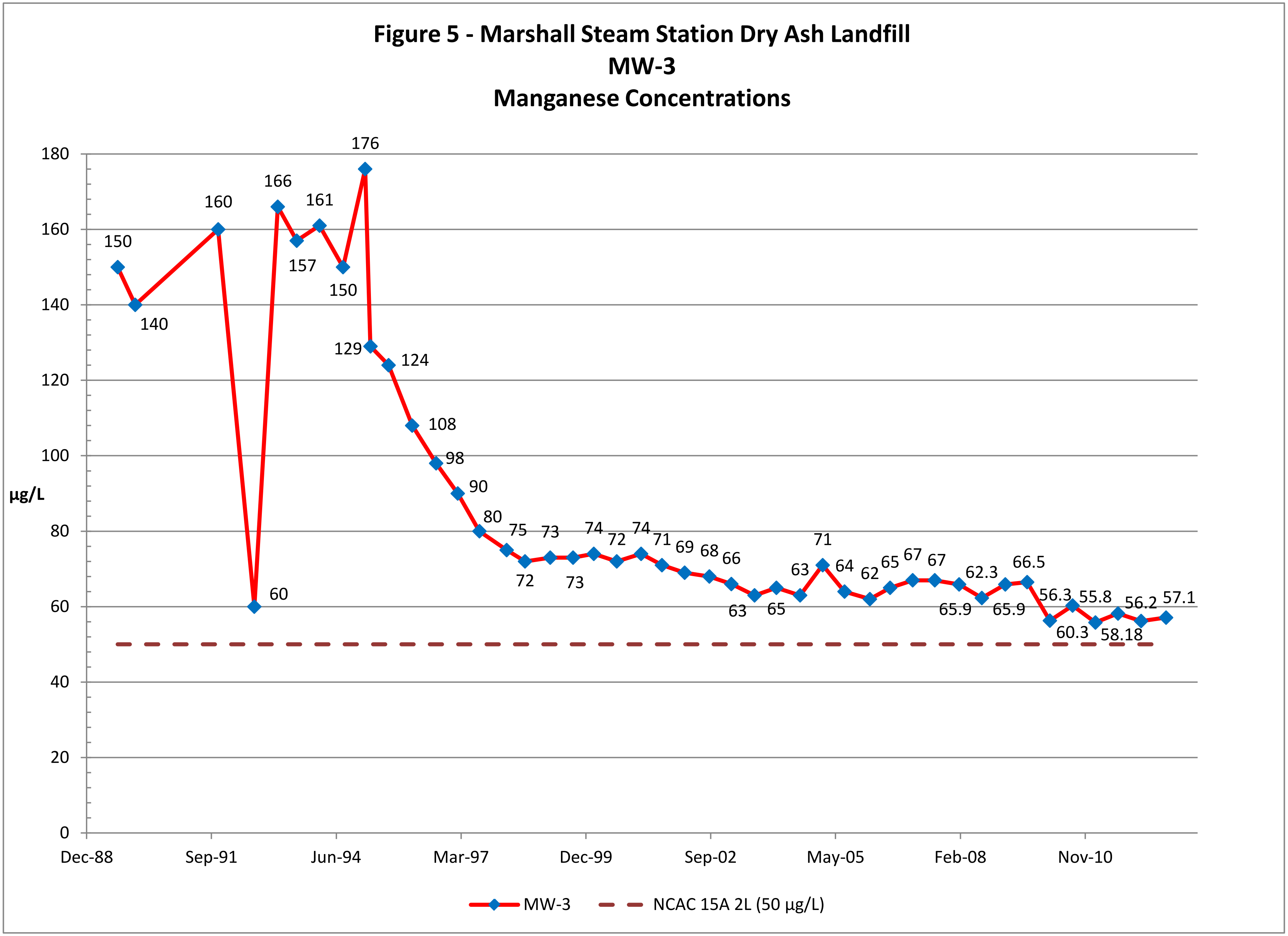


Figure 5 - Marshall Steam Station Dry Ash Landfill
MW-3
Manganese Concentrations
µg/L
0
20
40
60
80
100
120
140
160
180
Dec-88
Sep-91
Jun-94
Mar-97
Dec-99
Sep-02
May-05
Feb-08
Nov-10
150
140
160
60
166
157
161
150
176
129
124
108
98
90
80
75
72
73
73
74
72
74
71
69
68
66
63
65
63
71
64
62
65
67
67
65.9
62.3
65.9
66.5
56.3
60.3
55.8
58.18
56.2
57.1
MW-3
NCAC 15A 2L (50 µg/L)

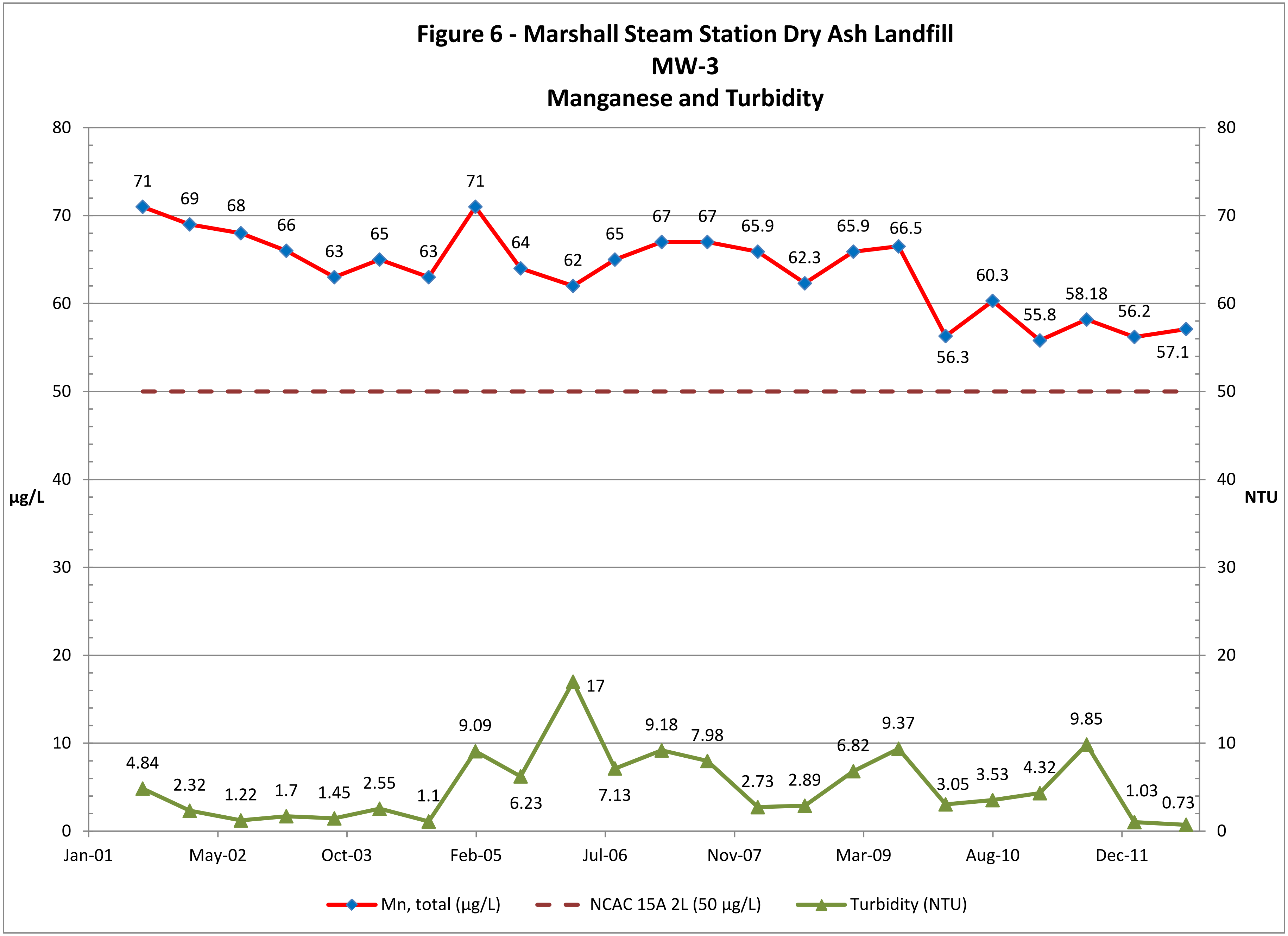


Figure 6 - Marshall Steam Station Dry Ash Landfill
MW-3
Manganese and Turbidity
µg/L
NTU
80
70
60
50
40
30
20
10
0
71
69
68
66
63
65
63
71
64
62
65
67
67
65.9
62.3
65.9
66.5
56.3
60.3
55.8
58.18
56.2
57.1
4.84
2.32
1.22
1.7
1.45
2.55
1.1
9.09
6.23
17
7.13
9.18
7.98
2.73
2.89
6.82
9.37
3.05
3.53
4.32
9.85
1.03
0.73
Jan-01
May-02
Oct-03
Feb-05
Jul-06
Nov-07
Mar-09
Aug-10
Dec-11
Mn, total (µg/L)
NCAC 15A 2L (50 µg/L)
Turbidity (NTU)

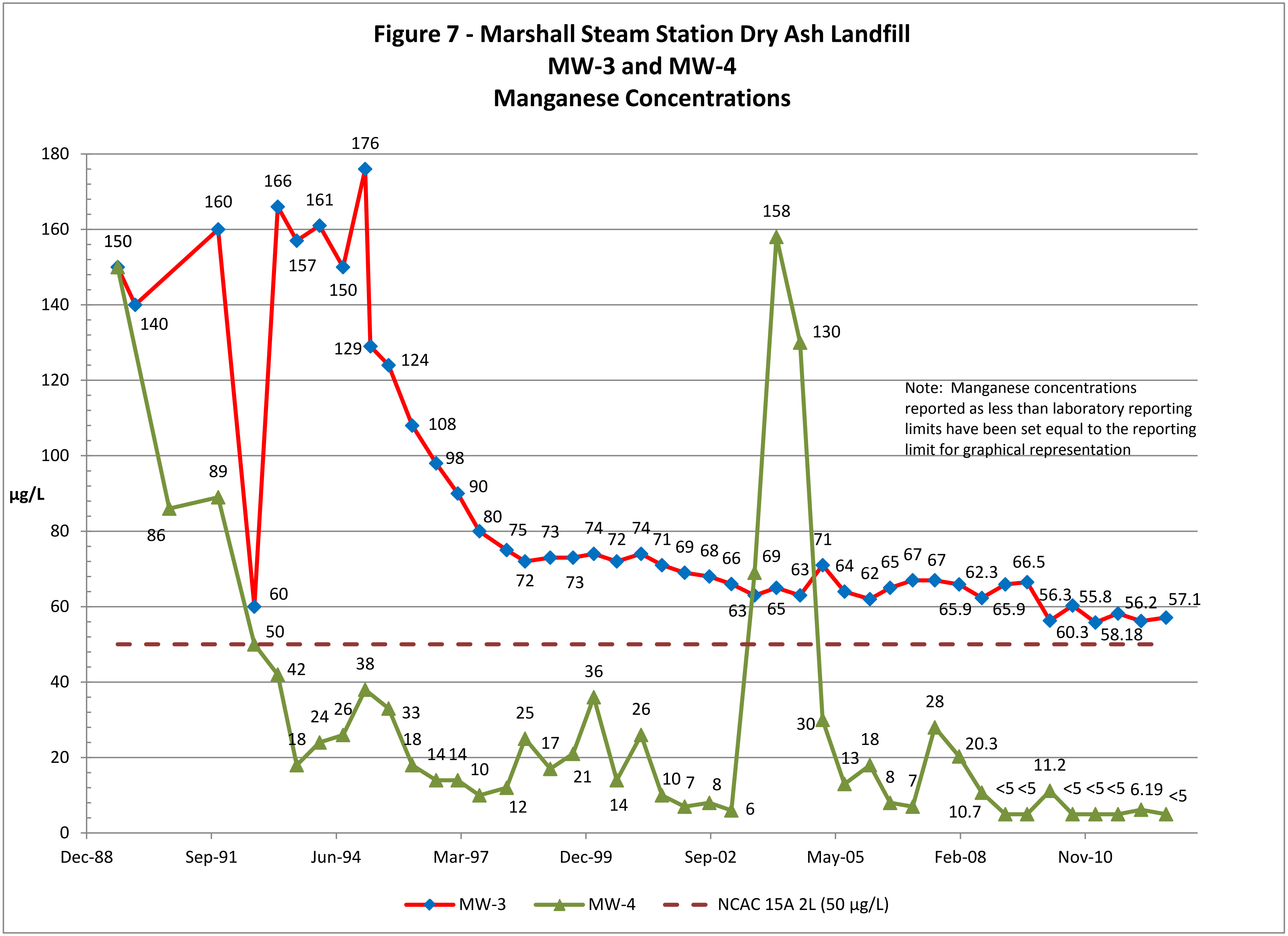


Figure 7 - Marshall Steam Station Dry Ash Landfill
MW-3 and MW-4
Manganese Concentrations
µg/L
Note: Manganese concentrations reported as less than laboratory reporting limits have been set equal to the reporting limit for graphical representation
Dec-88
Sep-91
Jun-94
Mar-97
Dec-99
Sep-02
May-05
Feb-08
Nov-10
MW-3
MW-4
NCAC 15A 2L (50 µg/L)

