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AMECFW's "Estimate of Coal
Combustion Residuals
Quantity – Robinson Steam
Station, Darlington, South
Carolina"



Memo

Date: October 7, 2015

To: Brandon Culberson, Duke Energy

From: Tom Maier, Amec Foster Wheeler

CC:

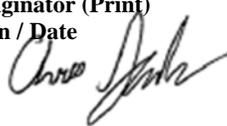
Ref: 7810140170

**Re: Estimate of Coal Combustion Residuals Quantity
Robinson Steam Station, Darlington County, South Carolina**

As requested, the estimate of the quantity of coal combustion residuals (CCR) at the Robinson Steam Station is attached. This estimate was prepared under Amec Foster Wheeler project number 7810140170 and was last updated on August 20, 2015.

Attachment (Estimate of CCR Quantity)

Calculation Cover Sheet

Project Robinson Steam Station – Waste Strategy Analysis		Calc/Analysis No. WBS 2	AMEC Project No. 7810-14-0170.02	
Title Estimate of Coal Combustion Residuals (CCR) Quantity		Client Contract NA		Sheet No. 1 of 5
		Discipline Civil		
Computer Program AutoDesk Civil 3D 2013		Version / Release No. N/A		
Purpose and Objective Estimate the quantity of CCR located on Robinson Steam Station property.		Quality Assurance Conditions (e.g. safety classification) NA		
Summary of Conclusion Based on the assumptions described in this calculation, the quantity of CCR on the Robinson Steam Station site was estimated to be approximately 2,800,000 cubic yards (2.3 million dry tons).				
Revision Log				
Rev. No.	Revision Description			
00	Initial issue.			
01	Revised Ash Basin Inventory Figures and Volume Incorporating Additional Boring Data			
02	Revised Ash Basin Inventory Figures and Volume Incorporating More Additional Boring Data			
Sign Off				
Rev. No.	Originator (Print) Sign / Date	Verification Method	Verifier (Print) Sign/Date	Technical Lead (Print) Sign / Date
00	 Chris Jordan, E.I., 1/21/15	Design Review	 Thomas Maier, P.E., 1/21/15	 Ken Daly, P.E., 1/22/15
01			 5/28/15	
02			 8/20/15	
Additional Reviewer (Print)			Signature	Date
NA				

RECORD OF REVISION

Revision No.	Date	Revisions Made
00	1/21/15	Initial issue
01	5/28/15	Revised ash basin inventory figures and volume
02	8/20/15	Revised ash basin inventory figures and volume

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1.0 OBJECTIVE

The objective of this calculation is to estimate the quantity of coal combustion residuals (CCR) located on Robinson Steam Station property. The areas containing CCR are shown on the attached **Figure 1**.

2.0 ASSUMPTIONS

The following assumptions and limitations are noted.

- Based on data gathered from several coal burning plants, the following typical CCR properties are assumed:

Material	Dry Unit Weight (tons/cy)	Moisture Content (%)	Moist Unit Weight (%)
CCR in Ponds	0.8	50%	1.2
CCR in Ash Fills	1.0	20%	1.2

3.0 APPROACH

Quantity of Material Within the Ash Basin (see attached Figures 2.1 through 2.5)

The quantity of material within the Ash Basin was estimated using AutoCAD Civil 3D. The approximate pre-fill topography was obtained from USGS 7.5 minute quadrangle entitled, “Lake Robinson, South Carolina,” dated 1968. The pre-fill grades were compared to recent LIDAR topography of the site obtained from South Carolina Department of Natural Resources via USGS National Elevation Dataset, dated 2009. The Civil 3D estimated quantity is provided below in **Table 1**.

Revision 1: The 1968 USGS pre-fill topography was modified by incorporating data from 2014 borings through the ash basin (Borings AP-5, AP-6, AP-7, AP-9 and AP-10).

Revision 2: The 1968 USGS pre-fill topography was modified by incorporating additional data from 2014 borings through the ash basin (Borings MW-108S and MW-108D). Boring location figure and boring logs are **attached**.

