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February 1, 2023

Submitted via electronic mail

Mr. Gerald Demers
Wisconsin Department of Natural Resources
1027 West Saint Paul Avenue
Milwaukee, WI 53233

Subject: **Plan of Operations Modification Request**
Initial Permitting of CCR Landfill
Wisconsin Power and Light Company
I-43 Ash Disposal Facility (License #2853)
Wisconsin Power and Light Company
Sheboygan, WI

Dear Mr. Demers,

On behalf of Wisconsin Power and Light Company (WPL), Alliant Energy is submitting this Plan of Operations Modification intended to meet the requirements of NR 514.045 for Initial Permitting of a CCR Landfill. As described in the document and discussed with the Department staff via conference call, this Plan Modification Request for the Edgewater I-43 Landfill (#2853) will be supplemented with additional information in the coming weeks.

Thank you very much for your consideration of this initial submittal. If you have any questions or comments regarding this information, please call me at (608) 458-3853.

Regards,

Jeff Maxted
Manager – Environmental Services
Alliant Energy

CC: Mark Peters – Wisconsin DNR
Eric Sandvig, Director of Operations – Edgewater Generating Station
Jim Jakubiak, Lead GENCO Environmental Specialist – Edgewater Generating Station
Phil Gearing, Eric Nelson, Tom Karwoski – SCS Engineers

February 1, 2023
File No. 25222259.00

Mr. Gerald Demers
Wisconsin Department of Natural Resources
1027 W. St. Paul Ave
Milwaukee, WI 53233

Subject: Plan of Operation Modification Request WDNR CCR Code Update
Edgewater I-43 Ash Disposal Facility, License #2853
Sheboygan, Sheboygan County, Wisconsin

Dear Mr. Demers:

On behalf of Wisconsin Power and Light Company (WPL), SCS Engineers (SCS) prepared this Plan Modification Request/Plan of Operation Update for the Edgewater I-43 Ash Disposal Facility, License No. 2853, in Sheboygan, Wisconsin. This Plan Modification Request/Plan of Operation Update covers information for the Wisconsin Department of Natural Resources (WDNR) Coal Combustion Residual (CCR) Code Update to demonstrate compliance with NR 514.045. WPL and SCS plan to submit additional addenda, as discussed below.

FUTURE ADDENDUM ITEMS

As discussed during the January 23, 2023 teleconference, attended by representatives from the WDNR, Alliant Energy, WPL, and SCS, there are additional items in progress that may be addressed through future addenda to this Plan Modification Request/Plan of Operation Update. These items include:

- Endangered Resource Review
- Slope stability analysis for closure slopes
- Beneficial use pad design
- Groundwater monitoring network demonstration under NR 514.045(1)(h)
- Updated sampling plan under NR 514.045(1)(h)

If you have any questions regarding this addendum, please contact Jeff Maxted with Alliant Energy at (608) 458-3853.

Sincerely,

Mark R. Huber
Mark R. Huber, PE
Design Director
SCS Engineers

Phil Gearing
Phil Gearing, PE
Senior Project Manager
SCS Engineers

MRH/REO/MJT/PEG

cc: Mark Peters, WDNR
Tony Peterson, WDNR
Jeff Maxted, Alliant Energy
Matt Bizjack, Alliant Energy
Jim Jakubiak, WPL

Encl. Plan of Operation Modification Request WDNR CCR Code Update

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Plan of Operation Modification Request
WDNR CCR Code Update

I-43 Ash Disposal Facility
Sheboygan, Wisconsin

Prepared for:

Wisconsin Power and Light Company
Edgewater Generating Station
3739 Lakeshore Drive
Sheboygan, Wisconsin 53081-7233

SCS ENGINEERS

25222259.00 | February 1, 2023

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CERTIFICATION

"I, Phillip E. Gearing, hereby certify that I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 538, Wis. Adm. Code."

WISCONSIN
PHILLIP E.
GEARING
E-45115
SUN PRAIRIE,
WIS.
PROFESSIONAL ENGINEER

2/1/23

, Senior Project Manager E-45115
Signature, title and P.E. number

February 1, 2023
Date

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1.0 INTRODUCTION

On behalf of Wisconsin Power and Light Company (WPL), SCS Engineers (SCS) prepared this Plan of Operation Modification (Plan Mod) Request for the I-43 Ash Disposal Facility. See **Figure 1** for the site location. This Plan Mod Request is submitted in accordance with the requirements of NR 514.045 and to demonstrate compliance with coal combustion residual (CCR) regulations that became effective in August 2022.

The I-43 facility includes a closed CCR landfill (Phase 1 and 2) and an existing (active) CCR landfill. The two landfills are located on the same property, but are not contiguous. The existing CCR landfill currently consists of three existing CCR modules in Phase 3 (Modules 1 and 2) and Phase 4 (Module 1). These three existing CCR modules are contiguous and managed as a single landfill by the facility. This Plan Mod Request addresses Phase 3, Modules 1 and 2, and Phase 4, Module 1 (the CCR landfill). The previously approved design for the landfill also includes Phase 4, Modules 2 and 3, but at this time it is not certain that these modules will be constructed. WPL reserves the right to provide additional information for the permitted disposal space in Phase 4, Modules 2 and 3 at a later date.

2.0 PERFORMANCE AND LOCATION CRITERIA

NR514.045 (1)

> *"...The plan of operation modification shall address all phases of the CCR landfill. At a minimum, the plan of operation modification shall include all of the following:"*

2.1 PERFORMANCE CRITERIA UNDER NR 514.045 (1)(b)

NR 514.045 (b)

> *"A demonstration that all phases of the CCR landfill meet the performance criteria under s. NR 504.04 (4) (a), (b), and (c)."*

NR 504.04 (4)

> *"PERFORMANCE STANDARDS. No person may establish, construct, operate, maintain or permit the use of property for a landfill if there is a reasonable probability that the landfill will cause:"*

2.1.1 Compliance With NR 504.04 (4)(a)

NR 504.04 (4) (a)

> *"A significant adverse impact on wetlands as provided in ch. NR 103."*

Phase 3, Module 1 and Phase 4, Module 1 are not located in wetlands. The location of Phase 3, Module 1 and Phase 4, Module 1 are shown on **Figure 2**, and maps from a 2009 wetland delineation study conducted by NRC, Inc. are included in **Appendix A1**.

A wetland delineation conducted in 2009 (**Appendix A1**) identified one wetland ("Wetland 1") within the Phase 3, Module 2 area (Figure 2). WPL received a wetland permit for the permanent filling of Wetland 1 (0.81 acres) from the WDNR as required by NR 103. Through the permitting process, WDNR and WPL determined that construction of Phase 3 Module 2 would have no adverse impact on wetlands as provided in NR 103, and the wetland was removed prior to construction of the Module 2 liner. No additional wetlands were delineated within the Phase 3, Module 2 area.

Run-off from the active portions of the facility (contact water) is handled as leachate and is collected by a leachate collection system or internal swales, which route the contact water run-off to a composite-lined contact water basin (shown on **Figure 2**), preventing contact water from having an adverse impact on wetlands.

The detention/sedimentation basin, shown on **Figure 2**, is designed to collect storm water diverted from covered portions of the CCR landfill. The detention/sedimentation basin is sized to handle storm water from a 25-year, 24-hour storm event without overtopping during the 100-year, 24-hour storm event and to allow a 15-micron particle size to settle out during a design storm event to prevent adverse impacts on downstream wetlands. The detention/sedimentation basin discharges to the northwest, into an existing drainage way.

Storm water from outside of the CCR landfill to the east is directed via the run-on diversion swale to the northern detention basin for treatment. Storm water from these areas does not result in adverse impacts to downstream wetlands.

2.1.2 Compliance With NR 504.04 (4)(b)

NR 504.04 (4) (b)

> *"A take of an endangered or threatened species in accordance with s. 29.604, Stats."*

An Endangered Resources Preliminary Assessment was completed for this report. Based on this assessment, there is potential to impact a nearby waterbody where a state listed fish, mussel, or aquatic insect may be present. No area affected by construction or operations of the CCR Landfill has been identified as critical habitat for endangered or threatened species. If construction occurs on the site, appropriate erosion and runoff prevention measures will be implemented to prevent the take of an endangered or threatened species in accordance with s. 29.604, Wis. Stats. A full Endangered Resources Review will be completed and included as an addendum to this plan.

2.1.3 Compliance With NR 504.04 (4)(c)

NR 504.04 (4) (c)

> *"A detrimental effect on any surface water."*

The landfill manages storm water in accordance with permits and approvals that prevent a detrimental impact on any surface water, including Wisconsin Pollution Discharge Elimination System (WPDES) Storm Water Tier 2 Discharge Permit Coverage issued by the Department on October 12, 2016. Storm water runoff calculations were performed to demonstrate that the existing storm water sedimentation basin and proposed storm water management features included in the CCR landfill can accommodate and safely convey the runoff from a 25-year, 24-hour storm event during post closure conditions. Calculations were provided with the March 2015 submission of the Plan Modification Request/Plan of Operation Update. Storm water that comes into contact with waste is routed to a lined basin and then pumped via force main and gravity sewer to the Sheboygan Wastewater Treatment Plant in accordance with a pre-treatment agreement.

2.2 LOCATIONAL CRITERIA UNDER NR 514.045 (1)(c)

NR 514.045 (c)

> *"A demonstration that all phases of the CCR landfill meet the locational criteria under s. NR 504.04 (3) (g), (h), and (i)...."*

NR 504.04 (3)

> *"LOCATIONAL CRITERIA. No person may establish, construct, operate, maintain or permit the use of property for a landfill where the limits of filling are or would be within the following areas:"*

2.2.1 Compliance With NR 504.04 (3)(g)

NR 504.04 (3) (g)

> *"Within 200 feet of a fault that has had displacement in Holocene time."*

Based on a review of the U.S. Geological Survey (USGS) Quaternary faults database and map as shown in Appendix A2, the CCR landfill is not located within 200 feet of the outermost damage zone of a fault that has had displacement in Holocene time. In NR 500.03 (103), Holocene is defined as the most recent epoch of the Quaternary period extending from the end of the Pleistocene Epoch to the present. The USGS map shows that no faults are located in Wisconsin.

2.2.2 Compliance With NR 504.04 (3)(h)

NR 504.04 (3) (h)

> *"Within seismic impact zones."*

The CCR landfill is not located in seismic impact zones. NR 500.03 (208) defines a seismic impact zone as an area having a 10 percent or greater probability that the maximum expected horizontal acceleration in lithified earth material, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10 g in 50 years. Based on a review of the USGS 2014 Long-Term Model National Seismic Hazard Map (see Appendix A3), the maximum expected horizontal acceleration for the majority of Wisconsin, including all of Sheboygan County, is less than 0.04 g, below the threshold for a seismic impact zone.

2.2.3 Compliance With NR 504.04 (3)(i)

NR 504.04 (3) (i)

> *"Within unstable areas."*

Unstable areas are addressed in Section 2.2.4.

2.2.4 Compliance With NR 514.045 (1)(c)(1)

NR 514.045 (1)(c)

> *"...The demonstration shall address all of the following factors, at a minimum, when determining whether an area is unstable:"*

NR 514.045 (1)(c)(1)

"On–site or local soil conditions that may result in significant differential settling.

As discussed in **Appendices A4** and **A5**, and as shown by the geologic cross sections from the 1977 Preliminary Site Feasibility Report prepared by Mead & Hunt, Inc. (see **Appendix A6**), the CCR landfill is not located in on-site or local soil conditions that may result in significant differential settling. The site soils consist of stiff to very stiff clay till that extend to depths greater than 90 feet. Because the clays are stiff to very stiff, they are not susceptible to appreciable differential settlement that would affect the performance of the landfill.

2.2.5 Compliance With NR 514.045 (1)(c)(2)

NR 514.045 (1)(c)(2)

"On–site or local geologic or geomorphologic features."

As discussed in **Appendices A4**, **A5**, and **A8**, and shown by the geologic cross sections in **Appendix A6**, the CCR landfill is not located in on-site or local geologic or geomorphologic features that are unstable. The cross sections show stiff to very stiff clay till that extend to depths greater than 90 feet. These geologic features provide a stable foundation for the CCR landfill.

This assessment is confirmed by the interim slope stability analysis in **Appendix A7** that indicates the slope stability safety factors are acceptable (i.e., safety factors against block or circular failure greater than or equal to 1.3 for interim conditions). Final grade waste stability analysis will be submitted as an addendum to this Plan.

2.2.6 Compliance With NR 514.045 (1)(c)(3)

NR 514.045 (1)(c)(3)

"On–site or local human–made features or events both surface and subsurface."

As shown by the geologic cross sections in **Appendix A6**, the CCR landfill is not located in on-site or local human-made features or events (both surface and subsurface) that are unstable. Prior to development of the landfill, the historical site use was agricultural with minimal site disturbance.

As discussed in **Appendix A8**, seepage from groundwater or surface water is unlikely to cause instability. The facility is designed with adequate run-on and run-off control systems. Groundwater monitoring wells at the perimeter of the facility show that groundwater hydraulic gradients are downward and therefore groundwater is unlikely to negatively impact the performance of the facility.

2.3 LOCATIONAL CRITERIA UNDER NR 514.045 (1)(d)

2.3.1 Compliance With NR 514.045 (1)(d)

NR 514.045 (1)(d)

"A demonstration that the facility or practices near floodplains may not restrict the flow of the regional flood, reduce the temporary water storage capacity of the floodplain, or result in

washout of solid waste so as to pose a hazard to human life, wildlife, or land or water resources."

The CCR landfill is not located within a floodplain as shown in Appendix A9.

2.4 LOCATIONAL CRITERIA UNDER NR 514.045 (1)(e)

2.4.1 Compliance With NR 514.045 (1)(e)

NR 514.045 (1)(e)

> *"A demonstration that the facility or practices may not result in the destruction or adverse modifications of the critical habitat of endangered or threatened species as identified under s. NR 27.03 (1)."*

An Endangered Resources Preliminary Assessment was completed for this report. No area affected by construction or operations of the CCR Landfill has been identified as critical habitat for endangered or threatened species. A full Endangered Resources Review will be completed and included as an addendum to this plan.

3.0 LANDFILL DESIGN DEMONSTRATION

3.1 LANDFILL DESIGN DEMONSTRATION UNDER NR 514.045 (1)(f)

NR 514.045 (1)(f)

> *"A demonstration that the CCR landfill design meets requirements under s. NR 504.12 or an alternate design under s. NR 504.10. The demonstration shall include a design report, engineering drawings, and calculations."*

3.1.1 Landfill Design Demonstration Under NR 504.12

3.1.1.1 Compliance With NR 504.12 (2)

NR 504.12 (2)

> *"RUN−ON AND RUN−OFF CONTROLS. An existing or new CCR landfill or any lateral expansion of a CCR landfill shall be designed, constructed, operated, and maintained with a run−off and run−on control system in accordance with the requirements under s. NR 504.09 (1) (f) and (g) and all of the following:"*

NR 504.09 (1)(f)

> *"Storm water shall be diverted away from the active fill area of the landfill and any borrow areas to a sedimentation control structure."*

Storm water run-on is controlled by berms and swales around the perimeter of the landfill that divert storm water away from the landfill and to the detention basin on the north end of the property.

Run-off from areas of the existing CCR units where final or intermediate cover is in place is diverted into the perimeter drainage swales, which drain to the on-site detention/sedimentation basin. Intermediate swales/berms, downslope flumes, and energy dissipaters on the final cover help minimize erosion of the final cover and divert water to the perimeter drainage system, and ultimately to the on-site detention/sedimentation basin. Run-off from the active portions of the existing CCR units at the facility is handled as contact water and is collected by a leachate collection system or internal swales, which route the contact water to a composite-lined contact water basin.

NR 504.09 (1)(g)

> *"Containment berms placed around active fill areas shall be designed to control and collect the liquid volume resulting from the 25 year, 24−hour storm event. The design shall consider the volume of liquid generated from active fill areas which shall include areas with exposed solid waste or areas with waste covered by daily cover. Storm water in contact with active fill areas shall be handled and treated as leachate in accordance with ch. NR 506."*

The storm water features described above are designed to handle run-on and run-off from a 25-year, 24-hour storm event. Storm water run-off calculations are included in **Appendix B1**, including calculations from the 2008 Plan of Operation (**Appendix B1.1**) and the 2015 Plan of Operation Modification (**Appendix B1.2**).

The calculations from the 2008 Plan of Operation describe the storm water management design and provide calculations showing that the run-on control system will prevent flow onto the active portion of the CCR units during the peak discharge from a 25-year, 24-hour storm. The calculations from the 2015 Plan of Operation Modification describe the updated storm water management design features from the 2008 Plan of Operation and provide calculations showing that the run-off control system for the active portions of the CCR units will collect and control the water volume resulting from a 25-year, 24-hour storm. A calculation (2016) was also completed to determine the maximum starting water elevation in the contact water basin prior to a 25-year, 24-hour storm event in order to accommodate the volume from the active landfill area (contact water handling areas) and direct discharges into the contact water basin (**Appendix B1.3**). The contact water basin storage calculation is conservative due to the installation of a force main in 2019 that allows WPL to discharge contact water collected in the basin to the local sanitary sewer. The pumping of contact water into the force main allows for maintenance of water levels in the contact water basin and assists with providing sufficient water storage between storm events.

Currently available design storm event data from National Oceanic and Atmospheric Administration NOAA Atlas 14, Volume 8, Version 2 and the design calculations described above were reviewed at the time of the 2021 update. Current design storm event data does not substantially affect the results of design calculations provided in **Appendix B1**.

NR 504.12 (2)(a)

> *"A run−on control system shall prevent flow onto the active portion of the CCR landfill during the peak discharge from a 24−hour, 25−year storm."*

The entire facility has run-on and run-off control in place, as approved by the WDNR and described further in **Appendix C2**. Run-on is controlled by berms and swales around the perimeter of the landfill that divert storm water away from the landfill to a sedimentation basin.

NR 504.12 (2)(b)

> *"A run–off control system from the active portion of the CCR landfill shall collect and control, at a minimum, the water volume resulting from a 24–hour, 25–year storm."*

Run-off from the active portions of the existing CCR units at the facility is handled as contact water and is collected by a leachate collection system or internal swales, which route the contact water to a composite-lined contact water basin. The contact water in the basin is used for ash conditioning, and other applications within the CCR units. Water in the contact water basin is also pumped through a force main to the sanitary sewer then on to the local waste water treatment facility for disposal.

Run-off from areas of the existing CCR units where intermediate/final cover is in place (which prevents contact with CCR) is diverted into the perimeter drainage swales, which drain to the on-site detention/sedimentation basin. Intermediate swales/berms, downslope flumes, and energy dissipaters on the final cover help minimize erosion of the final cover and divert water to the perimeter drainage system, and ultimately to the on-site detention/sedimentation basin.

3.1.1.2 Compliance With NR 504.12 (3)

NR 504.12 (3)(a)

> *"LINER DESIGN. (a) A new CCR landfill or a lateral expansion of a CCR landfill shall be designed, constructed, operated, and maintained with a composite liner that meets the requirements under s. NR 504.06 (2) and (3) and a leachate collection and removal system that meets the requirements under s. NR 504.06(5). The composite liner shall consist of 2 components; the upper component shall consist of a nominal 60–mil or thicker geomembrane liner, and the lower component shall consist of a minimum 4–foot–thick layer of compacted clay. A GCL and soil barrier may be used in place of the clay layer of a composite liner in accordance with s. NR 504.06 (7). In addition to the minimum design and construction criteria for landfill liners and leachate collection systems under s. NR 504.06, the liner and leachate collection system shall meet all of the following:…."*

For Phase 3, Modules 1 and 2, and Phase 4 Module 1 construction commenced prior to October 19, 2015. These modules do not fall under the NR 500.03 (152m) definition of "New CCR landfill" and meet the definition of "Existing CCR landfill" under NR 500.03 (76m). As existing CCR landfill modules, NR 504.12(3) is not applicable to Phase 3, Modules 1 and 2, and Phase 4, Module 1. At this time, future modules are not planned to be constructed. If future construction is planned, the design requirements of NR 504.12 (3) will be revisited for the new modules.

3.1.1.3 Compliance With NR 504.12 (4)

NR 504.12 (4)(a)

> *"A new or existing CCR landfill or a lateral expansion of a CCR landfill shall be designed and constructed with a final cover system that meets the requirements under s. NR 504.07."*

An alternate final cover system was approved by WDNR in June 2015 for Phase 3 and Phase 4 areas of final cover. The alternate cover consists of the following components (meeting the requirements of NR 504.07), from bottom to top:

- 2-foot-thick clay cap
- 40-mil-thick geomembrane
- Geonet geocomposite drainage layer
- 12 inches of rooting zone material
- 6 inches of topsoil

Phase 3, Module 1 and Phase 4, Module 1 have received some alternative final cover over outer sideslope areas that will no longer receive CCR (Area 1 and Area 2, **Figure 2**). **Figure 6** shows the final cover detail and **Figure 7** shows the final cover grades.

The alternative final cover design has been developed to meet the requirements of NR 504.12(4)(b) and is discussed in detail below.

NR 504.12 (4)(b)

> *"The owner or operator of a new or existing CCR landfill or a lateral expansion of a CCR landfill may propose an alternative final cover system design within a written closure plan in accordance with s. NR 504.10 and all of the following:"*

The alternative final cover system design previously approved by the Department in accordance with NR 504.10 is described further within the written closure plan provided in this Plan of Operation Update (**Appendix C3**). The final cover system design also complies with the federal requirements under 40 CFR Part 257, Subpart D.

NR 504.12 (4)(b)(1)

> *"The permeability of the final cover system shall be less than or equal to the permeability of any bottom liner system or natural subsoils present or shall be no greater than 1 x 10^{-5} cm/sec, whichever is less."*

The permeability of the final cover system is less than or equal to the permeability of the bottom liner system and is less than 1 x 10^{-5} centimeters per second (cm/sec) required by the rule. The final cover system 2-foot thick clay cap is compacted to 1x10^{-7} cm/sec permeability. Please see the Closure Plan (**Appendix C3**) for more information.

NR 504.12 (4)(b)(2)

> *"The design of the final cover system shall include an infiltration layer that achieves an equivalent reduction in infiltration as the layers specified under s. NR 504.07 (4)."*

The final cover includes 2 feet of compacted clay as required by NR 504.07(4) in addition to other layers to achieve an equivalent reduction in infiltration. The final cover system also includes features to minimize the amount of precipitation that could potentially infiltrate, including grading to promote surface water runoff and a later drainage layer. The surface layer of 18 inches of soil supports vegetation that assists with erosion control. Water that infiltrates through the vegetative support layers is collected by the lateral drainage layer (geonet geocomposite) and routed to the perimeter drainage system. Please see the Closure Plan (**Appendix C3**) for more information.

NR 504.12 (4)(b)(3)

> *"The design of the final cover system shall include an erosion layer that provides equivalent protection from wind or water erosion as the topsoil layer specified under s. NR 504.07 (7)."*

The erosion of the final cover system is minimized with a vegetative support layer consisting of 12 inches of uncompacted rooting zone material and 6 inches of topsoil. In addition, the surface has intermediate drainage swales to reduce the flow lengths down the final cover slope, also aiding in erosion control. Where needed, the intermediate drainage swales are connected to downslope flumes and energy dissipaters to control storm water runoff and prevent erosion of the final cover.

NR 504.12 (4)(b)(4)

> *"The disruption of the integrity of the final cover system shall be minimized through a design that accommodates settling and subsidence."*

The design of the final cover system accommodates settling and subsidence of the CCR fill below the cover. The CCR at the existing CCR landfill is placed dry and is compacted in place. CCR continues to consolidate and gain strength as filling progresses prior to final cover placement. The final cover system is designed with a maximum slope of 25 percent (4 horizontal to 1 vertical). Because the final cover has a relatively large positive slope and the CCR has been gaining strength over time, the final cover is expected to easily accommodate the remaining relatively minor settlement potential of the CCR fill when fill placement ends and the landfill is closed.

3.1.2 Alternate Landfill Design Demonstration Under NR 504.10

NR 504.10 (1)(a)

> *"An applicant may design a high volume industrial waste landfill to meet the standards contained in ss. NR 504.05 to 504.09 or may propose an alternative design in accordance with the provisions of this section."*

The CCR landfill has been designed to meet the standards contained in NR 504.05 to NR 504.09. However, an alternative final cover design that meets the requirements of NR 504.07 is being proposed, as discussed in Section 3.1.1.3. The alternative final cover design was approved by WDNR in the June 2015 plan of operation modification approval.

4.0 OPERATIONAL PLANS

4.1 LANDFILL DESIGN DEMONSTRATION UNDER NR 514.045 (1)(g)

NR 514.045 (1)(g)

> *"The plans required under s. NR 514.07 (10)."*

4.1.1 Plans Required Under NR 514.07 (10)

NR 514.07 (10)

> *"ADDITIONAL REQUIREMENTS FOR CCR LANDFILLS. The owner or operator of a new or existing CCR landfill or lateral expansion of a CCR landfill shall update the plan of operation every 10*

years during the landfill's active life to comply with regulations in place at the time of the update. The plan of operation update will be considered a plan of operation modification, but shall follow the completeness, review times, and pre−plan of operation submittal public meeting requirements under s. NR 514.04. The plan of operation for all CCR landfills shall include all of the following:"

4.1.1.1 Compliance With NR 514.07 (10)(a)

NR 514.07 (10)(a)

"A CCR fugitive dust control plan in accordance with all of the following:

1. The plan shall identify and describe the CCR fugitive dust control measures the owner or operator will use to minimize CCR from becoming airborne at the facility. The owner or operator shall select and include in the CCR fugitive dust control plan the CCR fugitive dust control measures that are most appropriate for site conditions, along with an explanation of how the measures selected are applicable and appropriate for site conditions. Control measures may include any of the following:

a. Locating CCR inside an enclosure or partial enclosure.

b. Operating a water sprayer or fogging system.

c. Reducing fall distances at material drop points.

d. Using wind barriers, compaction, or vegetative covers.

e. Establishing and enforcing reduced vehicle speed limits.

f. Paving and sweeping roads.

g. Covering trucks transporting CCR.

h. Reducing or halting operations during high wind events.

i. Applying a daily or intermediate cover.

2. The plan shall include procedures to wet CCR with water to a moisture content that will prevent wind dispersal but will not result in free liquids. In lieu of water, wetting of CCR may be accomplished with an appropriate chemical dust suppression agent.

3. The plan shall include a description of the procedures the owner or operator will follow to periodically assess the effectiveness of the control plan. At a minimum, the assessment shall include a visual inspection at least every 7 days, unless the CCR landfill is inactive and all areas are covered by intermediate or final cover.

4. The plan shall be modified in accordance with s. NR 514.04 (6) whenever there is a change in conditions that may substantially affect the plan of operation.

5. The plan shall address the preparation of an annual fugitive dust control report in accordance with s. NR 506.20 (3) (a)."

