SCS ENGINEERS

Unstable Areas Compliance Demonstration OML Expansion Phase 1 and Existing Landfill

Ottumwa Midland Landfill

Prepared for:

Interstate Power and Light Company

Ottumwa Midland Landfill
15300 130th Street
Ottumwa, Iowa 52501

Prepared by:

SCS ENGINEERS
2830 Dairy Drive
Madison, Wisconsin 53718-6751
(608) 224-2830

October 2018
File No. 25218089.00

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I:\25218089.00\Deliverables\Unstable Areas Demonstration\181010_OML Landfill_Unstable Areas Restriction_October_2018_Final.docx

P.E. Certification

I, Eric J. Nelson, hereby certify that the unstable areas demonstration prepared for the OML Expansion Phase 1 and Existing Landfill at the Ottumwa Midland Landfill meets the requirements in 40 CFR 257.64(a). This certification is based on my review of the October 2018 Unstable Areas Compliance Demonstration for the OML Expansion Phase 1 and Existing Landfill prepared by SCS Engineers. I am a duly licensed Professional Engineer under the laws of the State of Iowa.

_____ 10/12/2018

(signature) (date)

Eric J. Nelson

(printed or typed name)

License number 23136

My license renewal date is December 31, 2018.

Pages or sheets covered by this seal:
Unstable Areas Demonstration, OML

1.0 INTRODUCTION AND PROJECT SUMMARY

On behalf of Interstate Power and Light Company (IPL), SCS Engineers (SCS) has prepared the enclosed Unstable Areas Compliance Demonstration for the Ottumwa Midland Landfill (OML) Expansion Phase 1 and Existing Landfill (existing coal combustion residual [CCR] landfill units) as required by 40 CFR 257.64.

Future proposed CCR units (Expansion Phases 2 through 6) are permitted with the Iowa Department of Natural Resources (IDNR), but have not been developed. When developed, the units will be new CCR landfills, as defined in 40 CFR 257.53. This document addresses OML Expansion Phase 1 and Existing Landfill. Future CCR units beyond Phase 1 are not addressed and are not discussed further herein.

Figure 1 shows the site location. **Figure 2** shows the OML Expansion Phase 1 and Existing Landfill locations.

2.0 UNSTABLE AREAS RESTRICTION

257.64 *"Unstable areas."*

"(a) An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted."

"(b) The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable:

"(1) On-site or local soil conditions that may result in significant differential settling;

As discussed in **Appendices A** and **B**, and as shown by the geologic cross sections from the 2013 Soil and Hydrogeologic Investigation Report prepared by SCS (see **Appendix C**), the OML Expansion Phase 1 and Existing Landfill CCR units are not located in on-site or local soil conditions that may result in significant differential settling. The site soils consist of stiff to hard silts and clays overlying bedrock. Because the silts and clays are stiff to hard, they are not susceptible to appreciable differential settlement that would affect the performance of the landfill.

(2) On-site or local geologic or geomorphologic features; and

As discussed in **Appendices A**, **B**, and **E**, and shown by the geologic cross sections in **Appendix C**, the OML Expansion Phase 1 and Existing Landfill CCR units are not located in on-site or local geologic or geomorphologic features that are unstable.

The cross sections show stiff to hard silts and clays that extend to bedrock. These geologic features provide a stable foundation for the CCR landfill. This assessment is confirmed by the slope stability analysis summary in **Appendix D** that indicates the slope stability safety factors are acceptable (i.e., safety factors against block or circular failure greater than or equal to 1.3).

(3) On-site or local human-made features or events (both surface and subsurface)."

As shown by the geologic cross sections in **Appendix C**, the OML Expansion Phase 1 and Existing Landfill CCR units are not located in on-site or local human-made features or events (both surface and subsurface) that are unstable. Prior to development for the landfill, there was historical coal mining in the vicinity of the landfill site. IDNR records and a 2012 microgravity survey (**Appendix A**) were used to confirm that the OML Expansion Phase 1 and Existing Landfill are not located in areas of potential mine works.

As discussed in **Appendix E**, groundwater or surface water movement is unlikely to cause instability. The facility is designed with adequate run-on and run-off control systems. Groundwater monitoring wells at the perimeter of the facility show that groundwater hydraulic gradients are downward and therefore groundwater is unlikely to negatively impact the performance of the facility. In addition, the design of both units includes an underdrain to collect and drain groundwater that may occur below the landfill liner.

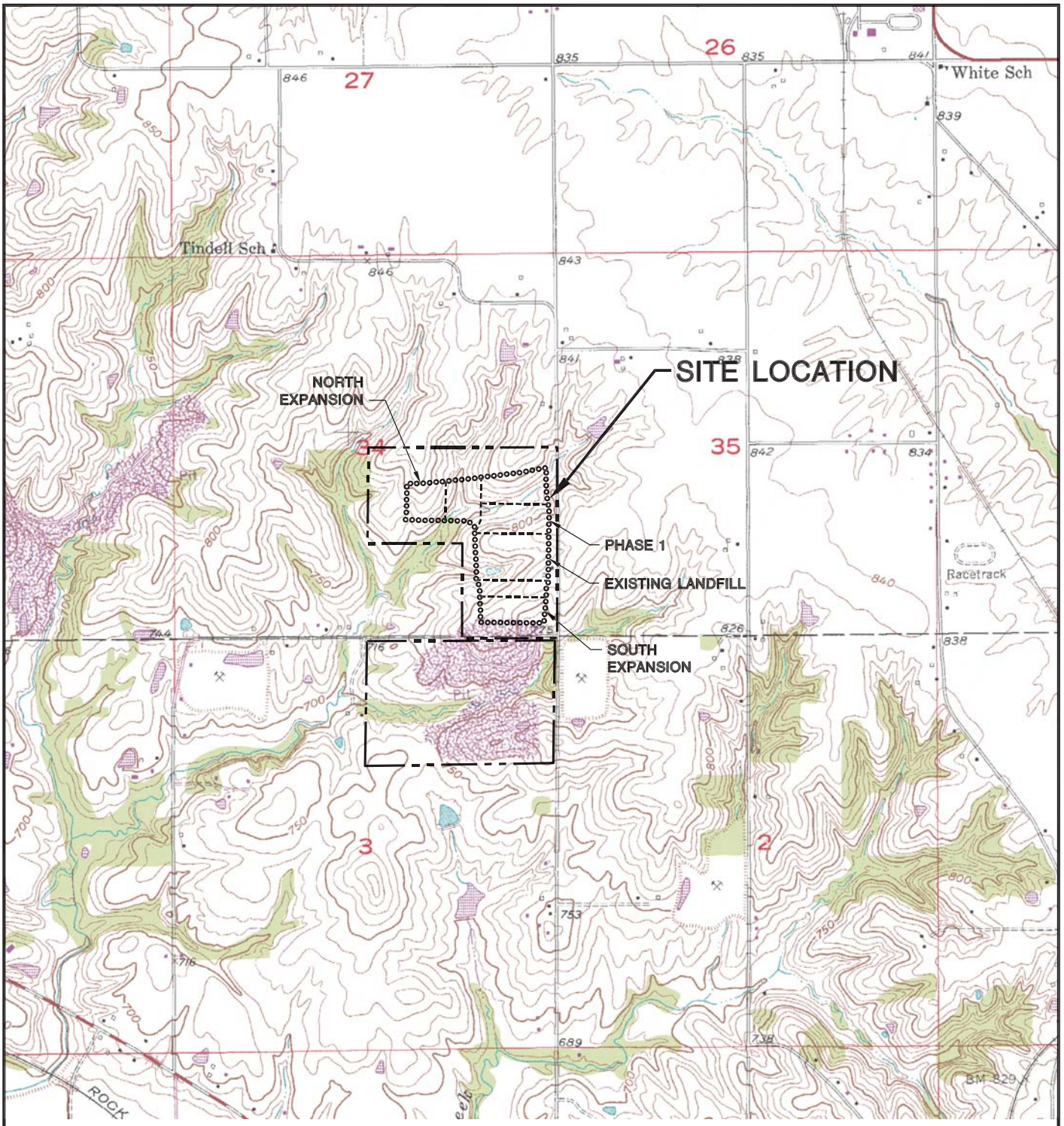
3.0 REFERENCES

A. Montgomery Watson, 1994, Hydrogeological Investigation Report and Hydrologic Monitoring System Plan, Ottumwa-Midland Commercial Landfill.

B. SCS Engineers, 2013, Proposed Landfill Expansion, Soil and Hydrogeologic Investigation Report, Ottumwa Midland Landfill, Interstate Power and Light Company, Ottumwa, Iowa.

C. SCS Engineers, 2013, Design Documents – Permit Amendment, Ottumwa Midland Landfill Expansion, Interstate Power and Light Company, Ottumwa, Iowa.

FIGURES

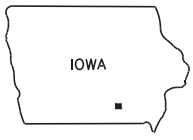


LEGEND

APPROXIMATE PROPERTY LINE

OTTUMWA NORTH QUADRANGLE
IOWA–WAPELLO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SW/4 OTTUMWA NORTH 15' QUADRANGLE
1976
SCALE: 1" = 2,000'

N



CLIENT	INTERSTATE POWER AND LIGHT CO. 15300 130th STREET OTTUMWA, IA 52501	SITE	OTTUMWA MIDLAND LANDFILL OTTUMWA, IOWA

SITE LOCATION MAP

PROJECT NO.	25218089.00	DRAWN BY:	KP
DRAWN:	09/15/11	CHECKED BY:	BSS
REVISED:	09/14/18	APPROVED BY:	

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

FIGURE
1

I:\25218089.00\Drawings\[illegible]ation Ma[illegible].dwg, 9/14/2018 9:53:55 [illegible]M

LEGEND

- APPROXIMATE PROPERTY LINE
- CURRENT LIMITS OF WASTE
- PHASE LIMITS
- EXISTING GROUND SURFACE (10' CONTOUR)
- EXISTING GROUND SURFACE (2' CONTOUR)
- EXISTING DITCH
- EXISTING STREAM
- EXISTING CULVERT
- ACCESS ROAD
- FENCE
- CULVERT
- WETLAND
- RIPRAP
- STAFF GAUGE
- MONITORING WELL
- PIEZOMETER

NOTES

1. TOPOGRAPHIC BASE MAP WAS COMPILED FROM IOWA DEPARTMENT OF NATURAL RESOURCES GENERALIZED TWO FOOT CONTOURS OF WAPELLO COUNTY IOWA DERIVED FROM LIDAR DATA. THE LIDAR DATA WAS ACQUIRED IN THE SPRING OF 2008. THE CONTOUR DATA WAS FIELD VERIFIED BY GLOBAL POSITIONING SURVEY (GPS) IN THE SPRING OF 2012. CONTOUR INTERVAL IS 2 FOOT. TOPOGRAPHIC BASE MAP IS SUPPLEMENTED WITH SURVEYS PERFORMED BY SCS ENGINEERS IN APRIL 2015 AND BY FRENCH RENEKER ASSOCIATES ON MAY 23, 2017.
2. ELEVATIONS ARE BASED ON NAVD 88 DATUM.
3. THE GRID SYSTEM IS BASED ON THE IOWA STATE PLANE COORDINATE SYSTEM NAD 83 (2007 ADJUSTMENT) AS DERIVED FROM NATIONAL GEODETIC SYSTEM (NGS) CONTROL MONUMENT DESIGNATION D 6.
4. PROPERTY LINE SOUTH OF 130TH STREET FROM SURVEY MAP PREPARED BY GARDEN & ASSOCIATES, OSKALOOSA, IOWA, DATED DECEMBER 20, 1988.
5. PROPERTY LINE NORTH OF 130TH STREET FROM PLAT OF SURVEY MAP PREPARED BY SCS ENGINEERS, MADISON, WISCONSIN, DATED FEBRUARY 20, 2013.
6. WETLAND LIMITS BASED ON WETLAND DELINEATIONS PERFORMED BY STANTEC CONSULTING SERVICES, INC., ON APRIL 15, 2012 AND OCTOBER 17, 2012 AND MITIGATION PERFORMED IN 2014/2015.
7. EXISTING STREAM ALIGNMENT SHOWN IN NORTH EXPANSION AREA IS APPROXIMATE CENTERLINE BASED ON GENERALIZED CONTOURS (EXISTING GRADE). EXISTING STREAM ALIGNMENT AT SOUTH END OF PROPERTY BASED ON SITE OBSERVATIONS BY STANTEC CONSULTING SERVICES, INC. ON OCTOBER 17, 2012.

N

200 0 200

SCALE: 1" = 200'

DRAWN BY: BJM/KP
CHECKED BY: PG
APPROVED BY:

PROJECT NO. 23218089.00
DRAWN: 09/17/18
REVISED: 09/17/18

CLIENT
INTERSTATE POWER AND LIGHT COMPANY
OTTUMWA MIDLAND LANDFILL
15300 130TH STREET
OTTUMWA, IOWA 52501

ENGINEER
SCS ENGINEERS
2830 DAIRY DRIVE, MADISON, WI 53718-6751
PHONE: (608) 224-2830

SITE
UNSTABLE AREAS COMPLIANCE DEMONSTRATION
OTTUMWA, MIDLAND LANDFILL
WAPELLO COUNTY, IOWA

FIGURE
OTTUMWA MIDLAND LANDFILL
EXISTING CONDITIONS
2

APPENDIX A

Site Description and Geologic Summary

Site Description and Geologic Summary

Site Information

The OML Existing Landfill and Expansion Phase 1 encompass approximately 24 acres, and are located in an agricultural area with rolling topography. The site is located in Wapello County at 15300 130th Street, Ottumwa, Iowa. The landfill is near Keb Lane and U.S. Highway 63.

Regional Geology

A summary of the regional hydrogeologic stratigraphy is presented in **Attachment A1**. Maps showing regional bedrock surface topography and the top of the Mississippian limestone in Southeastern Iowa are included in **Attachment A2**. The bedrock surface elevation is highly variable due to erosion.

The Des Moines River and associated alluvial aquifers are a major source of surface water and shallow groundwater in the area; however, the alluvial aquifer is not present at the OML site. Unconsolidated deposits at the site consist of clays overlain by loess. The uppermost bedrock unit in the site area consists of Pennsylvanian shales with minor siltstone, sandstone, limestone, and coal intervals. The continuity of these minor beds is highly variable. The thickness of the Pennsylvanian shale is variable; in some areas of Wapello County, it is over 100 feet thick, while in other areas it is absent. The variation in thickness is due to erosion of the bedrock surface. Underlying the Pennsylvanian shales are Mississippian limestone and dolomite, with some shale and sandstone. The Devonian units underlying the Mississippian are composed of shale, dolomite, and limestone, and are in turn underlain by Silurian dolomite.

Karst features have not been observed in boreholes at OML, and the site is not identified as an area with potential karst on reference GIS data available from Iowa Department of Natural Resources (IDNR) as shown in **Attachment A3**. The Pennsylvanian shale contains coal, and some evidence of historical mining activities has been observed in boreholes at OML. Based on the results of borings performed prior to construction of the Existing Landfill, Mongtomery Watson concluded that mine works that may have existed in the landfill area were fully collapsed and therefore are not a concern for performance of the landfill. A letter and map from the IDNR obtained during planning for the expansion of the landfill show the areas of historic coal mining in the vicinity of the landfill (**Attachment A4**). A microgravity survey was performed in 2012 to identify areas of potential mine works in the landfill expansion area, following the observation of a void in the Pennsylvanian shale at the northwestern corner of the site. The results of the microgravity survey indicated that mine works were potentially present in the northwestern portion of the site (**Attachment A4**). The landfill expansion was designed to avoid areas of potential mine works.

Previous Geologic Investigations

The landfill area was investigated by Montgomery Watson prior to construction of the OML Existing Landfill, and by SCS Engineers prior to construction of OML Expansion Phase 1. Approximately 14 borings were performed within and adjacent to the landfill area footprint. Seven of the borings were instrumented with groundwater monitoring wells. The borings

extended through the site soils and into the underlying bedrock. Split spoon and Shelby tube samples were collected. Laboratory soil testing included grain size analysis, Atterberg limits, water content, unit weight, permeability, and specific gravity. The boring locations and geologic cross sections are shown in **Appendix C**.

Based on the results of the subsurface investigations performed prior to landfill construction, the soils below the liner system within the facility footprint consist primarily of stiff to hard silts and lean clays overlying limestone, dolomite, shale, and sandstone bedrock.

References

Montgomery Watson, 1994, Hydrogeological Investigation Report and Hydrologic Monitoring System Plan, Ottumwa-Midland Commercial Landfill.

SCS Engineers, 2013, Proposed Landfill Expansion, Soil and Hydrogeologic Investigation Report, Ottumwa Midland Landfill, Interstate Power and Light Company, Ottumwa, Iowa.