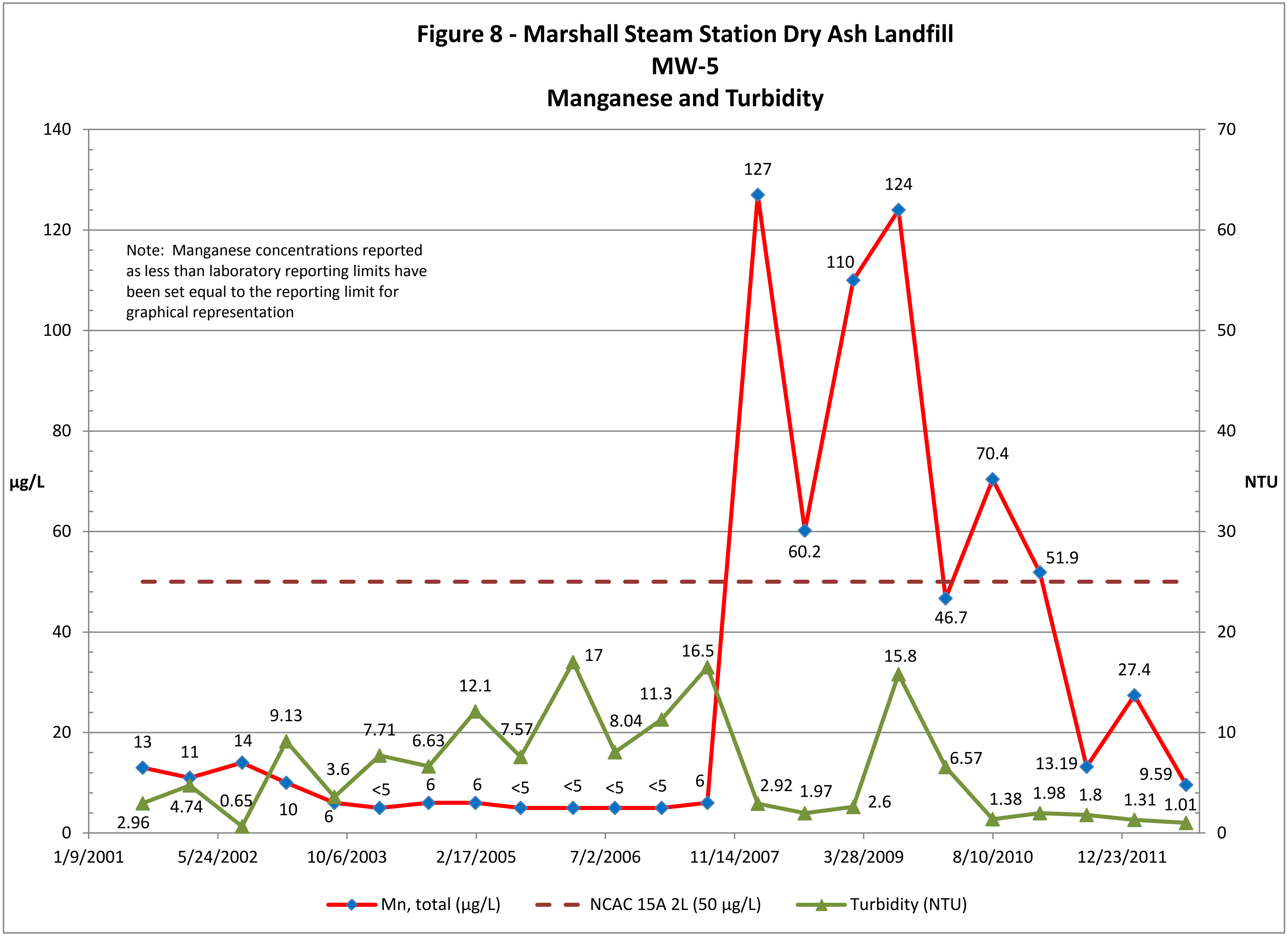


Figure 8 - Marshall Steam Station Dry Ash Landfill
MW-5
Manganese and Turbidity
Note: Manganese concentrations reported as less than laboratory reporting limits have been set equal to the reporting limit for graphical representation
µg/L
NTU
0
20
40
60
80
100
120
140
0
10
20
30
40
50
60
70
1/9/2001
5/24/2002
10/6/2003
2/17/2005
7/2/2006
11/14/2007
3/28/2009
8/10/2010
12/23/2011
13
11
14
10
6
<5
6
6
<5
<5
<5
<5
6
127
60.2
110
124
46.7
70.4
51.9
13.19
27.4
9.59
2.96
4.74
0.65
9.13
3.6
7.71
6.63
12.1
7.57
17
8.04
11.3
16.5
2.92
1.97
2.6
15.8
6.57
1.38
1.98
1.8
1.31
1.01
Mn, total (µg/L)
NCAC 15A 2L (50 µg/L)
Turbidity (NTU)

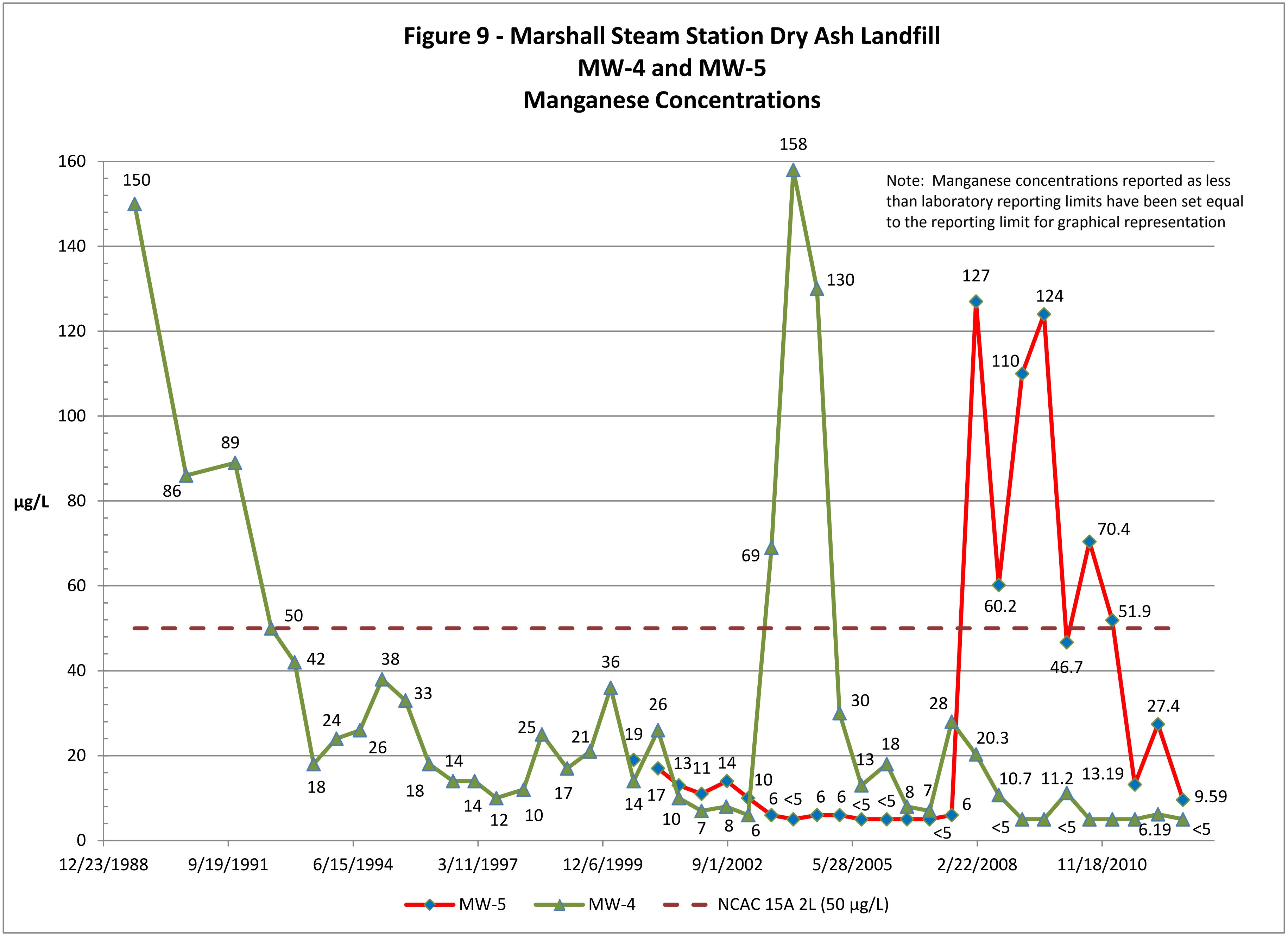


Figure 9 - Marshall Steam Station Dry Ash Landfill
MW-4 and MW-5
Manganese Concentrations
Note: Manganese concentrations reported as less than laboratory reporting limits have been set equal to the reporting limit for graphical representation
µg/L
0
20
40
60
80
100
120
140
160
12/23/1988
9/19/1991
6/15/1994
3/11/1997
12/6/1999
9/1/2002
5/28/2005
2/22/2008
11/18/2010
MW-5
MW-4
NCAC 15A 2L (50 µg/L)

APPENDICES

APPENDIX A

Letter from North Carolina Department of Environment and Natural Resources, November 9, 2011, To Ed Sullivan, P.E., Duke Energy DOC ID 15489

Letter from Duke Energy, June 18, 1999, to James C. Coffey, Environmental Engineering Supervisor, Permitting Branch, North Carolina Department of Environment and Natural Resources

NCDENR

North Carolina Department of Environment and Natural Resources

Division of Waste Management

Beverly Eaves Perdue
Governor

Dexter R. Matthews
Director

Dee Freeman
Secretary

November 9, 2011

Mr. Ed Sullivan, P.E.
Mail Code EC13K
PO Box 1006
Charlotte, NC. 28201

RE: Monitoring Well MW-3 Assessment
Duke Energy – Marshall Steam Dry Ash Landfill
Permit #18-04
Catawba County
DOC ID 15489

Dear Mr. Sullivan:

A review of groundwater analytical data from the FGD Landfill indicates exceedances of groundwater standards established in 15A NCAC 2L .0202 (2L Standards) during the February 8, 2011 monitoring event. Manganese has been reported at concentrations greater than the 2L Standards in groundwater samples collected from MW-3. Monitor well MW-3 appears to be located at the compliance boundary. Industrial landfills are required to comply with the 2L standards at the compliance boundary in accordance with 15A NCAC 13B .503 (2)(d)(iv).

Duke Energy shall acquire the services of a North Carolina licensed professional geologist and submit a groundwater assessment work plan to the Solid Waste Section (Section) outlining how the reported metals contamination in MW-3 will be delineated. The Section will review the submitted work plan, approve, or request additional information or amendments before implementation. Please submit this work plan within 90 days of receiving this letter. The work plan may include, but not limited to an alternate source demonstration for the metals contamination. In addition, monitoring wells MW-2 and MW-5 have boron, manganese and selenium concentrations above their respective 2L Standards and appear to be located at the review boundary, which triggers the need for assessment.

The Section solicits your cooperation and would like to remind you that it is your responsibility to comply with the requirements of the rules and statues since the rules are self-implementing. Please contact me at (919) 707-8253 or via email Elizabeth.werner@ncdenr.gov if you have any questions or concerns regarding this letter. Thank you in advance for your anticipated cooperation in this matter.

Sincerely,

Elizabeth S Werner

Elizabeth S Werner
Hydrogeologist

cc: William M. Miller, PE, Altamont Environmental Inc.
Mark Poindexter, SWS
Ellen Lorscheider, SWS
Jason Watkins, SWS
Deb Aja, SWS
Central File

Duke Power
A Duke Energy Company

Duke Power
Group Environment, Health & Safety
13339 Hagers Ferry Road
Huntersville, NC 28078-7929

SECTION FILE

June 18, 1999

North Carolina Department of
Environment and Natural Resources
Division of Waste Management
Solid Waste Section
P.O. Box 29603
Raleigh, NC 27611-9603

Attention: Mr. James C. Coffey
Environmental Engineering Supervisor, Permitting Branch

Re: Industrial Landfill Compliance Demonstration
Marshall Steam Station
Permit Number 18-04, Catawba County

Record: 004991-DP

Dear Mr. Coffey:

The following narrative addresses the concerns expressed in the December 18, 1998 letter from Bill Sessoms and you regarding the Compliance Demonstration Report for Marshall Steam Station:

Existing Groundwater Data
As noted in the December 18, 1998 letter, "The 2L standard has been exceeded at MW-3 for manganese and pH consistently according to our records. The manganese has been recorded at 3 times the 2L standard and seems to be increasing over time." Groundwater data from MW-3 indicates that manganese levels have steadily declined over the past decade, from approximately 0.150 mg/l in 1989 to approximately 0.075 mg/l in 1999. The pH values have consistently been in the 5.0 – 6.0 range. Please refer to the attached graphs, which illustrate these conclusions. Natural soils of the Piedmont region, composed of the Pacolet type found at Marshall, frequently yield groundwater results that exhibit low pH and elevated levels of manganese. The purpose of inclusion of both manganese and pH as National Secondary Drinking Water standards was to "control contaminants in drinking water that primarily affect the aesthetic qualities relating to public acceptance of drinking water" (see 40 CFR 143.1). For this reason, FOWL-GH does not model for pH or manganese.