A CCR fugitive dust control plan that complies with NR 514.07 (10)(c) is in place. The amended CCR fugitive dust control plan is included in **Appendix C1.**

4.1.1.2 Compliance With NR 514.07 (10)(b)

NR 514.07 (10)(b)

> *"A run−on and run−off control system plan that includes all of the following:*
>
> 1. *A run−on and run−off control system designed in accordance with the requirements under s. NR 504.12 (2).*
>
> 2. *Plan sheets depicting the location of run−on and run−off control features, detail drawings, and supporting engineering calculations.*
>
> 3. *Construction procedures and a schedule for construction.*
>
> 4. *Modification every 5 years from the date of the most recent plan approval or whenever there is a change in conditions that may substantially affect the written plan in effect. The modification shall be requested by the owner or operator in accordance with s. NR 514.04 (6) prior to the 5−year deadline."*

A run-on and run-off control system plan that complies with NR 514.07 (10)(b) is in place. The amended run-on and run-off control system plan is included in **Appendix C2.**

4.1.1.3 Compliance With NR 514.07 (10)(c)

NR 514.07 (10)(c)

> *"A written closure plan in accordance with the requirements under s. NR 514.06 (10) and all of the following:*
>
> 1. *A narrative description of how the CCR landfill will be closed, including a description of the steps necessary to close the CCR unit at any point during the active life of the CCR unit, consistent with recognized and generally accepted good engineering practices.*
>
> 2. *A description of the final cover system, designed in accordance with s. NR 504.07, and the methods and procedures to be used to install the final cover.*
>
> 3. *A demonstration, including a narrative discussion, of how final closure will meet the performance standards under s. NR 506.083 (6).*
>
> 4. *An estimate of the maximum volume in cubic yards of CCR that will be disposed on−site over the active life of the CCR landfill.*
>
> 5. *An estimate of the largest area of the CCR landfill that will require a final cover at any time during the CCR landfill's active life.*
>
> 6. *A schedule for completion of all closure activities, including ban estimate of the year in which all closure activities for the CCR landfill will be completed. The schedule shall provide sufficient information to describe the sequential steps that will be taken to close the CCR landfill, including identification of major milestones such as coordinating with other agencies and obtaining other necessary approvals or permits, installation of the final cover system, and the estimated timeframes to complete each step or phase of*

CCR landfill closure. If the estimated timeframes to complete closure exceed the timeframes specified under s. NR 506.083 (3) (a), the plan shall include the site−specific information, factors and considerations that support any time extension.

7. *The plan shall be modified in accordance with s. NR 514.04 (6) whenever there is a change in conditions that may substantially affect the written closure plan or unanticipated events necessitate a revision of the written closure plan. The modification shall be submitted to the department in writing at least 60 days prior to a planned change in the operation of the CCR landfill, or no later than 60 days after an unanticipated event requires the need to revise an existing written closure plan. If a written closure plan is revised after closure activities have commenced for a CCR landfill, the owner or operator shall submit the modification request to the department no later than 30 days following the triggering event.*

8. *If closure of the CCR landfill will be accomplished through removal of CCR from the CCR landfill, the closure plan shall be modified and approved by the department prior to implementation in accordance with s. NR 514.04 (6). The closure plan shall include a description of the procedures to remove the CCR and decontaminate all areas affected by the CCR landfill in accordance with s. NR 506.08 (5).*

A written closure plan that complies with NR 514.07 (10)(c) is in place for Phase 3 (Modules 1 and 2) and Phase 4 (Module 1). The amended written closure plan is included in **Appendix C3.**

4.1.1.4 Compliance With NR 514.07 (10)(d)

NR 514.07 (10)(d)

"A written long−term care plan that addresses all of the following:

1. *A description of the monitoring and maintenance activities and the frequency at which those activities will be performed. The activities shall include, at a minimum, all of the following:*

    a. Long−term care activities specified under s. NR 514.06 (11).

    b. Maintaining the integrity and effectiveness of the final cover system, including making repairs to the final cover as necessary to correct the effects of settlement, subsidence, erosion or other events, and preventing run−on and run−off from eroding or otherwise damaging the final cover.

    c. Maintaining the effectiveness of the leachate collection and removal system and operating the leachate collection and removal system in accordance with the requirements under s. NR 504.12 (3) (a). d. Maintaining the groundwater monitoring system and monitoring the groundwater in accordance with ch. NR 507 and the sampling plan approval.

2. *The name, address, telephone number, and email address of the person or office to contact about the facility during long− term care.*

3. *A description of the planned uses of the property during long−term care. Post−closure uses may not disturb the integrity of the final cover, liner, or any other component of the landfill, or the function of the monitoring systems unless approved in writing by the*

department. A written request for approval as part of the plan of operation submittal or a modification shall include a demonstration that disturbance of the final cover, liner, or other component of the containment system, including any removal of CCR, will not increase the potential threat to human health or the environment. The demonstration shall be certified by a professional engineer in accordance with s. NR 500.05 (4) (a)."

A written long-term care plan that complies with NR 514.07 (10)(d) is in place for Phase 3 (Modules 1 and 2) and Phase 4 (Module 1). The amended written long–term care plan is included in **Appendix C4**.

4.1.1.5 Compliance With NR 514.07 (10)(e)

NR 514.07 (10)(e)

"The long–term care plan under par. (d) may be modified in accordance with s. NR 514.04 (6). The owner or operator shall modify the long–term care plan whenever there is a change in the operation of the CCR landfill that would substantially affect the written long–term care plan in effect; or after long–term care activities have commenced, when unanticipated events necessitate a revision of the written long–term care plan. The modification shall be submitted to the department in writing at least 60 days prior to a planned change in the operation of the CCR landfill, or no later than 60 days after an unanticipated event requires the need to revise an existing long–term care plan. If a written long–term care plan is revised after long–term care activities have commenced for a CCR landfill, the owner or operator shall submit the modification request to the department no later than 30 days following the triggering event."

Any modification of the written long–term care plan will be submitted to the department in writing in compliance with NR 514.07 (10)(e).

5.0 GROUNDWATER MONITORING NETWORK DEMONSTRATION

5.1 GROUNDWATER MONITORING NETWORK DEMONSTRATION UNDER NR 514.045 (1)(h)

NR 514.045 (1)(h)

"A demonstration that the CCR groundwater monitoring system complies with the requirements under s. NR 507.15 (3), including documentation of the design, installation, and development of any CCR wells."

To be provided in an addendum to this report, per discussions with the WDNR.

6.0 UPDATED SAMPLING PLAN

6.1 UPDATED SAMPLING PLAN UNDER NR 514.045 (1)(h)

NR 514.045 (1)(i)

> *"An updated sampling plan that addresses the requirements under s. NR 507.15 (3)."*

To be provided in an addendum to this report, per discussions with the WDNR.

7.0 ADDENDUM DOCUMENTS

7.1 BENEFICIAL USE PAD

As part of the closure of the ash ponds at the Edgewater Generating Station, the coal combustion residuals (CCR) beneficial use storage area was also closed. Based on our discussions, the EDG facility continues to produce CCR materials that can be beneficially reused creating a need for a new storage area. Further development of plans for a potential new storage area will be submitted as an addendum to this Plan.

7.2 ENDANGERED RESOURCES REVIEW

A full Endangered Resources Review will be completed and included as an addendum to this plan

7.3 FINAL SLOPE STABILITY ANALYSIS

Slope stability analysis for final closure conditions is in progress and will be submitted as an addendum to this Plan.

7.4 CONDITIONS SUMMARY

An I-43 historical conditions summary will be provided as an addendum to this plan.

7.5 GROUNDWATER MONITORING NETWORK DEMONSTRATION

The groundwater monitoring network demonstration under NR 514.045 (1)(h) will be provided as an addendum to this plan.

7.6 UPDATED SAMPLING PLAN

The updated sampling plan under NR 514.045 (1)(h) will be provided as an addendum to this plan.

Table 1

Coal Combustion Residual (CCR) Landfill Plan of Operation Modification for Initial Permitting Checklist

Table 1.
Coal Combustion Residual (CCR) Landfill Plan of Operation Modification for Initial Permitting Checklist
Section NR 514.045, Wis. Adm. Code
Wisconsin Power and Light Company - Edgewater I-43 Ash Disposal Facility / SCS Engineers Project #25222259.00

REGULATORY REQUIREMENTS	COMPLETE?			LOCATION	COMMENTS
	Y	N	NA		
NR 514.045(1)(a) Does the submittal meet the requirements under s. NR 500.05, including the certifications required under s. NR 500.05(4)?					
NR 500.05 GENERAL SUBMITTAL REQUIREMENTS.					
(1) Has payment of the review fee of $30,500 been received? Note: The department sends an invoice to the facility contact upon receipt of the submittal. Payment is due within 30 days of receipt of the invoice.					
(2) Has a cover letter detailing the desired action been submitted?				Cover Letter	
(3) Have the appropriate number of written and electronic copies been submitted to the department?				N/A	
(4) Are the report and plan sheets submitted under the seals and certifications of a licensed professional engineer and professional geologist?					
(5) Technical Procedures:					
Were all test procedures specified in the report?				N/A	
Were all technical procedures used to investigate the facility current standard procedures?				N/A	
Were explanations and reasons given for deviations from any current standard method?				N/A	
(6) Do all maps, plan sheets, drawings, isometrics, cross-sections, figures, photographs and tables meet the following requirements?					
(a) No larger than 32 inches by 44 inches and no smaller than 8 ½ inches x 11 inches. Note: Section NR 514.045, Wis. Adm. Code requires engineering plans be drawn on standard 24 inch by 36-inch plan sheets.				Figures 1 - 5	
(b) Appropriate scale to show all required detail in sufficient clarity.				Figures 1 - 5	
(c) ___numbered ___legends for all symbols ___referenced in the narrative ___horizontal & vertical scales ___titled ___drafting and origination dates				Figures 1 - 5	
(d) Use uniform scales.				Figures 1 - 5	
(e) Contain a north arrow.				Figures 1 - 5	
(f) Use mean sea level as the basis for all elevations.				Figures 1 - 5	
(g) Contain a survey grid based on monuments established in the field and which utilize a coordinate system and datum, such as state plane coordinates, Universal Transverse Mercator (UTM), or Wisconsin Transverse Mercator.				Figures 1 - 5	
(h) Show original topography and a grid system shown on the plan sheets that show construction, operation, and closure topography.				Figures 1 - 5	
(i) Any cross-sections: ___Show survey grid locations, ___Reference major plan sheets, ___Include a reduced diagram of plan view showing cross-section location.				N/A	
(7) A table of contents listing all sections of the submittal.				Report Table of Contents	
(8) An appendix listing the following: ___names of all references ___all raw data ___testing and sampling procedures ___calculations				Report Appendices	
NR 514.045(1)(b) Does the submittal include a demonstration that all phases of the CCR landfill meet the performance criteria under s. NR 504.04(4)(a), (b), and (c)?					
NR 504.04(4) PERFORMANCE STANDARDS. Will the proposed landfill cause the following:					
(a) A significant adverse impact on wetlands? ___yes ___no Has a practicable alternatives analysis and a wetland functional values analysis been completed in accordance with ch. NR 103, if a wetland will be affected by the proposed landfill or any noncommercial soil borrow source activity? Note: See DNR wetland regulation website (https://dnr.wisconsin.gov/topic/Wetlands/permits) to help determine if a wetland permit may be needed per s. 281.36, Stats.				Report Section 2.1.1	
(b) A take of an endangered or threatened species in accordance with s. 29.604, Stats? ___yes ___no				Report Section 2.1.2	
(c) A detrimental effect on any surface water? ___yes ___no Note: Exemptions are not granted.				Report Section 2.1.3	
For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with the criteria above, has the landfill ceased placing CCR in the CCR landfill per NR 514.045(5)(b)?				N/A	
NR 514.045(1)(c) Does the submittal include a demonstration that all phases of the CCR landfill meet the locational criteria under s. NR 504.04(3)(g), (h), and (i)?					
NR 504.04(3) LOCATIONAL CRITERIA. Are the proposed limits of filling within:					
(g) 200 feet of a fault that has had displacement in Holocene time? ___yes ___no ___If yes, was an exemption requested?				Report Section 2.2.1	
(h) Seismic impact zones? ___yes ___no ___If yes, was an exemption requested?				Report Section 2.2.2	
(i) Unstable areas? ___yes ___no ___If yes, was an exemption requested?				Report Section 2.2.3	
For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with the criteria above, has the landfill ceased placing CCR in the CCR landfill per NR 514.045(5)(b)?				N/A	

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REGULATORY REQUIREMENTS	COMPLETE?			LOCATION	COMMENTS
	Y	N	NA		
NR 514.045(1)(c) (continued) Does the demonstration for unstable areas address all of the following factors, at a minimum, when determining whether an area is unstable:					
1. On-site or local soil conditions that may result in significant differential settling.				Report Section 2.2.4	
2. On-site or local geologic or geomorphologic features.				Report Section 2.2.5	
3. On-site or local human-made features or events both surface and subsurface.				Report Section 2.2.6	
For existing CCR landfills that do not comply with the location criteria for unstable areas specified above, has the owner or operator, within 6 months of the determination, done the following per NR 514.045(5)(a): __ceased placing CCR and non-CCR waste streams into the CCR landfill __closed the CCR landfill in accordance with the requirements under s. NR 506.083 Note: This timeframe does not apply if the owner or operator complies with the alternative closure procedures under s. NR 506.083 (7).				N/A	
NR 514.045(1)(d) Does the submittal include a demonstration that the facility or practices near floodplains will not cause the following effects:					
__Restrict the flow of the regional flood __Reduce the temporary water storage capacity of the floodplain __Result in washout of solid waste so as to pose a hazard to human life, wildlife, or land or water resources. Note: NR 504.04(3)(c) also requires no person may establish, construct, operate, maintain, or permit the use of property for a landfill where the limits of filling are or would be within a floodplain.				Report Section 2.3.1	
For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with the criteria above, has the landfill ceased placing CCR in the CCR landfill per NR 514.045 (5)(b)?				N/A	
NR 514.045(1)(e) Does the submittal include a demonstration that the facility or practices will not result in the destruction or adverse modifications of the critical habitat of endangered or threatened species as identified in s. NR 27.03(1)?				Report Section 2.4.1	
For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with the criteria above, has the landfill ceased placing CCR in the CCR landfill per NR 514.045 (5)(b)?				N/A	
NR 514.045(1)(f) Does the submittal include a demonstration that the CCR landfill design meets requirements under s. NR 504.12 or an alternate design under s. NR 504.10? Does the demonstration include a design report, engineering drawings, and calculations? Note: Complete NR 504.12 and if applicable NR 504.10 (for an alternate design) of the NR 504 Design and Construction Criteria Completeness Checklist.				Report Section 3.0	
For new CCR landfills or a lateral expansion of a CCR landfill, if the landfill failed to make the demonstration showing compliance with NR 504.12 and NR 504.10 (for an alternate design), has the landfill ceased placing CCR in the CCR landfill per NR 514.045(5)(b)?				N/A	
NR 514.045(1)(g) Does the submittal include all of the plans required under s. NR 514.07(10)?					
NR 514.07(10) PLAN OF OPERATION. Does the submittal include all of the following:					
(a) A CCR fugitive dust control plan in accordance with all of the following:					
1. The plan shall identify and describe the CCR fugitive dust control measures the owner will use to minimize CCR from becoming airborne at the facility. The owner shall select and include in the CCR fugitive dust control plan the CCR fugitive dust control measures that are most appropriate for site conditions, along with an explanation. See s. NR 514.07 (10)(a)1. for control measure examples.				Appendix C1, Measures for Controlling Fugitive Dust	
2. The plan shall include procedures to wet CCR with water to a moisture content that will prevent wind dispersal, but will not result in free liquids. In lieu of water, wetting of CCR may be accomplished with an appropriate chemical dust suppression agent.				Appendix C1, Procedure for Conditioning CCR Prior to Placement	
3. The plan shall include a description of the procedures the owner will follow to periodically assess the effectiveness of the control plan. At a minimum, the assessment shall include a visual inspection at least every 7 days, unless the CCR landfill is inactive, and all areas are covered by intermediate or final cover.				Appendix C1, Visual Inspections	
4. The plan shall be modified in accordance with s. NR 514.04 (6) whenever there is a change in conditions that may substantially affect the plan of operation.				Appendix C1, Procedure for Periodic Review of CCR Fugitive Dust Control Plan	
5. The plan shall address the preparation of an annual fugitive dust control report in accordance with s. NR 506.20 (3)(a).				Appendix C1, Procedure for Periodic Review of CCR Fugitive Dust Control Plan	
(b) A run-on and run-off control system plan that includes all of the following:					
1. A run-on and run-off control system designed in accordance with the requirements under s. NR 504.12 (2).				Appendix C2, Section 2.0	
2. Plan sheets depicting the location of run-on and run-off control features, detail drawings, and supporting engineering calculations.				Appendix C2, Figures and Appendix A	
3. Construction procedures and a schedule for construction.				Appendix C2, Section 2.3	
4. Modification every 5 years from the date of the most recent plan approval or whenever there is a change in conditions that may substantially affect the written plan in effect. The modification shall be requested by the owner in accordance with s. NR 514.04 (6) prior to the 5-year deadline.				Appendix C2, Section 4.0	

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Wisconsin Power and Light Company - Edgewater I-43 Ash Disposal Facility / SCS Engineers Project #25222259.00

REGULATORY REQUIREMENTS	COMPLETE? Y	N	NA	LOCATION	COMMENTS
(c) A written closure plan in accordance with all requirements under NR 514.06 (10) and all of the following:					
1. A narrative description of how the CCR landfill will be closed, including a description of the steps necessary to close the CCR unit at any point during the active life of the CCR unit, consistent with recognized and generally accepted good engineering practices.				Appendix C3, Section 2.0	
2. A description of the final cover system, designed in accordance with s. NR 504.07, and the methods and procedures to be used to install the final cover. Note: Complete NR 504.07 of the NR 504 Design and Construction Criteria Completeness Checklist.				Appendix C3, Section 3.0	
3. A demonstration, including a narrative discussion, of how final closure will meet the performance standards under s. NR 506.083 (6).				Appendix C3, Section 3.0	
4. An estimate of the maximum volume in cubic yards of CCR that will be disposed on-site over the active life of the CCR landfill.				Appendix C3, Section 4.0	
5. An estimate of the largest area of the CCR landfill that will require a final cover at any time during the CCR landfill's active life.				Appendix C3, Section 5.0	
6. A schedule for completion of all closure activities, including an estimate of the year in which all closure activities for the CCR landfill will be completed.				Appendix C3, Section 6.0 and 7.0	
7. The plan shall be modified in accordance with s. NR 514.04 (6) whenever there is a change in conditions that may substantially affect the written closure plan or unanticipated events necessitate a revision of the written closure plan.				Appendix C3, Section 9.0	
8. If closure of the CCR landfill will be accomplished through removal of CCR from the CCR landfill, the closure plan shall be modified and approved by the department prior to implementation in accordance with s. NR 514.04 (6).				N/A	
(d) A written long-term care plan that addresses all of the following:					
1. A description of the monitoring and maintenance activities and the frequency at which those activities will be performed. The activities shall include, at a minimum, all of the following: ___Long-term care activities specified under s. NR 514.06 (11). ___Maintaining the integrity and effectiveness of the final cover system, including making repairs as necessary. ___Maintaining the effectiveness of the leachate collection and removal system and operating the leachate collection and removal system in accordance with the requirements under s. NR 504.12 (3) (a). ___Maintaining the groundwater monitoring system and monitoring the groundwater in accordance with ch. NR 507 and the sampling plan approval.				Appendix C4, Section 2.0	
2. The name, address, telephone number, and email address of the person or office to contact about the facility during long-term care.				Appendix C4, Section 3.0	
3. A description of the planned uses of the property during long-term care. Post- closure uses may not disturb the integrity of the final cover, liner, or other component of the landfill, or function of the monitoring systems unless approved in writing by the department. A written request for approval as part of the plan of operation submittal or a modification shall include a demonstration that disturbance of any part of the CCR landfill will not increase the potential threat to human health or the environment.				Appendix C4, Section 4.0	
NR 514.045(1) (h) Does the submittal include a demonstration that the CCR groundwater monitoring system complies with the requirements under s. NR 507.15(3), including documentation of the design, installation, and development of any CCR wells?					
NR 507.15(3) CCR LANDFILLS. In addition to the detection groundwater monitoring system required under s. NR 507.19, the CCR landfill owner shall submit a plan establishing a separate CCR groundwater monitoring system for the purpose of monitoring groundwater quality in the uppermost aquifer. The plan shall be submitted with the plan of operation modification for initial permitting in accordance with s. NR 514.045 or in the feasibility report under ch. NR 512. The plan shall include all of the following:				To be provided in an addendum	
(a) Does the monitoring system consist of a sufficient number of CCR monitoring wells, installed at appropriate locations and depths?				To be provided in an addendum	
Are the CCR wells adequate to yield groundwater samples from the uppermost aquifer that accurately represent upgradient groundwater quality that has not been affected by leakage from CCR landfill and downgradient groundwater quality passing the waste boundary of the CCR landfill?				To be provided in an addendum	
Are the downgradient monitoring wells installed to ensure detection of groundwater contamination in the uppermost aquifer, including all known or suspected contaminant pathways?				To be provided in an addendum	
(b) Has the number, spacing, and depths of monitoring wells that are part of the CCR groundwater monitoring system plan based upon site-specific technical information that includes the following? ___Aquifer thickness ___Groundwater flow rate ___Groundwater flow direction, including seasonal and temporal fluctuations in groundwater flow				To be provided in an addendum	
Does the monitoring system consider the saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities, and effective porosities?				To be provided in an addendum	
(c) Does the monitoring system plan include the minimum number of monitoring wells necessary to meet performance standards specified under (a) based on the site-specific information specified under (b).?				To be provided in an addendum	
1. Does the groundwater monitoring system plan contain a minimum of one upgradient and 3 downgradient monitoring wells to be designated as CCR wells?				To be provided in an addendum	
2. Does the groundwater monitoring system contain additional monitoring wells as necessary to accurately represent the background groundwater quality in the uppermost aquifer that has not been affected by leakage from the CCR landfill and the quality of groundwater passing the waste boundary of the CCR landfill?				To be provided in an addendum	
(d) Have the monitoring wells been designed and installed in accordance with NR 507.06 and regularly inspected in accordance with NR 507.13?				To be provided in an addendum	
(e) Has the documentation of the design, installation, development, and decommissioning of all wells and measurement/sampling devices been performed in accordance with NR 507.14 and NR 141, where applicable? This includes submission of all required forms to the department in the timeframes specified.				To be provided in an addendum	

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REGULATORY REQUIREMENTS	COMPLETE?			LOCATION	COMMENTS
	Y	N	NA		
NR 514.045 (i) Does the submittal include an updated sampling plan that addresses the requirements under s. NR 507.15(3)?					
NR 507.15(3) CCR LANDFILLS. Does the sampling plan address all of the following:					
(f) A sampling plan, which includes the CCR groundwater monitoring system, in accordance with s. NR 507.16 and the requirements under s. NR 140.16. Note: Complete NR 507.16(1) below.				To be provided in an addendum	
Does the sampling plan include consistent sampling and analysis procedures designed to ensure the production of monitoring results that provide an accurate representation of groundwater results that provide an accurate representation of groundwater quality in the uppermost aquifer at the upgradient and downgradient CCR wells and that provide a characterization of leachate quality generated by the CCR landfill?				To be provided in an addendum	
(g) Does the sampling plan include sampling and analytical methods that are appropriate for groundwater sampling and that accurately measure all required monitoring parameters under ch. NR 507, Appendix I in groundwater samples?				To be provided in an addendum	
Does the sampling plan specify the CCR landfill owner or operator obtain and analyze samples in accordance with the sampling plan and the requirements under s. NR 507.17?				To be provided in an addendum	
(h) In addition to the field measurements required under s. NR 507.17(1), does the plan include measurement of the groundwater elevations in each CCR well immediately prior to purging, each time groundwater is sampled.				To be provided in an addendum	
Does the plan include determination of the rate and direction of groundwater flow each time groundwater is sampled and reporting the result to the department in accordance with s. NR 507.26?				To be provided in an addendum	
Does the plan include that groundwater elevations in wells that monitor the same CCR landfill be measured within a timeframe short enough to avoid temporal variations in groundwater flow that could preclude accurate determination of groundwater flow rate and direction?				To be provided in an addendum	
(i) Has the owner/operator established baseline groundwater quality levels for each CCR monitoring well in accordance with NR 507.18 for each CCR well and for each of the constituents required under ch. NR 507 Appendix I, Table 1A and the sampling plan?				To be provided in an addendum	
(j) Has the owner/operator measured the total recoverable metal concentrations when measuring groundwater quality for each CCR monitoring well?				To be provided in an addendum	
Does measurement of total recoverable metals include both the particulate fraction and dissolved fraction of metals in natural waters? To ensure this, groundwater samples from CCR wells may not be field filtered prior to analysis.				To be provided in an addendum	
(k) Does the plan specify the owner/operator notify the department in writing within 60 days of completing sampling and analysis at any CCR well when a groundwater standard at the point of standards application has been attained or exceeded in accordance with s. NR 507.30?				To be provided in an addendum	
(L) Does the plan specify the owner/operator conduct detection groundwater monitoring at all CCR monitoring wells in accordance with NR 507.19 and all of the following?				To be provided in an addendum	
Does detection groundwater monitoring include groundwater monitoring for all constituents appropriate for CCR wells as listed under ch. NR 507 Appendix I, Table 1A and additional parameters as required by the department.				To be provided in an addendum	
1. Is the minimum monitoring frequency semi-annual for detection groundwater monitoring?				To be provided in an addendum	
Has baseline groundwater quality been established at each CCR monitoring well in accordance with s. NR 507.18? This includes collection of a minimum of 8 independent groundwater quality samples for each CCR well, analyzed for constituents' approval for CCR landfills as listed under ch. NR 507 Appendix I, Tables 1A and 3 and additional parameters as required by the department.				To be provided in an addendum	
2. Does the plan specify the number and methodology of groundwater quality samples be collected and analyzed for each CCR well during subsequent sampling events consistent with the approved sampling plan?				To be provided in an addendum	
Does the plan specify the CCR landfill owner or operator inform the department in accordance with s. NR 507.26 of any CCR well that purges dry, is damaged or obstructed, or in any way is rendered such that a sample was unable to be collected from the well during a scheduled sampling event and does the plan specify the owner or operator propose remedial actions to correct the problem prior to the next sampling event?				To be provided in an addendum	
3. Does the plan specify the owner or operator of the CCR landfill notify the department and respond in accordance with s. NR 507.30 when a groundwater standard at the point of standards application has been attained or exceeded at any CCR well? This includes the establishment of an assessment monitoring program meeting the requirements under s. NR 508.06, unless the exceedance is determined by the department to be from a source other than the CCR landfill, or that the groundwater standard exceedance resulted from error in sampling, analysis, or natural variation in background groundwater quality in accordance with s. NR 508.06(2)(f)2.				To be provided in an addendum	
4. Does the plan specify the point of standards application for a groundwater quality exceedance at a CCR well, the horizontal distance for the design management zone under s. NR 140.22(3)(a) for a CCR landfill is 0 feet from the waste boundary and may not be expanded by the department under s. NR 140.22(3)(b)? The waste boundary includes the horizontal space taken up by any liner, dike or other barrier designed to contain CCR waste.				To be provided in an addendum	
(m) Does the plan specify the owner or operator of the CCR landfill prepare an annual groundwater monitoring and corrective action report for submittal to the department, placement in the written operating record and position g on the publicly accessible internet site under s. NR 506.17(2) and (3) no later than January 31 of the year following the calendar year a groundwater monitoring system has been approved by the department, and annually thereafter?				To be provided in an addendum	
Does the plan specify that the annual report document the status of the groundwater monitoring and any corrective action implemented at the CCR landfill, summarize key activities completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year?				To be provided in an addendum	
Does the plan specify the annual groundwater monitoring and corrective action report contain, at a minimum the information included in ss. NR 507.15(3)(m) 1. – 5.				To be provided in an addendum	