MDB/DLN/AJR/EJN

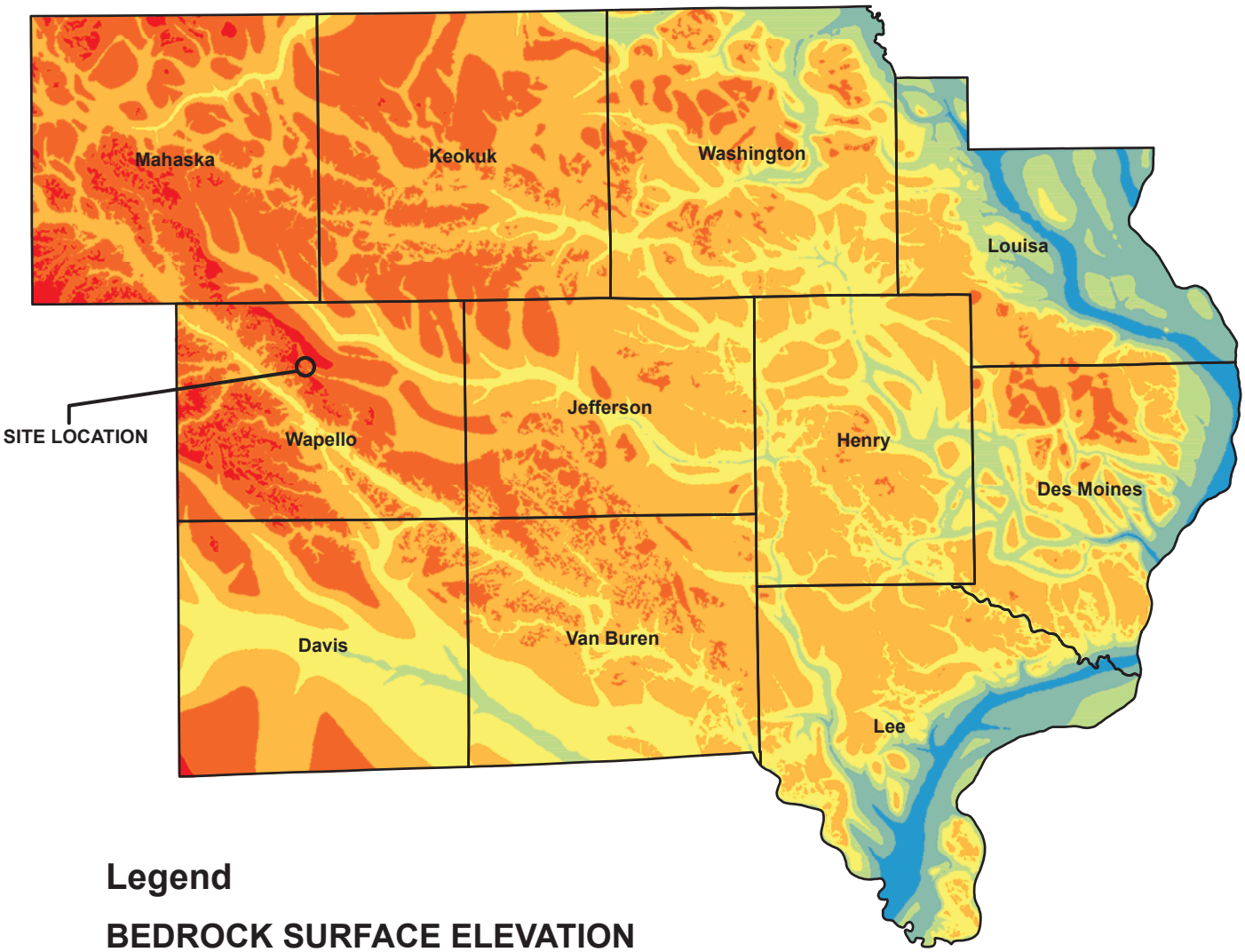
Table OML-3. Regional Hydrogeologic Stratigraphy
Ottumwa Midland Landfill / SCS Engineers Project #25218089.00

Age of Rocks	Hydrogeologic Unit	General Thickness (feet)	Name of Rock Unit[2]	Type of Rock
Quaternary (0-1 million years old)	Surficial Aquifers[1] • Alluvial • Buried-Channel • Drift	0 to 320	Undifferentiated	• Sand, gravel, silt, and clay • Sand, gravel, silt, and clay • Till (sandy, pebbly clay), sand, and silt
Pennsylvanian (180 to 310 million years old)	Aquiclude	0 to 370	Undifferentiated	• Shale, sandstone, limestone, and coal
Mississippian (310 to 345 million years old	Mississippian Aquifer • Upper	0 to 600	St. Louis Spergen	• Limestone and sandstone • Limestone
	• Lower		Warsaw Keokuk Burlington Hampton Starrs Cave	• Shale and dolomite • Dolomite, limestone, and shale • Dolomite and limestone • Limestone and dolomite • Limestone
	Aquiclude	0 to 425	Prospect Hill McCraney	• Siltstone • Limestone
Devonian (345 to 400 million years old)			Yellow Spring Lime Creek	• Shale, dolomite, and siltstone • Dolomite and shale
	Devonian Aquifer	110 to 420	Cedar Valley Wapsipinicon	• Limestone and dolomite • Dolomite, limestone, shale, and gypsum
Silurian (400 to 425 million years old)		0 to 105	Undifferentiated	• Dolomite
Ordovician (425 to 500 million years old)	Aquiclude	150 to 600	Maquoketa Galena Decorah Platteville	• Dolomite and shale • Dolomite and chert • Limestone and shale • Limestone, shale, and sandstone
	Cambrian-Ordovician aquifer	750 to 1,110	St. Peter Prairie du Chien	• Sandstone • Dolomite and sandstone
Cambrian (500 to 600 million years old)			Jordan St. Lawrence	• Sandstone • Dolomite
	Not considered an aquifer in southeast Iowa	450 to 750+	Franconia Galesville Eau Claire Mt. Simon	• Shale, siltstone, and sandstone • Sandstone • Sandstone, shale, and dolomite • Sandstone
Precambrian (600 million to 2 billion + years old)				• Sandstone, igneous rocks, and metamorphic rocks

(1) These Surficial Aquifers are either not present at OML or do not meet the definition of the Uppermost Aquifer in 40 CFR 257.53.
(2) This nomenclature and classification of rock units in this report are those of the Iowa Geological Survey and do not necessarily coincide with those accepted by the U.S. Geological Survey.

Source: "Water Resources of Southeast Iowa," Iowa Geologic Survey Water Atlas No. 4.

I:\25218089.00\Deliverables\Unstable Areas Demonstration\Appendices\Appendix A\Table_3_Regional_Hydrogeologic_Stratigraphy_rev01.doc



Legend

BEDROCK SURFACE ELEVATION

ELEVATION ABOVE MEAN SEA LEVEL IN FEET

- BELOW 300
- 300 TO 400
- 400 TO 500
- 500 TO 600
- 600 TO 700
- 700 TO 800
- 800 TO 900

N

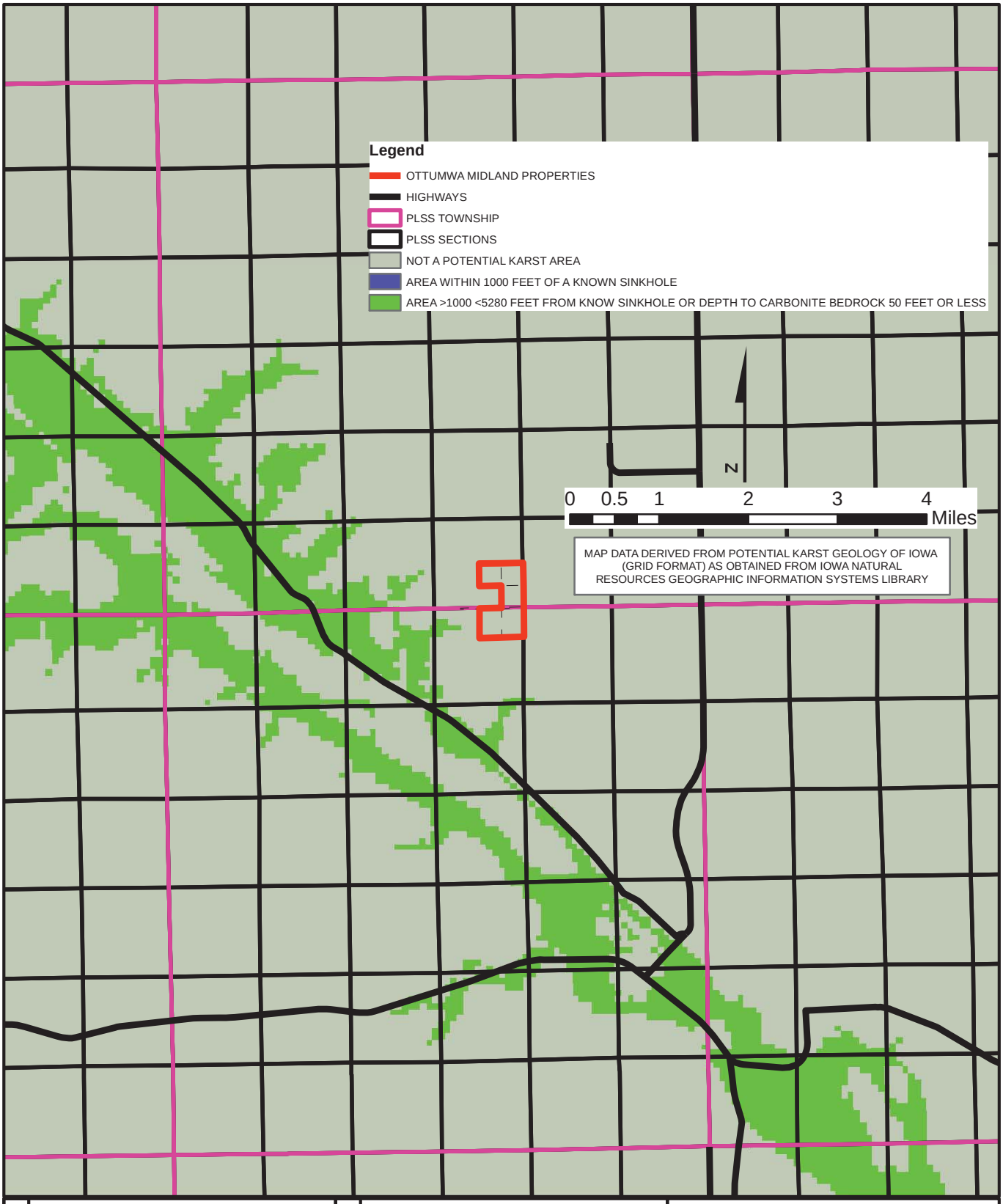
0 5 10 20 Miles

MAP DATA DERIVED FROM IOWA GEOLOGICAL AND WATER SURVEY
IOWA BEDROCK SURFACE ELEVATION AS OBTAINED
FROM IOWA NATURAL RESOURCES
GEOGRAPHIC INFORMATION SYSTEMS LIBRARY

CLIENT	INTERSTATE POWER AND LIGHT CO. 15300 130TH STREET OTTUMWA, IA 52501	SITE	OTTUMWA MIDLAND LANDFILL OTTUMWA, IOWA	SE IOWA REGIONAL BEDROCK SURFACE ELEVATION

PROJECT NO.	25215053.03	DRAWN BY:	JB	ENGINEER	FIGURE
DRAWN:	07/29/13	CHECKED BY:	MDB	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830 FAX: (608) 224-2839	4
REVISED:	08/02/13	APPROVED BY:			

I:\25215053\Drawings\OML\ArcMAP files\OML-BEDROCK TOPO 8.5X11 portrait.mxd



CLIENT	INTERSTATE POWER AND LIGHT CO. 15300 130th STREET OTTUMWA, IA 52501	SITE	OTTUMWA MIDLAND LANDFILL OTTUMWA, IOWA
	KARST FEATURES		

PROJECT NO.	25211509.03	DRAWN BY:	JB	ENGINEER	FIGURE
DRAWN:	09/16/13	CHECKED BY:	BP	SCS ENGINEERS	3
REVISED:	09/26/13	APPROVED BY:	TK	2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830 FAX: (608) 224-2839	

Iowa
Fields of Opportunities

STATE OF IOWA

TERRY E. BRANSTAD, GOVERNOR
KIM REYNOLDS, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
ROGER L. LANDE, DIRECTOR

August 19, 2011

Tim Leonard
SCS BT SQUARED
2830 Dairy Drive
Madison, WI 53718

Dear Mr. Leonard:

As requested in your email of August 17, 2011, I have investigated the potential for underground coal mines in the area of the proposed expansion of the Ottumwa-Midland Commercial Landfill. The results of that investigation are summarized in the following report.

Historic Coal Mining in the Area of Proposed Expansion of the Ottumwa Midlands Commercial Landfill

This report was prepared after reviewing available information about historic coal mining and coal resources in the area around the proposed landfill expansion northwest of Ottumwa, Iowa. Sources included historic mine maps, Iowa Geological Survey Annual Reports Vols. 2, 12, and 19, Reports of the Office of State Mine Inspectors from 1897 to 1905, compiled coal mine records and compiled coal resources records. Copies of the relevant sections of Annual Reports 2 and 12 are included for reference.

It is generally acknowledged by all sources that the area near the Des Moines River northwest of Ottumwa was extensively mined by underground mines in the late 1800's and early 1900's. At the same time clay was mined in the same area for brick and tile production. A side note is that loess, shale, and underclay were all mined in the Ottumwa area for bricks and tile. The coal surface mining was carried out generally after the underground mining had ended. The general information about the geology of the immediate area around Keb was that there were two coal seams at about 90 to 110 ft. deep that were 4-1/2 ft. thick and separated by about 20 ft. This coal resource in this area would have been an attractive target for development at turn of the twentieth century.

The enclosed map shows the known mining in the area of the landfill expansion, however, it is important to note that a large number of poorly documented underground mines also operated in the area along tributaries to the Des Moines River.

Area 1. The former mining community of Keb was located in this area. The southern part of the area is shown as having been strip mined. It isn't certain whether this was a coal or clay mine, although, it was common

practice to mine both and use the coal to fire the clay. It is possible that this area is partially underlain by the Illinois & Iowa Coal Company mine.

Area 2. This area encompasses most of an abandoned strip mine which probably mined clay, but may also have mined coal as well. The Baker Mine is shown on the map immediately south of Area 2. The precise location of this mine is unknown, but is generally known within ¼ section. It was 104 ft. deep and thus probably well below the level of the strip mine to the north. The Baker Mine supplied local sales only and apparently did not operate for more than a few years. From this information, it is likely that the mine was small, but it is impossible to determine from the available information if it impacts Area 2.

Area 3. This area may be impacted by the Utterback mine which was a small slope mine indicating that it was probably fairly shallow. The location is known to ¼ section, but no other information is available. This area has partially disturbed by clay and/or coal mining, but the presence of mining in a deeper coal seam is possible.

Area 4. This area probably includes the site of the entrance to the Illinois & Iowa Coal Co. mine in the disturbed area that appears in the 1930's aerial photography, northwest of the site of the existing landfill. Unfortunately, no map is available for this mine, but the existing documentation suggests that it may be a fairly large mine. According to notes in the 1897 and 1899 State Mine Inspectors' Reports the mine employed 200 miners and was capable of producing 1,000 tons/day. It operated for about fifteen years and at the turn of the century was one of the largest mines in Wapello County with sales to the Chicago, Milwaukee, and St. Paul railroad. A railroad line was built along the tributary to the Des Moines River where the mine shaft was located to haul the coal back to the main rail line. The mine was described as mining two coal seams early in its history, later mining on the lower seam. The shaft was 90 ft. deep to the upper coal seam and a slope extended to the lower seam. The mine operated from about 1890 to 1903. Based on the description, the Illinois & Iowa mine may underlie a fairly large area north of Keb potentially impacting a portion of Area 4.

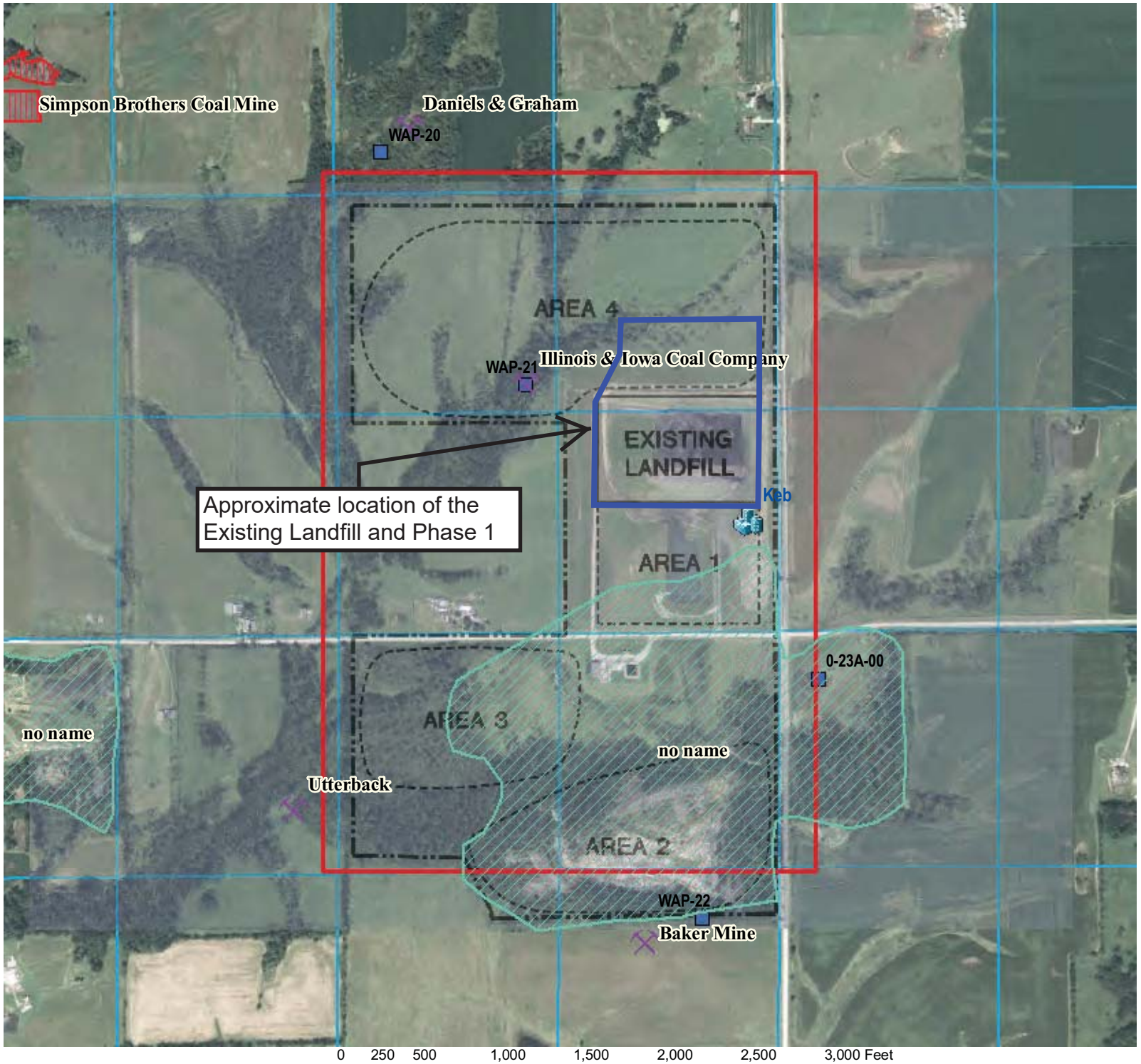
Conclusion. Some Area 4 and Area 2 are likely to undermined at a depth of 80 to 120 feet by room and pillar mines that operated beginning about 1890. The coal seams were typically four to four and a half feet thick. Underground coal mine openings eventually collapse, but the timing of the collapse and impact at the surface are difficult to predict with any certainty without detailed knowledge of the local geology. If the potential surface instability introduced by mine subsidence poses a risk to the expanded landfill area, then a thorough geotechnical investigation that includes drilling to a sufficient depth to reach the mines is recommended to determine 1) whether mining is present and 2) the extent to which subsidence has occurred previously.

