


United States Nuclear Regulatory Commission Official Hearing Exhibit	
In the Matter of:	POWERTECH USA, INC. (Dewey-Burdock In Situ Uranium Recovery Facility)
	ASLBP #: 10-898-02-MLA-BD01
	Docket #: 04009075
	Exhibit #: APP-016-AA-00-BD01
	Admitted: 8/19/2014
	Rejected:
	Other:
	Identified: 8/19/2014
	Withdrawn:
	Stricken:

DEWEY-BURDOCK PROJECT DEEP WELL DISPOSAL

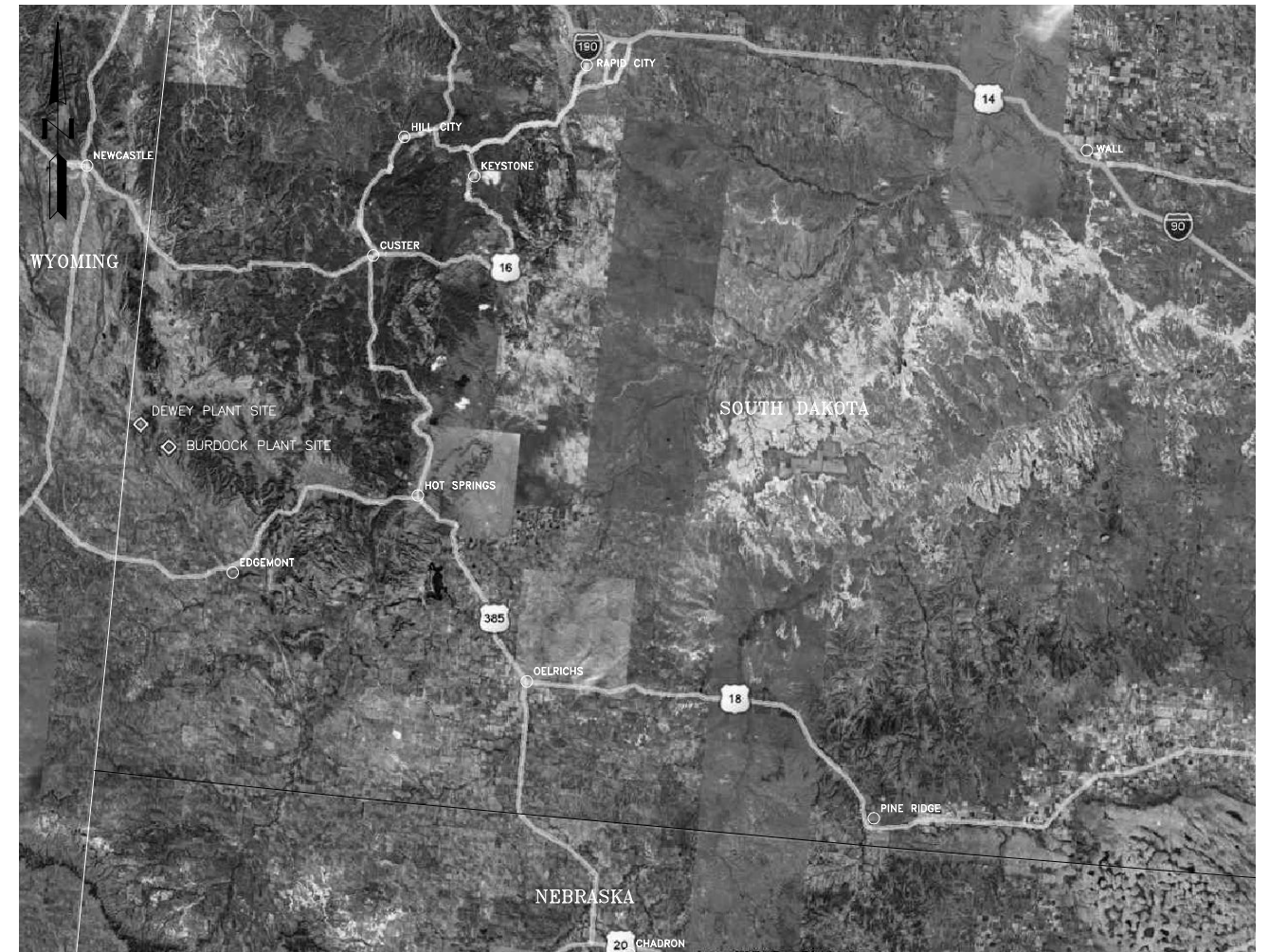
JULY 2010

Prepared for
POWERTECH URANIUM CORPORATION
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GREENWOOD VILLAGE, COLORADO, 80111 USA

Prepared by
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INDEX OF DRAWINGS

DRAWING NAME	DRAWING NUMBER
COVER PAGE	001
INDEX, GENERAL SITE LOCATION MAP AND SYMBOLS	010
SITE INVESTIGATION – TEST PIT LOCATIONS	050
SITE PLAN	100
BURDOCK PLANT SITE PLAN	101
DEWEY PLANT SITE PLAN	102
BURDOCK POND SECTIONS	200
DEWEY POND SECTIONS	201
TYPICAL POND SECTIONS AND DETAILS – SHEET 1 OF 2	301
TYPICAL POND SECTIONS AND DETAILS – SHEET 2 OF 2	302
DIVERSION CHANNEL SECTIONS	500



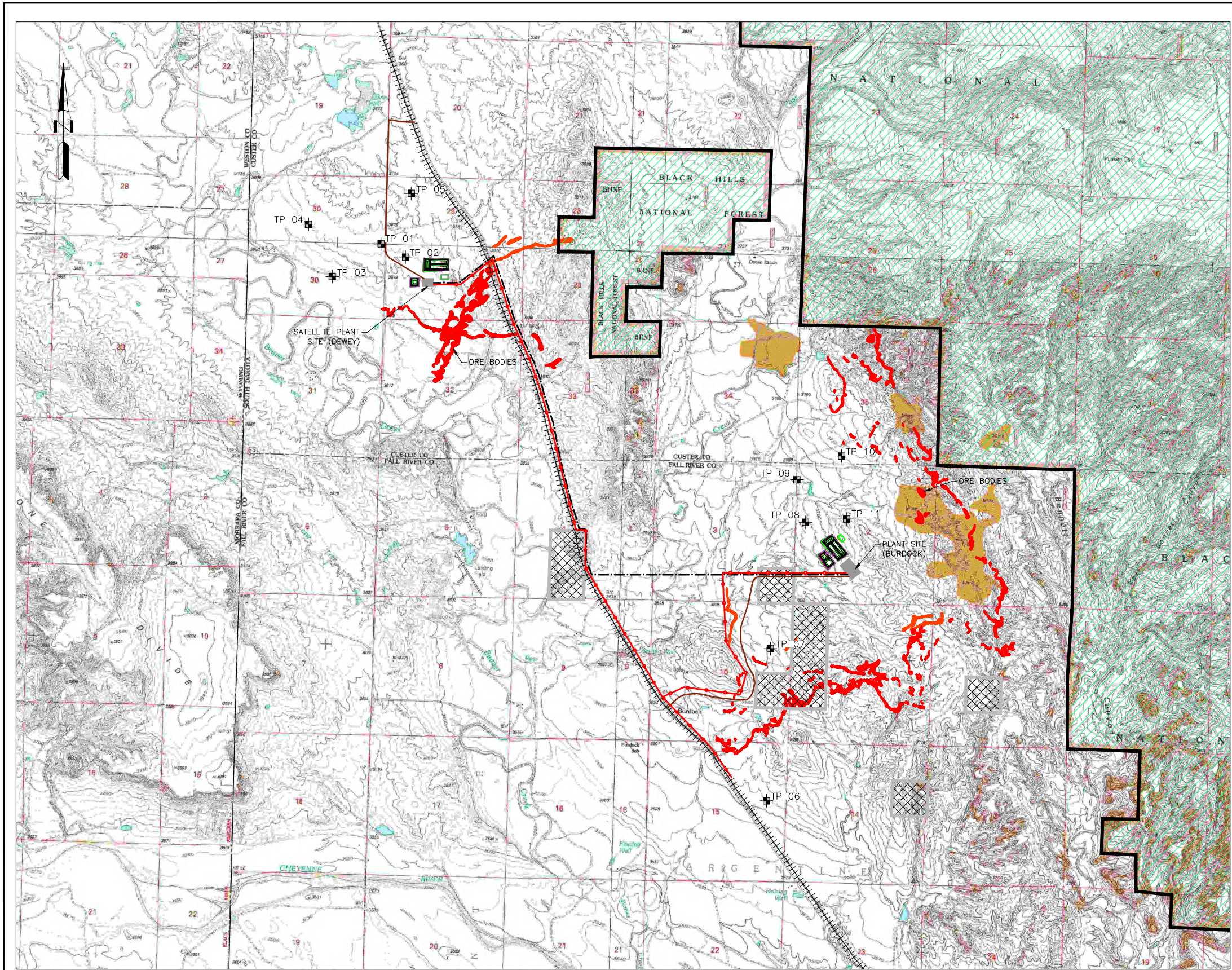
LOCATION MAP

COMMON ABBREVIATIONS	SYMBOLS AND DESCRIPTIONS	SYMBOLS AND DESCRIPTIONS
CL CENTER LINE	3:1 3 (HORIZONTAL) TO 1 (VERTICAL) SLOPE	SECTION CALLOUT WITH LOCATION REFERENCE
DIA DIAMETER	E 371000 EASTING COORDINATE	DETAIL OR DIMENSION BREAK
EL ELEVATION	N 364500 NORTHING COORDINATE	FENCE LINE
NTS NOT TO SCALE	DETAIL IDENTIFICATION	SLOPE INDICATOR (DETAIL)
REQ'D REQUIRED	DRAWING REFERENCE NUMBER	
SCH SCHEDULE	PROFILE OR CROSS SECTION IDENTIFICATION	
SDR STANDARD DIMENSION RATIO	DRAWING REFERENCE NUMBER	
TOC TOP OF CONCRETE	DIRECTION OF FLOW	
TOS TOP OF STEEL	EXISTING GROUND SURFACE OR BOTTOM OF EXCAVATION	
(TYP) TYPICAL	EXISTING GROUND SURFACE AND EL, FEET	
FT FEET	SLOPE INDICATOR	
	TOP OF ROCK OR ROCK SURFACE	
	WATER LEVEL	

CLIENT	POWERTECH (USA) Inc.			
PROJECT	DEWEY-BURDOCK PROJECT			
TITLE	DEEP WELL DISPOSAL INDEX, GENERAL SITE LOCATION MAP AND SYMBOLS			



REV	DATE	DESCRIPTION	APP'D	CADD
A	09/16/09	ISSUED FOR CLIENT REVIEW	ST	RJB
DISCLAIMER				
DESIGNED BY	ST	LOCATION	PROJECT NUMBER	DRAWING NUMBER
DRAWN BY	RJB	102	279.05	010
ACTIVITY CODE	N/A	XREF NUMBER	N/A	REVISION
				A



LEGEND:

- REGRADED CONTOURS
- EXISTING ROAD
- NEW ROADS
- RAILROAD
- POWER LINE
- PIPELINE
- ORE BODIES
- NATIONAL FOREST
- BLM AREAS
- TP 05 TEST PIT

NOTES:

1. SCALE BAR MEASURES 3" ON A FULL SIZE PLOT (ANSI-D) AND 1.5" ON A HALF SIZE PLOT (ANSI-B).

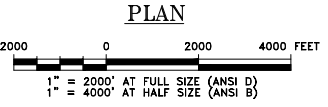
CLIENT	POWERTECH (USA) Inc.
PROJECT	DEWEY-BURDOCK PROJECT
TITLE	DEEP WELL DISPOSAL SITE INVESTIGATION – TEST PIT LOCATIONS

Knight Piésold
CONSULTING

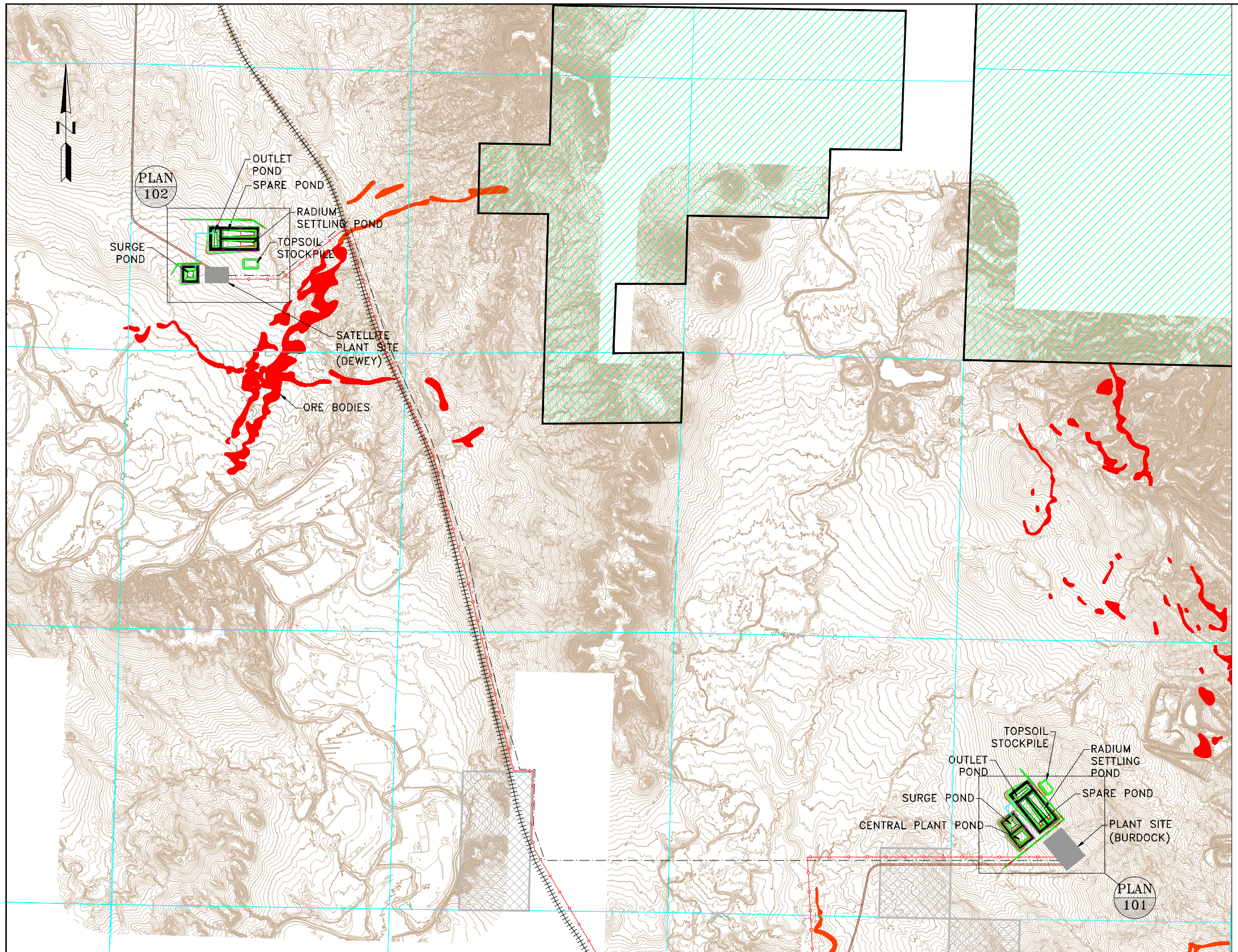
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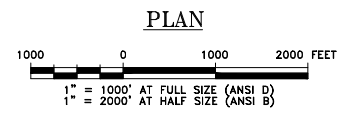


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- LEGEND:**
- REGRADED CONTOURS
 - EXISTING ROAD
 - NEW ROADS
 - RAILROAD
 - POWER LINE
 - PIPELINE
 - EXISTING STREAM
 - ORE BODIES
 - NATIONAL FOREST
 - BLM AREAS

NOTES:
 1. SCALE BAR MEASURES 3" ON A FULL SIZE PLOT (ANSI-D) AND 1.5" ON A HALF SIZE PLOT (ANSI-B).