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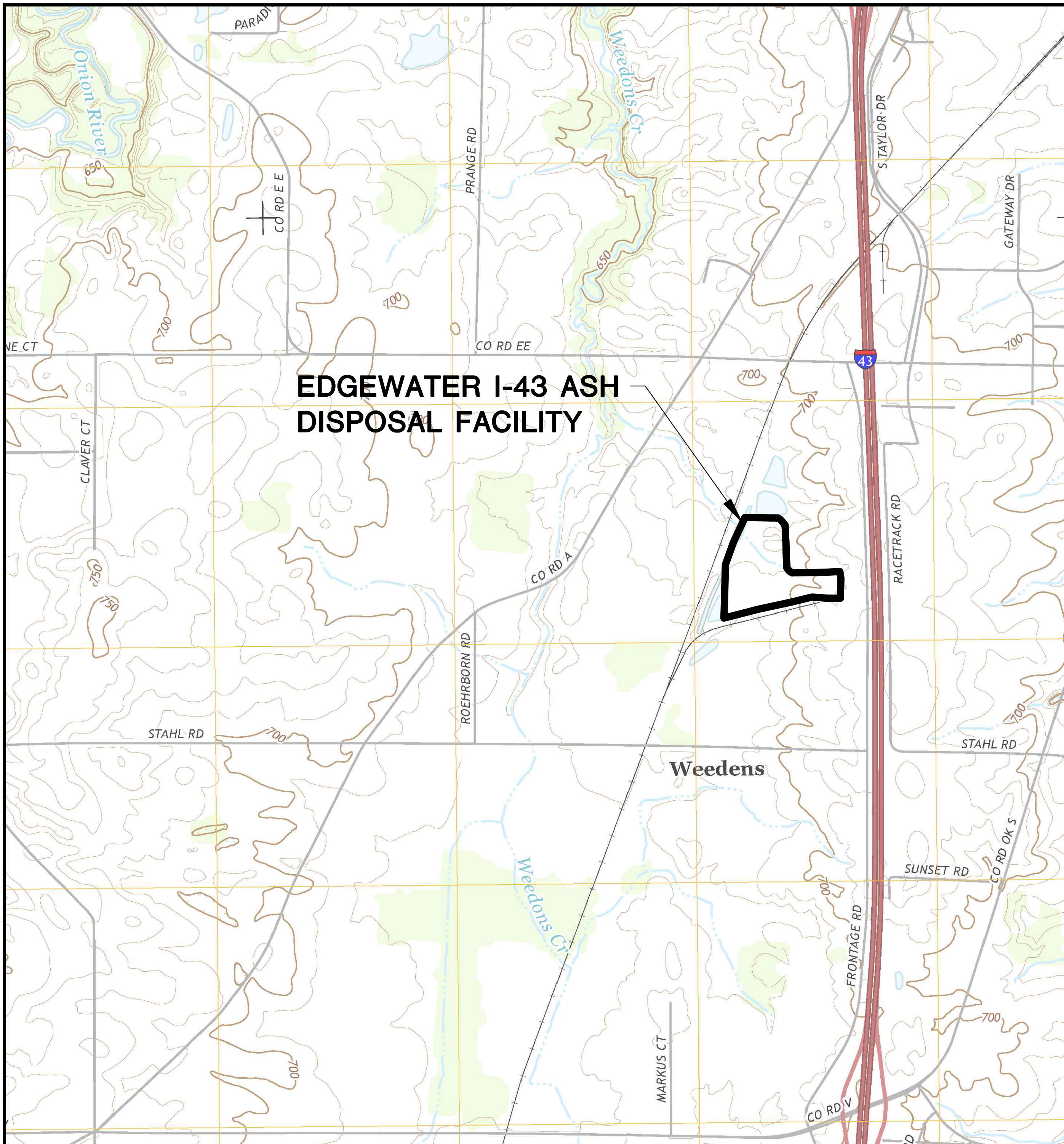
REGULATORY REQUIREMENTS	COMPLETE?			LOCATION	COMMENTS
	Y	N	NA		
NR 507.16(1) SAMPLING PLAN. Does the sampling plan include the following information:					
(a) An 8 1/2 by 11 inch site map showing locations of all sample points and devices. An 11 by 17 inch site map may be included if clarity is compromised using the 8 1/2 by 11 inch size. Different symbols shall be used to differentiate types of monitoring devices such as groundwater monitoring wells, collection lysimeters and gas monitoring wells. Each sample point shall be labeled.				To be provided in an addendum	
(b) A sample schedule, including all of the following: __1. The months that each sample point is to be sampled. __2. The sampling period, as designated by the department. __3. The list of parameters that are to be analyzed for in the sample from each monitoring device during each month that sampling occurs.				To be provided in an addendum	
(c) Procedures for field measurements, including all of the following: __1. The order in which wells should be sampled if the groundwater has been impacted by regulated or other activities. __2. The procedures and type of equipment used to measure water level elevations. __3. The procedures and type of equipment used to measure temperature, pH, conductivity and procedures to determine turbidity, odor and color.				To be provided in an addendum	
(d) Procedures for purging wells, including all of the following: __1. Procedures to purge wells prior to collecting samples. __2. Procedures for determining the volume of water to be removed from each well. __3. The type of equipment used to purge wells. __4. The rate of flow while purging, when applicable. __5. Procedures to clean purging equipment between wells. __6. The amount of time required between purging and sampling.				To be provided in an addendum	
(e) Procedures for obtaining samples from wells, including all of the following: __1. Procedures and type of equipment used to retrieve samples. __2. Volume of sample required for analysis. __3. Procedures and type of equipment to filter samples, including when to filter and when not to filter samples, if applicable. __4. The rate of flow when sampling, when applicable. __5. Procedures and type of equipment to physically and chemically preserve samples. __6. Procedures to clean sampling equipment following sampling of one well and prior to sampling the next well.				To be provided in an addendum	
(f) Procedures for establishing field quality assurance and quality control, including all of the following: __1. Field blank, duplicate sample and trip blank procedures. __2. The frequency at which the field blanks, duplicate samples and trip blanks will be collected or processed.				To be provided in an addendum	
(g) Special procedures to sample water supply wells.				To be provided in an addendum	
(h) Special procedures to sample leachate headwells and other devices.				To be provided in an addendum	
(i) Chain of custody procedures, including persons responsible for sampling and methods for transporting samples to the laboratory.				To be provided in an addendum	

Figures



N

SHEBOYGAN FALLS QUADRANGLE

WISCONSIN–SHEBOYGAN CO.

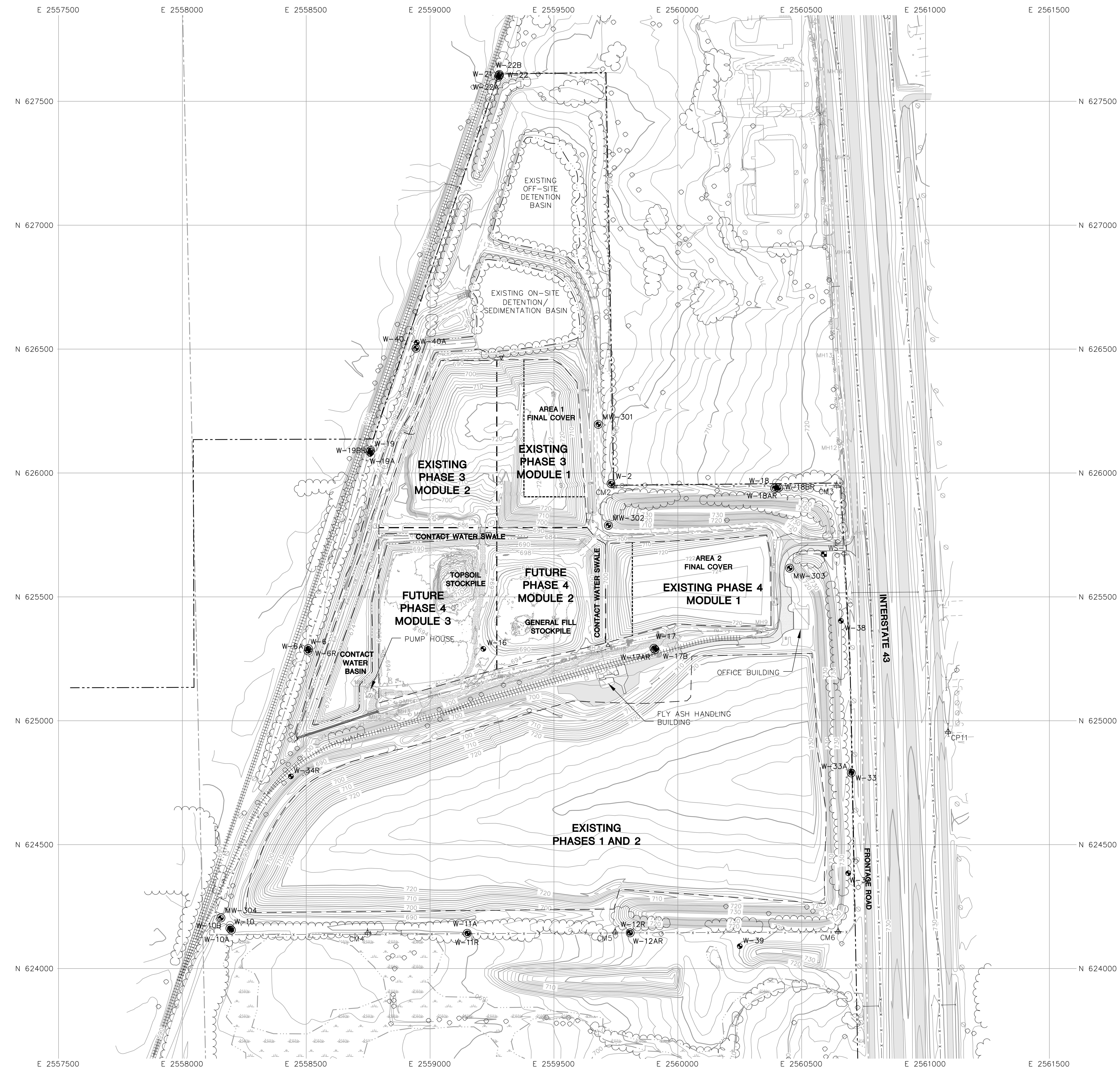
2015

SCALE: 1" = 2,000'

CLIENT	WISCONSIN POWER AND LIGHT COMPANY EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081	SITE	PLAN MODIFICATION EDGEWATER I–43 ASH DISPOSAL FACILITY TOWN OF WILSON, WISCONSIN	SITE LOCATION MAP

PROJECT NO.	25222259.00	DRAWN BY:	KP	ENGINEER	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718–6751 PHONE: (608) 224–2830	FIGURE
DRAWN:	09/17/18	CHECKED BY:	PG			1
REVISED:	09/17/18	APPROVED BY:	PG 01/31/23			

I:\25222259.00\Drawings\Site Location Map.dwg, 1/31/2023 10:48:21 AM



N

200 0 200

SCALE: 1" = 200'

LEGEND

- APPROXIMATE PROPERTY LINE
- LIMITS OF WASTE
- MODULE LIMITS
- LIMITS OF FINAL COVER
- GRADE (2' CONTOUR)
- 690 GRADE (10' CONTOUR)
- EDGE OF WATER
- SWALE
- WETLAND
- CULVERT
- MH MANHOLE
- W CONTACT WATER TRANSFER PIPE
- AB ABANDONED 3" DIA. HDPE PIPE
- FM CONTACT WATER FORCEMAIN
- E/I ELECTRIC/INSTRUMENTATION
- TREELINE/TREES
- PAVED ROAD
- UNPAVED ACCESS ROAD
- CONCRETE
- RAILROAD TRACKS
- FENCE
- UTILITY/LIGHT POLE
- CONTROL MONUMENT
- MONITORING WELL
- PIEZOMETER
- LEACHATE HEADWELL
- PRIVATE WATER SUPPLY WELL

CONTROL MONUMENT DATA		
MONUMENT NO.	STATION	ELEVATION
CM2	625946.374 N 2559742.153 E	700.043
CM3	625949.279 N 2560641.785 E	717.041
CM4	624143.955 N 2558747.460 E	687.448
CM5	624146.909 N 2559747.214 E	705.621
CM6	624149.566 N 2560647.002 E	723.265
NW MON	627611.72 N 2559277.25 E	692.50
SW MON	624917.81 N 2558582.66 E	702.70

NOTES:

1. BASE MAP PREPARED BY KBM, INC. BASED ON AERIAL TOPOGRAPHIC SURVEY FLOWN DECEMBER 1, 2014. BASE MAP PREPARED USING WISCONSIN STATE PLANE COORDINATES. ELEVATIONS BASED ON USGS NATIONAL GEODETIC VERTICAL DATUM, 1929. UPDATED WITH 2015 CONSTRUCTION AS-BUILT GRADES, 2016 CONSTRUCTION AS-BUILT GRADES FOR PHASE 4, MODULE 1 BY SCS ENGINEERS, DECEMBER 23, 2020 DRONE SURVEY OF PHASE 3, MODULE 2 ASH GRADES AND FUTURE PHASE 4 AREAS BY RYAN INCORPORATED CENTRAL, APRIL 11, 2022 PHASE 3 MODULE 2 SURVEY BY SCS ENGINEERS.
2. CONTOUR INTERVAL IS 2 FEET.
3. MONITORING WELL LOCATIONS BASED ON WELL INFORMATION FORM COORDINATES AND EXISTING CONDITIONS MAP F11 PREPARED BY WARZYN, INC. USING LOCAL COORDINATES.
4. WETLAND LIMITS BASED ON WETLAND DELINEATION REPORT, WISCONSIN POWER AND LIGHT COMPANY, EDGEWATER LANDFILL SITE, TOWN OF WILSON, SHEBOYGAN COUNTY, WISCONSIN, JUNE 25, 2010, NATURAL RESOURCES CONSULTING, INC. (NRC).

PROJECT NO.	25222259.00	DRAWN BY:	KP
DRAWN:	09/12/2018	CHECKED BY:	BSS
REVISED:	01/17/2023	APPROVED BY:	PG 01/31/23

WISCONSIN POWER AND LIGHT COMPANY
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081

CLIENT

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

ENGINEER

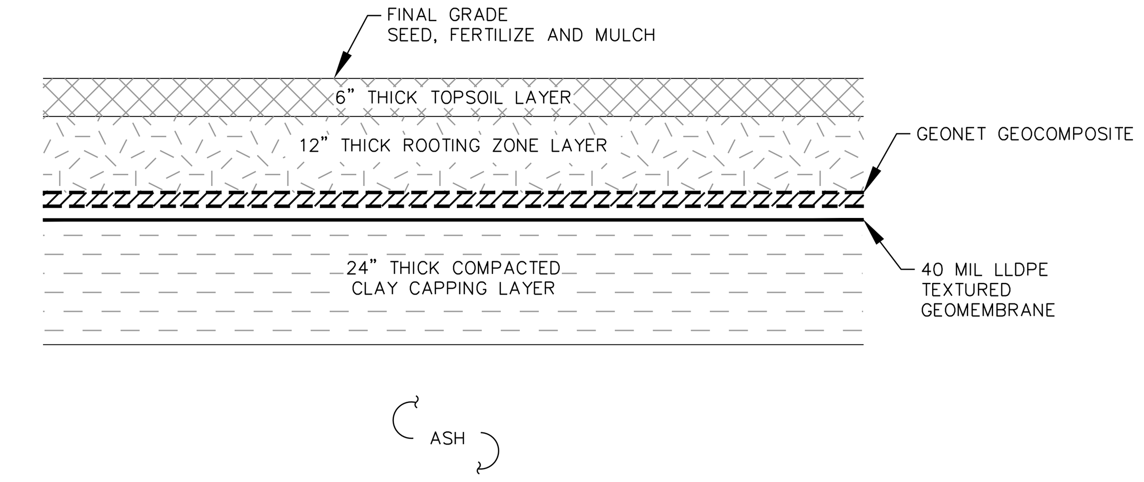
PLAN MODIFICATION
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

SITE

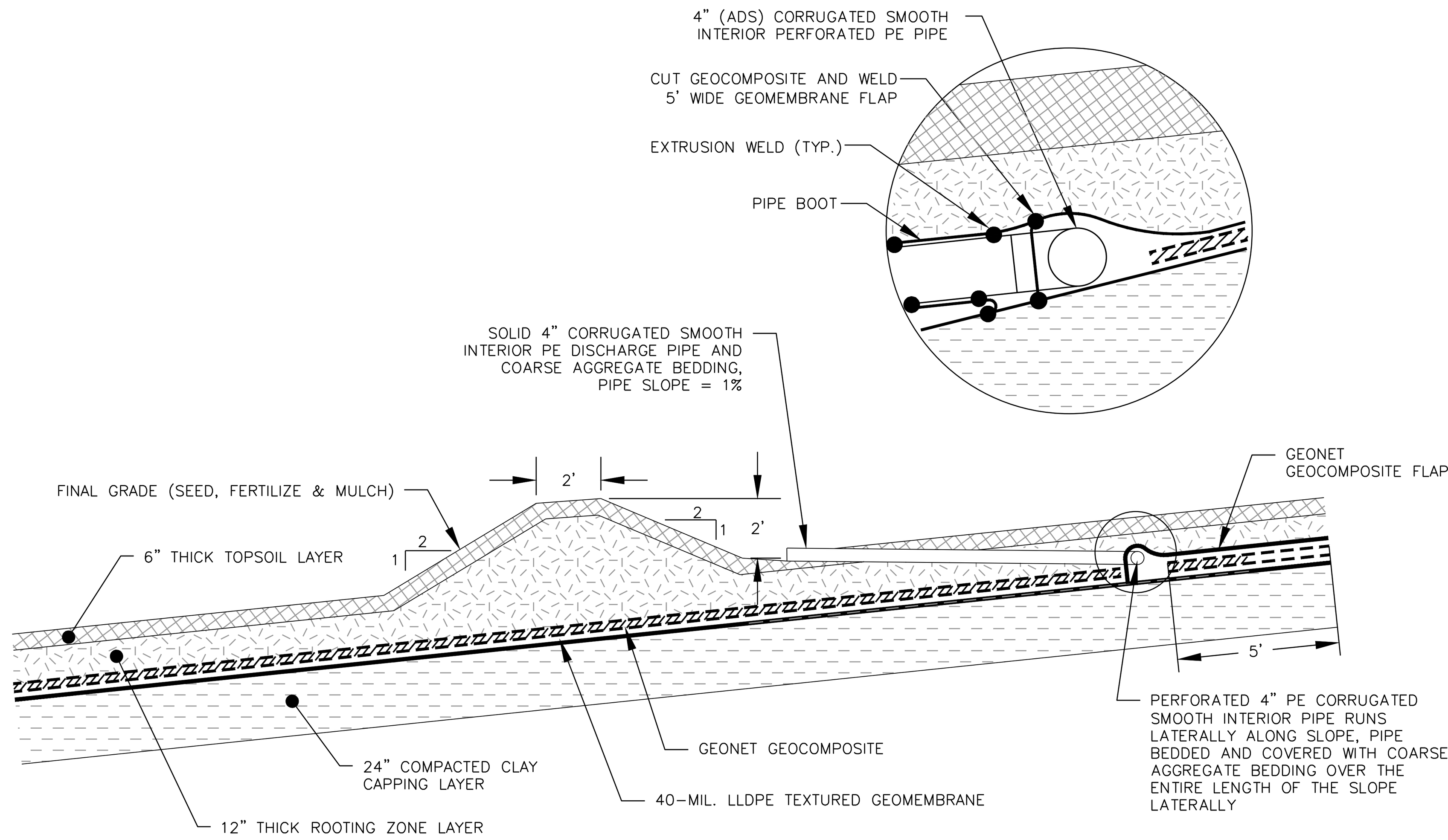
EXISTING CONDITIONS

FIGURE

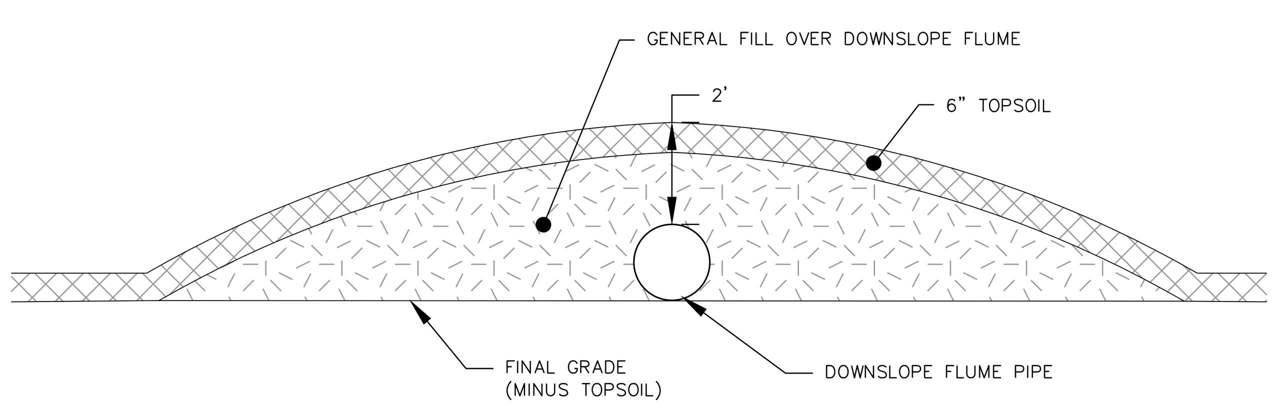
2



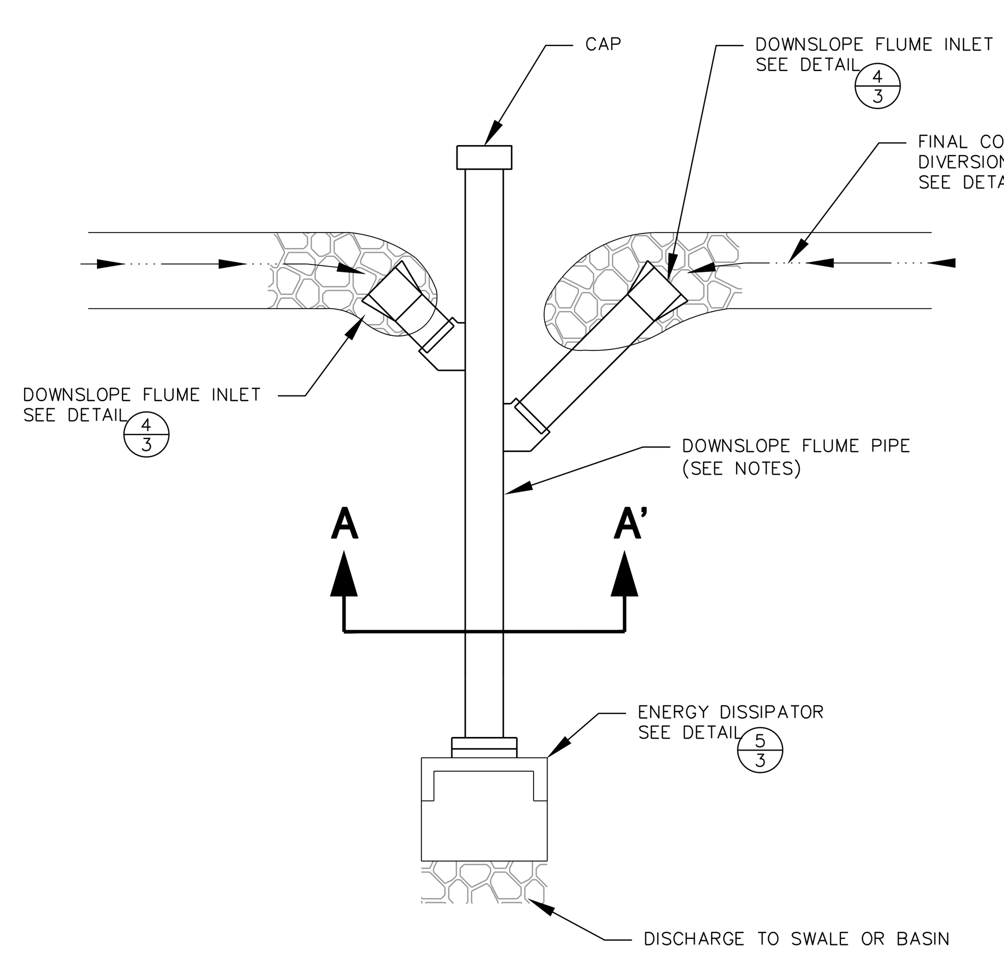
1/3 **FINAL COVER**
SCALE: 1" = 2'



2/3 **3% FINAL COVER DIVERSION BERM AND FINAL COVER DRAINAGE SYSTEM**
SCALE: 1" = 2'



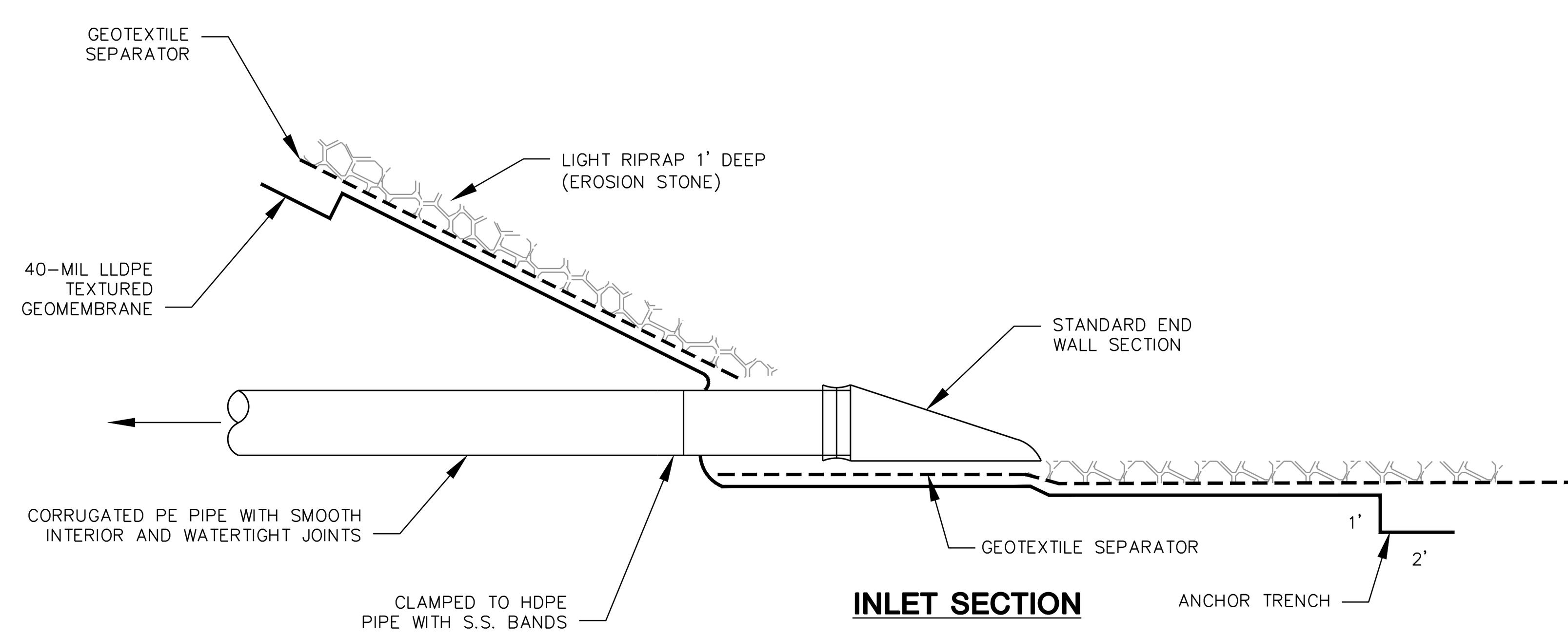
SECTION A-A'



