

**HISTORY OF CONSTRUCTION
ASH POND 2
JOLIET 29 STATION
OCTOBER 2016**

Geosyntec Consultants (Geosyntec) prepared this history of construction report for Ash Pond 2 located at the Joliet 29 Station (Site) in Joliet, Illinois, which is owned and operated by Midwest Generation, LLC (Midwest Generation). This history of construction report addresses the requirements of the Coal Combustion Residuals (CCR) Rule codified in the Code of Federal Regulations Title 40, Part 257, Subpart D. These regulations were published in the Federal Register on 17 April 2015 and became effective on 19 October 2015. This report identifies and addresses the specific requirements of §257.73(c) of the CCR Rule regarding preparing a history of construction report for CCR surface impoundments. Specifically, this report provides the history of construction through 17 October 2016 for Ash Pond 2.

This report was prepared under the direction of Ms. Jane Soule, P.E., and was reviewed in accordance with Geosyntec's internal review policy by Mr. Robert White of Geosyntec.

1. CCR Rule Requirements for History of Construction

History of construction requirements for existing CCR surface impoundments are included in the structural integrity criteria presented in §257.73 of the CCR Rule. The preamble of the CCR Rule (Page 21380) states that the history of construction for an existing CCR impoundment (in this case, Ash Pond 2) is required to include information only to the extent available and that only factual documentation, not anecdotal or speculative information, is to be included. Additionally, the preamble states that no new information should be generated to satisfy the requirements of §257.73(c).

2. History of Construction

2.1 Owner and Unit Identification - §257.73 (c)(1)(i)

Owner and unit identification for Ash Pond 2 is presented in Table 1 below.

Table 1: Owner and Unit Identification

UNIT NAME	OWNER/OPERATOR	IDENTIFICATION NUMBER
Ash Pond 2	Midwest Generation 804 Carnegie Center Princeton, NJ 08540	IL0064254

2.2 Unit Location on USGS Map – §257.73 (c)(1)(ii)

The Site is located approximately 35 miles southwest of Lake Michigan on the Des Plaines River in Joliet, Illinois. Figure 1 presents the location of Ash Pond 2 on a 7.5-minute United States Geological Survey (USGS) topographic quadrangle map.

2.3 Purpose of the CCR Units – §257.73 (c)(1)(iii)

Ash Pond 2 served as a settling pond for sluiced CCR and other process waters related to electrical power generation at the Site. While CCR is present in the pond, CCR is no longer sluiced to Ash Pond 2.

2.4 Name and Size of the Watershed – §257.73 (c)(1)(iv)

Ash Pond 2 is located in the Des Plaines River watershed (HUC 071200040905), which is approximately 23,808 acres in size (USGS, 2015). However, Ash Pond 2 was constructed with elevated embankments on the south, east and west perimeters, and surface water run-on to the pond is limited to the area within the embankment crests and the access road located north of the pond.

2.5 Description of Foundation– §257.73 (c)(1)(v)

Site observations and construction documents show Ash Pond 2 is surrounded by embankments on the south, east, and west. There are no embankments on the north side of the pond where existing ground elevations generally increase to the north; however, Site investigations indicate that fill material may be present along the northern boundary. For engineering purposes, material located along the northern embankment is considered consistent with embankment fill. Native materials do not provide any lateral support for the embankments and therefore the pond does not contain abutments. The remainder of this section addresses the foundation materials for the pond's embankments.

2.5.1 Physical Properties of Foundation Materials

Information on the physical properties of the foundation materials for Ash Pond 2 is based on published geologic information and field investigations performed at the Site by KPRG in 2005, Patrick Engineering in 2011, and Geosyntec in 2015. Detailed descriptions of these investigations and the regional geology at the Site are included in Geosyntec (2016).

Foundation materials in the vicinity of Ash Pond 2 vary from clay to sand and gravel with Silurian Dolomite as a bedrock layer at approximately 40 feet below the embankment crests.

2.5.2 Engineering Properties of Foundation

Table 2 presents engineering properties for the foundation materials at the Site developed for the periodic structural stability and safety factor assessments (Geosyntec, 2016). These engineering properties are based on investigations performed at the Site, published correlations, and laboratory testing of samples collected from foundation soils during the Site investigations. Engineering properties were not developed for the Silurian Dolomite bedrock layer due to its very dense consistency, relative depth below the ground surface, and negligible contribution to the slope stability analyses.

Table 2: Foundation Material Engineering Properties

MATERIAL	UNIT WEIGHT (PCF)	DRAINED FRICTION ANGLE (DEGREES)	EFFECTIVE COHESION (PSF)
Sand/Gravel	125	38	25

2.6 Description of the Materials, Methods, and Dates of Construction - §257.73 (c)(1)(vi)

The following sections describe the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of Ash Pond 2, the method of site preparation and construction of each zone of the unit, and the approximate dates of construction of each successive stage of construction of the unit, to the extent the information is available.

Information presented in the following sections is based on available construction drawings (NUS, 1978, NUS, 1979), liner replacement construction drawings (NRT, 2007; NRT, 2008) and subsequent investigations at the Site. No as-built construction drawings or construction completion reports detailing the actual materials and methods used for the original construction of the pond was available for this report; however, some as-built data was available for the liner replacement project.

Based on available construction drawings (NUS, 1978), excavation was required to construct Ash Pond 2 because the original ground surface is indicated at approximately the design embankment crest elevation.

Construction drawings for Ash Pond 2 do not indicate that it was constructed with engineered zones of different soil types typical of large earthen dams; therefore, the size and range of each zone or stage of construction is not applicable.

Interior embankments were designed at an inclination of 3H:1V (horizontal:vertical), with the exception of the concrete-lined inlet apron area on the western inboard slope, which is inclined at 2H:1V (NUS, 1978). Exterior embankment slopes were shown on the available construction drawings to be inclined at 3H:1V or flatter. The interior slopes and pond bottom, except the concrete-lined inlet apron, were originally designed with a 1 foot thick Poz-o-Pac™ liner system (NUS, 1978). The construction drawings also include site preparation requirements (NUS, 1978).

The available construction drawings also provide the design of a reinforced concrete retaining wall located south of the western half of Ash Pond 2 and north of the silo building. The retaining wall has a maximum retained height of approximately 17 feet and is approximately 250 feet in length with approximately 75-foot long wing walls extending southward at each end of the wall.

In 2009, the original Poz-o-Pac™ liner system was replaced with the existing high-density polyethylene (HDPE) geomembrane liner system. As-built drawings developed as part of the liner replacement project show that the southern, northern, and eastern interior slopes of the pond range from 2H:1V to 3H:1V (Ruettiger, Tonelli & Associates, Inc., 2009). Site surveys show that downstream slope inclinations are approximately 3H:1V or flatter on the slope south of the eastern half of Ash Pond 2 and the slope on the southern half of the eastern perimeter toward the clarifier (Aero-Metric, 2008). The interior slope of the east embankment for Pond 1 (the downstream slope of the west embankment for Ash Pond 2) was originally designed at 3H:1V; however, design drawings for the liner replacement of Pond 1 show this slope re-designed at 2H:1V (NRT, 2008). No as-built records were available for the Pond 1 liner replacement project.

In September 2016, approximately 100 cubic yards of engineered fill was placed on the Ash Pond 2 embankment crest in the southeast corner of the pond to provide additional freeboard for the pond. A drawing indicating the fill location and compaction requirements is included in Appendix A-1.

2.6.1 Engineering Properties

Engineering properties used for the design and construction of the Ash Pond 2 embankment materials were not available at the time of this report. However, engineering properties were estimated for use in the factor of safety assessment performed for the pond in accordance with the CCR Rule. The estimated engineering properties were based on investigations performed at the Site, published correlations, and laboratory testing of embankment materials and are presented in Geosyntec (2016) and reproduced in Table 3. For engineering analyses, two different materials were identified in the embankments for Ash Pond 2: stiff brown clay and black silty gravel. Observed depths of these two materials varied around Ash Pond 2.

Table 3: Embankment Fill Engineering Properties

MATERIAL	UNIT WEIGHT (PCF)	DRAINED FRICTION ANGLE (DEGREES)	EFFECTIVE COHESION (PSF)
Brown Clay	115	30	25
Silty Gravel	125	32	25

2.6.2 Construction Dates

Available construction dates for Ash Pond 2 are unknown; however, available construction drawings were approved for construction in 1977 and 1978 (NUS, 1977; NUS, 1978). Replacement of the original Poz-o-Pac™ liner system with the HDPE liner system was completed in 2009.

2.7 Drawings - §257.73 (c)(1)(vii)

Available construction drawings relevant to the design, construction, operation, and maintenance of Ash Pond 2¹ are included in Appendix A. Appendix A-2 includes available construction drawings (NUS, 1978; NUS, 1979), Appendix A-3 includes drawings from the liner replacement performed in 2009 for Ash Pond 2 (NRT, 2007), Appendix A-4 includes an as-built drawing from the Ash Pond 2 liner replacement project (Ruettiger, Tonelli & Associates, Inc., 2009), and

¹ Ash Pond 2 is also referred to as Ash Impoundment 2 in drawings prepared by NRT (2007).

Appendix A-5 includes relevant construction drawings from the liner replacement performed for Pond 1 (NRT, 2008)² as they relate to western boundary of Ash Pond 2.

2.8 Instrumentation - §257.73 (c)(1)(viii)

There is no instrumentation related to Ash Pond 2; thus, there are no records of instrumentation associated with hydraulic structures, embankments or slope performance related to Ash Pond 2.

2.9 Area-Capacity Curve - §257.73 (c)(1)(ix)

An area-capacity curve for Ash Pond 2 is included as Figure 2.

2.10 Spillway Description and Calculations - §257.73 (c)(1)(x)

Ash Pond 2 does not include a spillway.

2.11 Construction Specifications and Provisions for Surveillance, Maintenance and Repair - §257.73 (c)(1)(xi)

The only construction specification available for this report is an HDPE geomembrane specification for the liner replacement project performed in 2009. The specification was included in a draft application for construction permit approval and is marked “not for construction.” Generally, the HDPE geomembrane specification identifies that an HDPE, white, 60-mil, textured geomembrane be used for the project. It also identifies deployment and seaming requirements, quality control procedures, and requirements for materials placed above the geomembrane. The geomembrane specification is included in Appendix B.

As part of the 2009 liner replacement project, warning posts were installed at the toe of interior basin slopes above the geomembrane liner system. These posts are utilized as a visual guide to identify the toe of slope during CCR removal operations to limit potential damage to the liner system.

2.12 Record of Any Structural Instability - §257.73 (c)(1)(xii)

Based on discussions with Site staff and review of available information, there are no records or knowledge of structural instability for Ash Pond 2.

² Liner replacement drawings are based on the North American Vertical Datum of 1929 (NAVD29). The NUS construction drawings do not provide a referenced datum, however, elevations are generally consistent with those in the liner replacement drawings.

3. References

Aero-Metric, 2008. Topographic Mapping of Joliet 29 Station, prepared for Midwest Generation, LLC., (AutoCAD file)

Geosyntec, 2016. Soil Properties Calculations, Joliet 29 Station, October.

KPRG and Associates, Inc., 2005. Geotechnical Analysis of Soil Surrounding Settling Basins/Ponds, KPRG Project No. 15805, October.

Natural Resource Technology (NRT), 2007. Ash Impoundment #2 Liner Replacement, Midwest Generation, LLC, Joliet Station No. 29:

- Title Sheet, Sheet No. TS
- Existing Conditions, Sheet C010
- Liner Subgrade Preparation, Sheet C020
- Warning Layer Plan, Sheet No. C030
- Details and Sections, Sheet No. C031

Natural Resource Technology (NRT), 2008. Ash Impoundment #1 Liner Replacement, Midwest Generation, LLC, Joliet Station No. 29:

- Warning Layer Plan, Sheet No. C030
- Details and Sections, Sheet No. C031

NUS Corporation, 1978. Waste Water Treatment Facilities Joliet 7-8:

- Location Plot and Plan, Sheet No. 5079 C 5100.
- Ponds & Basins Profiles, Sections & Details, Sheet No. 5079 C 5019, Sheet 2 of 3.
- Ponds & Basins Profiles, Sections & Details, Sheet No. 5079 C 5019, Sheet 3 of 3.
- Detail Plan – Ash Silo Area, Sheet No. 5079 C 51.
- Ash Pond 1 & 2 – Outlet Weirs, Sheet No. 5079 C 5503.
- Retaining Wall at Silos – Plan, Sections & Elevations, Sheet 5079 C 5507

NUS Corporation, 1979. Waste Water Treatment Facilities Joliet 7-8:

- Site Plan – East Yard Area, Sheet No. 5079 C 5103.
- Pipe Support Plan and Details – PS 834, 836 thru 846, Sheet 5079 C 5743

Patrick Engineering, 2011. Hydrogeological Assessment Report, Joliet 29 Generating Station, Joliet, Illinois, Patrick Project No. 21053.070, February.

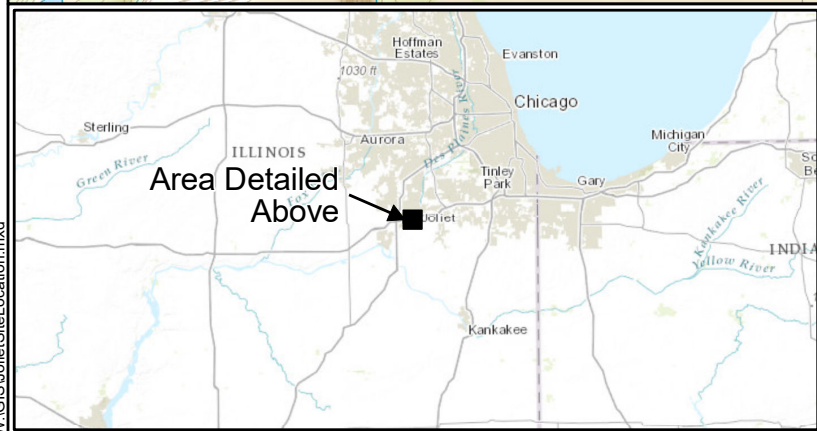
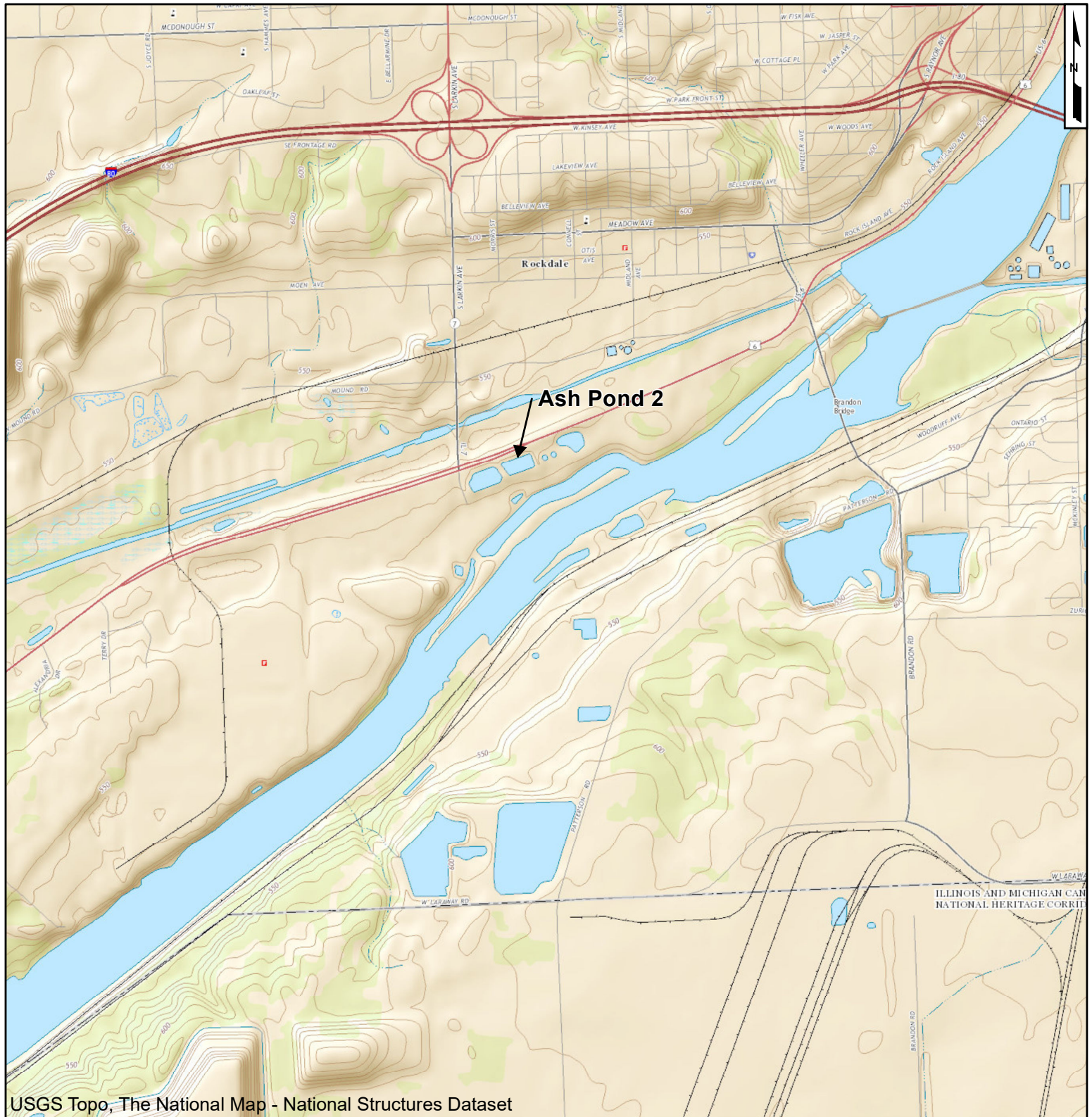
Ash Pond 2, Joliet 29 Station
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Ruettiger, Tonelli & Associates, Inc., 2009. Midwest Generation Joliet 29 Power Plant, Ash Impoundments, Ash Pond 2 Subgrade As-Built.