CLIENT	POWERTECH (USA) Inc.
PROJECT	DEWEY-BURDOCK PROJECT
TITLE	DEEP WELL DISPOSAL SITE PLAN

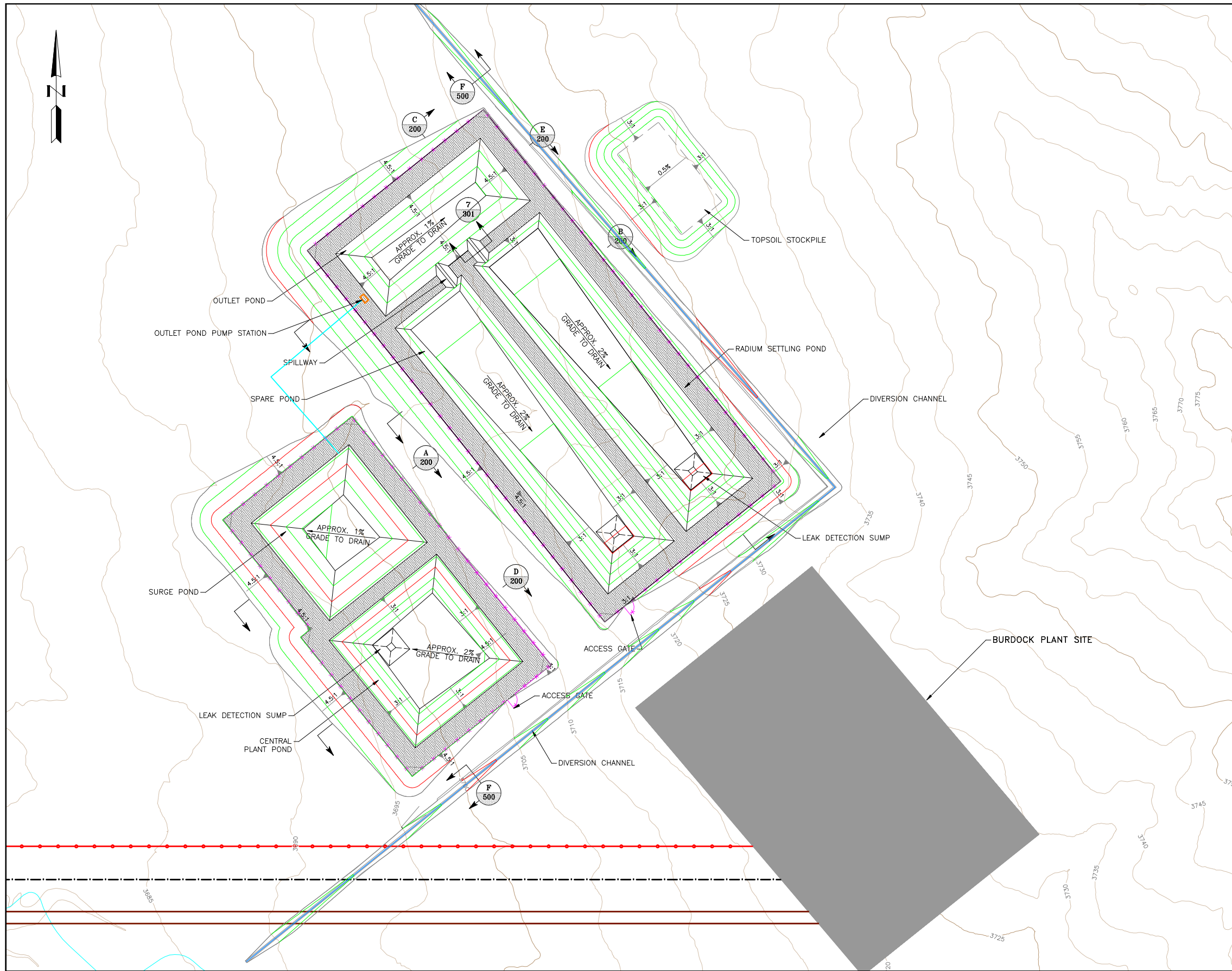
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<i>Knights</i> CONSULTING					
DESIGNED BY	ST	LOCATION	PROJECT NUMBER	DRAWING NUMBER	REVISION
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ACTIVITY CODE	N/A	XREF NUMBER	N/A		

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- LEGEND:**
- REGRADED CONTOURS
 - EMBANKMENT ROAD
 - - - - PERIMETER FENCE
 - PIPELINE
 - POWER LINE
 - ORE BODIES

NOTES:

1. SCALE BAR MEASURES 3" ON A FULL SIZE PLOT (ANSI-D) AND 1.5" ON A HALF SIZE PLOT (ANSI-B).

CLIENT	POWERTECH (USA) Inc.
PROJECT	DEWEY-BURDOCK PROJECT
TITLE	DEEP WELL DISPOSAL BURDOCK PLANT SITE PLAN



DESIGNED BY	ST	LOCATION	PROJECT NUMBER	DRAWING NUMBER	REVISION
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ACTIVITY CODE	N/A	XREF NUMBER	N/A		

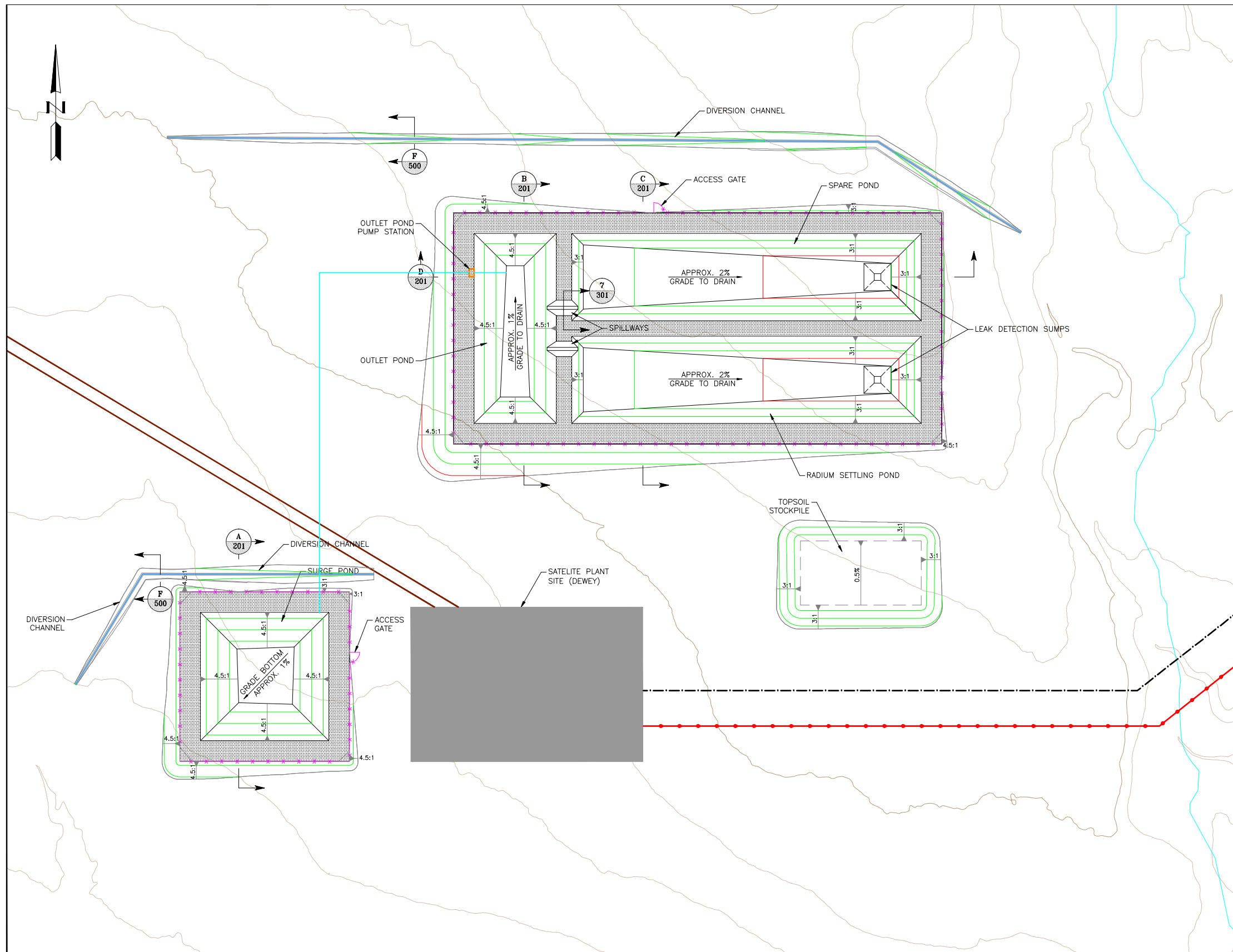
REFERENCE:
Existing ground surface generated from contours received from Powertech (USA) Inc. and dated 11 December 2008

PLAN - BURDOCK PLANT SITE



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LEGEND:

- REGRADED CONTOURS
- EMBANKMENT ROAD
- - - PERIMETER FENCE
- POWER LINE
- PIPELINE
- ORE BODIES

NOTES:

1. SCALE BAR MEASURES 3" ON A FULL SIZE PLOT (ANSI-D) AND 1.5" ON A HALF SIZE PLOT (ANSI-B).

REFERENCE:
Existing ground surface generated from contours received from Powertech (USA) Inc. and dated 11 December 2008

PLAN - DEWEY PLANT SITE



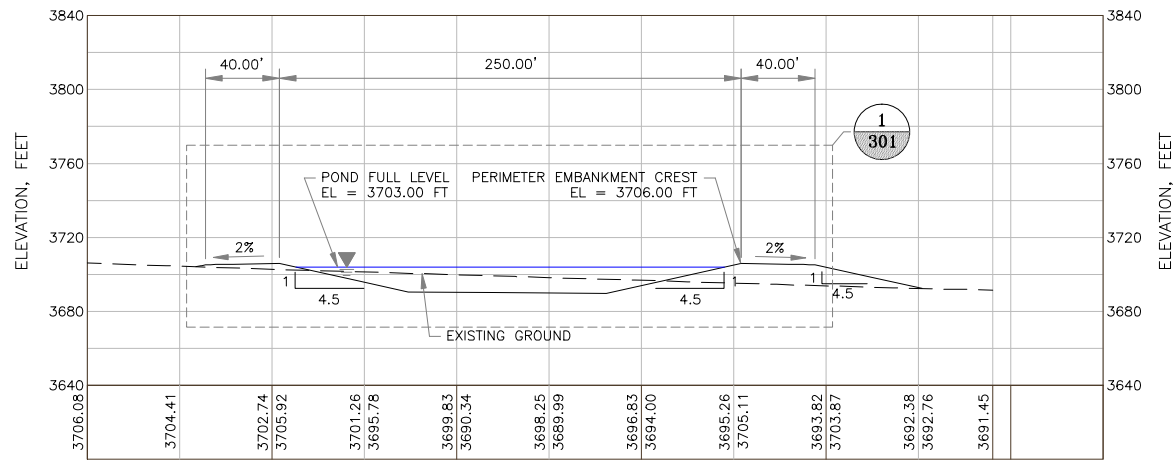
CLIENT	POWERTECH (USA) Inc.
PROJECT	DEWEY-BURDOCK PROJECT
TITLE	DEEP WELL DISPOSAL DEWEY PLANT SITE PLAN

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CONSULTING

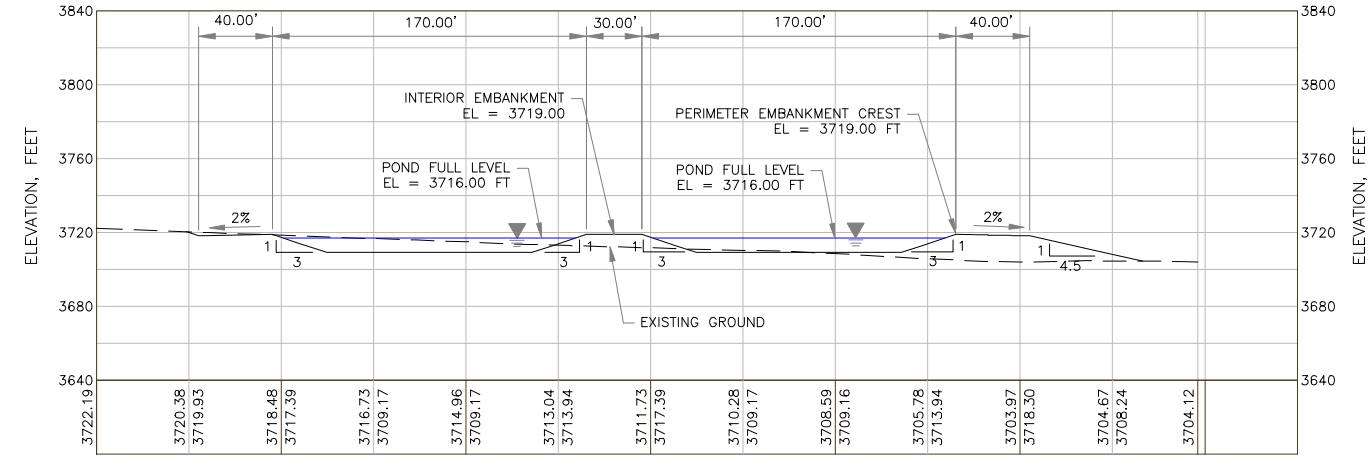
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ACTIVITY CODE	N/A	XREF NUMBER	N/A		

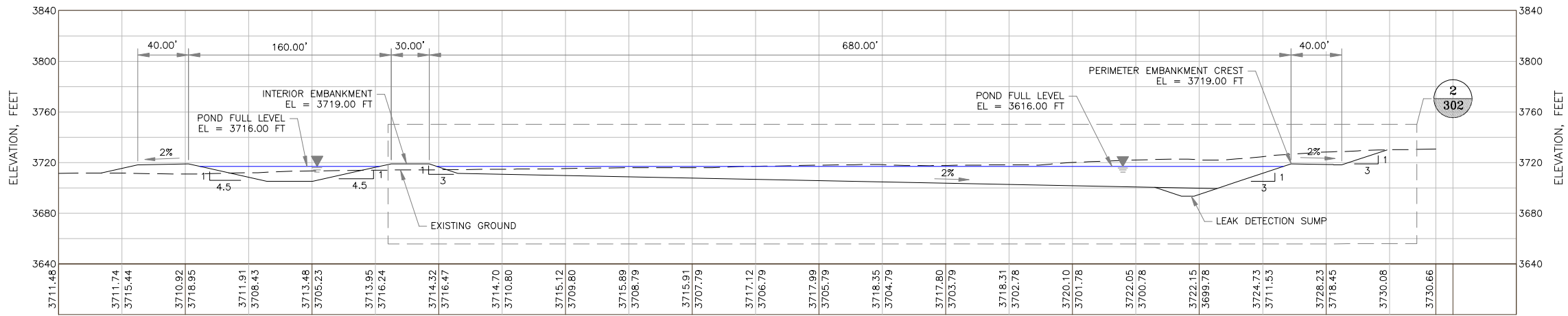
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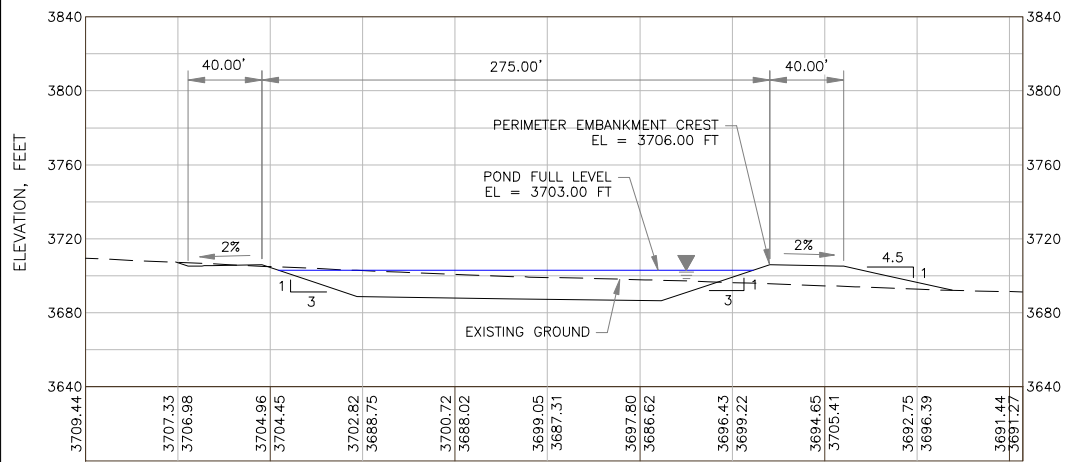
A BURDOCK SURGE POND SECTION



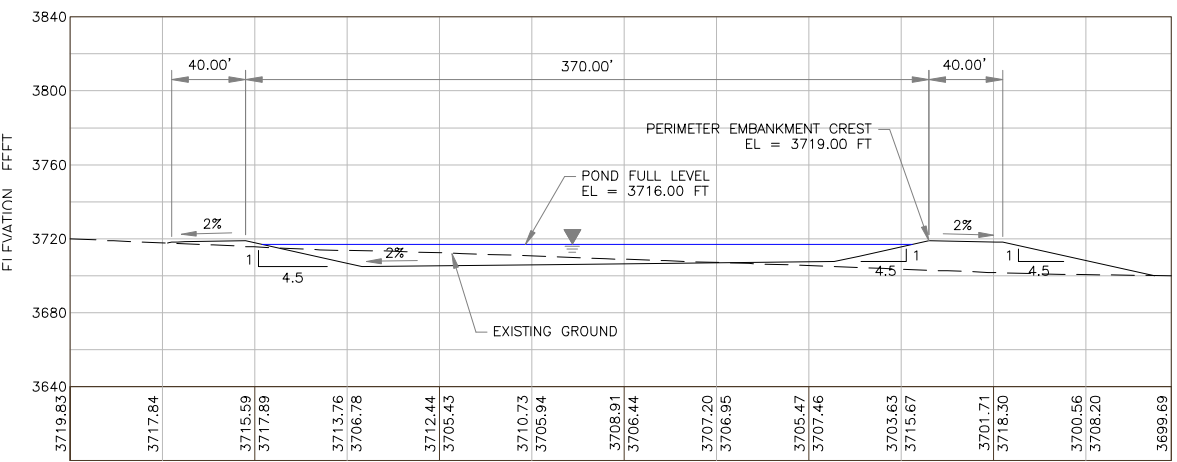
B BURDOCK RADIUM SETTLING PONDS SECTION



C BURDOCK RADIUM SETTLING AND OUTLET PONDS SECTION



D CENTRAL PLANT POND SECTION



E OUTLET POND SECTION

NOTES:

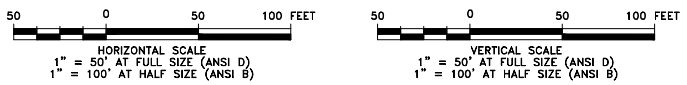
- 1. SCALE BAR MEASURES 3" ON A FULL SIZE PLOT (ANSI-D) AND 1.5" ON A HALF SIZE PLOT (ANSI-B).