Quantity of Material Within the Lay of Land

The estimated quantity of material in the lay of land ash area was obtained from an August 21, 2014 report prepared by AMEC for Duke Energy entitled, “Ash Pond Related Issues, Response to Duke Issue ROB-2,” where Issue ROB-2 included a field investigation to evaluate the extents of the lay of land ash disposal area. The estimated quantity is provided below in **Table 1**.

Data Limitations

The following data limitations, which are potential sources of inaccuracies in the calculated volumes, have been identified: bottom of ash basin topography was estimated from historical USGS topography modified to be consistent with data from seven borings advanced through the ash basin in 2014. Boring AP-7 provides the only data point for the southeastern area of the ash basin which appears to have been excavated after

the date of the USGS mapping. The estimated vertical accuracy of the unmodified historic topography for the ash pond is ± 5 feet (half of the 10 foot contour interval), which over the ash pond area of 65 acres equals a potential variance of $\pm 524,000$ cubic yards. The base topography modified using boring data is assumed to have a smaller potential variance. Actual CCR volume may be affected by other factors as well, including any earthwork that was performed between the date of historical topography and filling of ash ponds.

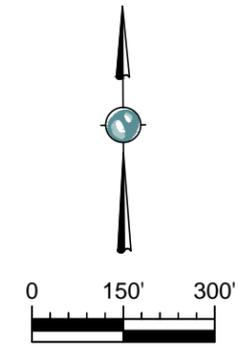
4.0 CONCLUSIONS

Based on the assumptions described in this calculation, the quantity of ash on the Robinson Steam Station property was estimated to be approximately 2,800,000 cubic yards (2.3 million dry tons). The estimated moist weight of ash is also reported in Table 1 because it is a more realistic representation of the mass of material to be handled during removal and construction activities. Moist weight is calculated based on the assumed dry unit weights and moisture contents noted herein.

Table 1: Estimated Volume and Weight of CCR in Ash Basins and Fills

Description	Unadjusted Volume (cy)	Estimated Dry Unit Weight (ton/cy)	Estimated Dry Weight (tons)	Estimated Moisture Content (%)	Estimated Moist Unit Weight (ton/cy)	Estimated Moist Weight* (tons)
Ash Pond	2,547,000	0.8	2,037,600	50%	1.2	3,056,400
Lay of Land	276,000	1.0	276,000	20%	1.2	331,200
TOTAL	2,823,000		2,314,000			3,388,000

*Moist unit weight is used for construction cost estimating purposes.



