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NOTE

Subject: EPA Comments on Alliant Energy, Interstate Power & Light Co - Sutherland Generating Station, Marshalltown, IA
Round 10 Draft Assessment Report

To: File

Date: January 31, 2012

1. In section 1.2 “Project Background” on page 1 and 2, it may be worth mentioning the ‘Bubbler Pond’ and the ‘Polishing Pond,’ which can be found labeled in Figure No. 2 “Site Map.” Although it appears these units are outside the scope of the assessment and likely do not receive CCRs, it may be advantageous to mention them upon introducing the other management units in order to eliminate confusion.

2. In section 1.2.1 “Coal Combustion Dam Inspection and Checklist Forms,” it is stated “A breach of the North and/or South Primary Settling Ponds would discharge to the Main Pond. It may be advantageous to clarify this statement, as it appears from “Site Map” that only a breach of the eastern embankments of these units would cause discharge to the Main Pond. Would a breach of any embankment regardless of abutting structures discharge exclusively to the Main Pond? Would structures located within the Plant Area (i.e., Cooling Towers) remain unaffected regardless of breach?

3. On p. 2, section 1.2.2, update the status of the NPDES permit request in the final report. Also, in section 1.4 “Ash Ponds,” it may be advantageous to clarify “ash pond discharge” to elaborate on which ash pond the NPDES permit pertains to, i.e., Main Ash Pond. From the description in the text, it is somewhat ambiguous the origin of the discharge from the CCR management units and would be useful to provide a brie clarification.

4. On p. 3, section 1.4, second and third paragraphs, the terms “ash pond” and “ash settling pond” are used, please clarify which ash pond in each instance.

5. In section 2.4 and its various subsections, the use of “Discharge Basin” and “Discharge Pond” seem to be used interchangeably. Neither shows up on the site map, figure 2. Is this the “Bubbler Pond?” Please clarify and maintain consistency with labeling the ponds.

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ALLIANT ENERGY.

Interstate Power and Light Co.
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August 13, 2012

**Via E-mail to: hoffman.stephen@epa.gov
and kohler.james@epa.gov**

Mr. Stephen Hoffman
U.S. Environmental Protection Agency (5304P)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

**Re: Response to Draft Assessment Report
Sutherland Generating Station**

Dear Mr. Hoffman:

This letter is sent on behalf of Interstate Power and Light Company's ("IPL") Sutherland Generating Station in response to the United States Environmental Protection Agency's ("EPA") Draft Report of Dam Safety Assessment of Coal Combustion Surface Impoundments for Sutherland Generating Station, dated July 2011 ("Draft Report"). The site assessment was conducted by EPA's contractor AMEC Earth & Environmental, Inc. on June 14, 2011. EPA's cover email accompanying the Draft Report requests that comments be submitted within 30 days of receipt. EPA extended this date to August 13, 2012 for IPL. The email also provides for a business confidentiality claim covering all or part of the information submitted by IPL.

CONFIDENTIAL BUSINESS INFORMATION CLAIM

IPL is claiming business confidentiality for both the Draft and Final Reports associated with the site assessment of the coal combustion material management units at the Sutherland Generating Station and for the comments submitted in this letter in their entirety, a claim which is being made in accordance with 40 C.F.R. Part 2, Subpart B.

Per the criteria established by 40 CFR. Part 2, Subpart B, §2.208, the documents for which confidential treatment is requested are entitled to confidential treatment because: (1) this claim is timely and has not been waived, (2) IPL has taken reasonable measures to protect the confidentiality of the information and intends to continue to take such measures, (3) the information is not reasonably obtainable without IPL's consent by other persons by use of legitimate means, (4) no statute specifically requires disclosure of this information, and (5) the disclosure of the information is likely to cause substantial harm to IPL's competitive position.

All of the documents for which confidential treatment is requested help IPL maintain its competitive position. IPL protects the confidentiality of this information by making it available only to those within the company with a legitimate need to know the information for purposes of performing their jobs.

COMMENTS ON THE DRAFT ASSESSMENT REPORT

Listed below are the comments associated with the Draft Report for the IPL – Sutherland Generating Station.

Italics indicate language in Draft Report. **Bold** indicates suggested language.

Section 1.2.2:

1. Page 3, State Issued Permits – Remove *"IPL reported they had filed for permit renewal"* and insert **"IPL submitted the NPDES Renewal Application through IDNR's WWPIE web based system on May 15, 2011"**.

Section 1.4

1. Page 4, First Paragraph, Ash Ponds – Please remove the word *"consists"* and insert after Station the following **"originally consisted of three coal fired generating units rated at 170 MW. With the retirement of Unit 2 in 2010 and the conversion of the remaining units to natural gas (but still capable of burning coal), the rated capacity for Units 1 and 3 is approximately 133 MWs"**.

2. Page 4, Second Paragraph, Ash Ponds – Please remove *"Fly ash captured in the electrostatic precipitators is conveyed dry to temporary on-site storage"* to **"Fly ash captured in the electrostatic precipitators is stored in the fly ash silos. When the fly ash cannot be trucked offsite for beneficial uses, it is trucked to an on-site storage area where it is hydrated to form a beneficially reusable product called C-Stone"**.

3. Page 4, Third Paragraph, Ash Ponds – Please remove *"All of the wastewater enters the ash pond at the same location at a small dipping pond (North Primary Settling Pond)"* to **"All of the wastewaters, except for sluicing of slag from Unit 3, enters the north primary settling pond at the same location. Since Unit 3 is a cyclone boiler and produces a hard glass-like material called slag, it is sluiced to the south primary settling pond as this material is beneficially reused. During dredging operations of the North or South Primary settling ponds, valves can**

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be turned to direct the wastewater to the pond that is not currently being dredged".

4. Page 4, Third Paragraph, Ash Ponds – The facility refers to the large ash settling pond as the Main Ash Pond. If the report wishes to accurately describe the main ash pond, please remove *"includes"* and insert **"consists"** in the following *"The Main Ash Pond ~~includes~~* ***consists of*** *a Secondary Pond, Polishing Pond, and* Discharge Pond…". It appears, as written, that the site has a Main Ash Pond and these other ponds as well.

Section 2.3:

1. Page 10, Visual Observations South Primary Settling Pond – Remove *"fenced"* in the first sentence as the entire site is fenced.

Section 3.3.1:

1. Page 23, *"No Static or Seismic analysis were provided for the North and South Primary Ponds"* – As the inspectors indicate on their inspection forms found in Appendix A, the North and South Primary Ponds are classified as "*less than low hazard dams"* that pose little or no probable loss of human life or economic or environmental losses. As Aether states in their July 19, 2012 response to IPL (attached), this category of dam is not supported by FEMA. The berm/embankment that separates the primary settling ponds from the main pond is approximately 20 feet wide at its narrowest section and is the main roadway in this area for site vehicle traffic and ash moving equipment. With this amount of traffic, the roadway is very compact and has never failed. Even if the embankment would fail, it would be entirely contained within the main ash pond. Based on the above, it was determined that a static and seismic analysis on a small; incised; less than low hazard rated pond is not necessary and not justified to ensure overall stability of the entire pond system. Please remove this from Section 3.3. and Section 4.2 – last paragraph on Page 28. In addition, the pond rating of *"poor"* found in Section 4.1 *"Acknowledgement of Management Unit Conditions"* should be changed to **"Satisfactory"** as supported in the Aether dbs July 19, 2012 response to IPL.

Section 3.3.2:

1. Page 23 and 24, *"Main Ash Pond (Secondary Pond) – Structural Adequacy and Stability".* As Aether states in their July 19, 2012 response to IPL, the issues raised by the inspectors are clearly addressed; supported with additional field work; and models were run to support the conclusion of the June 17, 2011 "Ash Pond Slope Stability and Hydraulic Analyses" prepared by Aether dbs that the impoundments at the Sutherland Generating Station exceed the minimum factors of safety. As a result, the proper rating for these ponds should be changed from *"poor"* to **"Satisfactory"**. Please update this section accordingly.

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Section 4.2.1:

1. Page 27, *"Hydrologic and Hydraulic Analysis – "Main Ash Settling Ponds"*. As Aether states in their July 19, 2012 response to IPL, the pond system was designed to operate as one pond during a 100 year 24 hour rain event. With the conversion to natural gas and even with the ability to burn coal in the future, the ash ponds; based on Aether dbs' June 17, 2011 report and the information provided in their July 19, 2012 response, can clearly handle a 100 year 24 hour rain event. Please update this section and remove the recommendation that the *"freeboard be increased through con figuration of the pond(s) such that the 100-year 24-hour storm does not cause the pond(s) to cease operating as individual structures"*.

Section 4.2.2:

1. Page 27 and 28, *"Geotechnical and Stability Recommendations"*. The six bulleted items of concern have been addressed in the June 17, 2011 Aether dbs report and in their July 19, 2012 response to IPL. This entire section should be revised accordingly to account for the additional studies completed or verification of the June 17, 2011 report.

2. Page 28, *"Geotechnical and Stability Recommendations – Vegetation and Inspections"*. After the Round 8 Assessments by EPA at some of our other generating station, Alliant Energy has prepared a "Corporate Operations and Maintenance Plan" (Corporate Plan)that outlines the proper operations and maintenance of coal combustion ash ponds based on the guidance documents readily available from the Corp of Engineers; FEMA; and OSHA. In addition to the Corporate Plan, each generating station has a "Site Specific Operations and Maintenance Plan" (Site Plan) that defines the roles; responsibilities; and actions required by the generating station to ensure our ponds are maintained and operated in a safe manner now and in the future. As part of the Site Plan, a 3rd Party PE will inspect the site on an annual basis to evaluate the current conditions; evaluate maintenance activities; and provide additional guidance to improve the overall safety of the ponds. The inspection sheet has been revised accordingly to include monthly and a more detailed quarterly inspection. We anticipate having this plan, including training; operational at the Sutherland Generating Station by December 31, 2012.

REQUEST FOR CONFERENCE CALL WITH AMEC TO REVIEW COMMENTS

Finally, because of the technical complexity and factual detail contained in the Draft Report, IPL believes it would be efficient and helpful to conduct a conference call between IPL; Aether dbs; EPA and AMEC to review the details of these comments. IPL would be happy to coordinate the time and set up a call-in number. IPL specifically requests such a discussion take place prior to the preparation of a Final Report.

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IPL appreciates this opportunity to provide comments on the Draft Report for the Sutherland Generating Station. If you have any technical questions, please contact William Skalitzky at (608) 458-3108. If you have any legal questions, please contact Jenna Wischmeyer at (319) 786-4843.

Very truly yours,

Kevin Schaefer
Manager GENCO Operations

cc: James Kohler - EPA
William Skalitzky - AECS
Jenna Wischmeyer – AECS
Maria Lauck - AECS
Terry Kouba - AECS

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CONFIDENTIAL BUSINESS INFORMATION

aether dbs

elemental design build solutions

July 18, 2012

154.017.002.002

Mr. William Skalitzky
Alliant Energy Corporate Services
4902 N. Biltmore Lane
Madison, WI 53718

Response
USEPA Draft Report
Safety of Coal Combustion Waste Ponds
Sutherland Generating Station
Marshalltown, Iowa

Dear Mr. Skalitzky

Aether DBS provides a response to the Draft Report issued by United States Environmental Protection Agency (USEPA) commenting on the structural safety analysis of the coal combustion waste pond on the Sutherland Generating Station property. The draft report was prepared by AMEC Earth & Environmental, Inc. (AMEC) and is dated July 2011. Since the time of the AMEC inspection, the Sutherland Generating Station transitioned to natural gas firing the boiler, however fossil fuel (coal) combustion equipment remains installed and could be used in the future. Since coal combustion waste is not presently discharged to the ponds the normal analysis conditions are different than 2011.

Aether DBS concurs with the AMEC finding that the Main Ash Pond on the Sutherland Generating Station is **low hazard potential**. The AMEC report further rates the North and South Primary Settling Ponds as separate structures with a rating of Less than Low Hazard Potential. Aether does not consider these internal structures separate of the single ash pond and the less than low hazard potential is not a category supported by the Interagency Committee on Dam Safety (FEMA).

In the conclusion of the draft report AMEC provides a United States Army Corps of Engineers (USACE) condition rating of **POOR** to the pond. In justification of the **POOR** rating AMEC cites the following:

- Analysis of the embankment stability should be based on long term conditions (effective stress) not short term conditions (total stress).

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- Pocket penetrometer tests alone should not be used to determine the strength parameters for the clay embankment.
- A geotechnical engineer should evaluate the use of conservative values for strength properties of the embankment and/or determine if further strength data is needed.
- The critical cross-sections of the embankment should be confirmed by survey measurements separate of the topographic mapping from 2006.
- The east dike where water is present at the toe of the embankment should be evaluated for the impact of high phreatic surface and soft foundation conditions.
- The impacts of rapid drawdown on the upstream embankment should be analyzed.
- Analysis should consider lower strength values to account for inconsistencies within in the fill or the foundation soil.
- The pond freeboard should be increased to keep the internal pond divisions operating as separate ponds at the extreme 100-year return flow event.