CLIENT	POWERTECH (USA) Inc.			
PROJECT	DEWEY-BURDOCK PROJECT			
TITLE	DEEP WELL DISPOSAL BURDOCK POND SECTIONS			

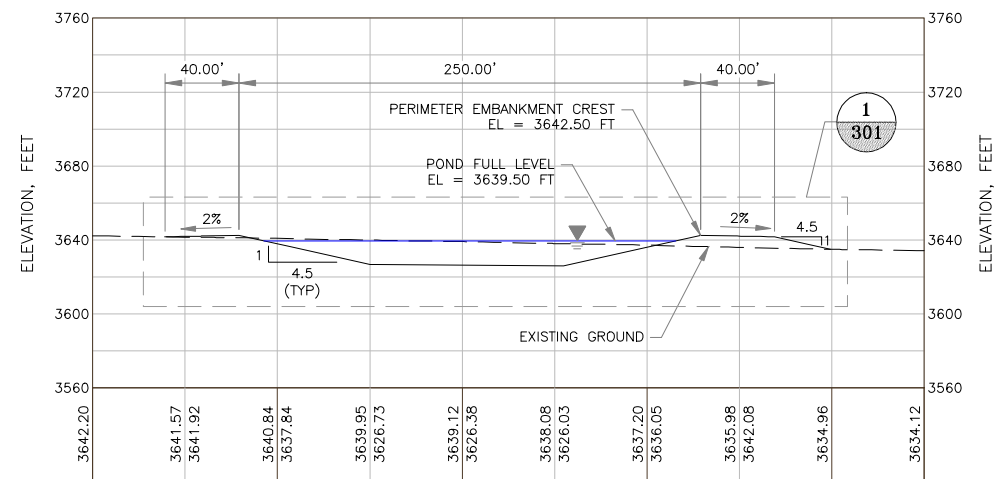


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A	09/16/09	ISSUED FOR CLIENT REVIEW	RJB
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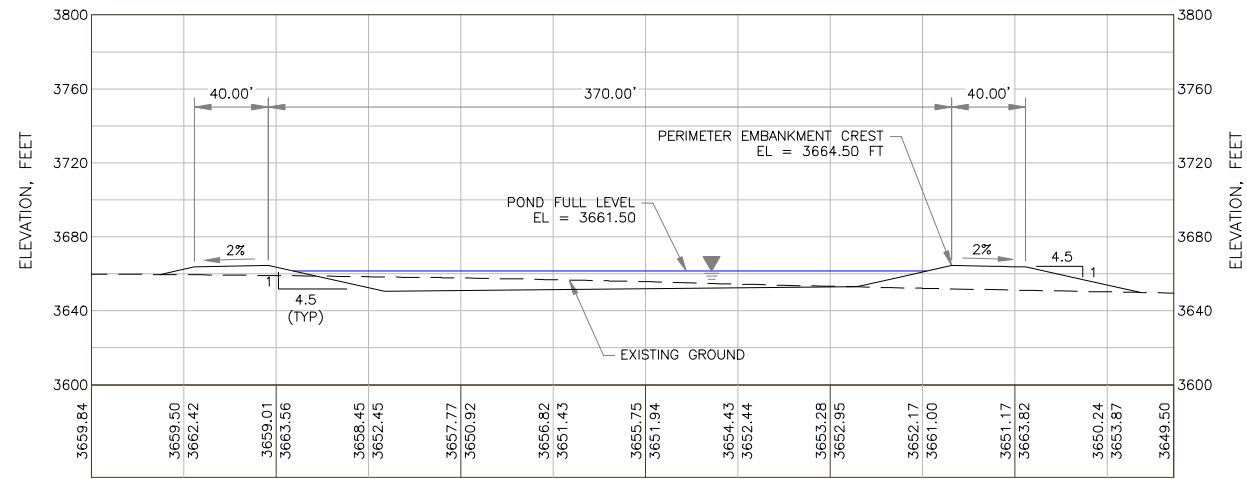
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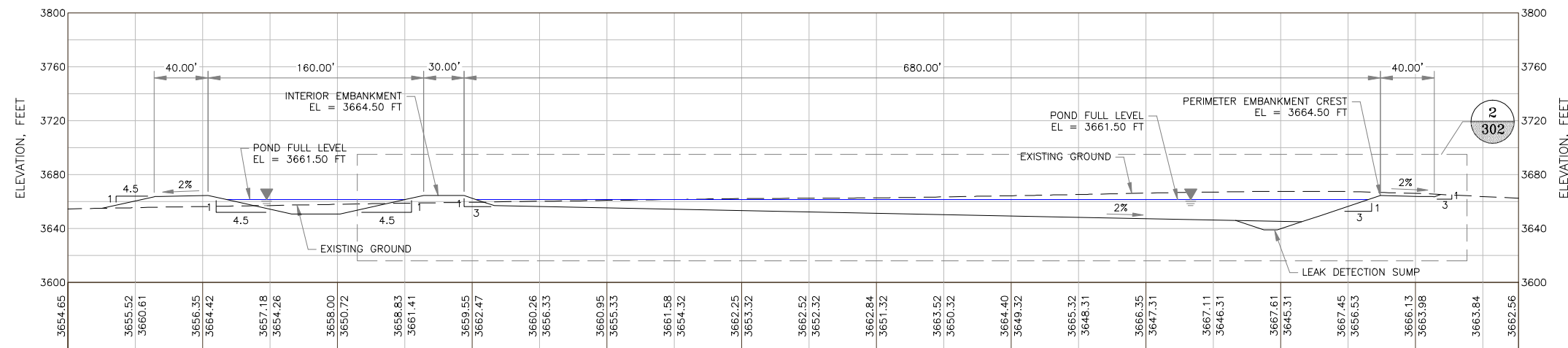
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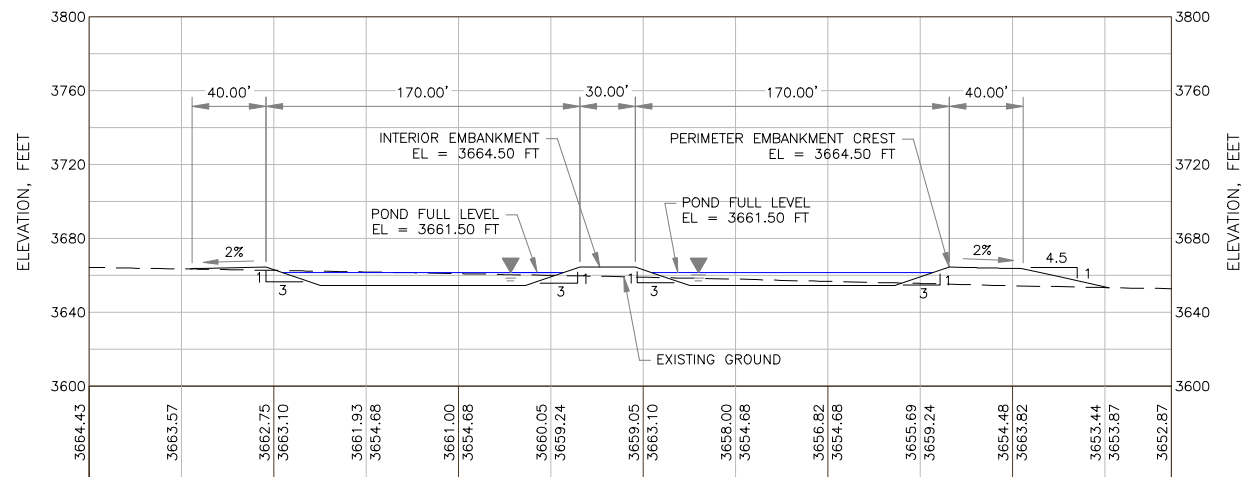
A
102 DEWEY SURGE POND SECTION



B
102 DEWEY OUTLET POND SECTION



D
102 DEWEY OUTLET AND RADIUM SETTLING PONDS SECTION



C
102 DEWEY RADIUM SETTLING AND SPARE PONDS SECTION

NOTES:

- SCALE BAR MEASURES 3" ON A FULL SIZE PLOT (ANSI-D) AND 1.5" ON A HALF SIZE PLOT (ANSI-B).

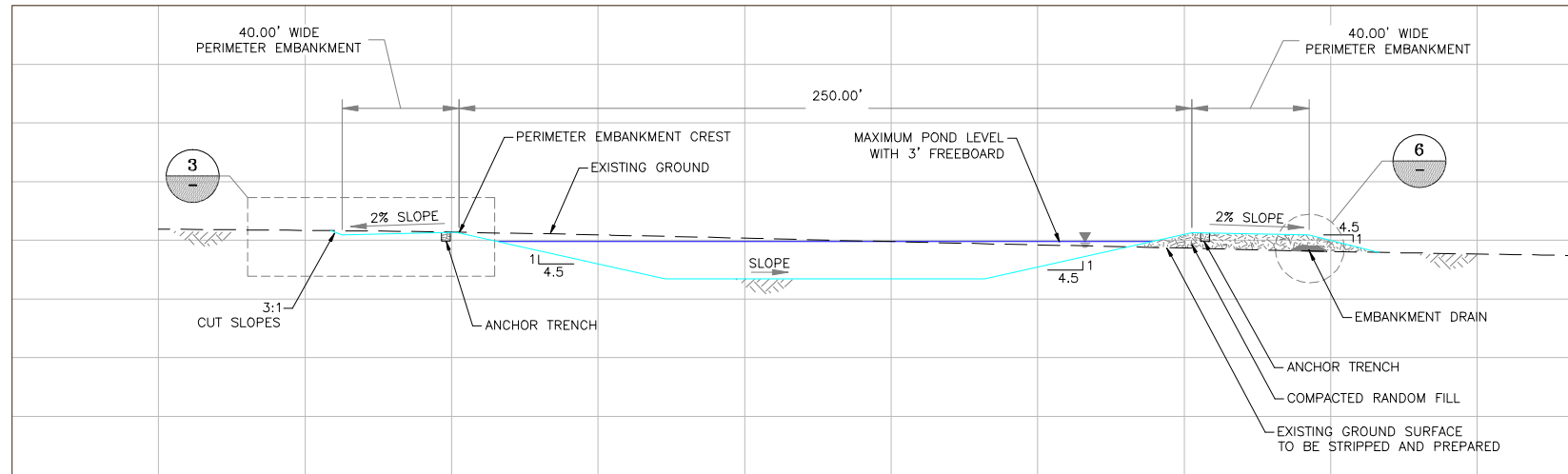


CLIENT		POWERTECH (USA) Inc.			
PROJECT		DEWEY-BURDOCK PROJECT			
TITLE		DEEP WELL DISPOSAL DEWEY POND SECTIONS			
DESIGNED BY		ST	LOCATION	PROJECT NUMBER	DRAWING NUMBER
DRAWN BY		RJB	102	279.05	201
ACTIVITY CODE		N/A	XREF NUMBER	N/A	REVISION
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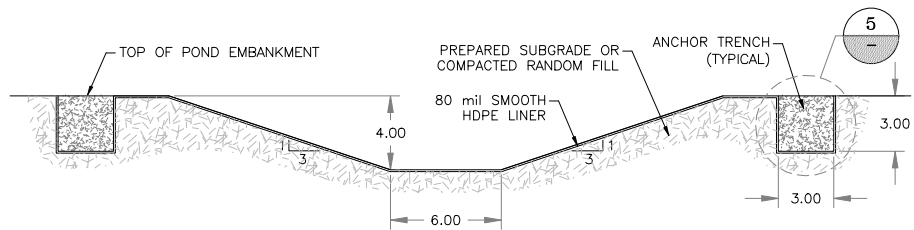
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1 1
200 201 SURGE POND DETAIL
TYPICAL OF SINGLE LINED PONDS

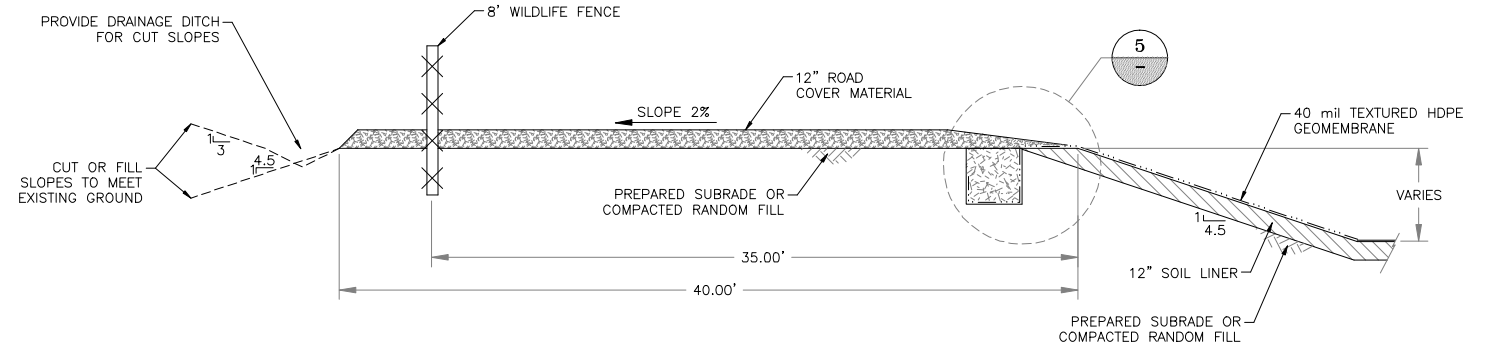
HORIZONTAL SCALE
1" = 30' AT FULL SIZE (ANSI D)
1" = 60' AT HALF SIZE (ANSI B)

VERTICAL SCALE
1" = 30' AT FULL SIZE (ANSI D)
1" = 60' AT HALF SIZE (ANSI B)



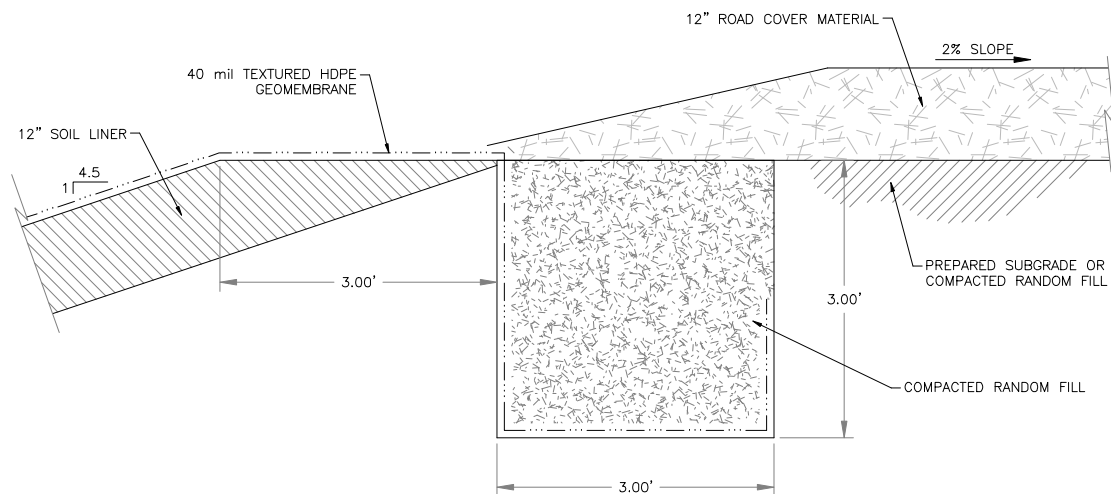
7 7
101 102 SPILLWAY DETAIL

1" = 5' AT FULL SIZE (ANSI D)
1" = 10' AT HALF SIZE (ANSI B)



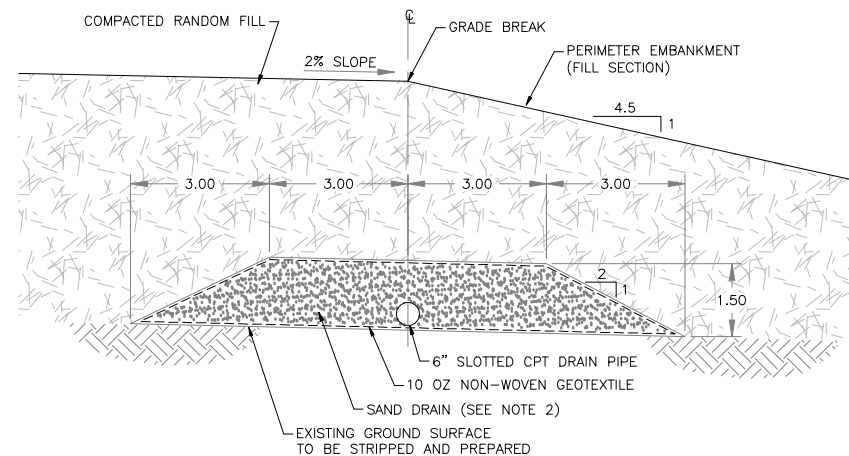
3 POND EMBANKMENT DETAIL
FOR SINGLE LINED PONDS

1" = 5' AT FULL SIZE (ANSI D)
1" = 10' AT HALF SIZE (ANSI B)



5 LINER ANCHOR TRENCH DETAIL
FOR SINGLE LINED PONDS

1" = 1' AT FULL SIZE (ANSI D)
1" = 2' AT HALF SIZE (ANSI B)