Monitoring Well Locations
As noted in the December 18, 1998 letter, "MW-3 is shown to be an upgradient and sidegradient well in the Information Package, but because of the height of the ash immediately next to this well it may indeed be downgradient and fairly representative of the discharge from the landfill." However, groundwater levels and analytical results taken from locations adjacent to MW-3 indicate that groundwater flow from the area above and northeast of MW-3 controls flow to this well rather than the landfill. Please refer the Marshall Steam Station Dry Ash Landfill Groundwater Quality Investigation Report, the Monitoring Well MW-3 Area Map (Figure 2) and Monitoring Well MW-3 Area Profile Map (Figure 3) which are attached.

The December 18, 1998 letter also questioned the location of monitoring well MW-1. Monitoring well MW-1 is located approximately 75 feet east of Phase I of the Marshall flyash landfill. Placement of flyash began in September 1984 in the area designated as Phase I. Phase I consists of approximately 15 acres and received approximately 280,000 tons of flyash between September 1984 and March 1986. Placement of ash in this area was completed around March 1986. Observation well OW-1 was installed to provide information on the direction of groundwater flow for Phase I. Observation well OW-1 is located slightly south of Phase I. Groundwater elevation data from these two wells indicate that groundwater flow is from the landfill area towards the northeast through MW-1. Please refer to the attached map (M-10), which designates the locations of MW-1 and OW-1.

Revised Water Quality Monitoring Plan
The December 18, 1998 letter requested that "a revised water quality monitoring plan needs to be submitted which includes an updated potentiometric map and additional wells which are to be located, sampled, and analyzed in such a way as 2L standards at the compliance boundaries can be demonstrated. Included in the new monitoring system should be 2 or more downgradient wells." The attached Marshall Steam Station Dry Ash Storage Area Jan. 1, 1999 Contours Plan (Figure 1) indicates the location of two proposed monitoring wells (MW-5 and MW-6) and one proposed observation well (OW-2) and their relation to the compliance boundaries. These well locations were designated based upon previous discussions with representatives of the Solid Waste Section of NC DENR. Additional data from the landfill site was also requested. Therefore, during the installation of monitoring wells MW-5 and MW-6, the following information will be obtained: 1) boring logs, 2) standard penetration – resistance at 5 foot intervals, 3) USCS soil classification, 4) water table depth (at time of boring and 24 hours after boring), 5) hydraulic conductivity, 6) undisturbed soil samples taken for void ratio and porosity determinations. For observation well OW-2, water table depth, hydraulic conductivity and boring logs will be collected.

Duke Power requests written acceptance of the forenamed proposal prior to the installation of monitoring wells MW-5, MW-6 and observation well OW-2. Hopefully, this letter has adequately addressed all of the issues identified previously in the December 18, 1998 letter. If there are additional concerns, questions or comments, please contact me at (704) 875-4655. A timely resolution to the Marshall Compliance Demonstration Report would be deeply appreciated. Thank you for your time and effort on our behalf.

Sincerely,

Allen Stowe

Allen Stowe, Scientist
Environmental Protection

jas/mssmw3

Attachment

cc: Ellen Lorscheider – NC DENR, Solid Waste Section
Bobby Lufty – NC DENR, Solid Waste Section

bc: Donna Burrell w/attachments
Sonny Cook w/o attachments
Buddy Davis w/o attachments
Larry Evans w/o attachments
Mark Hollis w/o attachments
Steve Immel w/attachments
Bill Miller w/o attachments
Mike Ruhe w/o attachments
Ron Santini w/o attachments

MARSHALL STEAM STATION
DRY ASH LANDFILL
GROUNDWATER QUALITY INVESTIGATION

Introduction

Environmental Chemistry personnel installed temporary monitoring wells at the north side of the Marshall Steam Station Dry Ash Landfill to determine the potential impact of the landfill on Monitoring Well MW3. As part of this investigation, personnel also sampled these wells, monitoring well MW3 and two adjacent ponds to determine groundwater flow and groundwater quality characteristics.

Temporary Monitoring Well Installation

Two temporary monitoring wells were installed using direct push technology (Table 1, Figures 1 and 2). Well MSSGP2 was used to characterize both groundwater elevation and groundwater quality, while MSSGP1 was used to characterize groundwater elevation. All wells were installed using a Geoprobe and well MSSGP2 was screened over a three foot interval using a pre-packed well screen. The pre-packed screen uses a 0.5-inch diameter, 0.010 inch screen slot size packed with sand with an outer casing of fine stainless steel mesh. A fine stainless steel mesh screen was used for water level measurements at MSSGP1. Each well was pushed to the desired depth and allowed to set for 24 hours. Water level measurements were taken at 24 hours and again at 48 hours. In addition, well MSSGP2 was developed prior to sampling by surge blocking.

Table 1. Monitoring Well Information

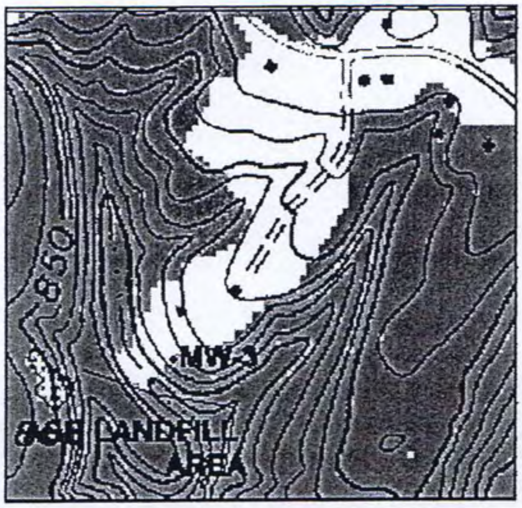
Parameter	Units	MSSGP1	MSSGP2	MW3
Top of Casing	msl-feet	840.18	817.56	813.07
Depth to Water	feet	34.82	11.04	7.65
Water Elevation	msl-feet	805.36	806.52	805.42
Well Depth	feet	48.65	19.99	28.15
Screen Length	feet	1.5	3	10
Screen Interval	msl-feet	792.53 - 791.03	800.57 - 797.57	794.92 -784.92

Water Elevation Results

Surface and subsurface drainage patterns within the Piedmont Physiographic Province generally indicate the movement of contaminants by surface water and groundwater. It can be assumed for Piedmont areas that surface topography approximates groundwater flow patterns. Groundwater recharge generally occurs in the upland areas of a site. Discharge from these areas occurs at surface water features such as lakes, streams, seeps or springs.

Groundwater elevations measured at monitoring wells MSSGP1, MSSGP2 and MW3 suggest the ash landfill has minimal influence on groundwater flow to monitoring well MW3. Well MSSGP1, located in the ash landfill measured a water elevation of 805.36 ft, slightly higher than the water elevation of 805.42 ft measured at MW3. However, the water elevation measured at MSSGP2, 806.52 ft, was greater than both MW3 and MSSGP1, suggesting flow from the area above and to the northeast of MW3 controls flow to this well (Figure 3). Water chemistry information explained in the next section supports this contention. The initial USGS Lake Norman North Topo Map (1993) (Figure 4) for this area would suggest that the controlling topographical feature would direct flow away from MW3, through a major drainage feature in a south-southeasterly direction toward the topographical low at the ash basin.

Figure 4: Section from Lake Norman North, NC USGS Topo Quad.



Geochemistry:

All monitoring wells, with the exception of MSSGP1, and the two ponds were sampled and analyzed for in-situ parameters, major cations and anions, and iron and manganese (Table 2).

Table 2: Groundwater Geochemistry

Parameter	Units	Monitoring Well Identification				
		MSSGP1	MSSGP2	MW-3	POND1	POND2
Field pH	Std. Units		4.7	4.2	6.4	6.2
Field Spec. Conductance	umho/cm		108	78	66	210
Temperature	C		14	15	16	16
Alkalinity	mg/l		3.50	1.50	22.00	36.00
Calcium	mg/l		1.509	0.71	4.1	17.8
Chloride	mg/l		13.80	11.20	3.50	3.10
Iron	mg/l		1.07	0.110	1.00	0.98
Magnesium	mg/l		5.1	4.9	1.8	2.7
Manganese	mg/l		0.64	0.074	0.15	0.48
Nitrate	mg/l		4.6	4.7	0.02	0.03
Potassium	mg/l		2.6	3.1	2.1	9.9
Sodium	mg/l		6.3	5.6	4.6	9.6
Sulfate	mg/l		1	1	7	114
Total Dissolved Solids	mg/l		72	66	43	117

A review of Table 2 indicates the major ionic characteristics of MSSGP2 and MW3 follows the general pattern Mg>Cl>Na>Ca>K>HCO3>SO4. This pattern is very different from Pond 1 (HCO3>Ca>Na>Mg>SO4>Cl>K) and Pond 2 (SO4>Ca>HCO3>Na>K>Mg>Cl), suggesting groundwater at MW3 is influenced predominately by the recharge area upgradient of the well. In addition to the ionic similarities between MSSGP2 and MW3, nitrate concentrations at these two wells (4.6 mg/L:MSSGP2; 4.7 mg/L:MW3) are also similar, but very different from the concentrations measured at the ponds (0.02 mg/L: Pond 1; 0.02 mg/L: Pond 2) and MSSGP3 (0.03 mg/L), giving additional validity to the direction of groundwater flow to MW3.

Iron (0.110 mg/L) and manganese (0.074 mg/L) concentrations are lowest at MW3. The high iron and manganese concentrations at the ponds may be attributed to turbidity.

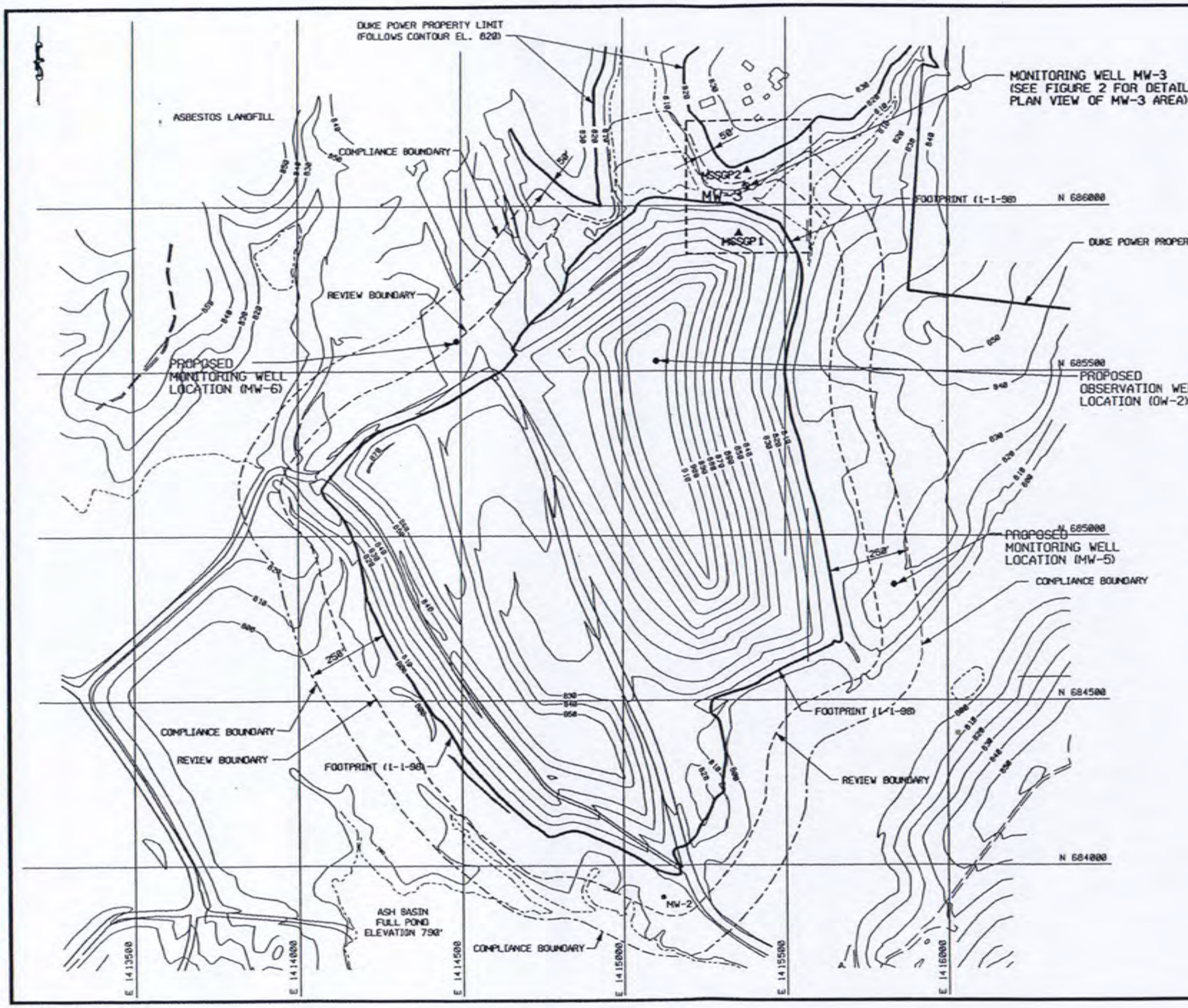
Historical Review of pH and Manganese Data at Monitoring Well MW-3

pH: pH trends from the start of monitoring in 1989 through February 1999 confirm pH values have been below the 2L Standard of 6.5 pH units (Figure 5). However, with the installation of a dedicated sampling system in 1992, pH has followed a flat trend (Figure 6). This flat trend suggests the landfill has not impacted monitoring MW-3 and all but two monitoring points fall outside of one standard deviation surrounding the mean pH (5.2 SU).