In the conclusion of the AMEC report, there is no mention that the total stress stability analysis of the pond embankment by Aether indicated an Earthquake and Long-Term factor of safety that is more than twice the minimums cited in Table 5 of the AMEC report.

In Appendix A of the AMEC report, the Main Ash Pond configuration is selected as DIKED. Aether believes that the correct selection is COMBINED INCISED/DIKED.

Response and Additional Information

The outer embankments of the coal combustion waste impoundment were constructed in 1955 along with the Sutherland Generating Station Units 1 and 2. The embankments were constructed by excavating Zook clay in the impoundment area and using the Zook clay to build embankments with a top elevation equal to the established generating station grade (elevation 865). This is evident from the findings that the hard pond bottom is lower than the surrounding ground surface[1] and that the embankments are constructed of black clay (Zook clay)[2].

The Sutherland Station is located in the alluvial outwash formations of the Iowa River. The TEAM Services deep borings west of the ponds and the Black & Veatch borings south of the ponds indicate that sand is present below elevation 850. The TEAM Services and Black & Veatch boring logs and locations were provided in the Aether stability analysis report[3]. The top elevation of the sand in each boring is tabularized below. (Boring BV-7 is approximately 900 feet down the valley.) The density of the sand immediately below the clay is loose to medium dense.

[1] Sheet 2, Final Design of Pond Reconfiguration, Hard Hat Services, Inc., April 19, 2006 (referenced in Appendix C of AMEC report).
[2] Soil Survey of Marshall County, United States Department of Agriculture, Soil Conservation Service.
[3] Aether, "Ash Pond Slope Stability and Hydraulic Analysis, June 2011.

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Soil Boring	*Boring Depth (Ft.)*	*Sand Depth (Ft.)*	*Surface Elevation (Ft.)*	*Sand Top Elevation (Ft.)*
B-1	48	8.0	859.3	851
B-2	80	8.0	859.7	852
B-3	40.5	8.5	859.9	851
BV-6	80.5	7.0	856.6	850
BV-7	80.5	8.0	855.9	848

The general soil stratigraphy in Iowa is windblown loess on the surface with glacial till below the loess. In some locations the loess is eroded away and in river valleys the till is also totally or partially eroded and overlain by alluvial soils. The Marshall County Soil Survey[2] indicates that Zook clay is some of the finest textured soil derived from alluvial deposition and is found in the lower parts of bottom lands below alluvial benches that divide the bottomland of river valleys from the loess deposits. The USGS topographic quadrangle "Marshalltown Southeast" indicates that the natural ground surface adjacent to the impoundments is between elevations 855-860. The USGS elevation range is consistent with the June 2012 cross-section survey results by Aether.

Zook clay is black clay with an organic content of 5-7% due to its deposition in areas where the ground water elevation is coincident with the ground surface most of the year. The Marshall County soil survey indicates that the upper 18 inches is CL or CH and from 18 to 60 inches CH. The liquid limit and plastic index range for Zook Clay is:

Zook Clay	Liquid Limit	Plastic Index
0-18 inches	45-65	20-35
18-60 inches	60-85	35-55

Selected pages from the Marshall County Soil Survey are provided in Attachment A.

The generalized soil conditions at the embankments is compacted Zook Clay from the top elevation at 865 (feet) to elevation 857-855 (assuming some topsoil was stripped prior to compacting the embankment), undisturbed Zook Clay to elevation 850 and loose to medium dense alluvial sand below that elevation. The Zook Clay prior to construction of the embankments was approximately 8-feet thick and was exposed to desiccation and bottom drainage after deposition. In addition to the natural drainage and desiccation, the undisturbed Zook Clay below the embankments has been surcharge loaded by as much as 8-feet of compacted embankment for over 50 years further consolidating the clay under the embankment. The pocket penetrometer results from the Aether borings indicate that Zook Clay under the embankments is over consolidated. Immediately after construction of the embankments and prior to consolidation from the construction, the external embankments were able to withstand normal operational water pressures without distress.

To resolve issues raised by AMEC on the geometric cross-section of the embankments, Aether surveyed the slopes at four locations in June 2012 as identified on Figure 1. The

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sections correspond to the areas of concern expressed by AMEC and to the original critical cross-section selected by Aether. The survey results are shown on Figure 2 and the field measurements indicate that the downstream (outer) slopes of the embankment range from 2.25:1 to 1.6:1. The results also show that the toe of the embankment is at elevation 857 or 858 and that the embankments are up to 8 feet high. The upstream / inside slopes are much more uneven due to the 2006 ash removal in the main pond and/or wind/wave erosion in the polishing pond.

Since water is not being used to sluice bottom ash from the boilers, the water elevation in the ponds has dropped dramatically, Photo 1. The ponds still receive storm water runoff, blow down water from the cooling water loop, sump water and air compressor cooling water. Without the sluicing water, the water elevation in the main ash pond is at the ground surface elevation outside the pond, Photo 1. Cattails growing at the outside base of the embankment indicate that the groundwater is at or near the ground surface.

Photo 1 - South western corner of the Main Ash Pond looking west. (Aether 6/19/2012)

Without the bottom ash sluicing water, there is no flow to the Polishing pond which shows a dry bottom, photo 2.

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Photo 2 - Looking north along the eastern outer embankment. (Aether 6/19/2012)

The low water elevation indicates that exfiltration through the bottom of the Main Ash Pond into the underlying sand is sufficient to balance present operational flows such that the Main Ash Pond water level is close to the natural groundwater table elevation. Under the present conditions, Aether estimates that the 100-year, 24-hour SCS design storm runoff would fit in the Main Ash Pond and would not discharge into the Polishing Pond.

To address stability concerns raised by AMEC, Aether modeled cross-section 2 on Figure 1 using total stress soil strength for the embankment. Cross-section 2 has the greatest height of the three sections measured on the Main Pond. The slope stability soil profile includes loose sand below elevation 850, a consolidated and/or compacted Zook Clay embankment, consolidated clay under the embankment, and a weak normally consolidated Zook Clay at the toe of the embankment.

With the pond water elevation nearly the same as the outside groundwater elevation, the critical loading case is the sudden filling and emptying of the Main pond due to an extreme storm event. Since the pond would fill relatively quickly during a storm, a total stress analysis is appropriate. Conservatively, the Zook Clay embankment and subgrade is assigned the minimum cohesion value measured by pocket penetrometer testing during the 2006 investigation (1,000 PSF). The clay at the toe of the embankment and in the pond is assumed to remain normally consolidated with cohesion of 250 psf (soft clay). The sand is assigned a friction angle of 28° representing loose sand.

Program STABL5M (1996) from Purdue University[4] was used to analyze hundreds of potential slip surfaces. The program calculates a factor of safety based on the ratio of the driving forces to the resisting forces along each potential slip surface. A calculated factor of safety greater than one indicates stability along the surface analyzed. The ten most

[4] STABL User Manual, By Ronald A. Siegel, Purdue University, June 4, 1975 and STABL5 …The SPENCER Method of Slices: Final Report, By J.R.Carpenter, Purdue University, August 28, 1985

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critical circular failure surfaces are shown in Attachment B. All ten surfaces extend into the sand layer because of the uplift water pressure in the sand. (Disproportional head loss or exfiltration through the pond's bottom was ignored.) The lowest calculated Factor of Safety is greater than 3.3. Because of the high factor of safety there is no need to obtain more accurate soil strength data.

To analyze for the impact of converting back to coal firing of the boiler and refilling the ash ponds with water, Aether analyzed the stability with the pond at previous water operating elevation. In this case the cross-section 4 on the polishing pond has the greatest overall embankment height and steepest outboard slope. Effective stress soil parameters were assigned to the compacted clay, consolidated clay under the embankment, and normally consolidated clay at the toe of the embankment. As discussed by the Bureau of Reclamation[5], average compacted clay strength parameters for CH clay may be used for dams of **Low Hazard** potential without further testing. Based on the Bureau of Reclamation compilation, a friction angle of 19º and cohesion of 240 psf was assigned to the embankment and the consolidated clay under the embankment. For the normally consolidated clay at the toe of the embankment, the friction angle is chosen as 24ºbased on a plastic index of 55 and the relationship reported by Kenney in 1959[6] between plastic index and friction angle for normally consolidated clay. The stiff clay in the embankment above the phreatic surface that would be established under effective stress conditions is conservatively ignored and the thin clay layer at the toe is assumed to be normally consolidated which is not likely for such a thin deposit subject to easy drainage and surface dessication.

The results of the stability analysis with the the ultra-conservative assumption of effective stress parameters using STABL5M is a safety factor of 1.6 with the pond at normal overflow operating elevations, Attachment B. The results indicate that there is no need to perform further laboratory analysis on the soils of this **Low Hazard** embankment.

A specific response to each of the issues raised by AMEC is:

1. Effective versus Total Stress -- The AMEC report makes reference to normally consolidated clay which means clay that has not been consolidated by previous loadings other than its self-weight (i.e., not preloaded by an ice sheet over the clay, eroded soil over the clay, or a lowered ground water elevation). There is no indication in the literature on the soil formation processes for Marshall County or in the conditions at the site that Zook Clay is normally consolidated. However, Aether made very conservative assumptions as recommended by the US Bureau of Reclamation for **Low Hazard** potential embankments and finds that the embankments are stable with an effective stress analysis.
2. Pocket Penetrometer Testing Alone Unacceptable --The observation of the personnel taking the samples is also factored into the determination of the clay strength. Pocket penetrometer results alone are not the sole determinate.

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[5] United States Bureau of Reclamation, Design of Small Dams, pages 136-139, 1977.
[6] Kenney, T. C., Discussion, Proc. ASCE, Vol 85, No. SM3, pp. 67-79

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Experienced personnel are able to see the physical difference between stiff clay and soft clay. The lowest observed clay strength is used in the analysis even though it is obvious that the upper part of the embankment above the saturation point is much stiffer. The LOW HAZARD potential of the embankments and determinate strength does not warrant more extensive testing.

3. Qualified Geotechnical Engineer Needs to Review Strength Properties -- Both of the authors have Masters Degrees in Geotechnical Engineering with over 35 years of experience in the field of geotechnical engineering, Attachment C provides the resume's of each author.
4. Critical Cross-Section Needs to be Measured – The results on Figure 2 show the measurements made at the two cross-sections noted by AMEC and two other locations selected by Aether. Due to the very short height of the embankments (eight feet versus thirteen feet), compared to the original analysis, the variations from 2 horizontal to 1 vertical on the outer slope are insignificant.
5. Water at Toe of East Dike – The section was measure by survey and found to be no different than the other sections. Groundwater surface and ground surface are approximately the same as shown on Photo 1 where cattails are prevalent at the natural ground surface below the toe of the embankment.
6. Analysis with Lower Strength Values – The cross-section was changed to include soft clay at the toe of the embankment and to show very loose sand under the Zook Clay. The changes result in total stress failure potential that is deeper than the previous analysis but approximately the same factor of safety. Results assuming a full pond and very conservative effective stress soil parameter show a failure surface that is through the embankment and into the normally consolidated clay assumed at the toe. Even when the stiff clay on top of the embankment is ignored, the safety factor still remains above 1.5.
7. Increase Pond Freeboard –The division embankment between the Main pond and the Polishing pond was designed to overtop in severe flow events. With the Sutherland facility no longer sluicing coal combustion waste the entire pond capacity is available as freeboard under gas-fired operations.

Summary

The available site information provides sound information on the characteristics of the small embankments that contain the coal combustion waste at Sutherland Generating Station. The information indicates that the embankments are constructed of the native clay that was present at the site and that the clay was excavated from the interior of the impoundment to create the embankments. Site information also shows that alluvial sand and gravel deposits exist below the clay.

Reasonable conservative soil strength assumptions demonstrate the factors of safety for an unusual loading event, a 100- year flood flow, is far greater than the required minimum. Very conservative assumptions of soil strength under full impoundment and effective stress analysis show an acceptable factor of safety.

The conversion of the Sutherland Generating Station to natural gas has changed the pond operations with no coal combustion waste being sent to the pond. As shown an extreme

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flow event to the Main Pond will satisfy the acceptable margins of safety with soil strengths that are conservative for the conditions at the site. In the event the station returns to coal firing, the Long Term (effective stress) strength of the embankment is adequate for a LOW HAZARD embankment.

Aether DBS believes the condition assessment for the Sutherland Coal Combustion Waste Pond should be a **SATISFACTORY** rating.

If you have any questions, please call or e-mail.

Very truly yours,

Timothy J. Harrington, P.E.

Thomas C. Wells, P.E.