I hope this information is helpful in your planning process. Feel free to contact me if you have further questions or need additional supporting materials.

Respectfully,

Mary Howes
Research Geologist
Iowa Geological and Water Survey
319-335-1448
Mary.Howes@dnr.iowa.gov

Historic Coal Mining - Area of proposed expansion, Ottumwa-Midlands Commercial Landfill



Area of Interest

Coal mines (unknown extent)

Point location, 1/4 section

Coal mine (known/approx. extent)

Surveyed map, poor location

Surface mine

Coal Geology Points

Coal Geology Points

Iowa Geological and Water Survey
109 Trowbridge Hall
Iowa City, IA 52242-1319
319-335-1575

August 19, 2011

SPOTLIGHT
GEOPHYSICAL SERVICES

Figure 8. Possible mined area based on microgravity data

APPENDIX B

Liquefaction and Settlement Potential Evaluation

Liquefaction and Settlement Potential Evaluation

Based on the results of the site investigation borings and laboratory soil test results performed by Montgomery Watson and SCS Engineers, the landfill site soils are not subject to liquefaction or settlement concerns for the performance of the landfill.

Liquefaction is the process by which a saturated, loose, cohesionless soil influenced by external forces can suddenly loses its shear strength and behave as a fluid. The external forces result from ground motion from an earthquake. The landfill site soils in borings consist primarily of stiff to hard silts and clays that are not subject to liquefaction. In addition, liquefaction is not a concern given the low magnitude (less than 0.04g, 2 percent in 50 years) of maximum ground accelerations expected in the area; see **Attachment B1**.

Settlement below a landfill can be a concern if the facility is underlain by extensive soft, fine-grained soils. Soft soils are subject to consolidation settlement depending on the load over the soft soils. The landfill site soils consist of stiff to hard silt and clays. Because these fine-grained soils are stiff to hard rather than soft, consolidation settlement is not a concern for the performance of the landfill.

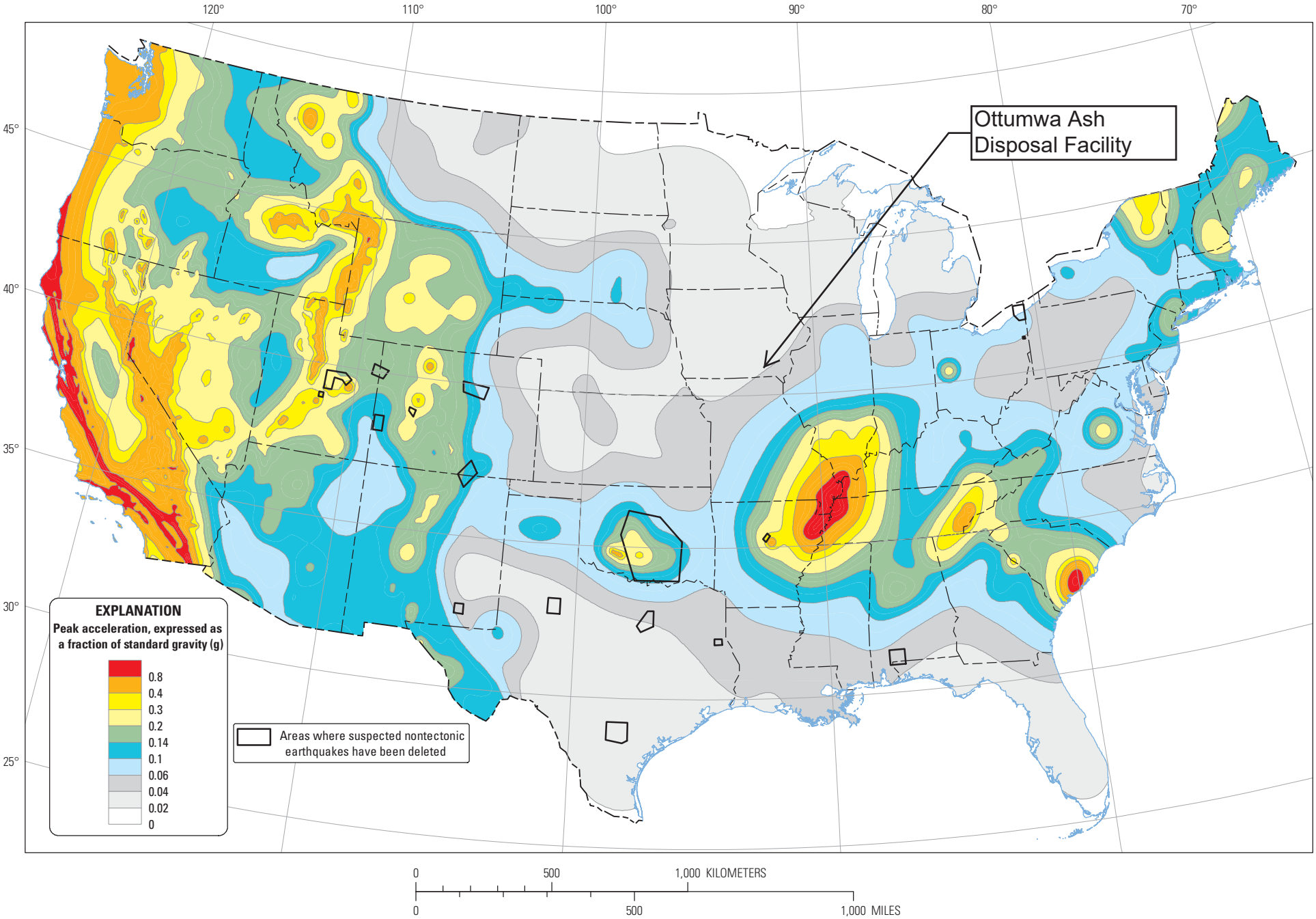
References

Montgomery Watson, 1994, Hydrogeological Investigation Report and Hydrologic Monitoring System Plan, Ottumwa-Midland Commercial Landfill.

SCS Engineers, 2013, Proposed Landfill Expansion, Soil and Hydrogeologic Investigation Report, Ottumwa Midland Landfill, Interstate Power and Light Company, Ottumwa, Iowa.

USGS seismic impact zones map website:
https://earthquake.usgs.gov/static/lfs/nshm/conterminous/2014/2014pga2pct.pdf

DLN/AJR_lmh/EJN



Two-percent probability of exceedance in 50 years map of peak ground acceleration

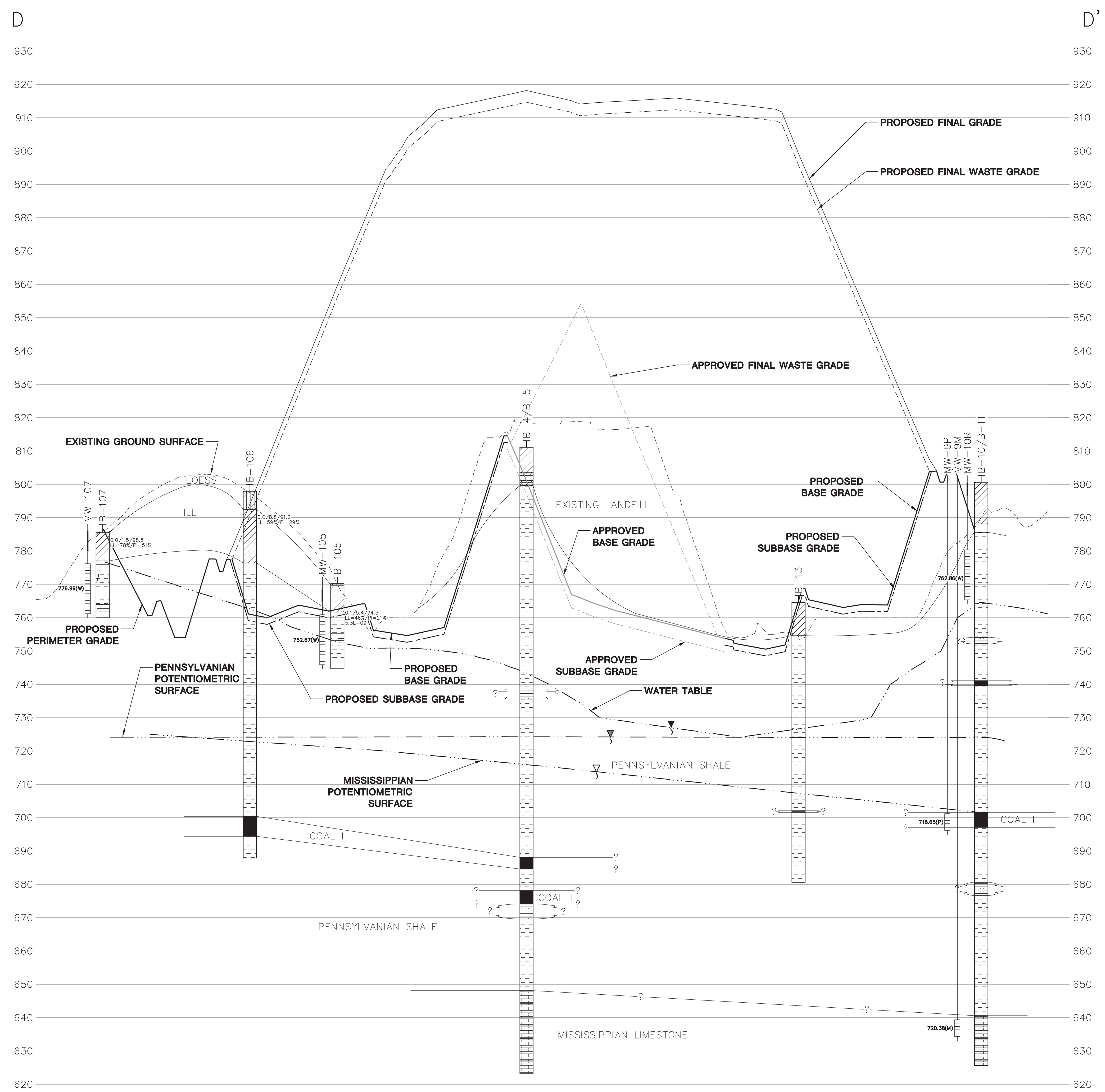
Source: USGS seismic impact zones map - https://earthquake.usgs.gov/static/lfs/nshm/conterminous/2014/2014pga2pct.pdf

APPENDIX C

Geologic Cross Sections

Unstable Areas Demonstration Notes:

1) The "Water Table" shown on these cross sections in the unconsolidated deposits is not indicative of the "Uppermost Aquifer" as defined in 40 CFR 257.53.
2) The "Uppermost Aquifer" as defined in 40 CFR 257.53 is present at OML in the Mississippian limestone and dolomite.



LEGEND

(symbol)	WATER TABLE (EXTRAPOLATED FROM APRIL 23, 2013 CONTOUR MAP–SEE FIGURE 22)
(symbol)	PENNSYLVANIAN POTENTIOMETRIC SURFACE (EXTRAPOLATED FROM APRIL 23, 2013 CONTOUR MAP–SEE FIGURE 23)
(symbol)	MISSISSIPPIAN POTENTIOMETRIC SURFACE (EXTRAPOLATED FROM APRIL 23, 2013 CONTOUR MAP–SEE FIGURE 24)
890.83(W/P/M)	GROUNDWATER ELEVATION MEASURED ON APRIL 23, 2013 AT: W – WATER TABLE WELL; P – PIEZOMETER IN PENNSYLVANIAN SHALE; M – PIEZOMETER IN LOWER MISSISSIPPIAN SHALE
(symbol)	GEOLOGIC CONTACT (? WHERE UNCERTAIN)
(symbol)	INFERRED GRADATIONAL GEOLOGIC CONTACT
0.0/2.6/97.4	% GRAVEL/SAND/SILT & CLAY
LL	LIQUID LIMIT
PI	PLASTICITY INDEX
6.5E–04	VERTICAL HYDRAULIC CONDUCTIVITY (LABORATORY VALUE)
TCR	TOTAL CORE RECOVERY (RECOVERED LENGTH/CORE RUN LENGTH)
(symbol)	AREA OF POOR RECOVERY OR VOID INDICATING POSSIBLE MINED COAL SEAM
(symbol)	INFERRED VERTICAL COMPONENT OF GROUNDWATER FLOW

USCS CLASSES

CL	LEAN CLAY
GM	SILTY GRAVEL
ML	SILT
CH	FAT CLAY
SC	CLAYEY GRAVEL
SP	POORLY-GRADED SAND
CL–ML	SILTY CLAY
	SANDSTONE
	SHALE
	LIMESTONE
	SILTSTONE
	COAL

MAJOR GEOLOGIC UNITS

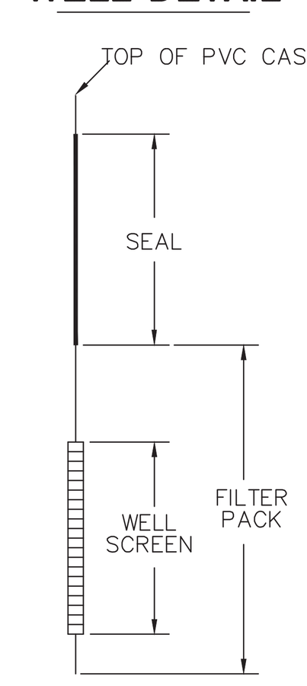
LOESS–SILT AND SILTY CLAY, GENERALLY THICKER ON HILLTOPS.

TILL–GLACIAL DEPOSIT, LEAN TO FAT CLAY WITH VARIABLE SAND CONTENT, NO DISTINCT BEDDING.

PENNSYLVANIAN SHALE–LIGHT TO DARK GRAY SHALE WITH DISCONTINUOUS LAYERS OF SILTSTONE, COAL, AND LIMESTONE. TWO COAL SEAMS IN THE SHALE (COAL I & COAL II) ARE AT LEAST SOMEWHAT LATERALLY CONTINUOUS.

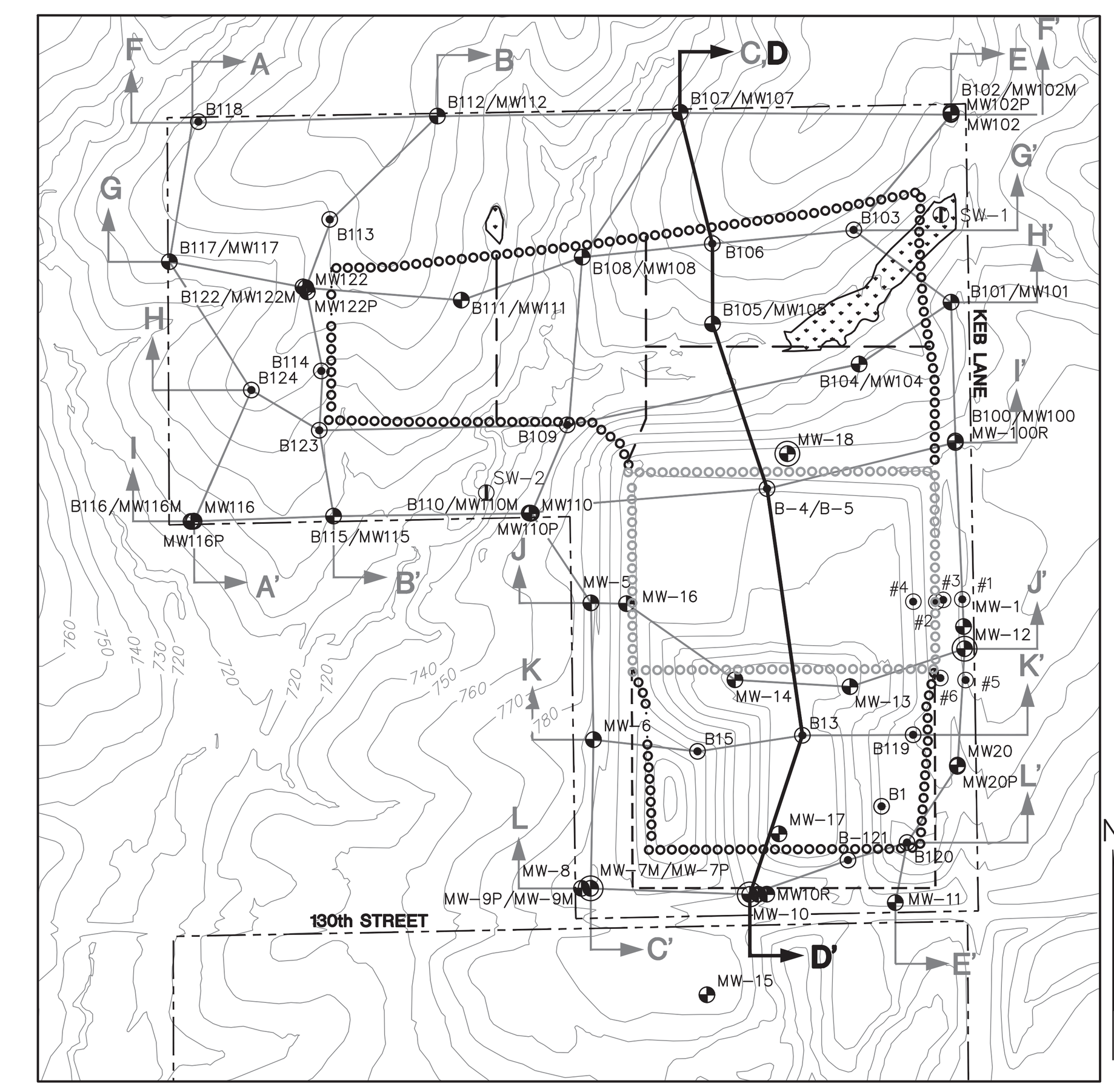
MISSISSIPPIAN LIMESTONE–GRAY LIMESTONE AND SHALY LIMESTONE.