USGS, 2015. "Watershed Boundary Dataset," accessed via The National Map, accessed 1 February 2016.

Attachments

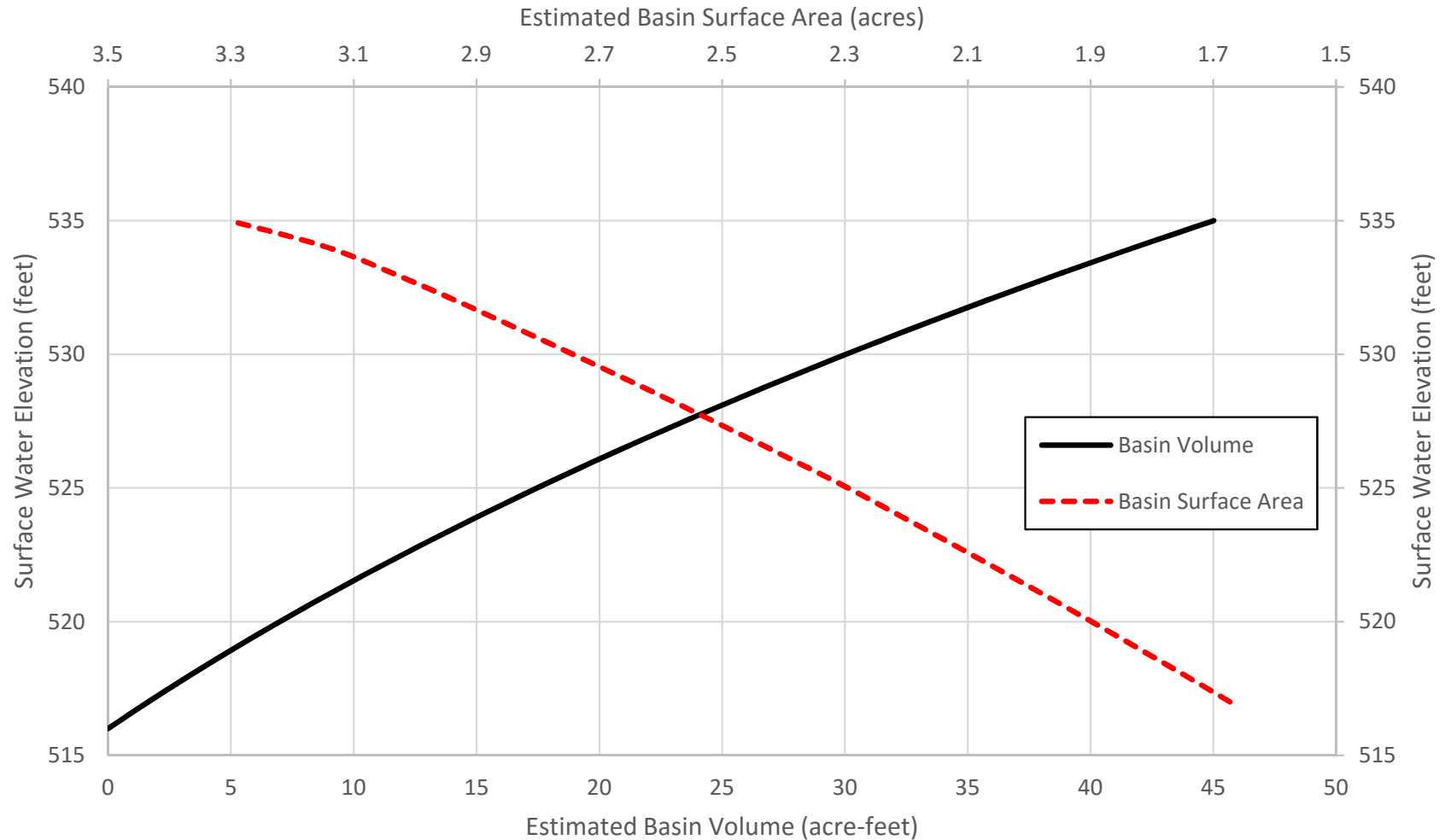
Figure 1:	Vicinity Map
Figure 2:	Area-Capacity Curves
Appendix A:	Construction Drawings
Appendix A-1	2016 Additional Fill Drawing
Appendix A-2	NUS Construction Drawings
Appendix A-3	Liner Replacement Construction Drawings
Appendix A-4	Ash Pond 2 Liner Replacement As-Built
Appendix A-5	Pond 1 Liner Replacement Construction Drawings
Appendix B	Technical Specifications



2,000 1,000 0 2,000 Feet	
Site Location Ash Pond 2 Joliet 29 Station Joliet, Illinois	
Geosyntec consultants	
San Diego	October 2016
Figure 1	

W:\GIS\Joliet\Site\location.mxd

Ash Pond 2



Notes:

- (1) Surface water elevations are NAVD88.
- (2) Basin volumes are estimated based on as-built information and 2008 site topography.

Geosyntec
consultants

OCTOBER 2016

SW0251-05

AREA-CAPACITY CURVE
ASH POND 2
JOLIET 29 STATION
JOLIET, ILLINOIS

**FIGURE
2**

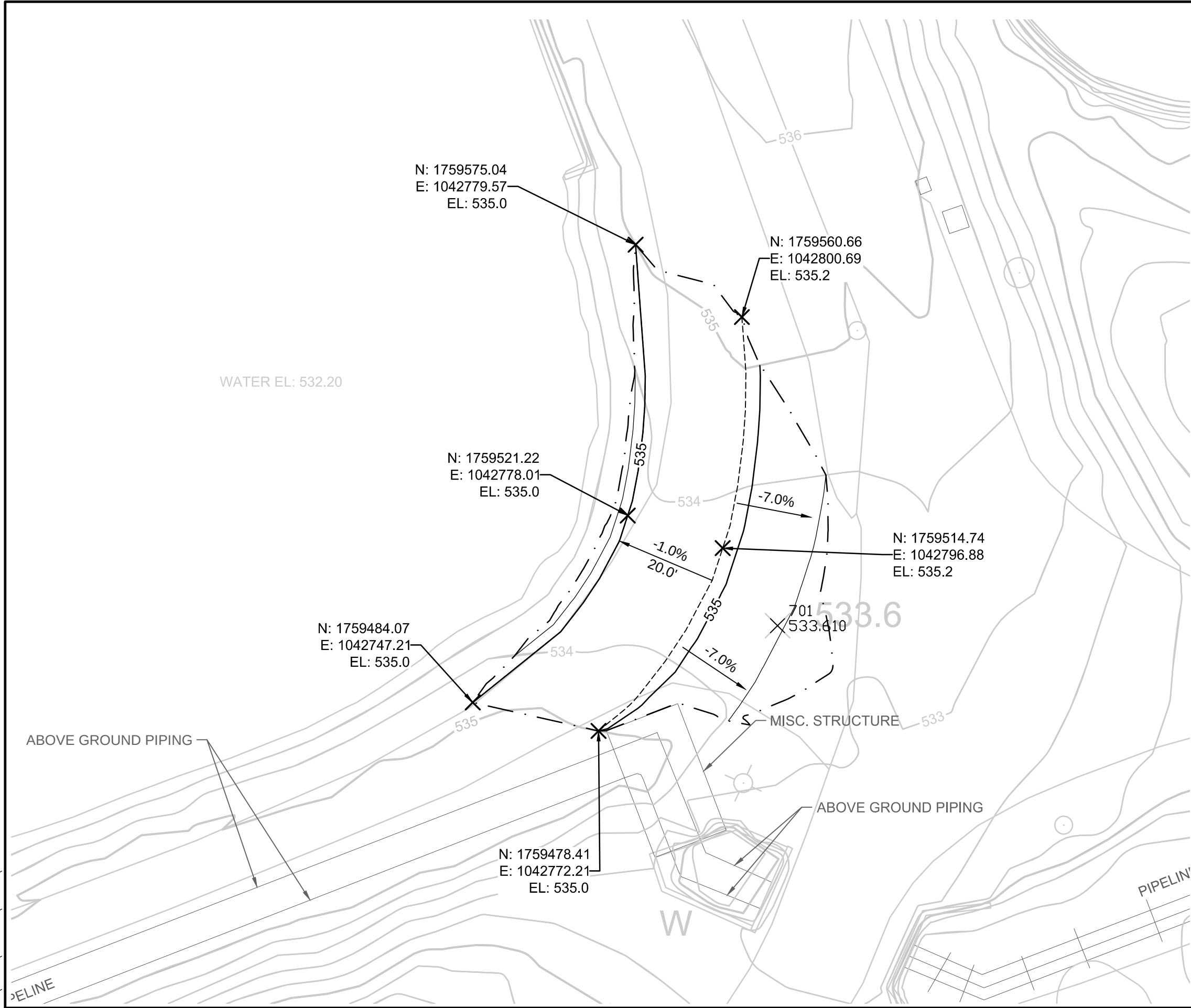
APPENDIX A

Construction Drawings

APPENDIX A-1

2016 Additional Fill Drawing

Z:\CADD\FIGURES\JOLIET\SW0251-05 BERM GRADING

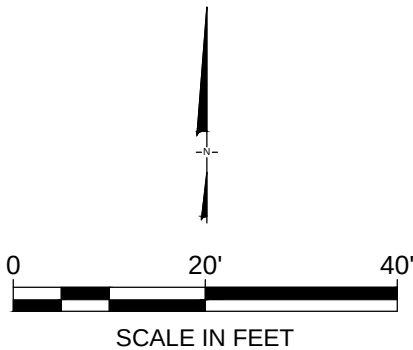


LEGEND

- 535— EXISTING GROUND MAJOR CONTOUR (5')
- EXISTING GROUND MINOR CONTOUR (1')
- 535— PROPOSED GRADING MAJOR CONTOUR (5')
- PROPOSED GRADING MINOR CONTOUR (1')
- - - - - PROPOSED LIMIT OF GRADING
- - - - - GRADE BREAK

NOTES:

- SOURCE AERIAL TOPOGRAPHY: AERO-METRIC, INC. DATE OF PHOTOGRAPHY: 6/17/2008.
- EARTHWORK VOLUME = 100 CY
- FILL (CA-6 AGGREGATE) SHALL BE PLACED WITH A MAXIMUM LOOSE LIFT THICKNESS OF 10 INCHES WITH A MAXIMUM COMPACTED LIFT THICKNESS OF 6 INCHES. FILL SHALL BE COMPACTED BY A MINIMUM OF 3 PASSES WITH A CAT 34B OR EQUIVALENT SMOOTH DRUM ROLLER (MINIMUM OPERATING WEIGHT OF 8,000 lbs. AND MINIMUM CENTRIFUGAL FORCE PER DRUM OF 5,000 lbs.) AND SHALL BE FIRM AND UNYIELDING.