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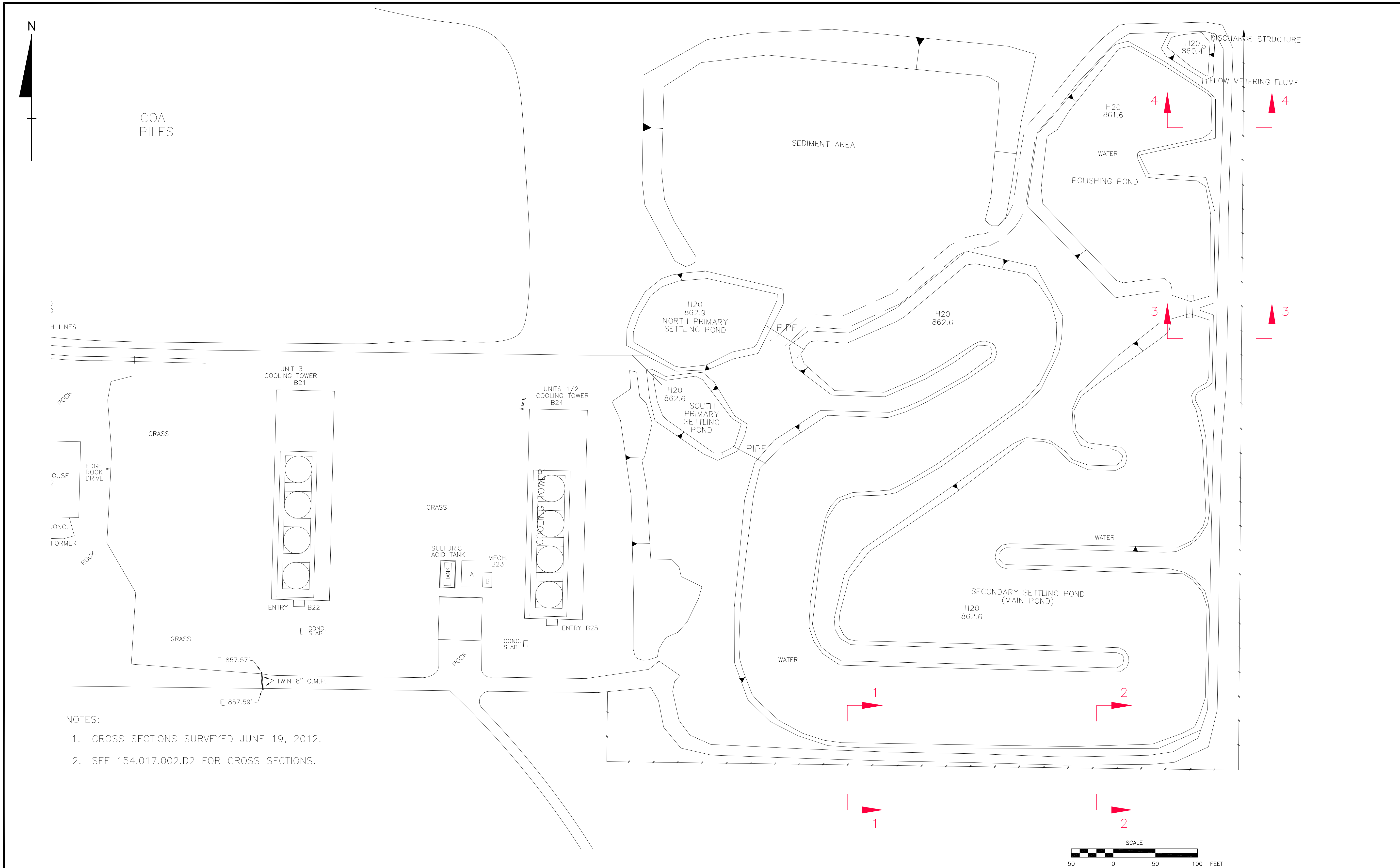

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REV	DATE	BY	DESCRIPTION
5			
4			
3			
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aether dbs
www.aetherdbs.com

SCALE:	AS SHOWN
DATE:	06-26-2012
DRAWN BY:	M A M
CHKD. BY:	
APPROVED:	

CLIENT / LOCATION

INTERSTATE POWER & LIGHT COMPANY
SUTHERLAND GENERATING STATION
MARSHALLTOWN, IOWA

DRAWING DESCRIPTION

CROSS SECTION LOCATIONS

JOB 154.017.002
SHT. SHEET 1
DWG. 154.017.002.D1

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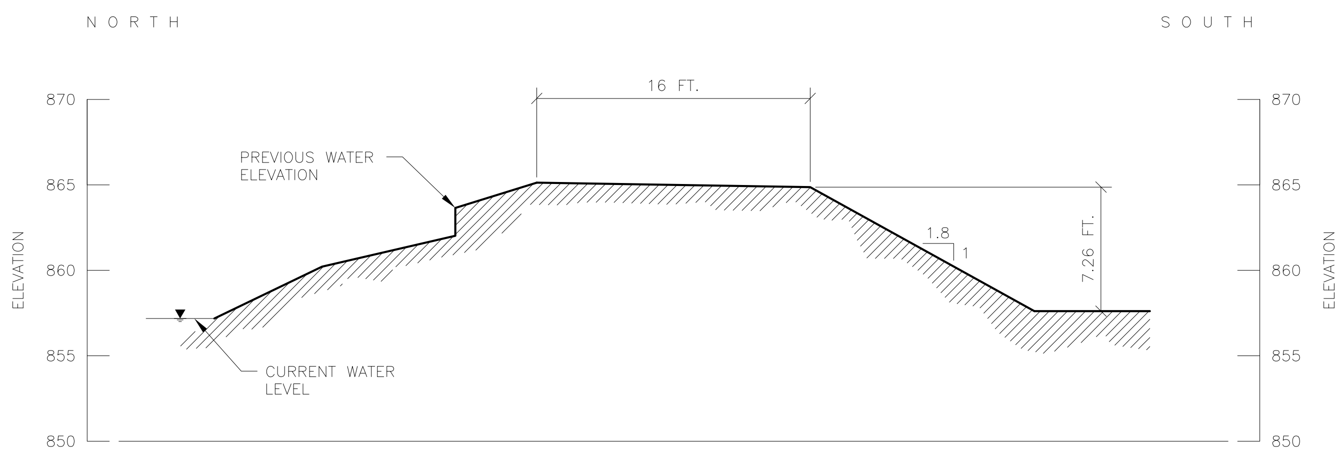
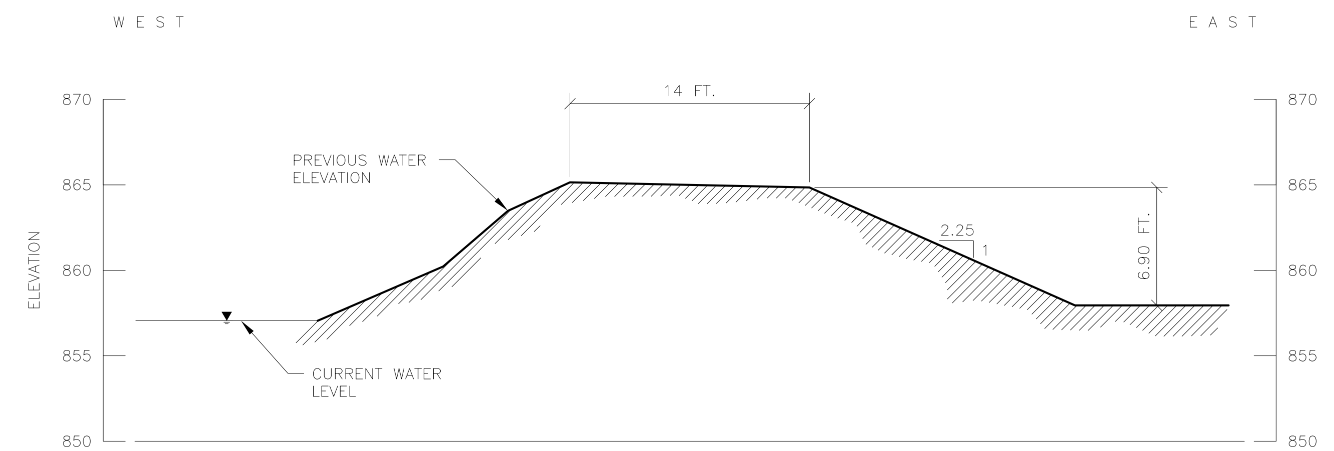
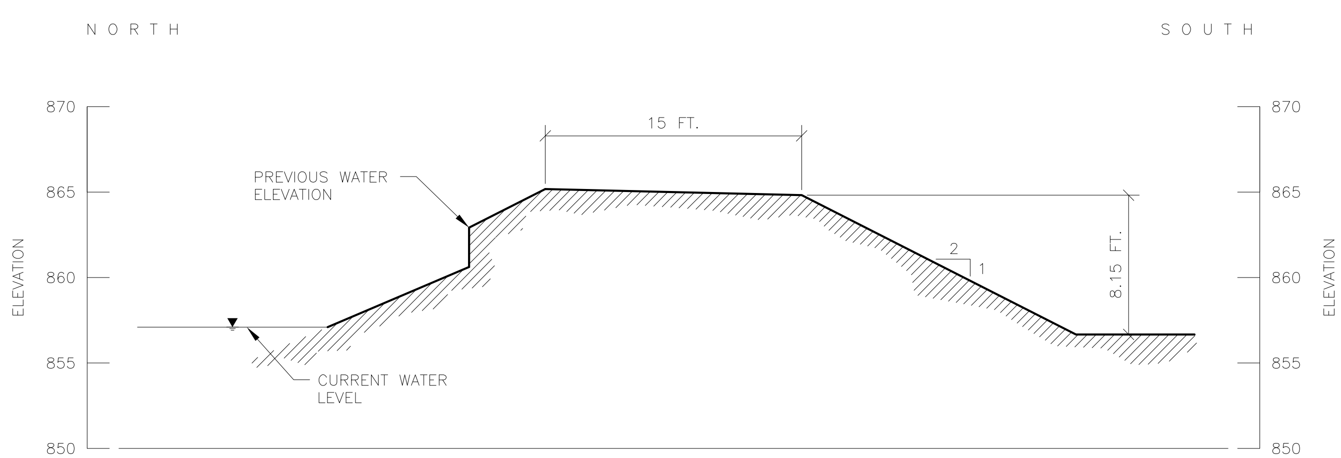


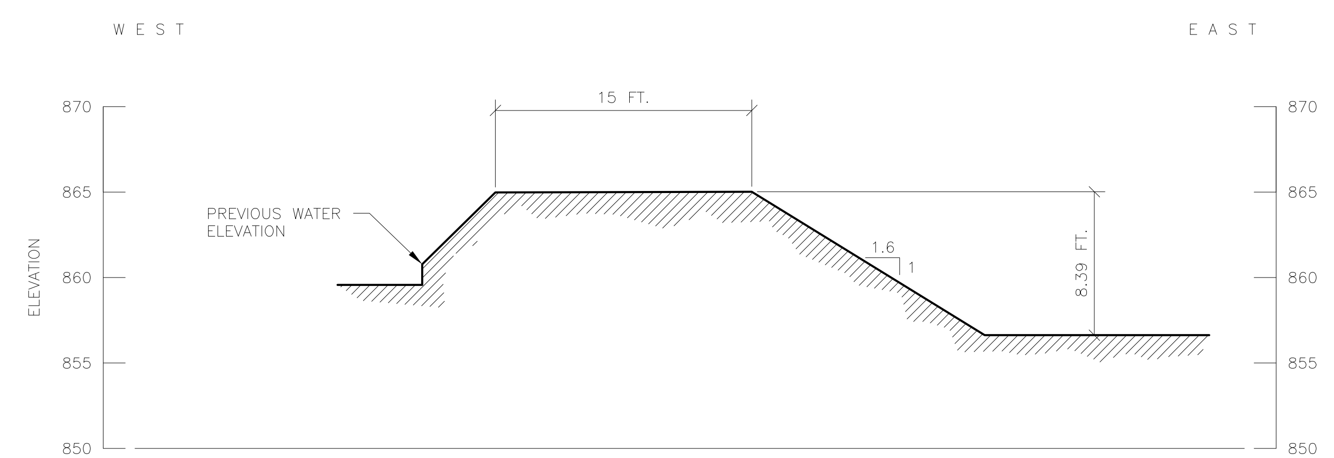
LOCATION 1



LOCATION 3



LOCATION 2



LOCATION 4

NOTES:

1. CROSS SECTIONS SURVEYED JUNE 19, 2012.

SCALE (HORIZONTAL AND VERTICAL)
5 0 5 10 FEET

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REV	DATE	BY	DESCRIPTION
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SCALE:	AS SHOWN
DATE:	06-26-2012
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CHKD. BY:	
APPROVED:	