ASH BASIN

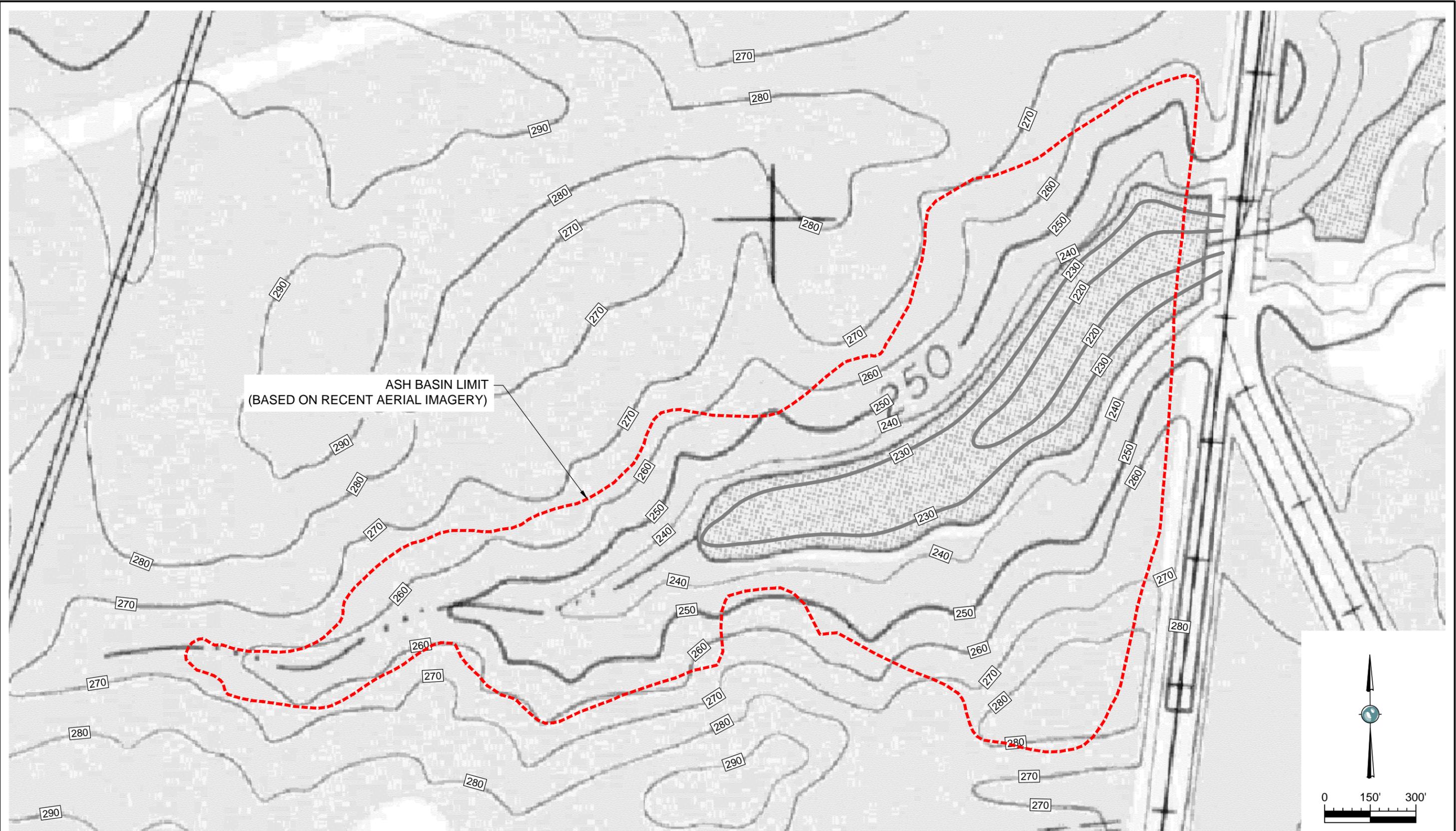
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NOTES:
1. ASH BOUNDARIES ARE APPROXIMATE.

REFERENCES
1. HIGH RESOLUTION 2013 AERIAL IMAGERY WAS OBTAINED FROM WWW.ESRI.COM.

CLIENT:  DUKE ENERGY Amec Foster Wheeler Environment & Infrastructure, Inc. 2801 YORKMONT ROAD, SUITE 100 CHARLOTTE, NC 28208 TEL: (704) 357-9633 FAX: (704) 357-8638 LICENSURE: NC ENG: F-1253 NC GEOLOGY: C-247		DATUM (HOR - VER): NAD83 - NAVD88	PROJECT:	PROJECT NO.:
		PROJECTION: SC83F	WASTE STRATEGY ANALYSIS ROBINSON - ASH INVENTORY	7810140170.02
		PREPARED BY: MA	TITLE:	REVISION NO.:
		REVIEWED BY: TM	ASH AREAS AERIAL IMAGERY	2
		SCALE: AS NOTED	ROBINSON STEAM STATION, DARLINGTON CO., SC	DATE: AUG. 2015
				FIGURE NO.:
				1

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- NOTES:**
1. BOXED CONTOUR LABELS HAVE BEEN ADDED FOR CLARITY.
 2. CONTOUR ELEVATIONS REFERENCE NGVD29 VERTICAL DATUM.

REFERENCES

1. USGS 7.5 MINUTE QUADRANGLE ENTITLED "LAKE ROBINSON, SOUTH CAROLINA", DATED 1968. HORIZONTAL DATUM WAS CONVERTED FROM NAD27 TO NAD83. VERTICAL DATUM NGVD29.