Manganese: Historical manganese concentrations suggest the concentrations have exceeded the 2L Standard of 0.05 mg/L manganese since the start of monitoring in 1989 (Figure 7). However, the data also suggests that manganese concentrations have declined since the installation of the dedicated sampling system in 1992 (Figure 8). This trend would suggest early year manganese concentrations are related more to sampling technique than actual groundwater dissolved manganese concentrations, and the landfill has not impacted Monitoring Well MW-3.

Conclusions

Based on the groundwater elevations and geochemistry data collected on April 15, 1999, it appears that Monitoring Well MW3 is influenced predominately by groundwater flow regimes associated with the recharge area north-northeast of the well. The groundwater elevations measured at MSSGP1 and MSSGP2 would suggest flow in a northeast to southwest direction from MSSGP2 to MW3. Geochemistry associated with the wells and the ponds strongly suggests MW3 is influenced by the northern recharge area rather than the dry ash landfill. This spatial influence is supported by a review of historical groundwater monitoring data for pH and manganese that suggests the landfill has not impacted MW-3. Topographical controls would suggest the drainage, both subsurface and surface, would migrate in a south-southeast direction away from MW3 and toward the existing ash basin.



NOTES:

1. DRAWING SHOWS JAN. 1, 1998 FOOTPRINT OF ASH STORAGE AREA.
2. COMPLIANCE BOUNDARY IS 250 FEET FROM JAN. 1, 1998 FOOTPRINT OR 50 FEET FROM DUKE POWER PROPERTY LINE, WHICHEVER IS CLOSER TO WASTE.
3. REVIEW BOUNDARY IS HALF-WAY BETWEEN COMPLIANCE BOUNDARY AND FOOTPRINT (1-1-98).

LEGEND:

- COMPLIANCE BOUNDARY
- REVIEW BOUNDARY
- FOOTPRINT (1-1-98)
- EXISTING ELEVATION CONTOURS
- EXISTING GROUNDWATER MONITORING WELL

DUKE POWER COMPANY
MARSHALL STEAM STATION

DRY ASH STORAGE AREA
JAN. 1, 1998 CONTOURS
PLAN

FIGURE: 1

c:\dgn\marsh1.dgn

DUKE ENERGY CORPORATION
MARSHALL STEAM STATION

FIGURE 2
MONITORING WELL MW–3 AREA

MOUNTAIN CREEK TOWNSHIP
CATAWBA COUNTY, N.C.

BOOK NO. 2321
FEBRUARY 22, 1999
SCALE: 1" = 50'

25 0 25 50 75
SCALE IN FEET

CREW: B. HOBBS
DRAWN BY: WRM
E.C. = 1' : 10,000'+

PROJECT NO. 4411 | REQUEST NO. 106932

STATE OF NORTH CAROLINA
MECKLENBURG COUNTY

I, W. MICHAEL JONES, certify that this plat was drawn under my supervision from an actual survey made under my supervision (deed description recorded in Book AS, page SHOWN, etc.) (other); that the boundaries not surveyed are clearly indicated as drawn from information found in Book AS, page SHOWN; that the ratio of precision as calculated is 1: 10,000+; that this plat was prepared in accordance with G.S. 47-30 as amended. Witness my original signature, registration number and seal this 22nd day of MARCH, A.D., 1999.

NORTH CAROLINA PROFESSIONAL LAND SURVEYOR SEAL L-3707 W. MICHAEL JONES 06-02-1999

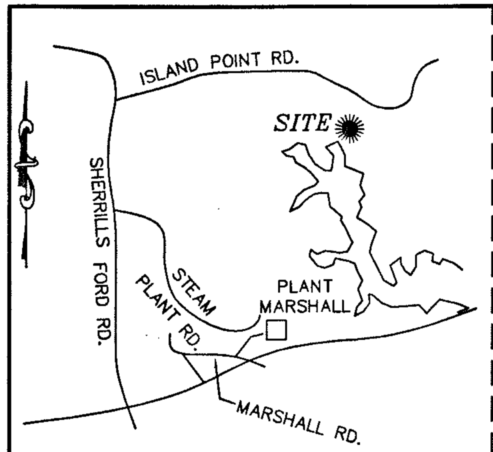
W. Michael Jones
Professional Land Surveyor
L-3707

NOTE:
ALL DISTANCES ARE HORIZONAL DISTANCES UNLESS OTHERWISE NOTED.

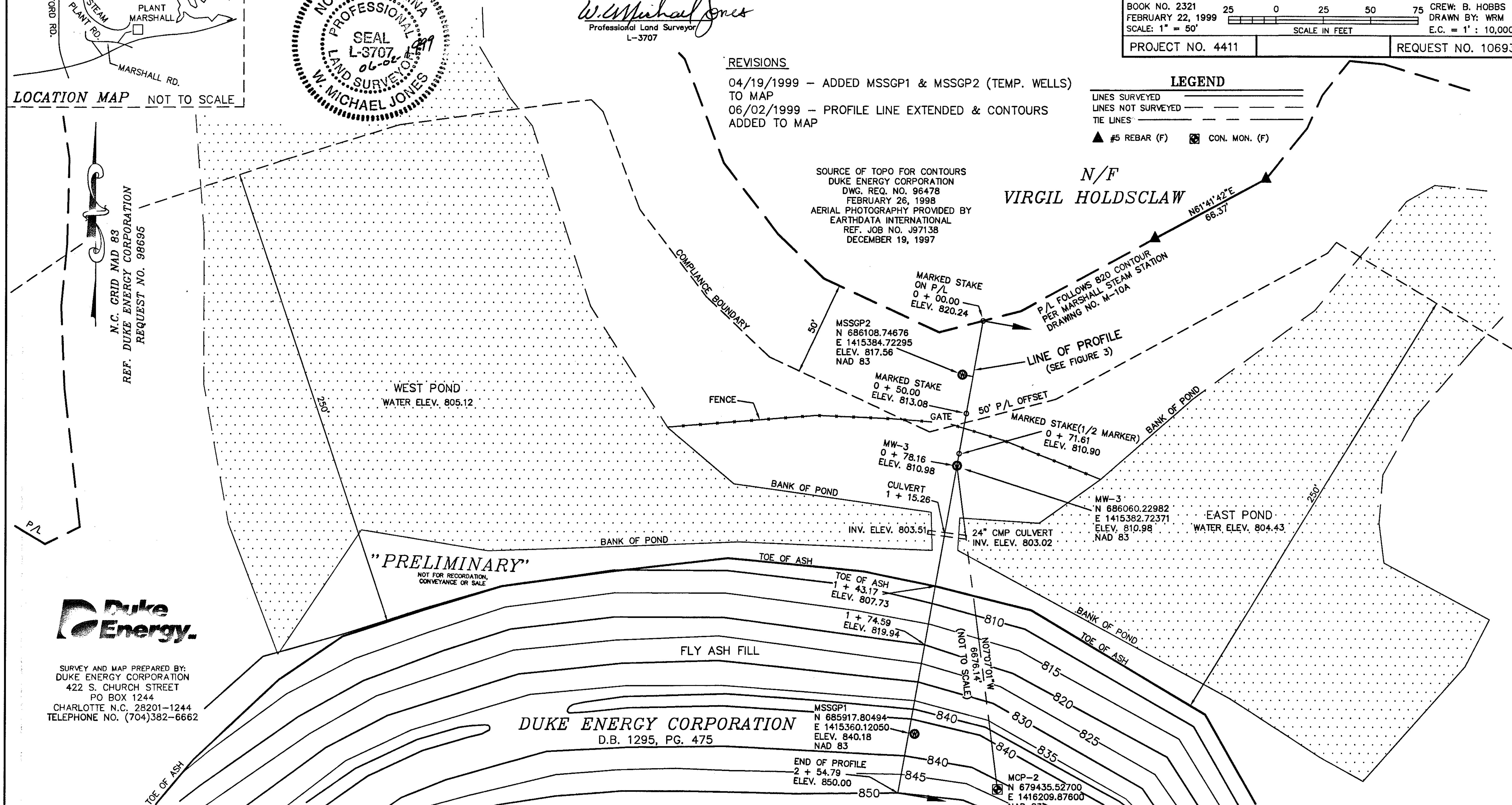
NOTE:
NOT INTENDED AS A BOUNDARY SURVEY.
MAY NOT BE USED FOR CONVEYANCE OR SALE.

REVISIONS
04/19/1999 – ADDED MSSGP1 & MSSGP2 (TEMP. WELLS) TO MAP
06/02/1999 – PROFILE LINE EXTENDED & CONTOURS ADDED TO MAP

LEGEND
LINES SURVEYED
LINES NOT SURVEYED
TIE LINES
#5 REBAR (F)
CON. MON. (F)

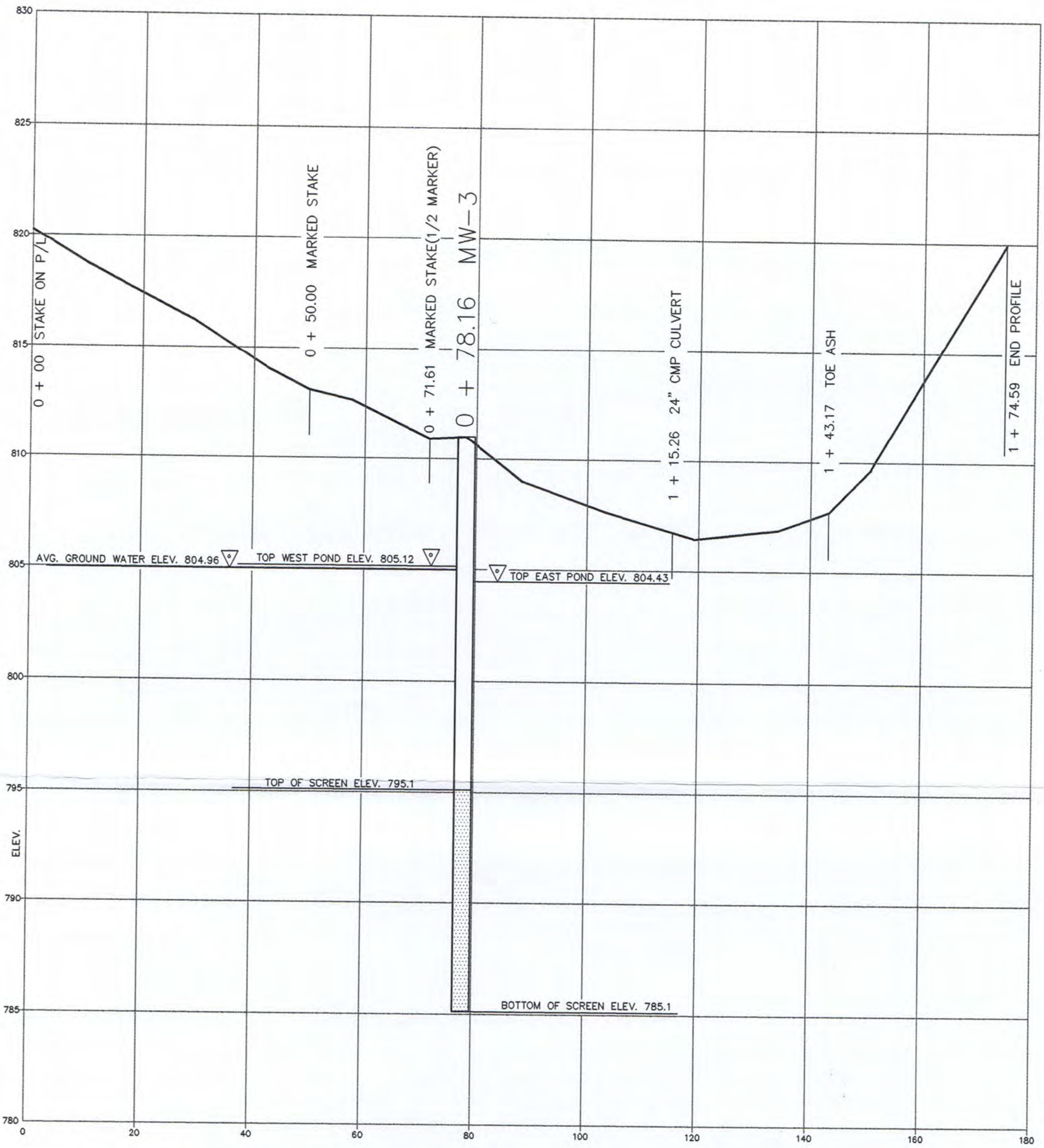


LOCATION MAP NOT TO SCALE



Duke Energy.