CLIENT / LOCATION
INTERSTATE POWER & LIGHT COMPANY
SUTHERLAND GENERATING STATION
MARSHALLTOWN, IOWA

DRAWING DESCRIPTION
CROSS SECTIONS

JOB	154.017.002
SHT.	SHEET 2
DWG.	154.017.002.D2

Attachment A

Soil Survey of Marshall County, Iowa

United States Department of Agriculture &

Soil Conservation Service

Excerpted Pages

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Soil Survey of

Marshall County, Iowa

United States Department of Agriculture, Soil Conservation Service
in cooperation with the
Iowa Agriculture and Home Economics Experiment Station
Cooperative Extension Service, Iowa State University
and Department of Soil Conservation, State of Iowa

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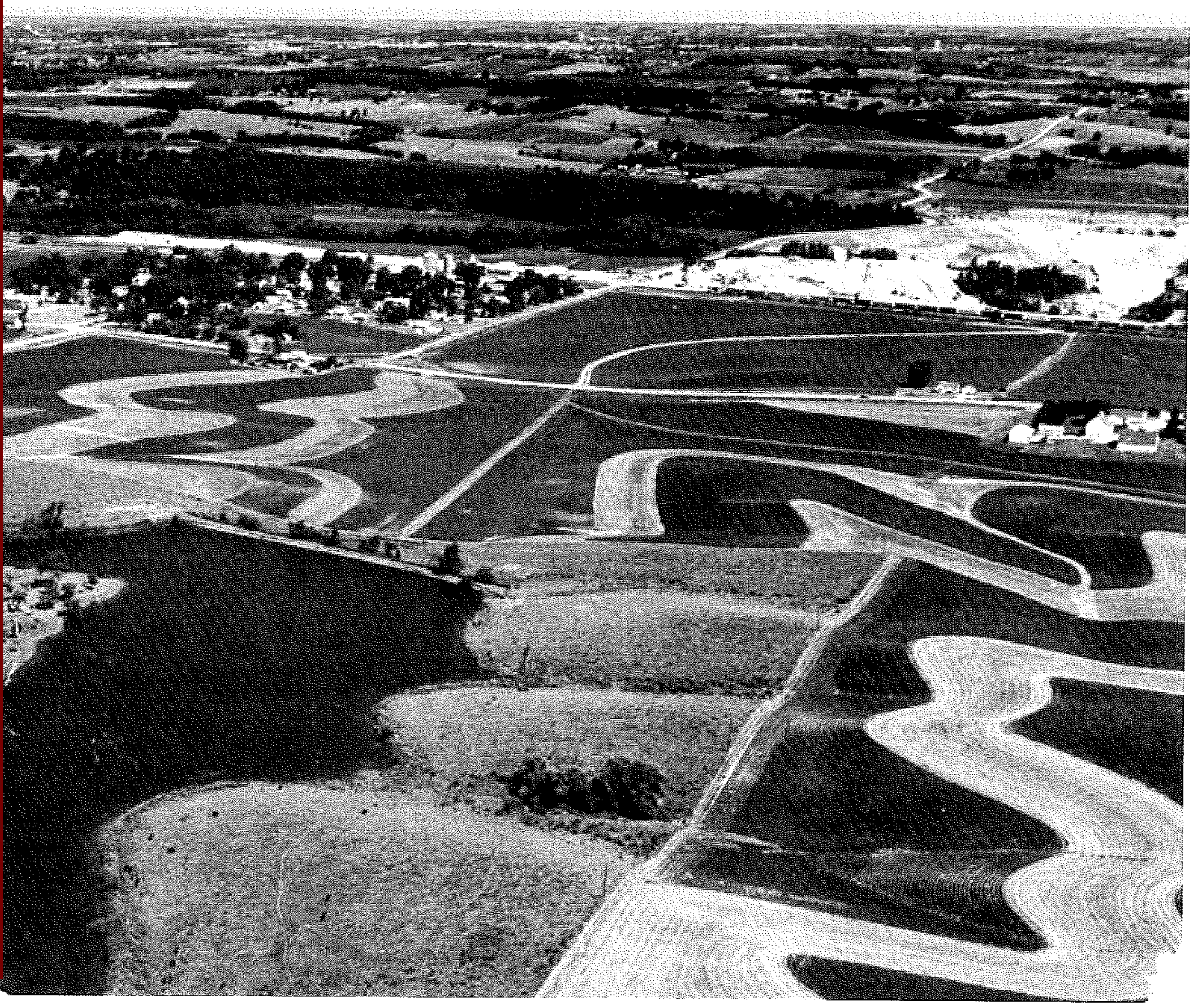

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general soil map units

The general soil map at the back of this publication shows broad areas, called soil associations, that have a distinctive pattern of soils, relief, and drainage. Each soil association on the general soil map is a unique natural landscape. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

1. Colo-Lawson-Zook association

Nearly level, poorly drained and somewhat poorly drained, silty soils formed in alluvium; on bottom lands and alluvial fans

This association consists of nearly level soils on flood plains and fans along major streams and in river valleys. These soils are subject to flooding. In places near the natural water course, the flood plains are severely dissected, and water stands in old channels.

This association makes up 10 percent of the county. It is about 29 percent Colo soils, 13 percent Lawson soils, 10 percent Zook soils, and 48 percent soils of minor extent (fig. 2).

Colo soils, on flood plains and alluvial fans, are nearly level and are poorly drained. Typically, the surface layer is black silty clay loam about 11 inches thick. The subsurface layer is black silty clay loam about 26 inches thick. The next layer is very dark gray silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is light brownish gray silty clay loam.

Lawson soils, on first and second bottoms, are nearly level and are somewhat poorly drained. Typically, the surface layer is black silty clay loam about 6 inches thick. The subsurface layer is black and very dark brown silty clay loam in the upper part and very dark grayish brown silty clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown silty clay loam.

Zook soils, on low flood plains, are nearly level and are poorly drained. Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black silty clay loam and silty clay about 31 inches thick. The subsoil to a depth of about 60 inches is very dark gray and grayish brown, friable silty clay loam.

Soils of minor extent in this association are the Ackmore, Hanlon, Lawler, Nevin, Nodaway, Saude, and Wiota soils. The poorly drained and somewhat poorly drained Ackmore soils and moderately well drained Nodaway and Hanlon soils are on broad flood plains and bottom lands near the natural stream channel. In addition, Ackmore and Nodaway soils are on alluvial fans near tributaries. The somewhat poorly drained Lawler soils and well drained Saude soils are on stream benches and outwash plains. The somewhat poorly drained Nevin soils are on high bottoms and low stream benches. The well drained and moderately well drained Wiota soils are on stream benches.

Most areas of this association are used for cultivated crops. Channeled and dissected areas of the flood plain are used for pasture and trees. The main enterprise is growing cash grain crops. The soils are well suited to cultivated crops if they are adequately drained and protected from flooding. They are poorly suited to building site development and sanitary facilities.

Corn, soybeans, oats, hay, and pasture grow well on the soils of this association. The organic matter content and the available water capacity of these soils are high. The main concerns of management are improving drainage and protecting the soils from flooding. These soils can be drained by tile and surface drains if adequate outlets are available. Diversions, levees, and channel improvements help to provide flood protection and control runoff from adjacent areas.

2. Muscatine-Tama-Garwin association

Nearly level and gently sloping, somewhat poorly drained, well drained, and poorly drained, silty soils formed in loess; on uplands

This association consists of wide areas of nearly level soils on divides and gently sloping soils on side slopes. The landscape is mostly gently undulating and undulating.

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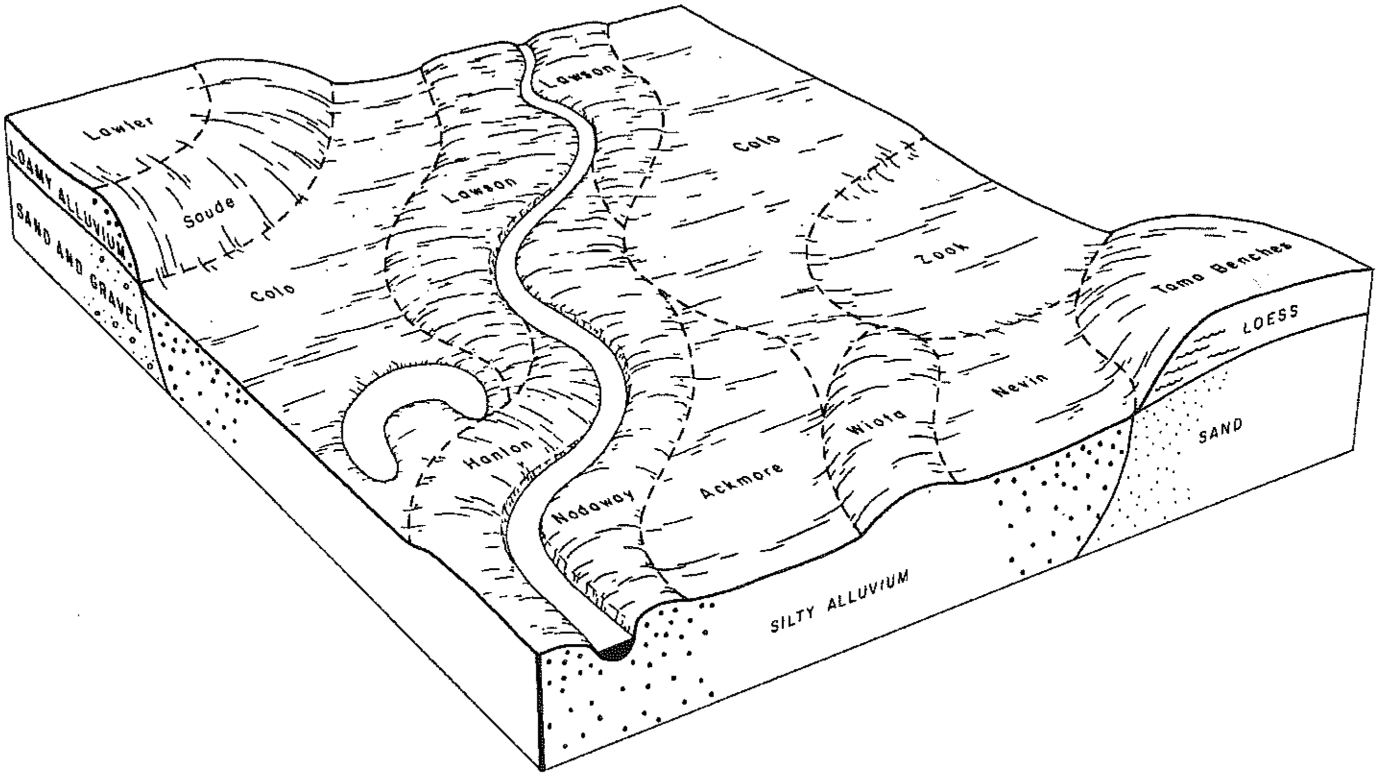

Figure 2.—Typical pattern of soils and parent material in the Colo-Lawson-Zook soil association.

This association makes up about 21 percent of the county. It is about 43 percent Muscatine soils, 38 percent Tama soils, 13 percent Garwin soils, and 6 percent soils of minor extent.

Muscatine soils, on moderately wide divides, are very gently sloping and are somewhat poorly drained. Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black and very dark brown silty clay loam about 10 inches thick. The subsoil is silty clay loam about 27 inches thick. It is very dark grayish brown and dark grayish brown in the upper part and mottled grayish brown and light olive brown in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam.

Tama soils, on broad convex ridgetops and side slopes, are nearly level and gently sloping and are well drained. Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown silty clay loam about 9 inches thick. The subsoil is friable silty clay loam about 31 inches thick. It is brown in the upper part, yellowish brown in the middle part, and dark yellowish brown and yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled silty clay loam.

Garwin soils, on wide divides and concave heads of drainageways, are nearly level and are poorly drained. Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray silty clay loam about 9 inches thick. The subsoil is friable silty clay loam about 26 inches thick. It is dark gray and gray in the upper part and mottled olive gray in the lower part. The substratum to a depth of about 60 inches is light olive gray, mottled silty clay loam.

The soils of minor extent in this association are the Colo, Ely, Harpster, and Sperry soils. The poorly drained Colo soils are in upland drainageways. The somewhat poorly drained Ely soils are on foot slopes. The poorly drained, calcareous Harpster soils are on wide divides and at the heads of drainageways. The very poorly drained Sperry soils are in slight depressions on wide divides.

Most areas of this association are used for row crops (fig. 3). The main enterprise is growing cash grain crops. These soils are well suited to all cultivated crops commonly grown in the county.

Corn, soybeans, oats, and hay grow well on the soils of this association. The available water capacity is high to very high. The organic matter content of these soils is moderate to high. The main concerns of management are controlling erosion and improving drainage.

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phosphorus, and low in available potassium. This soil has good tilth.