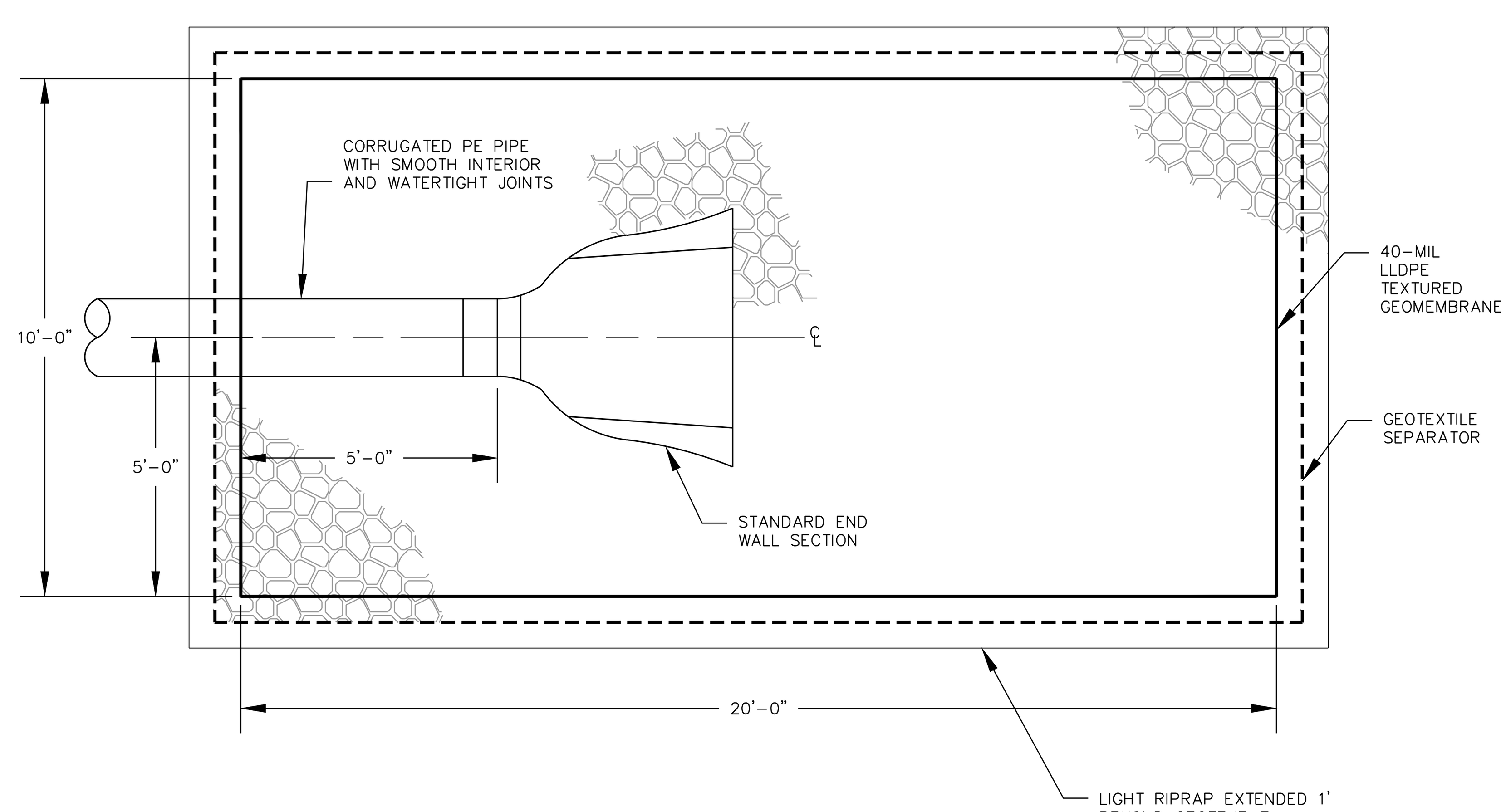
NOTES:

1. DOWNSLOPE FLUME PIPE SIZES:
   10 INCH DIAMETER – FLUME 1 AND 2
   12 INCH DIAMETER – FLUME 3 AND 4
2. DUAL-WALL CORRUGATED POLYETHYLENE ADS N-12 ST IB PIPE, OR EQUIVALENT.

3/3 **DOWNSLOPE FLUME**
NOT TO SCALE

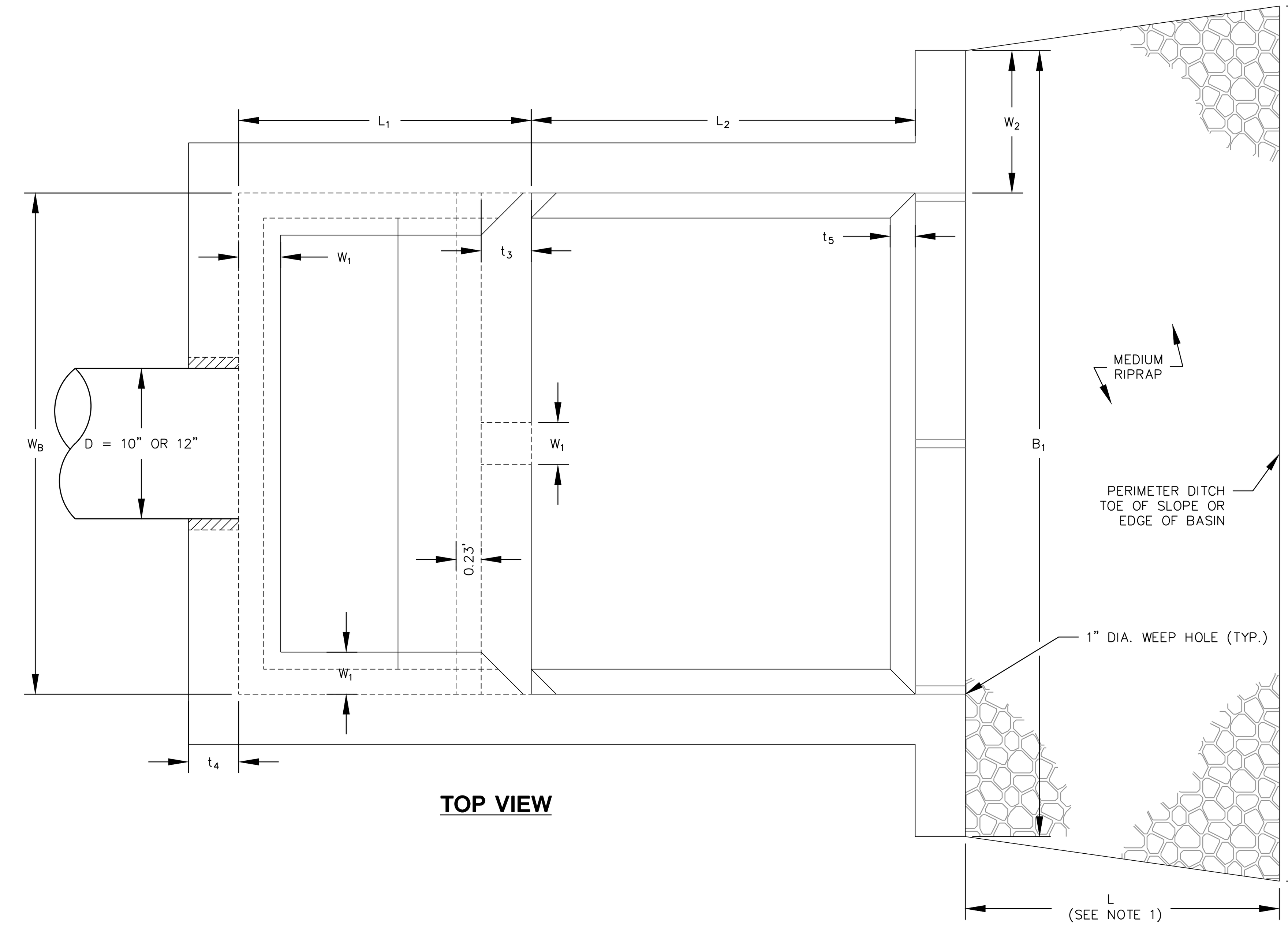


INLET SECTION

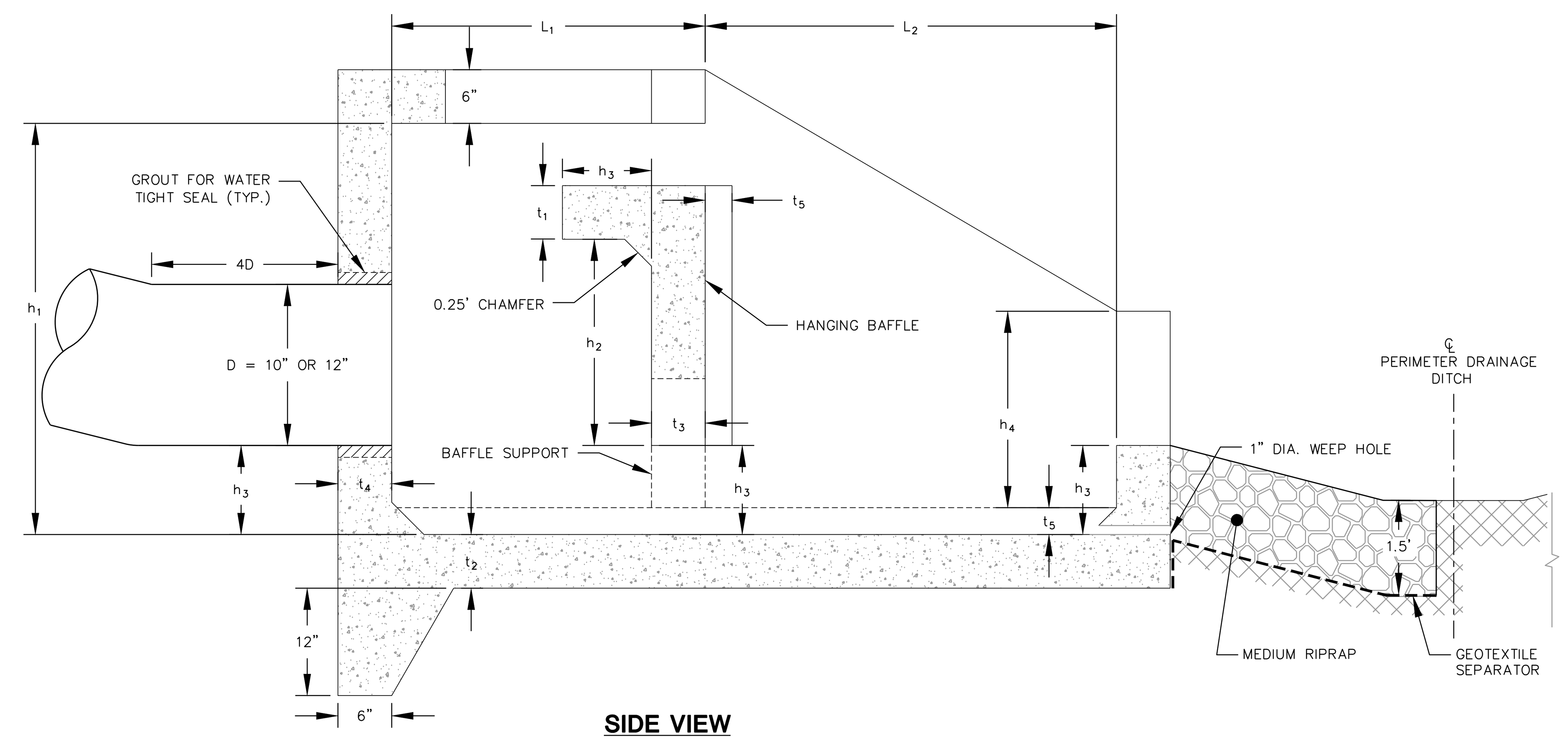


PLAN

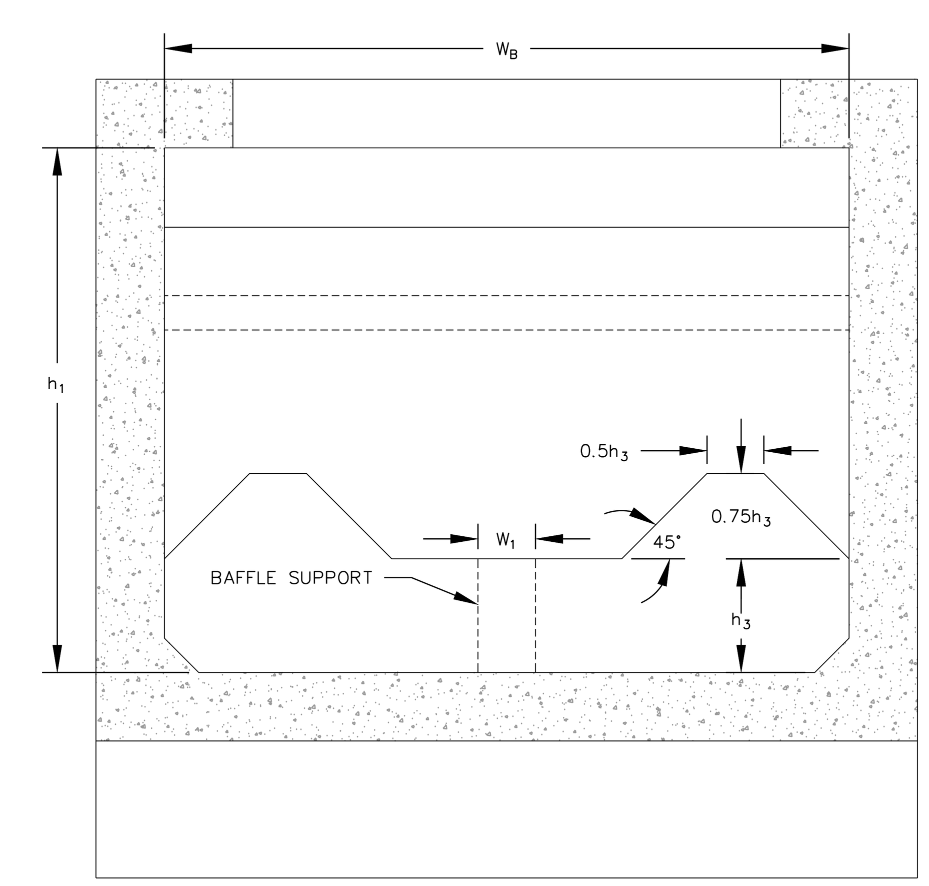
4/3 **DOWNSLOPE FLUME INLET**
NOT TO SCALE



TOP VIEW



SIDE VIEW



FRONT VIEW

NOTES:

1. EXTEND TO FAR SIDE OF SWALE OR TO THE WATERLINE.

W_B	h_1	h_2	h_3	h_4	L	L_1	L_2
4	3.08	1.50	0.67	1.67	--	2.33	3.08

W_1	W_2	t_1	t_2	t_3	t_4	t_5
0.33	1.08	0.50	0.50	0.50	0.50	0.25

5/3 **ENERGY DISSIPATOR**
NOT TO SCALE

PROJECT NO. 25222259.00 | DRAWN BY: KP/MJT
DRAWN: 01/27/15 | CHECKED BY: KG/LAB
REVISED: 01/17/23 | APPROVED BY: PG 01/31/23

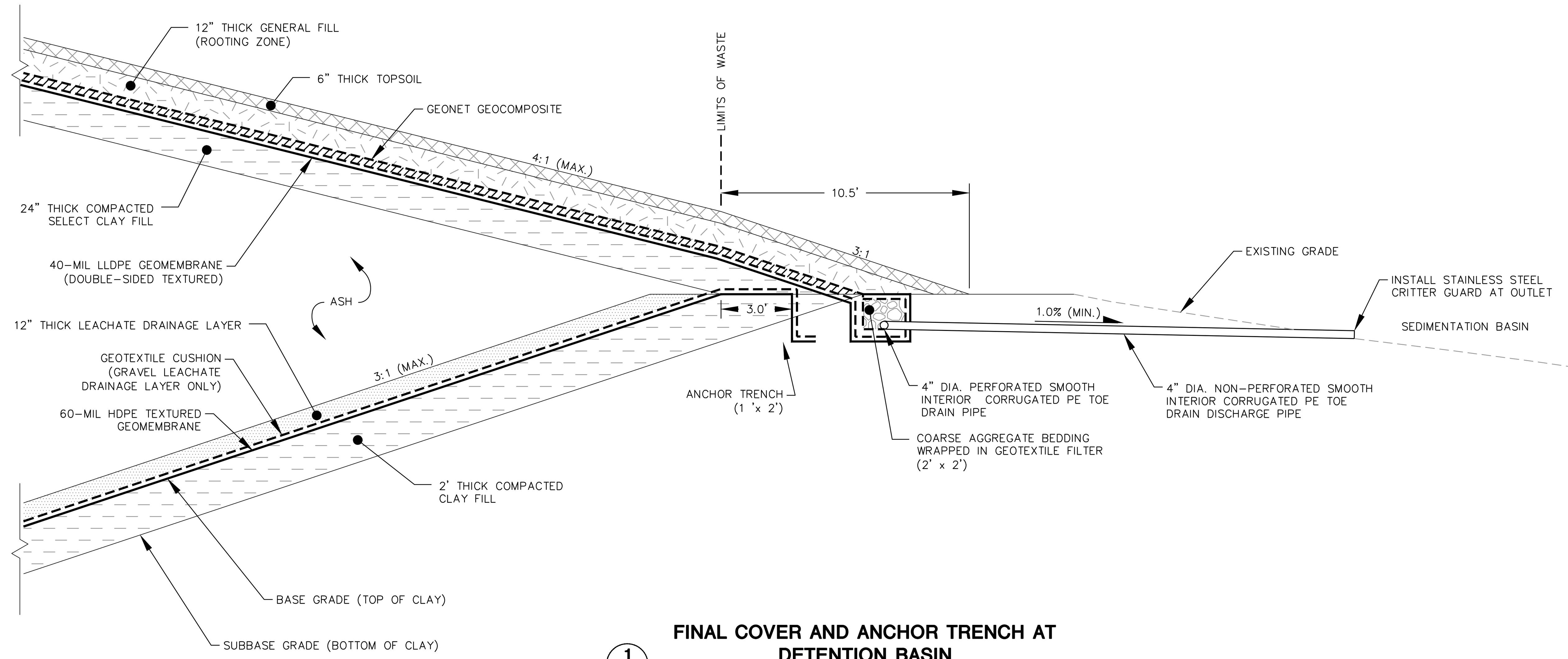
WISCONSIN POWER AND LIGHT COMPANY
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081
CLIENT

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

PLAN MODIFICATION
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN
SITE

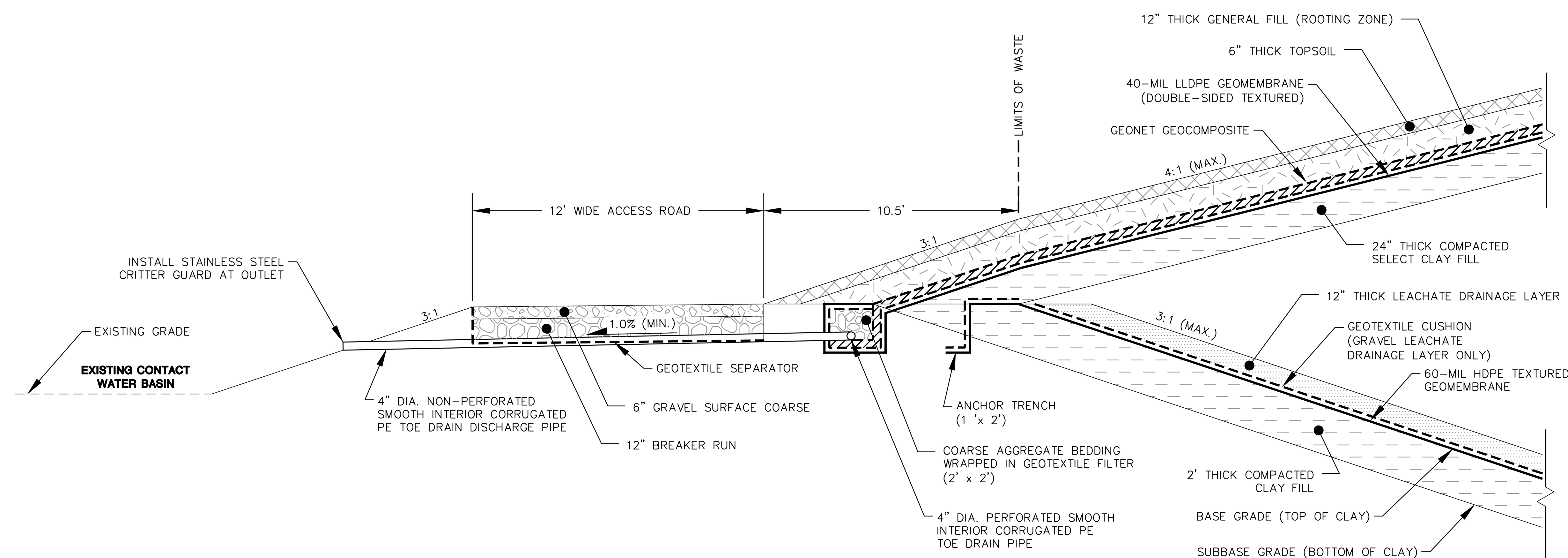
DETAILS

FIGURE
3



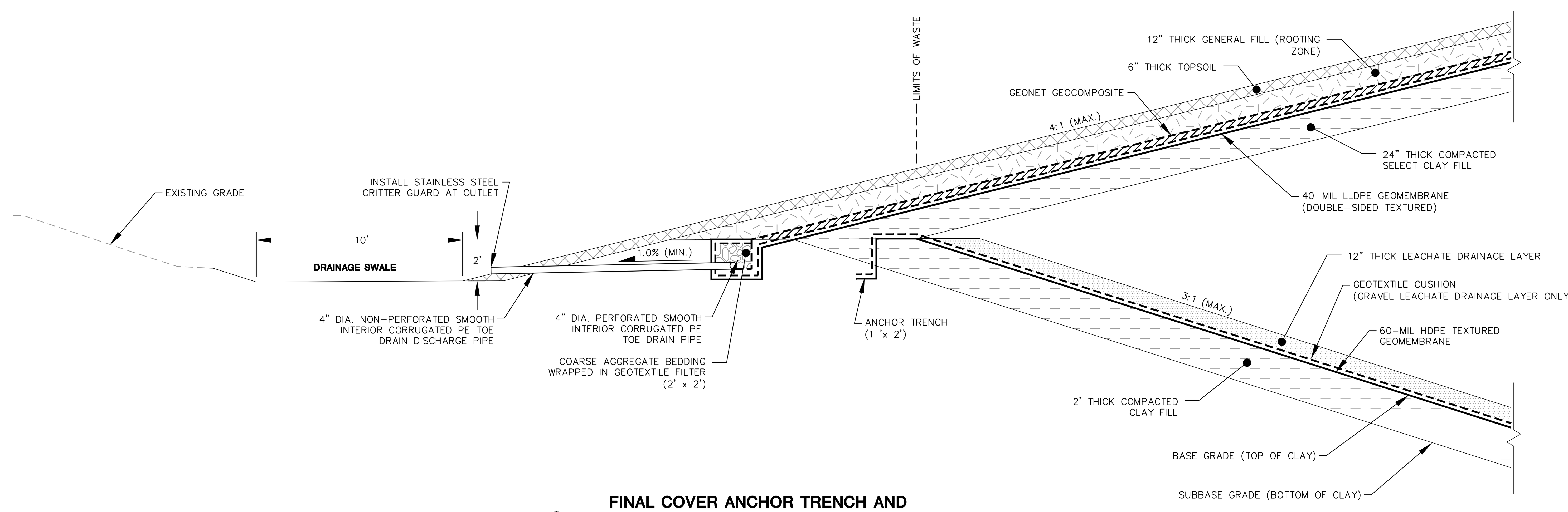
1/4 FINAL COVER AND ANCHOR TRENCH AT DETENTION BASIN

SCALE: 1" = 4'



2/4 FINAL COVER ANCHOR TRENCH, TOE DRAIN, AND ACCESS ROAD AT CONTACT WATER BASIN

SCALE: 1" = 4'



3/4 FINAL COVER ANCHOR TRENCH AND PERIMETER SWALE

SCALE: 1" = 4'

PROJECT NO. 25222259.00	DRAWN BY: KP/MJT		
DRAWN: 01/27/15	CHECKED BY: KG/LAB		
REVISED: 07/26/23	APPROVED BY: PG 07/31/23		

WISCONSIN POWER AND LIGHT COMPANY
EDGEWATER GENERATING STATION
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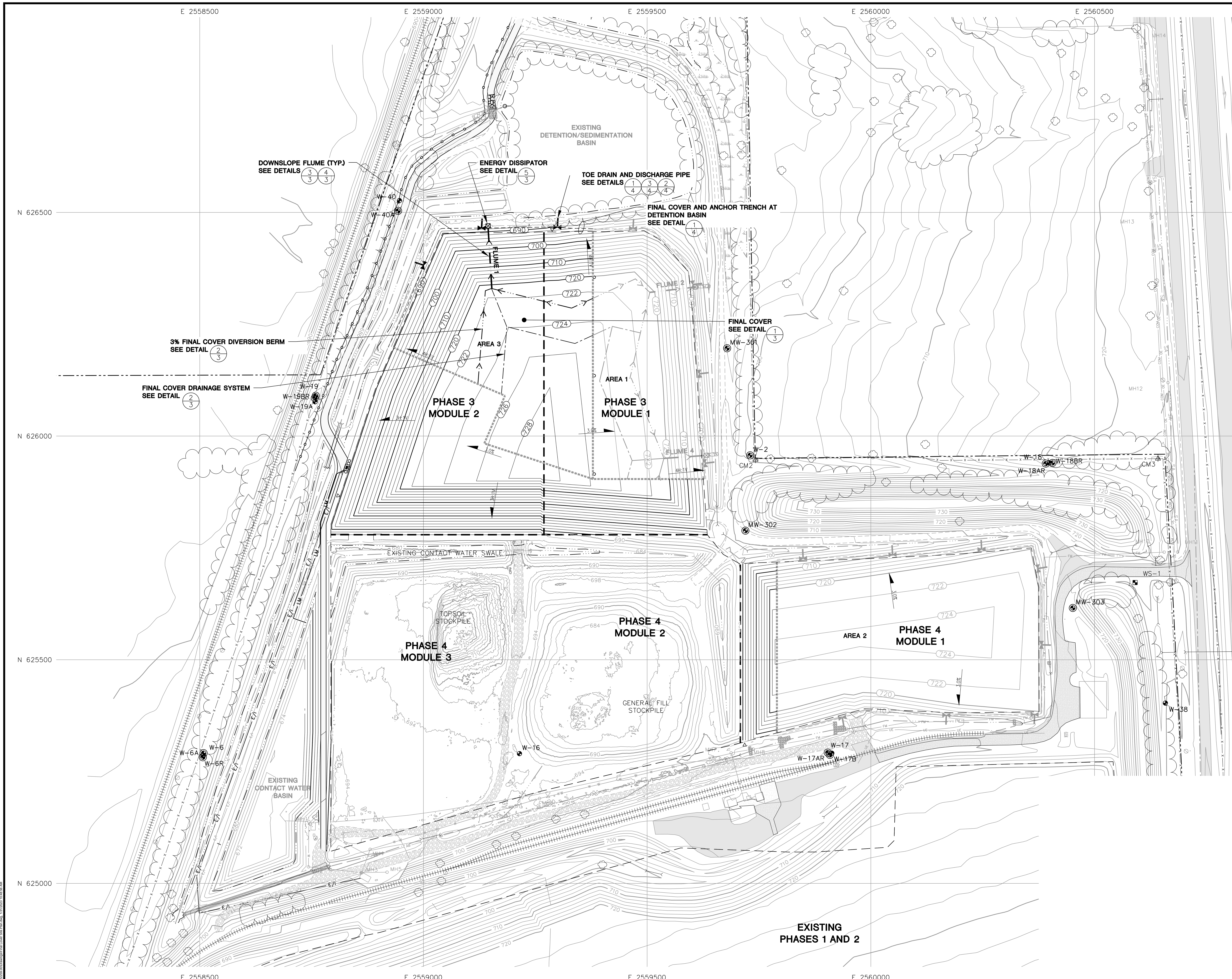
ENGINEER

PLAN MODIFICATION
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

SITE

DETAILS

FIGURE 4



LEGEND

	APPROXIMATE PROPERTY LINE
	PROPOSED LIMITS OF WASTE
	PROPOSED MODULE LIMITS
	EXISTING GRADE (2' CONTOUR)
690	EXISTING GRADE (10' CONTOUR)
	PROPOSED FINAL GRADE (10' CONTOUR)
720	PROPOSED FINAL GRADE (2' CONTOUR)
3.0%	SLOPE AND DIRECTION
	PROPOSED CULVERT
E/I	PROPOSED ELECTRIC AND INSTRUMENT CONDUITS
	PROPOSED ACCESS ROAD
	PROPOSED FINAL COVER DRAINAGE SYSTEM PIPE
	PROPOSED FINAL COVER DIVERSION BERM
	PROPOSED DOWNSLOPE FLUME
	PROPOSED ENERGY DISSIPATOR
	PROPOSED TOE DRAIN AND DISCHARGE PIPE
	CONCEPTUAL FINAL COVER SEQUENCE LIMITS
AREA 1	CONCEPTUAL FINAL COVER AREA

NOTES:

1. SEE SHEET 2 FOR ADDITIONAL BASE MAP LEGEND ITEMS AND NOTES.

FINAL COVER PLACEMENT – AREA 3

1. DOCUMENT FINAL ASH ELEVATIONS AND SURFACE IN PREPARATION OF COMPOSITE COVER PLACEMENT IN AREA 3.
2. INSTALL COMPACTED SELECT CLAY FILL IN AREA 3.
3. INSTALL GEOMEMBRANE, GEOCOMPOSITE, GEOCOMPOSITE DRAINS, AND GEOCOMPOSITE TOE DRAINS.
4. INSTALL ROOTING ZONE MATERIAL.
5. INSTALL FINAL GRADE SWALES, DOWNSLOPE FLUMES, AND ENERGY DISSIPATORS.
6. INSTALL TOPSOIL.
7. SEED, FERTILIZE, AND MULCH TOPSOIL AND DISTURBED AREAS.