6 EMBANKMENT DRAIN DETAIL

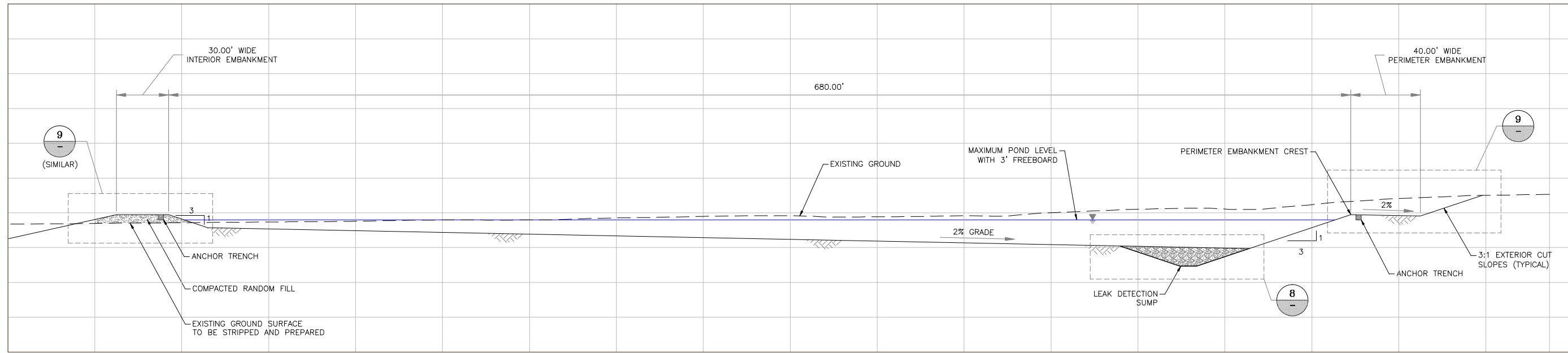
1" = 2' AT FULL SIZE (ANSI D)
1" = 4' AT HALF SIZE (ANSI B)

NOTES:

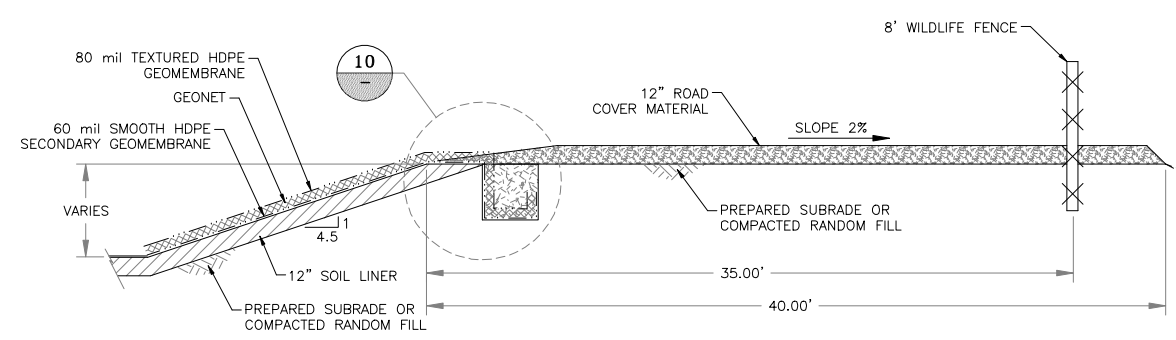
- SCALE BAR MEASURES 3" ON A FULL SIZE PLOT (ANSI-D) AND 1.5" ON A HALF SIZE PLOT (ANSI-B).
- TEXTURING OF PRIMARY GEOMEMBRANE IS AT SURFACE.
- EMBANKMENT DRAINS TO BE CONSTRUCTED BENEATH ALL FILL EMBANKMENTS.

CLIENT	POWERTECH (USA) Inc.				
PROJECT	DEWEY-BURDOCK PROJECT				
TITLE	DEEP WELL DISPOSAL TYPICAL POND SECTIONS AND DETAILS SHEET 1 OF 2				
Knight Piésold CONSULTING					
DESIGNED BY	ST	LOCATION	PROJECT NUMBER	DRAWING NUMBER	REVISION
DRAWN BY	RJB	102	279.05	301	A
ACTIVITY CODE	N/A	XREF NUMBER	N/A		

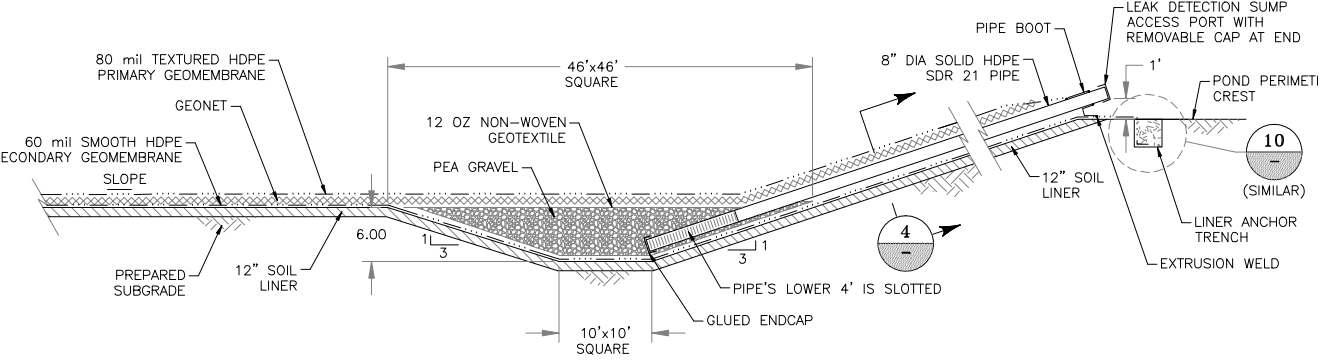
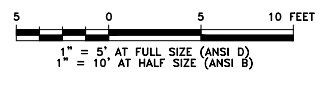
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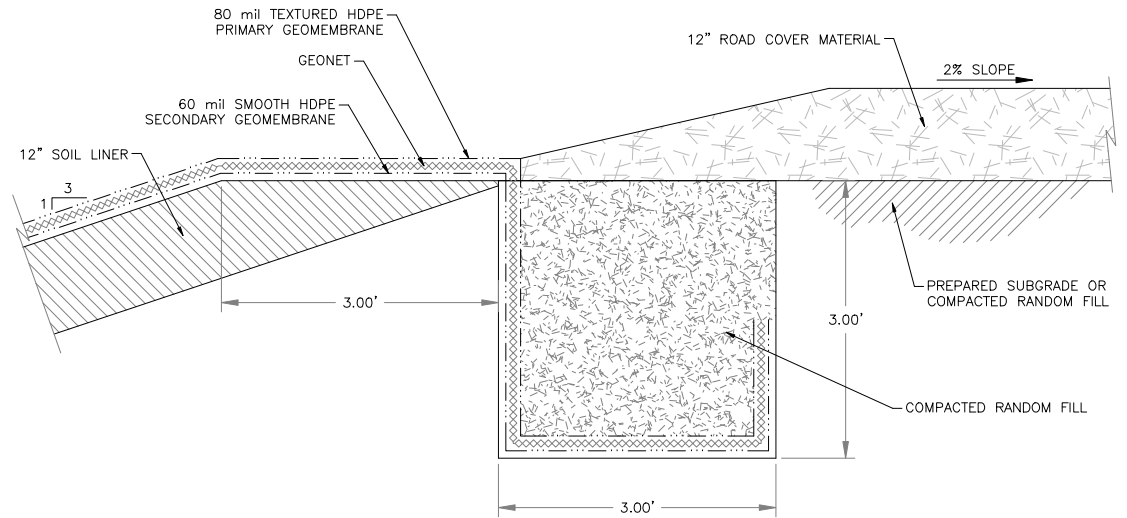
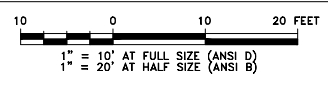
2 2
200 201 RADIUM SETTLING POND DETAIL
TYPICAL OF DOUBLE LINED PONDS



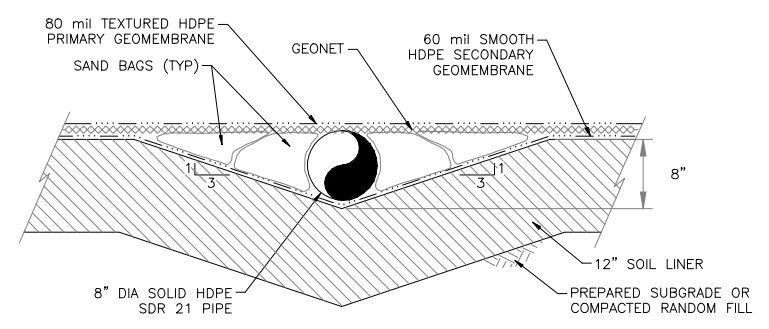
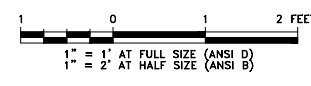
9
9 POND EMBANKMENT DETAIL
FOR DOUBLE LINED PONDS



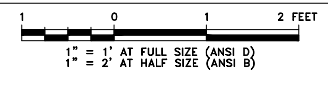
8 8
201 LEAK DETECTION SUMP AND ACCESS PORT DETAIL



10
10 ANCHOR TRENCH AND LINER DETAIL
FOR DOUBLE LINED PONDS



4
4 LEAK DETECTION SUMP ACCESS PORT DETAIL

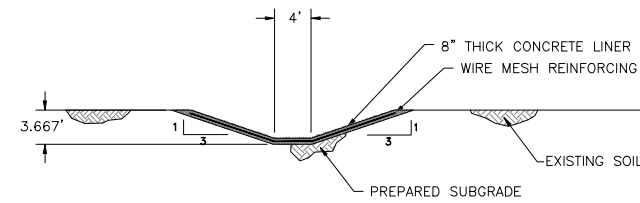


NOTES:

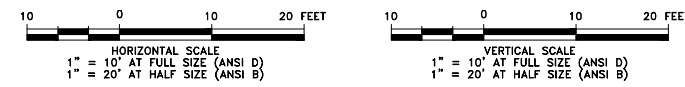
- SCALE BAR MEASURES 3" ON A FULL SIZE PLOT (ANSI-D) AND 1.5" ON A HALF SIZE PLOT (ANSI-B).
- EMBANKMENT DRAINS TO BE CONSTRUCTED BENEATH ALL FILL EMBANKMENTS.

CLIENT	POWERTECH (USA) Inc.						
PROJECT	DEWEY-BURDOCK PROJECT						
TITLE	DEEP WELL DISPOSAL TYPICAL POND SECTIONS AND DETAILS SHEET 2 OF 2						
		DESIGNED BY	ST	LOCATION	PROJECT NUMBER	DRAWING NUMBER	REVISION
		DRAWN BY	RJB	102	279.05	302	A
ACTIVITY CODE	N/A	XREF NUMBER	N/A				

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F
F
STORMWATER DIVERSION CHANNEL SECTION



CLIENT	POWERTECH (USA) Inc.
PROJECT	DEWEY-BURDOCK PROJECT
TITLE	DEEP WELL DISPOSAL DIVERSION CHANNEL SECTIONS

REV	DATE	DESCRIPTION	ST	APP'D	CADD
A	10/30/09	ISSUED FOR CLIENT REVIEW	ST		
Knightsold CONSULTING					
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DRAWN BY	ST	102	279.05	500	A
ACTIVITY CODE	N/A	XREF NUMBER	N/A		

**Powertech (USA) Inc.
Dewey-Burdock Project
Pond and Land Application
Technical Specifications and QA/QC Plan
Part 2 - Geosynthetics**

July 2010

prepared for:
Powertech (USA) Inc.
5575 DTC Parkway, Suite 140
Telephone: (303) 790-7528
Facsimile: (303) 790-3885

prepared by:
Knight Piésold and Co.
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Denver, Colorado 80203-1512 USA
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Facsimile: (303) 629-8789
E-mail: denver@knightpiesold.com

KP Project No. DV102.00279.09

Rev. No.	Date	Description	Knight Piésold	Client
0	July 2010		Paul Bergstrom	Powertech (USA) Inc.

**Powertech (USA) Inc.
Dewey-Burdock Project
Pond and Land Application
Technical Specifications and QA/QC Plan
Part 2 - Geosynthetics**

Table of Contents

	Page
Section 1.0 - General.....	1-1
1.1 Introduction	1-1
1.2 Limitations and Disclaimer	1-1
1.3 Contributors and Approvals	1-2
Section 2.0 - Scope and General Description of the Work	2-3
2.1 Definition of Terms	2-3
2.2 General Technical Requirements	2-3
2.2.1 General Specifications	2-4
2.3 Applicable Codes and Regulations	2-4
Section 3.0 - Mobilization and Demobilization.....	3-1
3.1 Scope	3-1
3.2 Mobilization	3-1
3.3 Contractor's Workshops, Stores, and Offices	3-1
3.4 Sanitation	3-1
3.5 Demobilization.....	3-1
Section 4.0 - Materials.....	4-1
4.1 Geonet.....	4-1
4.2 Geotextile	4-1
4.3 HDPE Geomembrane Liner	4-2
4.3.1 Conformance Sampling.....	4-3
Section 5.0 - Installation	5-4
5.1 Geonet.....	5-4
5.2 Geotextile	5-4
5.3 HDPE Geomembrane	5-4
Section 6.0 - Quality Control of HDPE Geomembrane.....	6-7
6.1 HDPE Geomembrane Testing and Inspection.....	6-7
6.1.1 Visual Inspections	6-8
6.1.2 Continuity Testing	6-8
6.1.3 Inter-seam Pressure Testing.....	6-8
6.1.4 Spark Testing	6-8

6.1.5	Vacuum Box Testing	6-9
6.1.6	Peel and Shear Strength Testing	6-9
6.2	Warranty	6-11
Section 7.0 - Submittals		7-12
Section 8.0 - As-Built Requirements.....		8-1
Section 9.0 - References.....		9-2

Tables

Table 4.1 - Geonet Specifications - Material Properties	4-1
Table 4.2 - Nonwoven Geotextile Specifications - Material Properties	4-1
Table 4.3 - HDPE Geomembrane Liner Specifications - Material Properties	4-2
Table 4.4 - HDPE Geomembrane Liner – Manufacturer Test Frequencies	4-3
Table 6.1 - HDPE Geomembrane Liner Specifications - Field Seaming Requirements	6-11
Table 7.1 - Submittal Requirements	7-12

Drawings

Drawing No.	Rev No.	Title
102-279.02-001	Rev A	Land Application and Irrigation - Cover Page
102-279.02-010	Rev A	Land Application and Irrigation – Index, General Site Location Map and Symbols
102-279.02-050	Rev A	Land Application and Irrigation – Site Plan – Test Pit Locations
102-279.02-100	Rev A	Land Application and Irrigation – Site Plan
102-279.02-101	Rev A	Land Application and Irrigation – Burdock Plant Site Plan
102-279.02-102	Rev A	Land Application and Irrigation – Dewey Plant Site Plan
102-279.02-200	Rev A	Land Application and Irrigation – Burdock Pond Sections – Sheet 1 of 2
102-279.02-201	Rev A	Land Application and Irrigation – Burdock Pond Sections – Sheet 2 of 2
102-279.02-202	Rev A	Land Application and Irrigation – Dewey Pond Sections – Sheet 1 of 2
102-279.02-203	Rev A	Land Application and Irrigation – Dewey Pond Sections – Sheet 2 of 2
102-279.02-301	Rev A	Land Application and Irrigation – Typical Pond Sections and Details – Sheet 1 of 2
102-279.02-302	Rev A	Land Application and Irrigation – Typical Pond Sections and Details – Sheet 2 of 2
102-279.02-500	Rev A	Land Application and Irrigation – Diversion Channel Sections
102-279.02-600	Rev A	Land Application and Irrigation – Dewey Evaporation Areas and Land Application Regrading
102-279.02-601	Rev A	Land Application and Irrigation – Burdock Evaporation Areas and Land Application Regrading
102-279.05-001	Rev A	Deep Well Disposal - Cover Page
102-279.05-010	Rev A	Deep Well Disposal – Index, General Site Location Map and Symbols
102-279.05-050	Rev A	Deep Well Disposal – Site Plan – Test Pit Locations
102-279.05-100	Rev A	Deep Well Disposal – Site Plan
102-279.05-101	Rev A	Deep Well Disposal – Burdock Plant Site Plan
102-279.05-102	Rev A	Deep Well Disposal – Dewey Plant Site Plan
102-279.05-200	Rev A	Deep Well Disposal – Burdock Pond Sections
102-279.05-202	Rev A	Deep Well Disposal – Dewey Pond Sections
102-279.05-301	Rev A	Deep Well Disposal – Typical Pond Sections and Details – Sheet 1 of 2
102-279.05-302	Rev A	Deep Well Disposal – Typical Pond Sections and Details – Sheet 2 of 2
102-279.05-500	Rev A	Deep Well Disposal – Diversion Channel Sections

**Powertech (USA) Inc.
Dewey-Burdock Project
Pond and Land Application
Technical Specifications and QA/QC Plan
Part 2 - Geosynthetics**

Section 1.0 - General

1.1 Introduction

This Specification stipulates materials and installation requirements for geosynthetics related to the construction of the Ponds and Land Application Systems at Powertech's Dewey-Burdock project.

1.2 Limitations and Disclaimer

This Specification titled Dewey-Burdock Project Pond and Land Application Technical Specifications and QA/QC Plan Part 2 - Geosynthetics has been prepared by Knight Piésold and Co. (Knight Piésold) for the exclusive use of Powertech (USA) Inc. (Client). No other party is an intended beneficiary of this Specification or the information, opinions, and conclusions contained herein. Any use by any party other than the Client of any of the information, opinions, or conclusions is the sole responsibility of said party. The use of this Specification shall be at the sole risk of the user regardless of any fault or negligence of the Client or Knight Piésold.