Most areas of this soil are in cropland. This soil is well suited to cultivated crops, hay, and pasture if protected from run-on water and if tile outlets are available. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans if drainage is adequate. Open drains and tile outlets are necessary to adequately drain this soil. This soil generally occurs as small areas within larger areas of better drained soils. Areas of this soil are subject to flooding because of runoff from adjoining soils. Return of all crop residue helps to maintain tilth.

This Vesser soil is in capability subclass IIw.

54—Zook silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on flood plains. Areas of this soil are subject to occasional flooding. Typical areas are broad and irregular in shape and range from 5 to more than 100 acres.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black silty clay loam and silty clay about 31 inches thick. The subsoil is very dark gray and grayish brown, friable silty clay loam to a depth of about 60 inches. Some areas have about 12 inches of silt loam overwash.

Included with this soil in mapping are small depressional areas that are high in organic matter content. These areas contain marsh vegetation. Marsh areas pond water for long periods and are not cultivated. These areas make up 5 percent of this map unit.

Permeability of this Zook soil is slow, and surface runoff is slow to very slow. The available water capacity is high. This soil has a seasonal high water table. The content of organic matter in the surface layer is 5 to 7 percent. The surface layer is slightly acid or neutral, and the subsoil is medium acid to mildly alkaline, low in available phosphorus, and very low in available potassium. This soil has poor tilth.

Most areas of this soil are in cropland. This soil is well suited to cultivated crops if adequately drained and if protected from flooding. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans if drainage is adequate. Areas can be drained by tile and surface drains if adequate outlets are available. Diversions, levees, and channel improvements are used to control flooding and runoff from adjacent areas. Artificial drainage improves the timeliness of field operations and helps to improve tilth.

This Zook soil is in capability subclass IIw.

55—Nicollet loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is on slightly convex or plane, sloping ground moraines that have low relief. In places, this soil is on toe slopes or in the upper part of drainageways. Individual areas are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is loam about 12 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is friable clay loam about 13 inches thick. It is dark grayish brown with dark yellowish brown mottles in the upper and middle parts and dark grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled loam.

Included with this soil in mapping are a few small areas of Webster and Okoboji soils that are poorly drained or very poorly drained. These soils are on lower areas and have a heavier textured subsoil. The Okoboji soils pond water. These soils make up 5 to 10 percent of this map unit.

Permeability of this Nicollet soil is moderate, and surface runoff is slow. This soil has a seasonal high water table. The available water capacity is high. The surface layer is slightly acid or neutral, and the subsoil is slightly acid or medium acid. The content of organic matter is about 5 to 6 percent in the surface layer. The subsoil is very low in available phosphorus and very low to low in available potassium. This soil has good tilth.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and moderately suited to building site development.

This soil is well suited to corn and soybeans. If the soil is used for cultivated crops, there is a very slight hazard of erosion on the more sloping areas. Adequate drainage for the fluctuating water table may be beneficial. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, helps to prevent soil loss caused by wind erosion. Returning crop residue helps to maintain good tilth.

If used for pasture or hay, overgrazing or grazing when the soil is wet causes surface compaction and decreased infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Nicollet soil is in capability class I.

62D2—Storden loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes of the uplands. Typically, the slopes are short. Individual areas are long and narrow and range from 10 to 20 acres.

Typically, the surface layer is light yellowish brown and dark grayish brown, calcareous loam. The substratum to a depth of about 60 inches is calcareous loam. The upper part is light yellowish brown, the middle part is pale brown, and the lower part is light brownish gray.

Included with this soil in mapping are a few small areas that contain more sand and gravel and are droughty. They make up 5 to 10 percent of the map unit.

Permeability of this Storden soil is moderate, and surface runoff is rapid. The available water capacity is

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roots; few worm channels; slightly acid; gradual smooth boundary.

A13—13 to 18 inches; very dark gray (10YR 3/1) light silty clay loam, very dark grayish brown (10YR 3/2) kneaded, dark grayish brown (10YR 4/2) dry; moderate very fine and fine subangular blocky structure; friable; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

A3—18 to 26 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) silty clay loam, very dark gray (10YR 3/1) coatings on peds, brown (10YR 5/3) dry; moderate fine subangular blocky structure; friable; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

B2t—26 to 37 inches; brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) coatings on peds; weak medium prismatic structure parting to moderate medium subangular blocky; friable; thin discontinuous clay films; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

B3—37 to 49 inches; brown (10YR 4/3) silty clay loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; thin discontinuous silt coats; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

C—49 to 60 inches; yellowish brown (10YR 5/4) silty clay loam; few fine faint grayish brown (10YR 5/2) mottles; massive; friable; thin discontinuous silt coats; few fibrous roots; slightly acid.

The solum ranges from 36 to 60 inches in thickness. The mollic epipedon ranges from 18 to 32 inches in thickness.

The A horizon is 25 to 32 percent clay. Reaction ranges from slightly acid to strongly acid. The B horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). The C horizon is silt loam or silty clay loam and is stratified in some pedons.

Zook series

The Zook series consists of poorly drained soils on flood plains commonly adjacent to foot slopes and bench escarpments. Permeability is slow. Zook soils formed in silty alluvium that is less than 15 percent sand. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Zook soils are similar to Colo soils and are commonly adjacent to Bremer and Nevin soils. Colo soils have less clay in the solum. Bremer soils have thinner A horizons and less clay in the B horizon. They are on second bottoms or low stream benches. Nevin soils have thinner A horizons, are somewhat poorly drained, and are on high second bottoms and low stream benches.

Typical pedon of Zook silty clay loam, 0 to 2 percent slopes, 1,040 feet south and 198 feet east of the northwest corner of sec. 20, T. 84 N., R. 18 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, black (N 2/0) dry; weak fine granular structure; friable; common fibrous roots; neutral; abrupt smooth boundary.

A12—9 to 18 inches; black (N 2/0) heavy silty clay loam, black (N 2/0) dry; moderate very fine subangular blocky structure; friable; few fibrous roots; neutral; gradual smooth boundary.

A13—18 to 25 inches; black (N 2/0) light silty clay, black (N 2/0) dry; moderate very fine and fine subangular blocky structure; firm; few fibrous roots; slightly acid; gradual smooth boundary.

A31—25 to 32 inches; black (10YR 2/1) light silty clay, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to fine and medium subangular blocky; firm; few fibrous roots; slightly acid; gradual smooth boundary.

A32—32 to 40 inches; black (10YR 2/1) heavy silty clay loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to fine and medium subangular blocky; firm; few fibrous roots; slightly acid; gradual smooth boundary.

B2g—40 to 48 inches; very dark gray (10YR 3/1) silty clay loam; weak medium prismatic structure parting to weak fine subangular blocky; friable; few fibrous roots; slightly acid; gradual smooth boundary.

B3g—48 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak medium prismatic structure; friable; few fibrous roots; neutral.

The solum ranges from 45 to 64 inches in thickness. The entire solum is 5 to 15 percent sand and below a depth of 16 inches, it is 38 to 46 percent clay.

The A horizon ranges from 30 to 40 inches in thickness. It is black (10YR 2/1, N 2/0) silty clay loam or silty clay. The A horizon is 32 to 42 percent clay. Reaction ranges from neutral to medium acid. The B and C horizons are very dark gray (10YR 3/1), dark gray (10YR to 5Y 4/1), gray (5Y 5/1), or grayish brown (2.5Y 5/2).

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formation of the soils

This section discusses the factors of soil formation and relates these factors to the soils in Marshall County.

factors of soil formation

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil development have acted on the soil materials (*8*).

Climate and vegetation are the active factors in the formation of soil. They act on the parent material and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil. It may be much or little, but some time is always required for horizon differentiation. A long period generally is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil development are unknown.

parent material and its geologic origin

Most of the soils in Marshall County developed from loess (windblown materials), glacial till (ice-laid materials), and alluvium (water-laid materials). A few areas of eolian sand are along the Iowa River and Minerva and Honey Creeks. Parent materials in most places are built up like layers of a cake. These layers can be observed in road cuts and in places on side slopes. In this county, parent material was important in developing the general character of the soil profile.

The major Pleistocene deposits of pre-Wisconsin age are either Kansan drift, Nebraskan drift, or both. The different drifts, or tills, are not readily differentiated in Marshall County. The glacial till ranges from none to over 300 feet in thickness.

Soils developed on the Kansan till plain during the Yarmouth and Sangamon interglacial ages. This soil development was before loess deposition. On nearly level interstream divides, the soils were strongly weathered and had a gray plastic subsoil called gumbotil. This gumbotil remains; it is several feet thick and very slowly permeable. The Clarinda soils developed in this gumbotil (*15*).

Geologic erosion has cut into and below the Yarmouth-Sangamon paleosol and into the Kansan till and older deposits. On the surface formed by this erosion, there is a stone line on top of till and erosional sediment called pedisediment. Soils that have a red clayey subsoil developed in the pedisediment, stone line, and subjacent till. This period of erosion and soil formation is called Late Sangamon. The Adair soils formed in the Late Sangamon paleosols (*9*).

The Kansan till is exposed mostly in hilly areas. The unweathered till is firm, calcareous clay loam. It contains pebbles, boulders, and sand as well as silt and clay. The soils that formed in Kansan till during the Yarmouth and Sangamon ages were covered by loess. Geologic erosion has removed the loess and paleosols on many side slopes. In these places, the till is only slightly weathered at the surface and has been exposed only during the Wisconsin State of the Quaternary period (*15*). Shelby, Gara, and Lindley soils formed in slightly weathered glacial till.

Glacial till is exposed in many rolling areas in the northeastern part of Marshall County. The till in this part of the county was truncated during the early part of loess deposition in the Wisconsin age. The truncated till surface is called the Iowan Erosion Surface (*15*).

The Iowan Erosion Surface is multi-leveled. Several levels of summits occur in a gradual progression from the stream valleys toward the low crests that mark the drainage divides. Other features typical of the Iowan Erosion Surface are erratics and paha. Erratics are large boulders partially buried or lying on the surface. Paha are prominent elongated ridges and are oriented in a distinct northwest-southeast direction. The core of the paha is an erosional remnant of the Kansan till, but the Yarmouth-Sangamon paleosol is intact (*16*). The paha are capped with thick loess or sand and loess.

The Iowan Erosion Surface is about 15 to 60 feet lower than the adjacent Kansan surface. The loess cap on the summits thins on shoulders and side slopes. Dinsdale soils formed in thin loess and glacial till.

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The glacial till is less than 100 feet thick in most of the Iowan Erosion Surface areas. Geologic erosion has reworked the glacial till on hillslopes. Liscomb soils formed in loamy surface sediment and glacial till.

Loess of Wisconsin age covers most of Marshall County and is an extensive parent material. It consists mainly of silt and clay particles that have been deposited by wind. Variations in the loess are related to the distance from the source of loess. The source of loess in Marshall County is probably the bottom lands to the northwest and the Iowa River. The major deposits of loess in Marshall County are older than 14,000 years (*15*).

On the stable upland divides of the Kansan till plain, the loess is about 21 feet thick. Killduff, Tama, Muscatine, Garwin and Sperry soils are formed in loess on this landform. On the Iowan Surface, the loess is about 12 feet thick. Tama, Muscatine, Garwin, Sperry, and Harpster soils formed in loess on this landscape. Dinsdale soils formed in both loess and glacial till.

Along the rivers, loess deposits are twice as thick on both the Kansan plain and Iowan Surface. Downs, Fayette, Tama, and Killduff soils formed in this loess. Some of the high stream benches along the major streams and rivers are covered with loess deposits as thin as 7 feet. Tama, Muscatine, and Downs soils formed in this loess.

A glacial till lies above the loess in the western part of Marshall County. This till is part of the Bemis moraine system of the Des Moines Lobe. The till is of Cary age, a subdivision of the Wisconsin Glacial Stage. The evidence for the geologic youth of the Cary Glaciation is the lack of deep weathering, the unleached calcareous till at a shallow depth, the poorly developed surface drainage, and many closed depressions (*15*).

Two major erosional and depositional episodes in recent time have modified the Cary till surface. The initial relief has been reduced by the movement of material from hill summits to depressions and lowland areas. The sediment on hillslopes has selectively sorted from the summits to the toe slopes and into the depressions (*15*). Clarion, Nicollet, Webster, Canisteo, Harps, Lester, and Storden soils formed in the Cary glacial drift.

Alluvium consists of sediment that has been removed and laid down by water. As it moves, this sediment is sorted to some extent, but only in a few places is it as well sorted as the loess. Also, alluvium does not have the wide range of particle sizes that occurs in glacial drift. Because the alluvium in Marshall County is derived from loess and glacial drift, it is largely a mixture of silt and clay, silt and sand, or sand and gravel.