PROPOSED BERM GRADING JOLIET 29 STATION JOLIET, ILLINOIS

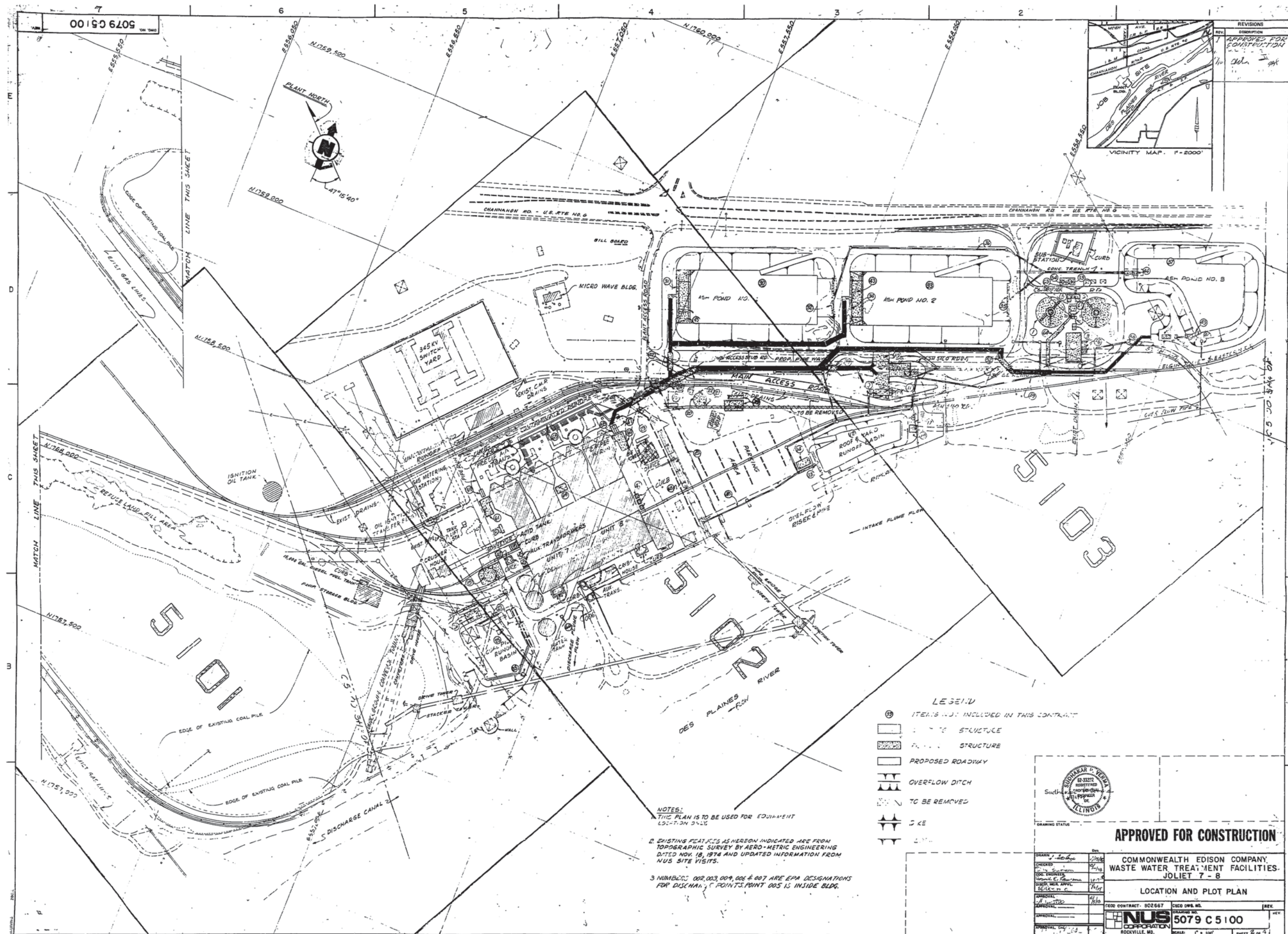
Geosyntec
consultants

PROJECT NO: SW0251-05 AUGUST 2016

FIGURE
1

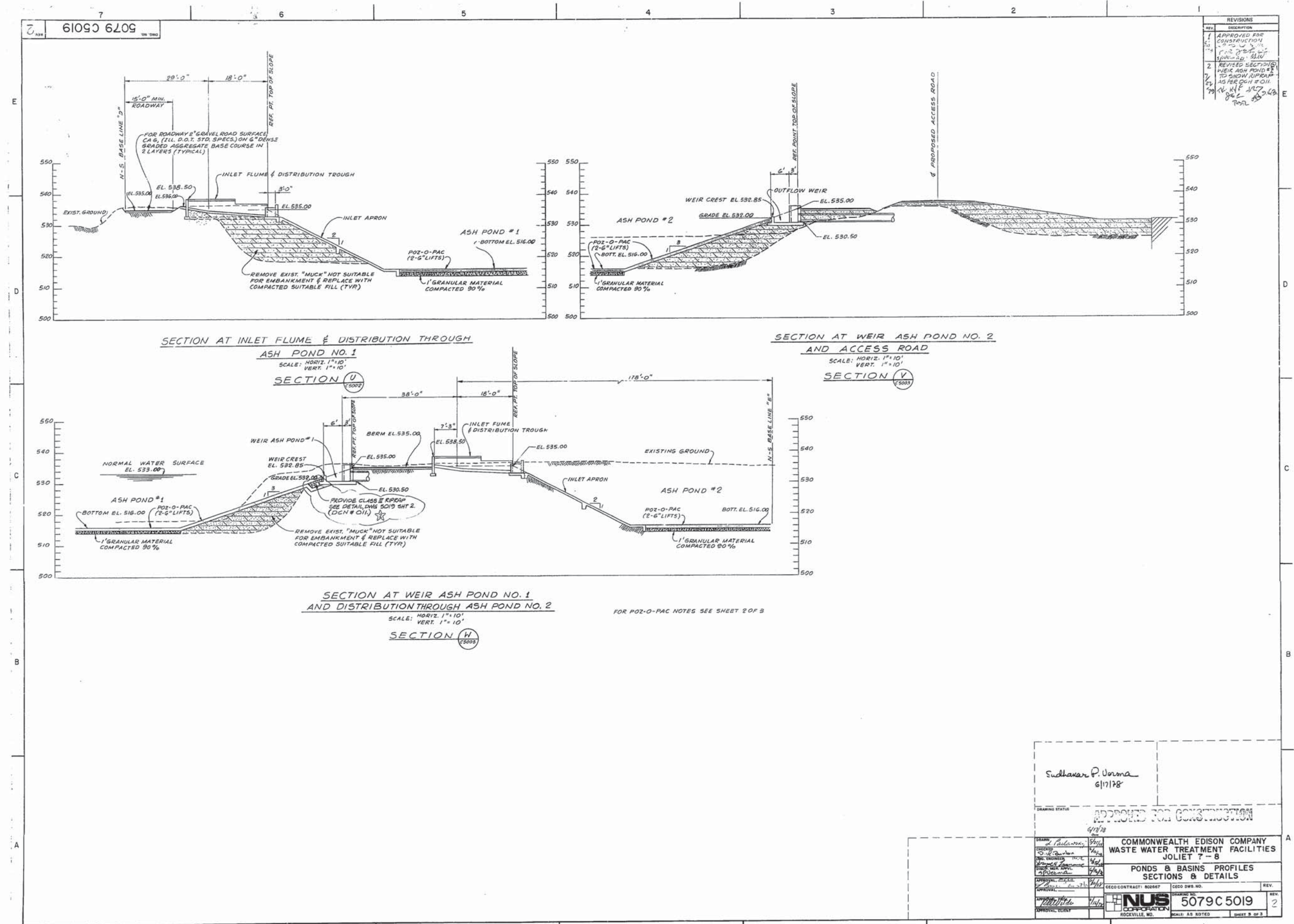
APPENDIX A-2

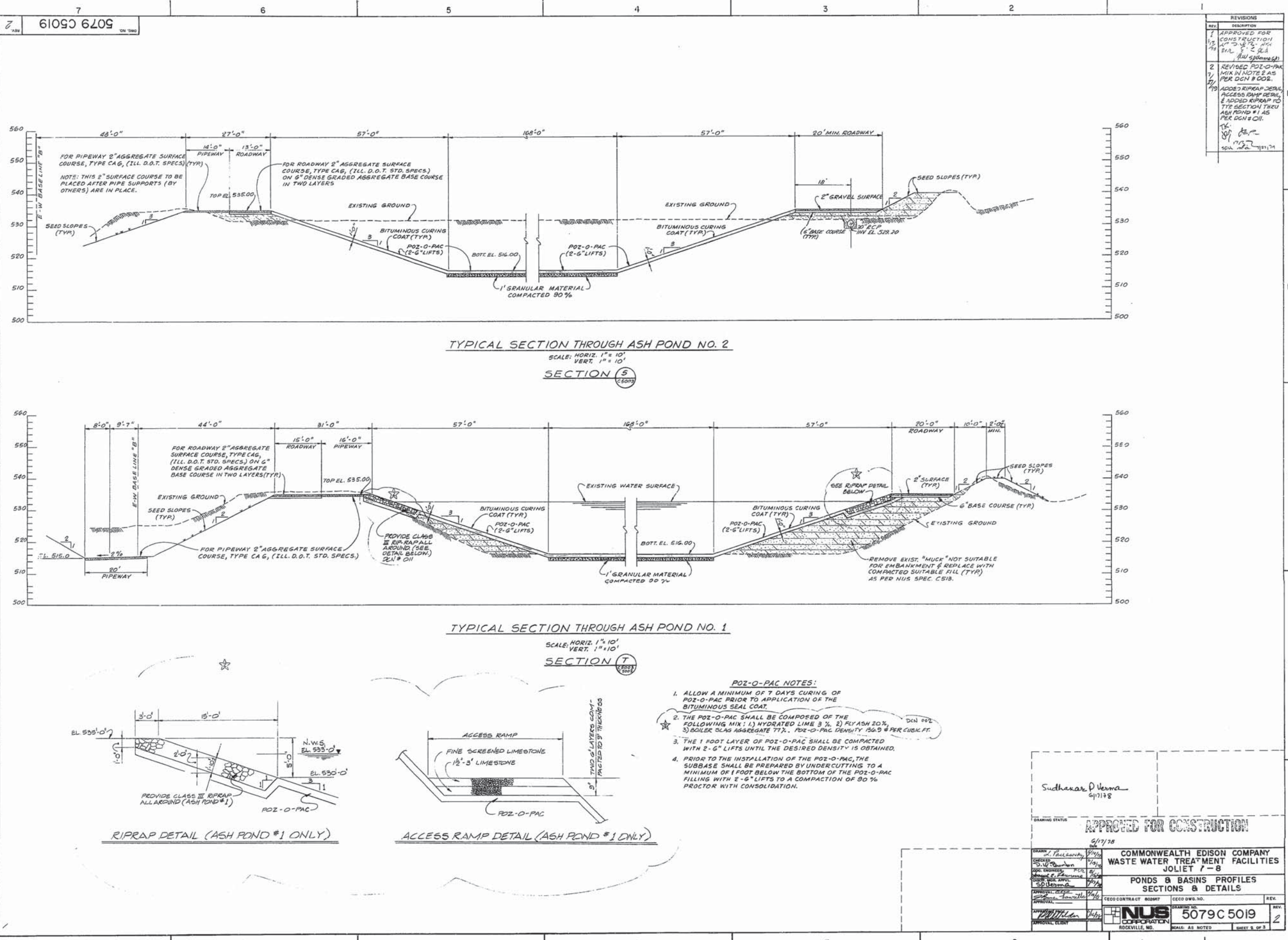
NUS Construction Drawings

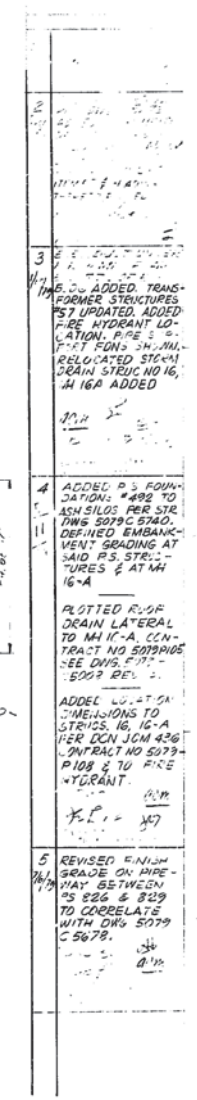


CONDITION OF ORIGINAL - FAIR - REPRODUCTION CONSULTANTS, LTD.
- BLUELINE PRINT -
30X42

5079C5019 SH3

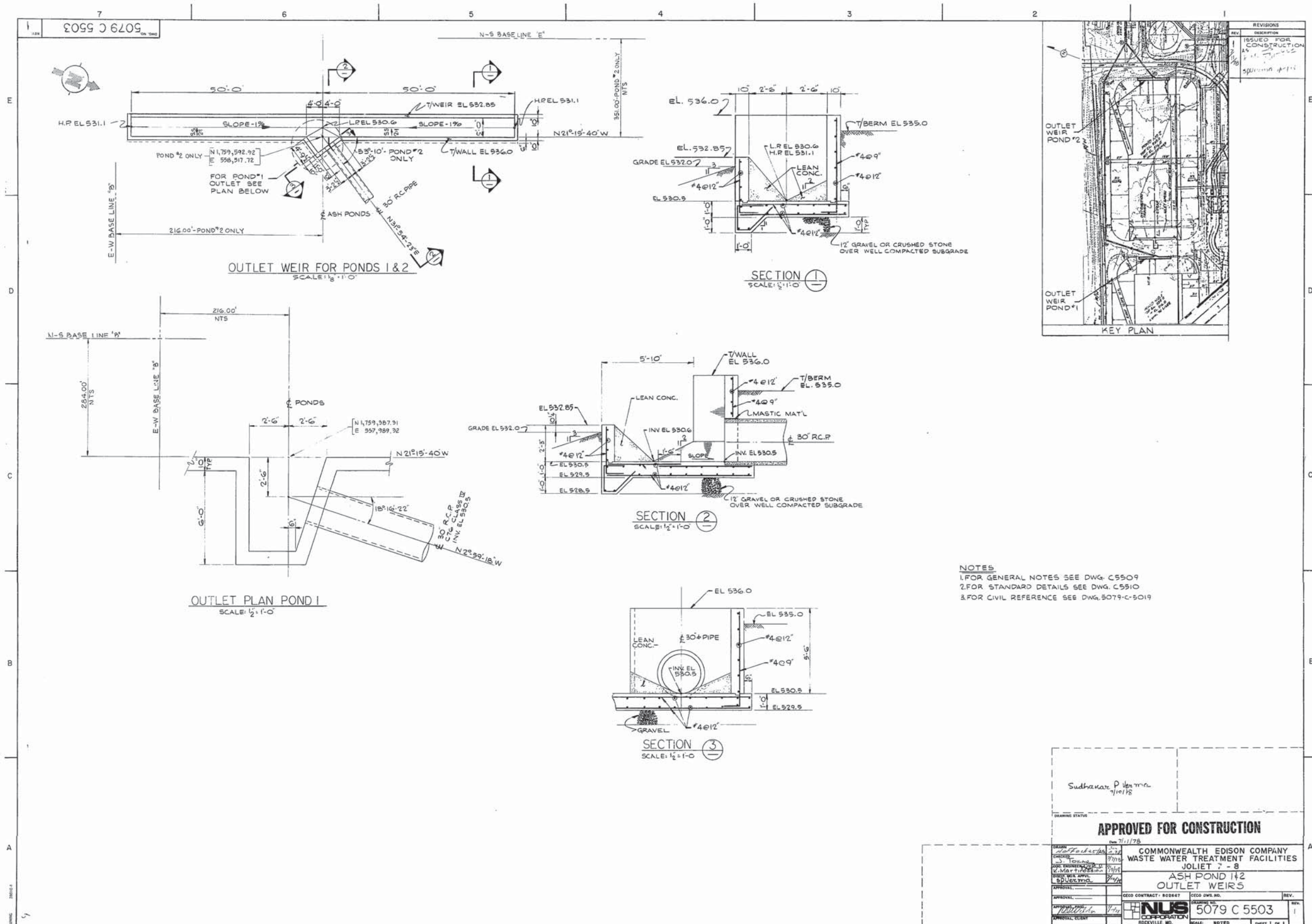






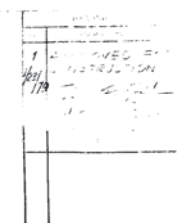
CONDITION OF ORIGINAL -FAIR- REPRODUCTION CONSULTANTS, LTD.
30X42

5079C5503



5079C5103

5079C5103

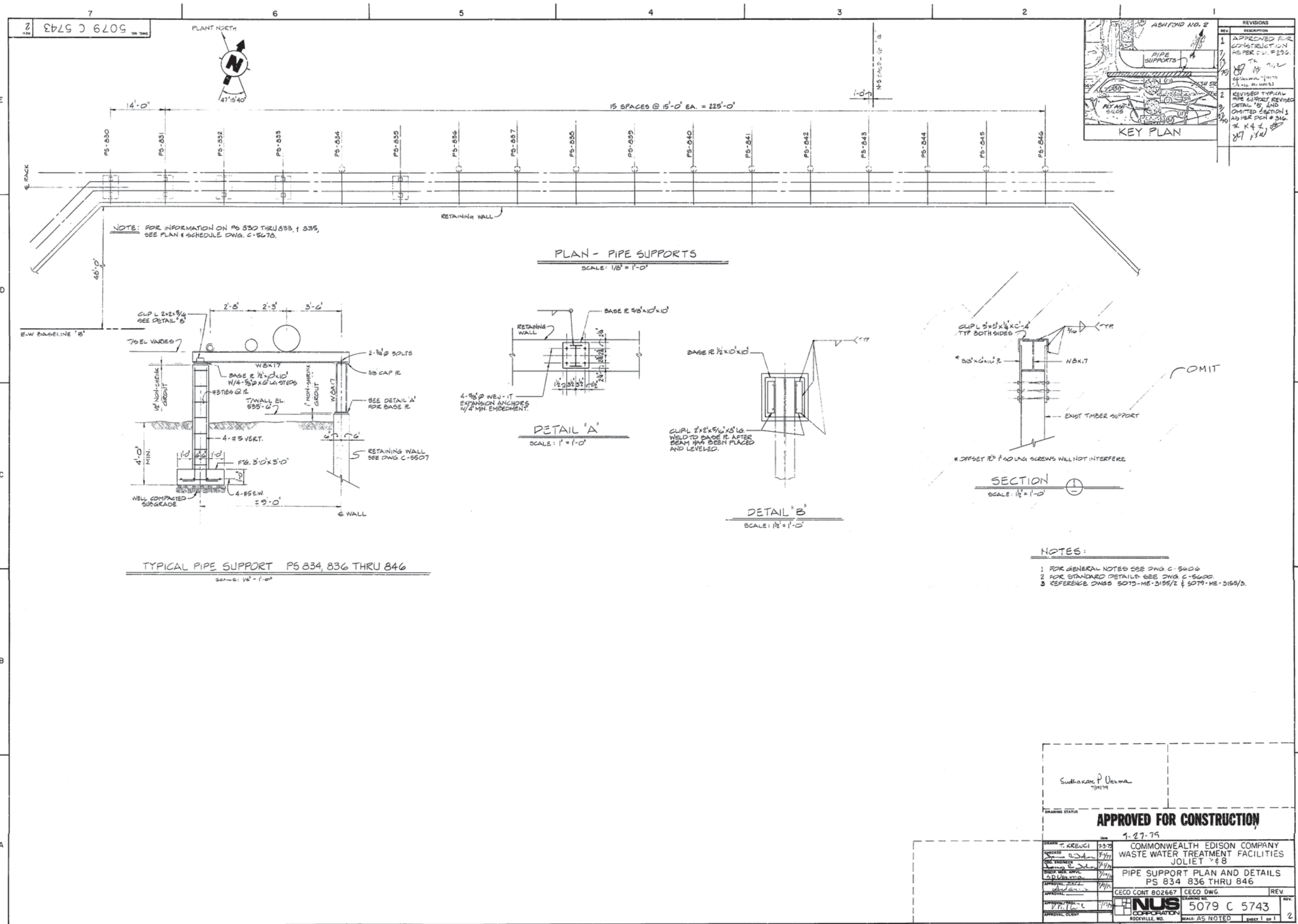


FOR GENERAL NOTES SEE DRAWING 5079C5101.

APPROVED FOR CONSTRUCTION

DATE: 1/23/73	COMMONWEALTH EDISON COMPANY
CHECKED: [Signature]	WASTE WATER TREATMENT FACILITIES
DESIGNED: [Signature]	JOLIET - S
DESIGNED: [Signature]	SITE PLAN
DESIGNED: [Signature]	EAST YARD AREA
DESIGNED: [Signature]	SCALE: 1" = 20'
DESIGNED: [Signature]	5079C5103
DESIGNED: [Signature]	NUS CORPORATION
DESIGNED: [Signature]	ROCKVILLE, MD

CONDITION OF ORIGINAL -FAIR- REPRODUCTION CONSULTANTS, LTD.
30X42



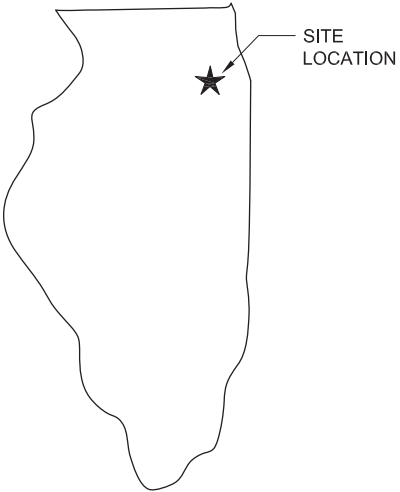
APPENDIX A-3

Liner Replacement Construction Drawings

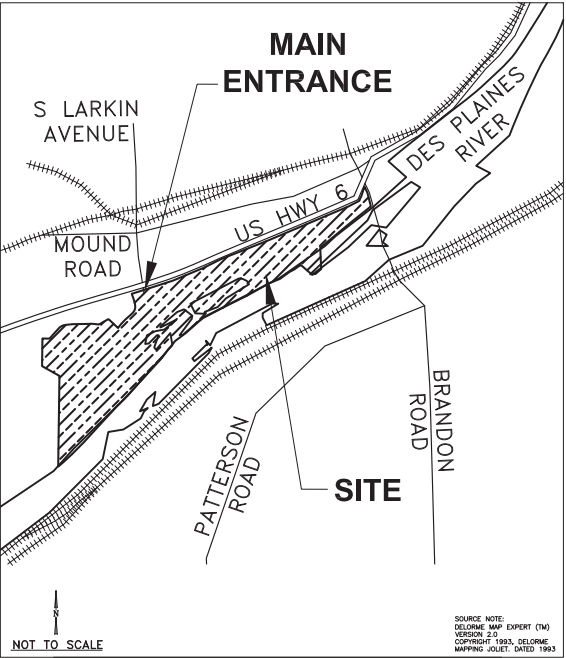
ASH IMPOUNDMENT DESIGN
JOLIET STATION NO. 29
MIDWEST GENERATION
JOLIET, WILL COUNTY, ILLINOIS

LIST OF DRAWINGS

SHEET NO.	TITLE	DRAWING NO.
TS	TITLE SHEET	D1862TS-00
C010	EXISTING CONDITIONS	D1862C010-01
C020	LINER SUBGRADE PREPARATION	D1862C020-01
C030	WARNING LAYER PLAN	D1862C030-01
C031	DETAILS AND SECTIONS	D1862C031-01