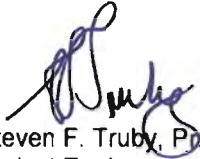
The information contained herein have been completed to a level of detail commensurate with the objectives of the assignment and in light of the information made available to Knight Piésold at the time of preparation. This specification and its supporting documentation have been reviewed and/or checked for conformance with industry-accepted norms and applicable government regulations. To the best of the information and belief of Knight Piésold, the information presented in this Specification is accurate to within the limitations specified herein.

This Specification is Knight Piésold pdf file: Dewey-Burdock Project Pond and Land Application Technical Specifications and QA/QC Plan Part 2 - Geosynthetics Rev 0.pdf. Any reproductions or modifications of this Specification are uncontrolled and may not be the most recent revision.

1.3 Contributors and Approvals

This specification was prepared, reviewed, and approved by the undersigned.

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Section 2.0 - Scope and General Description of the Work

This Specification stipulates materials and installation requirements for geosynthetics related to the construction of the Ponds and Land Application Systems at Powertech's Dewey-Burdock project. Should the Contractor wish to deviate from these Specifications, he shall notify the Engineer in writing, providing a description of the deviation. The description shall include data indicating the magnitude of the deviation, justification for the deviation, and any possible short or long-term impacts of the deviation on the project. Deviations in materials Specifications shall be subject to the approval of the Engineer and Owner prior to shipment of the materials.

All geosynthetic installation is to be completed in accordance with the Manufacturer's specifications. Prior to starting geosynthetic installation, the Contractor shall provide certification from the Manufacturer that the materials supplied have been produced and tested in accordance with relevant Specifications.

2.1 Definition of Terms

"Owner" is defined as an authorized representative of Powertech.

"Engineer" is defined as representative appointed and authorized by the Owner. The Engineer shall be a Registered Professional Engineer, or a designated site representative under the supervision of a Registered Professional Engineer.

"Contractor" is defined as the party that has executed a contract agreement for the specified Work with the Owner.

"Technical Specifications" is defined as this document, prepared by Knight Piésold and Co. and all supplemental addenda.

"Drawings" is defined as the Drawings, in conjunction with these Technical Specifications, prepared by Knight Piésold and Co. for the ponds and land application system at Powertech's Dewey-Burdock Project.

"Work" is defined as the entire completed construction, or the various separately identifiable parts thereof, as shown on the Drawings, and required to be furnished under the Contract Documents.

"Site" is defined as the project area where the work is to be performed.

"Contract Documents" are defined as the Agreement, Addenda, Contractor's Bid (when attached as an Exhibit to the Agreement), Bonds, General Conditions, Special Conditions, Technical Specifications, Drawings and all modifications issued after execution of the Agreement.

"Modifications" are defined as changes made to the Technical Specifications or the Drawings, that are approved by the Owner and Engineer, in writing, after the Technical Specifications and Drawings have been finalized.

All slopes are defined as horizontal to vertical distances.

2.2 General Technical Requirements

The general technical requirements specified herein shall apply to all activities and operations relating to carrying out the Work or as required by the Engineer or Owner for the earthworks associated with the construction of the ponds and land application system at Powertech's Dewey-Burdock Project, South Dakota.

In the event of an inconsistency in the Technical Specifications and Drawings, the Contractor shall refer all questions to the Engineer for final decision. Work that concerns the inconsistency shall not be performed until the contradiction is remedied or explained by the Engineer. In all events, the decision of the Engineer is final.

2.2.1 General Specifications

The contractor will be required to submit to the Engineer or Owner, at a minimum, the following plans and comply with training requirements associated with their project tasks, as may be applicable:

- Occupational Safety and Health Administration (OSHA)
 - Healthy and Safety Plan in accordance with 29 CFR Part 1910 – Occupational Safety and Health Standards
 - Hazardous Communication Plan in accordance with 29 CFR Part 1910.1200 – Toxic and Hazardous Substances
 - Material Safety Data Sheets (MSDS) for all chemicals in accordance with 29 CFR 1910.1200 (g)
- Spill Prevention, Control and Countermeasure (SPCC) Plan in accordance with 40 CFR Part 112.3 – Requirement to prepare and implement a Spill Prevention, Control, and Countermeasure Plan
- Training
 - Mine Safety and Health Administration – 24-hour class plus 8-hour refresher course in accordance with 30 CFR
 - HAZWOPER – 40-hour class plus 8-hour refresher course in accordance with 29 CFR 1910.120

2.3 Applicable Codes and Regulations

The following publications of the latest issue are a part of this Specification, except where replaced or revised by local codes or ordinances having jurisdiction, in which case the more stringent shall govern.

- National Sanitation Foundation Standard 54
- American Society for Testing Materials (ASTM)
- Mine Safety and Health Administration (MSHA) Code of Federal Regulations - Title 30 (Mineral Resources)
- Army Corps of Engineers Test Methods
- Occupational Safety and Health Administration, General Industry and Health Standards - OSHA 2206 (29 CFR 1910)
- AASHTO - AGC - ARTBA - Task Force 25
- Federal Test Method Standards (FTMS)

Section 3.0 - Mobilization and Demobilization

3.1 Scope

The Work covered by this section consists of the Contractor's mobilization to the Site of all the equipment and temporary facilities required for the successful completion of the Work, and shall include, but not necessarily be limited to, the following:

- Establish the Contractor's maintenance facilities, temporary workshops, temporary office accommodation and sanitary facilities.
- Maintain equipment and temporary facilities for the duration of the Work.
- All items required to be moved onto the Site for execution of the Work.
- On completion of the Work, remove all equipment and temporary facilities from the Site, and clean up the Site to the satisfaction of the Owner and the Engineer.

3.2 Mobilization

The Contractor shall mobilize to the Site sufficient labor, materials, and equipment to allow commencement of the Work. The Contractor shall bring on to the Site, as and when necessary, any additional equipment, labor and materials which may be required to complete the remainder of the Work in the time specified in the General Terms and Conditions.

3.3 Contractor's Workshops, Stores, and Offices

The Contractor shall erect, in the area designated by the Owner and Engineer, adequate workshops, offices and other buildings and structures for the completion of the Work as designated in the Contract Documents. Such workshops, offices and etc., shall be maintained in a neat and tidy condition throughout the duration of the Work to the satisfaction of the Engineer and Owner.

3.4 Sanitation

The Contractor shall provide and maintain adequate sanitary facilities for the personnel at the Site, including the Contractor's offices and Engineer's offices, in compliance with local health regulations and to the satisfaction of the Engineer and Owner.

3.5 Demobilization

On completion of the Work, the Contractor shall remove all of the Contractor's equipment, temporary facilities and materials from the Site. The Site shall be left in a clean and tidy state, to the satisfaction of the Engineer and Owner. All waste and refuse shall be disposed of in a legal manner acceptable to the Owner.

Section 4.0 - Materials

4.1 Geonet

Geonet used in the Work shall be manufactured by extruding two crossing strands to form a bi-planar drainage net structure. The material provided as geonet shall conform to the following standards:

Table 4.1 - Geonet Specifications - Material Properties

Property	ASTM Test Methods	Minimum Average Value	Unit
Transmissivity	D4716	9.50	gal/min/ft
Thickness	D5199	200	mil
Density	D1505	0.94	g/cm ³
Tensile Strength (MD)	D5035/7179	45	lb/in
Carbon Black Content	D1603 ⁽²⁾ /D4218	2.0	%

Notes:

1. Gradient of 0.1, normal load of 10,000 psf, water at 70° F, between steel plates for 15 minutes. Contact manufacturer for performance transmissivity value for use in design.
2. Modified

The Contractor shall provide a written material guarantee covering the geonet material for a minimum warranty period of 1 year. The material warranty shall cover the cost of any replacement material required to replace any failed material. A minimum 1-year installation warranty shall also be provided and shall cover the cost of labor and equipment to replace the failed material.

4.2 Geotextile

This Section defines the requirements for nonwoven geotextile material and its installation.

Any alternatives or exceptions to this Specification shall be submitted in writing to the Engineer and shall be approved in writing prior to implementation of the Work.

The materials supplied as nonwoven geotextile shall be of new first-quality needle-punched polypropylene. The material is to be designed and manufactured specifically for the purpose of separation, tensile reinforcement, planar flow, and filtration. Geotextile material shall be produced so that it is free of holes, undispersed raw material, broken needles, or any contamination by foreign matter. Each type of geotextile shall be uniform in color, thickness, size, and texture.

The nonwoven geotextile fabric shall be 10 oz/yd² and 12 oz/yd², as specified on the Drawings. All geotextile material shall meet the requirements indicated in the table below:

Table 4.2 - Nonwoven Geotextile Specifications - Material Properties

Property	ASTM Test Methods	Unit	Minimum Average Value	
Mass per Unit Area	D5261	oz/yd ²	10	12
Grab Tensile Strength	D4632	lb	260	320
Grab Elongation	D4632	%	50	50
Trapezoidal Tear Strength	D4533	lb	100	125
Puncture Strength	D4833	lb	165	190
Apparent Opening Size (AOS)	D4751	U.S. Sieve Size	100 ⁽²⁾	100 ⁽²⁾
Permeability (k)	D4491	in/sec	0.12	0.11

Notes:

1. All values reported in weaker principle direction.

2. Value listed is a maximum value.

All rolls of nonwoven geotextile shall be properly identified and tagged by the Manufacturer. A copy of the Manufacturer's specifications is to be submitted to the Engineer by the Contractor prior to ordering materials. A copy of the geotextile certification will be provided to the Engineer prior to deployment.

It is essential that the nonwoven geotextile fabric retain its integrity after UV exposure. The Contractor shall provide a written guarantee covering the fabric against UV degradation for a minimum of 2 years. The guarantee shall cover the cost of the material, labor and equipment required to replace any failed material. With respect to UV degradation the geotextile fabric must meet the following requirements:

1. Retain 70 percent of its tensile strength after 500 hours of exposure to UV rays.
2. Remain intact with no holes evident due to UV degradation for a period of 2 years

4.3 HDPE Geomembrane Liner

The HDPE geomembrane liner shall be 40, 60, or 80 mil thickness, black surfaced, and either smooth or textured, as specified on the Drawings and in Table 4.3. The HDPE liner shall be a high quality formulation containing approximately 98 percent polymer and 2 percent carbon black with antioxidants and heat stabilizers. It shall be resistant to Ultraviolet (UV) rays.

The liner material shall comprise HDPE material manufactured of new, first-quality products designed and manufactured specifically for the purpose of liquid containment in hydraulic structures as applied to the mining industry.

The material shall be produced as to be free of holes, blisters, undispersed raw materials or any sign of contamination by foreign matter. Any such defects shall be repaired using extrusion fusion welding techniques or industry-accepted standard in accordance with the Manufacturer's recommendations.

Liner material samples and Manufacturer's minimum specifications for materials and installation shall be submitted to the Engineer. A copy of the Manufacturer's Quality Control Manual shall be submitted for approval, as required by the Engineer. The material provided as HDPE liner shall conform to the following standards:

Table 4.3 - HDPE Geomembrane Liner Specifications - Material Properties

Property	ASTM Test Methods	Minimum Average Value			Unit
		40 mil Textured	60 mil Smooth	80 mil Textured	
Thickness	D5199 (smooth) D5994 (textured)	40	60	80	mil
Density	D1505	0.94	0.94	0.94	g/cm ³
Tensile @ Break	D6693(1) Type IV	75	243	155	lb/in-width
Tensile @ Yield		90	132	177	lb/in-width
Elongation @ Break		100	700	100	%
Elongation @ Yield		12	13	12	%
Tear Resistance	D1004	32	42	60	lb
Puncture Resistance	D4833	95	125	160	lb
Notched Constant Tensile Load	D5397 Appendix	1,000	1,000	1,000	Hours
Carbon Black Content	D1603 ^(b) /D4218	2.0-3.0	2.0-3.0	2.0-3.0	% (Range)
Carbon Black Dispersion	D5596	Note ⁽³⁾	Note ⁽³⁾	Note ⁽³⁾	n/a

Notes:

1. Machine direction (MD) and cross machine direction (XMD) average values should be the basis of 5 test specimens each direction.
2. Yield elongation is calculated using a gauge length of 1.3 inches. Break elongation is calculated using a gauge length of 2.0 inches.
3. Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
4. Samples may be taken from material delivered to the site and tested for material conformance. Testing frequency to be determined by the Engineer.
5. Modified.

The manufacturer of the liner shall take random samples of the liner material from fabricated rolls during manufacture and test them at a frequency according to the following Table 4.4

Table 4.4 - HDPE Geomembrane Liner – Manufacturer Test Frequencies

Property	ASTM Test Methods	Frequency
Thickness	D5199 (smooth) D5994 (textured)	Per roll
Tensile Properties	D6693(1) Type IV	Every 50,000 square feet
Tear Resistance	D1004	Every 50,000 square feet
Puncture Resistance	D4833	Every 50,000 square feet
Carbon Black Content	D1603 ^(b) /4218	Every 50,000 square feet
Carbon Black Dispersion	D5596	Every 50,000 square feet
Density	D1505	Every resin batch
Dimensional Stability (max. ave. %)	D1204	Every resin batch

All welding material shall be of a type recommended and supplied by the liner material manufacturer and shall be delivered in the original sealed containers, each with an indelible label bearing the manufacturer's mark number, and complete directions as to proper usage. The composition of welding wire or pellets shall be identical to the lining material.

The Contractor shall provide a written material guarantee covering the HDPE liner materials, including degradation due to UV light, for a minimum warranty period of 20 years. The material warranty shall cover the cost of replacement material required to replace any failed material. A minimum 1-year installation warranty shall also be provided and shall cover the cost of labor and equipment to replace the failed material.

4.3.1 Conformance Sampling

During liner deployment, the Engineer shall collect conformance samples at a rate of 1 per 120,000 square yards of liner shipped to site. The Contractor shall assist in the collection of these samples. Conformance samples collected shall be tested for thickness, density, tensile properties (yield stress, break stress, yield elongation and break elongation), carbon black content, and carbon black dispersion.

Section 5.0 - Installation

5.1 Geonet

Geonet shall be installed between the primary and secondary geomembrane liners in the areas shown on the Drawings. Geonet shall be installed parallel with the slope, and in the direction of potential flow of fluids. To the extent possible, seams shall be oriented parallel to the slope of the ground. Geonet shall extend to and be anchored in the pond anchor trenches.

Geonet panels shall be butted to each other, and secured with cable ties placed at minimums of every 5 ft along roll length, and placed every 1 foot along roll width. Panels shall be secured with cable ties placed 6 inches on center in the anchor trenches, or at other locations as required by the Engineer.

5.2 Geotextile

The geotextile shall be placed over a prepared surface as shown on the Drawings or as directed by the Engineer. The geotextile shall be placed in such a manner that it will not excessively stretch or tear upon placement of the overlying materials. Care should be taken to place the geotextile in intimate contact with the prepared surface such that no voids exist between the geotextile and the underlying material.

The individual panels of the geotextile shall be sewn, overlapped or fusion-seamed with a heat gun, as site conditions and design dictate and as directed by the Engineer. Joints made by sewing or fusion seaming, shall be overlapped a minimum of 6 inches. Joints not sewn or heat-seamed shall be overlapped a minimum of 36 inches. The installer shall ensure that no foreign material is present within the seams or overlaps. All joints shall be constructed with the upslope sheet placed over the down-slope sheet. Care shall be taken during installation to prevent contamination and/or damage to the geotextile. Torn or punctured material shall be patched when feasible. The patch shall extend a minimum of 36 inches beyond the edge of the tear or damage.

Sewn seams shall be sewn with a Type 401 stitch with 1 or 2 rows of stitching. Each row of stitching shall have between 4 to 7 stitches per 1 inch. The minimum distance between the stitch line and the edge of the geotextile shall be 1.5 inches.

All geotextile panels shall be temporarily secured from the wind until the final covering material is placed. Temporary ballast, such as soil heaps, UV resistant sand bags, or stones, shall be placed on the overlaps and at the perimeter as necessary to secure the geotextile. Where temporary ballasting comparable to the cover material is used and it will not interfere with the placement of the covering material, it may be left in place, subject to the approval of the Engineer.

Methods used for placement of the geotextile shall be selected by the Contractor and are subject to approval by the Engineer. Modifications to construction procedures and techniques may be necessary to prevent undue wastage of the material.

The installed geotextile will be inspected by the Engineer for continuity and defects. Any defects will be repaired at the Contractor's expense.

5.3 HDPE Geomembrane

The HDPE liner shall be installed on the areas shown on the Drawings or as directed by the Engineer. The surface on which the liner is to be installed shall be free of sharp particles, rocks or other debris to the satisfaction of the Engineer. Sharp objects shall be removed by raking, brooming or hand picking as necessary.

The Contractor shall supply the Engineer with panel layouts of the liner. These panel layouts must have been approved by the Engineer prior to the Contractor commencing the Work. It is the Contractor's responsibility to submit timely proposals (allowing a minimum of 2 weeks for approval).

Installation of the HDPE liner shall be performed under the direction of a field Engineer or supervisor who has installed a minimum of 120,000 square yards of flexible lining material.

The liner shall be placed over the prepared surfaces using methods and procedures that assure a minimum of handling. Adequate temporary and permanent anchoring devices and ballasting shall be provided to prevent damage due to winds.

To the extent possible, seams shall be oriented parallel to the slope of the ground. The panels shall be secured temporarily with sandbags or other approved ballasting method to hold them in place until the field seams have been completed and the liner has been permanently anchored.

The Contractor shall take into account that winds may result in delays. The Contractor shall take all necessary measures to ensure that each panel is sufficiently ballasted to prevent damage or movement by wind. Fusion of panels and repairs will only be permitted under weather conditions allowing such work, and within the warranty limits of the liner Manufacturer, as approved by the Owner and Engineer.