PROJECT NO. 25222259.00	DRAWN BY: KP/MJT	DRAWN: 01/05/15	CHECKED BY: KG/LAB
REVISED: 07/26/23	APPROVED BY: PG 07/31/23		

WISCONSIN POWER AND LIGHT COMPANY
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081

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ENGINEER

PLAN MODIFICATION
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

SITE

FINAL GRADES

FIGURE
5

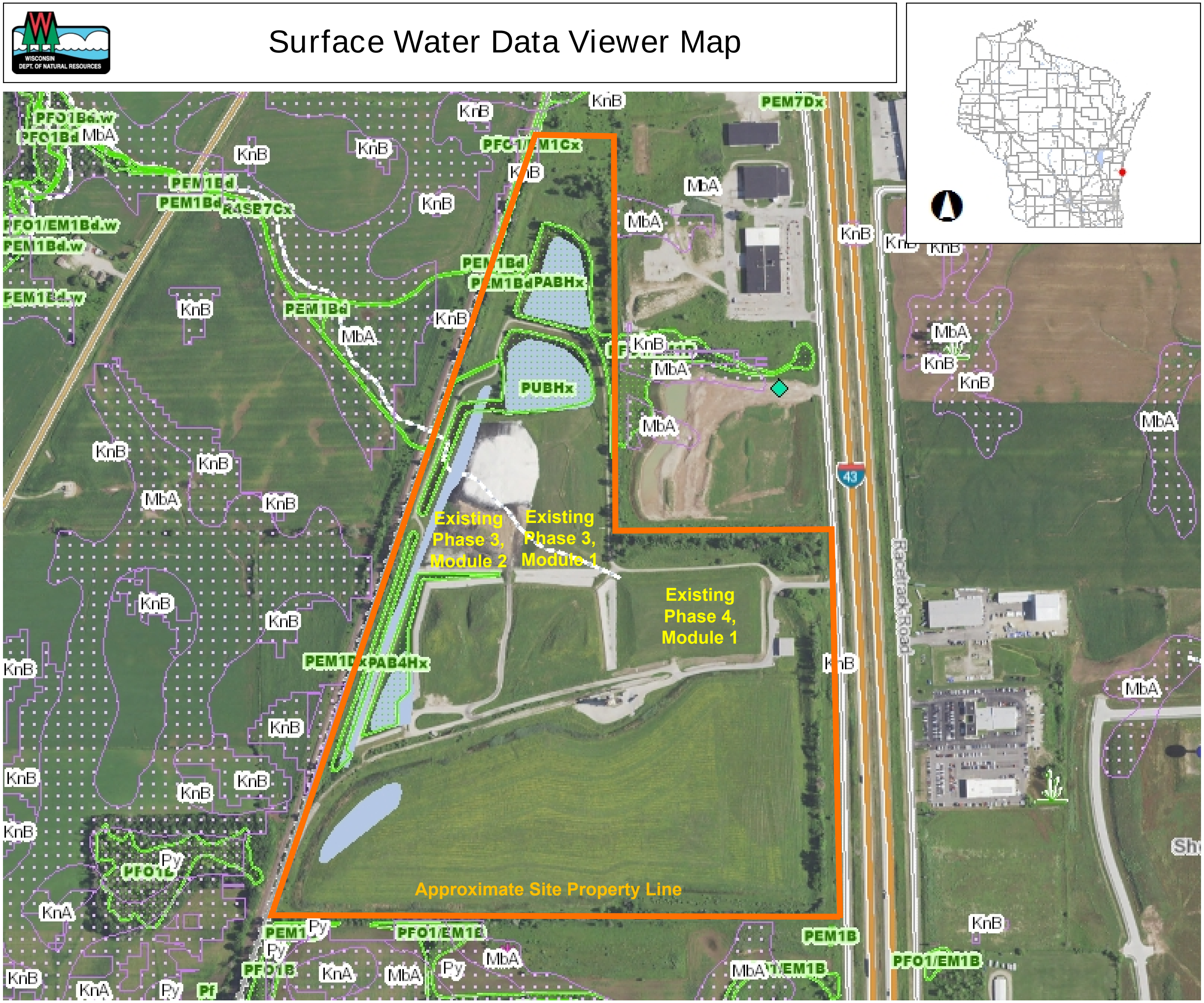
Appendix A

Performance and Location Criteria

Appendix A1

Wetland Delineation Maps

Surface Water Data Viewer Map



Legend

- Wetland Indicators
- Wetland Class Areas
- Wetland Class Points
  - Dammed pond
  - Excavated pond
  - Filled/drained wetland
  - Wetland too small to delineate
  - Filled excavated pond
- Filled Points
- Wetland Class Areas
- Filled Areas
- Wetland Class Areas
- Wetland Class Points
  - Dammed pond
  - Excavated pond
  - Filled/drained wetland
  - Wetland too small to delineate
  - Filled excavated pond
- Filled Points
- Wetland Class Areas
- Filled Areas
- Wetland Identifications and Confirmations
- NRCS Wetspots
- Municipality
- State Boundaries
- County Boundaries
- Major Roads
  - Interstate Highway
  - State Highway
  - US Highway
- County and Local Roads
  - County HWY
  - Local Road

Notes

0.3 0 0.13 0.3 Miles

NAD_1983_HARN_Wisconsin_TM

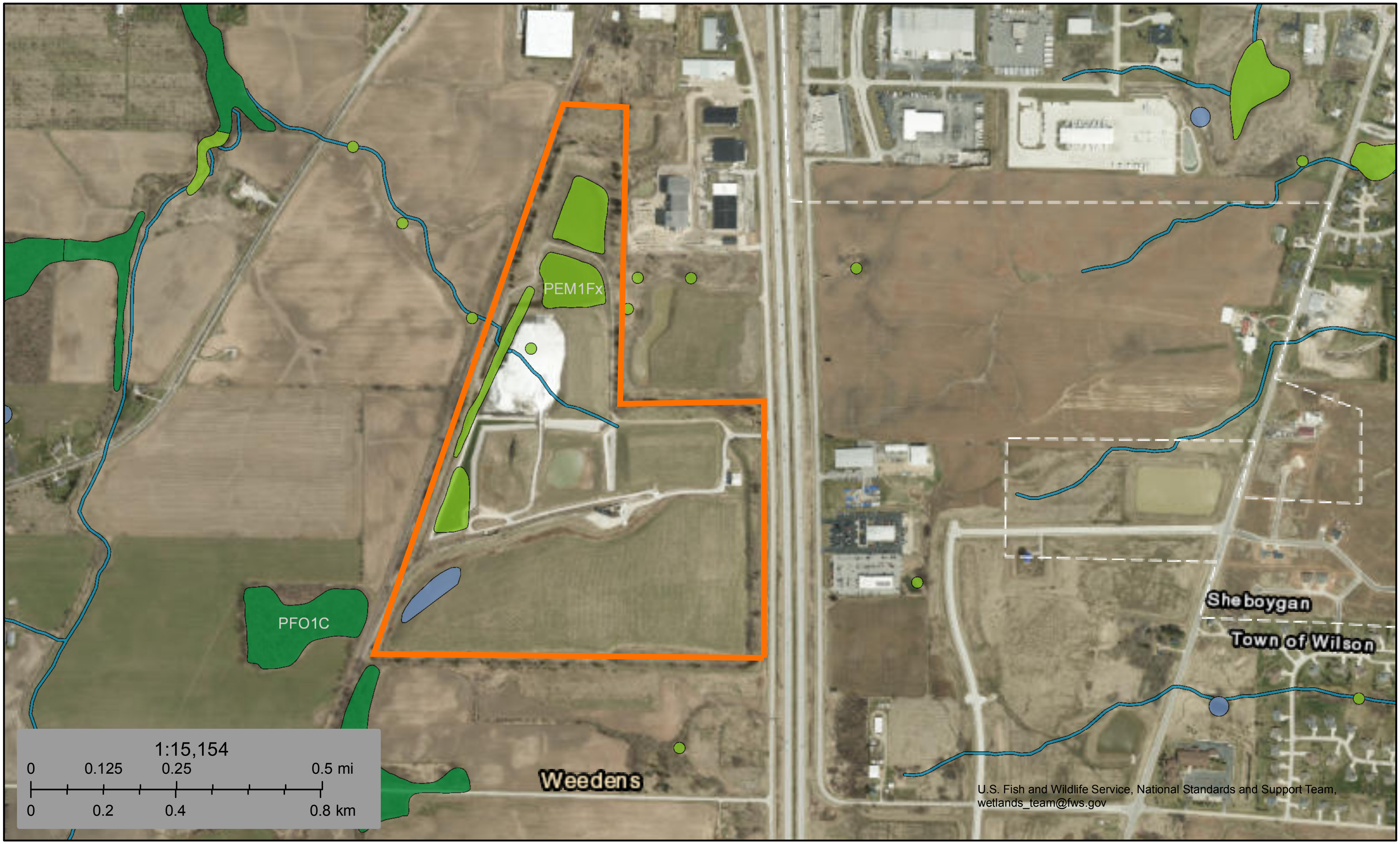
1: 7,920

DISCLAIMER: The information shown on these maps has been obtained from various sources, and are of varying age, reliability and resolution. These maps are not intended to be used for navigation, nor are these maps an authoritative source of information about legal land ownership or public access. No warranty, expressed or implied, is made regarding accuracy, applicability for a particular use, completeness, or legality of the information depicted on this map. For more information, see the DNR Legal Notices web page: http://dnr.wi.gov/legal/

U.S. Fish and Wildlife Service

National Wetlands Inventory

Wetlands



January 13, 2023

Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
101 S. Webster Street
P.O. Box 7921
Madison, WI 53707-7921

Scott Walker, Governor
Cathy Stepp, Secretary
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

May 20, 2014 IP-SE-2014-60-N00754

Ted Shonts
Wisconsin Power & Light Company
3739 Lakeshore Drive
Sheboygan, WI 53081

Dear Mr. Shonts:

The Department has completed review of your application to discharge fill material into wetlands for the Edgewater Landfill Expansion (Phases III & IV) Project. We have determined that your project meets state wetland standards.

Enclosed is your state wetland permit which authorizes the permanent and temporary wetland fill for your project, and lists the conditions which must be followed. Please read your permit carefully so that you are fully aware of what is expected of you. The attached permit is not an approval from the WDNR Solid Waste Program.

Please note you are required to submit photographs of the completed project within 7 days after you've finished construction. This helps both of us to document the completion of the project and compliance with the permit conditions.

If you have any questions, please feel free to call me at 608.266.3524, or you can email me at benjamin.callan@wisconsin.gov

Sincerely,

Benjamin Callan
Water Management Specialist

cc: Chuck Hermann, Stantec
Sheboygan County Zoning
Anthony Jernigan, US Army Corps of Engineers
Kathi Kramasz, WDNR (SER – Plymouth)
Bob Grefe, WDNR (WA/5)
Rob Grosch, WDNR (SER - Waukesha)

STATE OF WISCONSIN **Wetland Individual Permit**
DEPARTMENT OF NATURAL RESOURCES **IP-SE-2014-60-N00754**

Wisconsin Power and Light Company (WPL) is hereby granted under Section 281.36, Wisconsin Statutes, and 33 U.S.C.S §1341 (CWA §401) a permit to discharge fill material into wetlands in the Town of Wilson, Sheboygan County, also described as in the NE1/4 of Section 08, Township 14 North, Range 23 East, subject to the following conditions:

PERMIT

1. You must notify Ben Callan (phone 608.266.3524 or email Benjamin.Callan@wisconsin.gov) before starting the discharge and again not more than 5 days after the discharge is complete.

2. You must complete the discharge as described on or before 05/13/2019. If you will not complete the discharge by this date, you must submit a written request for an extension prior to the expiration date of the permit. Your request must identify the requested extension date and the reason for the extension. A permit extension may be granted, for good cause, by the Department. You may not begin or continue construction after the original permit expiration date unless the Department grants a new permit or permit extension in writing.

3. This permit does not authorize any work other than what you specifically describe in your application and plans dated 09/13/2011, and as modified by the conditions of this permit. If you wish to alter the project or permit conditions, you must first obtain written approval of the Department.

4. No wetlands may be disturbed other than where specifically authorized in the plans approved by the Department.

5. You are responsible for obtaining any permit or approval that may be required for your project by local zoning ordinances, the state of Wisconsin, and by the U.S. Army Corps of Engineers before starting your project.

6. Upon reasonable notice, you shall allow access to your project site during reasonable hours to any Department employee who is investigating the project's construction, operation, maintenance or permit compliance.

7. The Department may modify or revoke this permit if the project is not completed according to the terms of the permit, or if the Department determines the activity results in significant adverse impact to wetland functional values, in significant adverse impact to water quality, or in other significant adverse environmental consequences.

8. You must post a copy of this permit at the main construction entrance to the project site, for at least five days prior to construction, and remaining while active wetland filling is occurring. You must also have a copy of the permit and approved plan available at the project site at all times until the project is complete.

9. Your acceptance of this permit and efforts to begin work on this project signify that you have read, understood and agreed to follow all conditions of this permit.

10. You must submit a series of photographs to the Department documenting the before / during / after conditions where temporary wetland impacts occur. The photographs must be taken from different vantage points and depict all work authorized by this permit.

11. You, your agent, and any involved contractors or consultants may be considered a party to the violation pursuant to Section 281.36 (13), Wis. Stats., for any violations of Section 281.36, Wisconsin Statutes, or this permit.

12. This permit has been issued with the understanding that all construction vehicles and equipment used are appropriate for the job, and can be brought to and removed from the project site without causing harm to fish, wildlife, and their habitats.

13. You must restrict the removal of native vegetative cover in wetlands to the minimum amount necessary for construction.

14. Construction shall be accomplished in such a manner as to minimize erosion and siltation into surface waters. All erosion control measures must meet or exceed the technical standards of ch. NR 151, Wis. Adm. Code. The technical standards are found at: http://dnr.wi.gov/topic/stormwater/standards/const_standards.html .

15. Appropriate erosion control must be in place and effective during every phase of this project.

16. Erosion control measures must be in place at the end of each working day.

17. Erosion control measures must be inspected, and any necessary repairs or maintenance performed, after every rainfall exceeding ½ inch and at least once per week.

18. Dewatering of work areas shall be conducted in accordance with the standards of the applicable permit under Wisconsin's Pollutant Discharge Elimination System and approved technical standards.

19. At no time shall dewatering activities directly discharge to wetlands or waterways without prior effective water quality treatment.

20. All vehicles and equipment used in wetlands must be checked at least once per work day for fluid (e.g. fuel, oil, hydraulic, coolant, etc.) leaks. All leaks must be immediately corrected before the equipment is allowed back into operation.

21. All equipment used for the project, including but not limited to, vehicles, mats, hoses and pumps, shall be free of invasive and exotic species and viruses prior to use and after use in any waterway and wetland. Decontamination protocols can be found at: http://dnr.wi.gov/invasives/action.htm.

22. Work for this project must comply with all conditions that are part of any required Incidental Take Authorization / Permit, or avoidance measures provided by BER.

23. Except where permanent fill is authorized, this project shall not result in adverse hydrologic impacts to wetlands.

24. Construction and operation of the landfill expansion shall be in conformance with the plans submitted to the Department and comply with the conditions specified in the Feasibility Determination and any other subsequent approvals by the Waste and Materials Management Program.

25. Final site stabilization requires the re-establishment of vegetation and should not contain any plant species listed as invasive by the Department. A listing of what the Department considers invasive species can be found on the Department's website http://dnr.wi.gov/org/caer/ce/invasives/.

26. Authorization hereby granted by the Department is transferable upon prior written approval of the transfer by the Department.

FINDINGS OF FACT

1. Wisconsin Power and Light (WPL) has filed an application for a permit to discharge fill material into wetlands west of I-43 and north of Stahl Road, in the Town of Wilson, Sheboygan County, also described as NE1/4 S08, T14N, R23E.

2. The Edgewater Landfill Expansion (Phases III & IV) Project includes permanent fill of 0.81 acres of wetland, and temporary fill of 0.08 acres of wetland.

3. The existing landfill site is approximately 125 acres in size, and is comprised of active landfill cells, covered landfill cells maintained in rough grass, stabilized soil stockpile areas, accessory buildings, stormwater management systems, fallow areas, and wetlands.

4. The landfill site began operation in 1985, and is used to dispose of ash from the Edgewater Electric Generating Station.

5. The WPL application for the project was originally submitted on 9-13-2011, and wetland compensatory mitigation is not required.

6. No practicable alternative exists which would avoid impacts to wetlands, and the project will result in the least environmentally damaging practicable alternative taking into consideration practicable alternatives that avoid wetland impacts. Expansion of the existing landfill facility will utilize the site's capacity, minimize the need for additional waste ash handling, and take advantage of existing infrastructure for waste handling and stormwater management.

7. All practicable measures to minimize adverse impacts to the functional values of the wetland have been taken. Alternative considerations varied in their ability to address design requirements necessary to satisfy the Feasibility Determination by the Waste Program. Alternatives (including no-build and off-site locations) have been examined, but were demonstrated to not be practicable due to the constraints associated with the Feasibility Determination from the Waste Program.

8. The proposed project will not result in significant adverse impacts to wetland functional values, significant impacts to water quality, or other significant adverse environmental consequences.

9. The Department has completed an investigation of the project site and has evaluated the project as described in the application and plans.

10. The Department of Natural Resources has completed all procedural requirements and the project as permitted will comply with all applicable requirements of 33 U.S.C.S. §1341 (CWA §401); Sections 1.11, 281.36, Wisconsin Statutes and Chapters NR 102, 103, 150, and 299 of the Wisconsin Administrative Code.

11. The applicant was responsible for fulfilling the procedural requirements for publication of notices under s. 281.36(3p)(d)1m., Stats., and was responsible for publication of the notice of pending application under s. 281.36(3m)(g), Stats. or the notice of public informational hearing under s. 281.36(3m)(h), Stats., or both. S. 281.36(3m)(i), Stats., provides that if no public hearing is held, the Department must issue its decision within 30 days of the 30-day public comment period, and if a public hearing is held, the Department must issue its decision within 20 days after the 10-day period for public comment after the public hearing. S. 281.36(3p)(c), Stats., requires the Department to consider the date on which the department publishes a notice on its web site as the date of notice.

CONCLUSIONS OF LAW

1. The Department has authority under the above indicated Statutes and Administrative Codes, to issue a permit for the construction and maintenance of this project.

NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision, you should know that the Wisconsin statutes and administrative rules establish time periods within which requests to review Department decisions shall be filed. For judicial review of a decision pursuant to sections 227.52 and 227.53, Wis. Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review shall name the Department of Natural Resources as the respondent.

To request a contested case hearing of any individual permit decision pursuant to section 281.36.(3q), Wis. Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to serve a petition for hearing on the Secretary of the Department of Natural Resources, P.O. Box 7921, Madison, WI, 53707-7921. The petition shall be in writing, shall be dated and signed by the petitioner, and shall include as an attachment a copy of the decision for which administrative review is sought. If you are not the applicant, you must simultaneously provide a copy of the petition to the applicant. If you wish to request a stay of the project, you must provide information, as outlined below, to show that a stay is necessary to prevent significant adverse impacts or irreversible harm to the environment. If you are not the permit applicant, you must provide a copy of the petition to the permit applicant at the same time that you serve the petition on the Department.

The filing of a request for a contested case hearing is not a prerequisite for judicial review and does <u>not</u> extend the 30 day period for filing a petition for judicial review.

A request for contested case hearing must meet the requirements of section 281.36 (3q), Wis. Stats., and section NR 2.03, Wis. Adm. Code, and if the petitioner is not the applicant the petition must include the following information:

1. A description of the objection that is sufficiently specific to allow the department to determine which provisions of this section may be violated if the proposed discharge under the wetland individual permit is allowed to proceed.

2. A description of the facts supporting the petition that is sufficiently specific to determine how the petitioner believes the discharge, as proposed, may result in a violation of the provisions of this section.

3. A commitment by the petitioner to appear at the administrative hearing and present information supporting the petitioner's objection.

4. If the petition contains a request for a stay of the project, the petition must also include information showing that a stay is necessary to prevent significant adverse impacts or irreversible harm to the environment.

Dated at Department Headquarters in Madison, Wisconsin on 05/20/2014.