ILLINOIS

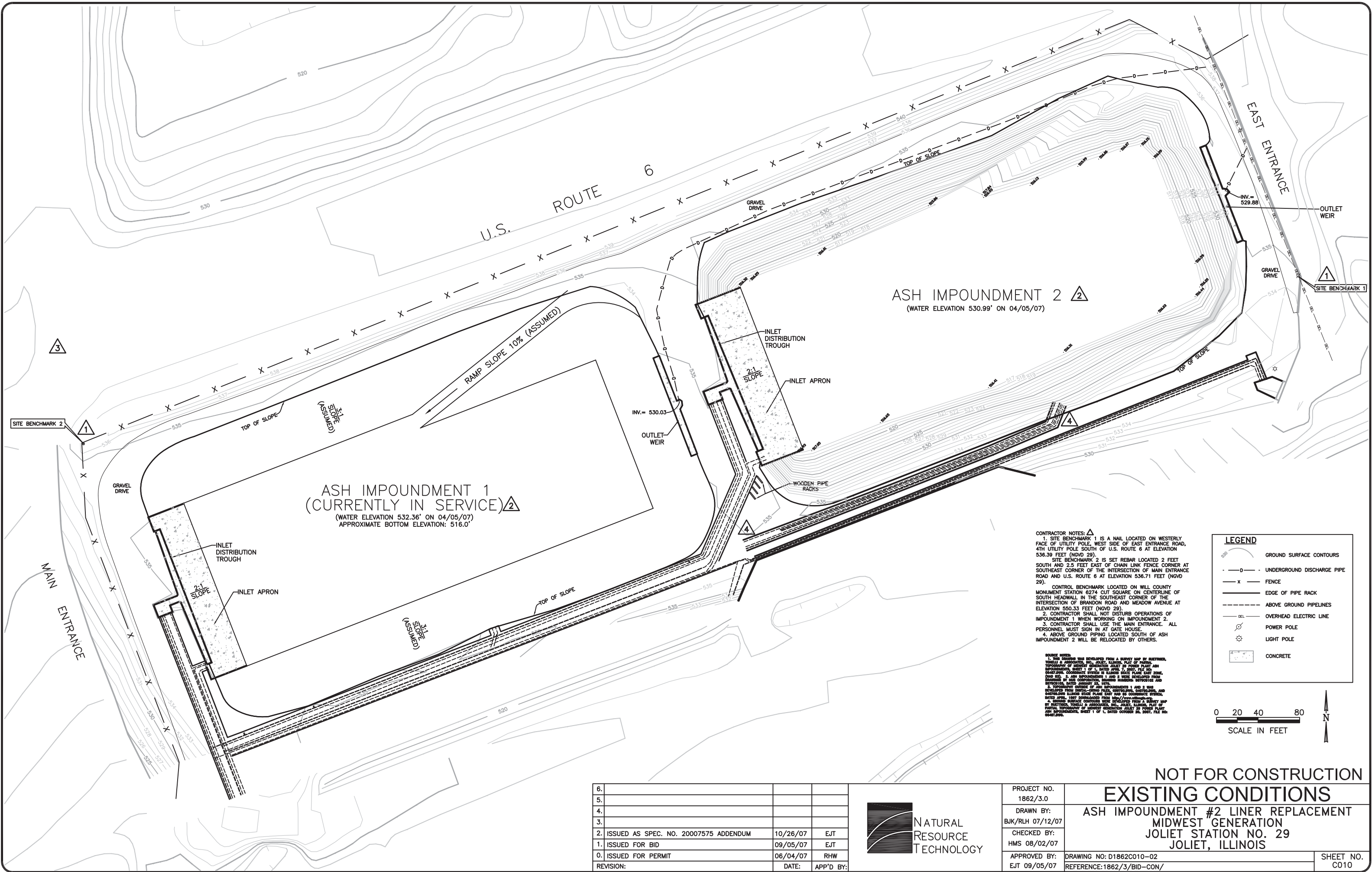


SITE VICINITY

PREPARED FOR:
MIDWEST GENERATION, LLC
1800 CHANNAHON ROAD
JOLIET, ILLINOIS 60436

SEPTEMBER 2007

SEPTEMBER 2007			NOT FOR CONSTRUCTION		
			TITLE SHEET		
			PROJECT NO. 1862/3.0		
			DRAWN BY: BJK 07/12/07		
			CHECKED BY: HMS 08/02/07		
			APPROVED BY: EJT 09/05/07		
			DRAWING NO: D1862TS-00		
			REFERENCE: 1862/3/BID-CON/		
			SHEET NO. TS		
			</		



CONTRACTOR NOTES:

1. SITE BENCHMARK 1 IS A NAIL LOCATED ON WESTERLY FACE OF UTILITY POLE, WEST SIDE OF EAST ENTRANCE ROAD, 4TH UTILITY POLE SOUTH OF U.S. ROUTE 6 AT ELEVATION 536.39 FEET (NGVD 29).

2. SITE BENCHMARK 2 IS SET REBAR LOCATED 2 FEET SOUTH AND 2.5 FEET EAST OF CHAIN LINK FENCE CORNER AT SOUTHEAST CORNER OF THE INTERSECTION OF MAIN ENTRANCE ROAD AND U.S. ROUTE 6 AT ELEVATION 536.71 FEET (NGVD 29).

CONTROL BENCHMARK LOCATED ON WILL COUNTY MONUMENT STATION 6274 CUT SQUARE ON CENTERLINE OF SOUTH HEADWALL IN THE SOUTHEAST CORNER OF THE INTERSECTION OF BRANDON ROAD AND MEADOW AVENUE AT ELEVATION 550.33 FEET (NGVD 29).

3. CONTRACTOR SHALL NOT DISTURB OPERATIONS OF IMPOUNDMENT 1 WHEN WORKING ON IMPOUNDMENT 2.

4. CONTRACTOR SHALL USE THE MAIN ENTRANCE. ALL PERSONNEL MUST SIGN IN AT GATE HOUSE.

5. ABOVE GROUND PIPING LOCATED SOUTH OF ASH IMPOUNDMENT 2 WILL BE RELOCATED BY OTHERS.

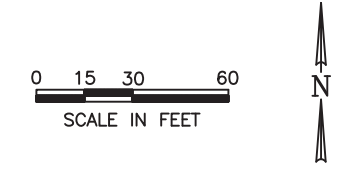
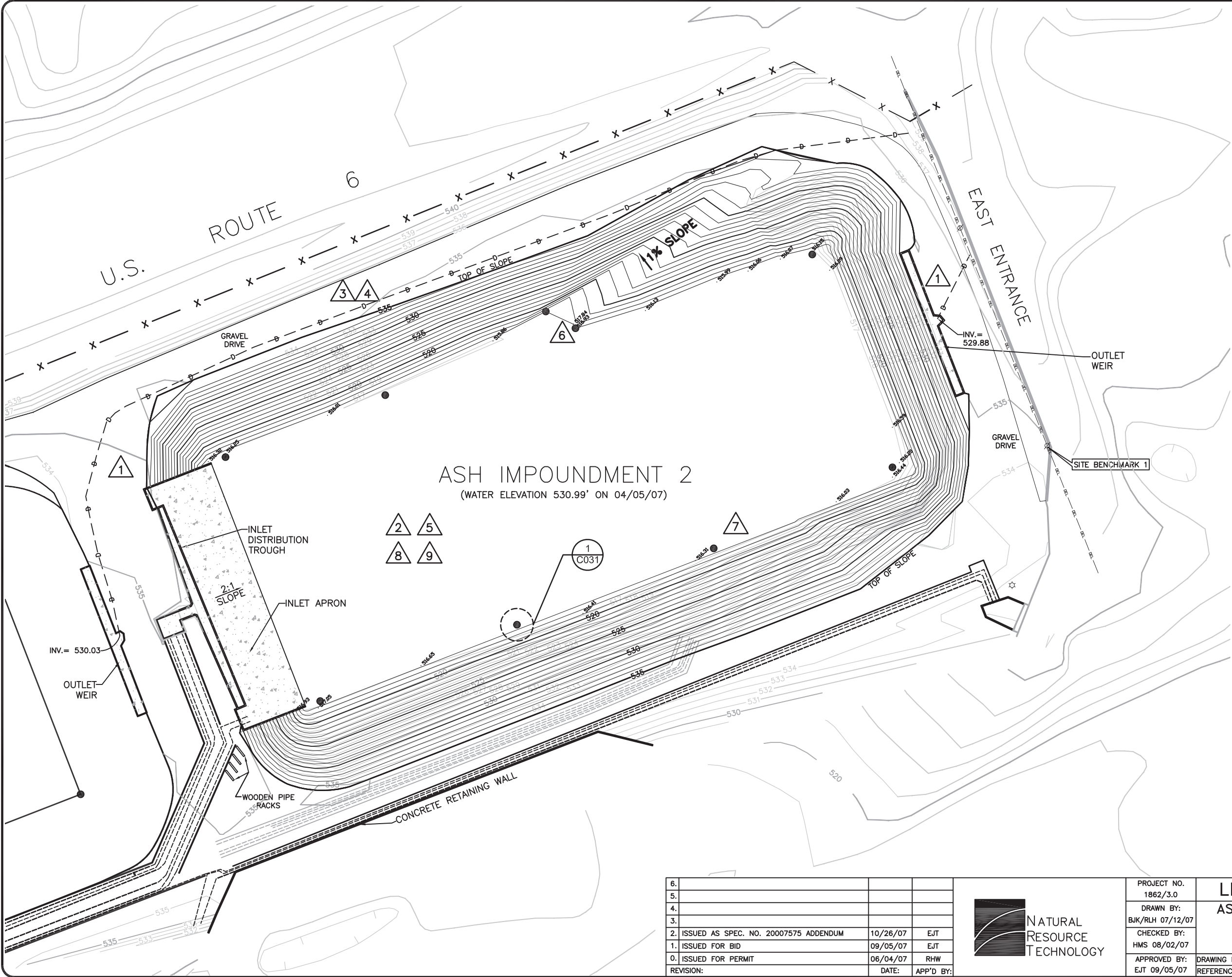
SOURCE NOTES:

1. THIS DRAWING WAS DEVELOPED FROM A SURVEY MAP BY BUEHLER, WILLIAMS & ASSOCIATES, INC., JOLIET, ILLINOIS, FILE NO. 00467.2006. THE SURVEY MAP WAS DEVELOPED FROM A SURVEY MAP BY BUEHLER, WILLIAMS & ASSOCIATES, INC., JOLIET, ILLINOIS, FILE NO. 00467.2006. THE SURVEY MAP WAS DEVELOPED FROM A SURVEY MAP BY BUEHLER, WILLIAMS & ASSOCIATES, INC., JOLIET, ILLINOIS, FILE NO. 00467.2006.

6.			
5.			
4.			
3.			
2.	ISSUED AS SPEC. NO. 20007575 ADDENDUM	10/26/07	EJT
1.	ISSUED FOR BID	09/05/07	EJT
0.	ISSUED FOR PERMIT	06/04/07	RHW
REVISION:		DATE:	APP'D BY:



PROJECT NO. 1862/3.0	NOT FOR CONSTRUCTION EXISTING CONDITIONS ASH IMPOUNDMENT #2 LINER REPLACEMENT MIDWEST GENERATION JOLIET STATION NO. 29 JOLIET, ILLINOIS	SHEET NO. C010
DRAWN BY: BJK/RLH 07/12/07		
CHECKED BY: HMS 08/02/07		
APPROVED BY: EJT 09/05/07		
DRAWING NO: D1862C010-02		
REFERENCE: 1862/3/BID-CON/		



LEGEND

- GROUND SURFACE CONTOURS
- PROPOSED SURFACE CONTOURS
- UNDERGROUND DISCHARGE PIPE
- FENCE
- EDGE OF PIPE RACK
- ABOVE GROUND PIPELINES
- OVERHEAD ELECTRIC LINE
- POWER POLE
- LIGHT POLE
- MARKER POST
- CONCRETE

CONTRACTOR NOTES:

1. CONTRACTOR SHALL FIELD VERIFY LOCATION OF UNDERGROUND DISCHARGE PIPES WITH ASSISTANCE OF OWNER'S UTILITY LOCATOR.
2. PROTECT ALL CONCRETE AND UTILITY STRUCTURES THROUGHOUT PROJECT DURATION.
3. CONTRACTOR SHALL STORE ALL GEOSYNTHETICS AND SUBGRADE MATERIALS AT A LOCATION APPROVED BY OWNER AS DISCUSSED DURING PRE-BID MEETING.
4. CONTRACTOR SHALL STORE AND STAGE EQUIPMENT AT A LOCATION APPROVED BY THE OWNER.
5. CONTRACTOR SHALL REMOVE VEGETATION, ROCKS AND OTHER DEBRIS GREATER THAN 3 INCHES FROM IMPOUNDMENT SUBGRADE AND DISPOSE AT AN APPROVED FACILITY. SIDE SLOPES SHALL BE GRADED FLAT TO REMOVE EROSION RILLS.
6. CONTRACTOR SHALL REMOVE AT LEAST 18 INCHES OF EXISTING RAMP MATERIAL FOR PLACEMENT OF SUBGRADE LAYER AND FINAL LAYER OF RAMP. EXCAVATED RAMP MATERIAL SHALL BE REUSED AS FINAL LAYER OF RAMP AS APPROVED BY OWNER. RAMP SUBGRADE SHALL BE SLOPED AS INDICATED ON THIS SHEET.
7. CONTRACTOR SHALL INSTALL MARKER POSTS ALONG THE BASE OF THE IMPOUNDMENTS AS SHOWN AND IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS AND DETAIL 1 ON SHEET C031.
8. CONTRACTOR SHALL PLACE 16 OZ. NON WOVEN GEOTEXTILE OVER THE PREPARED SUBGRADE IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS AND AS APPROVED BY GEOMEMBRANE INSTALLER PRIOR TO INSTALLATION OF GEOMEMBRANE.
9. CONTRACTOR SHALL PROVIDE MEANS TO PROTECT 18-OZ. NON WOVEN GEOTEXTILE FROM POTENTIAL DAMAGE. DAMAGE TO GEOTEXTILE SHALL BE REPAIRED AT THE CONTRACTOR'S EXPENSE.

SOURCE NOTES:

1. THIS DRAWING WAS DEVELOPED FROM A SURVEY MAP BY HUNTER, TOWELL & ASSOCIATES, INC., JOLIET, ILLINOIS, PLAT OF PARTIAL TOPOGRAPHY OF MIDWEST GENERATION JOLIET 20 POWER PLANT ASH IMPOUNDMENTS, SHEET 1 OF 1, DATED APRIL 2, 2007, FILE NO. 04-02-001. COORDINATE SYSTEM IS ILLINOIS STATE PLANE EAST ZONE, 1983 EDITION.
2. ASH IMPOUNDMENTS 1 AND 2 WERE DEVELOPED FROM DRAWINGS BY THE CONSULTING ENGINEER, HUNTER, TOWELL & ASSOCIATES, INC., JOLIET, ILLINOIS, DATED OCTOBER 20, 2007, FILE NO. 04-02-001.
3. TOPOGRAPHY OF THE ASH IMPOUNDMENTS 1 AND 2 WAS DEVELOPED FROM EXISTING FIELD MEASUREMENTS, PHOTOGRAPHS, AND AERIAL PHOTOGRAPHS. THE SURVEY WAS CONDUCTED IN ACCORDANCE WITH THE ILLINOIS SURVEYING ACT AND THE ILLINOIS SURVEYING BOARD'S STANDARDS.
4. EXISTING SURFACE CONTOURS WERE DEVELOPED FROM A SURVEY MAP BY HUNTER, TOWELL & ASSOCIATES, INC., JOLIET, ILLINOIS, PLAT OF PARTIAL TOPOGRAPHY OF MIDWEST GENERATION JOLIET 20 POWER PLANT ASH IMPOUNDMENTS, SHEET 1 OF 1, DATED OCTOBER 20, 2007, FILE NO. 04-02-001.

6.

5.

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3.