The Contractor shall take into account that weather changes could result in delays to the construction of field seams. Fusion of panels and repairs will only be permitted under weather conditions that allow such work, and within the warranty limits of the manufacturer.

Horizontal field seams on slopes shall be kept to a minimum. Horizontal seams on steep slopes shall be avoided where possible by cutting the liner at a 45° angle. Generally, horizontal seams are to be no closer than 5 feet from the toe of the slope. If required, horizontal seams shall be made by lapping the uphill material over the downhill material. Panels shall be shingled in a manner that prevents water from running beneath the liner.

The liner shall be installed in a relaxed condition and shall be free of tension or stress upon completion. The installed liner shall contain sufficient slack material to allow for thermal expansion and contraction. Individual wrinkles should take the form of undulations in the liner but should not be large enough for the material to fold over itself.

During installation, the Contractor shall give each field panel an "identification" code number consistent with the layout plan. The numbering system must have been approved by the Engineer. The Contractor shall upgrade the layout plan as each panel is installed to show the location of each panel. A field panel is defined as the area of liner that is to be seamed in the field (roll or portion of a roll cut in the field).

Individual panels of HDPE material shall be laid out in a pattern that will produce the least number of seams. The material shall be overlapped prior to welding. Extreme care shall be taken by the Contractor in the preparation of the areas to be welded. The joint interface shall be cleaned and prepared according to procedures laid down by the material Manufacturer and approved by the Engineer. Seaming shall not take place unless the panel is dry and clean. All sheeting shall be welded together by thermal methods.

The liner material shall be installed such that foot traffic is minimized. No vehicle traffic or heavy generators are permitted on the liner surface. No open seams or holes shall be allowed in the deployed liner at the end of the shift.

Any liner area showing damage due to excessive scuffing, puncture or distress from any cause shall be replaced or repaired with an additional piece of liner material of the same type. The cost of replacing or repairing the liner shall be borne solely by the Contractor.

The welding equipment used shall be well maintained and in good working condition. It shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the lining material to ensure changes in environmental conditions will not affect the integrity of the weld. The double wedge fusion-welding process shall be used unless the Engineer approves alternate methods. Extrusion welding will be permitted to repair small areas or where test samples have been removed.

No "fish mouths" will be allowed within the seam area. Where "fish mouths" occur, the material shall be cut, overlapped and an overlap extrusion weld shall be applied.

Liner panels must have a finished overlap of 4 inches for double-wedge welding seams and 3 inches for extrusion welding seams. Notwithstanding this provision, sufficient overlap shall be provided to allow peel tests to be performed on any seam.

The temperature of hot air at the nozzle of any welding apparatus shall be controlled at all times such that the liner is not damaged. Upon completion of the Work, all welds shall be tightly bonded.

Handling and storage of HDPE liner material shall be in accordance with the Manufacturer's printed instructions. All persons walking or working on the HDPE liner shall wear soft-sole shoes.

The liner shall extend into the anchor trench as shown on the Drawings. All anchor trenches must have been approved by the Engineer prior to installation of the liner in the trench. The trench must have again been inspected by the Engineer once the liner has been placed in it, and prior to backfilling.

Section 6.0 - Quality Control of HDPE Geomembrane

Written certification shall be provided from the supplier that the material delivered to the project complies with these specifications. A copy of the Manufacturer's printed instruction for installation is also to be provided.

The Manufacturer of the liner shall take random samples of the liner material during manufacture. Samples shall be tested by a qualified laboratory by methods specified within this Section, or applicable ASTM standards, for thickness, strength, tear resistance, low temperature impact, density and dimensional stability. The results shall be supplied to the Engineer.

The Contractor shall be fully responsible for carrying out all quality control tests on HDPE liner and shall do so to the satisfaction of the Engineer and in accordance with this Specification. On-site physical non-destructive and destructive testing shall be completed on all joints to ensure that watertight uniform seams are achieved on a continuous basis as installation proceeds. The Contractor shall provide Technicians experienced in the testing procedures that are to be used. At the time of bid submission, details shall be provided by the Contractor that set forth the method proposed for both destructive and non-destructive testing of seams. The Engineer must have approved these methods prior to the Contractor commencing the Work. Visual inspection alone is unacceptable.

The Contractor shall furnish labor and equipment required to assist in any other sampling and testing that is requested by the Owner or the Engineer.

The welding equipment used shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the material to ensure changes in environmental conditions will not affect the integrity of the weld. Fusion of panels and repairs will only be permitted under weather conditions allowing work that is in conformance to the specifications and within the warranty limits imposed by the manufacturer.

At a minimum, the Contractor's field installation test program shall include periodic visual observations and continuity and strength tests as defined in the following subsections. The amount of geomembrane liner deployed without final quality control and final repairs being completed shall never exceed 300,000 square feet. Upon completion of an area of the liner, the Contractor shall identify the boundaries of the area. At this time, the final inspection by Engineer shall take place to identify any defects in the completed liner. The Contractor shall repair any defects identified to the satisfaction of the Engineer.

6.1 HDPE Geomembrane Testing and Inspection

These tests are to be made routinely on seams from each welding machine regardless of other types of testing required. The procedure for both double wedge fusion and extrusion seams is described as follows (beginning of each day of seaming and upon resumption of work after any stoppage or operator change):

- Run a test seam with each machine to be used. Repair or replace and retest any machine determined to be defective or malfunctioning.
- Visually inspect the seam for squeeze out and melt.
- Record observations.
- Perform a peel and shear seam strength test on each test seam as per Section 6.1.6 (on a continuing basis).
- Visually check field seams for squeeze out, footprint, melt and overlap.
- Check machines for cleanliness, temperature and related items.

6.1.1 Visual Inspections

The Owner, his representatives, and the Engineer shall have unrestricted access and right to inspect all Contractor's work, materials, equipment, tools, and records pertaining to the lining work.

The Contractor shall perform visual inspections of deployed and welded HDPE panels to identify defects, damage, or protrusion of sharp objects that may affect the integrity of the liner. Defective or damaged areas will be marked and repaired according to the Technical Specifications.

The Contractor's QC Technician(s) or Field Engineer shall inspect each panel and all seams, marking his initials and date inspected at the end of each panel. Prior to final inspection of the liner by the Owner and Engineer, the following shall have been completed:

- All trash and debris must have been cleared from the liner.
- All loose gravel around ballast piles or damaged sand bags must have been removed from the liner.
- The area must have been thoroughly inspected by the Contractor's QC personnel.
- All documentation, including destructive test results, air test results and deployment records shall have been completed and submitted to the Engineer.

6.1.2 Continuity Testing

A maximum effort shall be made to install a perfect liner. This implies that all seams completed in the field, patches and extrusions shall be tested and recorded. All failures shall be isolated and repaired as directed by the Engineer. A general testing procedure is included as follows:

- Test all field seams and patches with inter-seam pressure, spark test or other approved methods. Pressure and spark testing are discussed in following subsections.
- Isolate and repair all areas indicating any leakage. Retest the repair.

Testing equipment shall be in good condition and be to the satisfaction of the Engineer. Any equipment that is found to be unacceptable shall be removed from service until it has been repaired, and it has been approved by the Engineer.

6.1.3 Inter-seam Pressure Testing

Test procedure for inter-seam pressure for seams over 65 yards long (for double wedge welding only):

- Seal both ends of the seam to be tested by applying heat to the end of the seam via a heat gun until flow temperature is achieved. Clamp off the ends and let cool.
- Insert a pressure gauge/needle assembly into the end of the seam and seal.
- Apply between 40 and 45 psi air pressure to the void between the 2 seams, for a minimum of 5 minutes.
- The allowable leak down for the seam is 3 psi.
- Enter the results of the leak test on the appropriate document, indicating either a passed or failed seam. The seam is to be repaired if it fails, with the repair work and subsequent testing being recorded on the same document.

6.1.4 Spark Testing

All extrusion welded patches, caps, etc, shall be "spark" tested in accordance with ASTM D6365. All extrusion welds in pipe boots shall be spark tested. The basic concept for spark testing is as follows:

- Just prior to applying the extrusion bead, a small gauge copper wire is placed into the seam. An 18-gauge bare copper wire usually works well. The wire should be grounded at one end and be placed at the edge of the top sheet of the overlap seam. Tucking the wire under the edge of the top sheet will help hold the wire in place during welding, but this should be done prior to grinding to avoid the risk of contamination of the weld area.
- Apply the extrudate bead as normal, and allow the weld to cool.
- Energize the spark tester, and move the electrode wand near a grounding source to determine the maximum length of spark that can be generated. Adjust the output voltage setting until the spark length exceeds the greatest potential leak path distance. This is typically the diagonal distance from the embedded wire to the edge of the weld bead at a “T” joint.
- Once the output voltage has been set, testing may be started. Testing is performed by passing the electrode over the seams with the electrode in contact with the membrane and/or the extruded weld bead. The audible and visual indication of a spark provides the determination of a potential leak path.
- If a potential leak is detected, the area can be repaired by grinding and re-welding. Applying additional weld beads adjacent to the leaking weld is not an acceptable repair technique. This will only lengthen the leak path to the extent that the spark tester may not be capable of generating a spark of sufficient length to breach the lengthened gap.
- After grinding and re-welding, the seam must be retested. If there is still an indication of a potential leak (spark), it may be required to apply a patch over the entire area.

6.1.5 Vacuum Box Testing

Vacuum box testing can be used as a secondary test to check for leaks and holes in addition to spark testing, or in locations where spark testing is not feasible. All vacuum box testing is to be done in accordance with ASTM D5641.

6.1.6 Peel and Shear Strength Testing

The Engineer shall test a minimum of 20 percent of the samples obtained for peel and bonded seam strength. The samples shall be tested either on site, or submitted for testing to an independent laboratory. In all instances, failed coupons determined by the Engineer’s testing shall overrule passing test results obtained by the Contractor.

These tests shall be carried out on trial seams comprising a test weld 36 inches long by 12 inches wide for each welding machine at the following times:

- At the beginning of seaming operations
- After every four hours of seaming operation
- A minimum of 1 sample per 500 feet of seam
- After repairs have been made to the seaming equipment
- By each Technician using the seaming equipment
- As required by the Engineer

The test weld shall be marked with date, ambient temperature, and welding machine number. Samples of the weld, 8 inches long by 1 inch wide, shall be cut from the test weld and tested for shear and peel strength requirements. Seams should be stronger than the material. The weld sample shall be kept for subsequent testing on laboratory tensiometer equipment in accordance with the applicable ASTM standards.

Peel and shear seam strength testing shall also be carried out on samples of seams removed from the Work. For these tests, the following procedures shall be followed:

- Coupon sampling of all field seams, including patches and repair areas, shall be taken by cutting perpendicular to the seams a sample approximately 36 inches by 12 inch. This sample shall be cut into three 24 inch by 12 inch samples and labeled with seaming crew names, date, location and individually marked "Owner Sample," "QA/QC Sample" and "Lab QA/QC Sample." The frequency and location shall be determined by the Engineer but shall not be less than one sample per 500 linear feet of field seams. These coupons shall be tested for peel and shear seam strength and thickness. Coupons (5 per series of tests 1 inch by 12 inches) from the destructive sample shall be tested for peel and bonded-seam strength as well as for thickness in accordance with the applicable ASTM standards. All shear and peel test results shall meet or exceed the project requirements. If one or more of the coupons fails, the sample will be considered a failure.
- Heat-welded seams shall be allowed to cool or warm to about 70° F prior to testing. Solvent seams, when used, shall be allowed to cure according to the Manufacturer's recommendations. Additionally, at the Engineer's option, approximately 10 percent of the coupons shall be sent to an independent laboratory for confirmation testing. Should the lab and field tests conflict, installation shall halt until the conflict is resolved to the satisfaction of the Engineer.
- A quality control Technician or field Engineer acting for the Contractor shall inspect each seam, marking his initials and date inspected at the end of each panel. Any area showing a defect shall be marked and repaired in accordance with the applicable repair procedures.

In the case that a destructive seam test fails in either shear or peel, the entire length of seam represented by this test is in question. As a minimum, the procedure for destructive test failures shall be as follows;

- The Contractor shall provide the Engineer with 2 additional destructive test samples at least 150-feet on either side of the failed test. The Engineer and Owner reserve the right to take additional samples as warranted to adequately assess the quality of the work.
- If a failing test occurs at the new destructive test location, an additional test shall be taken at another minimum 50-foot interval from the additional tests. This procedure is repeated until the defective section is fully defined, or the edge of the seam that was originally represented by the original test is reached.
- If passing tests are achieved at the minimum 150-foot distance from the failed destructive test, additional destructive tests may be taken at a closer spacing from the failed test at the discretion of the Contractor. If the tests at the closer interval fail, additional destructive tests shall be taken until the length of the defective seam is fully defined.
- Once the length of defective seam is identified, the Contractor shall either cut out the defective seam and wedge weld a new piece of liner in the seam area; or install a cap-patch strip over the affected seam area. Cap-patches or new sections of liner shall be a minimum of 3-feet in width, and shall be centered over the defective seam. Extrusion welding the exposed flap of liner on wedge welded seams, or additional extrusion welding of extrusion welded seams shall not be allowed.
- In the case that the retest of the repaired area fails, the procedure described above shall be repeated until passing tests are achieved.

In the case that a destructive seam test fails at the beginning or end of a seam, the previous or following seam completed by that same welding machine shall also be tested.

Results of all seam and strength testing completed for a day shall be compiled and submitted to the Engineer by the end of each day. All destructive samples tested by the Contractor shall be tested the same day they are marked.

Destructive samples taken from the liner shall identify the two panels that are joined by that seam.

The Engineer will continuously inspect the installation of the HDPE liner to ensure that the procedures specified in this section are fully adhered to.

Table 6.1 - HDPE Geomembrane Liner Specifications - Field Seaming Requirements

Property (Seam Strengths) ⁽¹⁾	Test Method	Minimum Average Value			Unit
		40 mil Textured	60 mil Smooth	80 mil Textured	
Fusion Peel	ASTM D4437	65	98	130	lb/in
Extrusion Peel ⁽²⁾		52	78	104	lb/in
Shear Strength		81	121	162	lb/in

Notes:

1. Seam tensile strength testing shall be performed at the same strain rate as the parent material.
2. Seam must exhibit film tear bond (FTB). Trial welds should have no incursion into the weld.

Any material or workmanship that fails to comply with the Specifications shall be corrected or replaced by the Contractor at his expense. The cost of retests and re-inspection shall be the responsibility of the Contractor.

A copy of all tests performed by the Contractor shall be furnished to the Owner and Engineer prior to final acceptance of the HDPE liner. Failure by the Contractor to provide required test and inspection documentation in an acceptable time period may result in the suspension of installation work until the required documentation is submitted.

6.2 Warranty

The Contractor shall provide a written guarantee covering materials, and all workmanship, as well as degradation due to UV light for exposed areas, that the material will not fail for a minimum of 20 years. This guarantee shall cover the cost of material, labor and equipment to replace any failed material.

Section 7.0 - Submittals

The Contractor shall provide the Owner and Engineer with the following material submittals for review prior to the materials being approved for use on the project, or for the Work incorporating the material to be allowed to commence. Data submitted shall include drawings showing essential details of any changes proposed by the Contractor.

Table 7.1 – Submittal Requirements

Section	Subsection	Material	Details
4.0	4.1	Geonet	Material Specifications
4.0	4.2	Geotextile	Material Specifications
4.0	4.3	HDPE Geomembrane Liner	Material Specifications

Section 8.0 - As-Built Requirements

To assist in the production of adequate as-built Drawings and documentation, the Contractor will be required to provide a panel log, seaming log, QC log, repair log, and a 22 inch by 34 inch set of drawings, along with the executable format, showing panel numbers, and locations and types of patches and seams. Locations of all destructive test samples are to be identified on the Drawings. The panel log shall include roll identification numbers.

Section 9.0 - References

- ASTM International, 2009, *ASTM A1004 - 09 Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting*, ASTM International.
- ASTM International, 2008, *ASTM D1204 - 08 Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature*, ASTM International.
- ASTM International, 2003, *ASTM D1505 - 03 Standard Test Method for Density of Plastics by the Density-Gradient Technique*, ASTM International.
- ASTM International, 2006, *ASTM D1603 - 06 Standard Test Method for Carbon Black Content in Olefin Plastics*, ASTM International.
- ASTM International, 1996, *ASTM D4218 - 96 Standard Test Method for Determination of Carbon black Content in Polyethylene Compounds by the Muffle-Furnace Technique*, ASTM International.
- ASTM International, 1996, *ASTM D4437 - 08 Standard Practice for Non-destructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes*, ASTM International.
- ASTM International, 2004, *ASTM D4491 - 99a(2004)e1 Standard Test Methods for Water Permeability of Geotextiles by Permittivity*, ASTM International.
- ASTM International, 2009, *ASTM D4533 - 04(2009) Standard Test Method for Trapezoid Tearing Strength of Geotextiles*, ASTM International.
- ASTM International, 2008, *ASTM D4632 - 08 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles*, ASTM International.
- ASTM International, 2008, *ASTM D4716 - 08 Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head*, ASTM International.
- ASTM International, 2004, *ASTM D4751 - 04 Standard Test Method for Determining Apparent Opening Size of a Geotextile*, ASTM International.
- ASTM International, 2007, *ASTM D4833 - 07 Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products*, ASTM International.
- ASTM International, 2008, *ASTM D5035 - 06(2008)e1 Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)*, ASTM International.
- ASTM International, 2006, *ASTM D5199 - 01(2006) Standard Test Method for Measuring the Nominal Thickness of Geosynthetics*, ASTM International.
- ASTM International, 2009, *ASTM D5261 - 92(2009) Standard Test Method for Measuring Mass per Unit Area of Geotextiles*, ASTM International.
- ASTM International, 2007, *ASTM D5397 - 07 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test*, ASTM International.