SURVEY AND MAP PREPARED BY:
DUKE ENERGY CORPORATION
422 S. CHURCH STREET
PO BOX 1244
CHARLOTTE N.C. 28201–1244
TELEPHONE NO. (704)382–6662



Thu Mar 11 13:38:20 1999 Scale: Vertical 1" = 5' Horizontal 1" = 20'	Sheet 2 of 2

Figure 3

Duke Energy

SURVEY AND MAP PREPARED BY:
DUKE ENERGY CORPORATION
422 S. CHURCH STREET
PO BOX 1244
CHARLOTTE N.C. 28201-1244
TELEPHONE NO. (704)382-6662

DUKE ENERGY CORPORATION
MARSHALL STEAM STATION

PROFILE IN VICINITY OF
MONITORING WELL MW-3

MOUNTAIN CREEK TOWNSHIP
CATAWBA COUNTY, N.C.

BOOK NO. 2321
FEBRUARY 22, 1999
SCALE: AS SHOWN

25 0 25 50 75
SCALE IN FEET

CREW: B. HOBBS
DRAWN BY: WRM
E.C. = 1' : 10,000'+

PROJECT NO. 4411	SHEET 2 OF 2	REQUEST NO. 106932P1

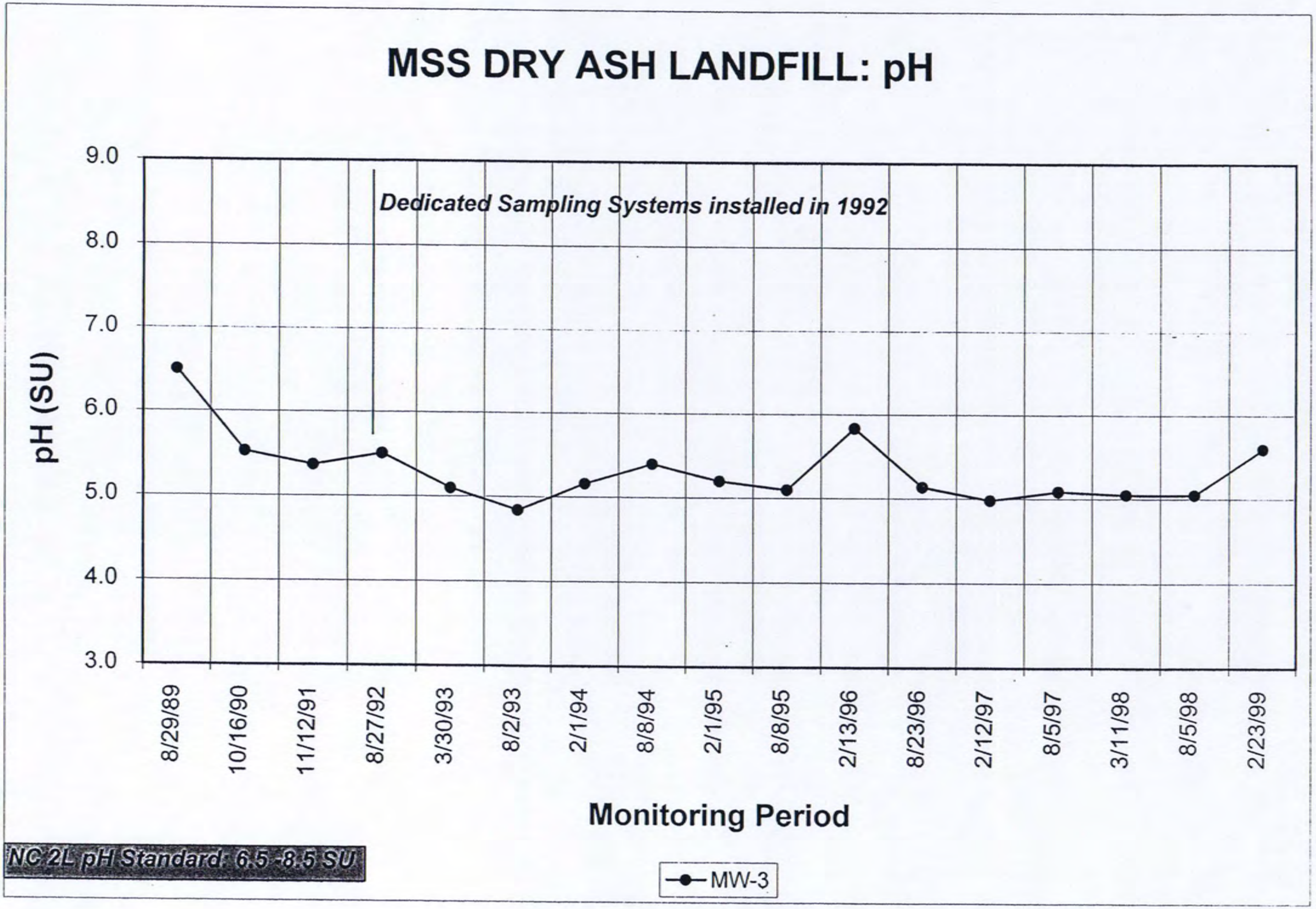

MSS DRY ASH LANDFILL: pH
Dedicated Sampling Systems installed in 1992
pH (SU)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
8/29/89
10/16/90
11/12/91
8/27/92
3/30/93
8/2/93
2/1/94
8/8/94
2/1/95
8/8/95
2/13/96
8/23/96
2/12/97
8/5/97
3/11/98
8/5/98
2/23/99
Monitoring Period
NC 2L pH Standard: 6.5 -8.5 SU
MW-3

Figure 5

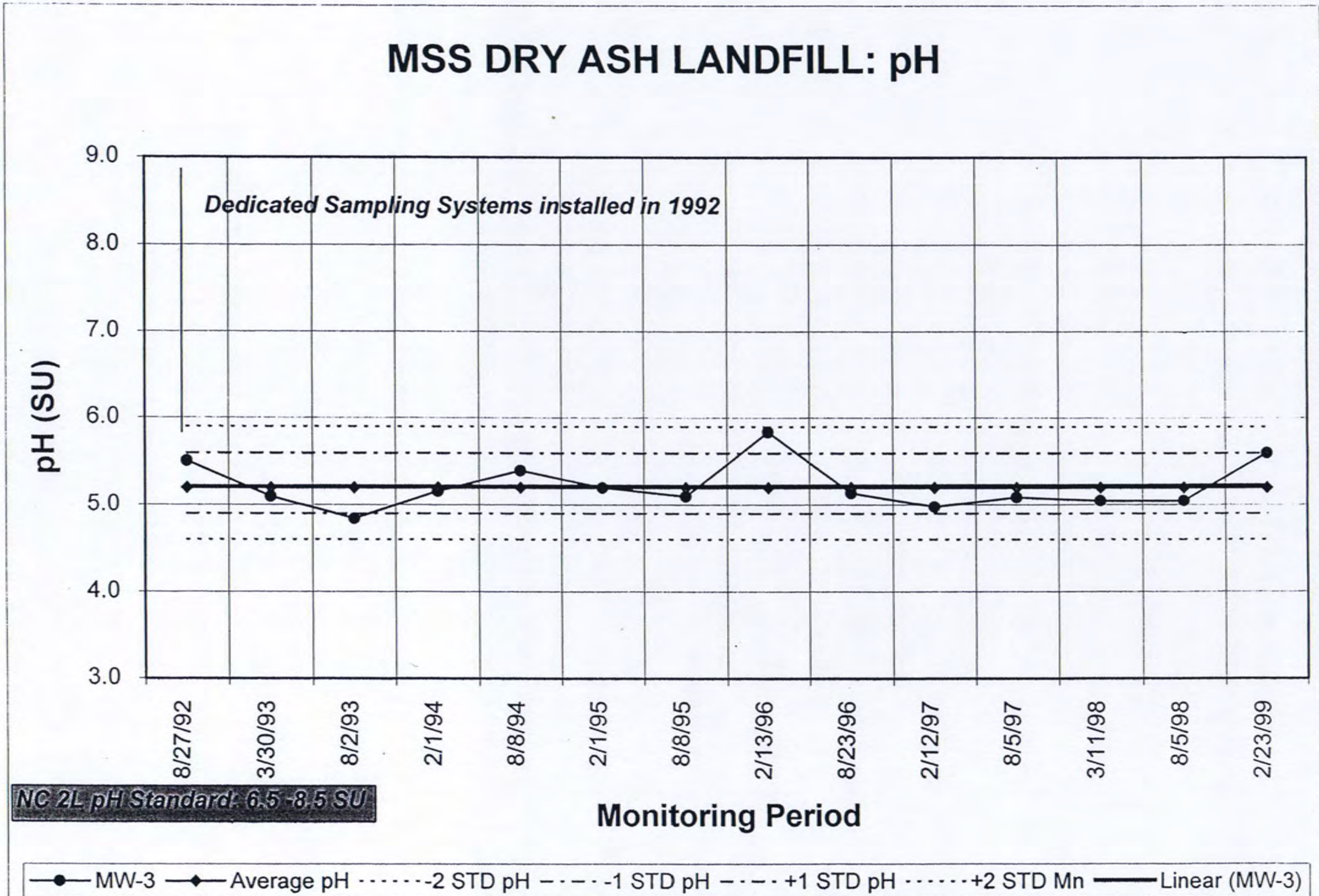

MSS DRY ASH LANDFILL: pH
Dedicated Sampling Systems installed in 1992
9.0
8.0
7.0
6.0
5.0
4.0
3.0
pH (SU)
8/27/92
3/30/93
8/2/93
2/1/94
8/8/94
2/1/95
8/8/95
2/13/96
8/23/96
2/12/97
8/5/97
3/11/98
8/5/98
2/23/99
NC 2L pH Standard: 6.5 - 8.5 SU
Monitoring Period
MW-3
Average pH
-2 STD pH
-1 STD pH
+1 STD pH
+2 STD Mn
Linear (MW-3)