2. ISSUED AS SPEC. NO. 20007575 ADDENDUM

1. ISSUED FOR BID

0. ISSUED FOR PERMIT

REVISION:

10/26/07

09/05/07

06/04/07

DATE:

EJT

EJT

RHW

APP'D BY:

PROJECT NO.
1862/3.0

DRAWN BY:
BJK/RLH 07/12/07

CHECKED BY:
HMS 08/02/07

APPROVED BY:
EJT 09/05/07

NOT FOR CONSTRUCTION

LINER SUBGRADE PREPARATION

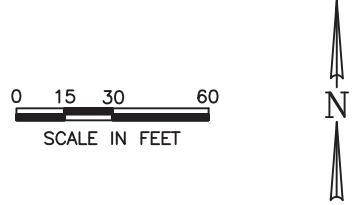
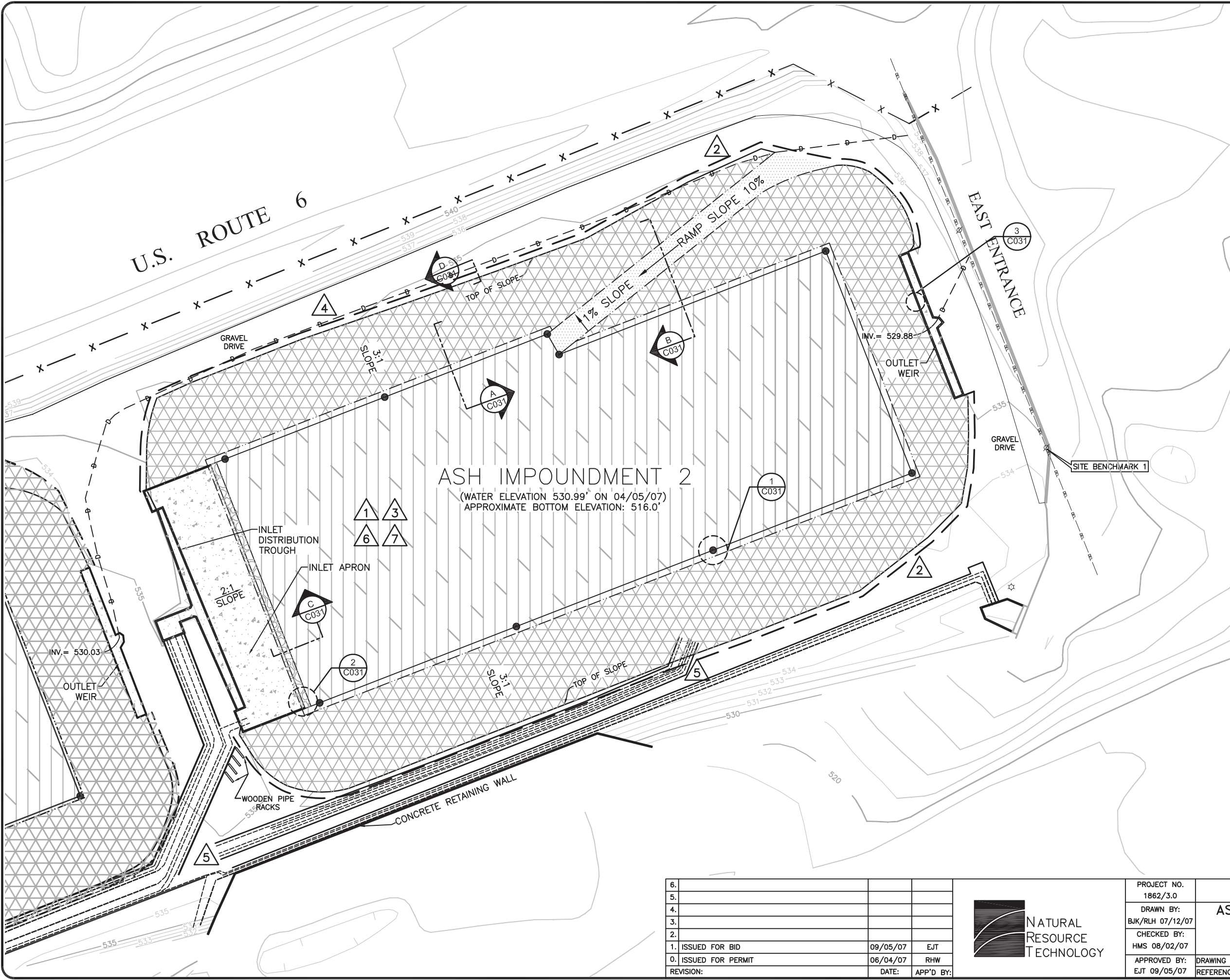
ASH IMPOUNDMENT #2 LINER REPLACEMENT

MIDWEST GENERATION

JOLIET STATION NO. 29

JOLIET, ILLINOIS

SHEET NO.
C020



LEGEND	
	GROUND SURFACE CONTOURS
	UNDERGROUND DISCHARGE PIPE
	FENCE
	EDGE OF PIPE RACK
	ABOVE GROUND PIPELINES
	OVERHEAD ELECTRIC LINE
	POWER POLE
	LIGHT POLE
	MARKER POST
	ANCHOR TRENCH
	12 OZ. NON-WOVEN GEOTEXTILE
	CONCRETE
	EXCAVATED RAMP MATERIAL
	RIP RAP
	WARNING LAYER
	HDPE GEOMEMBRANE

CONTRACTOR NOTES: **△**

1. CONTRACTOR SHALL INSTALL 60 MIL. HDPE, WHITE, TEXTURED GEOMEMBRANE IN ACCORDANCE WITH THE TECHNICAL SPECIFICATION PRIOR TO PLACEMENT OF THE WARNING LAYER. CONTRACTOR SHALL PROVIDE AND FOLLOW AN APPROVED GEOMEMBRANE LAYOUT PLAN.
2. GEOMEMBRANE SHALL BE ANCHORED INTO 2.5 FEET DEEP TRENCHES ALONG TOP OF IMPOUNDMENT BANK, AS SHOWN IN SECTION D ON SHEET C031. CONTRACTOR SHALL ADVISE OWNER AND/OR ENGINEER IF PROPOSED LOCATION NOT POSSIBLE. DISCHARGE PIPE SHALL BE FIELD LOCATED AND CONTRACTOR SHALL NOTIFY OWNER IF ANCHOR TRENCH INTERFERES WITH PIPING.
3. CONTRACTOR SHALL PLACE 12-OZ. NON-WOVEN GEOTEXTILE OVER THE GEOMEMBRANE, SAND MATERIAL AND WARNING LAYER MATERIAL AT BASE AND 4 FEET ON SIDE SLOPES AFTER RECEIVING APPROVAL FROM ENGINEER AND PASSING QUALITY CONTROL RESULTS IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS. (SEE SHEET C031)
4. RESTORE AREAS DISTURBED BY EQUIPMENT AND MATERIAL LAYDOWN.
5. ABOVE GROUND PIPING TO BE INSTALLED BY OTHERS.
6. CONTRACTOR SHALL PROVIDE SURVEY DOCUMENTATION OF THE ITEMS LISTED IN THE TECHNICAL SPECIFICATIONS.
7. CONTRACTOR SHALL PERFORM A LEAK LOCATION SURVEY IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS.

REVISION NOTES:

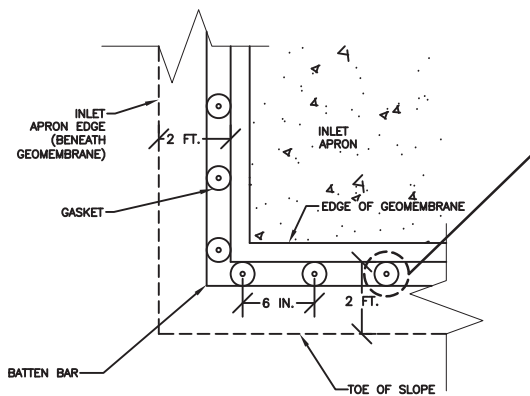
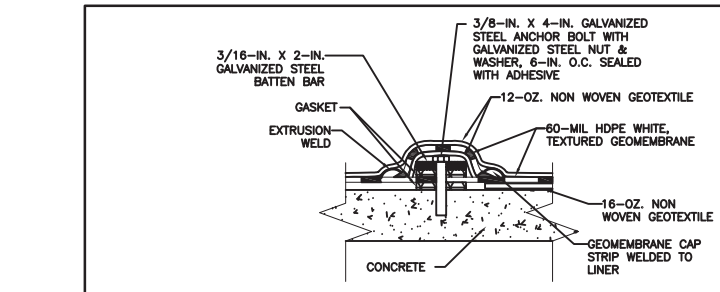
1. THIS DRAWING WAS DEVELOPED FROM A SURVEY MAP BY BUELL, TOWNE & ASSOCIATES, INC., JOLIET, ILLINOIS, FILED AT THE OFFICE OF THE JOLIET CITY ENGINEER, JOLIET, ILLINOIS, ON 04/05/07, AS SHOWN IN SECTION D ON SHEET C031. COORDINATE SYSTEM IS ILLINOIS STATE PLANE EAST ZONE, NAD 83.
2. ASH IMPOUNDMENTS 1 AND 2 WERE DEVELOPED FROM DRAWINGS BY THE CONSULTING ENGINEER, BUELL, TOWNE & ASSOCIATES, INC., JOLIET, ILLINOIS, DATED JANUARY 28, 1976.
3. TOPOGRAPHY COURTESY OF AEP IMPOUNDMENTS 1 AND 2 WAS DEVELOPED FROM DIGITAL-TOPO PLATS, CONTROLLING, SURVEYING, AND MAPPING, ILLINOIS STATE PLANE EAST ZONE, NAD 83 COORDINATE SYSTEM, DATED APRIL, 1987 DOWNLOADED FROM <http://www.illinois.gov>.

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1. ISSUED FOR BID	09/05/07	EJT
0. ISSUED FOR PERMIT	06/04/07	RHW
REVISION:	DATE:	APP'D BY:

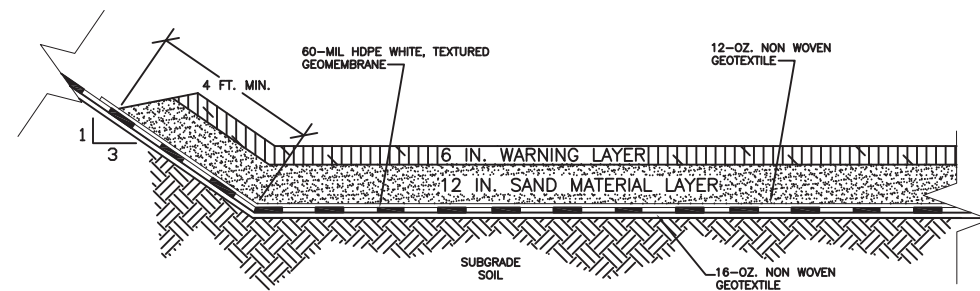


PROJECT NO. 1862/3.0
DRAWN BY: BJK/RLH 07/12/07
CHECKED BY: HMS 08/02/07
APPROVED BY: EJT 09/05/07

NOT FOR CONSTRUCTION	
WARNING LAYER PLAN	
ASH IMPOUNDMENT #2 LINER REPLACEMENT	
MIDWEST GENERATION	
JOLIET STATION NO. 29	
JOLIET, ILLINOIS	
DRAWING NO: D1862C030-01	SHEET NO. C030
REFERENCE: 1862/3/BID-CON/	

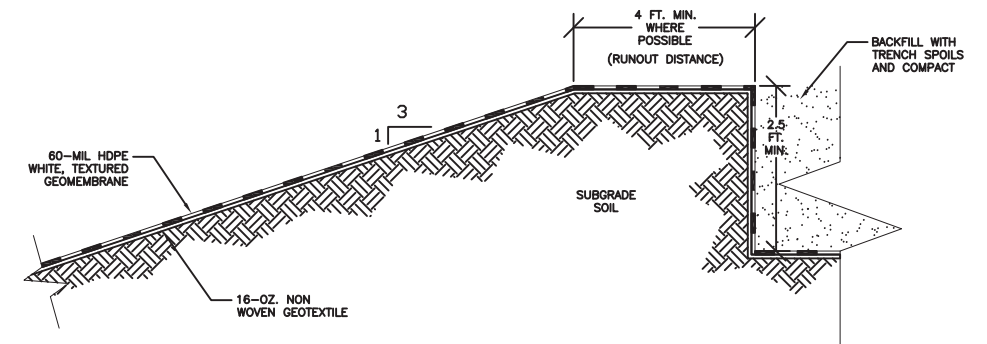


2 INLET APRON DETAIL PLAN
C030 NOT TO SCALE

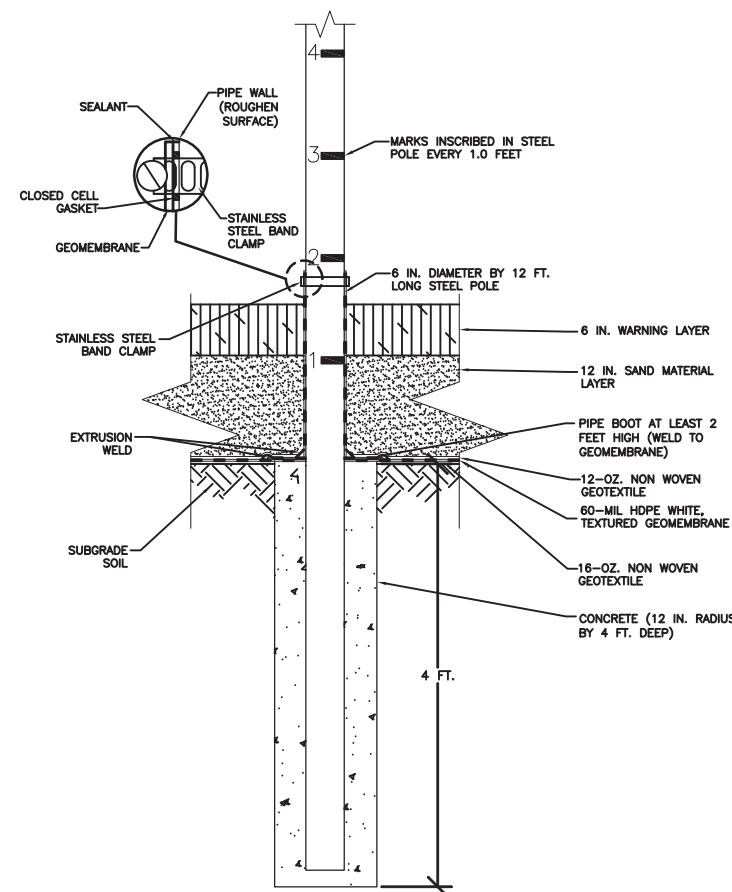


NOTE:
1. WELDS TO BE PLACED 2 TO 5 FT. FROM TOE OF SLOPE AT A MINIMUM.

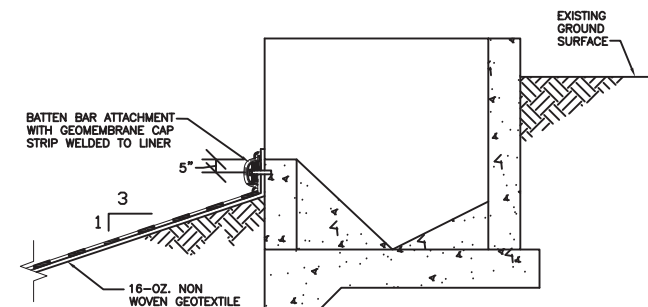
A SLOPE TRANSITION SECTION
C030 NOT TO SCALE



D ANCHOR TRENCH SECTION
C030 NOT TO SCALE

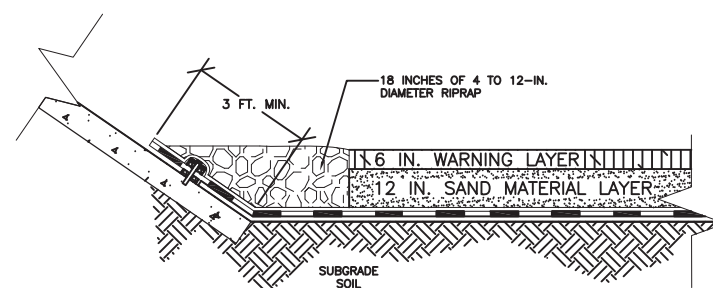


1 MARKER POST DETAIL
C020 NOT TO SCALE

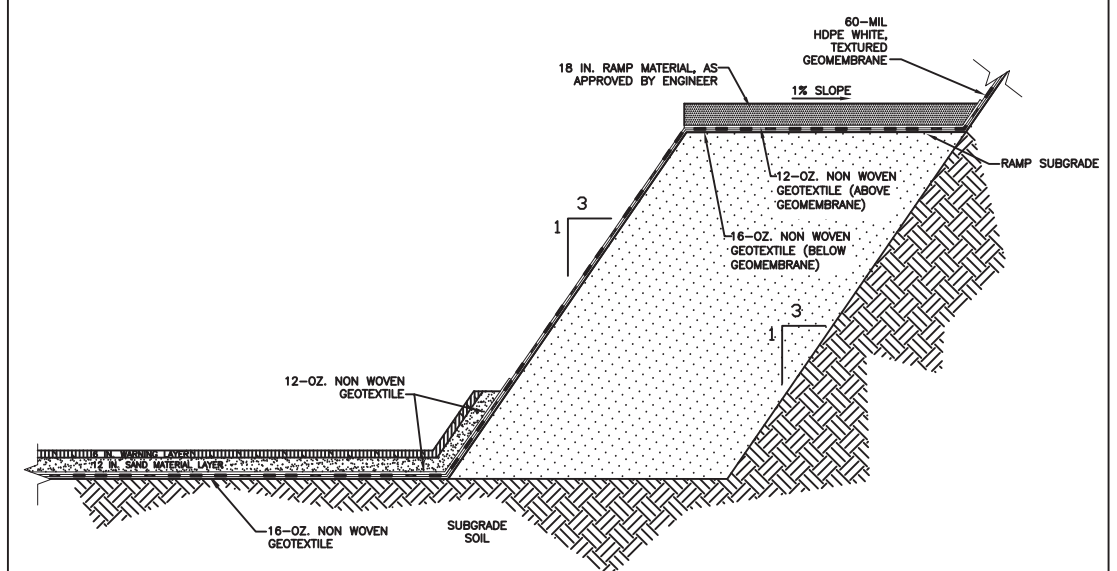


NOTE:
1. REFER TO DETAIL 2 FOR BATTEN BAR ATTACHMENT. EXCLUDE USE OF THE TOP LAYER OF 12-0Z. NON WOVEN GEOTEXTILE.