Alluvial sediment is the parent material for the soils on flood plains, on low benches, and in long drainageways. As the river overflows its channels and the water spreads over the flood plains, coarse textured material, such as sand and coarse silt, are deposited first. As the floodwater continues to spread, it moves more slowly, and finer textured sediment is deposited. After the flood has passed, the finest particles, or clay, settle from the water that is left standing in the lowest part of the flood plain. The Hanlon, Spillville, Nodaway, and Lawson soils commonly are closest to the stream channel and are coarser textured than the other soils on flood plains. The Ackmore, Coland, and Colo soils are on upland drainageways as well as on the flood plains of larger streams. Colo soils are extensive. Zook soils commonly are on the lower part of the bottom land and are one of the finest textured soils derived from alluvium in the county.

Alluvial stream benches are intermediate in elevation between the flood plains and the loess-covered benches. The Wiota, Nevin, Koszta, and Bremer soils formed in the silty alluvium on this landform. The Saude, Waukee, Lawler, and Hanska soils formed in loamy-over-sandy alluvium on these benches.

Sediment that has accumulated at the foot of the slope on which it originated is called colluvium or local alluvium. The Ely, Judson, Terril, and Vesser soils formed in the sediment on the foot slopes. Downslope from these soils is alluvial sediment carried in to the area from distant sources.

A secondary topographic form associated with alluvial plains is sand dunes. Fine sand is blown by the wind from stream channel and flood plain surfaces to higher elevations (*12*). Accumulations of dune sand are found on low stream benches, on high loess-covered benches, and upland fringing the leeward side of valleys. Dickinson, Sparta, and Chelsea soils are formed in eolian sand that is more than 5 feet thick.

climate

The soils in Marshall County have been developing under a midcontinental, subhumid climate for the past 5,000 years. The morphology and properties of most of the soils indicate that this climate was similar to the present climate. From 6,500 to 16,000 years ago, however, the climate probably was cool and moist and conducive mostly to the growth of forest vegetation.

The influence of the general climate in a region is modified by local conditions in or near the developing soils. For example, soils on south-facing slopes formed under a microclimate that is warmer and drier than the average climate of nearby areas. The low-lying, poorly drained soils on bottom lands formed under a wetter and colder climate than that in most areas around them. These local differences influence the characteristics of the soil and account for some of the differences among soils in the same climatic region.

vegetation and animal life

Many changes in climate and vegetation have taken place in Iowa during the past 28,000 years (*14*). The period between 28,000 to 11,000 years ago was dominated by coniferous forest with a transitional period of birch and alder. Deciduous forest dominated 11,000 to

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9,000 years ago. A very dry period occurred between 9,000 to 3,200 years ago, with prairie vegetation dominating. Trees, especially oak, have invaded the prairie since 3,200 years ago, but the prairie still dominates.

For the past 5,000 years, the soils of Marshall County appear to have been influenced by two main kinds of vegetation—prairie grasses and trees. Big bluestem and little bluestem were the main prairie grasses. The main trees were deciduous, mainly oak, hickory, ash, elm, and maple.

The effects of vegetation on soils similar to those in Marshall County have been studied recently. Evidence shows that vegetation shifted while soils developed in areas bordering both trees and grasses. The morphology of the Downs, Sparta, Gara, and Lester soils reflect the influence of both trees and grasses. The Chelsea, Fayette, and Lindley soils formed under the influence of trees (*11*). Grasses influenced the development of the Tama, Muscatine, Garwin, Clarion, Colo, Dickinson, Killduff, Shelby, and Zook soils and the remaining minor soils in the county.

In most places, the soils that formed under trees are lighter colored, are more acid, and have a thinner surface layer that is lower in organic matter content than soils that formed under grasses. The soils in the county that formed under shifting vegetation or mixed grasses and trees have properties that are intermediate between the properties of soils formed under grasses and those of soils formed under trees.

Animals, such as earthworms and burrowing animals, help to keep the soil open and porous. Bacteria and fungi decompose the vegetation, thus releasing nutrients for plant food.

relief

Relief also may cause important differences among soils. It indirectly influences soil development through its effect on drainage. In Marshall County, the soils range from level to very steep. In many areas of the bottom lands, the nearly level soils are frequently flooded and have a permanently or periodically high water table. In depressions, water soaks into the nearly level soils that are subject to flooding. Much of the rainfall runs off the steep soils or uplands.

Level soils are on the broad upland flats and on the stream bottoms. The very steepest soils in the county are generally on slopes near the major streams and their tributaries. The intricate pattern of upland drainageways indicates that in most of the county the landscape has been modified by geological processes.

Generally, the soils in Marshall County that formed where the seasonal water table was well below the subsoil have a subsoil that is yellowish brown. Examples of such soils are the Clarion, Dickinson, Downs, Killduff, Shelby, and Tama soils. The Lawler, Muscatine, Nevin, and similar soils formed where the seasonal water table fluctuated and was periodically high. The Garwin, Webster, and similar soils formed where the seasonal water table is high and have a subsoil that is dominantly grayish. The Colo, Garwin, Webster, Zook and similar soils developed under prairie grasses and have a high water table. These poorly drained soils contain more organic matter in the surface layer than do well drained soils formed under prairie grasses. Clay accumulates in the subsoil of such soils as Sperry soils that are slightly depressional or nearly level. This is because a large amount of water enters the soils and carries clay particles downward. Sperry soils are called claypan soils because they have a hard layer where the greatest amount of clay accumulates.

The Killduff, Shelby, Tama, and similar soils that have wide slope ranges have some properties that change as slope increases. Two of these properties are the depth to carbonates and the thickness of the surface layer. Depth to carbonates is shallow where slopes are steepest. The surface layer becomes thin in stronger sloping soils.

time

Time is required for a soil to develop. An older and more strongly developed soil shows well defined genetic horizons. A soil with less development shows no horizons, or only weakly defined ones. Most soils on the flood plains are of this kind because these materials have not been in place long enough for distinct horizons to develop.

As an example, the effects of time can be seen by the increase of clay in the subsoil. A high clay content in the subsoil compared to that in the surface soil indicates a high degree of soil profile development has taken place. This can be important because soils with a high clay content in the subsoil generally have poorer drainage.

Material is generally removed from soils on steep slopes before there has been time for a thick profile with strong horizons to develop. Also, much of the water runs off the slopes rather than through the soil material, so that even though the material has been in place for a long time, the soil may exhibit little development.

Most of the parent materials in Marshall County are thousands of years old. The present land surface and many soils are much younger because of recent geologic erosion (*15*).

The oldest soils in Marshall County are those formed in loess on upland summits and on nearly level, loess-covered stream benches. The Garwin, Harpster, Muscatine, Sperry, and Tama soils might be as old as 14,000 years (*13*). The Clarion and other soils that formed in Cary glacial drift are as young as 3,000 years. The Liscomb and other strongly sloping soils on the Iowan Erosion Surface area are as young as or younger than 2,000 years. The Shelby and other strongly sloping or steeper soils on the Kansan till plain are as young as or younger than 6,800 years. Soils formed in alluvium

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and eolian sand are only a few thousand years old or less. The Wiota, Saude, and other soils that formed in materials on stream benches are the oldest alluvial soils. The Colo, Hanlon, Spillville, and other soils that formed in materials on the flood plains are younger than Wiota and Saude soils. The Dickinson, Sparta, and Chelsea soils are of an age intermediate between Hanlon and Wiota soils. Two soils that formed in alluvium, Nodaway and Ackmore soils, are less than 125 years old.

man's influence on the soil

Important changes take place if the soil is cultivated. Some of these changes have little effect on productivity; others have a drastic effect. Changes caused by erosion generally are most apparent. On many of the cultivated soils in the county, particularly the gently rolling to hilly soils, part or all of the original surface layer has been lost through sheet erosion. In some places, shallow to deep gullies have formed.

A study of eroded soils in Iowa, including Marshall County, was started in 1974 by the Iowa Cooperative Soil Survey. Soil descriptions and laboratory data of selected sites are available. Initial results show a lower organic matter content in eroded soils.

Nodaway and Ackmore soils formed in stratified silt loam alluvium on alluvial fans and flood plains. This alluvium has been deposited on the bottom during the past 125 years of cultivation. Many sloping soils have lost topsoil through water erosion to form these recent flood plain deposits. About 23 percent of the soils in Marshall County are eroded.

In many continuously cultivated fields, the granular structure that was apparent when the grassland was undisturbed is no longer present. In these fields the surface tends to bake and harden when it dries. Fine textured soils that have been plowed when too wet tend to puddle and are less permeable than similar soils in undisturbed areas. Poor seedling emergence and root penetration result in these areas.

Man has done much to increase the productivity of the soils and to reclaim areas not suitable for crops. He has made large areas of bottom land suitable for cultivation by digging drainage ditches and constructing diversions and dikes. Broad flats and nearly level soils, such as Garwin and Webster soils, have been greatly improved for cultivation by installing some kind of drainage system. By adding commercial fertilizers, man has counteracted deficiencies in plant nutrients and has made some soils more productive than they were in their natural state.

processes of horizon differentiation

Horizon differentiation is caused by four basic kinds of change—additions, removals, transfers, and transformation in the soil system (*18*). Each of these four kinds of change affects many substances that compose soils, such as organic matter, soluble salts, carbonates, sesquioxides, or silicate clay materials. In general, these processes tend to promote horizon differentiation, but some tend to offset or retard it. These processes and the changes brought about proceed simultaneously in soils, and the ultimate nature of the profile is governed by the balance of these changes within the profile.

An accumulation of organic matter is an early step in the process of horizon differentiation in most soils. Soils in Marshall County range from very high to very low in the amount of organic matter that has accumulated in their surface layers. Some soils that were formerly quite high in organic matter content are now low because of erosion. The accumulation of organic matter has been an important process in the differentiation of soil horizons in Marshall County.

The process through which substances are removed from parts of the soil profile is important in the differentiation of soil horizons. The movement of calcium carbonates and bases downward in soils is an example. All the soils in the county, except Canisteo, Harps, Harpster, and Storden soils, have been leached free of calcium carbonates in the upper part of their profile. Some soils have been so strongly leached that they are strongly acid or very strongly acid even in their subsoil.

Phosphorus is removed from the subsoil by plant roots and transferred to other parts of the plant. It is then returned to the surface layer in the plant residue. These processes affect the forms and distribution of phosphorus in the profile.

The translocation of silicate clay minerals is another important process. The clay minerals are carried downward in suspension in percolating water from the surface layer. They accumulate in the subsoil in pores and root channels and as clay films. In Marshall County, this process has had an influence on the profiles of many of the soils. In other soils, the clay content of the horizons are not markedly different and other evidence of clay movement is minimal.

Another kind of transfer that is minimal in most soils, but occurs to some extent in very clayey soils, is that brought about by shrinking and swelling. This causes cracks to form and incorporates some material from the surface layer into lower parts of the profile. Clarinda soils are examples of soils with potential for this kind of physical transfer.

Transformations are physical and chemical. For example, soil particles are weathered to smaller sizes. The reduction of iron is another example of a transformation. This process is called gleying and involves the saturation of the soil with water for long periods in the presence of organic matter. It is characterized by the presence of ferrous iron and gray colors. Gleying is associated with poorly drained soils, such as the Garwin soils. Reductive extractable iron, or free iron, is normally lower in somewhat poorly drained soils, such as Muscatine soils (*20*). Still another kind of transformation is the weathering of the primary apatite mineral present in soil parent materials to secondary phosphorous compounds.

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geologic profile of Marshall County

Marshall County has a gently undulating to rolling and steep landscape. It is mainly dissected by the Iowa River and the North Skunk River. Clear Creek, the three Timber Creeks, Linn Creek and three Minerva Creeks, and the two Asher Creeks are the principal interior streams (*4*).

The broad upland areas are dominated by loess at the surface. The soils formed in loess, such as the Muscatine and Tama soils, are the most productive soils in Marshall County and in Iowa. Strongly sloping to steep soils, such as the Shelby soils, formed in glacial till and till-derived materials. These soils are on slopes that descend to the major streams. Along the bottom of the streams are complex patterns of alluvium and related areas of wind-reworked sands. In the western part of the county are Clarion soils formed in Wisconsin glacial till.

Although the unconsolidated materials dominate the present land surface, such bedrock as limestone and sandstone is exposed locally. All the bedrock material would be exposed if the unconsolidated materials were removed. However, the surface exposed would not be flat but would exhibit landforms much like the present surface. There are bedrock valleys and ridges which can affect water movement within the overlying unconsolidated materials.

Bedrock is exposed in about 21 different sections in Marshall County. In most places the natural outcrops are small. The bedrock exposed in Marshall County is primarily of Mississippian and Pennsylvanian age (*7*). The general rock types are mostly dolomite and sandstone. The dolomite is quarried and provides stone for aggregate, road surfacing, and agstone. Some coal measure shales are exposed by Honey Creek.

Information collected during the drilling of wells and test holes is available for over 180 wells in Marshall County (*6*). Detailed information is available for many of these wells. Some of these wells are drilled into rocks that are aquifers. Three distinct levels of rocks that are aquifers occur in Marshall County (*5*).