Figure 6

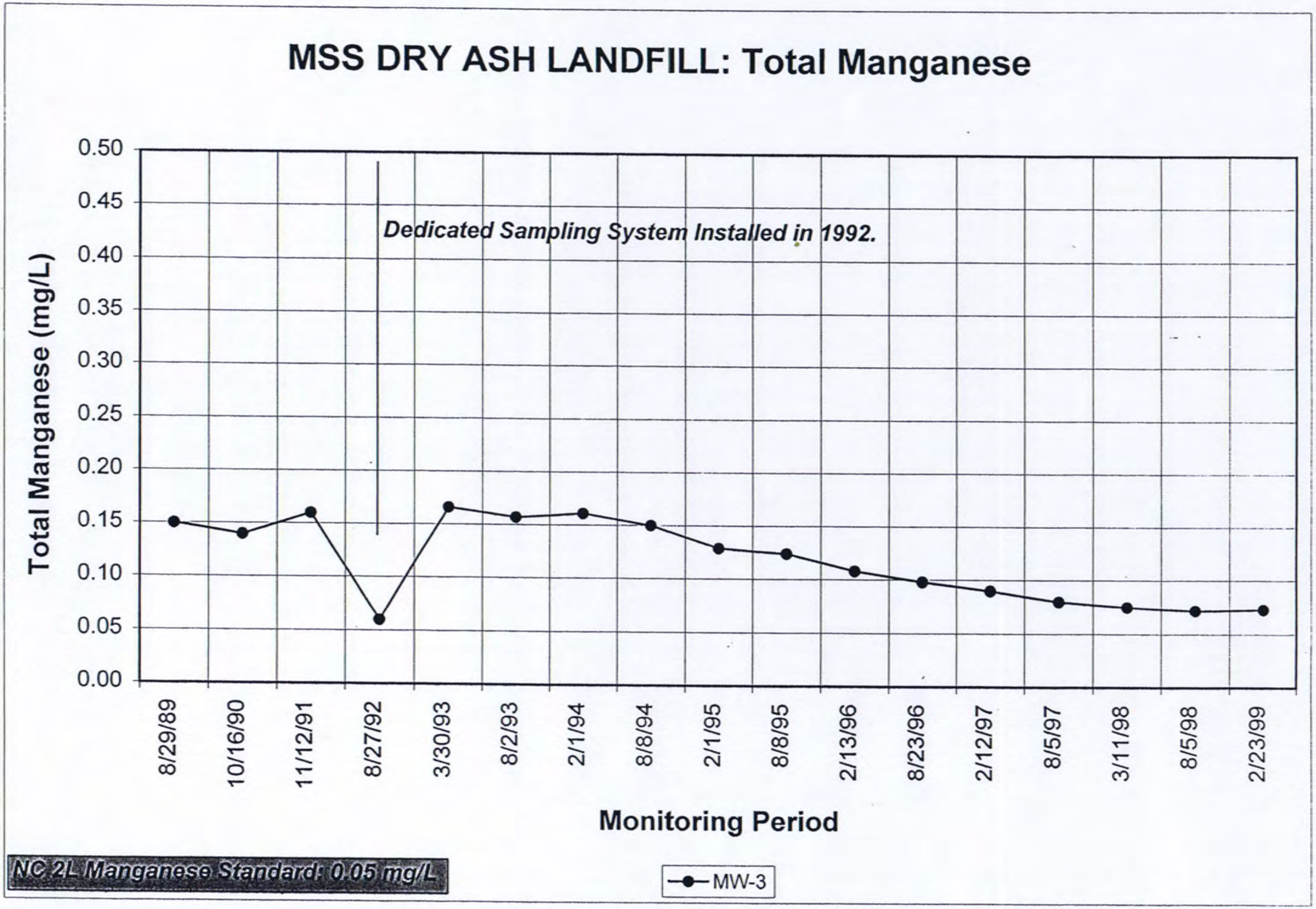
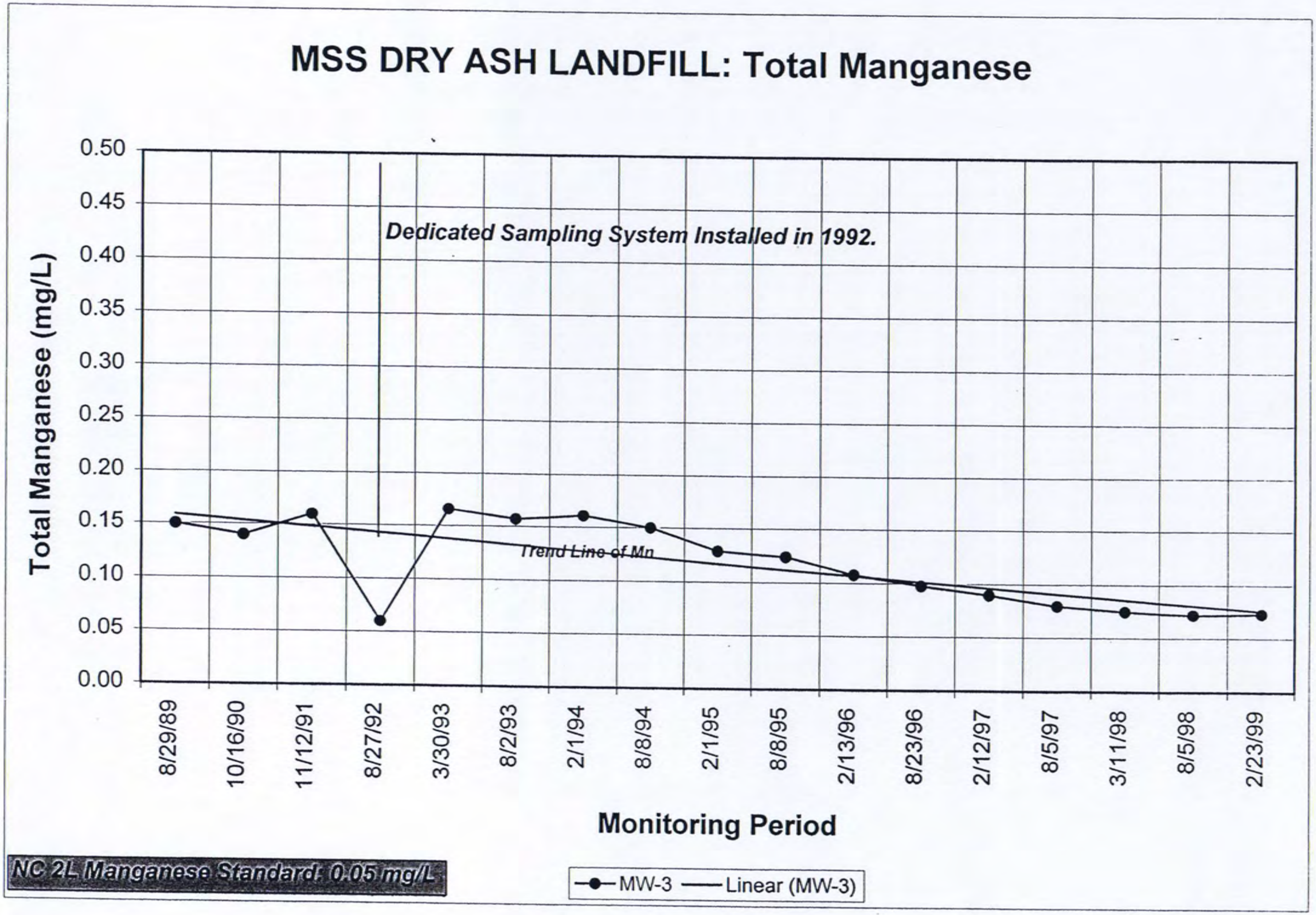

MSS DRY ASH LANDFILL: Total Manganese
Total Manganese (mg/L)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Dedicated Sampling System Installed in 1992.
8/29/89
10/16/90
11/12/91
8/27/92
3/30/93
8/2/93
2/1/94
8/8/94
2/1/95
8/8/95
2/13/96
8/23/96
2/12/97
8/5/97
3/11/98
8/5/98
2/23/99
Monitoring Period
NC 2L Manganese Standard: 0.05 mg/L
MW-3

Figure 7



MSS DRY ASH LANDFILL: Total Manganese
Total Manganese (mg/L)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Dedicated Sampling System Installed in 1992.
Trend Line of Mn
8/29/89
10/16/90
11/12/91
8/27/92
3/30/93
8/2/93
2/1/94
8/8/94
2/1/95
8/8/95
2/13/96
8/23/96
2/12/97
8/5/97
3/11/98
8/5/98
2/23/99
Monitoring Period
NC 2L Manganese Standard: 0.05 mg/L
MW-3
Linear (MW-3)

Figure 8

APPENDIX B

Monitoring Well Installation Records

Form 25630 (R3-87)

FORM M–26C	REVISION 2
	PAGE 1 OF 1

DUKE POWER COMPANY
CONSTRUCTION DEPARTMENT
PROJECT MARSHALL

SOIL TEST BORING FIELD REPORT

STARTING TIME N/A
GROUND SURFACE ELEV.

JOB NO. N/A
JOB NAME FLYASH LANDFILL MW'S — HRS. DRILLING N/A — HRS. MOVING N/A
DATE 6-28-89 — WEATHER Hot — INSPECTOR D. DICKSON — BORING NO. MW-2

SAMPLING		1ST 6"	2ND 6"	3RD 6"	SCALE	UD	SOIL CLASSIFICATION AND REMARKS
					0		AD-2 DRILL RIG # 2555 SURFACE GRASS
1	4.5 6.0	3	4	4	5		REDDISH YELLOW MICA. SILTY FINE TO COARSE SAND-
2	9.5 11.0	3	4	4	10		LT. ~~BR~~ YELLOWISH BRN. MICA. SILTY FINE TO COARSE SAND.
3	14.5 16.0	3	3	4	15		LT. OLIVE GRAY MICA SILTY FINE TO COARSE SAND
4	19.5 21.0	4	7	10	20		LT. OLIVE GRAY MICA. SILTY FINE TO COARSE SAND.
5	24.5 26.0	13	26	24	25		LT. OLIVE BROWN MICA. SILTY FINE TO COARSE SAND
6	29.5 31.0	13	23	33	30		LT. OLIVE BROWN MICA. SILTY FINE TO COARSE SAND.
7	34.3 34.8	50=4"			35		NO RECOVERY AUGER REFUSAL @ 34.9 BORING TERMINATED SET 6"ϕ CASING TO 34.9' SET MONITOR WELL PER ATTACHED SKETCH.
					40		

+ STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES

BORING TERMINATED @ 34.9
BORING REFUSAL AUGER @ 34.9'
WATER TOB DEPTH 15.0' on 6.28.89
WATER 24 HR: DEPTH 5.0' ON 7-6-89
WATER LOSSES NONE
CASING SIZE PW (6"ϕ) LENGTH 34.9'

METHOD OF ADVANCING BORING	DEPTH
POWER AUGER	0 TO 34.9
~~HAND CHOP: W/MUD: W/WATER~~	—TO—
~~ROTARY DRILL: W/MUD: W/WATER~~	—TO—
~~DIAMOND CORE~~	—TO—

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH, N.C. 27611, PHONE (919) 733-5083

WELL CONSTRUCTION RECORD

FOR OFFICE USE ONLY

Quad. No. ______ Serial No. ______
Lat. ______ Long. ______ Pc ______
Minor Basin ______
Basin Code ______
Header Ent. ______ GW-1 Ent. ______

DRILLING CONTRACTOR: DUKE POWER CO.
DRILLER REGISTRATION NUMBER: 921

STATE WELL CONSTRUCTION PERMIT NUMBER: 18-04

1. WELL LOCATION: (Show sketch of the location below)
   Nearest Town: DENVER
   HIGHWAY #150
   (Road, Community, or Subdivision and Lot No.)

County: CATAWBA

2. OWNER: DUKE POWER CO.
   ADDRESS: P. O. BOX 33189
   (Street or Route No.)
   CHARLOTTE, NC 28242
   City or Town / State / Zip Code
3. DATE DRILLED: 6-28-89 USE OF WELL: MONITORING
4. TOTAL DEPTH: 34.9 CUTTINGS COLLECTED ☑ Yes ☐ No
5. DOES WELL REPLACE EXISTING WELL? ☐ Yes ☑ No
6. STATIC WATER LEVEL: 7.2 FT. ☐ above ☑ below TOP OF CASING,
   TOP OF CASING IS 2.2 FT. ABOVE LAND SURFACE.
7. YIELD (gpm): N/A METHOD OF TEST: N/A
8. WATER ZONES (depth): N/A
9. CHLORINATION: Type N/A Amount N/A
10. CASING:

Depth From	To	Ft. Diameter	Wall Thickness or Weight/Ft.	Material
0	23.0	2" I.D.	~~.07~~ .154	PVC

11. GROUT:

Depth From	To	Ft. Material	Method
0	18.0	NEAT CEMENT	PUMPED

12. SCREEN:

Depth From	To	Ft. Diameter	in. Slot Size	in. Material
23.0	33.0	2" I.D.	.010	PVC

13. GRAVEL PACK:

Depth From	To	Ft. Size	Material
21.0	34.9		CLEAN SAND
			NC-2S

14. REMARKS: BENTONITE SEAL PLACED FROM 18.0' - 21.0'

DRILLING LOG

Depth From	To	Formation Description
		SEE ATTACHED SOIL TEST BORING FIELD REPORT FOR #MW-2

If additional space is needed use back of form.

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

[signature] 7-15-89
SIGNATURE OF CONTRACTOR OR AGENT — DATE

GW-1 Revised 11/84

Submit original to Division of Environmental Management and copy to well owner.

N. C. Department of Human Resources
Division of Health Services

WELL COMPLETION RECORD

C MPLETE ALL INFORMATION REQUESTED BELOW FOR EACH WELL INSTALLED, AND RETURN FORM TO THE DEPARTMENT OF HUMAN RESOURCES, SOLID AND HAZARDOUS WASTE MANAGEMENT BRAN P. O. BOX 2091, RALEIGH, N.C. 27602

NAME OF SITE: MARSHALL STEAM STATION	PERMIT NO.: 18 04
ADDRESS: HIGHWAY # 150 , TERRELL , NC	OWNER (print): DUKE POWER CO.
DRILLING CONTRACTOR: DUKE POWER CO.	REGISTRATION NO.: 9221

Casing Type: TRILOC THREADED PVC dia. 2" in.
Casing Depth: from 0 to 23.0 ft. - dia. 2" in.
Screen Type: TRILOC THREADED PVC dia. 2" in.
Screen Depth: from 23.0 to 33.0 ft. - dia. 2" in.

Grout Depth: from 0 to 18.0 ft. - dia. 6
Bentonite Seal: from 18.0 to 21.0 ft. - dia. 6"
Sand/Gravel PK: from 21.0 to 34.9 ft. - dia. 6"
Total Well Depth: from 0 to 34.9 ft. - dia. 6

Static Water Level: 7.2 feet from top of casing Date Measured 7 / 6 /

Yield (gpm): N/A Method of Testing: N/A Casing is 2.2 feet above land su

DRILLING LOG

DEPTH FROM	TO	FORMATION DESCRIPTION
		SEE ATTACHED SOIL TEST BORING FIELD REPORT FOR MW-#2.

LOCATION SKETCH

(show distance to numbered roads, or other map reference po

REMARKS: SCREEN IS PLACED IN THE MOST HYDRAULICALLY CONDUCTIVE ZONE PER CONVERSATIONS WITH RALPH ROBERTS AND ED SULLIVAN

DATE: 7-18-87 SIGNATURE: [signature]

Form CI-51P	Revision 0	Page

DUKE POWER COMPANY – MARSHALL STEAM STA.