TYPICAL WELL DETAIL



CROSS SECTION SCALE

0 200 FEET
HORIZONTAL SCALE: 1" = 200'
VERTICAL SCALE: 1" = 20'
VERTICAL EXAGGERATION = 10X



CROSS SECTION LOCATION

500 0 500
SCALE: 1" = 500'

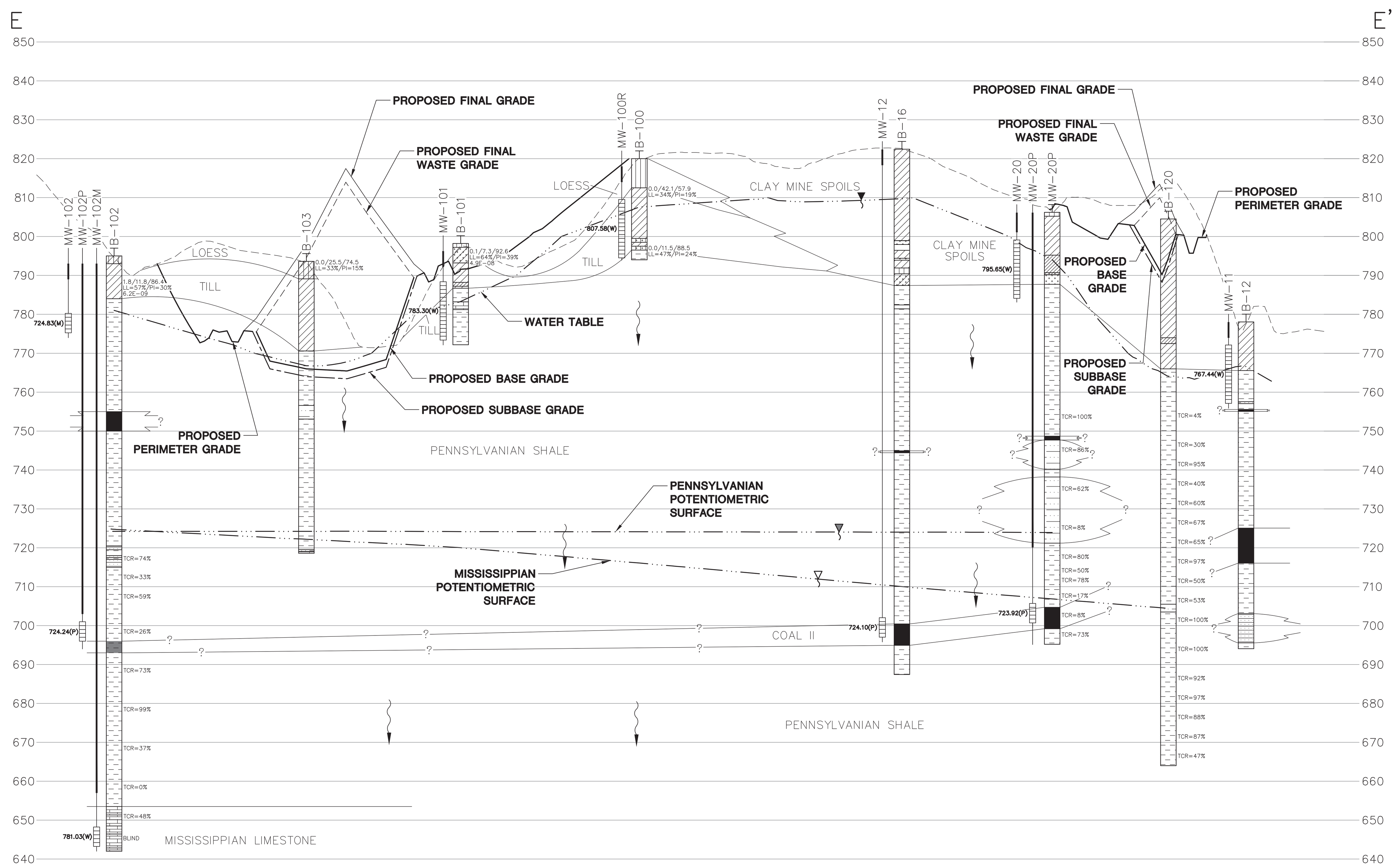
NOTES

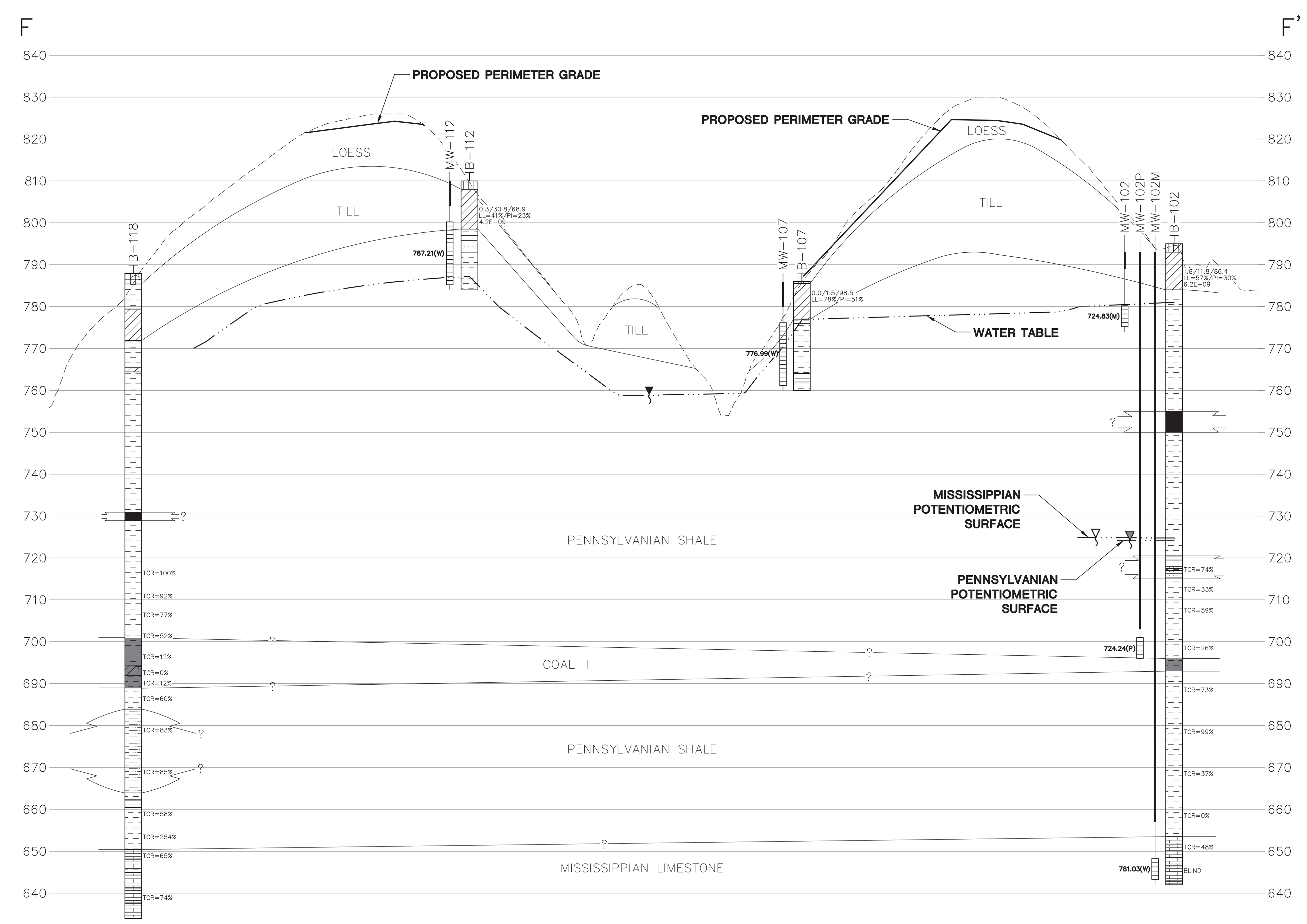
1. LINES CORRELATING STRATA ARE BASED ON INTEGRATION BETWEEN BORINGS AND MAY NOT REPRESENT ACTUAL SUBSURFACE CONDITIONS.
2. HORIZONTAL DISTANCES MEASURED FROM TICK MARK SHOWN AT EACH GRAPHIC LOG. FOR WELL NESTS THE GRAPHIC LOG IS POSTED AT THE CENTER OF THE DEEPEST WELL AND INCLUDES INFORMATION FROM ALL BORINGS.
3. GROUNDWATER ELEVATIONS AT WELLS MEASURED ON APRIL 23, 2013 BY SCS ENGINEERS.
4. EXISTING GROUND SURFACE ELEVATIONS ARE BASED ON KBM, INC., AERIAL PHOTOGRAPHY, MAY 1, 2008 AND APRIL 27, 2011.
5. ELEVATIONS ARE SHOWN IN REFERENCE TO USGS MEAN SEA LEVEL (MSL) DATUM (1929 ADJUSTMENT).
6. BORING ELEVATIONS FOR B–100 THROUGH B–124 BASED ON SCS SURVEYS DATED JUNE 14, 2012; NOVEMBER 14, 2012; DECEMBER 18, 2012 & FEBRUARY 19, 2013.
7. COAL SEAMS I & II ARE THE ONLY COAL SEAMS WITHIN THE PENNSYLVANIAN SHALE THAT APPEAR TO BE CONTINUOUS ACROSS MULTIPLE BORING LOCATIONS.

SHEET	5 OF 14
	CROSS SECTION D–D'
SITE	PROPOSED LANDFILL EXPANSION SOIL AND HYDROGEOLOGIC INVESTIGATION OTTUMWA MIDLAND LANDFILL OTTUMWA, IOWA
CLIENT	INTERSTATE POWER AND LIGHT CO. OTTUMWA MIDLAND LANDFILL 15300 130th STREET OTTUMWA, IOWA 52501
ENGINEER	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830
PROJECT NO.	25211509.03
DRAWN:	05/06/13
REVISED:	09/25/13
DRAWN BY:	AHB
CHECKED BY:	MDB
APPROVED BY:	EN 09/27/13

Unstable Areas Demonstration Notes:

1) The "Water Table" shown on these cross sections in the unconsolidated deposits is not indicative of the "Uppermost Aquifer" as defined in 40 CFR 257.53.
2) The "Uppermost Aquifer" as defined in 40 CFR 257.53 is present at OML in the Mississippian limestone and dolomite.





LEGEND

	WATER TABLE (EXTRAPOLATED FROM APRIL 23, 2013 CONTOUR MAP–SEE FIGURE 22)
	PENNSYLVANIAN POTENTIOMETRIC SURFACE (EXTRAPOLATED FROM APRIL 23, 2013 CONTOUR MAP–SEE FIGURE 23)
	MISSISSIPPIAN POTENTIOMETRIC SURFACE (EXTRAPOLATED FROM APRIL 23, 2013 CONTOUR MAP–SEE FIGURE 24)
890.83(W/P/M)	GROUNDWATER ELEVATION MEASURED ON APRIL 23, 2013 AT: W – WATER TABLE WELL; P – PIEZOMETER IN PENNSYLVANIAN SHALE; M – PIEZOMETER IN LOWER MISSISSIPPIAN SHALE
	GEOLOGIC CONTACT (? WHERE UNCERTAIN)
	INFERRED GRADATIONAL GEOLOGIC CONTACT
0.0/2.6/97.4	% GRAVEL/SAND/SILT & CLAY
LL	LIQUID LIMIT
PI	PLASTICITY INDEX
6.5E–04	VERTICAL HYDRAULIC CONDUCTIVITY (LABORATORY VALUE)
TCR	TOTAL CORE RECOVERY (RECOVERED LENGTH/CORE RUN LENGTH)
	AREA OF POOR RECOVERY OR VOID INDICATING POSSIBLE MINED COAL SEAM
	INFERRED VERTICAL COMPONENT OF GROUNDWATER FLOW

USCS CLASSES

CL	LEAN CLAY
GM	SILTY GRAVEL
ML	SILT
CH	FAT CLAY
SC	CLAYEY GRAVEL
SP	POORLY-GRADED SAND
CL–ML	SILTY CLAY
	SANDSTONE
	SHALE
	LIMESTONE
	SILTSTONE
	COAL

MAJOR GEOLOGIC UNITS

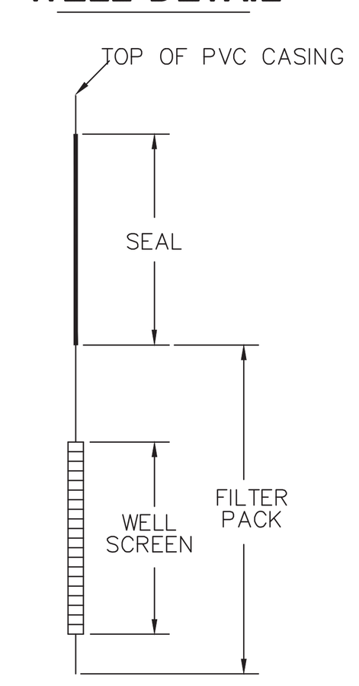
LOESS–SILT AND SILTY CLAY, GENERALLY THICKER ON HILLTOPS.

TILL–GLACIAL DEPOSIT, LEAN TO FAT CLAY WITH VARIABLE SAND CONTENT, NO DISTINCT BEDDING.

PENNSYLVANIAN SHALE–LIGHT TO DARK GRAY SHALE WITH DISCONTINUOUS LAYERS OF SILTSTONE, COAL, AND LIMESTONE. TWO COAL SEAMS IN THE SHALE (COAL I & COAL II) ARE AT LEAST SOMEWHAT LATERALLY CONTINUOUS.

MISSISSIPPIAN LIMESTONE–GRAY LIMESTONE AND SHALY LIMESTONE.

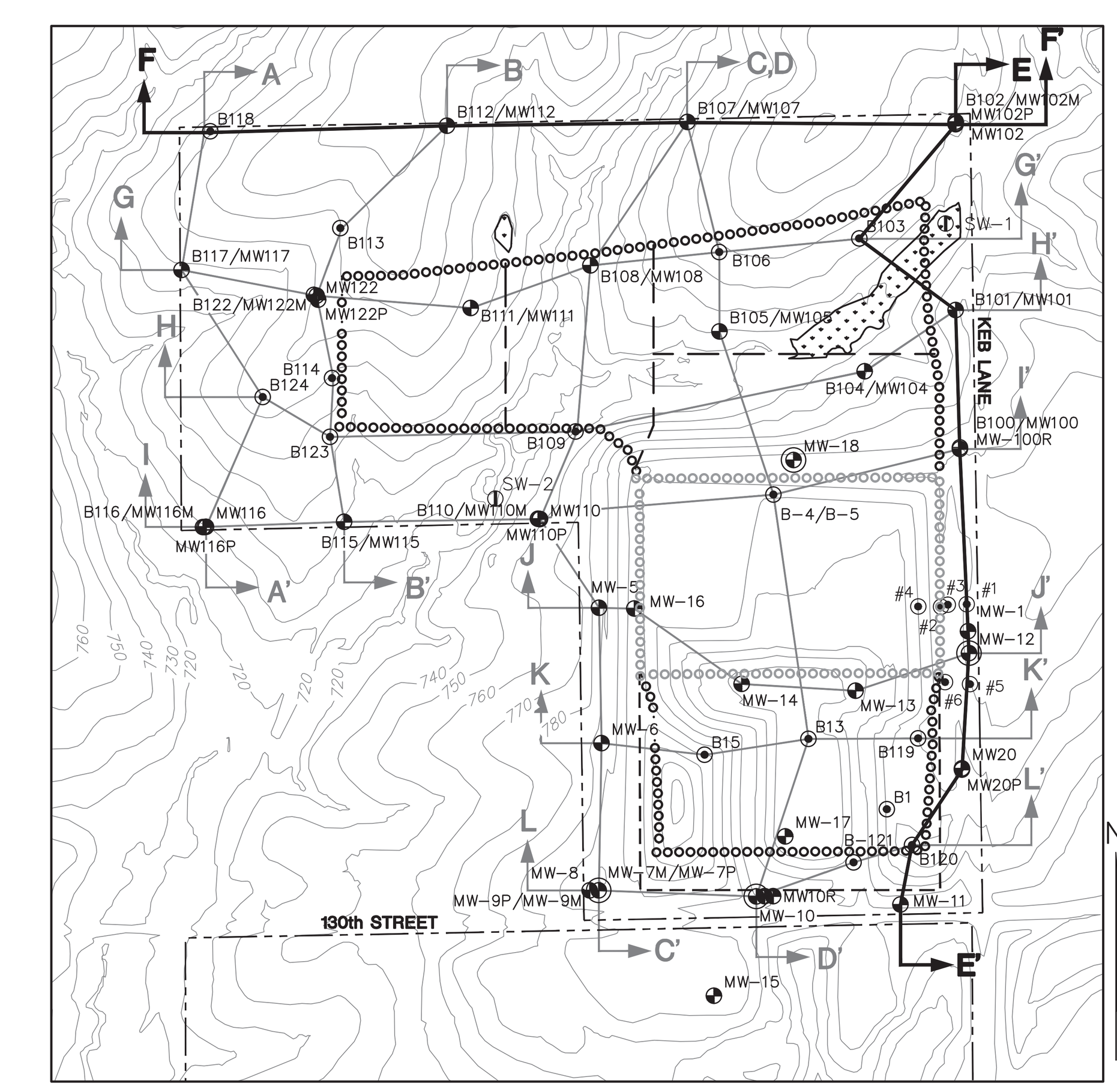
TYPICAL WELL DETAIL



CROSS SECTION SCALE

0 200 FEET

HORIZONTAL SCALE: 1" = 200'
VERTICAL SCALE: 1" = 20'
VERTICAL EXAGGERATION = 10X



CROSS SECTION LOCATIONS

500 0 500

SCALE: 1" = 500'

NOTES

1. LINES CORRELATING STRATA ARE BASED ON INTEGRATION BETWEEN BORINGS AND MAY NOT REPRESENT ACTUAL SUBSURFACE CONDITIONS.
2. HORIZONTAL DISTANCES MEASURED FROM TICK MARK SHOWN AT EACH GRAPHIC LOG. FOR WELL NESTS THE GRAPHIC LOG IS POSTED AT THE CENTER OF THE DEEPEST WELL AND INCLUDES INFORMATION FROM ALL BORINGS.
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4. EXISTING GROUND SURFACE ELEVATIONS ARE BASED ON KBM, INC., AERIAL PHOTOGRAPHY, MAY 1, 2008 AND APRIL 27, 2011.
5. ELEVATIONS ARE SHOWN IN REFERENCE TO USGS MEAN SEA LEVEL (MSL) DATUM (1929 ADJUSTMENT)
6. BORING ELEVATIONS FOR B–100 THROUGH B–124 BASED ON SCS SURVEYS DATED JUNE 14, 2012; NOVEMBER 14, 2012; DECEMBER 18, 2012 & FEBRUARY 19, 2013.
10. FOR B–102: POTENTIAL COLLAPSED ZONE AT 99'–102' BELOW GROUND SURFACE.
11. COAL SEAMS I & II ARE THE ONLY COAL SEAMS WITHIN THE PENNSYLVANIAN SHALE THAT APPEAR TO BE CONTINUOUS ACROSS MULTIPLE BORING LOCATIONS.