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TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification Unified	Classification AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
51 Vesser	0-17	Silt loam	CL	A-6	0	100	100	98-100	95-100	30-40	10-20
	17-28	Silt loam	CL	A-6	0	100	100	98-100	95-100	30-40	10-20
	28-60	Silty clay loam	CL, CH	A-7	0	100	100	98-100	95-100	40-55	20-30
54 Zook	0-18	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	18-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
55 Nicollet	0-20	Loam	OL, ML, CL	A-6, A-7	0	95-100	95-100	85-98	55-85	35-50	10-25
	20-33	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-95	55-80	35-50	15-25
	33-60	Loam	CL, ML	A-6, A-4	0-5	95-100	90-100	75-90	50-75	30-40	5-15
62D2 Storden	0-8	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
63C, 63E Chelsea	0-8	Loamy fine sand	SM, SP-SM	A-2-4	0	100	100	65-80	10-35	---	NP
	8-60	Fine sand, sand, loamy sand.	SP, SM, SP-SM	A-3, A-2-4	0	100	100	65-80	3-15	---	NP
65F, 65G Lindley	0-7	Loam	CL-ML, CL	A-4, A-6	0	95-100	90-100	85-95	50-65	15-30	5-15
	7-50	Clay loam, loam	CL	A-6, A-7	0	95-100	90-100	85-95	55-75	30-45	15-25
	50-60	Loam, clay loam	CL	A-6	0	95-100	90-100	85-95	50-70	30-40	15-25
88 Nevin	0-24	Silty clay loam	CL, OL	A-6, A-7	0	100	100	100	90-95	35-45	10-20
	24-47	Silty clay loam	CL	A-7	0	100	100	95-100	90-95	40-50	20-30
	47-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	90-95	40-50	20-30
93D2*, 93E2*:											
Shelby	0-7	Loam	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	10-20
	7-45	Clay loam	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	45-60	Clay loam	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
Adair	0-6	Clay loam	CL	A-6	0	95-100	80-95	75-90	60-80	30-40	10-20
	6-60	Silty clay, clay, clay loam.	CL, CH	A-7	0	95-100	80-95	70-90	55-80	40-55	20-30
95 Harps	0-18	Loam, clay loam	CL, CH	A-6, A-7	0-5	100	95-100	80-90	65-80	30-55	15-35
	18-43	Loam, clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-60	15-35
	43-60	Loam	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
107 Webster	0-20	Silty clay loam	CL, CH	A-7, A-6	0-5	100	95-100	85-95	70-90	35-60	15-30
	20-39	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	15-30
	39-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
118 Garwin	0-17	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	45-55	20-30
	17-60	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	45-55	25-35
119 Muscatine	0-19	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	15-25
	19-60	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	20-30
120, 120B, 120C, 120C2, 120D2, 120E2 Tama	0-16	Silty clay loam	ML	A-6, A-7	0	100	100	100	95-100	35-50	10-20
	16-47	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	15-25
	47-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25
122 Sperry	0-22	Silt loam	CL	A-6	0	100	100	100	95-100	30-40	10-20
	22-37	Silty clay loam, silty clay.	CH	A-7	0	100	100	100	95-100	50-65	25-35
	37-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	100	95-100	40-50	20-30
133 Colo	0-11	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	11-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30

See footnote at end of table.

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TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
54-------------- Zook	0-18	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	High----------	0.28	5	7	5-7
	18-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High----------	0.28			
55-------------- Nicollet	0-20	24-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate------	0.24	5	6	5-6
	20-33	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	Moderate------	0.32			
	33-60	22-28	1.35-1.45	0.6-2.0	0.14-0.19	7.4-7.8	Low-----------	0.32			
62D2------------ Storden	0-8	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low-----------	0.28	5	4L	.5-2
	8-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
63C, 63E--------- Chelsea	0-8	8-15	1.50-1.55	6.0-20	0.10-0.15	5.6-7.3	Low-----------	0.17	5	2	<.5
	8-60	5-10	1.55-1.70	6.0-20	0.06-0.08	5.1-5.5	Low-----------	0.17			
65F, 65G--------- Lindley	0-7	18-27	1.20-1.40	0.6-2.0	0.16-0.18	4.5-7.3	Low-----------	0.32	5	6	.5-1
	7-50	25-35	1.50-1.75	0.2-0.6	0.14-0.18	4.5-6.5	Moderate------	0.32			
	50-60	18-32	1.75-1.85	0.2-0.6	0.12-0.16	6.1-7.8	Moderate------	0.32			
88-------------- Nevin	0-24	26-29	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate------	0.32	5	7	4-6
	24-47	30-35	1.30-1.40	0.6-2.0	0.18-0.20	6.1-6.5	Moderate------	0.43			
	47-60	25-36	1.40-1.45	0.6-2.0	0.18-0.20	6.6-7.3	Moderate------	0.43			
93D2*, 93E2*:											
Shelby-----------	0-7	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate------	0.28	5	6	.5-2
	7-45	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.8	Moderate------	0.28			
	45-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate------	0.37			
Adair------------	0-6	27-35	1.45-1.50	0.2-0.6	0.17-0.19	5.6-7.3	Moderate------	0.32	2	6	1-3
	6-60	38-50	1.50-1.60	0.06-0.2	0.13-0.16	5.1-6.5	High----------	0.32			
95-------------- Harps	0-18	25-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate------	0.24	5	4L	4-6
	18-43	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate------	0.32			
	43-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.9-8.4	Moderate------	0.32			
107------------- Webster	0-20	26-36	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	Moderate------	0.24	5	6	6-7
	20-39	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate------	0.32			
	39-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate------	0.32			
118------------- Garwin	0-17	30-35	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	High----------	0.28	5	7	6-7
	17-60	28-34	1.28-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High----------	0.28			
119------------- Muscatine	0-19	28-30	1.30-1.35	0.6-2.0	0.22-0.24	5.1-7.3	Moderate------	0.28	5	6	5-6
	19-60	30-34	1.28-1.35	0.6-2.0	0.18-0.20	5.1-7.3	Moderate------	0.43			
120, 120B, 120C, 120C2, 120D2, 120E2----------- Tama	0-16	24-29	1.25-1.30	0.6-2.0	0.22-0.24	5.1-7.3	Moderate------	0.32	5	7	1-5
	16-47	28-34	1.30-1.35	0.6-2.0	0.18-0.20	5.1-6.0	Moderate------	0.43			
	47-60	22-28	1.35-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate------	0.43			
122------------- Sperry	0-22	18-22	1.35-1.40	0.6-2.0	0.22-0.24	5.6-7.3	Moderate------	0.28	5	6	3-4
	22-37	38-45	1.40-1.45	0.06-0.2	0.14-0.16	5.1-6.5	High----------	0.43			
	37-60	26-34	1.45-1.50	0.2-0.6	0.19-0.21	5.6-6.5	High----------	0.43			
133------------- Colo	0-11	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High----------	0.28	5	7	5-7
	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High----------	0.28			
133+------------ Colo	0-11	20-26	1.25-1.30	0.6-2.0	0.22-0.24	6.6-7.3	Moderate------	0.28	5	6	3-5
	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High----------	0.28			
133B------------ Colo	0-11	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High----------	0.28	5	7	5-7
	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High----------	0.28			
135------------- Coland	0-40	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High----------	0.28	5	7	5-7
	40-60	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High----------	0.28			

See footnote at end of table.

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Attachment B

Main Ash Pond Stability Analyses Results

Ten Most Critical Surfaces

Sutherland Generating Station

Source:

Program psSTABL5m/SI output by Aether dbs, July 2012

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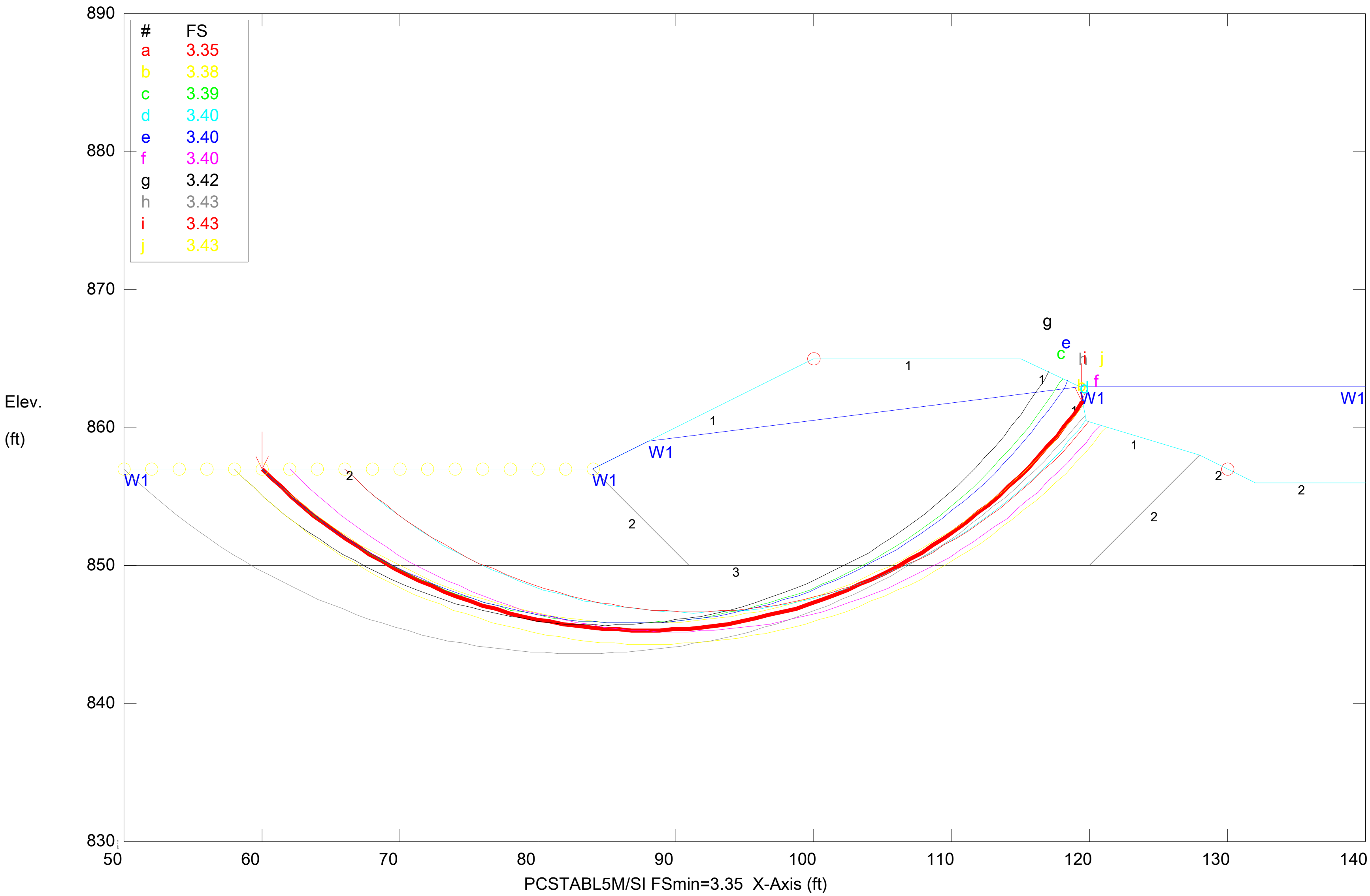
Alliant Energy - Marshalltown, Iowa Static Case - Total Stress Analysis

Ten Most Critical. C:MARSH42.PLT By: TCW 06-26-12 1:59pm



Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Dike	120	120	1000	0	0	0	W1
2	NC Clay	100	110	250	0	0	0	W1
3	Sand	120	120	0	28	0	0	W1