STATE OF WISCONSIN DEPARTMENT OF NATURAL RESOURCES
For the Secretary

By ___________________________________
Benjamin Callan
Water Management Specialist

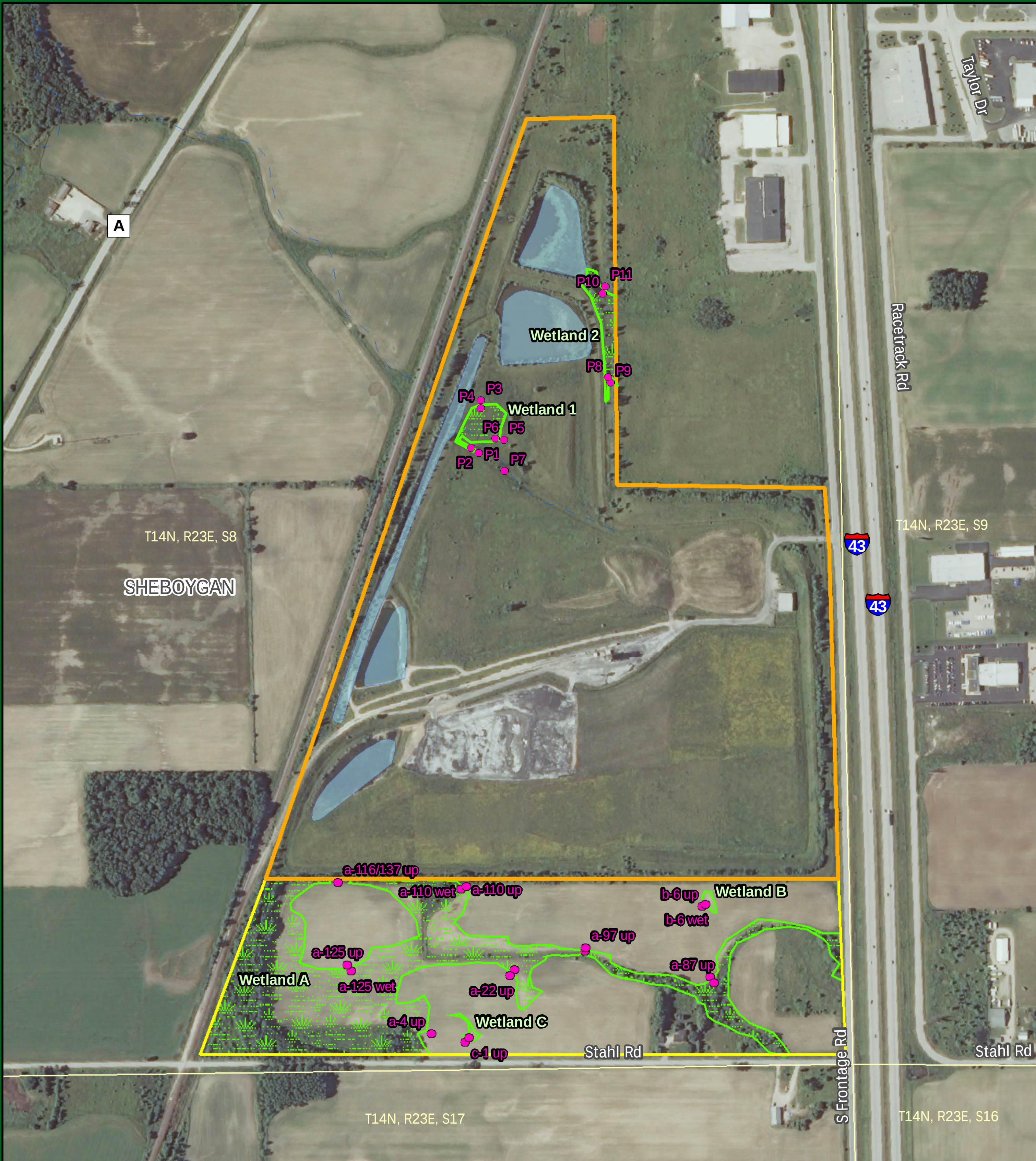


Figure 4. Field Delineated Wetlands
WPL Edgewater Facility

Sheboygan
Washington
Map Area Shown in Red

Location
S8, T14N, R23E;
Town of Wilson, Sheboygan Co., WI
0 300 600 Feet
N

Project Information
Project Number : 009-0074-01
Modified March 11, 2010

Legend
- Existing Facility
- Spoils Storage Site
- Field Delineated Wetlands
- Sample Points
- Section Line

DNR 24k Hydrography
- Perennial Stream
- Intermittent Stream
- Waterbody

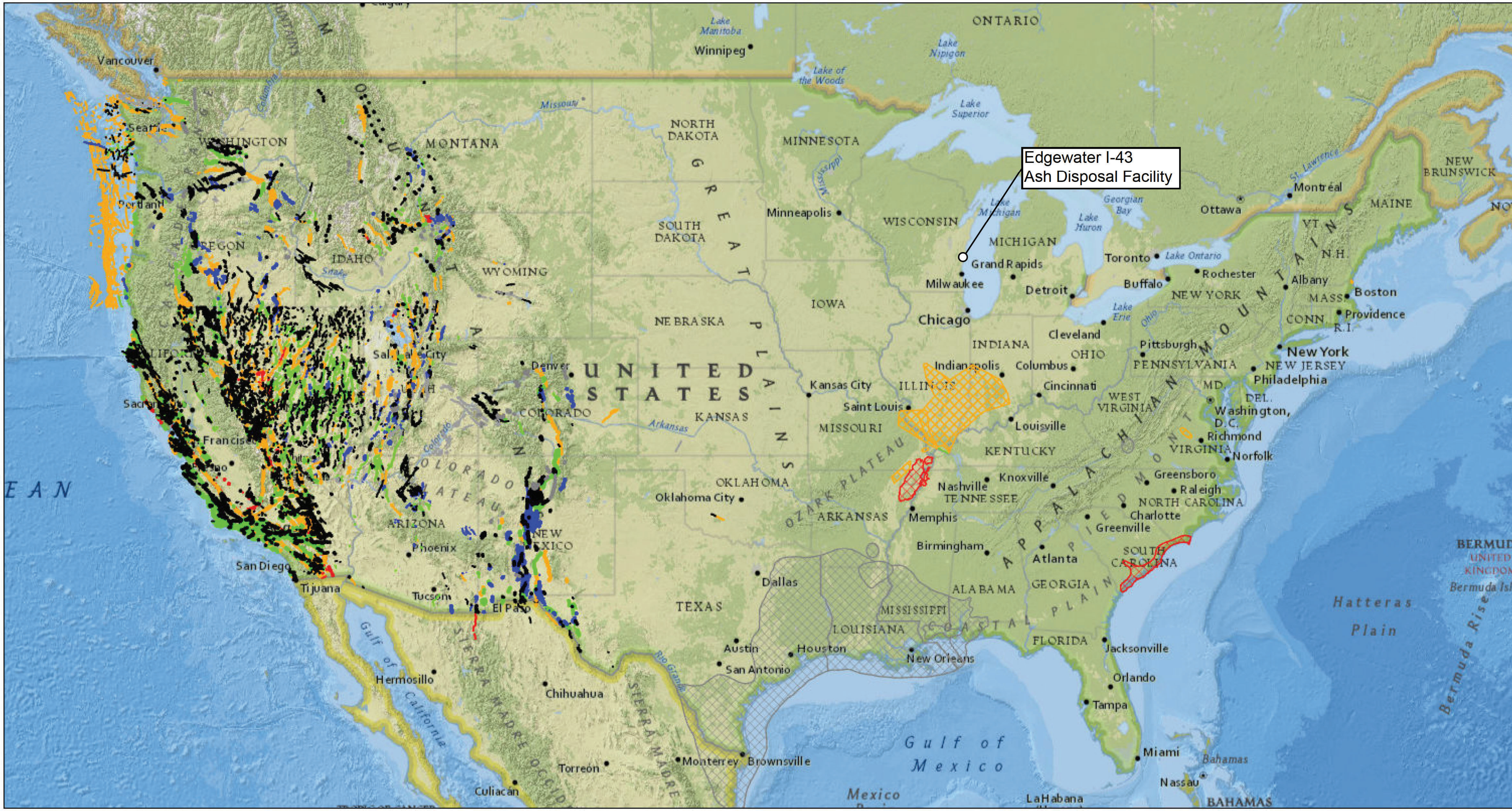
NRC
Natural Resources Consulting, Inc.
209 Commerce Parkway
P.O. Box 128
Cottage Grove, WI 53527-0128
phone: 608-839-1998
fax: 608-839-1995
www.nrcdifference.com

Data Sources include WDNR, WDOT, USDA 2008 NAIP Orthophotography.

Appendix A2

Fault Location Map

U.S. Geological Survey Quaternary Faults



12/7/2022, 11:13:48 AM

Fault Areas
- Class B
- historic
- late Quaternary
- latest Quaternary
- middle and late Quaternary

National Database
- Historic (< 150 years), well constrained location
- Historic (< 150 years), moderately constrained location
- Historic (< 150 years), inferred location
- Latest Quaternary (<15,000 years), well constrained location
- Latest Quaternary (<15,000 years), moderately constrained location
- Latest Quaternary (<15,000 years), inferred location
- Late Quaternary (< 130,000 years), well constrained location
- Late Quaternary (< 130,000 years), moderately contrained location
- Late Quaternary (< 130,000 years), inferred location
- Middle and late Quaternary (< 750,000 years), well constrained location
- Middle and late Quaternary (< 750,000 years), moderately constrained location
- Middle and late Quaternary (< 750,000 years), inferred location
- Undifferentiated Quaternary (< 1.6 million years), well constrained location
- Undifferentiated Quaternary (< 1.6 million years), moderately constrained location
- Undifferentiated Quaternary (< 1.6 million years), inferred location

1:18,489,298

0 180 360 720 mi

0 285 570 1,140 km

National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

Source - https://www.usgs.gov/natural-hazards/earthquake-hazards/faults?qt-science_support_page_related_con=4#qt-science_support_page_related_con

USGS

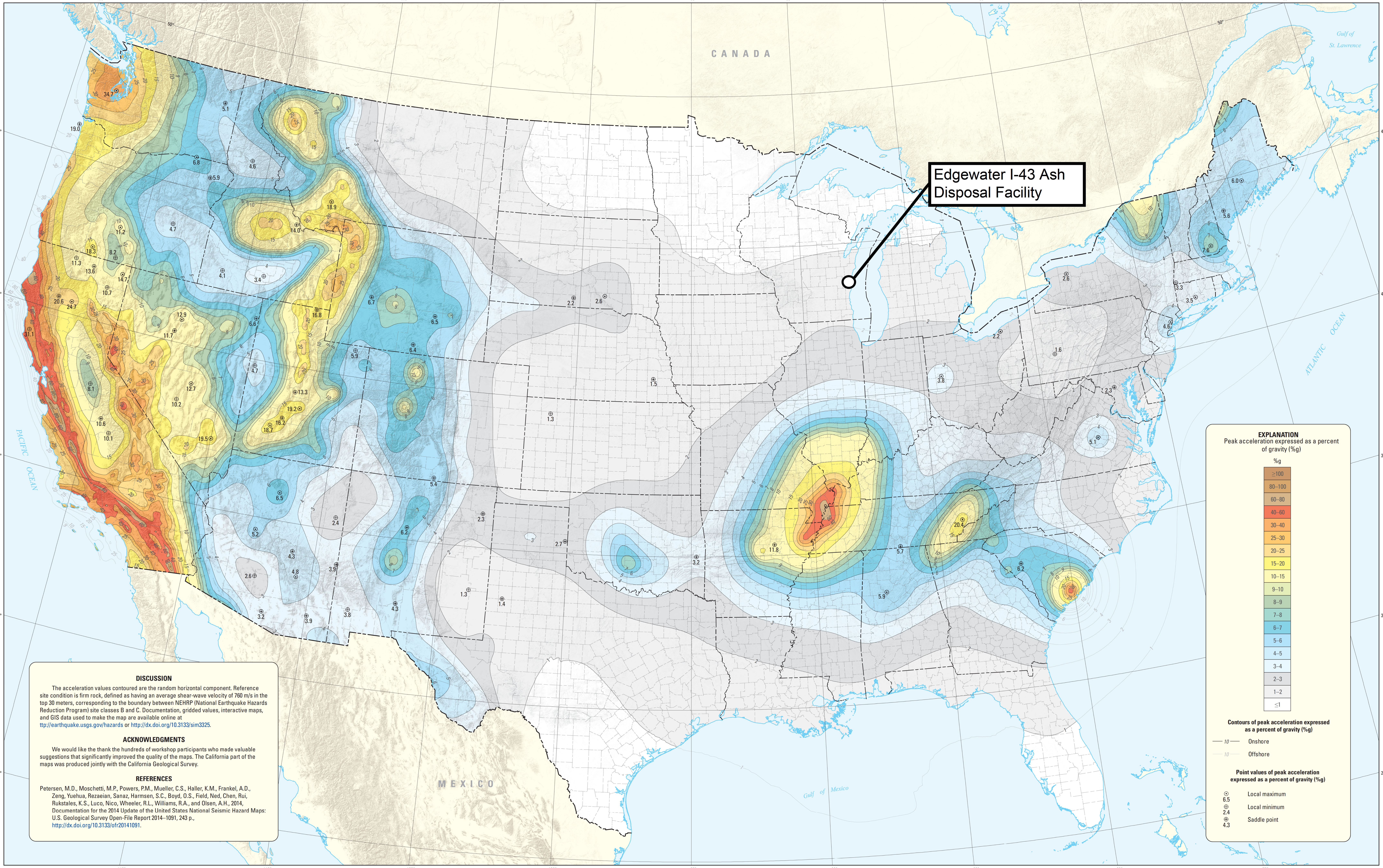
National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp. | USGS |

Appendix A3

Seismic Hazard Map

U.S. Department of the Interior
U.S. Geological Survey

Scientific Investigations Map 3325
Sheet 1 of 6



Shaded relief base from Esri Inc., 2008, Data and Maps
All other base map data from Esri Inc., 1993, Digital Chart of the World
United States County base map from the U.S. Geological Survey National Atlas, available at http://nationalatlas.gov/

Projection: Albers equal-area conic
Standard parallels 29.5°N. and 45.5°N., central meridian 95°W

SCALE 1:7 000 000

Digital data prepared with ArcGIS 10.1 running under Windows 7

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For more information concerning this publication, contact:
Center Director, USGS Geologic Hazards Science Center
Box 25046, Mail Stop 966
Denver, CO 80225
(303) 273-8579
Or visit the Geologic Hazards Science Center Web site at:
http://geohazards.cr.usgs.gov/.

Seismic-Hazard Maps for the Conterminous United States, 2014

Peak Horizontal Acceleration with 10 Percent Probability of Exceedance in 50 Years

By

Mark D. Petersen,[1] Morgan P. Moschetti,[1] Peter M. Powers,[1] Charles S. Mueller,[1] Kathleen M. Haller,[1] Arthur D. Frankel,[1] Yuehua Zeng,[1] Sanaz Rezaeian,[1]
Stephen C. Harmsen,[1] Oliver S. Boyd,[1] Edward H. Field,[1] Rui Chen,[2] Nicolas Luco,[1] Russell L. Wheeler,[1] Robert A. Williams,[1] Anna H. Olsen,[1] and Kenneth S. Rukstales[1]

2015

[1]U.S. Geological Survey
[2]California Geological Survey, Sacramento, Calif.

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http://dx.doi.org/10.3133/sim3325

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Denver, CO 80225

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This report is available at:
http://pubs.usgs.gov/sim/3325/

Suggested citation: Petersen, M.D., Moschetti, M.P., Powers, P.M., Mueller, C.S., Haller, K.M., Frankel, A.D., Zeng, Yuehua, Rezaeian, Sanaz, Harmsen, S.C., Boyd, O.S., Field, E.H., Chen, Rui, Luco, Nicolas, Wheeler, R.L., Williams, R.A., Olsen, A.H., and Rukstales, K.S., 2015, Seismic-hazard maps for the conterminous United States, 2014: U.S. Geological Survey Scientific Investigations Map 3325, 6 sheets, scale 1: 7,000,000, http://dx.doi.org/10.3133/sim3325.

Appendix A4

Site Description and Geologic Summary

Site Description and Geologic Summary

Site Information

The I-43 ash disposal facility encompasses approximately 75 acres, and is located in an agricultural area. The site location is the East ½ of Section 8, T14N, R23E, in the Town of Wilson, located in Sheboygan County, Wisconsin. The facility is bounded by a frontage road to Interstate Highway I-43 to the east and by a rail line to the west.

Regional Geology

The I-43 disposal facility is located in an area of thick glacial sediment overlying Silurian carbonate bedrock. The uppermost bedrock in the area is Silurian dolostone, a unit in which karst features such as closed depression, sinkholes and caves may develop by solution along fractures, joints, and bedding planes. However, in areas covered by Pleistocene ice sheets such as northeastern Wisconsin, glacial processes have eroded away or filled in most karst features.

A regional report for northeastern Wisconsin notes that the Silurian dolostone is characterized by complex fracturing and anisotropic flow, but that extensive weathering is generally absent, and caves are rare (Erb and Stiglitz, eds., 2007). In addition, most karst features in northeastern Wisconsin appear to have formed prior to Pleistocene glaciation of the area (more than about 2.4 million years ago) and sinkholes, caves, and solution-enlarged joints are filled in with a wide variety of sediments, some of which was emplaced by subglacial water under high pressure in an interconnected karst/subglacial drainage system (Luczaj and Stieglitz, 2008). If these sediment-filled features are located below the water table, they are supported by the hydrostatic pressure of groundwater, and are not expected to be zones of instability.

The I-43 area has been covered by Pleistocene ice sheets several times (Carlson and others, 2011), and borings drilled on the I-43 disposal facility penetrate up to 90 feet of predominantly clay till with some sand and sorted sediment layers. The total sequence of sediment is about 150 feet thick, as indicated by water supply records in the area of the facility. Because of the multiple glacial advances and associated erosional and depositional processes resulting in a thick sediment layer overlying the bedrock, the area is not likely to be unstable due to karstic processes.

Previous Geologic Investigations

The disposal facility area was investigated by Mead & Hunt prior to construction by performing 9 borings within and adjacent to the facility footprint. Four of the borings were instrumented with groundwater monitoring wells. The borings extended to depths of up to 90 feet. Soil samples were collected for laboratory testing that includes Atterberg limits and permeability. The boring locations and geologic cross sections are shown in **Appendix A6**. The boring locations and geologic cross sections are also shown on drawings in **Appendix A6** from the 2008 Plan of Operation prepared by BT2, Inc.

Based on the results of the subsurface investigation performed prior to disposal facility construction, the soils below the liner system within the facility footprint consist primarily of stiff to very stiff lean clays with scattered sand seams to the maximum drilling depth of 90 feet.

References

BT2, Inc., 2008, Plan of Operation, Edgewater I-43 Ash Disposal Facility, Phases 3 and 4.

Carlson, A.E., Principato, S.M., Chapel, D.M., and Mickelson, D.M., 2011, Quaternary Geology of Sheboygan County, Wisconsin: Wisconsin Geological and Natural History Survey Bulletin 106, 32 p., 2 pls.

Erb, K., and Stieglitz, R., eds., 2007, Final Report of the Northeast Karst Task Force (G3836), University of Wisconsin Extension, Green Bay, Wisconsin.

Luczaj, J.A., and Stieglitz, R.D., 2008, Geologic History of New Hope Cave, Manitowoc County, Wisconsin. https://www.uwgb.edu/luczajj/reprints/New_Hope_Cave_4-08.pdf

Mead & Hunt, Inc., 1977, Preliminary Site Feasibility Report, Ash Disposal Site, Beeck-Goebel Properties, Wilson Township, Sheboygan County, Wisconsin.

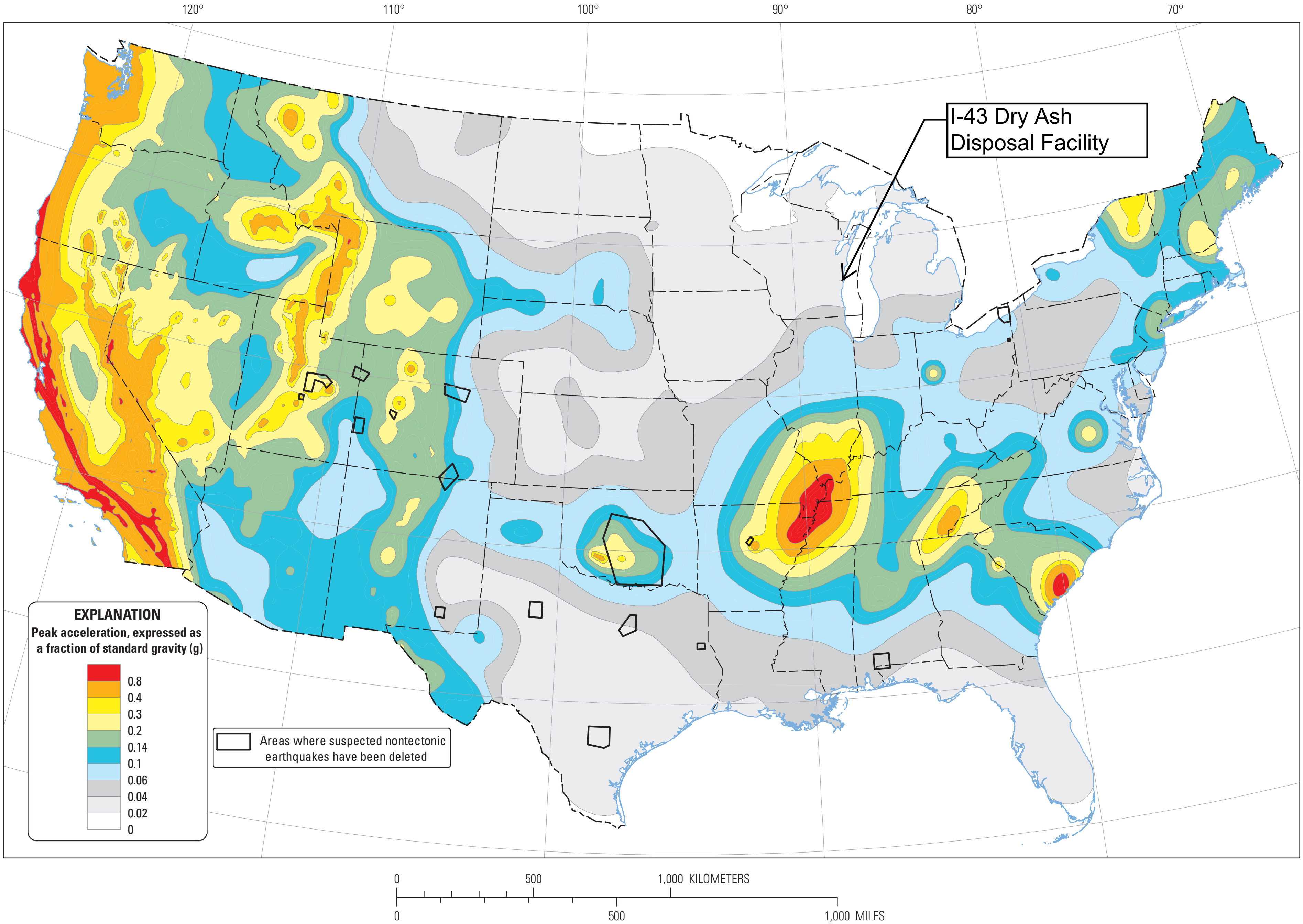
BJS/DLN/AJR/EJN

MJT, 12/7/2022

I:\25222259.00\Deliverables\Plan Modification\Appendix\A4_Site and Geologic Summary.docx

Appendix A5

Liquefaction and Settlement Potential Evaluation



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

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

Liquefaction and Settlement Potential Evaluation

Based on the results of the site investigation borings and laboratory soil test results performed by Mead & Hunt (**Appendix A6**), the disposal facility soils are not subject to liquefaction or settlement concerns for the performance of the disposal facility.

Liquefaction is the process by which a saturated, loose, cohesionless soil influenced by external forces can suddenly loses its shear strength and behave as a fluid. The external forces result from ground motion from an earthquake. The disposal facility site soils in borings consist primarily of stiff to very stiff clay that is not subject to liquefaction. In addition, liquefaction is not a concern given the low magnitude (less than 0.04 g, 2 percent in 50 years) of maximum ground accelerations expected in the area; see **Attachment A5.1**.

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

References

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

DLN/AJR/EJN
MJT, 12/7/2022

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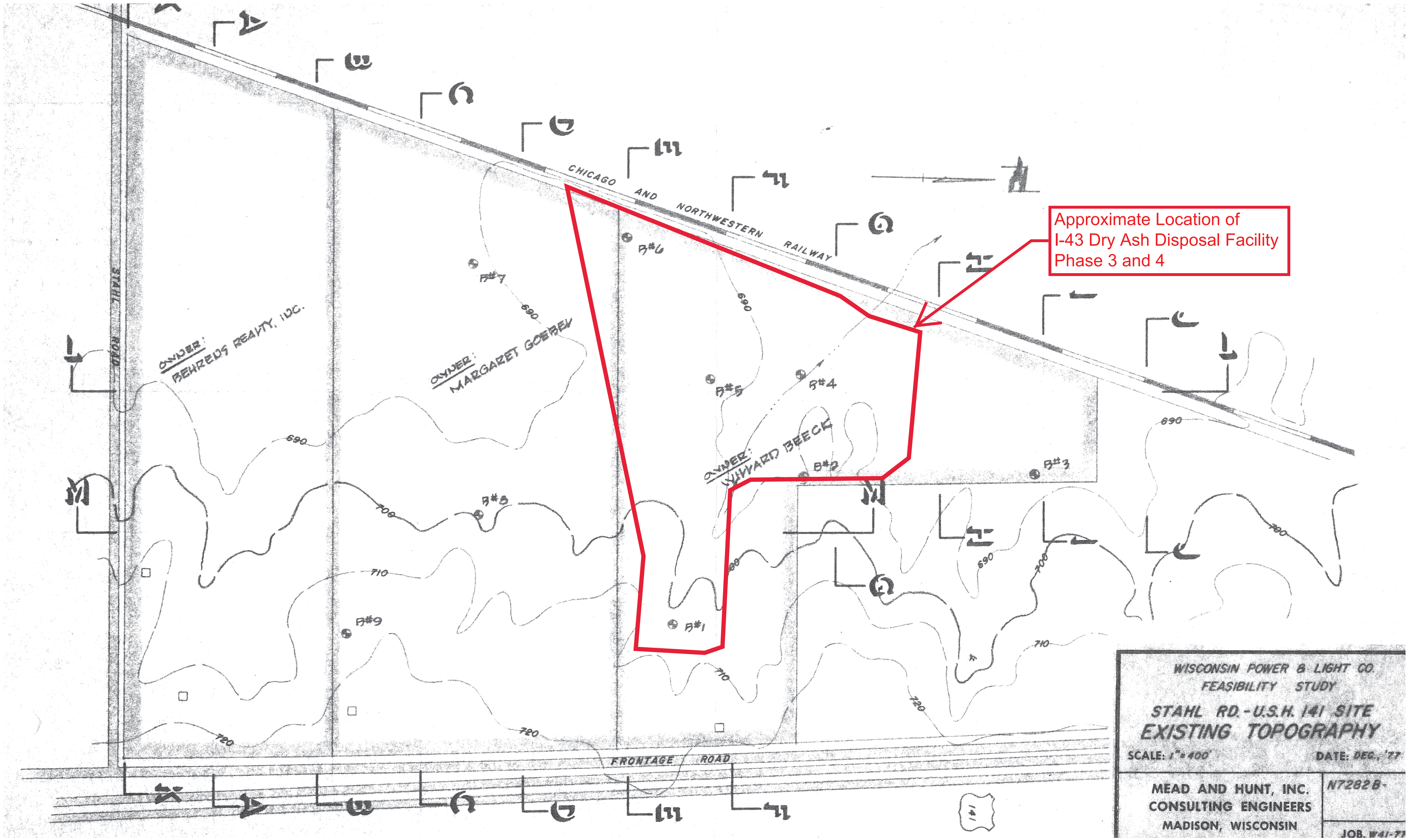
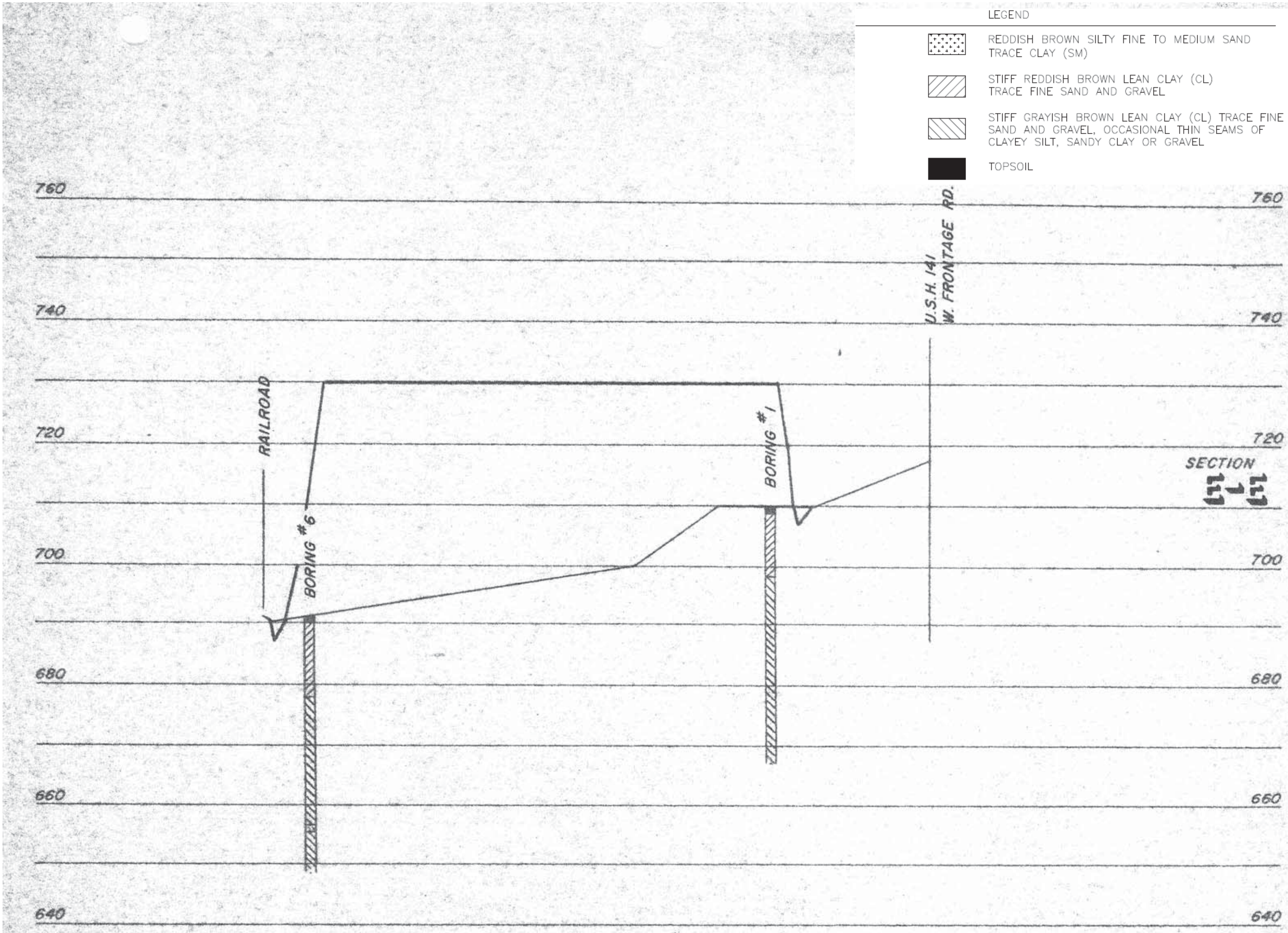
Appendix A6