PROJECT NO.	25211509.03
DRAWN:	05/06/13
REVISED:	09/25/13
DRAWN BY:	AHB
CHECKED BY:	MDB
APPROVED BY:	EN 09/27/13

ENGINEER: SCS ENGINEERS, 2830 DAIRY DRIVE MADISON, WI 53718–6751, PHONE: (608) 224–2830

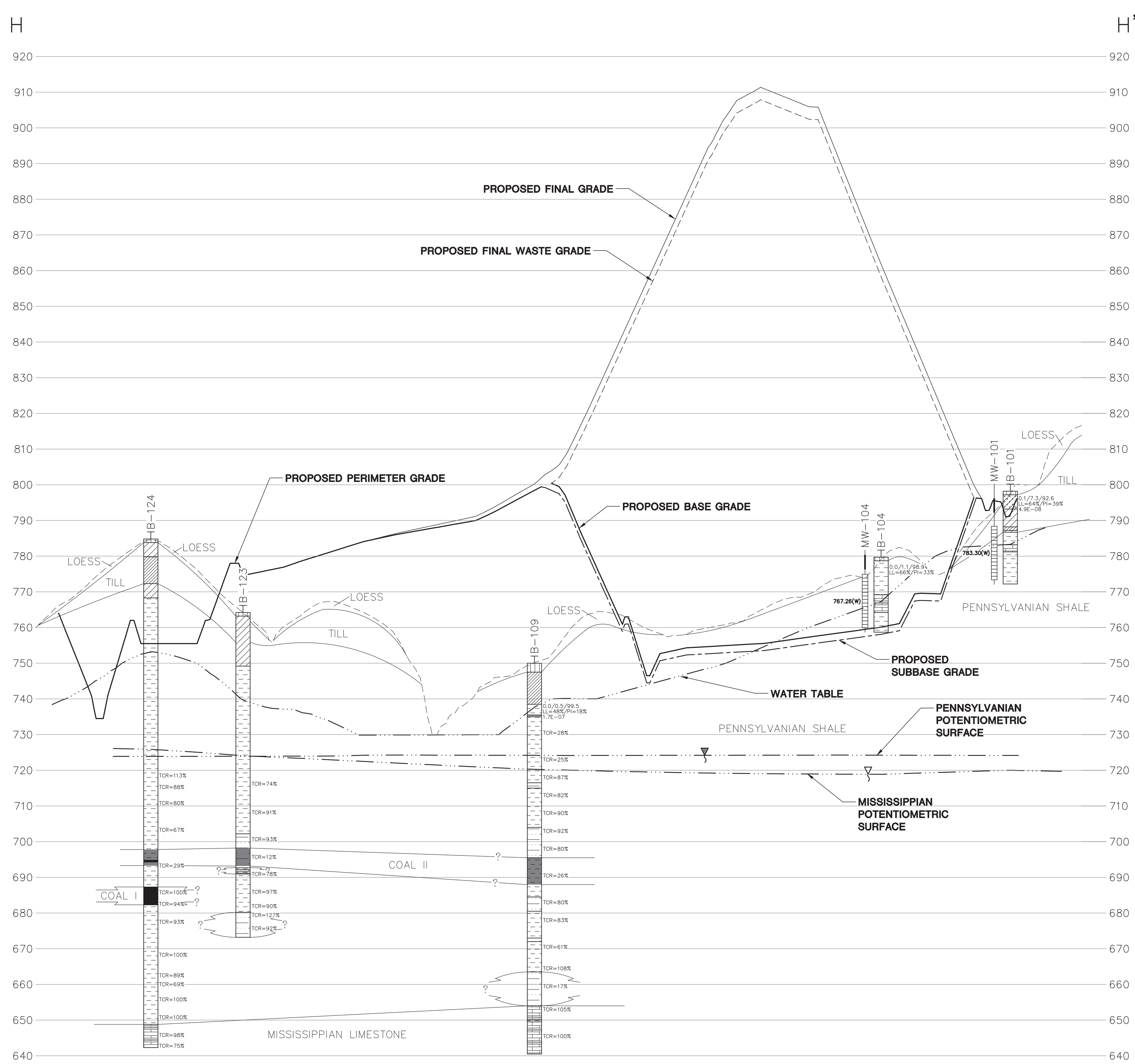
CLIENT: INTERSTATE POWER AND LIGHT CO., OTTUMWA MIDLAND LANDFILL, 15300 130th STREET, OTTUMWA, IOWA 52501

SITE: PROPOSED LANDFILL EXPANSION, SOIL AND HYDROGEOLOGIC INVESTIGATION, OTTUMWA MIDLAND LANDFILL, OTTUMWA, IOWA

CROSS SECTION E–E' & F–F'

Unstable Areas Demonstration Notes:

1) The "Water Table" shown on these cross sections in the unconsolidated deposits is not indicative of the "Uppermost Aquifer" as defined in 40 CFR 257.53.
2) The "Uppermost Aquifer" as defined in 40 CFR 257.53 is present at OML in the Mississippian limestone and dolomite.



LEGEND

Symbol	Description
(line symbol)	WATER TABLE (EXTRAPOLATED FROM APRIL 23, 2013 CONTOUR MAP–SEE FIGURE 22)
(line symbol)	PENNSYLVANIAN POTENTIOMETRIC SURFACE (EXTRAPOLATED FROM APRIL 23, 2013 CONTOUR MAP–SEE FIGURE 23)
(line symbol)	MISSISSIPPIAN POTENTIOMETRIC SURFACE (EXTRAPOLATED FROM APRIL 23, 2013 CONTOUR MAP–SEE FIGURE 24)
890.83(W/P/M)	GROUNDWATER ELEVATION MEASURED ON APRIL 23, 2013 AT: W – WATER TABLE WELL; P – PIEZOMETER IN PENNSYLVANIAN SHALE; M – PIEZOMETER IN LOWER MISSISSIPPIAN SHALE
(line symbol)	GEOLOGIC CONTACT (? WHERE UNCERTAIN)
(line symbol)	INFERRED GRADATIONAL GEOLOGIC CONTACT
0.0/2.6/97.4	% GRAVEL/SAND/SILT & CLAY
LL	LIQUID LIMIT
PI	PLASTICITY INDEX
6.5E–04	VERTICAL HYDRAULIC CONDUCTIVITY (LABORATORY VALUE)
TCR	TOTAL CORE RECOVERY (RECOVERED LENGTH/CORE RUN LENGTH)
(shaded box)	AREA OF POOR RECOVERY OR VOID INDICATING POSSIBLE MINED COAL SEAM
(arrow symbol)	INFERRED VERTICAL COMPONENT OF GROUNDWATER FLOW

USCS CLASSES

Code	Description
CL	LEAN CLAY
GM	SILTY GRAVEL
ML	SILT
CH	FAT CLAY
SC	CLAYEY GRAVEL
SP	POORLY–GRADED SAND
CL–ML	SILTY CLAY
	SANDSTONE
	SHALE
	LIMESTONE
	SILTSTONE
	COAL

MAJOR GEOLOGIC UNITS

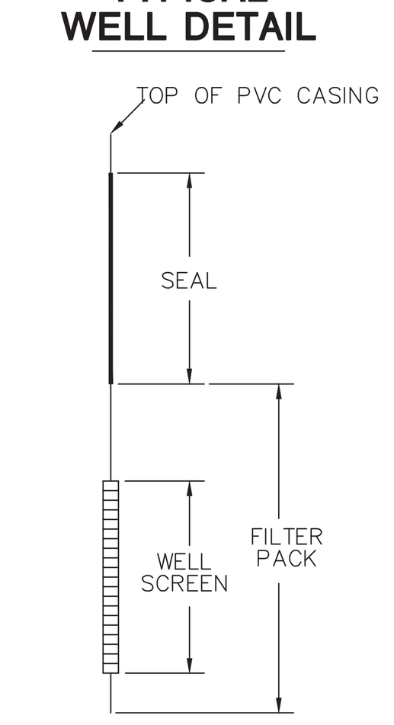
LOESS–SILT AND SILTY CLAY, GENERALLY THICKER ON HILLTOPS.

TILL–GLACIAL DEPOSIT, LEAN TO FAT CLAY WITH VARIABLE SAND CONTENT, NO DISTINCT BEDDING.

PENNSYLVANIAN SHALE–LIGHT TO DARK GRAY SHALE WITH DISCONTINUOUS LAYERS OF SILTSTONE, COAL, AND LIMESTONE. TWO COAL SEAMS IN THE SHALE (COAL I & COAL II) ARE AT LEAST SOMEWHAT LATERALLY CONTINUOUS.

MISSISSIPPIAN LIMESTONE–GRAY LIMESTONE AND SHALY LIMESTONE.

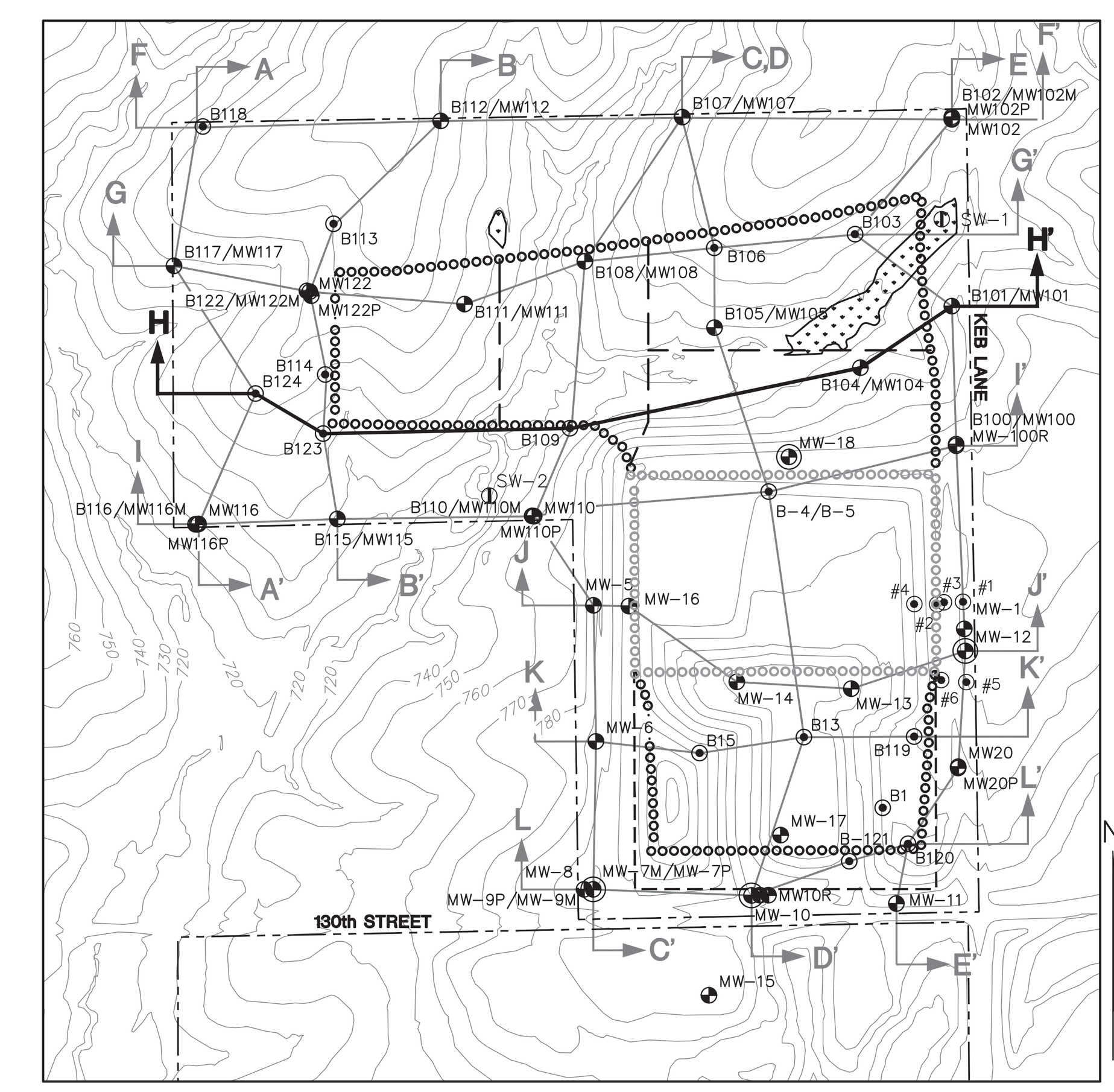
TYPICAL WELL DETAIL



CROSS SECTION SCALE

0 200 FEET

HORIZONTAL SCALE: 1" = 200'
VERTICAL SCALE: 1" = 20'
VERTICAL EXAGGERATION = 10X



CROSS SECTION LOCATION

500 0 500

SCALE: 1" = 500'

NOTES

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5. ELEVATIONS ARE SHOWN IN REFERENCE TO USGS MEAN SEA LEVEL (MSL) DATUM (1929 ADJUSTMENT)
6. BORING ELEVATIONS FOR B–100 THROUGH B–124 BASED ON SCS SURVEYS DATED JUNE 14, 2012; NOVEMBER 14, 2012; DECEMBER 18, 2012 & FEBRUARY 19, 2013.
10. FOR B–109: POTENTIAL COLLAPSED ZONE AT 54.5' TO 62'.
11. FOR B–122: VOIDS OBSERVED BETWEEN 93' AND 97' DURING DRILLING.
12. COAL SEAMS I & II ARE THE ONLY COAL SEAMS WITHIN THE PENNSYLVANIAN SHALE THAT APPEAR TO BE CONTINUOUS ACROSS MULTIPLE BORING LOCATIONS.