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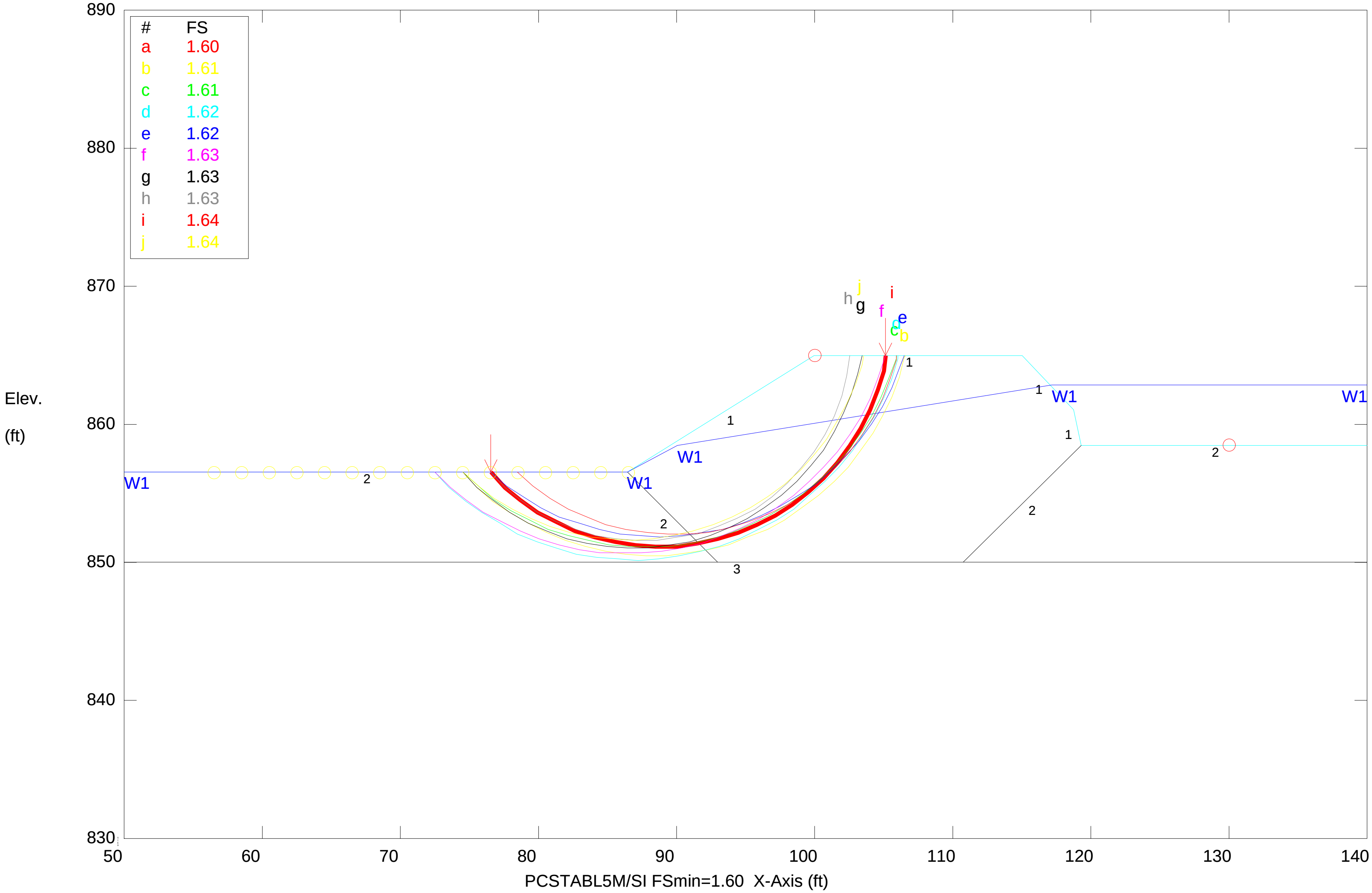
Alliant Energy - Marshalltown, Iowa Static Case - Effective Stress

Ten Most Critical. C:MARSH31.PLT By: TCW 06-25-12 10:07am



Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Dike	120	120	240	19	0	0	W1
2	NC Clay	100	110	0	24	0	0	W1
3	Sand	120	120	0	28	0	0	W1

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Attachment C

Curriculum Vita

Mr. Timothy J. Harrington, P.E.

Mr. Thomas C. Wells, P.E.

Aether DBS

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aetherdbs

TIMOTHY HARRINGTON, P.E.

Principal

PROFESSIONAL ENGINEERING LICENSES

New Jersey, 1985 (GE 30238); Delaware, 1987 (7145); New York, 1986 (62728-1); Pennsylvania, 1979 (28505-E); Michigan, 1980 (27309); Indiana, 1981 (19646); Illinois, 1984 (062-041983); California, 1983 (35743); Georgia, 1984 (14874); Florida, 1982 (31484); Wisconsin 2003 (36243)

QUALIFICATIONS

Mr. Harrington has 37 years in the application of engineering solutions to the management and completion of projects involving many geotechnical, and environmental remediation components, specializing in soil and sediment remediation. He has:

- Managed Large Remediation Projects from design through construction
- Managed complex Superfund projects with intertwined design, regulatory and construction issues
- Negotiated for single and multiple PRP groups to receive agency approval of remedial actions
- Negotiate for single and multiple PRP groups to drive completion of construction remediation
- Developed innovative solutions that satisfy agency objectives and reach owner goals for the project
- Recognized as an expert on contaminate sediment and soil remediation in several USEPA regions
- Consulted on the recovery of fly ash from the Emory River in Kingston, Tennessee

Geotechnical Engineering Experience:

Mr. Harrington has consulted on the design and construction of systems to control slope stability and liquefaction of loose soils.

- Consultant on the means and methods of recovering 2.5 million cubic yards of fly ash from the Emory River near Kingston Tennessee.
- Personal observation of the fly ash impoundment failure at Kingston shortly after the failure and before the start of remedial action.
- Stability analysis and design for facilities in dune sand around Lake Michigan to maintain excavations.
- Stability analysis of Uranium Tailings ponds constructed by hydraulic placemnt methods in New Mexico.
- Design of systems to stabilize Uranium Tailings ponds by controlling seepage on the embankment face.
- Design of methods to remediate loose soil to control liquefaction by compaction and/or drainage methods.

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- Liquefaction testing of soils by both laboratory and field methods.

EXPERIENCE

Principal and Senior Environmental Engineer, aether DBS., Naperville , IL

Mr. Harrington's firm was acquired in January of 2006 by Hard Hat Services (now aether DBS). Both firms coming together increased respectively each others' capabilities as well as offered additional services to their clients. Mr. Harrington manages major environmental remediation efforts and solutions as well as being responsible for the Chesterton, Indiana office. His expertise is in soils, sediment and marine environments.

President, Harrington Engineering & Construction, Inc., Chesterton, IN

Mr. Harrington was owner and provider of engineering and construction management services on domestic and international projects. Projects include design and construction management for the rebuilding of intake structures in Lake Michigan, removal and processing of sediment containing lead shot to restore beneficial reuse of a critical ocean shore environment, design of an upland landfill to contain sediment from the Fox River in Green Bay, Wisconsin, design of an in-water landfill in Auckland, New Zealand to contain low solids content sediment, and services on numerous facilities to construct or repair dock walls and marinas, resolve drainage problems and repair unstable slopes.

Canonie Environmental Services Corporation, Chesterton, IN

As vice president of the construction services division, Mr. Harrington was responsible for the direction of operations in the eastern USA. Projects included the construction of an upland disposal facility at the 102nd street site in Tonowanda, New York and the excavation of sediment from the St. Lawrence River, soil thermal treatment on high plasticity clay in Memphis, Tennessee, and site restoration including the removal of lime sludge and riverbank restoration in western Pennsylvania.

Rust Remedial Services Inc., Chicago, IL

Mr. Harrington served as Vice President and General Manager responsible for the operations of the Northern Region and the Thermal Operations groups. He managed work under contract totaling approximately $400,000,000 and including numerous jobs where sediment remediation was a part of the total remedy including the Brio site in Houston, Texas, the construction of landfills in New York and Massachusetts, and removal of solidified sludge from two 20-acre basins in Southern New Jersey.

Canonie Environmental Services Corporation, Chesterton, IN

Mr. Harrington served as vice president of eastern operations responsible for design and construction projects, project manager, and project engineer for design and construction field engineering. Work included the design and construction of in-water and upland landfill's at Waukegan Harbor, Illinois, design and construction of a cap and slope protection for remnant sediments in the Hudson River, work on landfills caps in New Jersey and Indiana, and numerous projects working as a geotechnical engineering consultant on failure investigations.

US EPA ARCHIVE DOCUMENT

D'Appolonia Consulting Engineers, Inc., Pittsburgh, PA
Mr. Harrington worked as a project engineer on projects to build power plants, on the investigation and design of mine tailing impoundments for uranium tailings in New Mexico, on design of underground mine works for the waste isolation pilot plant in New Mexico, and on several projects for water supply and dewatering of aquifer formations.

EDUCATION

Michigan State University – Masters of Science in Civil Engineering (Geotechnical and Structural Engineering Specialty)
Michigan State University – Bachelor of Science in Civil Engineering

CERTIFICATIONS

- 40-Hour OSHA HAZWOPER Training
- 8-Hour Refresher for 40-Hour Hazardous Training
- Certificates for Continuing Education from ACI, AISI, SJI and others for Renewal of Professional Licensing

PROFESSIONAL ACTIVITIES

American Society of Civil Engineers
American Concrete Institute

US EPA ARCHIVE DOCUMENT

aether dbs

THOMAS CHARLES WELLS, P.E.
Senior Project Engineer

PROFESSIONAL ENGINEERING LICENSE
Michigan, 1991 (6201036924)

QUALIFICATIONS
Mr. Wells has over 35 years of geoenvironmental engineering and database management / programming experience. As a senior engineer for Aether DBS, Mr. Wells has supplied both office and field based engineering and information technology support services.

As a Professional Engineer, Mr. Wells has considerable experience in the key areas of geotechnical, environmental, hydrology, hydraulic, and foundation engineering. He has continued to practice in these areas as a part of his engineering/database focus.

Geotechnical Engineering Experience:
Mr. Wells has contributed to many heavy construction projects involving industrial facilities and environmental remediation. Geotechnical engineering related projects / tasks have included:

- Performed stability analyses for 8 miles of I-74 in Dearborn County, Indiana following a major interstate highway embankment failure. The stability investigation led to the design of a corrective berm on a similar nearby side-hill highway embankment.
- Performed stability analyses for a riparian fill design following the foundation soil failure of approximately 800 feet of ore yard at Sparrows Point, Maryland.
- Analyzed the extreme settlement (3-4 feet) of Chemical Storage Tanks in Paulsboro, New Jersey.
- Investigated and analyzed a slope stability failure along the St. Joseph River in Michigan.
- Analyzed a slope stability failure along the Grand Calumet River in Gary, Indiana and designed a corrective slope.
- Development and improvement of a 1-D finite-difference numerical model to simulate large-strain soil/sediment consolidation for use in predicting the large settlements that occur in hydraulically placed sediment.

EXPERIENCE

WELLS Technical Services, Chesterton / Union Mills, IN
As a sole Proprietor serving primarily Aether DBS (formerly Harrington Engineering & Construction), Envirocon, Inc. and Locus Technologies, Mr. Wells supplies engineering and information technology support services on a project-by-project basis. Aether DBS specializes in Sediment Restoration Services, Marine Design, Environmental Engineering, and Site Remediation. Envirocon is a full-service environmental remediation, demolition and civil construction contractor. Locus Technologies is an engineering and construction management firm based in northern California and serving primarily the environmental market. Locus Technologies is the leader in on-demand world-wide-web based Environmental Data Management Software, Services and Solutions.

US EPA ARCHIVE DOCUMENT

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Harding Lawson Associates, Chicago, IL
As an associate engineer in the Chicago office, Mr. Wells contributed to multiple projects and systems including HLADBMS (the Harding Lawson Associates DataBase Management System). HLADBMS was used to manage site characterization data generated by environmental projects. Mr. Wells also served as the North Carolina Low Level Radioactive Waste Facility feasibility project database administrator in Raleigh, NC during the project start-up phase November 1996 through March 1997.

Canonie Environmental Services Corporation
Mr. Wells served as a Technical Manager / Staff Consultant where he provided engineering and information technology support to both the technical and administrative staffs. Mr. Wells also acted as the drafting supervisor and network administrator at times (while performing his other roles). Geotechnical and Environmental project work included ground water & hydraulic modeling, geotechnical analysis & foundation design and geoenvironmental data management.

Environmental construction management tasks included the development of a construction equipment cost management system and the development of a companywide environmental construction cost estimating system used to estimate project costs totaling millions of dollars.

D'Appolonia Consulting Engineers, Inc., Pittsburgh, PA
Mr. Wells acted as the Computer department's liaison with the technical staff, supported project usage of the PRIME® super-minicomputers, and Mr. Wells also assisted with ground water modeling projects. During his first project assignment beyond graduate school, Mr. Wells authored a flood-routing program for a probable maximum flood study. During this period as a staff engineer, Mr. Wells performed pile driving, slope stability, and foundation analyses. He designed foundations, waste embankments, earthen dams, drainage channels, and spillways.

EDUCATION

Penn State University – Certificate in Geographic Information Systems
Michigan State University – Masters of Science in Civil Engineering (Geotechnical and Hydraulics / Hydrology Engineering Specialty)
Michigan State University – Bachelor of Science in Civil Engineering

CERTIFICATIONS

- 40-Hour OSHA HAZWOPER Training
- 8-Hour Refresher for 40-Hour Hazardous Training
- Certificates for Continuing Education from ASTM, Purdue University and others

PROFESSIONAL ACTIVITIES

American Society of Civil Engineers