Geologic Cross Sections



Approximate Location of
I-43 Dry Ash Disposal Facility
Phase 3 and 4
CHICAGO AND NORTHWESTERN RAILWAY
STAHL ROAD
FRONTAGE ROAD
OWNER: BEHRENS REALTY, INC.
OWNER: MARGARET GOEBEL
OWNER: WILLARD BEECK
B#1
B#2
B#3
B#4
B#5
B#6
B#7
B#8
B#9
690
700
710
720
WISCONSIN POWER & LIGHT CO.
FEASIBILITY STUDY
STAHL RD. - U.S.H. 141 SITE
EXISTING TOPOGRAPHY
SCALE: 1"= 400'
DATE: DEC., '77
MEAD AND HUNT, INC.
CONSULTING ENGINEERS
MADISON, WISCONSIN
N7282B
JOB. W41-77

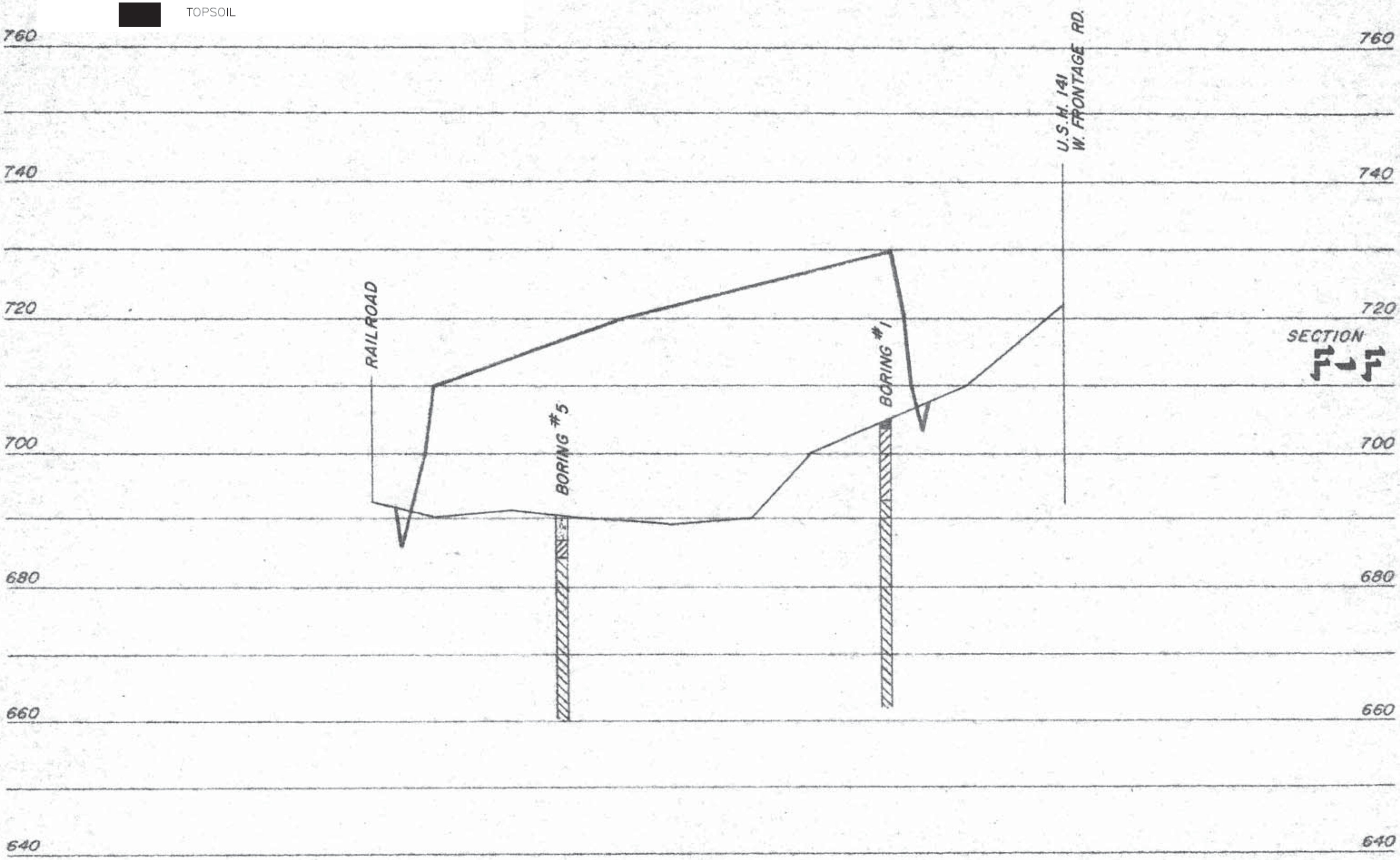


SCALE: HOR. 1" = 400'

MEAD AND HUNT, INC.
CONSULTING ENGINEERS

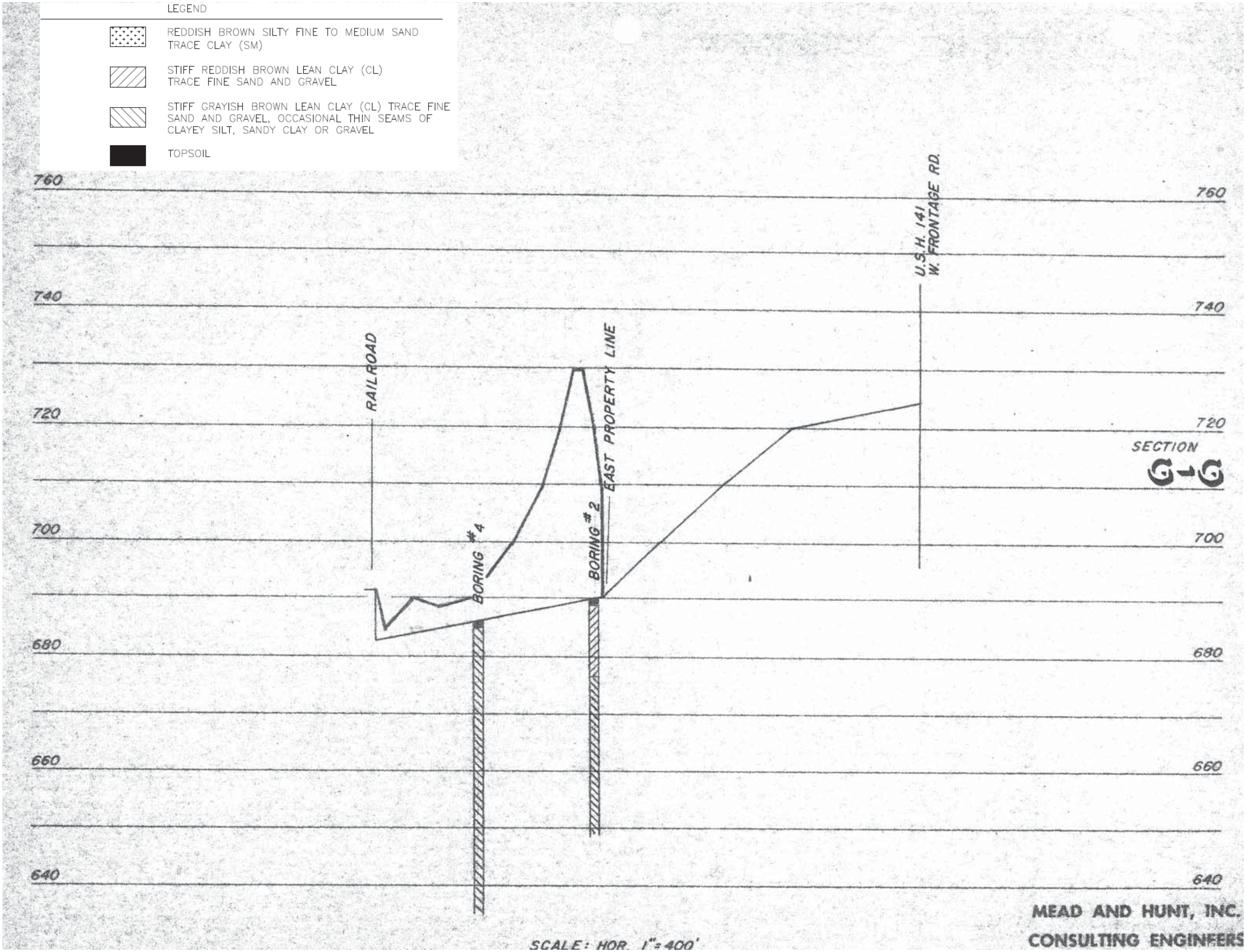
LEGEND

- REDDISH BROWN SILTY FINE TO MEDIUM SAND TRACE CLAY (SM)
- STIFF REDDISH BROWN LEAN CLAY (CL) TRACE FINE SAND AND GRAVEL
- STIFF GRAYISH BROWN LEAN CLAY (CL) TRACE FINE SAND AND GRAVEL, OCCASIONAL THIN SEAMS OF CLAYEY SILT, SANDY CLAY OR GRAVEL
- TOPSOIL



MEAD AND HUNT, INC.
CONSULTING ENGINEERS

SCALE: HOR. 1"=400'



LEGEND
REDDISH BROWN SILTY FINE TO MEDIUM SAND TRACE CLAY (SM)
STIFF REDDISH BROWN LEAN CLAY (CL) TRACE FINE SAND AND GRAVEL
STIFF GRAYISH BROWN LEAN CLAY (CL) TRACE FINE SAND AND GRAVEL, OCCASIONAL THIN SEAMS OF CLAYEY SILT, SANDY CLAY OR GRAVEL
TOPSOIL
760
740
720
700
680
660
640
RAILROAD
BORING #4
BORING #2
EAST PROPERTY LINE
U.S.H. 141
W. FRONTAGE RD.
SECTION
G-G
MEAD AND HUNT, INC.
CONSULTING ENGINEERS
SCALE: HOR. 1"=400'

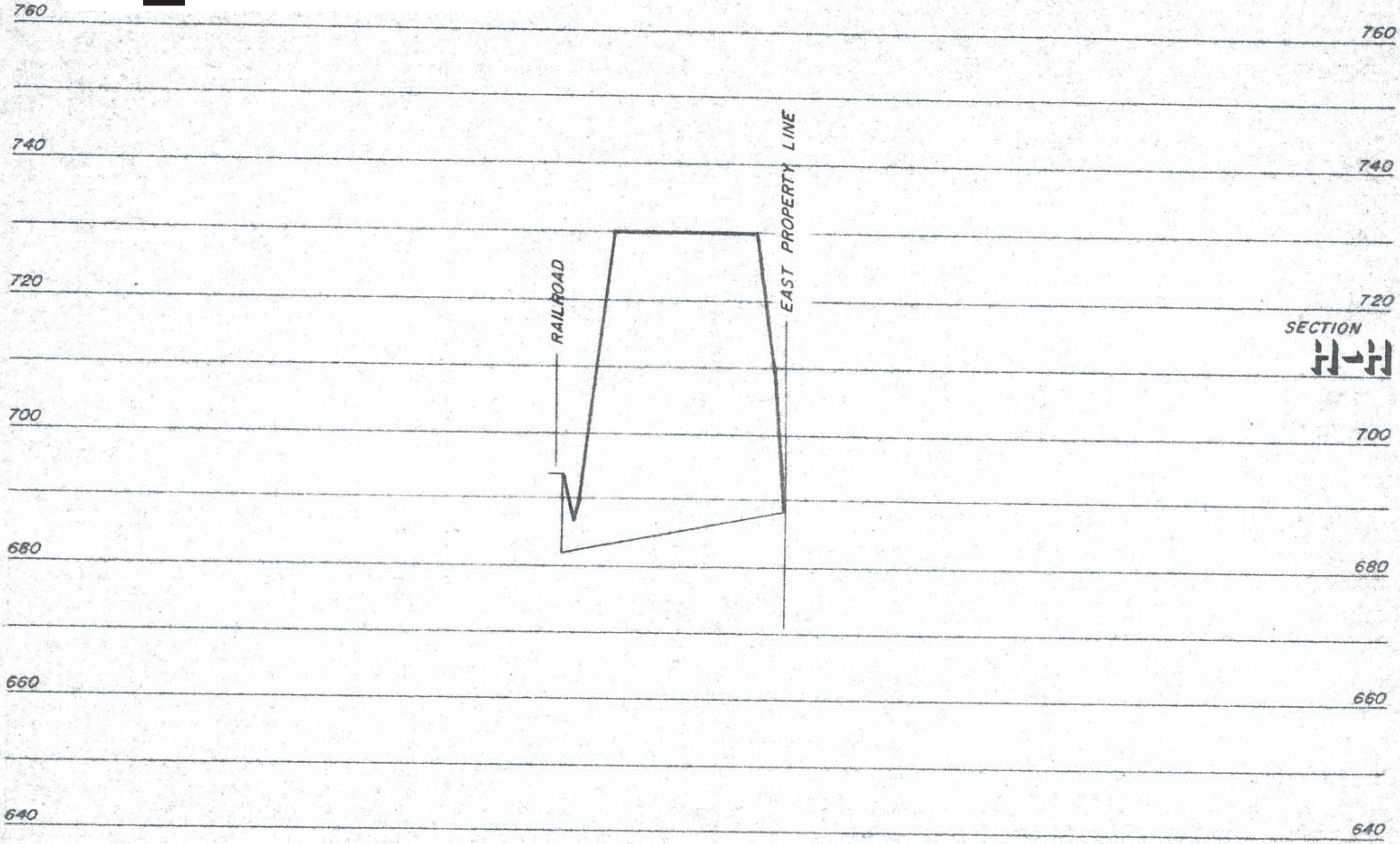
LEGEND

REDDISH BROWN SILTY FINE TO MEDIUM SAND TRACE CLAY (SM)

STIFF REDDISH BROWN LEAN CLAY (CL) TRACE FINE SAND AND GRAVEL

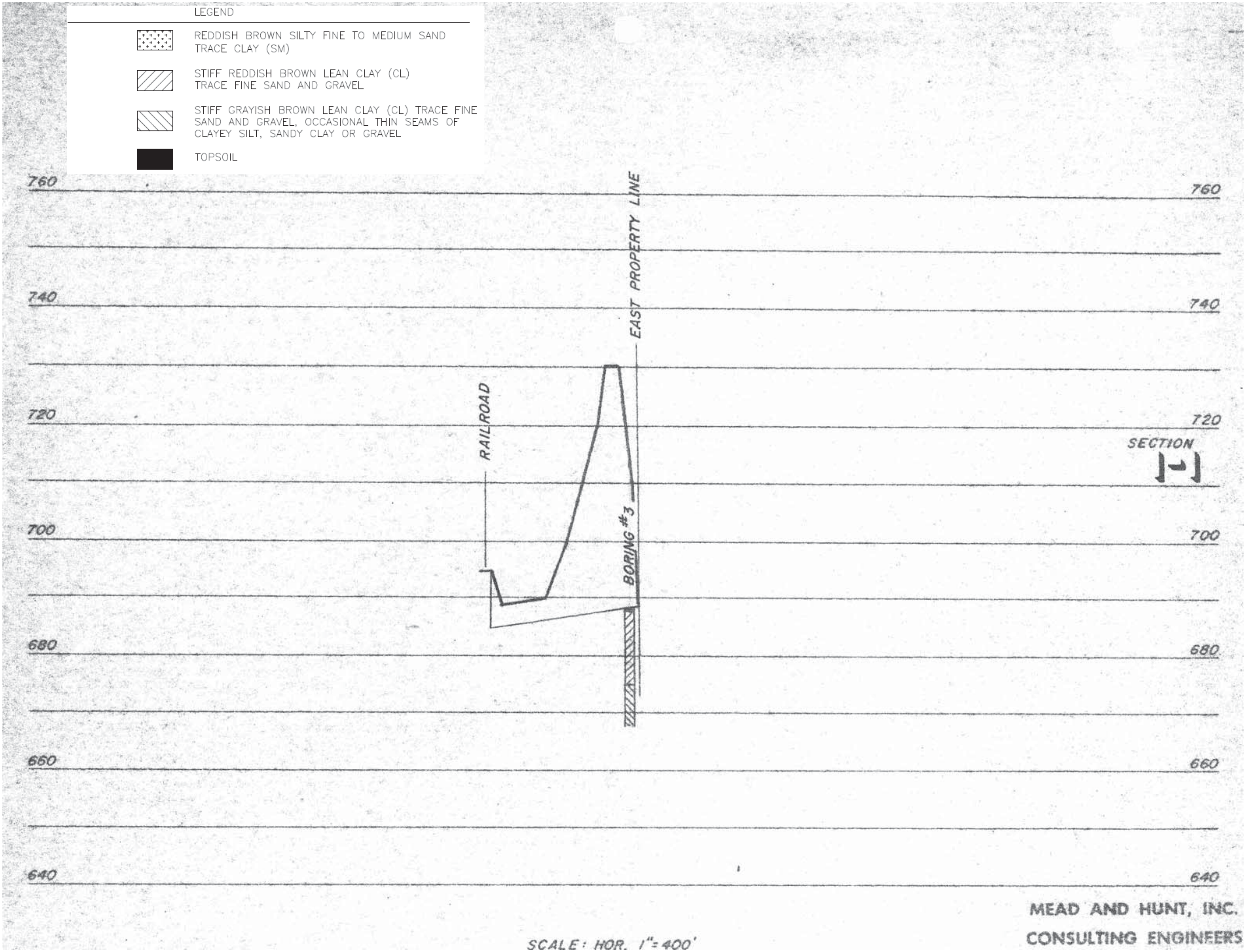
STIFF GRAYISH BROWN LEAN CLAY (CL) TRACE FINE SAND AND GRAVEL, OCCASIONAL THIN SEAMS OF CLAYEY SILT, SANDY CLAY OR GRAVEL

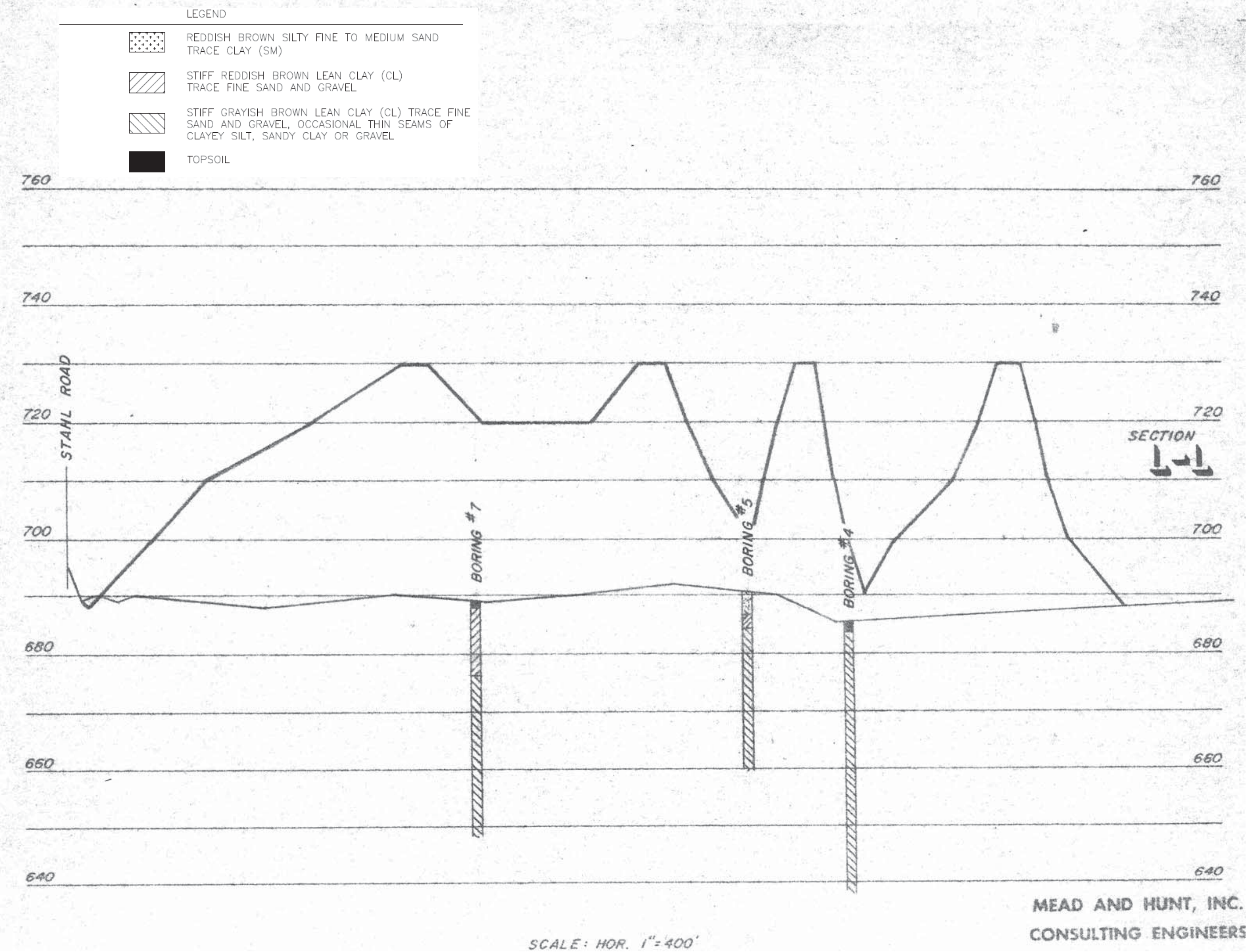
TOPSOIL



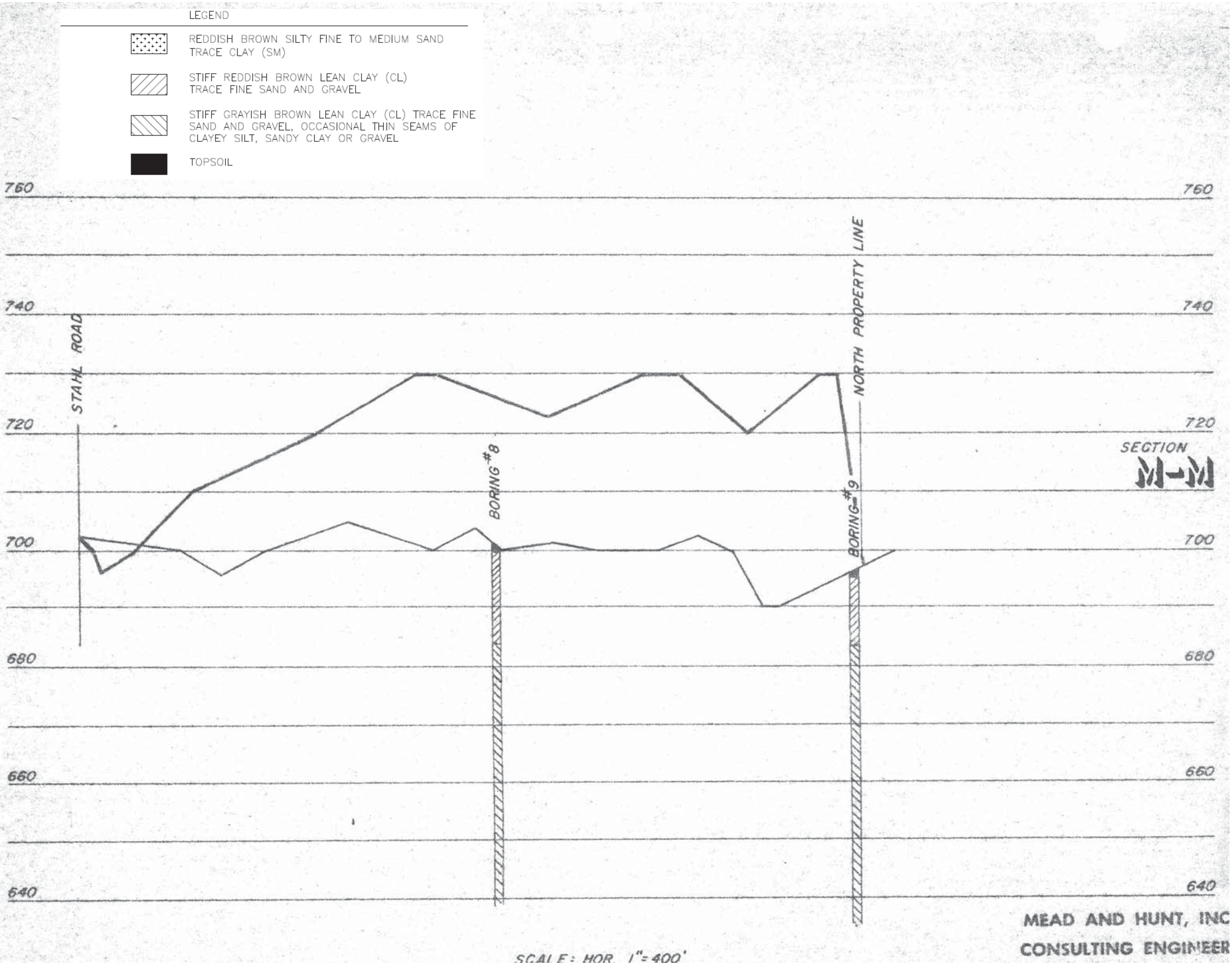
SCALE: HOR. 1"=400'

MEAD AND HUNT, INC.
CONSULTING ENGINEERS


LEGEND
REDDISH BROWN SILTY FINE TO MEDIUM SAND TRACE CLAY (SM)
STIFF REDDISH BROWN LEAN CLAY (CL) TRACE FINE SAND AND GRAVEL
STIFF GRAYISH BROWN LEAN CLAY (CL) TRACE FINE SAND AND GRAVEL, OCCASIONAL THIN SEAMS OF CLAYEY SILT, SANDY CLAY OR GRAVEL
TOPSOIL
760
740
720
700
680
660
640
EAST PROPERTY LINE
RAILROAD
BORING #3
SECTION
1-1
SCALE: HOR. 1"=400'
MEAD AND HUNT, INC.
CONSULTING ENGINEERS