PROJECT NO.	25211509.03
DRAWN:	05/06/13
REVISED:	09/25/13
DRAWN BY:	AHB
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APPROVED BY:	EN 09/27/13

ENGINEER: SCS ENGINEERS, 2830 DAIRY DRIVE MADISON, WI 53718–6751, PHONE: (608) 224–2830

CLIENT: INTERSTATE POWER AND LIGHT CO., OTTUMWA MIDLAND LANDFILL, 15300 130TH STREET, OTTUMWA, IOWA 52501

SITE: PROPOSED LANDFILL EXPANSION, SOIL AND HYDROGEOLOGIC INVESTIGATION, OTTUMWA MIDLAND LANDFILL, OTTUMWA, IOWA

CROSS SECTION H–H'

Unstable Areas Demonstration Notes:

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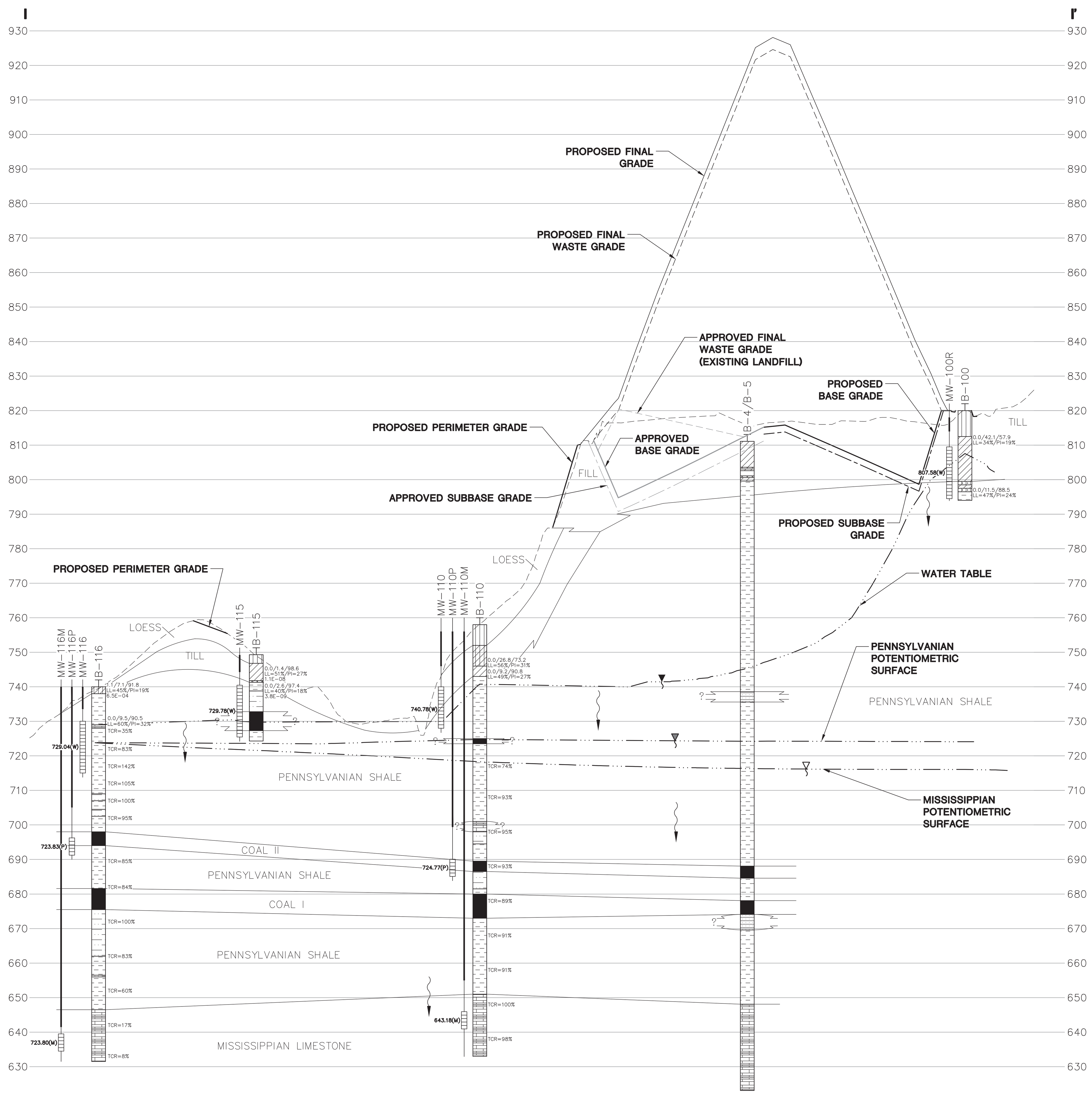

LEGEND

— ▽ —	WATER TABLE (EXTRAPOLATED FROM APRIL 23, 2013 CONTOUR MAP-SEE FIGURE 22)
— ▽ —	PENNSYLVANIAN POTENTIOMETRIC SURFACE (EXTRAPOLATED FROM APRIL 23, 2013 CONTOUR MAP-SEE FIGURE 23)
— ▽ —	MISSISSIPPIAN POTENTIOMETRIC SURFACE (EXTRAPOLATED FROM APRIL 23, 2013 CONTOUR MAP-SEE FIGURE 24)
890.83(W/P/M)	GROUNDWATER ELEVATION MEASURED ON APRIL 23, 2013 AT: W – WATER TABLE WELL; P – PIEZOMETER IN PENNSYLVANIAN SHALE; M – PIEZOMETER IN LOWER MISSISSIPPIAN SHALE
	GEOLOGIC CONTACT (? WHERE UNCERTAIN)
	INFERRED GRADATIONAL GEOLOGIC CONTACT
0.0/2.6/97.4	% GRAVEL/SAND/SILT & CLAY
LL	LIQUID LIMIT
PI	PLASTICITY INDEX
6.5E-04	VERTICAL HYDRAULIC CONDUCTIVITY (LABORATORY VALUE)
TCR	TOTAL CORE RECOVERY (RECOVERED LENGTH/CORE RUN LENGTH)
	AREA OF POOR RECOVERY OR VOID INDICATING POSSIBLE MINED COAL SEAM
	INFERRED VERTICAL COMPONENT OF GROUNDWATER FLOW

USCS CLASSES

CL	LEAN CLAY
GM	SILTY GRAVEL
ML	SILT
CH	FAT CLAY
SC	CLAYEY GRAVEL
SP	POORLY-GRADED SAND
CL-ML	SILTY CLAY
	SANDSTONE
	SHALE
	LIMESTONE
	SILTSTONE
	COAL

MAJOR GEOLOGIC UNITS

LOESS–SILT AND SILTY CLAY, GENERALLY THICKER ON HILLTOPS.

TILL–GLACIAL DEPOSIT, LEAN TO FAT CLAY WITH VARIABLE SAND CONTENT, NO DISTINCT BEDDING.

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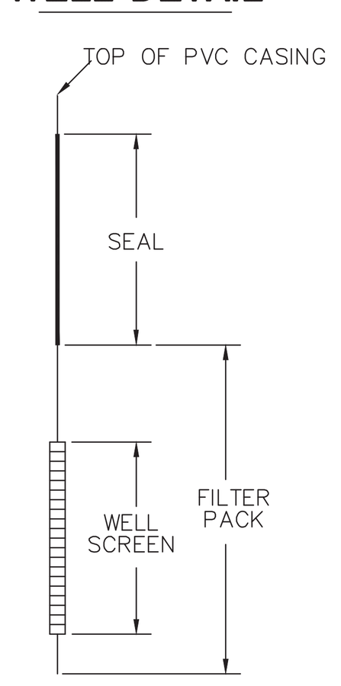
MISSISSIPPIAN LIMESTONE–GRAY LIMESTONE AND SHALY LIMESTONE.

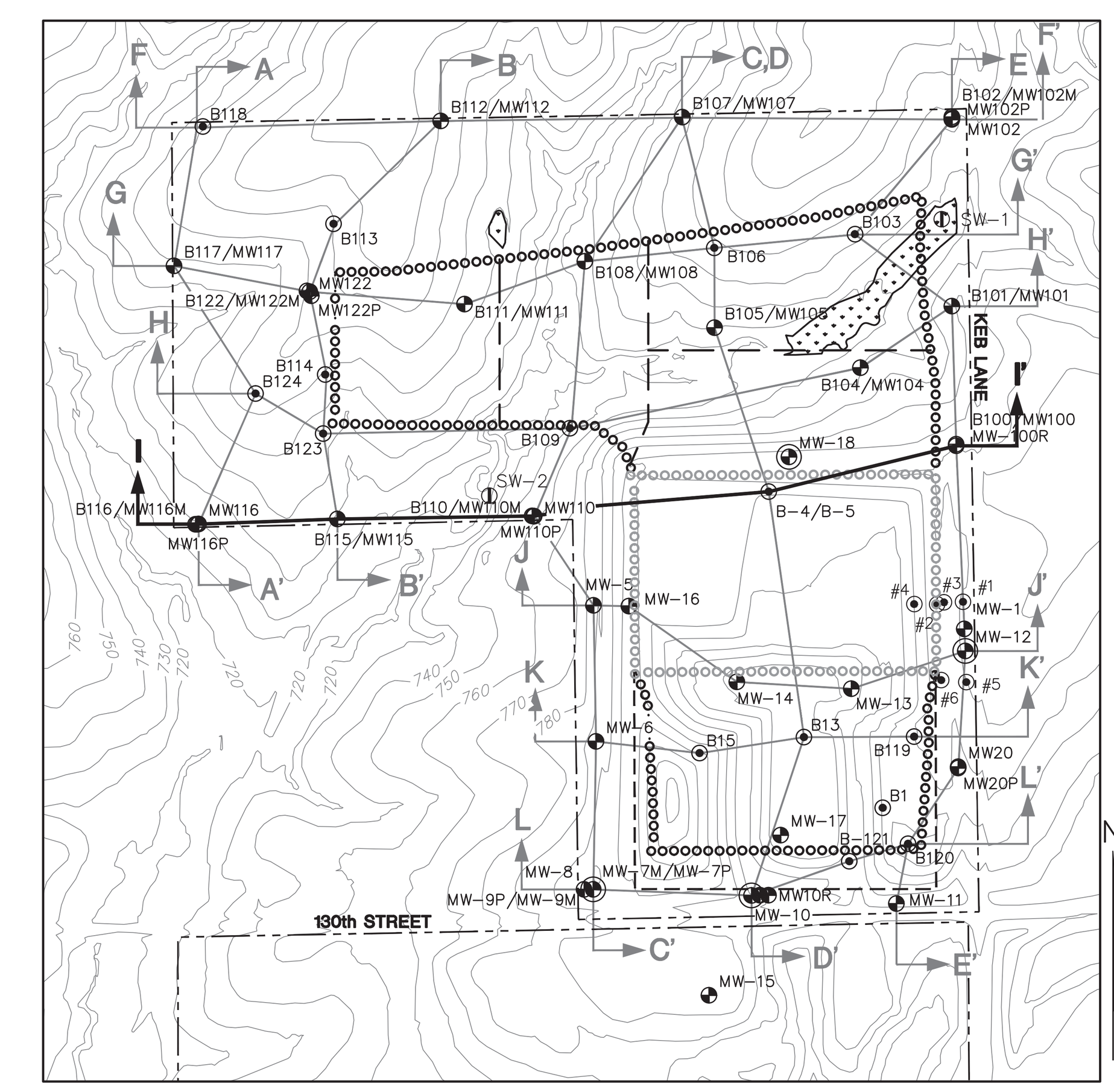
TYPICAL WELL DETAIL



CROSS SECTION SCALE

0 200 FEET

HORIZONTAL SCALE: 1" = 200'
VERTICAL SCALE: 1" = 20'
VERTICAL EXAGGERATION = 10X



CROSS SECTION LOCATION

500 0 500

SCALE: 1" = 500'

NOTES

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PROJECT NO.	25211509.03	DRAWN BY:	AHB
DRAWN:	05/06/13	CHECKED BY:	MDB
REVISED:	09/25/13	APPROVED BY:	EN 09/27/13

ENGINEER: SCS ENGINEERS, 2830 DAIRY DRIVE MADISON, WI 53718-6751, PHONE: (608) 224-2830

CLIENT: INTERSTATE POWER AND LIGHT CO., OTTUMWA MIDLAND LANDFILL, 15300 130th STREET, OTTUMWA, IOWA 52501

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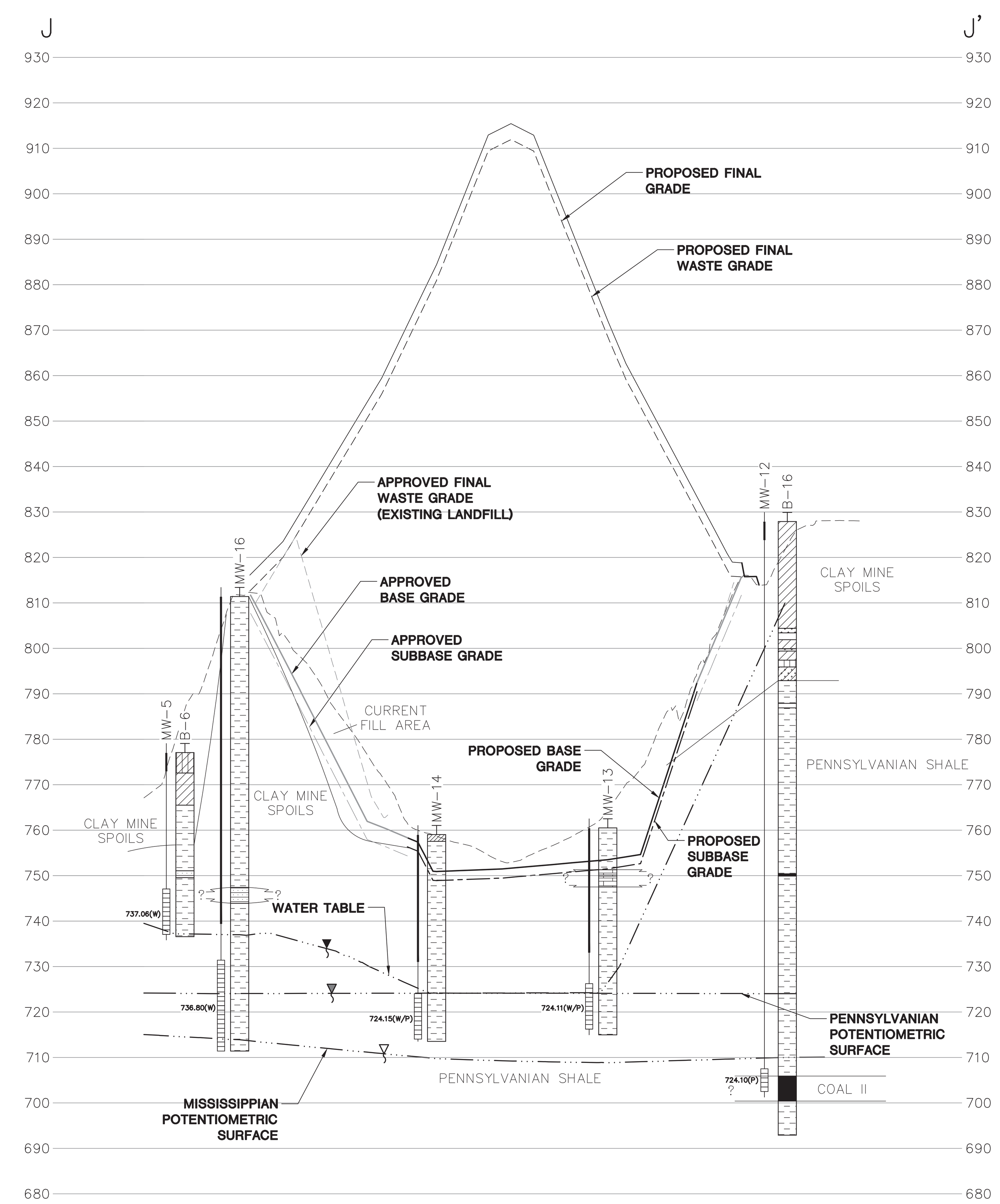
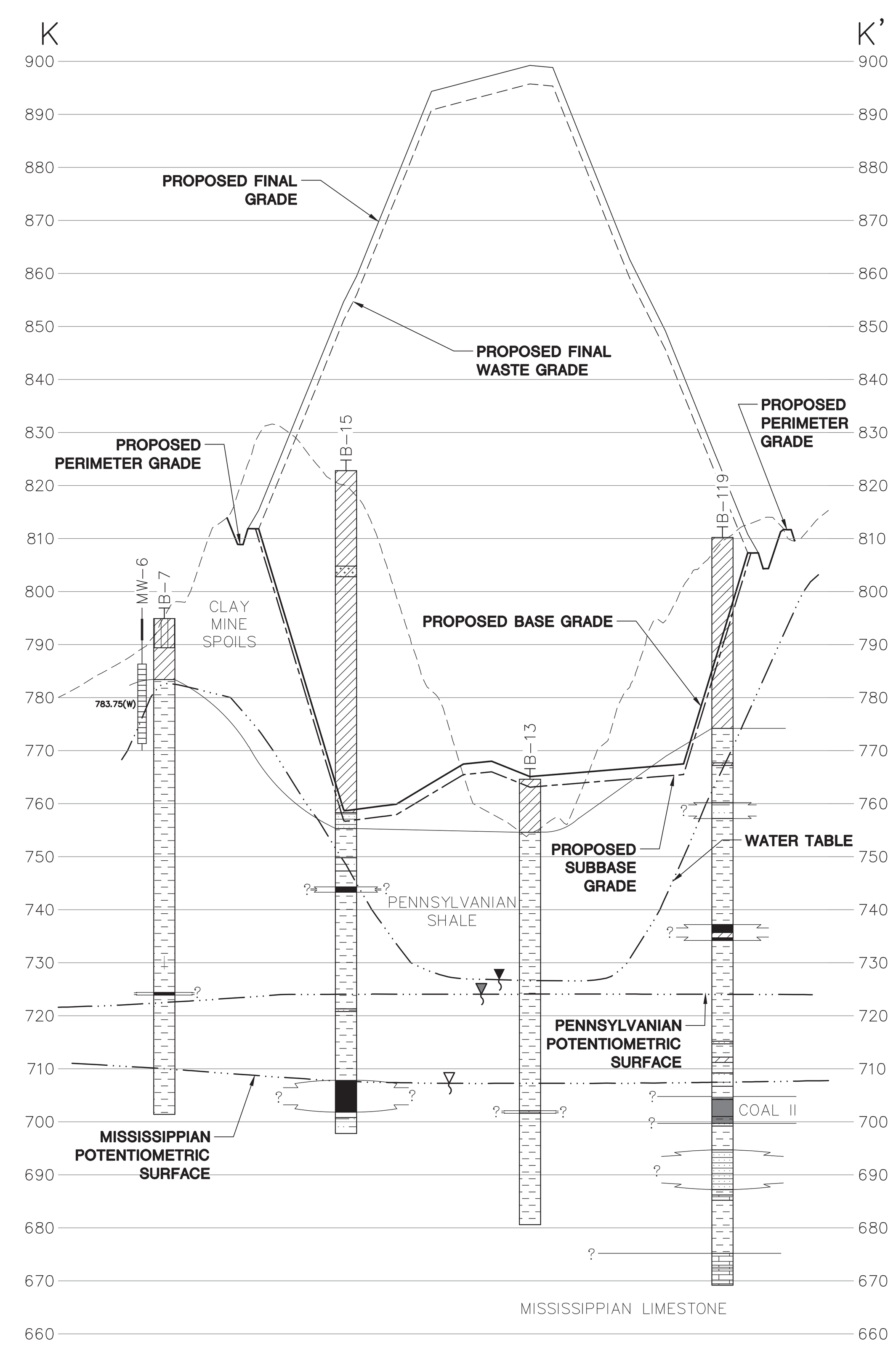
CROSS SECTION I–I'





Unstable Areas Demonstration Notes:

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LEGEND

(symbol)	WATER TABLE (EXTRAPOLATED FROM APRIL 23, 2013 CONTOUR MAP–SEE FIGURE 22)
(symbol)	PENNSYLVANIAN POTENTIOMETRIC SURFACE (EXTRAPOLATED FROM APRIL 23, 2013 CONTOUR MAP–SEE FIGURE 23)
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(symbol)	GEOLOGIC CONTACT (? WHERE UNCERTAIN)
(symbol)	INFERRED GRADATIONAL GEOLOGIC CONTACT
0.0/2.6/97.4	% GRAVEL/SAND/SILT & CLAY
LL	LIQUID LIMIT
PI	PLASTICITY INDEX
6.5E–04	VERTICAL HYDRAULIC CONDUCTIVITY (LABORATORY VALUE)
TCR	TOTAL CORE RECOVERY (RECOVERED LENGTH/CORE RUN LENGTH)
(symbol)	AREA OF POOR RECOVERY OR VOID INDICATING POSSIBLE MINED COAL SEAM
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USCS CLASSES

CL	LEAN CLAY
GM	SILTY GRAVEL
ML	SILT
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CL–ML	SILTY CLAY
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	SHALE
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	SILTSTONE
	COAL

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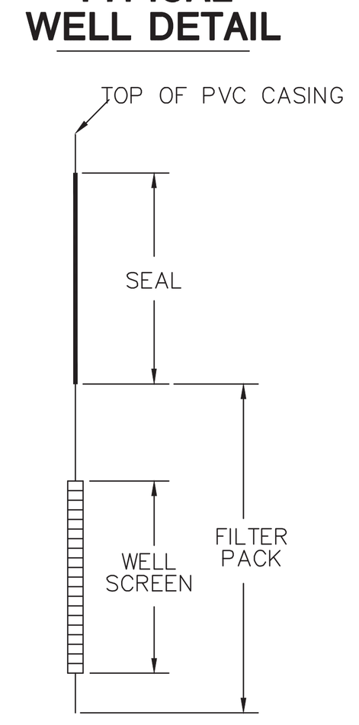
MISSISSIPPIAN LIMESTONE–GRAY LIMESTONE AND SHALY LIMESTONE.