3 OUTLET WEIR DETAIL
C030 NOT TO SCALE



C INLET APRON SECTION
NOT TO SCALE



B RAMP SECTION
C030 NOT TO SCALE

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1. ISSUED FOR BID	09/05/07	EJT	
0. ISSUED FOR PERMIT	06/04/07	RHW	
REVISION:	DATE:	APP'D BY:	



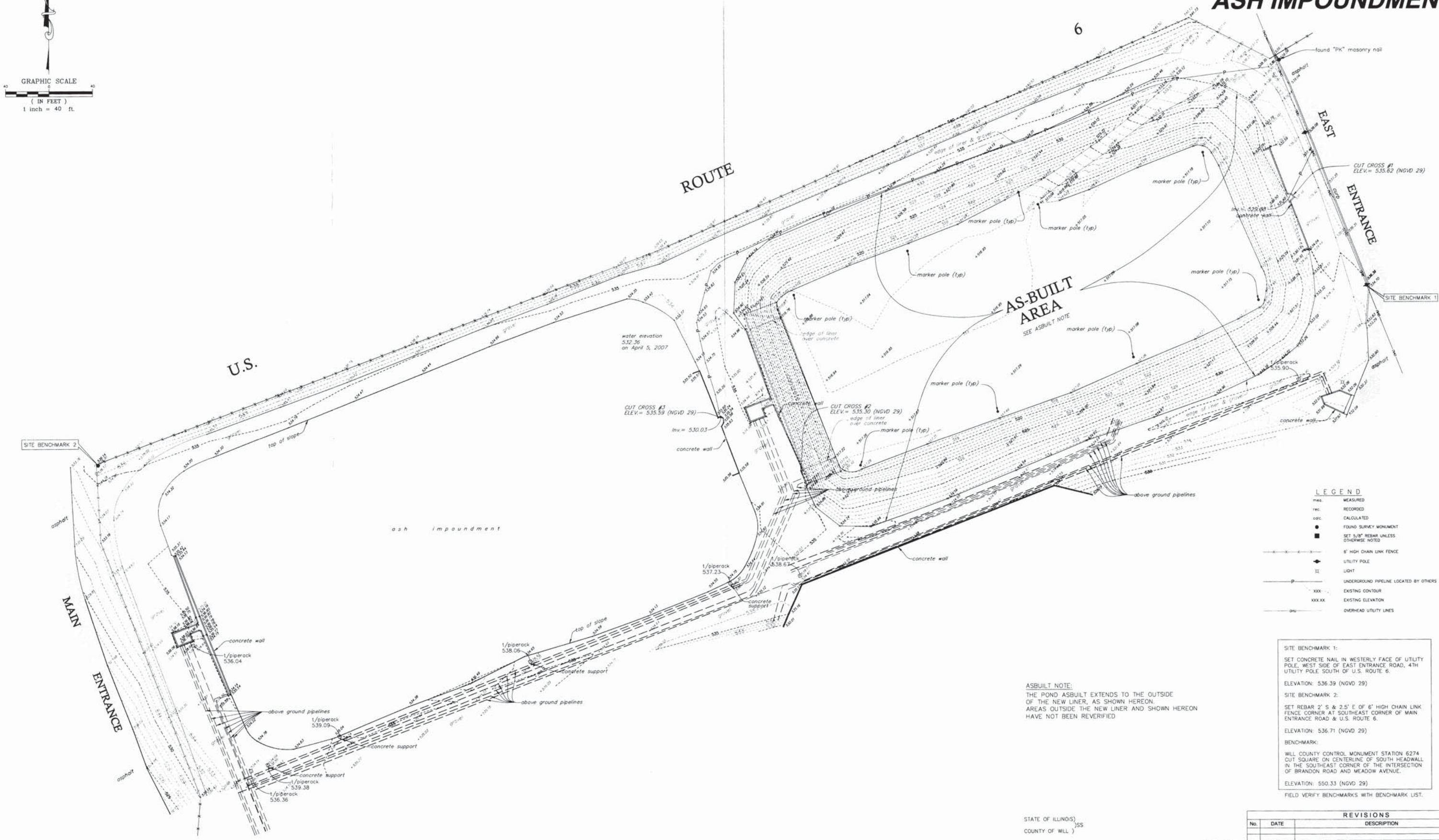
PROJECT NO.	1862/3.0
DRAWN BY:	BJK/RLH 07/12/07
CHECKED BY:	HMS 08/02/07
APPROVED BY:	EJT 09/05/07

NOT FOR CONSTRUCTION	
DETAILS AND SECTIONS	
ASH IMPOUNDMENT #2 LINER REPLACEMENT	
MIDWEST GENERATION	
JOLIET STATION NO. 29	
JOLIET, ILLINOIS	
DRAWING NO: D1862C031-01	SHEET NO. C031
REFERENCE: 1862/3/BID-CON/	

APPENDIX A-4

Ash Pond 2 Liner Replacement As-Built

MIDWEST GENERATION JOLIET 29 POWER PLANT ASH IMPOUNDMENTS



LEGEND

mea	MEASURED
rec	RECORDED
calc	CALCULATED
●	FOUND SURVEY MONUMENT
■	SET 5/8\" REBAR UNLESS OTHERWISE NOTED
—X—X—X—	6\" HIGH CHAIN LINK FENCE
—U—	UTILITY POLE
—L—	LIGHT
—P—	UNDERGROUND PIPELINE LOCATED BY OTHERS
XXX	EXISTING CONTOUR
XXX.XX	EXISTING ELEVATION
—DU—	OVERHEAD UTILITY LINES

SITE BENCHMARK 1:
SET CONCRETE NAIL IN WESTERLY FACE OF UTILITY
POLE, WEST SIDE OF EAST ENTRANCE ROAD, 4TH
UTILITY POLE SOUTH OF U.S. ROUTE 6.
ELEVATION: 536.39 (NGVD 29)
SITE BENCHMARK 2:
SET REBAR 2\" S & 2.5\" E OF 6\" HIGH CHAIN LINK
FENCE CORNER AT SOUTHEAST CORNER OF MAIN
ENTRANCE ROAD & U.S. ROUTE 6.
ELEVATION: 536.71 (NGVD 29)
BENCHMARK:
WILL COUNTY CONTROL MONUMENT STATION 6274
CUT SQUARE ON CENTERLINE OF SOUTH HEADWALL
IN THE SOUTHEAST CORNER OF THE INTERSECTION
OF BRANDON ROAD AND MEADOW AVENUE.
ELEVATION: 550.33 (NGVD 29)
FIELD VERIFY BENCHMARKS WITH BENCHMARK LIST.

ASBUILT NOTE:
THE POND ASBUILT EXTENDS TO THE OUTSIDE
OF THE NEW LINER, AS SHOWN HEREON.
AREAS OUTSIDE THE NEW LINER AND SHOWN HEREON
HAVE NOT BEEN REVERIFIED

STATE OF ILLINOIS)
COUNTY OF WILL)

RUETTIGER, TONELLI & ASSOCIATES, INC., ILLINOIS PROFESSIONAL DESIGN FIRM
No. 184-001251, HEREBY CERTIFIES THAT IT HAS TOPOGRAPHICALLY SURVEYED
THE POND AREA NOTED HEREON AND AS SHOWN ON THE
ANNEXED PLAT, WHICH IS A TRUE AND CORRECT REPRESENTATION OF
SAID TOPOGRAPHY.

SURVEY FIELD WORK COMPLETED 6/6/09
GIVEN UNDER MY HAND AND SEAL OF OFFICE THIS 30TH DAY OF MAY, 2008



REVISIONS

No.	DATE	DESCRIPTION	BY

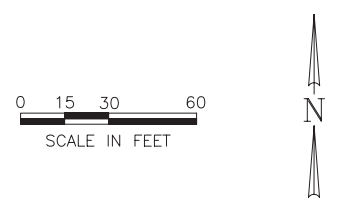
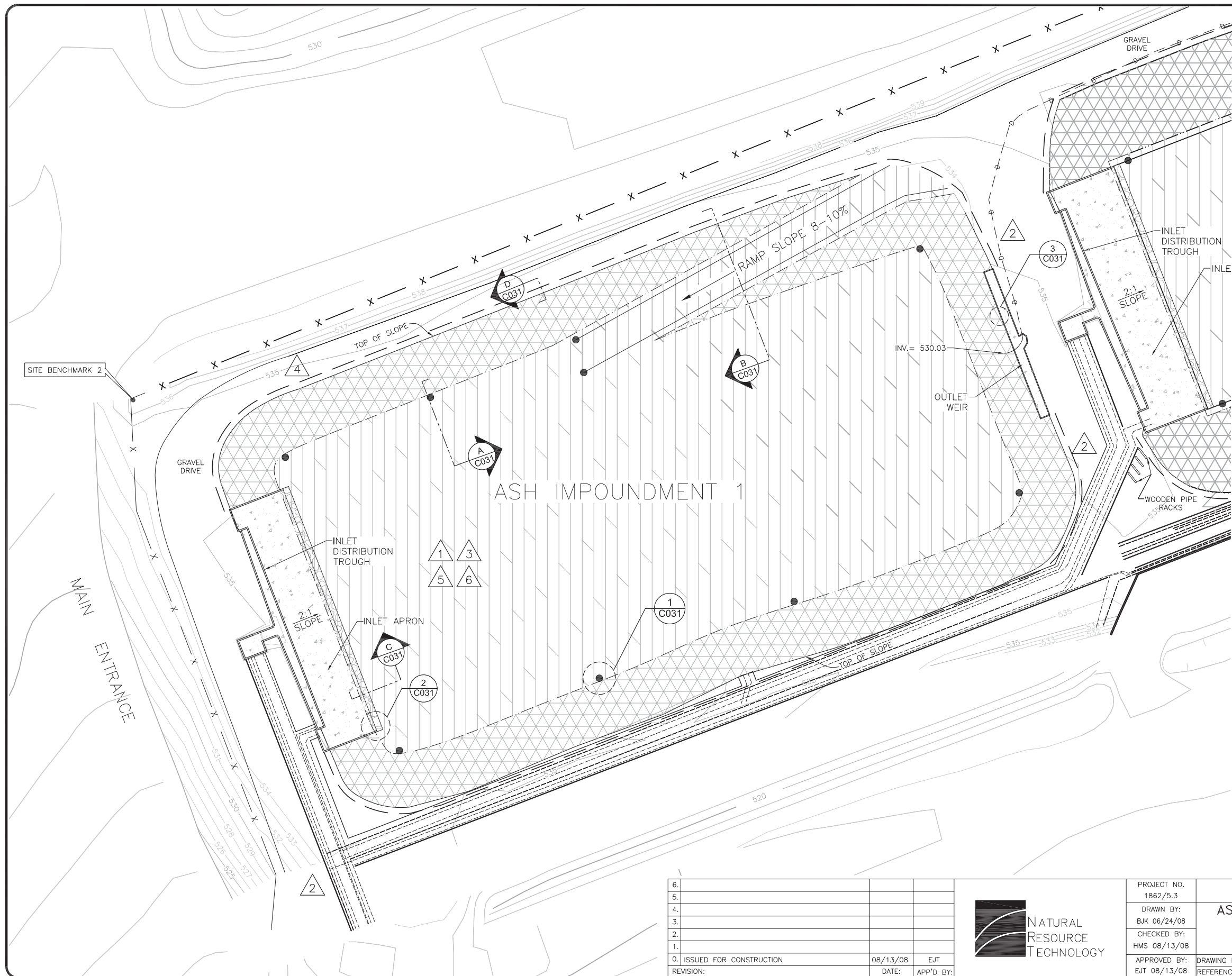
RT & A Ruettiger, Tonelli & Associates, Inc.
Surveyors • Engineers • Planners • Landscape Architects • GIS Consultants
2174 ONEIDA STREET JOLIET, ILLINOIS 60435
PH. (815) 744-6600 FAX (815) 744-0101
2603 S. WASHINGTON STREET - SUITE 170 NAPERVILLE, ILLINOIS 60565
PH. (630) 420-7740 FAX (630) 420-7741

DATE: 6/9/08 SCALE: 1\" = 40\" DRAWN BY: MJ CHECKED BY: EC
PREPARED FOR: BREISER CONSTRUCTION COMPANY FIELD BOOK: MIDWEST GEN

X:\0485\SURVEYING\ASBUILT\ASB.dwg, TPOD, 01/13/2008 11:15:24 AM, rwe

APPENDIX A-5

Pond 1 Liner Replacement Construction Drawings



LEGEND	
	GROUND SURFACE CONTOURS
	UNDERGROUND DISCHARGE PIPE
	FENCE
	EDGE OF PIPE RACK
	ABOVE GROUND PIPELINES
	MARKER POST
	ANCHOR TRENCH
	12 OZ. NON-WOVEN GEOTEXTILE
	CONCRETE
	RIP RAP
	WARNING LAYER
	HDPE GEOMEMBRANE
	MWG
	MIDWEST GENERATION, LLC

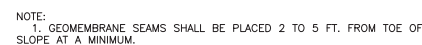
CONTRACTOR NOTES:
1. CONTRACTOR SHALL INSTALL 60 MIL HDPE, WHITE, TEXTURED GEOMEMBRANE IN ACCORDANCE WITH THE TECHNICAL SPECIFICATION PRIOR TO PLACEMENT OF THE WARNING LAYER. CONTRACTOR SHALL PROVIDE AND FOLLOW AN APPROVED GEOMEMBRANE LAYOUT PLAN.
2. GEOMEMBRANE SHALL BE ANCHORED INTO 2.5 FEET DEEP TRENCHES ALONG TOP OF IMPOUNDMENT BANK, AS SHOWN IN SECTION D ON SHEET C031. CONTRACTOR SHALL ADVISE MWG AND/OR ENGINEER IF PROPOSED LOCATION NOT POSSIBLE. DISCHARGE PIPE SHALL BE FIELD LOCATED AND CONTRACTOR SHALL NOTIFY MWG IF ANCHOR TRENCH INTERFERES WITH PIPING.
3. CONTRACTOR SHALL PLACE 12-OZ. NON-WOVEN GEOTEXTILE OVER THE GEOMEMBRANE, CUSHION MATERIAL AND WARNING LAYER MATERIAL AT BASE AND 4 FEET ON SIDE SLOPES, AND RAMP FOLLOWING ENGINEER APPROVAL AND PASSING QUALITY CONTROL RESULTS IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS (SEE SHEET C031).
4. RESTORE AREAS DISTURBED BY EQUIPMENT AND MATERIAL LAYDOWN.
5. CONTRACTOR SHALL PROVIDE SURVEY DOCUMENTATION OF THE ITEMS LISTED IN THE TECHNICAL SPECIFICATIONS.
6. CONTRACTOR SHALL PERFORM A LEAK LOCATION SURVEY IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS.

SOURCE NOTES:
1. THIS DRAWING WAS DEVELOPED FROM A SURVEY MAP BY RIETHEIS, TONELLI & ASSOCIATES, INC., JOLIET, ILLINOIS, PLAT OF PARTIAL TOPOGRAPHY OF MIDWEST GENERATION JOLIET 29 POWER PLANT IMPOUNDMENTS, SHEET 1 OF 1, DATED APRIL 7, 2007, FILE NO. 04447.J29. COORDINATE SYSTEM IS ILLINOIS STATE PLANE, EAST ZONE, (NAD 83).
2. ASH IMPOUNDMENTS 1 AND 2 WERE DEVELOPED FROM DRAWINGS BY HUS CORPORATION, DRAWING NUMBERS M07C0122 AND M07C0123, DATED JANUARY 23, 1978.
3. TOPOGRAPHY OUTSIDE OF ASH IMPOUNDMENTS 1 AND 2 WAS DEVELOPED FROM DIGITAL-ORTHO FILES, GEOTRANSFORM, AND DIGITIZED ILLINOIS STATE PLANE EAST AND WEST COORDINATE SYSTEMS.
4. SURFACE ELEVATION CONTOURS WERE DEVELOPED FROM A SURVEY MAP BY RIETHEIS, TONELLI & ASSOCIATES, INC., JOLIET, ILLINOIS, PLAT OF PARTIAL TOPOGRAPHY OF MIDWEST GENERATION JOLIET 29 POWER PLANT ASH IMPOUNDMENTS, SHEET 1 OF 1, DATED OCTOBER 20, 2007, FILE NO. 04447.J29.
5. TOPOGRAPHY OF ASH IMPOUNDMENT 1 FROM SURVEY POINTS COLLECTED BY MIDWEST GENERATION PERSONNEL, DATE JULY 22, 2008.

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0.	ISSUED FOR CONSTRUCTION	08/13/08	EJT
REVISION:		DATE:	APP'D BY:



PROJECT NO. 1862/5.3	WARNING LAYER PLAN	
DRAWN BY: BJK 06/24/08	ASH IMPOUNDMENT #1 LINER REPLACEMENT MIDWEST GENERATION, LLC JOLIET STATION NO. 29 JOLIET, ILLINOIS	
CHECKED BY: HMS 08/13/08		
APPROVED BY: EJT 08/13/08	DRAWING NO: D1862C030-00 REFERENCE: 1862/BID-CON IMPOUNDMENT 1/	SHEET NO. C030



A SLOPE TRANSITION SECTION
C030 NOT TO SCALE



3 OUTLET WEIR DETAIL
C030 NOT TO SCALE



C INLET APRON SECTION
-- NOT TO SCALE



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0.	ISSUED FOR CONSTRUCTION	08/13/08	EJT
REVISION:		DATE:	APP'D BY



PROJECT NO. 1862/5.3
DRAWN BY: BJK 06/24/08
CHECKED BY: HMS 08/13/08
APPROVED BY: EJT 08/13/08

DETAILS AND SECTIONS

ASH IMPOUNDMENT #1 LINER REPLACEMENT
MIDWEST GENERATION, LLC
JOLIET STATION NO. 29
JOLIET, ILLINOIS

DRAWING NO: D1862C031-00
REFERENCE: 1862/BID-CON IMPOUNDMENT 1/

SHEET NO.
C031

APPENDIX B

Technical Specifications

SECTION 02600

HIGH DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE

PART 1 - GENERAL

1.01 WORK INCLUDES

- A. Furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for installation of 60-mil High Density Polyethylene (HDPE) geomembrane, as specified herein, and as shown on Contract Drawings.