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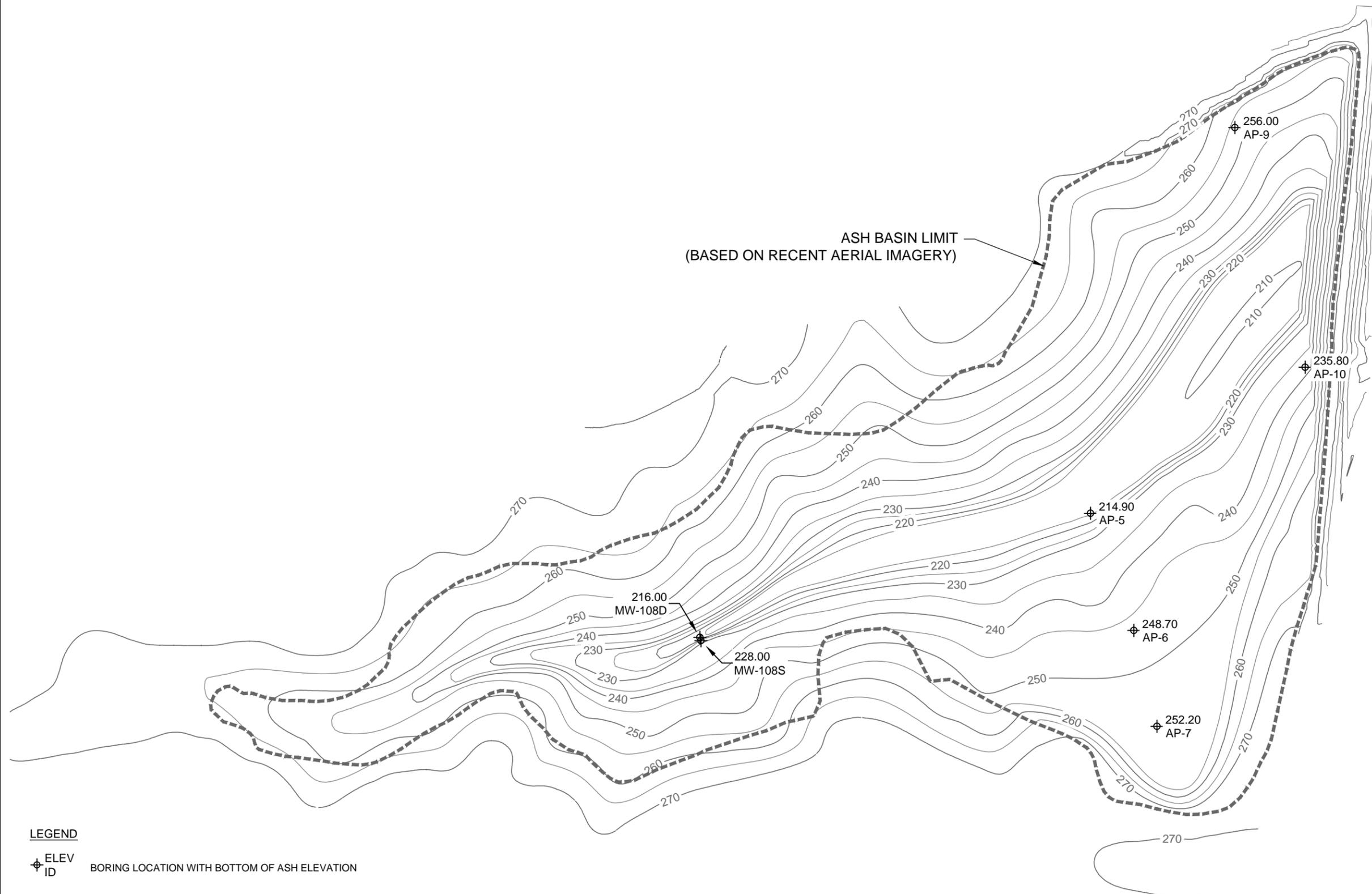


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ROBINSON - ASH INVENTORY

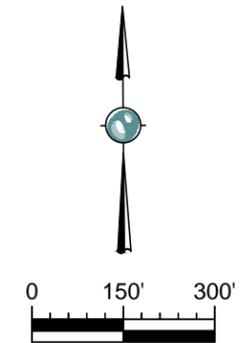
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ORIGINAL TOPOGRAPHY**
ROBINSON STEAM STATION, DARLINGTON CO., SC

PROJECT NO.: 7810140170.02
REVISION NO.: 2
DATE: AUG. 2015
FIGURE NO.: **2.1**



LEGEND

⊕ ELEV
ID BORING LOCATION WITH BOTTOM OF ASH ELEVATION



NOTES:

1. (10FT) CONTOURS WERE DIGITIZED FROM HISTORICAL TOPO SHOWN IN FIGURE 2.1 (REFERENCE 1) AND WERE MODIFIED BASED ON DATA FROM 2014 BORINGS THROUGH ASH POND (REFERENCE 2). (5FT) CONTOURS ARE INTERPOLATED.