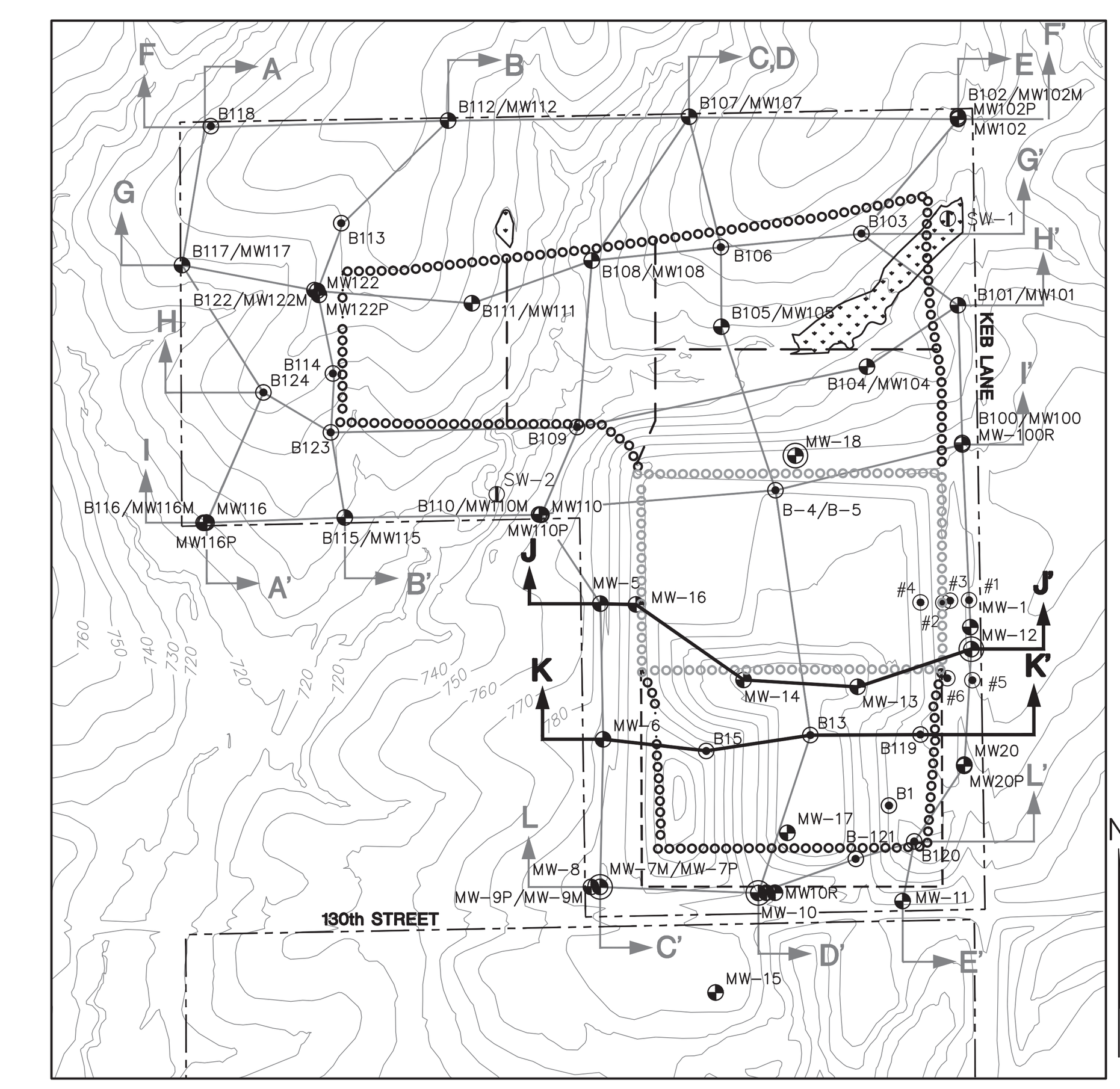
TYPICAL WELL DETAIL



CROSS SECTION SCALE

0 200 FEET

HORIZONTAL SCALE: 1" = 200'
VERTICAL SCALE: 1" = 20'
VERTICAL EXAGGERATION = 10X



CROSS SECTION LOCATIONS

500 0 500

SCALE: 1" = 500'

NOTES

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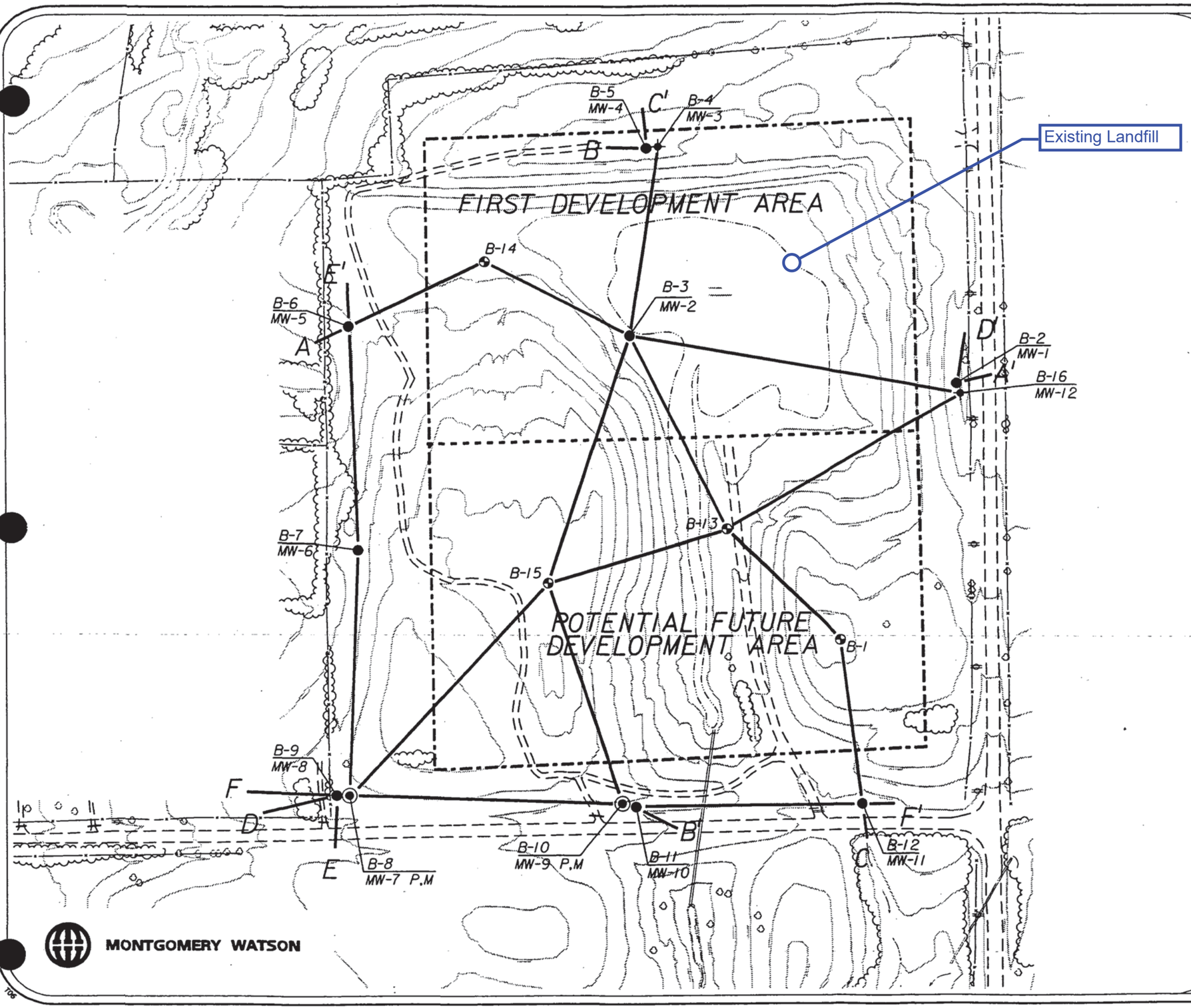
SHEET	10 OF 14
	CROSS SECTION J–J' & K–K'
SITE	PROPOSED LANDFILL EXPANSION SOIL AND HYDROGEOLOGIC INVESTIGATION OTTUMWA MIDLAND LANDFILL OTTUMWA, IOWA
CLIENT	INTERSTATE POWER AND LIGHT CO. OTTUMWA MIDLAND LANDFILL 15300 130th STREET OTTUMWA, IOWA 52501
ENGINEER	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718–6751 PHONE: (608) 224–2830
PROJECT NO.	25211509.03
DRAWN:	05/06/13
REVISED:	09/25/13
DRAWN BY:	AHB
CHECKED BY:	MDB
APPROVED BY:	EN 09/27/13



N

0 200

SCALE IN FEET

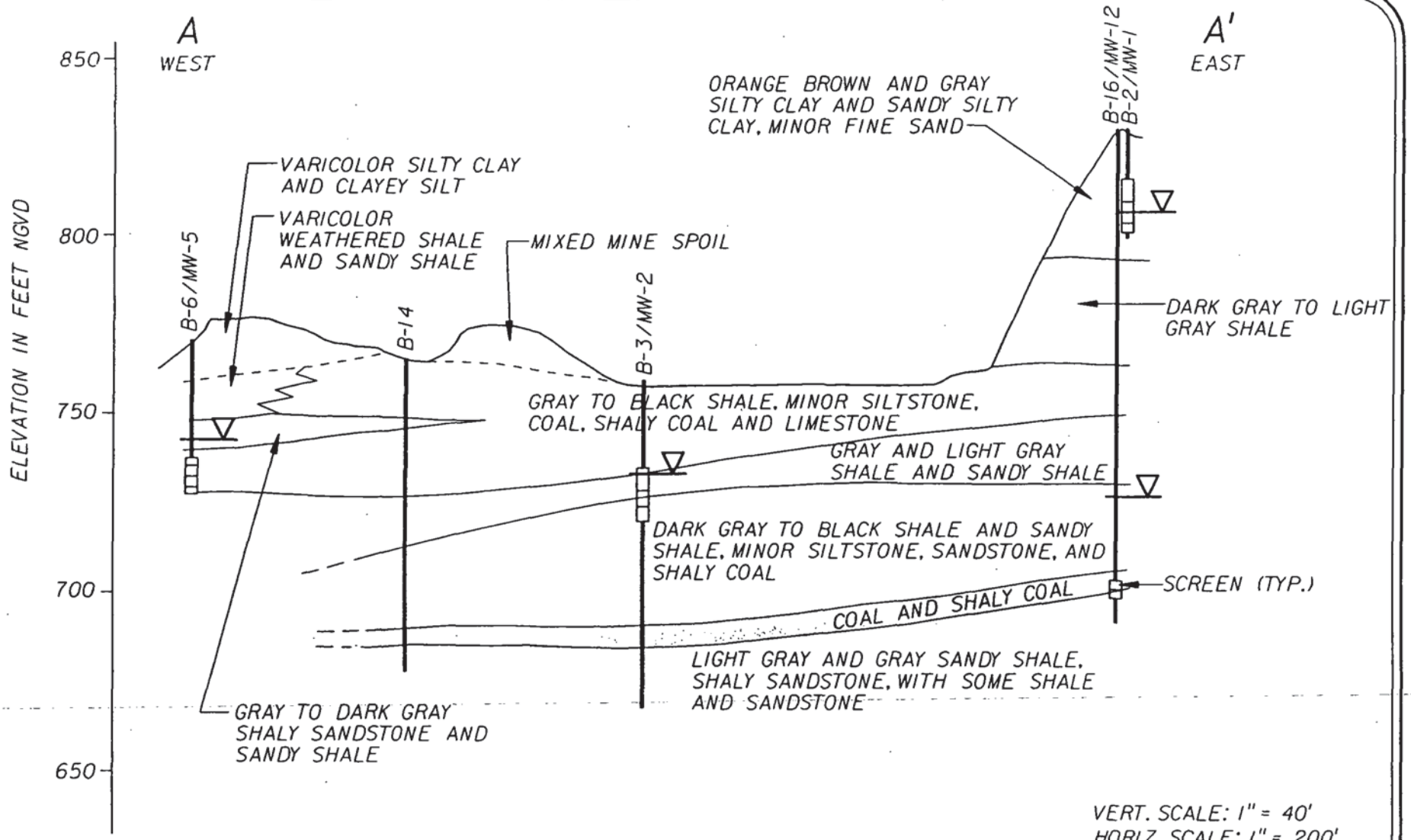
LEGEND:

- BORING
- DEEP MONITORING WELL
- MULTIPLE-CASED DEEP WELL
- SHALLOW MONITORING WELL
- PROPOSED LANDFILL BOUNDARY

OTTUMWA–MIDLAND
DEVELOPMENT CORPORATION

CROSS SECTION LOCATIONS

FIGURE 4–5



MONTGOMERY WATSON

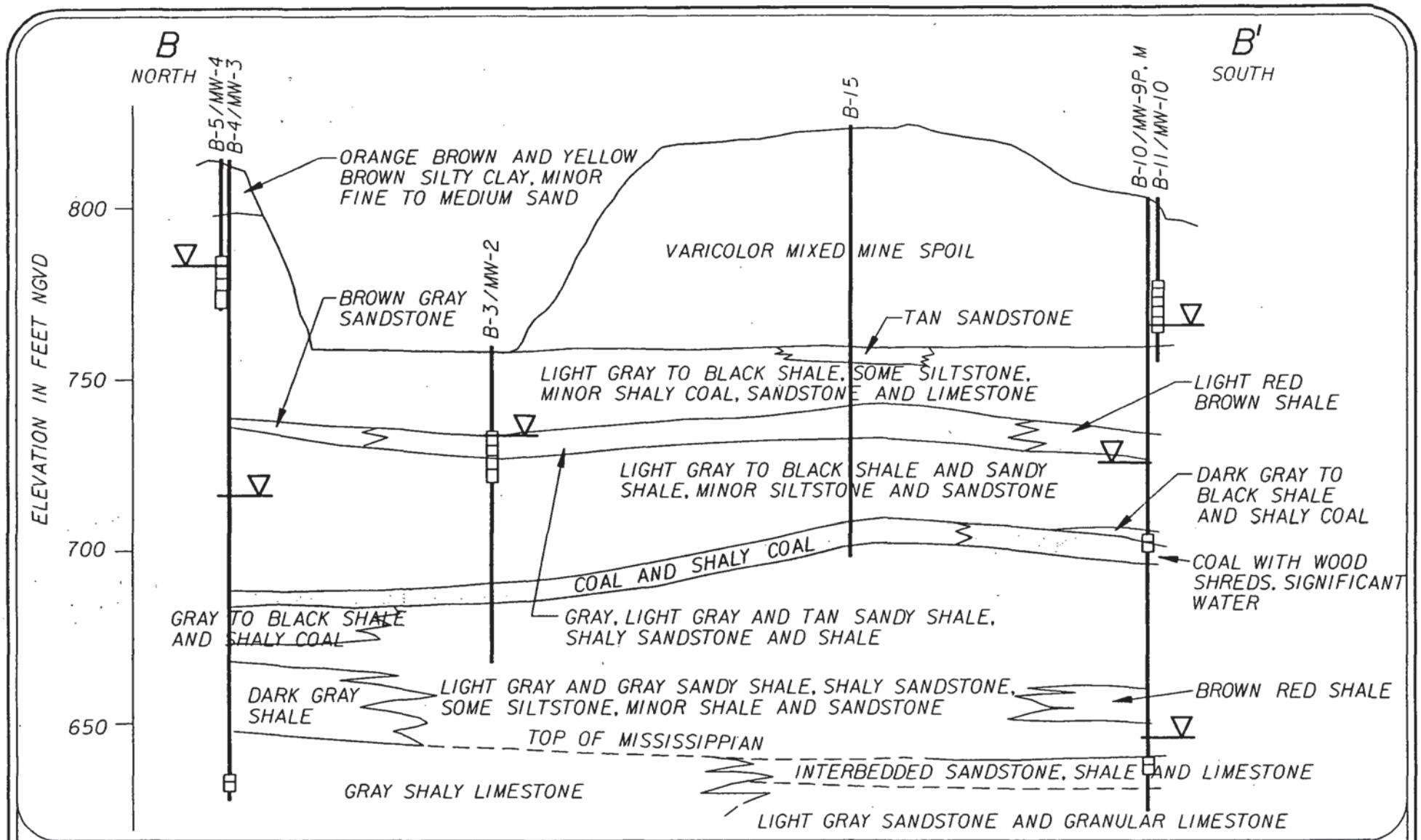
LEGEND:

GROUNDWATER ELEVATION (03-02-94)

OTTUMWA-MIDLAND DEVELOPMENT CORPORATION

CROSS SECTION A – A'

FIGURE 4-6



VERT. SCALE: 1" = 40'
HORIZ. SCALE: 1" = 200'
V.E. = 5x

LEGEND:

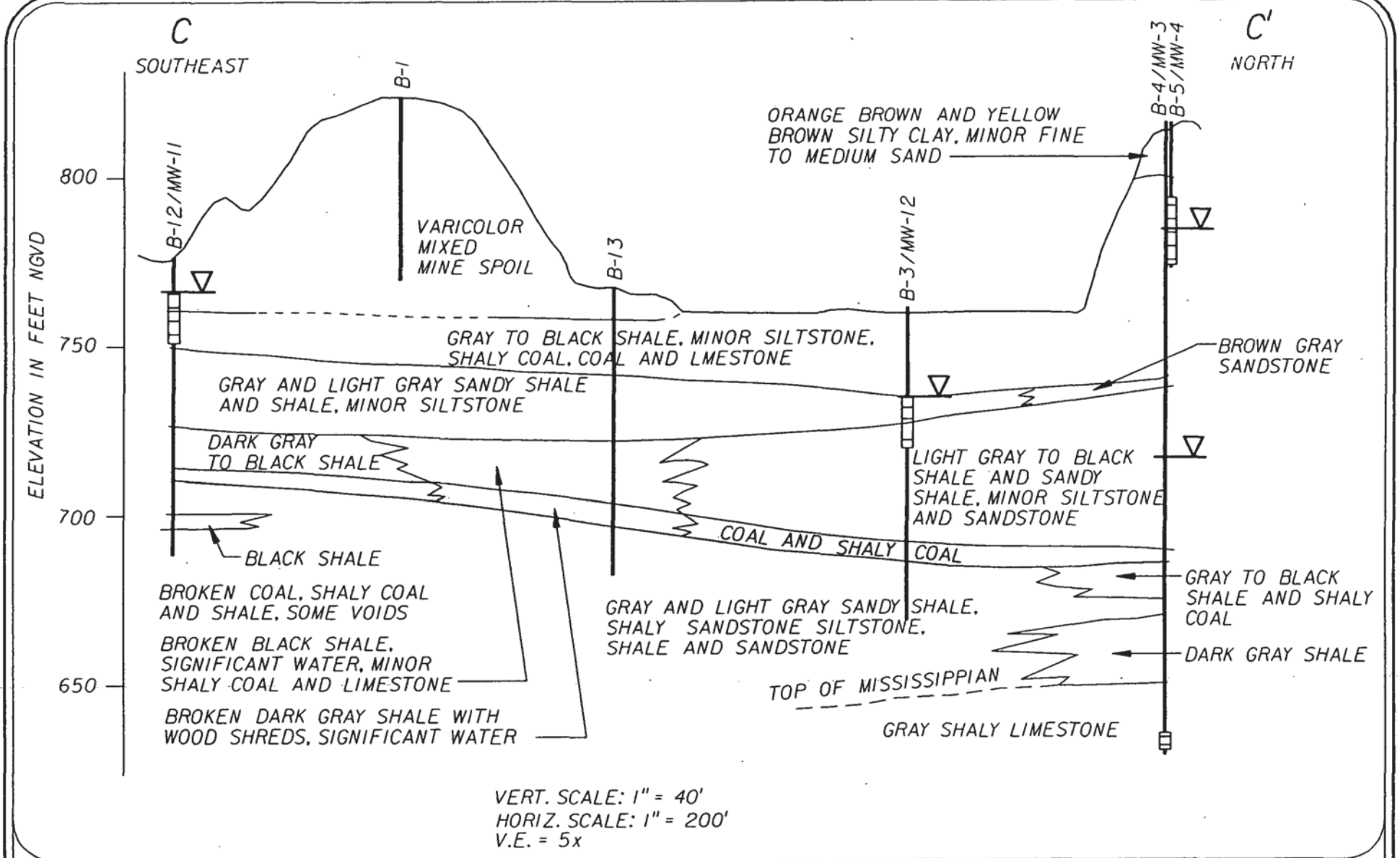
GROUNDWATER ELEVATION (03-02-94)

MONTGOMERY WATSON

OTTUMWA-MIDLAND DEVELOPMENT CORPORATION

CROSS SECTION B – B'

FIGURE 4-7



VERT. SCALE: 1" = 40'
HORIZ. SCALE: 1" = 200'
V.E. = 5x

MONTGOMERY WATSON

LEGEND:

▽ GROUNDWATER ELEVATION (03-02-94)

OTTUMWA-MIDLAND DEVELOPMENT CORPORATION

CROSS SECTION C – C'

FIGURE 4-8

APPENDIX D

Slope Stability Analysis Summary

Slope Stability Analysis Summary

Analysis Results

Prior to construction of OML Expansion Phase 1, slope stability analysis was performed during the site design process in 2013. The analysis evaluated the Phase 1 interim waste slope adjacent to the OML Existing Landfill as shown on **Attachment D1**. The interim waste slope angle is 4 horizontal to 1 vertical (4H:1V). The maximum waste slope height is approximately 164 feet.

The slope stability analysis results are shown in **Attachment D2**. The minimum slope stability safety factor is 1.47 which exceeds the minimum recommended safety factor of 1.3 for an interim waste slope. The recommended safety factor of 1.3 for an interim waste slope is based on end-of-construction safety factors discussed in the U.S. Army Corps of Engineers engineer manual on slope stability (USACE 2003).

Assumptions and Material Properties

The waste materials are flue gas desulfurization (FGD) ash, fly ash, and bottom ash from coal combustion processes. Both circular and sliding block slope stability analyses were performed. The material properties are shown in the table below, based on the indicated references and assumed values based on experience:

Material	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)	Reference
Ash Waste Material	120	20	0	3,4
Geosynthetics (Textured Geomembrane)	58	27.5	0	1
Bottom Ash Drainage Material	130	35	0	3
Clay Liner	121.7	28	0	2
Clay Fill/Native Clay	121.7	28	0	2

CCR waste samples were tested in the laboratory for shear strength in 2015 (Reference 7 below). A drained friction angle of 28.7 degrees was obtained confirming that the 20 degree friction angle used in the analyses in 2013 is conservative.

References

1. TRI, Interface Test Reports, Previous project experience for GSE Textured 60-mil HDPE Material vs GSE 12 oz. Non-woven Geotextile

2. Ottumwa Midland Landfill, Clay Borrow Samples, Summary of Soils Physical Testing Results, 2013, (Average of typical properties)

3. U.S. Department of Transportation, Federal Highway Administration, Recycled Materials, Coal Ash User's Guide

4. Stabilization of FGD By-Products by Using Fly Ash, Cement, and Sialite, 2009 WOCA Conference

5. WinSTABL (PC STABL6) slope stability software developed by Purdue University and modified by the University of Wisconsin – Madison.

6. SCS Engineers, 2013, Design Documents – Permit Amendment, Ottumwa Midland Landfill Expansion, Interstate Power and Light Company, Ottumwa, Iowa.

7. TRI/Environmental, Consolidated-Undrained Triaxial Compression Test Results for FGD Material, 2015, material properties for CCR.

8. U.S. Army Corps of Engineers, Slope Stability Engineer Manual EM 1110-2-1902, October 2003.

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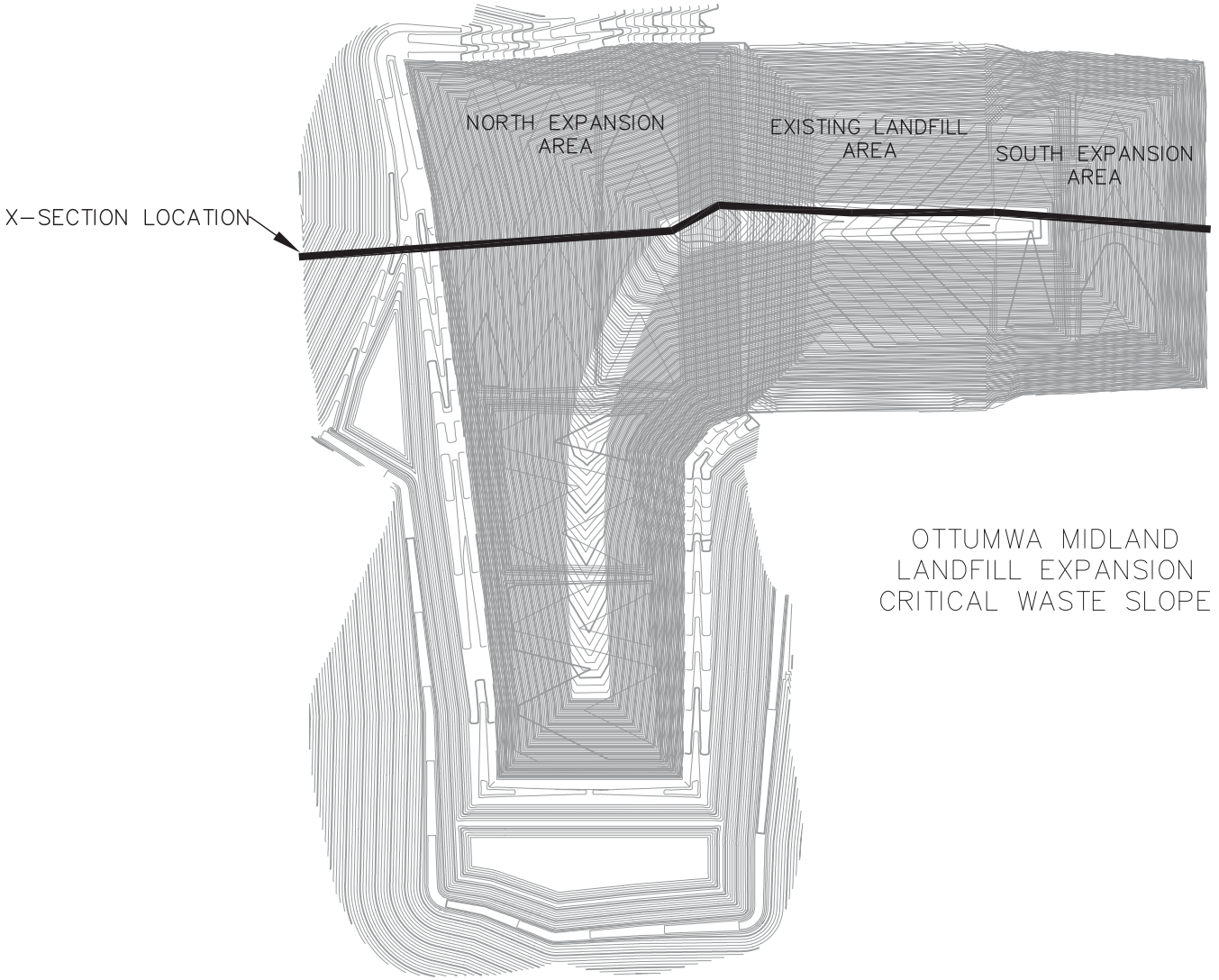

OTTUMWA MIDLAND
LANDFILL EXPANSION
CRITICAL WASTE SLOPE

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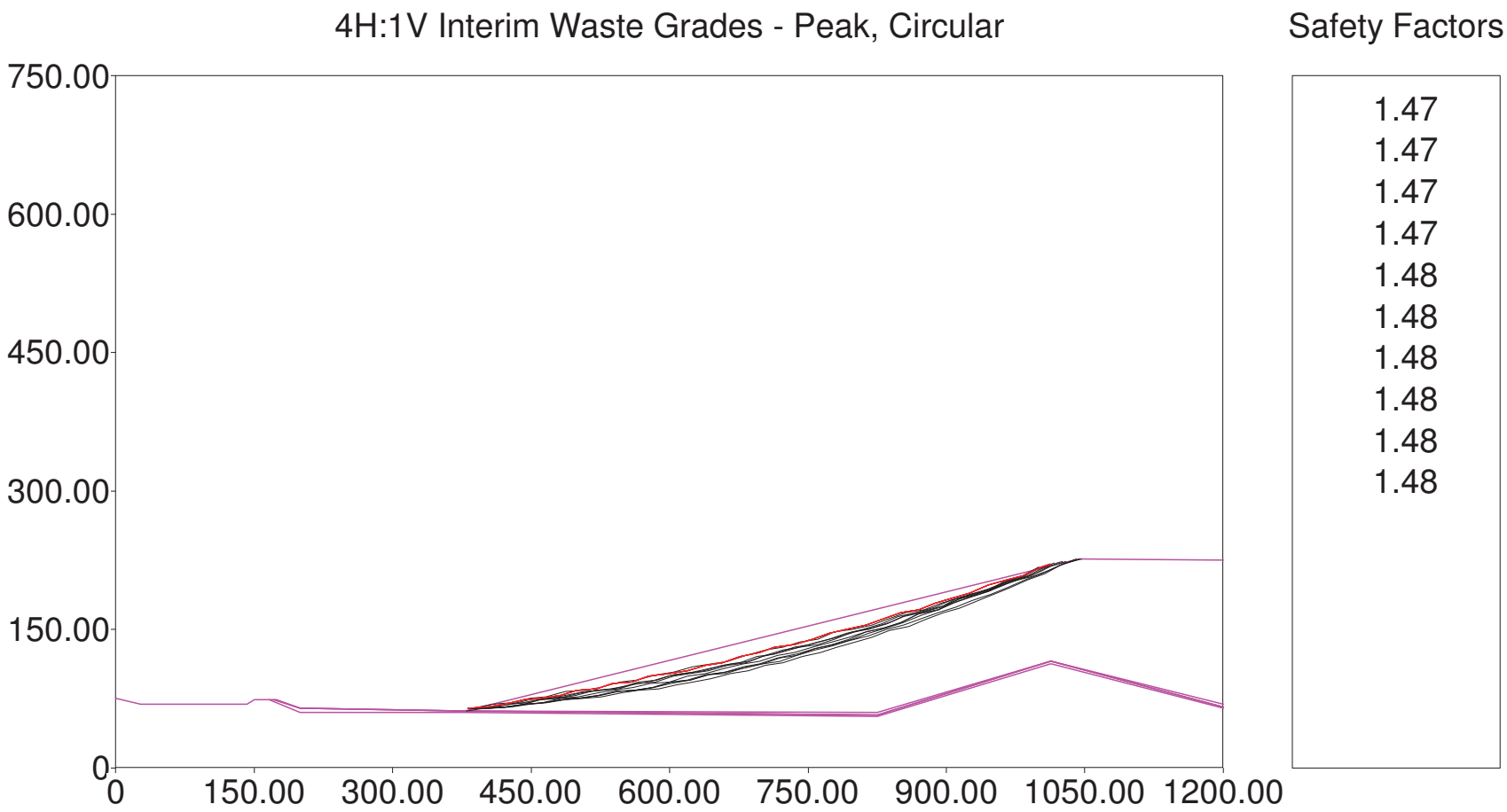
4H:1V Interim Waste Grades - Peak, Circular
Safety Factors
1.47
1.47
1.47
1.47
1.48
1.48
1.48
1.48
1.48
1.48
750.00
600.00
450.00
300.00
150.00
0
0
150.00
300.00
450.00
600.00
750.00
900.00
1050.00
1200.00

APPENDIX E

Seepage Potential and Karst Condition Assessment

Seepage Potential and Karst Condition Assessment

The landfill is designed and constructed to include storm water run-on and run-off management and leachate collection systems. Based on water table elevations from groundwater monitoring in 2013 prior to OML Expansion Phase 1 landfill construction, groundwater is higher than the landfill grade at the base of the liner in limited areas. Groundwater monitoring in 2013, in monitoring wells adjacent to the facility, show downward hydraulic gradients indicating that groundwater will not flow up under the landfill. The OML Expansion Phase 1 landfill and the OML Existing Landfill are constructed with underdrain systems to collect and drain away groundwater that might be present under the liner. The underdrain systems minimize the potential for soil pore water pressures to build up under the liner due to groundwater and causing liner stability issues. Therefore, there are currently no concerns that storm water, leachate, or groundwater movement will impact the stability of the landfill.

As noted in **Appendix A**, karst features were not observed in the borings within and adjacent to the disposal facility. As shown in **Appendix A**, the site is not identified as an area with potential karst, so karst structures are not a concern at the landfill site.

References

Montgomery Watson, 1994, Hydrogeological Investigation Report and Hydrologic Monitoring System Plan, Ottumwa-Midland Commercial Landfill.

SCS Engineers, 2013, Proposed Landfill Expansion, Soil and Hydrogeologic Investigation Report, Ottumwa Midland Landfill, Interstate Power and Light Company, Ottumwa, Iowa.

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