ASTM International, 2009, *ASTM D5596 - 03(2009) Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics*, ASTM International.

ASTM International, 2006, *ASTM D5641 - 94(2006) Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber*, ASTM International.

ASTM International, 2003, *ASTM D5994 - 98(2003) Standard Test Method for Measuring Core Thickness of Textured Geomembrane*, ASTM International.

ASTM International, 2006, *ASTM D6365 - 99(2006) Standard Practice for the Nondestructive Testing of Geomembrane Seams using the Spark Test*, ASTM International.

ASTM International, 2008, *ASTM D6693 - 04 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes*, ASTM International.

ASTM International, 2007, *ASTM D7179 - 07e1 Standard Test Method for Determining Geonet Breaking Force*, ASTM International.

Drawings

(see Drawings for Part 1 – Earthworks)

**Powertech (USA) Inc.
Dewey-Burdock Project
Pond and Land Application
Technical Specifications and QA/QC Plan
Part 3- Pipeworks and Appurtenances**

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KP Project No. DV102.00279.09

Rev. No.	Date	Description	Knight Piésold	Client
0	July 2010		Paul Bergstrom	Powertech (USA) Inc.

**Powertech (USA) Inc.
Dewey-Burdock Project
Pond and Land Application
Technical Specifications and QA/QC Plan
Part 3- Pipeworks and Appurtenances**

Table of Contents

	Page
Executive Summary	ES-1
Section 1.0 - General.....	1-1
1.1 Introduction	1-1
1.2 Limitations and Disclaimer	1-1
1.3 Contributors and Approvals	1-2
Section 2.0 - Codes, Regulations and Definitions.....	2-1
2.1 Definition of Terms	2-1
2.2 General Technical Requirements	2-1
2.2.1 General Specifications	2-2
2.3 Applicable Codes and Regulations	2-2
Section 3.0 - Mobilization and Demobilization.....	3-1
3.1 Scope	3-1
3.2 Mobilization	3-1
3.3 Contractor’s Workshops, Stores, and Offices	3-1
3.4 Sanitation	3-1
3.5 Demobilization.....	3-1
Section 4.0 - Materials.....	4-2
4.1 General.....	4-2
4.2 High Density Polyethylene (HDPE) Pipe	4-2
4.2.1 Fittings.....	4-2
4.3 Carbon Steel Pipe	4-3
4.3.1 Fittings.....	4-3
4.4 Bolts and Gaskets	4-3
4.4.1 Bolts	4-3
4.4.2 Gaskets	4-3
4.5 Valves.....	4-4
4.6 Pumps	4-4
4.7 Submittals	4-4
4.7.1 General.....	4-4
4.7.2 HDPE Pipe	4-4
4.7.3 Carbon Steel Pipe	4-4
4.8 Pipe and Valve Delivery, Handling and Storage	4-5
4.8.1 HDPE Pipe	4-5

4.8.2	Carbon Steel Pipe	4-5
Section 5.0 - Installation		5-6
5.1	Pipe	5-6
5.1.1	HDPE Pipe	5-7
5.1.2	Carbon Steel Pipe	5-7
5.2	Valves.....	5-8
5.3	Pumps	5-8
5.4	Compatibility.....	5-8
Section 6.0 - Testing		6-9
6.1	HDPE Pipe	6-9
6.1.1	Bent Strap Tests	6-9
6.1.2	Destructive Laboratory Tests of Butt Fusion Joints	6-9
6.1.3	Pressure Testing	6-9
6.2	Carbon Steel Pipe	6-11
6.2.1	Pressure Testing	6-11
Section 7.0 - As-Built Requirements.....		7-12
Section 8.0 - References.....		8-1

Drawings

Drawing No.	Rev No.	Title
102-279.02-001	Rev A	Land Application and Irrigation - Cover Page
102-279.02-010	Rev A	Land Application and Irrigation – Index, General Site Location Map and Symbols
102-279.02-050	Rev A	Land Application and Irrigation – Site Plan – Test Pit Locations
102-279.02-100	Rev A	Land Application and Irrigation – Site Plan
102-279.02-101	Rev A	Land Application and Irrigation – Burdock Plant Site Plan
102-279.02-102	Rev A	Land Application and Irrigation – Dewey Plant Site Plan
102-279.02-200	Rev A	Land Application and Irrigation – Burdock Pond Sections – Sheet 1 of 2
102-279.02-201	Rev A	Land Application and Irrigation – Burdock Pond Sections – Sheet 2 of 2
102-279.02-202	Rev A	Land Application and Irrigation – Dewey Pond Sections – Sheet 1 of 2
102-279.02-203	Rev A	Land Application and Irrigation – Dewey Pond Sections – Sheet 2 of 2
102-279.02-301	Rev A	Land Application and Irrigation – Typical Pond Sections and Details – Sheet 1 of 2
102-279.02-302	Rev A	Land Application and Irrigation – Typical Pond Sections and Details – Sheet 2 of 2
102-279.02-500	Rev A	Land Application and Irrigation – Diversion Channel Sections
102-279.02-600	Rev A	Land Application and Irrigation – Dewey Evaporation Areas and Land Application Regrading
102-279.02-601	Rev A	Land Application and Irrigation – Burdock Evaporation Areas and Land Application Regrading
102-279.05-001	Rev A	Deep Well Disposal - Cover Page
102-279.05-010	Rev A	Deep Well Disposal – Index, General Site Location Map and Symbols
102-279.05-050	Rev A	Deep Well Disposal – Site Plan – Test Pit Locations
102-279.05-100	Rev A	Deep Well Disposal – Site Plan
102-279.05-101	Rev A	Deep Well Disposal – Burdock Plant Site Plan
102-279.05-102	Rev A	Deep Well Disposal – Dewey Plant Site Plan
102-279.05-200	Rev A	Deep Well Disposal – Burdock Pond Sections
102-279.05-202	Rev A	Deep Well Disposal – Dewey Pond Sections
102-279.05-301	Rev A	Deep Well Disposal – Typical Pond Sections and Details – Sheet 1 of 2

102-279.05-302 Rev A Deep Well Disposal – Typical Pond Sections and Details – Sheet 2 of 2
102-279.05-500 Rev A Deep Well Disposal – Diversion Channel Sections

**Powertech (USA) Inc.
Dewey-Burdock Project
Pond and Land Application
Technical Specifications and QA/QC Plan
Part 3- Pipeworks and Appurtenances**

Section 1.0 - General

1.1 Introduction

This Specification stipulates materials and installation requirements for pipework and appurtenances related to the construction of the Ponds and Land Application Systems at Powertech's Dewey-Burdock project.

1.2 Limitations and Disclaimer

This Specification titled Dewey-Burdock Project Pond and Land Application Technical Specifications Part 3 - Pipework and Appurtenances has been prepared by Knight Piésold and Co. (Knight Piésold) for the exclusive use of Powertech (USA) Inc. (Client). No other party is an intended beneficiary of this Specification or the information, opinions, and conclusions contained herein. Any use by any party other than the Client of any of the information, opinions, or conclusions is the sole responsibility of said party. The use of this Specification shall be at the sole risk of the user regardless of any fault or negligence of the Client or Knight Piésold.

The information contained herein have been completed to a level of detail commensurate with the objectives of the assignment and in light of the information made available to Knight Piésold at the time of preparation. This specification and its supporting documentation have been reviewed and/or checked for conformance with industry-accepted norms and applicable government regulations. To the best of the information and belief of Knight Piésold, the information presented in this Specification is accurate to within the limitations specified herein.

This Specification is Knight Piésold pdf file: Dewey-Burdock Pond and Land Application Technical Specifications Part 3 - Pipework and Appurtenances Rev 0.pdf. Any reproductions or modifications of this Specification are uncontrolled and may not be the most recent revision.

1.3 Contributors and Approvals

This specification was prepared, reviewed, and approved by the undersigned.

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Section 2.0 - Codes, Regulations and Definitions

This Specification stipulates materials and installation requirements for pipework and appurtenances related to the construction of the Ponds and Land Application Systems at Powertech's Dewey-Burdock project. Should the Contractor wish to deviate from these Specifications, he shall notify the Engineer in writing, providing a description of the deviation. The description shall include data indicating the magnitude of the deviation, justification for the deviation, and any possible short or long-term impacts of the deviation on the project. Deviations in materials Specifications shall be subject to the approval of the Engineer and Owner prior to shipment of the materials.

All pipe installation is to be completed in accordance with the Manufacturer's specifications. Prior to starting pipe installation, the Contractor shall provide certification from the Manufacturer that the materials supplied have been produced and tested in accordance with relevant Specifications.

2.1 Definition of Terms

"Owner" is defined as an authorized representative of Powertech.

"Engineer" is defined as representative appointed and authorized by the Owner. The Engineer shall be a Registered Professional Engineer, or a designated site representative under the supervision of a Registered Professional Engineer.

"Contractor" is defined as the party that has executed a contract agreement for the specified Work with the Owner.

"Technical Specifications" is defined as this document, prepared by Knight Piésold and Co. and all supplemental addenda.

"Drawings" is defined as the Drawings, in conjunction with these Technical Specifications, prepared by Knight Piésold and Co. for the ponds and land application system at Powertech's Dewey-Burdock Project.

"Work" is defined as the entire completed construction, or the various separately identifiable parts thereof, as shown on the Drawings, and required to be furnished under the Contract Documents.

"Site" is defined as the project area where the work is to be performed.

"Contract Documents" are defined as the Agreement, Addenda, Contractor's Bid (when attached as an Exhibit to the Agreement), Bonds, General Conditions, Special Conditions, Technical Specifications, Drawings and all modifications issued after execution of the Agreement.

"Modifications" are defined as changes made to the Technical Specifications or the Drawings, that are approved by the Owner and Engineer, in writing, after the Technical Specifications and Drawings have been finalized.

All slopes are defined as horizontal to vertical distances.

2.2 General Technical Requirements

The general technical requirements specified herein shall apply to all activities and operations relating to carrying out the Work or as required by the Engineer or Owner for the pipeworks and appurtenances associated with the construction of the ponds and land application system at Powertech's Dewey-Burdock Project, South Dakota.

In the event of an inconsistency in the Technical Specifications and Drawings, the Contractor shall refer all questions to the Engineer for final decision. Work that concerns the inconsistency shall not be performed until the contradiction is remedied or explained by the Engineer. In all events, the decision of the Engineer is final.

2.2.1 General Specifications

The contractor will be required to submit to the Engineer or Owner, at a minimum, the following plans and comply with training requirements associated with their project tasks, as may be applicable:

- Occupational Safety and Health Administration (OSHA)
 - Healthy and Safety Plan in accordance with 29 CFR Part 1910 – Occupational Safety and Health Standards
 - Hazardous Communication Plan in accordance with 29 CFR Part 1910.1200 – Toxic and Hazardous Substances
 - Material Safety Data Sheets (MSDS) for all chemicals in accordance with 29 CFR 1910.1200 (g)
- Spill Prevention, Control and Countermeasure (SPCC) Plan in accordance with 40 CFR Part 112.3 – Requirement to prepare and implement a Spill Prevention, Control, and Countermeasure Plan
- Training
 - Mine Safety and Health Administration – 24-hour class plus 8-hour refresher course in accordance with 30 CFR
 - HAZWOPER – 40-hour class plus 8-hour refresher course in accordance with 29 CFR 1910.120

2.3 Applicable Codes and Regulations

The following publications of the latest issue are a part of this Specification, except where replaced or revised by local codes or ordinances having jurisdiction, in which case the more stringent shall govern.

- American National Standard Institute (ANSI)
- American Society of Mechanical Engineers (ASME)
- American Society for Testing and Materials (ASTM)
- American Water Works Association (AWWA)
- American Association of State Highway Transportation Officials (AASHTO)
- Society of Plastics Inc. (SPI)
- American Petroleum Institute (API)
- Plastic Pipes Institute (PPI)

Section 3.0 - Mobilization and Demobilization

3.1 Scope

The Work covered by this section consists of the Contractor's mobilization to the Site of all the equipment and temporary facilities required for the successful completion of the Work, and shall include, but not necessarily be limited to, the following:

- Establish the Contractor's maintenance facilities, temporary workshops, temporary office accommodation and sanitary facilities.
- Maintain equipment and temporary facilities for the duration of the Work.
- All items required to be moved onto the Site for execution of the Work.
- On completion of the Work, remove all equipment and temporary facilities from the Site, and clean up the Site to the satisfaction of the Owner and the Engineer.

3.2 Mobilization

The Contractor shall mobilize to the Site sufficient labor, materials, and equipment to allow commencement of the Work. The Contractor shall bring on to the Site, as and when necessary, any additional equipment, labor and materials which may be required to complete the remainder of the Work in the time specified in the General Terms and Conditions.

3.3 Contractor's Workshops, Stores, and Offices

The Contractor shall erect, in the area designated by the Owner and Engineer, adequate workshops, offices and other buildings and structures for the completion of the Work as designated in the Contract Documents. Such workshops, offices and etc., shall be maintained in a neat and tidy condition throughout the duration of the Work to the satisfaction of the Engineer and Owner.

3.4 Sanitation

The Contractor shall provide and maintain adequate sanitary facilities for the personnel at the Site, including the Contractor's offices and Engineer's offices, in compliance with local health regulations and to the satisfaction of the Engineer and Owner.

3.5 Demobilization

On completion of the Work, the Contractor shall remove all of the Contractor's equipment, temporary facilities and materials from the Site. The Site shall be left in a clean and tidy state, to the satisfaction of the Engineer and Owner. All waste and refuse shall be disposed of in a legal manner acceptable to the Owner.

Section 4.0 - Materials

4.1 General

The Contractor shall perform all material tests in accordance with the Specifications. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor's schedule is not delayed.

In addition to those tests specifically required, the Engineer may request additional samples of material for testing. The additional samples shall be supplied at no additional cost to the Client.

4.2 High Density Polyethylene (HDPE) Pipe

The type of pipe used shall be as specified on the Drawings, or an equivalent that has been approved by the Engineer, and shall comply with American Water Works Association (AWWA) Specifications C906. It shall have a minimum density of 0.955 grams per cubic centimeter, and a Hydrostatic Design Basis (HDB) of 1,600 psi (ASTM D2837).

HDPE pipe and fittings shall be from a single manufacturer who is fully experienced, reputable and qualified in the manufacture of the HDPE pipe to be furnished.

HDPE pipework and fittings shall be high density, high molecular weight polyethylene pipe such as PLEXCO PE 3408, manufactured by PLEXCO, Inc., or an equivalent that has been approved by the Engineer.

Material used for the manufacture of HDPE pipe and fittings shall be made from a PE 3408 high density polyethylene resin compound meeting cell classification 345434C per ASTM D3350; and meeting Type III, Class C, Category 5, Grade P34 per ASTM D1238.

Should rework compounds be required, only those generated in the Manufacturer's own plant from resin compounds of the same class and type, and from the same raw material supplier shall be used.

Pipe shall be furnished in standard laying lengths not to exceed 50 feet, and to be no shorter than 20 feet.

Dimensions and workmanship shall be as specified by ASTM F714, ASTM D2513 and ASTM D3035.

Stub ends for butt fusion shall be at least the same wall thickness, pressure rating, resin type, and Manufacturer as the pipe to be joined, unless the Engineer has approved otherwise.

Where HDPE and Corrugated Polyethylene Tubing (CPT) pipes are connected, only manufactured fittings shall be used. All other joints shall be flanged joints or as indicated on the Drawings. Backing flanges for HDPE pipe shall be ductile iron unless the Engineer has approved otherwise.

Pipe diameters and thicknesses shall be as specified on the Drawings.

4.2.1 Fittings

All molded fittings and fabricated fittings shall be fully pressure rated to match the pipe SDR rating to which they are made.

The manufacturer of the HDPE pipe shall supply all HDPE fittings and accessories as well as any adapters and/or specials required to perform the work as shown in the Drawings or specified herein. No Contractor fabricated fittings shall be used unless approval has been obtained from the Engineer.

HDPE fittings and transitions shall meet ASTM D3261

4.3 Carbon Steel Pipe

All pipes, fittings and flanges shall be carefully examined for cracks and other defects prior to shipment. All defective pipes, fittings and flanges shall be rejected and replaced.

In addition to any other markings specified herein, each length of pipe and each special section shall be legibly marked by paint stenciling, die stamping, or hot roll marking to show the following:

- Manufacturer's name and mark.
- Size and weight of the pipe or special section.
- Type of steel from which the pipe or special section was made.

Carbon steel pipe shall be ERW, bare finish, have beveled ends, and conform to ASTM A-135, Grade B requirements. Pipe schedule shall be Standard unless shown otherwise on the Drawings. All pipes and fittings shall be free from fins and burrs.

4.3.1 Fittings

Butt weld fittings are to be manufactured from carbon steel, to be seamless, conform to ASTM A234 Grade WPB, to be butt welded, and are to be Schedule 40.

Grooved couplings are to be Vitaulic Style 77 or an equivalent that has been approved by the Engineer, have Grade "O" Fluoro-elastomer, are to conform to ANSI C606, to be manufactured from ductile iron conforming to ASTM A536, and to have carbon steel heat treated track bolts conforming to ASTM A183. All bolts, nuts and washers shall be made of Type 316 stainless steel.

Pipe Flanges are to be manufactured from Class 150 carbon steel, are to conform to ASTM A105, to be raised face, weldneck, and are to be Schedule 40 bore.