2. A DATUM SHIFT OF -0.92 FT WAS APPLIED TO CONVERT ELEVATIONS FROM NGVD29 TO NAVD88.

3. THIS IS AN APPROXIMATION OF THE BOTTOM OF ASH BASIN CONTOURS BASED ON THE INFORMATION AVAILABLE TO AMEC FOSTER WHEELER IN AUGUST 2015.

REFERENCES

- USGS 7.5 MINUTE QUADRANGLE ENTITLED "LAKE ROBINSON, SOUTH CAROLINA", DATED 1968. HORIZONTAL DATUM WAS CONVERTED FROM NAD27 TO NAD83. VERTICAL DATUM NGVD29.
- BORING LOGS PROVIDED BY HDR.

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ROBINSON - ASH INVENTORY

TITLE:

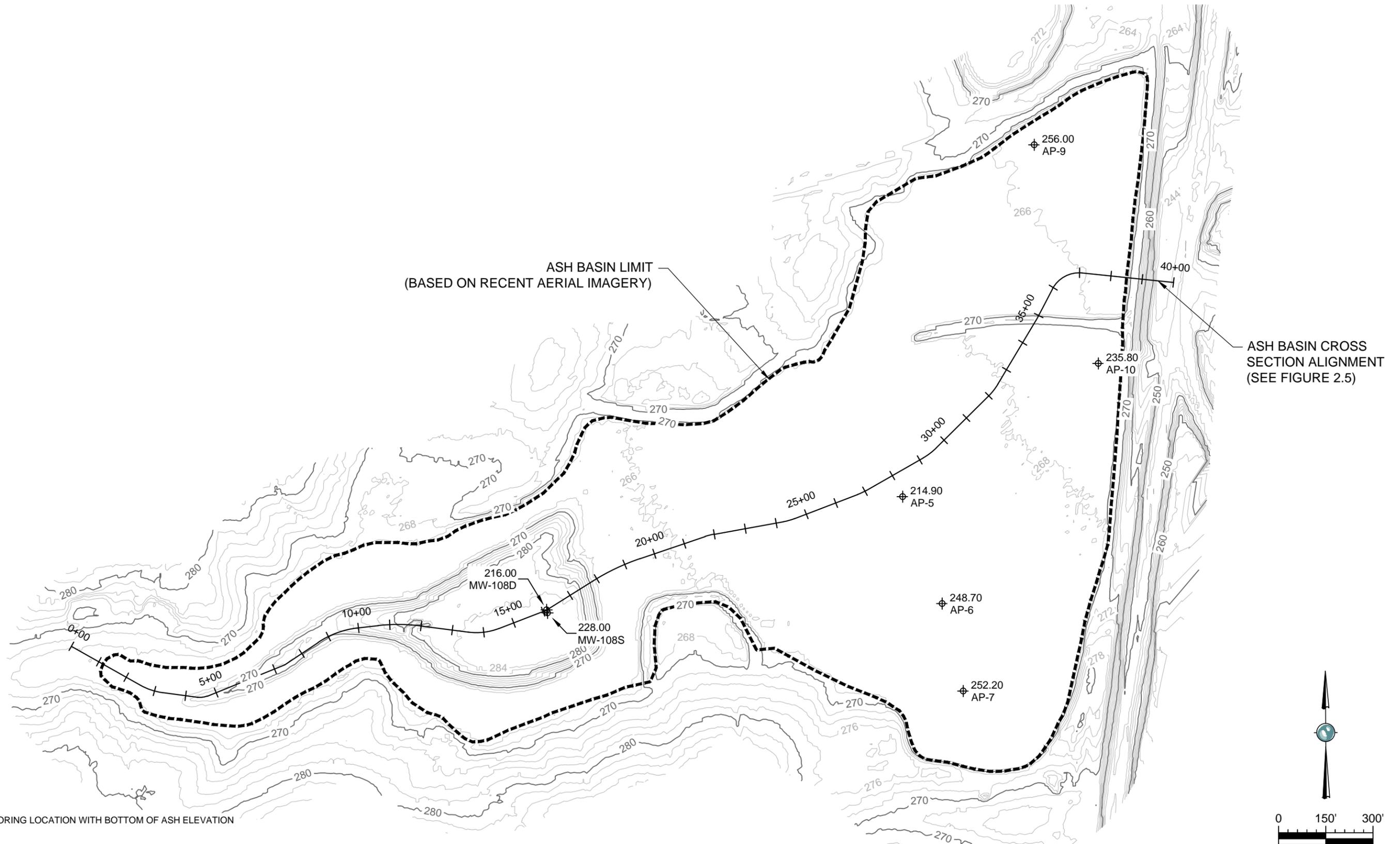
ASH BASIN
DIGITIZED BASE CONTOURS
ROBINSON STEAM STATION, DARLINGTON CO., SC

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REVISION NO.:
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DATE:
AUG. 2015
FIGURE NO.:

2.2

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LEGEND

⊕ ELEV
ID BORING LOCATION WITH BOTTOM OF ASH ELEVATION

NOTES

1. ASH BOUNDARIES ARE APPROXIMATE.

REFERENCES

1. LIDAR TOPOGRAPHY OBTAINED FROM SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES (DNR) VIA USGS NATIONAL ELEVATION DATASET (NED), DATED 2009. VERTICAL DATUM NAVD88.

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RECENT TOPOGRAPHY
ROBINSON STEAM STATION, DARLINGTON CO., SC

PROJECT NO.:

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REVISION NO.:

2

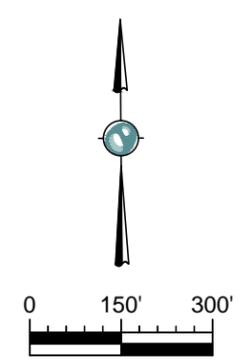
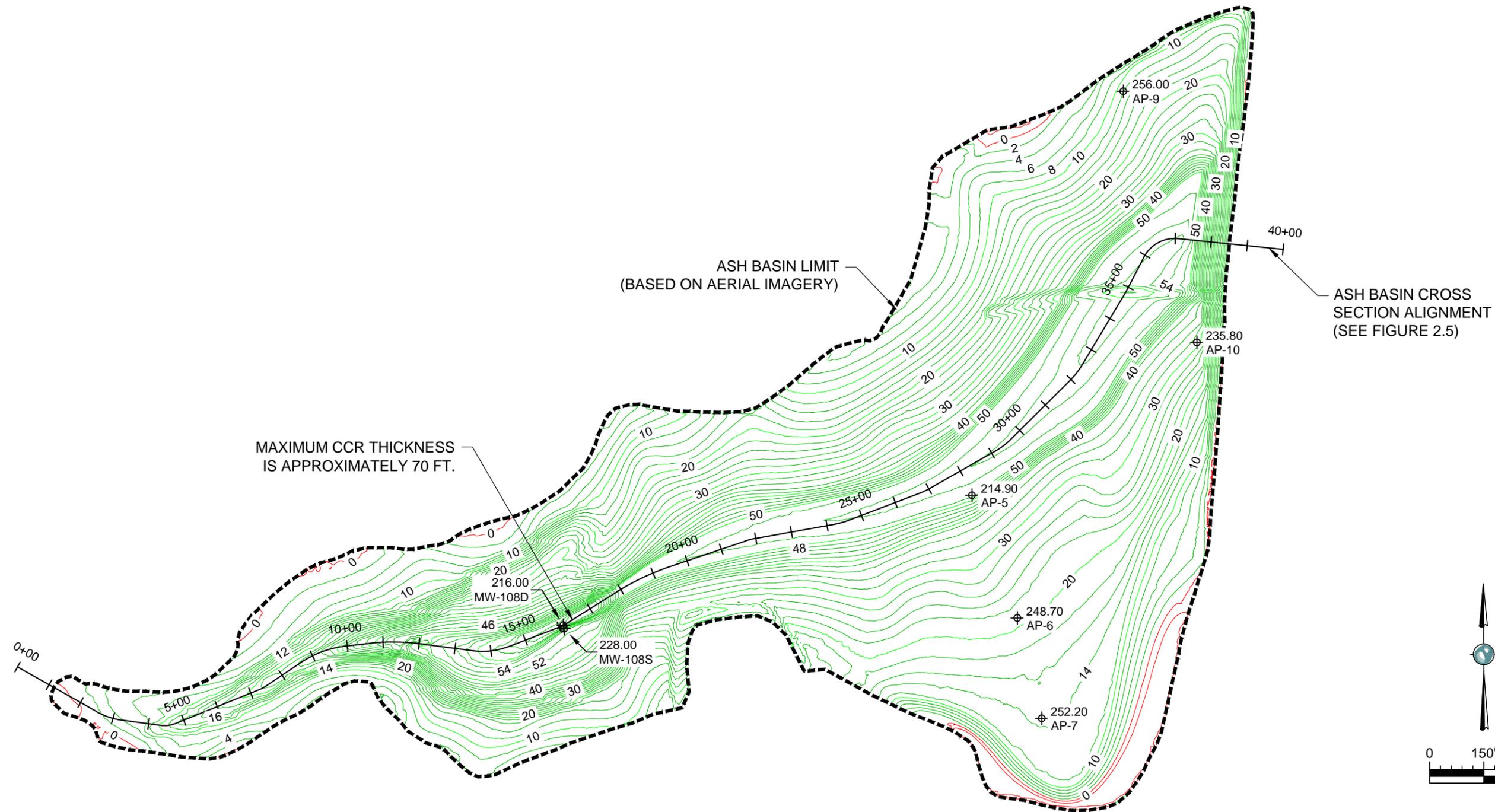
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FIGURE NO.:

2.3

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- LEGEND**
- ⊕ ELEV ID BORING LOCATION WITH BOTTOM OF ASH ELEVATION
 - CONTOUR OF CCR THICKNESS (APPROXIMATE)
 - CONTOUR OF "CUT" THICKNESS (SEE NOTE 2)

Volume Summary					
Area Name	2D Area (acres)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Base	Comparison
V-Ash Basin	66.06	5,815	2,546,845	Reference 1	Reference 2

NOTES:
 1. COAL COMBUSTION RESIDUALS (CCR) VOLUME WAS CALCULATED USING AUTOCAD CIVIL 3D SOFTWARE.
 2. RED CONTOURS, IF PRESENT, INDICATE THAT THE BASE SURFACE IS AT HIGHER ELEVATION THAN THE COMPARISON SURFACE. THIS MAY BE DUE TO REGRADING AND/OR LIMITATIONS OF DATA QUALITY.

REFERENCES:
 1. USGS 7.5 MINUTE QUADRANGLE ENTITLED "LAKE ROBINSON, SOUTH CAROLINA", DATED 1968. HORIZONTAL DATUM WAS CONVERTED FROM NAD27 TO NAD83. VERTICAL DATUM CONVERTED FROM NGVD29 TO NAVD88. HISTORICAL TOPOGRAPHY WAS MODIFIED BASED ON DATA FROM 2014 BORINGS THROUGH ASH POND.
 2. LIDAR TOPOGRAPHY OBTAINED FROM SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES (DNR) VIA USGS NATIONAL ELEVATION DATASET (NED), DATED 2009. VERTICAL DATUM NAVD88.