AS-BUILT INSTALLATION SKETCH

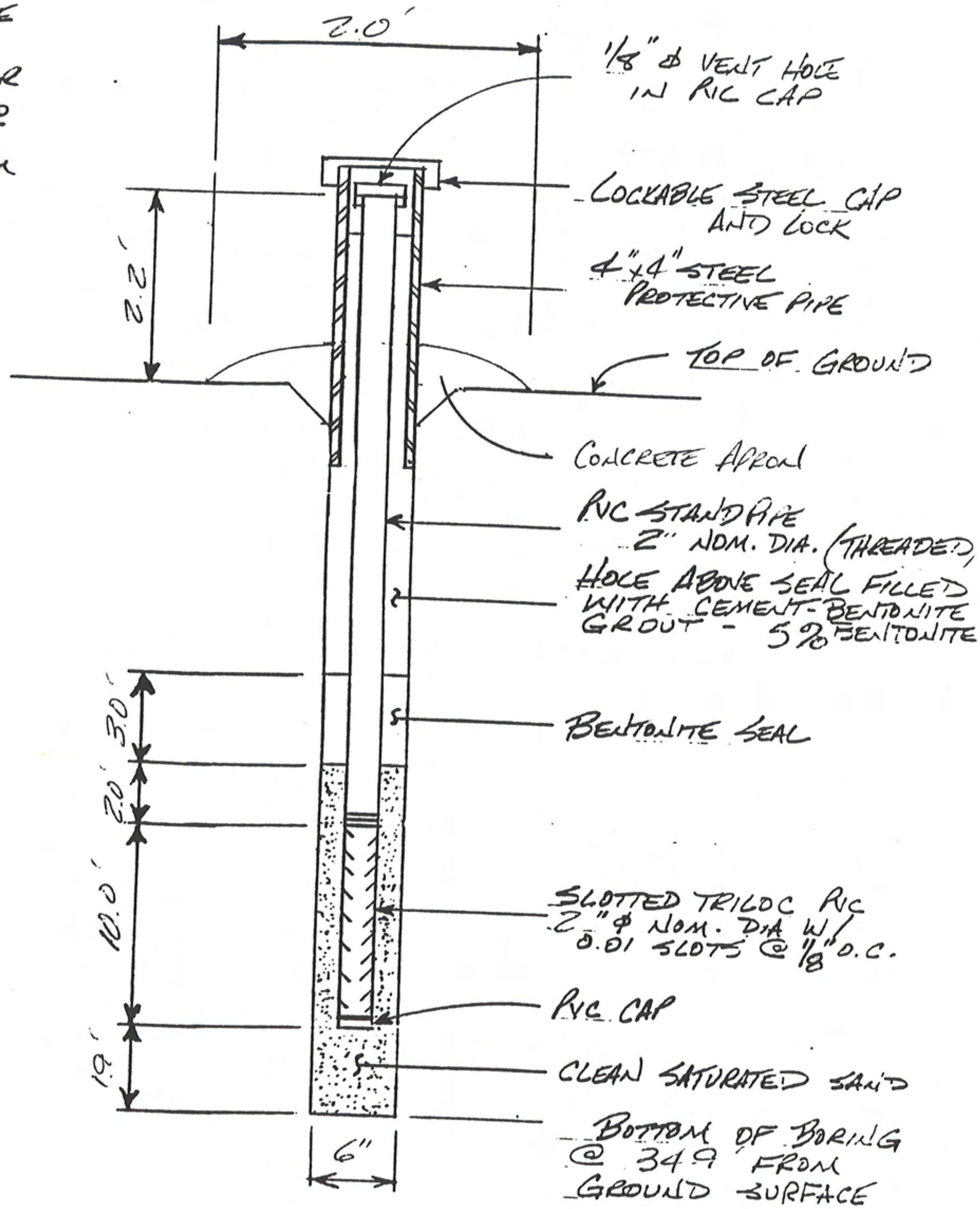
Instrument No. MW-2 Station N/A Offset N/A

By D. DICKSON Date 7-15-89

NOTE:
NOT TO SCALE

INITIAL WATER LEVEL RDG @ 7.2' FROM TOP/PIPE ON 7-6-89

T/PIPE ELEV. 15



Form 25630 (R3-87)

FORM M–26C	REVISION 2
	PAGE 1 OF 1

DUKE POWER COMPANY
CONSTRUCTION DEPARTMENT
PROJECT MARSHALL

SOIL TEST BORING FIELD REPORT

STARTING TIME N/A
JOB NO. N/A
GROUND SURFACE ELEV.
JOB NAME FLYASH LANDFILL MW'S
HRS. DRILLING N/A HRS. MOVING N/A
DATE 6-29-89 WEATHER HOT INSPECTOR D-DICKSON BORING NO. MW-3

SAMPLING		1ST 6"	2ND 6"	3RD 6"	SCALE	UD	SOIL CLASSIFICATION AND REMARKS
					0		AD-2 DRILL RIG #2555
1	4.8 / 6.3	3	3	4	5		STRONG BROWN MICA. FINE TO MED. SANDY SILT.
2	9.8 / 11.3	9	13	21	10		WHITE MICA. FINE TO COARSE SAND
3	14.8 / 16.3	12	21	16	15		WHITE MICA. FINE TO COARSE SAND
4	19.8 / 21.3	15	14	13	20		VERY PALE BROWN MICA. FINE TO COARSE SAND.
5	24.8 / 26.3	3	5	5	25		STRONG BROWN MICA. SILTY FINE TO MEDIUM SAND.
							AUGER REFUSAL @ 27.4' BORING TERMINATED SET MONITOR WELL PER ATTACHED SKETCH
					30		
					35		
					40		

+ STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES

BORING TERMINATED @ 27.4
BORING REFUSAL AUGER @ 27.4'
WATER TOB DEPTH 21.0 ON 6-29-89
WATER 24 HR: DEPTH 6.8' ON 7-6-89
WATER LOSSES N/A
CASING SIZE N/A LENGTH 0

METHOD OF ADVANCING BORING	DEPTH
POWER AUGER	0 TO 27.4
~~HAND CHOP: W/MUD: W/WATER~~	— TO —
~~ROTARY DRILL: W/MUD: W/WATER~~	— TO —
~~DIAMOND CORE~~	— TO —

27.4

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT – GROUNDWATER SECTION
P.O. BOX 27687 – RALEIGH,N.C. 27611, PHONE (919) 733-5083

FOR OFFICE USE ONLY

Quad. No. ______ Serial No. ______
Lat. ______ Long. ______ Pc ______
Minor Basin ______
Basin Code ______
Header Ent. ______ GW-1 Ent. ______

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR: DUKE POWER CO.
DRILLER REGISTRATION NUMBER: 921

STATE WELL CONSTRUCTION PERMIT NUMBER: 18-04

1. WELL LOCATION: (Show sketch of the location below)
   Nearest Town: DENVER
   HIGHWAY #150
   (Road, Community, or Subdivision and Lot No.)
2. OWNER: DUKE POWER CO.
   ADDRESS: P.O. BOX 33189 (Street or Route No.)
   CHARLOTTE (City or Town) NC (State) 28242 (Zip Code)
3. DATE DRILLED: 6-29-89 USE OF WELL: MONITORING
4. TOTAL DEPTH: 27.4 CUTTINGS COLLECTED ☑ Yes ☐ No
5. DOES WELL REPLACE EXISTING WELL? ☐ Yes ☑ No
6. STATIC WATER LEVEL: 8.9' FT. ☐ above ☑ below TOP OF CASING,
   TOP OF CASING IS 2.1 FT. ABOVE LAND SURFACE.
7. YIELD (gpm): N/A METHOD OF TEST: N/A
8. WATER ZONES (depth): N/A
9. CHLORINATION: Type N/A Amount N/A
10. CASING:

Depth From	To	Diameter	Wall Thickness or Weight/Ft.	Material
0	15.9 Ft.	2" I.D.	.154	PVC
	Ft.			
	Ft.			

11. GROUT:

Depth From	To	Material	Method
0	11.0 Ft.	NEAT CEMENT	PUMPED
	Ft.		

12. SCREEN:

Depth From	To	Diameter	Slot Size	Material
15.9	25.9 Ft.	2" I.D. in.	.010 in.	PVC
	Ft.	in.	in.	
	Ft.	in.	in.	

13. GRAVEL PACK:

Depth From	To	Size	Material
14.0	27.4 Ft.		NC #2 SAND
	Ft.		

14. REMARKS: BENTONITE SEAL PLACED FROM 11.0' – 14.0'

County: CATAWBA

DRILLING LOG

Depth From	To	Formation Description
		SEE ATTACHED
		SOIL TEST
		BORING FIELD
		REPORT FOR
		#MW-3

If additional space is needed use back of form.

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

[signature] 7-15-89
SIGNATURE OF CONTRACTOR OR AGENT DATE

 Submit original to Division of Environmental Management and copy to well owner.

N. C. Department of Human Resources
Division of Health Services

WELL COMPLETION RECORD

COMPLETE ALL INFORMATION REQUESTED BELOW FOR EACH WELL INSTALLED, AND RETURN FORM TO THE DEPARTMENT OF HUMAN RESOURCES, SOLID AND HAZARDOUS WASTE MANAGEMENT BRAN P. O. BOX 2091, RALEIGH, N.C. 27602

NAME OF SITE: MARSHALL STEAM STATION	PERMIT NO.: 18-04
ADDRESS: HIGHWAY #150 TERRELL, NC	OWNER (print): DUKE POWER CO.
DRILLING CONTRACTOR: DUKE POWER CO.	REGISTRATION NO.: 961

Casing Type: TRILOC THREADED PVC dia. 2" in.
Casing Depth: from 0 to 15.3 ft. - dia. 2" in.
Screen Type: TRILOC THREADED PVC dia. 2" in.
Screen Depth: from 15.9 to 23.9 ft. - dia. 2" in.

Grout Depth: from 0 to 14.0 ft. - dia. 6
Bentonite Seal: from 11.0 to 14.0 ft. - dia. 6
Sand/Gravel PK: from 14.0 to 27+ ft. - dia. 6
Total Well Depth: from 0 to 27.0 ft. - dia. 6

Static Water Level: 8.9' feet from top of casing Date Measured 7/16/

Yield (gpm): N/A Method of Testing: N/A Casing is 2.1 feet above land su

DRILLING LOG		
DEPTH		
FROM	TO	FORMATION DESCRIPTION
		SEE ATTACHED SOIL TEST BORING FIELD REPORT FOR MW-#3.

LOCATION SKETCH
(show distance to numbered roads, or other map reference po

REMARKS: SCREEN IS PLACED IN THE MOST HYDRAULICALLY CONDUCTIVE ZONE PER CONVERSATIONS WITH RALPH ROBERTS AND ED SULLIVAN.

DATE: 7-15-87 SIGNATURE: David L. [illegible]

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DUKE POWER COMPANY – MARSHALL STEAM STA.

AS-BUILT INSTALLATION SKETCH

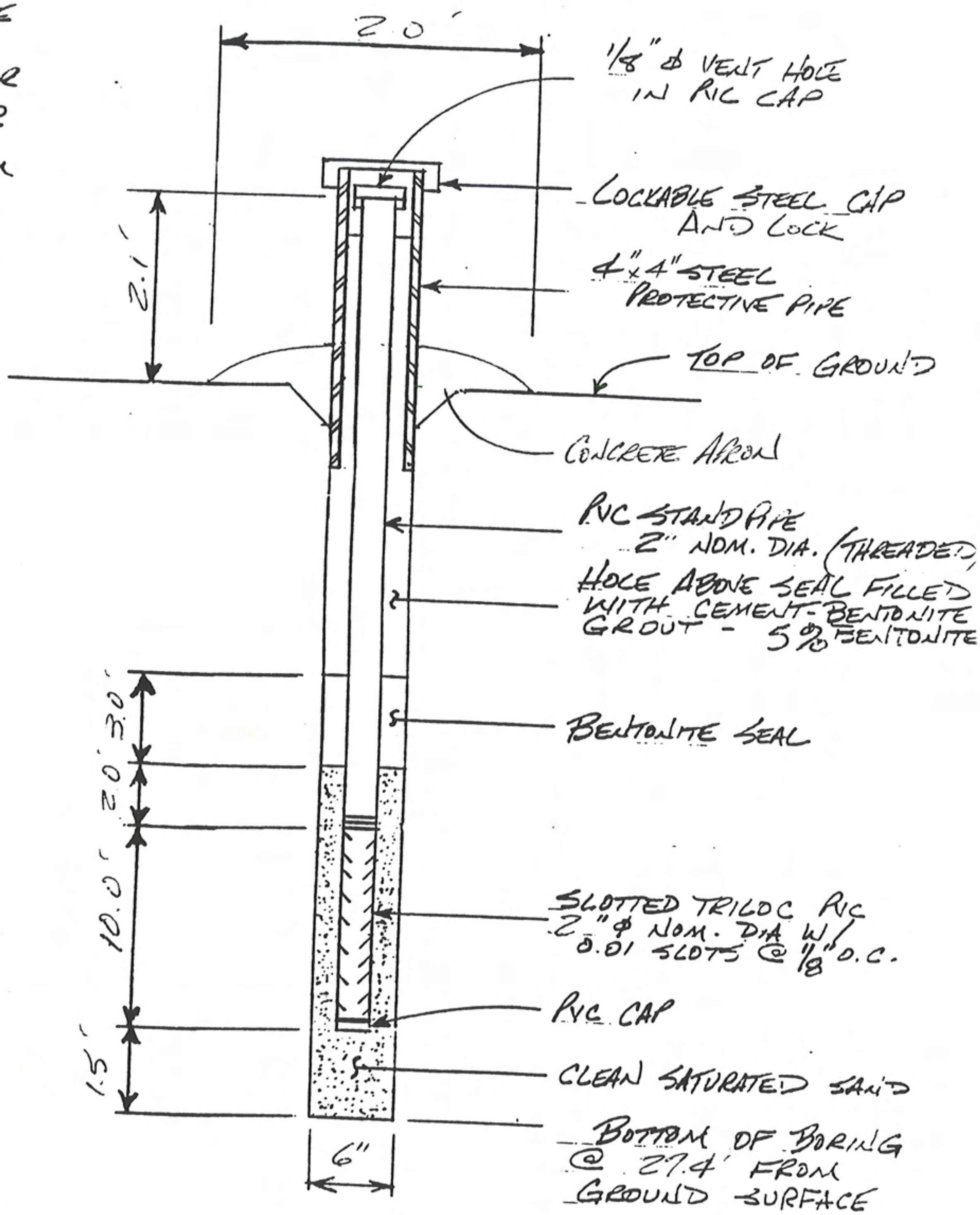
Instrument No. MW-3 Station N/A Offset N/A

By D DICKSON Date 7-15-89

NOTE:
NOT TO SCALE

INITIAL WATER LEVEL RDG @ 8.9' FROM TOP/PIPE ON 7-6-89

T/PIPE ELEV. IS



Form 269683 (R11-92) • Previously Form 25630

FORM M-26C	REVISION 3
	PAGE 1 OF 1

DUKE POWER COMPANY

PROJECT Marshall Steam Sta.