1.02 REFERENCE STANDARDS

- A. ASTM D1004 – Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
- B. ASTM D1238 – Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
- C. ASTM D1505 – Test Method for Density of Plastics by the Density-Gradient Technique.
- D. ASTM D1603 – Test Method for Carbon Black in Olefin Plastics.
- E. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
- F. ASTM D5199 – Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
- G. ASTM D5397 – Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
- H. ASTM D5596 – Test Method for Microscopic Evaluation of Dispersion of Carbon Black in Polyolefin Geosynthetics.
- I. ASTM D5994 Standard Test Method for Measuring Core Thickness of Textured Geomembranes.
- J. ASTM D6392 – Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
- K. ASTM D6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.
- L. GRI Test Method, GM 13 - Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
- M. GRI Test Method, GM 14 – Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes.

- N. GRI Test Method, GM 19 – Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

1.03 DEFINITIONS

- A. Geomembrane Installer: hired by Contractor or Owner responsible for field handling, transporting, storing, deploying, seaming and testing of the geomembrane seams.
- B. Geomembrane Manufacturer: hired by Geomembrane Installer to provide HDPE geomembrane.
- C. Geosynthetic Quality Assurance Consultant: Consultant, independent from the Owner, Manufacturer, and Installer, responsible for field oversight of geosynthetics installation, and related testing, usually under the direction of the Owner.
- D. Geosynthetic Quality Assurance Laboratory (Testing Laboratory): Party, independent from the Owner, Manufacturer and Installer, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing, usually under the direction of the Owner.
- D. Lot: A quantity of resin (usually the capacity of one rail car) used in the manufacture of geomembranes. Finished roll will be identified by a roll number traceable to the resin lot used.
- E. Resin Supplier: selected by Geomembrane Manufacturer to provide resin used in manufacturing geomembrane.
- F. Panel: Unit area of a geomembrane that will be seamed in the field that is larger than 100ft².
- G. Patch: Unit area of a geomembrane that will be seamed in the field that is less than 100ft².
- H. Subgrade Surface (Bedding Layer): Soil Layer surface which immediately underlies the geosynthetic material(s).

1.04 QUALITY ASSURANCE

- A. Qualifications:
1. Geomembrane Installer:
 - a. 5 years of continuous experience in installation of HDPE geomembrane.
 - b. Experience totaling a minimum of 5,000,000 square feet of installed HDPE geomembrane on some combination of at least 10 completed facilities.
 - c. Personnel performing seaming operations qualified by experience or by successfully passing seaming tests. Master seamer shall have experience

seaming a minimum of 3,000,000 square feet of geomembrane using same type of seaming apparatus to be used on this project.

B. Quality Assurance Program:

1. Geomembrane Manufacturer/Installer shall conform with requirements of these Technical Specifications.
2. The Engineer will document geomembrane installation including panel placement, seaming, pre-qualification seam testing, non-destructive seam and repair testing, repair size and locations, weather conditions.
3. The Owner will engage and pay for the services of a Geosynthetic Quality Assurance Consultant and Laboratory to monitor geomembrane installation.

1.05 SUBMITTALS

A. Prior to project start, submit the following to Geosynthetic Quality Assurance Consultant in accordance with Section 01300, Submittals:

1. Raw Materials:
 - a. Name of Resin Supplier, location of supplier's production plant(s), resin brand name and product number.
 - b. Source and nature of plasticizers, fillers, carbon black and any other additives along with their percent addition to geomembrane material.
 - c. Test results documenting conformance with the "index properties" of GRI Test Method, GM 13.
2. Geomembrane Manufacturer's Certification:
 - a. Written certification that Geomembrane Manufacturer's Quality Control Plan was fully implemented during production of geomembrane material supplied for this project. (Submittal shall be made within 5 working days of delivery to site).
3. Geomembrane Installer's Seaming Personnel
 - a. Corporate background information indicating compliance with qualification requirements.
 - b. Training completed by personnel.
 - c. Seaming experience for each personnel.
4. Geomembrane Manufacturer Production Information:
 - a. Corporate background information indicating compliance with qualification requirements.

- b. Quality control plan for manufacturing.
 - c. Copy of quality control certificates demonstrating compliance with the quality control plan for manufacturing and the test property requirements of GRI Test method, GM 13 (i.e. mill certificates).
 - 5. Geomembrane Installer's Information:
 - a. Corporate background information indicating compliance with qualification requirements.
 - b. List of completed facilities, totaling 5,000,000 square feet minimum for which Geomembrane Installer has completed installation of a HDPE geomembrane. Include name and purpose of facility, location, date of installation, and quantity installed.
 - c. Resumes of personnel performing field seaming operation, along with pertinent experience information. Include documentation regarding which seamers are qualified to use thermal fusion welding apparatus.
 - d. Installation quality control plan.
 - 6. Installation panel layout diagram identifying placement of geomembrane panels, seams, and any variance or additional details which deviate from Contract Drawings or Technical Specifications. Layout shall be drawn to scale and shall be adequate for use as a construction plan. Layout shall include dimensions and pertinent seam and anchorage details.
 - 7. Installation Sequence and Schedule shall be included as part of Construction Progress Schedule.
 - 8. Description of seaming apparatus to be used indicating compliance with specified requirements.
- B. During installation, submit the following to the Geosynthetic Quality Assurance Consultant:
- 1. Daily records/logs prepared by Geomembrane Installer documenting work performed, personnel involved, general working conditions, and any problems encountered or anticipated on project. Submit on a weekly basis.
 - 2. Copy of subgrade acceptance signed by Geomembrane Installer for areas to be covered with geomembrane each day.
- C. Within 10 days of geomembrane installation completion, submit the following to Geosynthetic Quality Assurance Consultant:
- 1. Geomembrane installation certification that Work was performed under Geomembrane Installer's approved quality control plan and in substantial compliance with Technical Specifications and Contract Drawings.

2. As-built panel diagram identifying placement of geomembrane panels, seams, repairs, and destructive seam sample locations.
 3. Copy of warranty for material (including factory seams) and installation covering both for a period of 2 years from the date of substantial completion.
- D. The Geosynthetic Quality Assurance Consultant will review and inspect HDPE geomembrane installation upon completion of all Work specified in this Section. Deficiencies noted shall be corrected at no additional cost to the Owner.
- E. The Geosynthetic Quality Assurance Consultant will provide written final acceptance of the geomembrane installation after completion of material placement above geomembrane. Written conditional geomembrane installation acceptance can be provided to the Contractor prior to completion of material placement above geomembrane when the following conditions are satisfied, if necessary, and requested by the Contractor:
1. The entire geomembrane installation is completed or any pre-determined subsection if the project is phased.
 2. All installation quality assurance/control documentation has been completed and submitted to the Geosynthetic Quality Assurance Consultant or Owner.
 3. Verification of the adequacy of all field seams, repairs and associated testing is complete.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Transportation:
1. Geomembrane rolls shall be transported, unloaded and handled at the job site in accordance with manufacturer recommendations. Damaged material may be rejected by the Geosynthetic Quality Assurance Consultant. Manufacturer packaging shall be labeled in accordance with Section 02700, 2.02G.
- B. On-site Storage:
1. Geomembrane rolls which have been delivered to job site shall be unloaded and stored in original, unopened packaging in a secure location, determined by Owner and/or Geosynthetic Quality Assurance Consultant.
 2. Store geomembrane rolls to ensure adequate protection against exposure to the following:
 - a. Equipment;
 - b. Strong oxidizing chemicals, acids, or bases;
 - c. Flames, including welding sparks;

- d. Temperatures in excess of 160 deg. F;
 - e. Dust;
 - f. Ultraviolet radiation (i.e. sunlight); and
 - g. Inclement weather.
- 3. Whenever possible, provide a 6-inch minimum air space between rolls.
- 4. Containers/rolls shall not be stacked.
- C. On-Site Handling:
 - 1. Handle rolls per Geomembrane Manufacturer's recommendations and as necessary to prevent damage.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. High Density Polyethylene (HDPE) White Textured Geomembrane.
 - 1. HDPE geomembrane shall be white, textured, 60-mil product approved by the Engineer and/or Geosynthetic Quality Assurance Consultant.
 - 2. The Contractor shall submit, with the bid, written certification from the proposed Geomembrane Manufacturer that geomembrane products proposed in the bid satisfy the following requirements:
 - a. The proposed Geomembrane Manufacturer shall have a minimum of 5 years of continuous experience manufacturing HDPE geomembrane totaling 1,000,000 square feet.
 - b. The proposed HDPE compound shall be comprised entirely of virgin materials. Compliance with this specification shall be documented in accordance with Geomembrane Manufacturer's quality control program and submitted to the Geosynthetic Quality Assurance Consultant with the written conformance certification.
 - c. The proposed Geomembrane Manufacturer shall certify that any plasticizers, fillers and additives incorporated into the manufacturing process for the proposed HDPE geomembrane have demonstrated acceptable performance on past projects.
 - d. The proposed geomembrane shall meet the requirements of Geosynthetic Research Institute's test method GM 13.
 - e. The nominal thickness of proposed geomembrane shall be 60 mil., or as approved by the Engineer and/or Geosynthetic Quality Assurance Consultant.

3. Geomembrane sheets shall be visually consistent in appearance and shall contain no holes, blisters, undisbursed raw materials or other signs of contamination by foreign material. Geomembrane must have no striations, roughness or bubbles on the surface.

B. Seaming Apparatus

1. Thermal fusion welding machines used for joining geomembrane surfaces may be either extrusion or hot wedge. These machines shall include sufficient temperature and rate-of-travel monitoring devices to allow continuous monitoring of operating conditions.
2. One spare, operable thermal fusion seaming device shall be maintained on site at all times.

C. Field Test Equipment

1. Field Tensiometer: the field tensiometer shall be calibrated within three months prior to project start date over the range of field test values.
2. Air Channel Test Equipment: air channel test equipment shall consist of hoses, fittings, valves and pressure gauge(s) needed to deliver and monitor the pressure of compressed air through an approved pressure feed device.
3. Air Compressor: the air compressor utilized for field testing shall be capable of producing and maintaining an operating pressure of at least 50 psi.
4. Vacuum Box: the vacuum box shall consist of a vacuum gage, valve, and a gasket around the edge of the open bottom needed to apply vacuum to a surface.

2.02. CONFORMANCE TESTING REQUIREMENTS

- A. Geomembrane shipped to site shall undergo conformance testing. Manufacturer's roll certificates may be used for conformance evaluation at the option of the Geosynthetic Assurance Consultant. Nonconforming material shall either be retested at the direction of the Geosynthetic Quality Assurance Consultant or removed from site and replaced at Contractor's expense.

B. Conformance Test Methods

1. Samples will be located and collected by the Geosynthetic Quality Assurance Consultant at a rate of one sample per 100,000 square feet of geomembrane delivered to site.
2. One sample will be obtained from each geomembrane production batch delivered to the site.

3. Samples shall be cut by Geomembrane Installer and be at least 45 square feet in size.
4. Samples shall be tested in accordance with Table 1 (Smooth) or Table 2 (Textured) specified in GRI Test Method GM13.
5. Geomembrane thickness shall be measured a minimum of three times per panel during deployment to verify conformance with GRI Test Method GM13.

C. Role of Testing Laboratories

1. The Geosynthetic Quality Assurance Consultant will be responsible for acquiring samples of the geomembrane for conformance testing. The Owner or Geosynthetic Quality Assurance Consultant will retain an independent, third party laboratory to perform conformance testing on samples of geomembrane.
2. Retesting of geomembrane panels by the Geomembrane Installer because of failure to meet any of the conformance specifications can only be authorized by the Geosynthetic Quality Assurance Consultant. Non-conforming panels may be retested in accordance with Subsection 2.03(B) and 2.03(D) under authorization of the Geosynthetic Quality Assurance Consultant only.
3. The Geomembrane Manufacturer and/or Geomembrane Installer may perform independent tests in accordance with methods and procedures specified in Subsection 2.03(B). Results shall not be substituted for quality assurance testing described herein.

D. Procedures for Determining Conformance Test Failures

1. If conformance test results fail to meet specifications, the roll and/or batch may be retested using specimens from either the original roll sample or from another sample collected by the Geosynthetic Quality Assurance Consultant. Two additional tests (retests) shall be performed for each failed test procedure. Each retest shall consist of multiple specimen tests if multiple specimens are specified in the test procedure. If the results of both retests meet specifications, the roll and batch will be considered to have passed conformance testing.
2. Failure of any retest shall be cause for rejection of the entire roll or batch depending on the type of failing test. The Geosynthetic Quality Assurance Consultant reserves the right to collect samples from other roll of a particular batch for further conformance testing. The Geosynthetic Quality Assurance Consultant may choose to accept only a portion of the batch on the basis of the results of conformance testing of samples collected from other rolls.
3. If retesting does not result in conformance with the specifications as defined in preceding paragraph, or if there are any other nonconformities with the material

specifications, the Contractor shall remove the rolls from use in project. The Contractor shall also be responsible for removal of rejected geomembrane from the site and replacement with acceptable geomembrane at no additional cost to the Owner.

PART 3 - EXECUTION

3.01 PRE-CONSTRUCTION MEETING

- A. A Pre-Construction Meeting shall be held at the site in accordance with Section 01040, Project Administration, to discuss and plan the details of geomembrane installation. This meeting shall be attended by the Geomembrane Installer, Owner, Geosynthetic Quality Assurance Consultant and the General Contractor.
- B. The following topics relating to geomembrane installation shall be addressed:
 - 1. Responsibilities of each party.
 - 2. Lines of authority and communication.
 - 3. Methods for documenting, reporting and distributing documents and reports.
 - 4. Procedures for packaging and storing archive samples.
 - 5. Review of the schedule for all installation and quality assurance testing, including third-party testing turnaround times.
 - 6. Review of panel layout, access and numbering systems for panels and seams including details for marking on the HDPE geomembrane.
 - 7. Procedures and responsibilities for preparation and submittal of as-built drawings.
 - 8. Temperature and weather limitations, installation procedures for adverse weather conditions and defining acceptable subgrade or ambient moisture and temperature conditions for working during liner installation.
 - 9. Subgrade conditions, dewatering responsibilities and subgrade maintenance plan.
 - 10. Deployment techniques including allowable subgrade for geomembrane.
 - 11. Procedures for covering of the geomembrane to prevent damage.
 - 12. Plan for minimizing wrinkles in the geomembrane.
 - 13. Measurement and payment schedules.
 - 14. Site health and safety procedures/protocols.

3.02 SUBGRADE PREPARATION

- A. Contractor shall prepare a subgrade surface in accordance with Section 02243, Subgrade Layer Preparation, and excavate and backfill in accordance with Section 02222, Anchor Trenching, Backfilling and Compaction.
- B. The Contractor shall not excavate more than the amount of anchor trench required for one day of geosynthetics deployment, unless otherwise specified by the Geosynthetic Quality Assurance Consultant. Rounded corners shall be provided in the trenches where the geosynthetics enter the trench to allow them to be uniformly supported by the subgrade and to avoid sharp bends. The geosynthetics shall not be supported by loose soils in anchor trenches.
- C. The Geomembrane Installer shall visually inspect the subgrade immediately prior to geomembrane deployment. Inspection shall verify that there are no potentially harmful foreign objects present, such as sharp rocks and other deleterious debris. Any foreign objects encountered shall be removed by Geomembrane Installer or Contractor. All subgrade damaged by construction equipment and deemed unsuitable for geomembrane deployment shall be repaired prior to geomembrane deployment. All repairs shall be approved by the Geosynthetic Quality Assurance Consultant and Geomembrane Installer. The responsibility for preparation, repairs, and maintenance of the subgrade shall be defined in the preconstruction meeting. The Geomembrane Installer shall provide the Geosynthetic Quality Assurance Consultant with written acceptance of subgrade surface over which geomembrane is deployed (Part 1 .05B) for each day of deployment.

3.03 GEOMEMBRANE DEPLOYMENT

- A. Geomembrane shall not be deployed until all applicable certifications/quality control certificates listed in subsection 1.05 of this section and conformance testing listed in subsection 2.03 of this section are submitted and approved by the Geosynthetic Quality Assurance Consultant. Any geomembrane deployed prior to approval by the Geosynthetic Quality Assurance Consultant shall be at the sole risk of the Geomembrane Installer and/or Contractor. If material installed prior to approval by the Geosynthetic Quality Assurance Consultant does not meet the requirements of this specification, it shall be removed from the site at no additional cost to the Owner.
- B. Geomembrane will be deployed according to submitted panel layout drawing as approved by the Geosynthetic Quality Assurance Consultant. The Geosynthetic Quality Assurance Consultant is to be notified of and approve any revisions or modifications to the approved panel layout drawing prior to deploying geomembrane in the area of review.
- C. Adequate temporary anchoring (sand bags, tires, etc.) that will not damage the geomembrane shall be placed on a deployed panel to prevent uplift by wind.
- D. Geomembrane shall not be deployed if:
 - 1. Ambient temperatures are below 41 degrees F (5 degrees C) or above 104 degrees F (40 degrees C) measured six inches above geomembrane surface unless approved by the Geosynthetic Quality Assurance Consultant.
 - 2. Precipitation is expected or in the presence of excessive moisture or ponded water on the subgrade surface.