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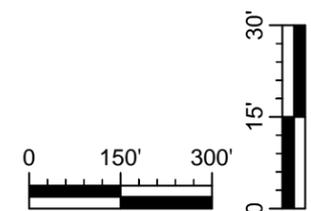
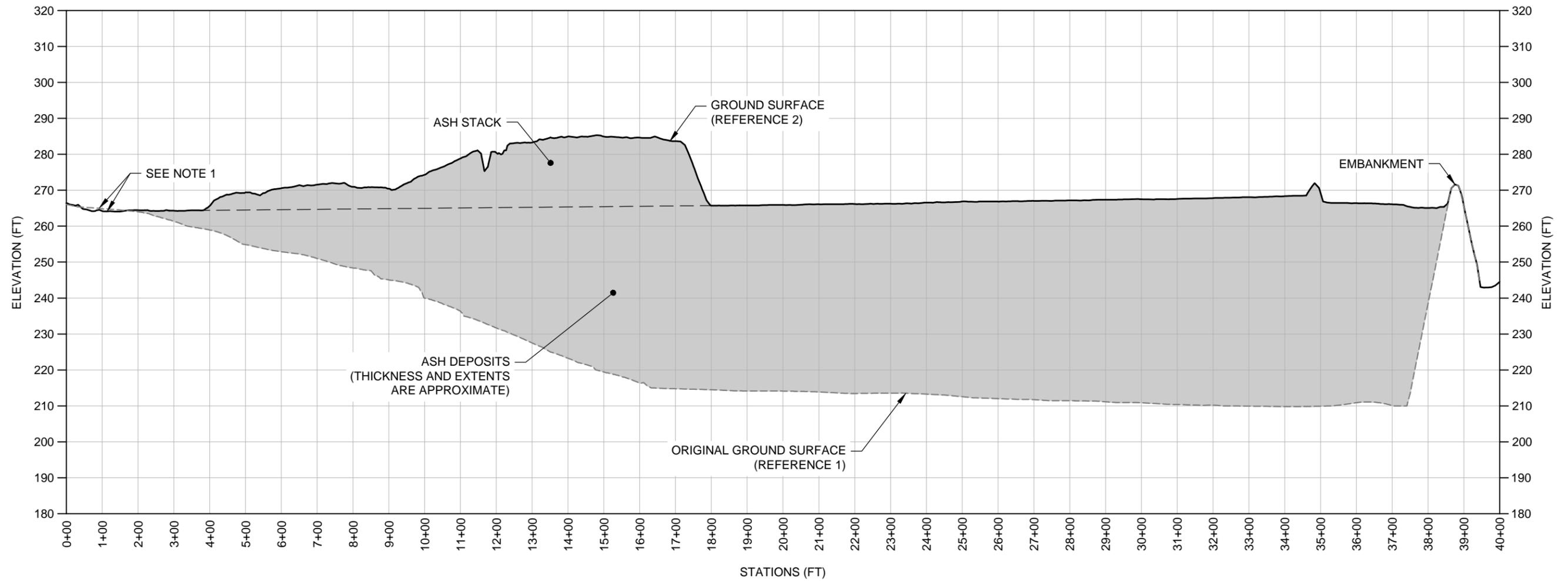
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 SCALE:
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 FIGURE NO.:
2.4

ROBINSON STEAM STATION ASH BASIN



NOTES:
 1. AT THE DESIGNATED LIMIT OF ASH BASIN, THE ORIGINAL GROUND SURFACE ELEVATION MAY NOT EQUAL THE "EXISTING" GROUND SURFACE ELEVATION DUE TO REGRADING AND/OR LIMITATIONS OF DATA QUALITY.

REFERENCES:
 1. USGS 7.5 MINUTE QUADRANGLE ENTITLED "LAKE ROBINSON, SOUTH CAROLINA", DATED 1968. HORIZONTAL DATUM WAS CONVERTED FROM NAD27 TO NAD83. VERTICAL DATUM CONVERTED FROM NGVD29 TO NAVD88. HISTORICAL TOPOGRAPHY WAS MODIFIED BASED ON DATA FROM 2014 BORINGS THROUGH ASH POND.
 2. LIDAR TOPOGRAPHY OBTAINED FROM SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES (DNR) VIA USGS NATIONAL ELEVATION DATASET (NED), DATED 2009. VERTICAL DATUM NAVD88.

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 SCALE:
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 ROBINSON - ASH INVENTORY

TITLE: ASH BASIN
 CROSS SECTION
 ROBINSON STEAM STATION, DARLINGTON CO., SC

PROJECT NO.: 7810140170.02
 REVISION NO.: 2
 DATE: AUG. 2015
 FIGURE NO.: 2.5

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