SOIL TEST BORING FIELD REPORT

BORING NO. MW-5 STARTING TIME

JOB NO. Fly Ash Landfill GROUND SURFACE ELEV.

JOB NAME Monitoring Well HRS. DRILLING HRS. MOVING

DATE 5-22-00 WEATHER Clear Hot INSPECTOR/DRILLER C.A. Medlin / Jim Barker Ricky Dickard

SAMPLING		1ST 6"	2ND 6"	3RD 6"	SCALE	UD	SOIL CLASSIFICATION AND REMARKS
					0		
1	3.5' 5.0'	2	3	5	5		BRN, mica, Fine sandy silt
2	8.5' 10.0'	2	3	5	10		BRN, very mica, very silty Fine sand
3	13.5' 15.0'	2	2	3	15		yellowish BRN, very mica, Fine sandy silt
4	18.5' 20.0'	3	5	7	20		yellowish BRN, very mica, Fine sandy silt
5	23.5' 25.0'	3	3	5	25		yellowish BRN, very mica, silty Fine sand
6	28.5 30.0'	3	3	5	30		yellowish BRN, very mica, silty Fine sand
7	33.5' 35.0	6	9	13	35		yellowish BRN, very mica, silty Fine sand
							Hole terminated @ 35.0'
					40		

+ STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES

BORING TERMINATED 35.0'
BORING REFUSAL N/A
WATER TOB DEPTH 23.35'
WATER 24 HR:DEPTH 21.40' 5-23-00
WATER LOSSES None Used
CASING SIZE N/A LENGTH N/A

METHOD OF ADVANCING BORING	DEPTH
POWER AUGER 7 1/4" Auger	0.0' TO 35.0'
~~HAND CHOP:W/MUD:W/WATER~~	— TO —
~~ROTARY DRILL:W/MUD:W/WATER~~	— TO —
~~DIAMOND CORE~~	— TO —

North Carolina - Department of Environment and Natural Resources - Division of Water Quality - Groundwater Section
1636 Mail Service Center - Raleigh, N.C. 27699-1636-Phone (919) 733-3221

WELL CONSTRUCTION RECORD

WELL CONTRACTOR: Duke Engineering & services Charles A. Medlin
WELL CONTRACTOR CERTIFICATION #: 2172
STATE WELL CONSTRUCTION PERMIT#:

1. WELL USE (Check Applicable Box): Residential ☐ Municipal ☐ Industrial ☐ Agricultural ☐ Monitoring ☑
Recovery ☐ Heat Pump Water Injection ☐ Other ☐ If Other, List Use:

2. WELL LOCATION: (Show sketch of the location below)
Nearest Town: Terrell, N.C. County: ~~Davidson~~ CAM CATAWBA

(Road Name and Numbers, Community, or Subdivision and Lot No.)

3. OWNER Duke Power CO.
Address 422 South church St.
(Street or Route No.)
Charlotte, NC. 28242
City or Town State Zip Code

4. DATE DRILLED 5/23/00
5. TOTAL DEPTH 35.0'
6. CUTTINGS COLLECTED YES ☑ NO ☐
7. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☑
8. STATIC WATER LEVEL Below Top of Casing: 21.4' FT.
(Use "+" if Above Top of Casing)
9. TOP OF CASING IS 2.5' FT. Above Land Surface*
*Top of casing terminated at/or below land surface requires a variance in accordance with 15A NCAC 2C .0118
10. YIELD (gpm): N/A METHOD OF TEST N/A
11. WATER ZONES (depth): - N/A

12. CHLORINATION: Type N/A Amount N/A

13. CASING:

Depth From	To	Ft. Diameter	Wall Thickness or Weight/Ft.	Material
0.0'	18.0'	2"	sch. 40	PVC

14. GROUT:

Depth From	To	Material	Method
0.0'	14.5'	Neat Cement	Pumped

15. SCREEN:

Depth From	To	Diameter (in.)	Slot Size (in.)	Material
18.0'	28.0'	2"	.010	PVC

16. SAND/GRAVEL PACK:

Depth From	To	Size	Material
17.0'	35.0'	#1	clean SAND

17. REMARKS: Note: A Bentonite seal is From 14.5' TO 17.0'

DRILLING LOG

DEPTH From	To	Formation Description
See Attached field Report		Soil test Boring For MW-5

If additional space is needed use back of form

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Charles A. Medlin 5-29-00
SIGNATURE OF PERSON CONSTRUCTING THE WELL DATE

FOR OFFICE USE ONLY
Quad No:
Serial No.

Submit original to Division of Water Quality, Groundwater Section within 30 days

GW-1 REV. 12/99

APPENDIX C

Water Quality Locations, Marshall Steam Station drawing.
WSP-Sells. August 6, 2012

LOCATION	NORTHING	EASTING	ELEVATION (NGVD-29)
SW-1	679608.80	1412345.23	817.25
ASH POND DISCHARGE TOWER MARK	681308.92	1417284.22	790.00
MW-2 TOP PVC	683902.36	1415126.46	797.15
MW-2 GROUND	683902.20	1415126.61	795.54
ASH ELEVATION NEAR MW-2	683739.96	1415066.13	789.73
MW-5 CONCRETE	684783.47	1415744.52	820.76
MW-5 TOP PVC	684783.41	1415745.01	822.99
CENTERLINE CREEK	684661.25	1415697.83	798.24
CENTERLINE CREEK	684777.80	1415660.85	799.14
CENTERLINE CREEK	684891.20	1415648.78	801.29
ASH POND WATER ELEV. NEAR DAM	682097.37	1417608.61	788.77

NCGS MONUMENT
"HOLDSCLAW"
N 678033.115 FT.
E 1417630.585 FT.
ELEV: 849.02' (NGVD 29)
NAD 83/2007

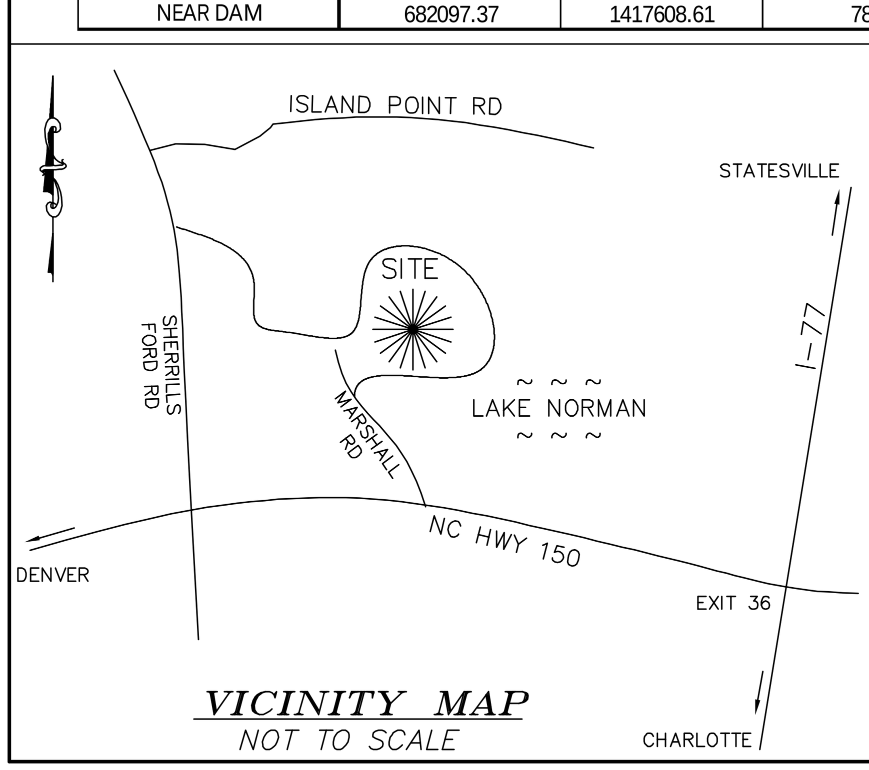
N57°24'57"E
2458.94'

NCGS MONUMENT
"STEAM"
N 676709.06 FT.
E 1415559.05 FT.
ELEV: 834.89' (NGVD 29)
NAD 83/2007

GRAPHIC SCALE

250 0 125 250 500 1000

(IN FEET)
1 inch = 250 feet



VICINITY MAP
NOT TO SCALE

I, STEVEN A AMOS, CERTIFY THAT THIS PLAT WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL TOPOGRAPHICAL SURVEY MADE UNDER MY SUPERVISION THAT THE RATIO OF PRECISION IS ONE HALF THE CONTOUR INTERVAL AS SHOWN. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER AND SEAL; THIS 6TH DAY OF AUGUST, 2012.

STEVEN A AMOS, NC PLS L-4520

NORTH CAROLINA PROFESSIONAL SEAL L-4520 LAND SURVEYOR STEVEN A. AMOS

LEGEND

= NOT TO SCALE

SURVEYOR NOTES:

1) ALL DIMENSIONS SHOWN ARE IN US SURVEY FEET AND DECIMALS THEREOF AND ARE HORIZONTAL GROUND DISTANCES UNLESS OTHERWISE INDICATED. AREA BY COORDINATE METHOD.

2) THE PURPOSE OF THIS SURVEY IS TO VERIFY THE ELEVATIONS OF VARIOUS LOCATIONS ON SITE PER THE CLIENTS INSTRUCTIONS.

3) BASIS OF BEARINGS:
BEARINGS ARE BASED ON THE NORTH CAROLINA STATE PLANE COORDINATE SYSTEM, NAD 83/2007.

4) ELEVATIONS BASED ON NGVD 29 AND VERIFIED WITH THE 790.00 MARK ON THE DISCHARGE TOWER IN THE ASH BASIN.

5) NO FIELD WORK OR RESEARCH WAS PERFORMED BY WSP SELLS TO DETERMINE OR VERIFY ANY BOUNDARY LINES.

6) COORDINATE VALUES AND DISTANCES AS SHOWN HEREON ARE GROUND (US SURVEY FOOT) UNLESS OTHERWISE NOTED AND ARE BASED ON THE NORTH CAROLINA STATE PLANE COORDINATE SYSTEM NAD 83/2007. THE AVERAGE COMBINED FACTOR USED FOR THE PROJECT WAS 0.99985533. COORDINATE VALUES FOR NCGS MONUMENT "STEAM" ARE OBSERVED.

WATER QUALITY LOCATIONS
MARSHALL STEAM STATION

MOUNTAIN CREEK TOWNSHIP, CATAWBA COUNTY, N.C.

OWNER:	PREPARED FOR:
DUKE ENERGY 400 S. TRYON STREET CHARLOTTE, NC 28201-1007	HDR INC 440 S. CHURCH STREET SUITE 1000 CHARLOTTE, NC 28202

WSP · SELLS
Transportation & Infrastructure
128 Overhill Drive Suite 105 • Mooresville, NC 28117 • 704.662.0100
www.wspsells.com

LICENSE NO.:F-0891

Tax Parcel Number	Drawn By	Date of Field Survey	Field Book	Job Number
Portion of 461603149641	SAA	JULY, 2012		12-7505
File Name	**Checked By**	**Date**	**Scale**	**Sheet Number**
12-7505-WATERQUALITY	SAA	AUGUST 6, 2012	1" = 100'	1 OF 1