3. Winds are excessive as determined by Geomembrane Installer in agreement with the Geosynthetic Quality Assurance Consultant.
 4. The Geosynthetic Quality Assurance Consultant will have the authority to suspend work during such conditions.
- E. The Geomembrane Installer shall be responsible for conformance with the following requirements:
1. Equipment utilized for installation/quality assurance testing does not damage geomembrane. Such equipment shall have rubber tires and a ground pressure not exceeding 5 psi or total weight exceeding 750 lbs. Only equipment necessary for installation and quality assurance testing is allowed on the deployed geomembrane.
 2. Personnel working on geomembrane do not damage geomembrane (activities such as smoking or wearing damaging clothing shall not be allowed).
 3. Method of deployment does not damage geomembrane.
 4. Method of deployment minimizes wrinkles.
 5. Temporary loading or anchoring does not damage geomembrane.
 6. Direct contact with geomembrane is minimized.
- F. No vehicles shall be allowed on deployed geomembrane under any circumstances.

3.04 FIELD SEAMS

- A. Seam Layout
1. In general, seams shall be oriented parallel to the line of the maximum slope. In corners and at other odd-shaped geometric intersections, number of seams should be minimized. If at all possible, seams shall not be located at low points in the subgrade unless geometry requires seaming to be done at these locations.
 2. A seam numbering system compatible with the panel numbering system shall be agreed upon at the Pre-Construction Meeting.
- B. Seaming Processes/Equipment
1. Approved processes for field seaming (panel to panel) are extrusion or hot wedge fusion-type seam methods. No other processes can be used without prior written authorization from the Geosynthetic Quality Assurance Consultant. Only equipment which has been specifically approved by make and model shall be used, if applicable.
 2. The Geomembrane Installer will meet following requirements regarding use, availability, and cleaning of welding equipment at job site:

- a. Intersecting hot wedge seams shall be patched using extrusion welding process.
 - b. Electric generator for equipment shall be placed on a smooth base such that no damage occurs to geomembrane. A smooth insulating plate or fabric shall be placed beneath hot equipment after usage.
3. The Geomembrane Installer shall keep records for performance and testing of all seams.

C. Seaming Requirements/Procedures

1. Weather Conditions - Range of weather conditions under which geomembrane seaming can be performed are as follows:
 - a. Unless otherwise authorized in writing by Geosynthetic Quality Assurance Consultant, no seaming shall be attempted or performed at an ambient temperature below 41 degrees F (5 degrees C) or above 104 degrees F (40 degrees C).
 - b. Between ambient temperatures of 32 degrees F (0 degrees C) and 41 degrees F (5 degrees C), seaming shall be performed only if geomembrane is preheated by either sun or a hot air device, provided there is no excessive ambient cooling resulting from high winds. Pre-qualification seams shall be produced under identical conditions.
 - c. Above 41 degrees F (5 degrees C), no preheating of geomembrane will be required.
 - d. Geomembrane shall be dry and protected from wind.
 - e. Seaming shall not be performed during any precipitation event.
 - f. Seaming shall not be performed in areas where ponded water has collected below surface of geomembrane.
2. If the Geomembrane Installer chooses to use methods which may allow seaming at ambient temperatures below 41 degrees F or above 104 degrees F, the Geomembrane Installer shall demonstrate and submit certification to Geosynthetic Quality Assurance Consultant that methods and techniques used to perform seaming produce seams that are equivalent to seams produced at temperatures above 41 degrees F and below 104 degrees F. The Geosynthetic Quality Assurance Consultant may deny approval for use of the proposed technique regardless of demonstration results.
3. Overlapping - Geomembrane panels shall have finished overlap as follows:
 - a. Minimum of 6 inches for thermal fusion welding.
 - b. Insufficient overlap will be considered a failed seam.

4. Pre-qualification tests for geomembrane fusion welding shall be conducted by a minimum of 2 pre-qualification seams conducted per day per welding machine by each seaming technician performing welding with that machine. At least one test shall be performed at the start of each work day, with tests at intervals of no greater than 5 hours and additional pre-qualification tests following work interruptions, weather changes, changes to machine settings, or as directed by the Geosynthetic Quality Assurance Consultant. Pre-qualification seams shall be made under the same conditions as the actual seams.
 - a. Pre-qualification seam samples shall be 5 feet long by 1-foot wide (minimum) after seaming, with seam centered along its length. Each pre-qualification seam shall be labeled with the date, geomembrane temperature, seaming unit identifier, seam number or test location, technician performing the test seam and description of testing results.
 - b. Seam overlap shall be in accordance with subsection 3.04(C)(3).
 - c. Pre-qualification seams shall be inspected for proper squeeze-out, footprint pressure, and general appearance.
 - d. Four specimens, each 1-inch in length, shall be cut from opposite ends of the pre-qualification seam sample by the Geomembrane Installer. The remainder of pre-qualification seam shall be retained by the Geosynthetic Quality Assurance Consultant and may be submitted for laboratory testing.
 - e. The Geomembrane Installer shall complete two shear tests and two peel tests.
 - f. Pre-qualification seams failed by inspection or testing may be retested at request of the Geomembrane Installer. If the second pre-qualification seam fails, then the seaming apparatus or seaming technique shall be disqualified from use until two consecutive, satisfactory pre-qualification seams are obtained.
5. Seam Preparation
 - a. Prior to seaming, seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.
 - b. Seams shall be aligned so as to minimize number of wrinkles and fishmouths.
6. General Seaming Procedures
 - a. Fishmouths or wrinkles at seam overlaps shall be cut along ridge of the wrinkle to achieve a flat overlap. Cut fishmouths or wrinkles shall be repaired, and/or patched in accordance with Part 3.07.
 - b. Seaming shall extend to the outside edge of geomembrane panels including material placed in anchor trenches.

- c. For cross seams, the intersecting thermal fusion seams shall be patched using the extrusion welding process.

3.05 NON-DESTRUCTIVE TESTING

- A. Each field seam shall be non-destructively tested over its entire length by the Installer. Testing shall be conducted as field seaming progresses, not at completion of all seams, unless specifically agreed to by the Geosynthetic Quality Assurance Consultant in writing.
- B. Vacuum Testing – shall be performed in accordance with ASTM D5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
- C. Air Pressure Testing – shall be performed in accordance with ASTM D5820, Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes, and GRI GM 6, Pressurized Air Channel Test for Dual Seamed Geomembranes.
- D. Each seam tested non-destructively shall be marked with the date of the test, name of the testing technician, length of the seam, test method and results. The same shall also be recorded by the Geosynthetic Quality Assurance Consultant on the appropriate CQA documentation.
- E. Non-Destructive Seam Test Failures
 - 1. Seams failing non-destructive testing shall be repaired by the Geomembrane Installer according to Part 3.07. Seams shall be non-destructively retested. If the seam defect cannot be located, the entire section of seams affected shall be repaired and retested.

3.06 DESTRUCTIVE TESTING

- A. The Owner shall have the option to conduct destructive testing of geomembrane panel seams completed in the field. Destructive seam sampling and testing shall be performed by the Geomembrane Installer under the observation of the Geosynthetic Quality Assurance Consultant.
- B. Sampling Procedure
 - 1. For each sample location, the Geosynthetic Quality Assurance Consultant will:
 - a. Assign a sample number and mark the sample accordingly.
 - b. Record the sample location on the as-built layout drawing.
 - c. By sample number, record reason for collecting sample (e.g., as part of statistical testing program, suspicious seam, retest, etc.).

- d. Record pertinent information, including date, time, seam number, number of seaming unit, and name of seamer, on both the seam sample and CQA documentation.
- 2. Each destructive sample shall be at least 12 inches wide (at least 6 inches on each side of seam) by 54 inches long. Samples will be cut by the Geomembrane Installer into three parts and distributed as follows:
 - a. A 12-inch by 12-inch portion shall be cut and tested in accordance with subsection 3.06(C) by the Geomembrane Installer.
 - b. A 12-inch by 12-inch portion shall be cut and retained by the Geomembrane Installer. The Geomembrane Installer may elect to omit this requirement.
 - c. A 12-inch by 12-inch portion shall be cut and retained by the Geosynthetic Quality Assurance Consultant as an archive sample.
 - d. A 12-inch by 18-inch portion shall be submitted by the Geosynthetic Quality Assurance Consultant for laboratory testing as described in Part 3.06(D).
- 3. Ten specimens, each 1 inch wide by 12 inches long with seam centered perpendicular to width, shall be collected and field tested by the Geomembrane Installer prior to shipping the sample to the laboratory. If all samples pass field tensiometer test described in Part 3.06(C), then the laboratory sample shall be collected according to procedure described in Part 3.06(B)(2)(d).
- 4. Holes cut into geomembrane resulting from destructive seam sampling shall be immediately repaired by Geomembrane Installer in accordance with repair procedures described in Part 3.07.

C. Field Test Methods

- 1. Ten 1-inch-wide samples described above under Part 3.06(B)(3) shall be field tested for peel (5 samples) and shear (5 samples).
- 2. One end of seam sample shall be field tested for peel and shear at end of each continuous field seam 100 feet long or greater.
- 3. Testing shall be performed in accordance to with ASTM D6392 using a field tensiometer or equivalent device to qualitatively and quantitatively determine mode of failure.
- 4. Seam shall be considered passing if failure in both peel and shear meet criteria listed in GRI GM 19, Table 2.

5. The procedures specified in Subsection 3.06(D) shall be implemented when sample passes field tensiometer test.

D. Laboratory Test Methods

1. Laboratory testing of seam samples shall be conducted by the Geosynthetic Quality Assurance Laboratory under contract with the Geosynthetic Quality Assurance Consultant or Owner. Five specimens shall be tested in shear and five in peel.
2. Laboratory testing shall be conducted in accordance with ASTM D6392.
3. For both seam shear and peel tension tests, an indication will be given for each specimen tested which defines locus of failure.
4. For shear tests, the following values, along with the mean and standard deviation where appropriate, will be reported for each specimen tested:
 - a. Maximum tension in pounds per square inch.
 - b. Elongation at break (up to a tested maximum of 100 percent).
 - c. Locus of failure using ASTM designations.
5. For peel tests, the following values, along with the mean and standard deviation where appropriate, will be reported for each specimen tested:
 - a. Maximum tension in pounds per square inch.
 - b. Seam separation (expressed as percent of original seam area).
 - c. Locus of failure.
4. Retesting of seams due to nonconformance with specifications may be performed at the discretion of the Geosynthetic Quality Assurance Consultant.

E. Destructive Seam Test Failure

1. Shear and peel test results derived from testing described in Parts 3.06(C) and 3.06(D) shall comply with GRI GM 19, Table 2 for seam to be considered acceptable.
2. The Geomembrane Installer has two options in determining the repair boundary whenever a seam has failed destructive testing:

- a. The seam can be reconstructed between the two previously tested and passed destructive sample locations; or,
 - b. The Geomembrane Installer can trace the welding path to an intermediate location at least ten feet from point of failed test in each direction and obtain destructive test samples collected from these locations. If destructive tests on these samples are acceptable, then the seam shall be reconstructed between the intermediate locations. If either sample fails, the process may be repeated until an acceptable seam test has been performed on both sides of the original failed sample. If a passing sample is not realized on one (or both) side of the original failed sample, then seam repair must extend to the end(s) of the seam. Retesting of seams according to this procedure shall utilize the sampling methodology described in Part 3.06(B). The Owner reserves the right to terminate this process, at the discretion of the Geosynthetic Quality Assurance Consultant, after the second retesting. An additional sample taken from the reconstructed zone must pass destructive seam testing, if destructive sample failure(s) causes reconstruction.
3. The Geosynthetic Quality Assurance Consultant shall be responsible for documenting all actions taken in repairing seams. The Geomembrane Installer will be responsible for keeping the Geosynthetic Quality Assurance Consultant informed of seaming progress.
 3. Additional fees for destructive seam test failures shall be assessed to the Contractor and deducted from payment. This fee shall be assessed only if the failing sample is a laboratory sample.

3.07 DEFECTS AND REPAIRS

- A. The geomembrane shall be examined by the Geomembrane Installer and the Engineer for defects, holes, blisters, undispersed raw materials, and any signs of contamination by foreign matter. The geomembrane surface shall be swept and/or washed by the Geomembrane Installer if the amount of dust or mud inhibits examination. The Contractor shall provide a water truck, an operator, clean water and hoses as reasonably necessary to assist the Geomembrane Installer in this activity.
- B. Portions of geomembrane exhibiting flaws, or failing a non-destructive or destructive (if conducted) test, shall be repaired or replaced by the Geomembrane Installer. Repair procedures available include:
 1. Patching - used to repair large holes, tears, undispersed raw materials, contamination by foreign matter, holes resulting from destructive sampling (if conducted), and locations where seam overlap is insufficient;
 2. Capping - used to repair large lengths of failed seams; and

3. Additional Procedures - used upon recommendation of the Geomembrane Installer if agreed to by the Engineer.
- C. Patches or caps.
1. Extend patch or cap 6 inches (minimum) beyond the edge of the defect.
 2. Round corners of patch and/or cap (suggest 3-inch radius).
 3. Repair procedures, equipment, materials, and techniques will be approved by the Geosynthetic Quality Assurance Consultant prior to repair.
 4. Geomembrane below large caps shall be appropriately cut to avoid water or gas collection between two sheets.
- D. The Geomembrane Installer shall mark on the geomembrane (using a non-puncturing writing utensil), repair date, time, and personnel involved.
- E. Each repair shall be non-destructively tested in accordance with Part 3.05. Large caps may require destructive test sampling at the discretion of the Geosynthetic Quality Assurance Consultant (in accordance with Part 3.06).
- F. Repairs which fail testing shall be redone and retested until a passing result is obtained. The Geomembrane Installer will perform non-destructive testing or repairs and will document retesting of repairs.
- G. The Geosynthetic Quality Assurance Consultant will document repairs, repair testing, and retesting results.
- H. The Geomembrane Installer shall cut and seam wrinkles which may adversely affect long-term integrity of the geomembrane, hinder subsequent construction of overlying layers, or impede drainage off of the geomembrane after it is covered by soil. Seaming shall be done in accordance with procedures described in Parts 3.04(B) and 3.04(C), and it shall be subject to test provisions of Parts 3.05 (non-destructive testing) and 3.06 (destructive testing – if conducted).

3.08 PROTRUSIONS AND CONNECTIONS TO GEOMEMBRANE

- A. If required, the Geomembrane Installer shall install geomembrane around utility poles, guy wires, and other structures according to the Contract Drawings and the following requirements:
1. Use minimum 1-ft long membrane pipe boots and steel straps to seal the geomembrane around pole or structure.
 2. Use standard welding procedures to seam the membrane boot to the geomembrane.
 3. Seaming performed on and around penetrations, and other appurtenances shall be non-destructively tested using the vacuum testing method.

3.09 SURVEY DOCUMENTATION

- A. The Geomembrane Installer shall survey the completed geomembrane prior to covering and provide the Geosynthetic Quality Assurance Consultant with 24-hour notification of survey. The Contractor shall document the location of all seams (panel corners acceptable), destructive test samples (if conducted) and repairs. The Contractor shall provide survey data to the Geosynthetic Quality Assurance Consultant within one working day of survey completion and in accordance with Section 01050.

3.10 DAILY FIELD INSTALLATION REPORTS

- A. At the beginning of each day, the Geomembrane Installer shall provide the Geosynthetic Quality Assurance Consultant with a report for all work completed the previous day.
- B. The Daily Field Installation Report shall include the following:
 - 1. The total amount and location of geomembrane placed.
 - 2. The total length and location of seams completed, technician name and welding unit numbers.
 - 3. A drawing or sketch depicting the geomembrane installed the previous day including the panel number, seam number and locations of non-destructive and destructive testing (if conducted).
 - 4. Results of pre-qualification test seams, if available.
 - 5. Results of non-destructive testing.
- C. Destructive test results (if conducted) shall be reported within 48 hours or prior to covering the geomembrane, whichever is practical.

3.10 MATERIAL ABOVE GEOMEMBRANE

- A. The Geosynthetic Quality Assurance Consultant and Geomembrane Installer shall verify the area of geomembrane completion prior to placement of material over the geomembrane.
- B. Soils - Requirements for placement of general fill are described in Sections 02221 and 02222. Apply following general criteria for covering of the geomembrane:
 - 1. Do not place soils on the geomembrane at an ambient temperature below 32 degrees F, (0 degrees C) nor above 104 degrees F (40 degrees C), unless otherwise specified.
 - 2. Do not drive equipment used for placing soil directly on the geomembrane.
 - 3. A minimum thickness of 1 foot of soil is specified between a low ground pressure dozer (maximum contact pressure of 5 lb/sq. inch) and the geomembrane.

4. A minimum thickness of 2 feet of soil is required between rubber-tired vehicles and the geomembrane.
5. Do not compact soils placed directly on geomembrane.
6. Damage to the geomembrane resulting from placement of cover soils shall be repaired in accordance with Part 3.07 by the Geomembrane Installer at the Contractor's expense.
7. Do not push soil downslope. Soil shall be placed over the geomembrane starting from base of the slope, up to top of the slope.

END OF SECTION