Blind Flanges are to be Class 150 Carbon Steel, are to conform to ASTM A105, and are to be raised face.

Orifice Flanges are to be Class 300 Carbon Steel, are to conform to ASTM A105, be raised face, Weldneck, to have 1/2" screwed taps, and are to be Schedule 40 bore.

4.4 Bolts and Gaskets

4.4.1 Bolts

Flange assembly bolts are to conform to ASTM A307, Grade A Standard. Bolt/stud length shall be such that on completed joints, the ends of the bolts shall protrude the unit by no more than 12mm. Threads shall conform to ASME B1.1. Bolts are to be assembled with an anti-seize compound.

4.4.2 Gaskets

Flange gaskets shall conform to ASME/ANSI B 16.21 and shall be used with all flanged joints unless otherwise specified by the supplier of the valves, fittings or pipework, and approved by the Engineer.

Gaskets are to have a 1/16" minimum thickness for plain finished surfaces, and a 3/32" minimum thickness for serrated surfaces.

4.5 Valves

All valves are to conform to API Specification 6D and API 600. They are to be Class 150, unless otherwise specified. They are to be carefully examined prior to shipment for defects, with any defective valves being rejected and replaced. Valves are to be reexamined when they are offloaded at site, and again when they are installed.

All valves shall be as specified on the Drawings. Valves shall not have any brass, copper, aluminum or zinc parts. Valve specifications, per the valve supplier, shall be submitted to the Engineer for approval prior to bringing such valves on site.

4.6 Pumps

Pumps are to be carefully examined prior to shipment for defects, with any defective pumps being rejected and replaced. Pumps are to be reexamined when they are offloaded at site, and again when they are installed.

All pumps shall be as specified on the Drawings. Pumps shall not have any brass, copper, aluminum or zinc parts. Pump specifications, per the pump manufacturer, shall be submitted to the Engineer for approval prior to bringing such pumps on site.

4.7 Submittals

4.7.1 General

The Contractor shall submit to the Engineer upon request a Manufacturer's certification that all pipe, valves and fittings comply with the applicable portions of the Specification.

The Contractor shall provide a warranty against manufacturing defects of material and workmanship for a period of ten years after final acceptance of the project by the Owner. The Contractor shall replace, at no expense to the Owner, any defective piping/fitting material, including labor, within the warranty period.

4.7.2 HDPE Pipe

Documentation from the resin's manufacturer showing results of the following tests for resin identification is to be provided:

- Melt flow index – ASTM D1238
- Density – ASTM D1505

The HDPE pipe manufacturer shall provide certification that stress regression testing has been performed on the specific polyethylene resin being utilized in the manufacture of the product. This stress regression testing shall be in accordance with ASTM D2837. The manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi, as determined in accordance with ASTM D2837.

4.7.3 Carbon Steel Pipe

The Contractor is to provide Manufacturer's data on the furnished pipe, indicating compliance with the specifications regarding dimensions, thickness, weights and materials. In addition, he is to provide the manufacturer's "Certificate of Compliance", stating that the materials furnished comply with this Specification.

4.8 Pipe and Valve Delivery, Handling and Storage

All pipe and appurtenances furnished by the Contractor shall be delivered, distributed, and stored at the project site by the Contractor. All items are to be shipped in accordance with the manufacturer's instructions, and stored in a manner that they are not damaged. Care shall be taken in loading, transporting and unloading to prevent damage to the pipe or appurtenances. Pipe, fittings, valves and other appurtenances shall be loaded and unloaded by lifting with hoists or by skidding so as to avoid shock or damage.

- All items shall be handled in such a manner as to avoid damage or hazard.
 - Ropes, fabric or rubber protected slings and straps shall be used when handling pipes.
 - Two slings spread apart shall be used for lifting each length of pipe.
 - Under no circumstances shall pipe or pipe fittings be dropped to the ground or into trenches.
 - Under no circumstances shall chains, cables or hooks inserted into pipe ends be used for lifting the pipe.
- Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground. The Contractor shall ensure the safe and proper storage of pipe and fittings. The interior of all pipe shall be kept free from dirt and foreign material at all times.

The Contractor shall be responsible for all materials at all times. The Contractor shall be responsible for all material furnished by him, and shall replace or repair at his own expense, and in a manner that has been approved by the Engineer, all such material found to be defective in manufacture or damaged in handling or during storage after delivery by the Manufacturer. This shall include the furnishing of all materials and labor required for the replacement of installed material discovered to be damaged or defective prior to final acceptance of the work, or during the guaranteed period.

Pipe shall not be stacked higher than the manufacturer's recommendations.

4.8.1 HDPE Pipe

Pipes shall be stored on clean, level ground, preferably turf or sand, and free from sharp objects that could damage the pipe. Where necessary due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such width so as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

Stacking of HDPE pipe shall be limited to a height that will not cause excessive deformation of the bottom layers of pipe under anticipated temperature conditions.

Pipe shall be handled so that it is not damaged by dragging it over sharp and cutting objects. The maximum allowable depth of cuts, scratches or gouges on the exterior of the pipe is 5 percent of wall thickness. The interior of the pipe is to be free of cuts, scratches or gouges.

4.8.2 Carbon Steel Pipe

All pipes, fittings, flanges and accessories shall be stored at the job site in unit packages provided by the manufacturer, and caution shall be exercised to avoid compression damage or deformation of the piping. Any gaskets shall be stored in a cool, dark place out of the direct rays of the sun, in their original cartons, and are not to come into contact with petroleum products.

Section 5.0 - Installation

5.1 Pipe

All pipe and appurtenances shall be examined before installation, and no piece is to be installed that is found to be defective. Any damage to the pipe shall be replaced or repaired, as directed by the Engineer. If any defective pipe is discovered after it has been installed, it shall be removed and replaced by the Contractor in a satisfactory manner that has been approved by the Engineer, at the Contractor's expense.

All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid.

All pipes and fittings shall be lowered into trenches; under no circumstances shall pipe or appurtenances be dropped into trenches.

All pipe installation is to be completed in accordance with the pipe Manufacturer's specifications. Prior to commencing pipe installation a copy of the Manufacturer's specifications shall be submitted to the Engineer for approval. A copy of the Manufacturer's specifications shall be maintained on site during construction.

The Contractor shall supply and install all piping required to complete the piping installation in accordance with good piping practices, whether such piping is specifically detailed on the Drawings or not. All pipe shown on the Drawings shall be installed to the alignments and grades indicated by the Drawings. Where specific alignments and grades are not indicated on the Drawings, they shall be determined in the field by the Engineer to suit existing conditions and to fulfill the requirements of the project. Where interference is encountered during installation, or relocation of piping is deemed necessary, the Engineer shall be consulted before any changes are made. Care shall be taken in the installation of pipeline runs where drainage is required to ensure that the pipeline has a continuous slope to the point of drainage.

Care should be taken to prevent foreign material from entering the pipe during installation. The open ends of the pipes shall be covered with fabricated end caps or other approved means when installation is not in progress, including lunchtime.

Pipes bent to form curves in any direction shall not exceed the deflections recommended by the Manufacturer and Engineer. The cutting of the pipe for inserting fittings or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe.

Backfill materials shall be as indicated on the Drawings and according to Earthworks Specifications. Where compacted earth backfill is indicated, the backfill material shall be placed around and over buried sections in lifts not exceeding 8-inches loose. Compaction is to be achieved by hand operated compactors, or other methods approved by the Engineer. Unless otherwise specified, compaction is to be to a minimum of 90 percent of the maximum dry density as determined by ASTM D1557.

Pipe and fittings shall rest solidly on the pipe bed, with recessed excavation to accommodate bells, joints and couplings. Anchors and supports shall be provided where necessary and where indicated on the drawings for fastening work into place. Fittings shall be independently supported.

Once installation has been completed, thoroughly clean all new pipelines to remove dirt, stones, pieces of wood or other material which may have entered during the construction period by forcing a cleaning swab through all pipes 6" or greater. Flushing velocities shall be a minimum of 2.5 feet per second. All flushing shall be coordinated with the Engineer. Debris removed from the lines shall be removed from the job site and be disposed of in a legal manner that has been approved by the Engineer and Owner.

5.1.1 HDPE Pipe

All HDPE pipe shall be designed, constructed and installed with the best practices and methods, and shall comply with these Specifications. Installation shall be in accordance with the manufacturer's instructions, as show on the Drawings, and as specified herein.

Sections of pipe with cuts, gouges or scratches exceeding 5 percent of the pipe wall thickness, or which is in any other way defective, shall be removed completely and the ends of the pipes rejoined to the Engineer's approval, at the cost of the Contractor.

Joining techniques and operating procedures shall be in accordance with written instructions provided by the pipe Manufacturer and the joining equipment supplier. Joining equipment shall be supplied by, leased from, or otherwise approved by the pipe Manufacturer. Where an inconsistency between pipe Manufacturer and joining equipment supplier exist, the pipe Manufacturer shall overrule once approval has been obtained from the Engineer. A copy of all instructions shall be present at any location that butt fusion is being conducted.

Joining HDPE pipe lengths shall be by thermal butt fusion as outlined in ASTM D2657, and shall conform to the Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe, Technical Report TR-33/2006, published by the Plastic Pipe Institute (PPI), unless otherwise specified on the Drawings.

Pipe segments shall be joined in continuous lengths at the location of installation. Dragging of pipe into place shall be kept to a minimum and will only be permitted when the pipe will not be damaged.

The polyethylene pipe flange adapters at pipe material transitions shall be backed up by stainless steel flanges conforming to ASME/ANSI B16.1 and shaped as necessary to suit the outside dimensions of the pipe. The flange adapter assemblies shall also conform to the following:

- The flange adapter assemblies shall be connected with corrosion resisting bolts and nuts of Type 316 Stainless Steel, as specified in ASTM A726 and ASTM A307.
- All bolts shall be tightened to the manufacturer's specifications; bolts shall be tightened alternatively and evenly.
- After installation, a bitumastic coating is to be applied to the bolts and nuts.

All HDPE pipe must be at the temperature of the surrounding soil at the time of backfilling and compaction.

5.1.1.1 Fittings

All fittings shall be installed using butt-fused fittings, thermo-fused fittings/couplings, or flanged adapters, and must have been approved by the Engineer. No size-on-size wet taps shall be permitted.

5.1.2 Carbon Steel Pipe

All work on carbon steel pipe shall be done by qualified craftsmen in a workmanlike manner, and shall conform to API 1104 and industry standards. All welders shall be certified in accordance with API 1104. However, other certification may be accepted at the discretion of the Engineer. The Contractor shall submit certifications to the Engineer prior to welding of the pipework.

Before jointing, all joint contact surfaces shall be wire brushed, wiped clean, and kept clean until the jointing is completed. Flange faces shall be wire brushed and cleaned to remove all oil, grease, loose primer, mill scale, or any other foreign matter that could affect the proper seating of the gasket.

All welds shall be full penetration and no backup rings shall be used. Welding shall conform to ASME B31.1.

5.2 Valves

All valves are to be installed as shown on the Drawings, and as specified by the valve manufacturer.

5.3 Pumps

All pumps are to be installed as shown on the Drawings, and as specified by the pump manufacturer.

5.4 Compatibility

The Contractor is responsible for the compatibility between all pipe materials, fittings and appurtenances.

Section 6.0 - Testing

6.1 HDPE Pipe

6.1.1 Bent Strap Tests

On days that butt fusions are to be made, the first fusion shall be a trial fusion in the presence of the Engineer. The following shall apply:

- Heating plates shall be inspected for cuts and scrapes.
- The plate temperature shall be measured at various locations to ensure proper heating/melting per the manufacturer's recommendations.
- Once the trial fusion has been completed, a fusion or test strip shall be cut out of the pipe after cooling completely for inspection.
- The test strip shall be a minimum of 12" or 30 times the wall thickness in length, whichever is greater. The fusion joint shall be located midway along the strip.
- The test strip shall be a minimum of 1" or 1.5 times the wall thickness in width, whichever is greater.
- The joint shall be visually inspected as to continuity of "beads" from the melted material, and for assurance of "cold joint" prevention (a "cold joint" forms when the molten material is squeezed out of the joint, resulting in unmelted sections of the pipe butting up against each other on each side of the joint).
- Joint spacing between the walls of the two ends shall be a minimum of 1/16" to a maximum of 3/16".
- A bent strap test is to be performed on the test strip.
 - These tests require safety measures against inadvertent release, joint failure, and springback during bending. Considerable force may be required to complete the test for pipe having larger wall thicknesses.
 - The Contractor is to ensure that the appropriate safety equipment is provided for the test, and that all participants and witnesses have the appropriate personal protective equipment.
 - During the bent strap test, the test strip is to be bent so that the ends of the strip touch.
 - Any disbondment of the fusion is unacceptable and indicates poor fusion quality.
 - If failure occurs, fusion procedures and/or machine setup should be changed, a new trial fusion must be made, and a new bent strap test specimen prepared and tested.
 - Field fusion shall not proceed until a test joint has passed the bent strap test.

6.1.2 Destructive Laboratory Tests of Butt Fusion Joints

Destructive laboratory tests of tensile specimens prepared from butt fusion joined pipes shall be performed for every 2,500 ft of pipe installed. A minimum of three tests shall be performed for each pipe diameter/SDR combination. These tests shall be performed according to ASTM D638, and shall be compared to specimens without joints, and obtained from the parent pipe.

6.1.3 Pressure Testing

All HDPE pipelines shall be field pressure tested. The Contractor shall supply all labor, equipment, material, gauges, pumps, meters and incidentals required for testing. Each pipeline shall be pressure tested upon completion of pipe laying and backfilling operations, including placement of any required temporary roadway surfacing.

Hydrostatic pressure leak tests of HDPE pipe shall be conducted in accordance with ASTM F2164. The pipes shall be tested using clean water. The following must be complied with during the testing procedure:

- The pipeline must be restrained against movement in the event of catastrophic failure. Joints may be exposed for leakage examination, provided that restraint is maintained.
- The testing equipment capacity and the pipeline test section shall be such that the pipeline can be pressurized and examined for leaks within the test duration time limits. Lower capacity testing and pressurizing equipment may require a shorter test section.
- Test equipment and the pipeline shall be examined before pressure is applied to ensure that connections are tight, necessary restraints are in place and are secure, and that components that should be isolated or disconnected are isolated or disconnected. All low pressure filling lines and other items not subject to the test pressure shall be disconnected and isolated.
- All pipelines shall be tested to 150 percent of the operating design pressure of the pipe at the lowest elevation in the section under test, unless otherwise approved or instructed by the Engineer.
 - If lower pressure rated components cannot be removed or isolated from the test section, the maximum test pressure is the pressure rating of the lowest pressure rated component that cannot be isolated from the test section.
 - Test pressure is temperature dependent, and the pipe manufacturer must be consulted where the pipe is to be tested at elevated temperatures.
- The pressure testing procedure shall be per the Manufacturer's recommendations and as approved by the Engineer, or as follows:
 - Fill the pipeline slowly with water; maintain a flow velocity of less than 2 feet per second.
 - Expel air completely from the line during filling and again before applying the test pressure. Air shall be expelled by means of taps at the points of highest elevation.
 - The test procedure consists of an initial expansion phase, and a test phase.
 - For the initial expansion phase, the test section is pressurized to the test pressure, and make up liquid is added as required to maintain the maximum test pressure for four hours. This allows for the diametric expansion/pipe stretching to stabilize.
 - For the test phase, the pressure is reduced by 10 psi and the pump is turned off. This is the target test pressure. If the pressure remains steady (within 5% of the target test pressure) for an hour, and provided no leaks are observed, the pipe is considered to have passed the test.
 - Upon completion of the test, the pressure shall be bled off from a location other than the point where the pressure was monitored. The pressure drop shall be witnessed by the Engineer at the point where the pressure is being monitored and shall be shown on the recorded pressure readout submitted to the Engineer.
- If any test pipe laid discloses leakage, and/or a significant pressure drop greater than 5% of the target test pressure, the Contractor shall locate and repair the cause of leakage at his own expense, and retest the line.
- All visible leaks shall be repaired regardless of the amount of leakage.
- If leaks are discovered, depressurize the pipeline before repairing leaks. Leakage of a butt fusion joint may indicate imminent catastrophic rupture, and in such circumstances, the pipe must be depressurized immediately. Leaks at fusion joints require that the fusion joint be cut out of the pipeline and redone.
- If the pressure leak test is not completed for any reason, including equipment failure, the test section shall be depressurized and repairs made. The test section is to remain depressurized for at least eight hours before retesting.
- The Contractor must submit his plan for testing to the Engineer for review at least 10 days before starting the test. The Engineer is to be present throughout the entire test procedure.

6.2 Carbon Steel Pipe

6.2.1 Pressure Testing

All carbon steel pipelines shall be hydrostatically pressure tested in accordance with ASME B31.3 - 2008 Process Piping. The Contractor shall supply all labor, equipment, material, gauges, pumps, meters and incidentals required for testing. Each pipeline shall be pressure tested upon completion of pipe laying and backfilling operations, including placement of any required temporary roadway surfacing.

Section 7.0 - As-Built Requirements

To assist in the production of adequate as-built Drawings and documentation, the Contractor will be required to provide one set of 22 inch by 34 inch red-lined Drawings with construction modifications, as well as the electronic formatted version of the Drawings to the Owner.

Section 8.0 - References

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- ASTM International, 2008, *ASTM D3350 - 08 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials*, ASTM International
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- American Society of Mechanical Engineers (ASME), 2003, *ASME B1.1-2003 Unified Inch Screw Threads, UN and UNR Thread Form*, American Society of Mechanical Engineers (ASME).
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Drawings

(see Drawings for Part 1 – Earthworks)