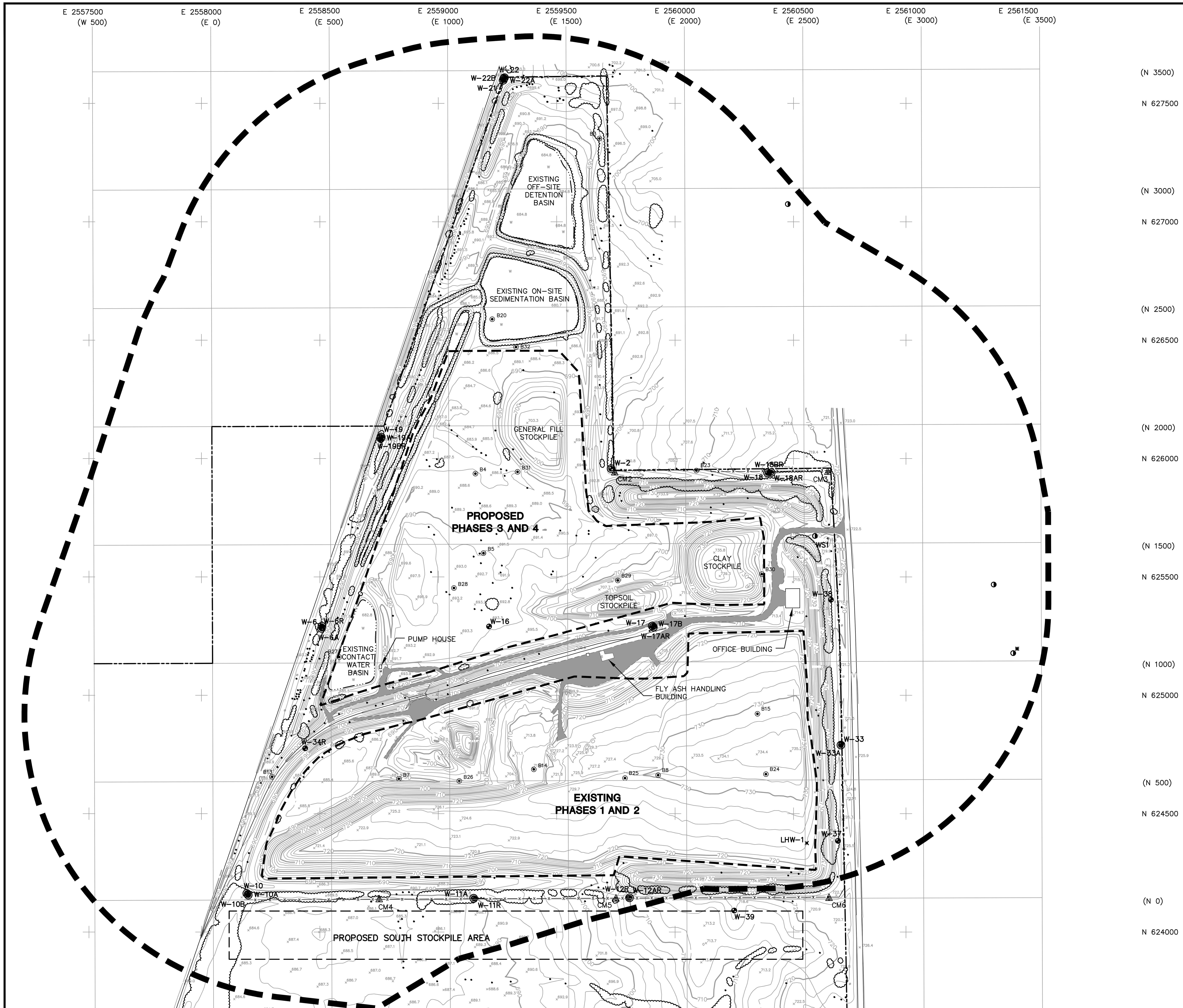


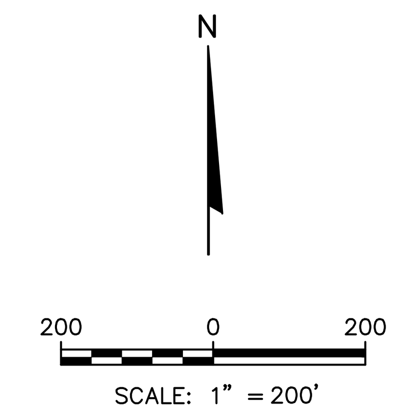
MEAD AND HUNT, INC.
CONSULTING ENGINEERS



MEAD AND HUNT, INC

CONSULTING ENGINEER





LEGEND

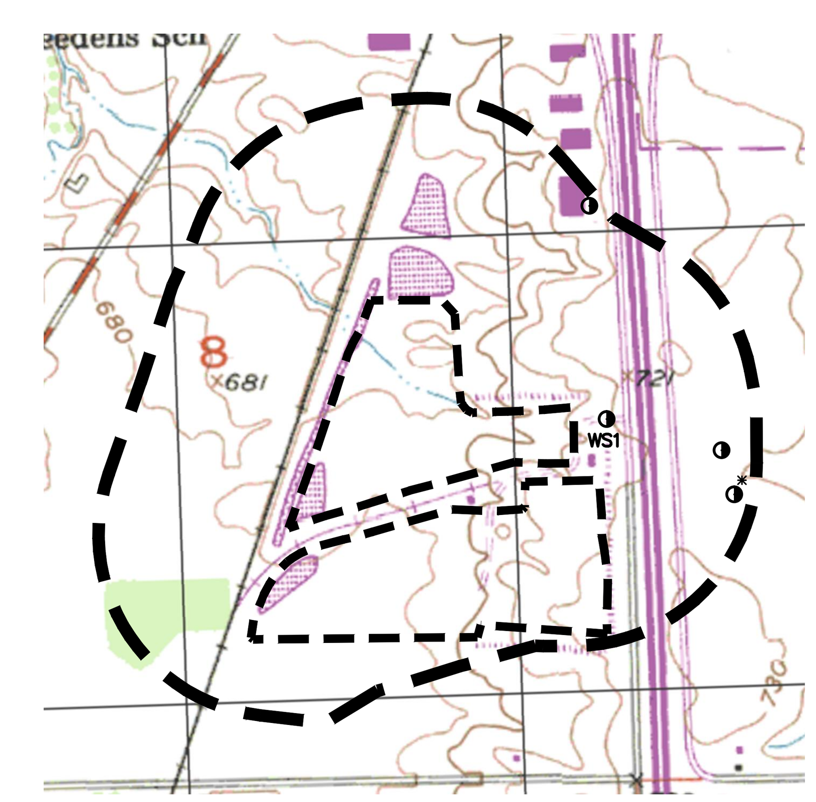
- APPROXIMATE PROPERTY LINE
- EXISTING GRADE (2' CONTOUR)
- 690 EXISTING GRADE (10' CONTOUR)
- 686.6 EXISTING GRADE SPOT ELEVATION
- TREELINE/TREES
- PAVED ROAD
- UNPAVED ROAD
- TRAIL/PATH
- RAILROAD TRACKS
- FENCE
- UTILITY/LIGHT POLE
- EDGE OF WATER
- LIMITS OF WASTE
- CONTROL MONUMENT
- SOIL BORING
- MONITORING WELL
- PIEZOMETER
- LEACHATE HEADWELL
- PRIVATE WELL
- 1,200-FOOT RADIUS FROM PHASE 3/4 LIMITS OF WASTE
- PROPOSED SOUTH STOCKPILE AREA

CONTROL MONUMENT DATA

MONUMENT NO.	STATION	ELEVATION
2	17+99.98 N 16+99.78 E	700.04
3	18+00.22 N 25+99.42 E	717.04
4	6+99.74 N 0+0.52 E	687.45
5	16+99.50 N 0+0.51 E	705.62
6	25+99.29 N 0+0.50 E	723.27

NOTES:

1. BASE MAP PREPARED BY KBM, INC. BASED ON AERIAL TOPOGRAPHIC SURVEY FLOWN JULY 1, 2007. BASE MAP PREPARED USING WISCONSIN STATE PLANE COORDINATES. ELEVATIONS BASED ON USGS NATIONAL GEODETIC VERTICAL DATUM, 1929.
2. CONTOUR INTERVAL IS 2 FEET.
3. CONVERSION FROM LOCAL COORDINATE SYSTEM TO STATE PLANE: SHIFT 2558047.2314, 624139.6532, ROTATE 0.17' AROUND POINT WITH COORDINATES 2559697.2314, 625039.6532.
4. SOIL BORING AND MONITORING WELL LOCATIONS BASED ON WELL INFORMATION FORM COORDINATES AND EXISTING CONDITIONS MAP F11 PREPARED BY WARZYN, INC. USING LOCAL COORDINATES.
5. * PRIVATE WELL LOCATION IS APPROXIMATE AND ASSUMED BASED ON WELL ADDRESS SHOWN ON WELL CONSTRUCTION REPORT. THE WELL ADDRESS AND COORDINATES INCLUDED ON THE CONSTRUCTION REPORT ARE NOT CONSISTENT.



PRIVATE WELL LOCATION MAP
SCALE: 1" = 1,000'

PROJECT NO.	3391	DRAWN BY:	KP
DRAWN:	07/31/07	CHECKED BY:	KG
REVISED:	01/07/08	APPROVED BY:	

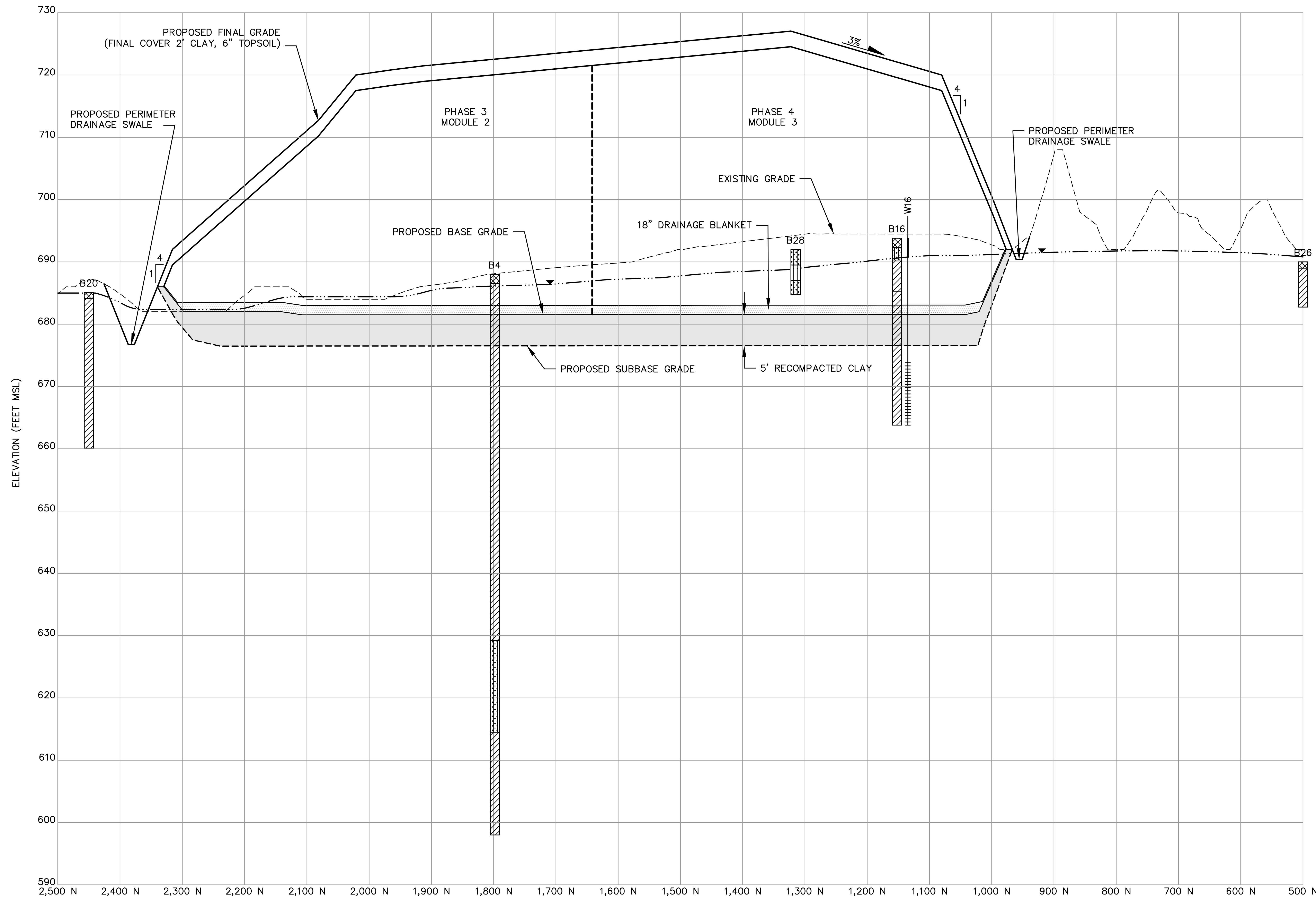
ENGINEER: BT² inc — 2830 DAIRY DRIVE, MADISON, WI 53718-6751, PHONE: (608) 224-2830, FAX: (608) 224-2839

CLIENT: WISCONSIN POWER AND LIGHT, EDGEWATER GENERATING STATION, 3739 LAKESHORE DRIVE, SHEBOYGAN, WI 53081

SITE: PLAN OF OPERATION PHASES 3 AND 4, EDGEWATER I-43 ASH DISPOSAL FACILITY, WILSON, WISCONSIN

EXISTING CONDITIONS AND PRIVATE WELL LOCATION MAP

SHEET 2 of 17

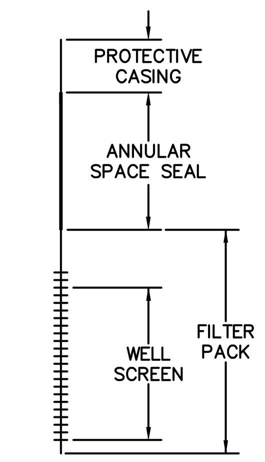


1,000 EAST

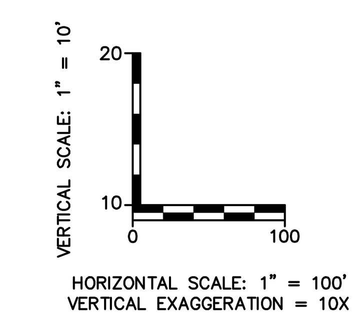
Note: Design information depicted here has been superseded by design updates in the March 2015 Plan of Operation Modification for Phases 3 and 4 prepared by SCS Engineers.

LEGEND

- FILL/TOPSOIL
- SILT (ML)
- LEAN CLAY (CL)
- SILTY SAND (SM)
- WATER TABLE ON APRIL 4, 2006

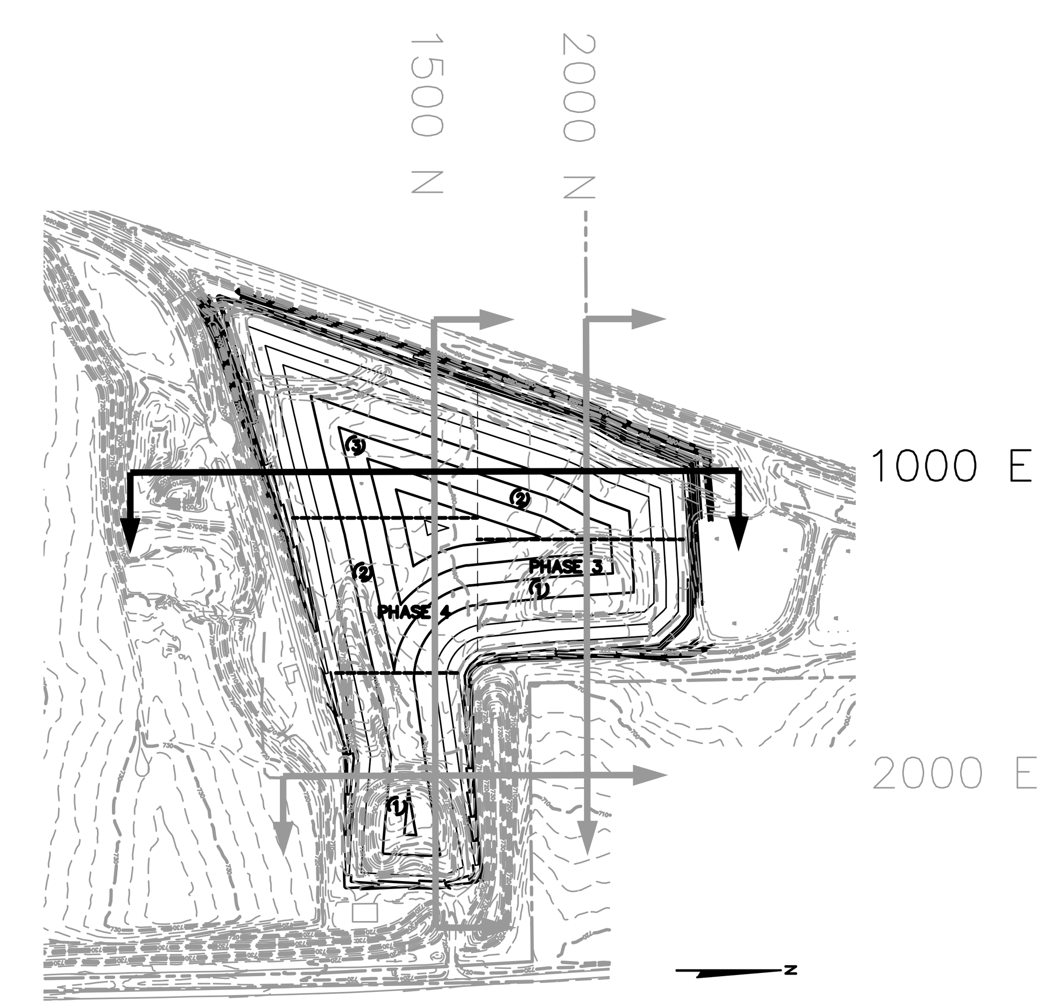


WELL DETAIL



NOTES:

1. BORINGS B4, B16, AND B20 WERE INSTALLED BY SOILS & ENGINEERING SERVICES, INC. IN 1977 AND 1978.
2. BORINGS B26 AND B28 WERE INSTALLED BY WARZYN ENGINEERING, INC. IN 1981.



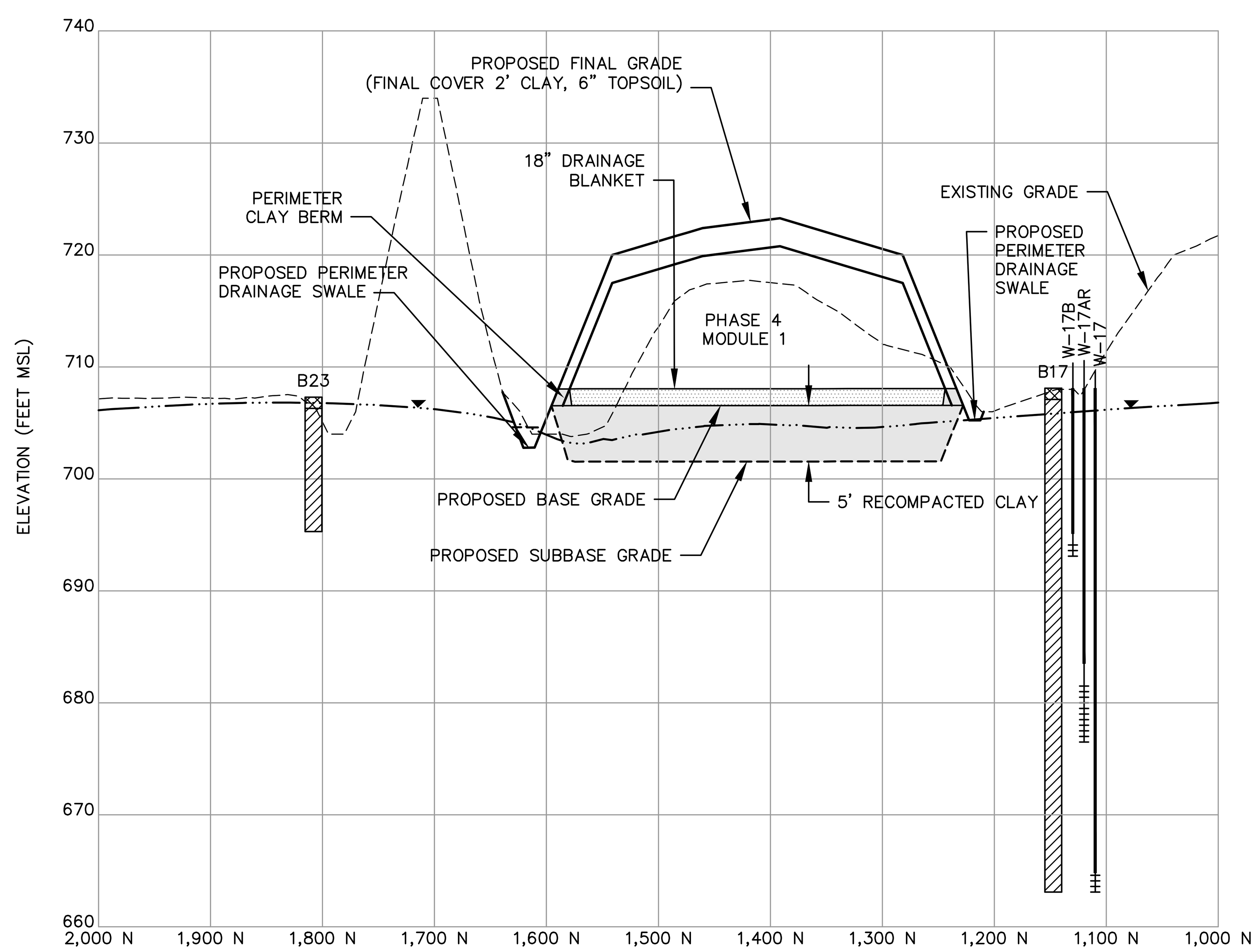
CROSS SECTION LOCATION

1" = 500'

PROJECT NO. 3391	DRAWN BY: KP	ENGINEER	BT² inc 2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830 FAX: (608) 224-2839	CLIENT	WISCONSIN POWER AND LIGHT EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081	SITE	PLAN OF OPERATION PHASES 3 AND 4 EDGEWATER I-43 ASH DISPOSAL FACILITY WILSON, WISCONSIN
DRAWN: 11/23/07	CHECKED BY: KG						
REVISED: 12/10/07	APPROVED BY:						

CROSS SECTION 1,000 EAST

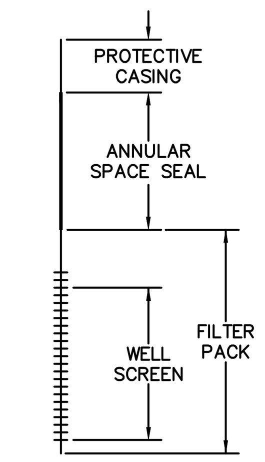
SHEET 12 of 17



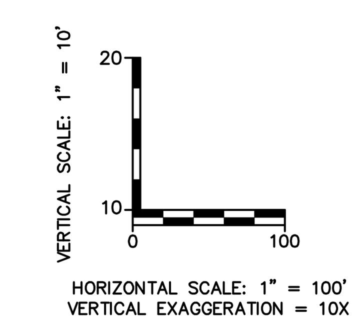
2,000 EAST

LEGEND

- FILL/TOPSOIL
- SILT (ML)
- LEAN CLAY (CL)
- SILTY SAND (SM)
- WATER TABLE ON APRIL 4, 2006

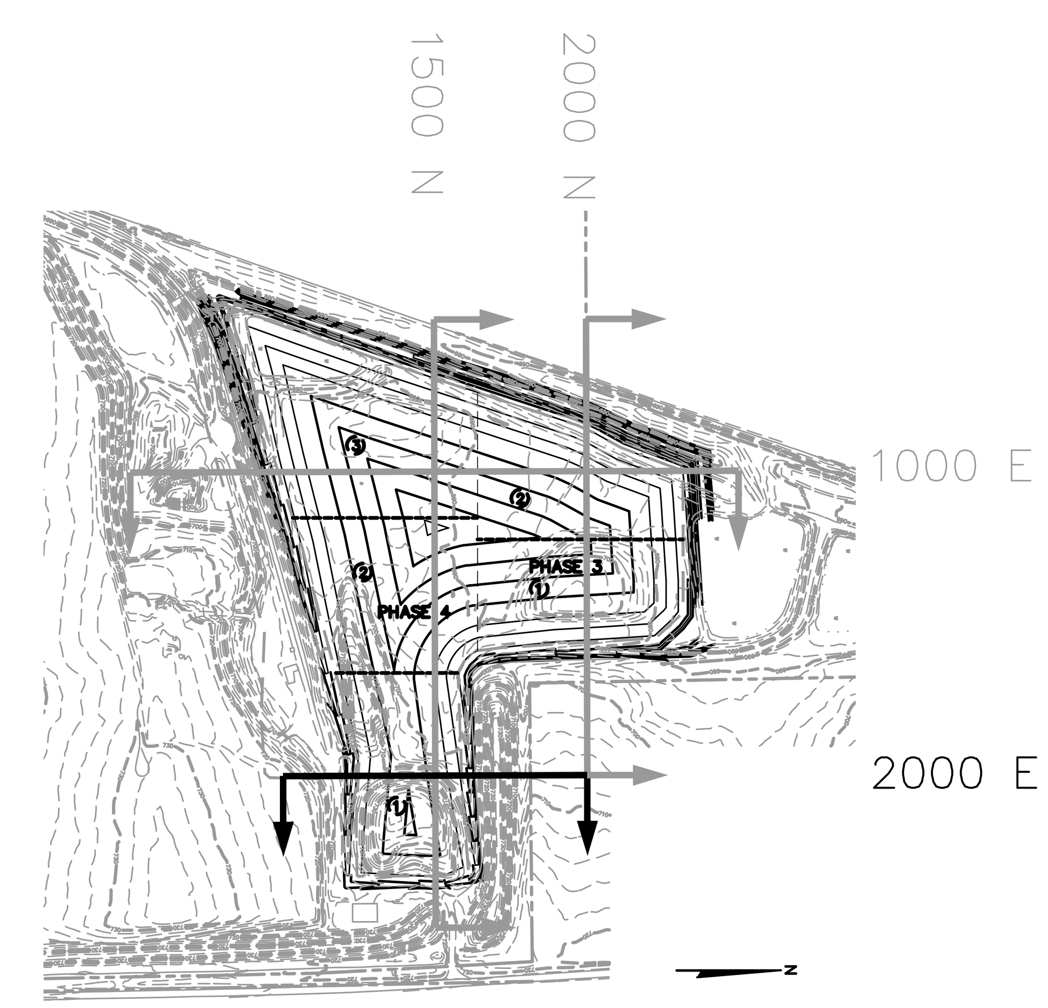


WELL DETAIL



NOTES:

1. BORINGS B17 AND B23 WERE INSTALLED BY SOILS & ENGINEERING SERVICES, INC. IN 1978.



CROSS SECTION LOCATION

1" = 500'

Note: Design information depicted here has been superseded by design updates in the March 2015 Plan of Operation Modification for Phases 3 and 4 prepared by SCS Engineers.

PROJECT NO.	3391	DRAWN BY:	KP		
DRAWN:	11/23/07	CHECKED BY:	KG		
REVISED:	12/10/07	APPROVED BY:			

ENGINEER: BT² inc — 2830 DAIRY DRIVE, MADISON, WI 53718-6751, PHONE: (608) 224-2830, FAX: (608) 224-2839

CLIENT: WISCONSIN POWER AND LIGHT, EDGEWATER GENERATING STATION, 3739 LAKESHORE DRIVE, SHEBOYGAN, WI 53081

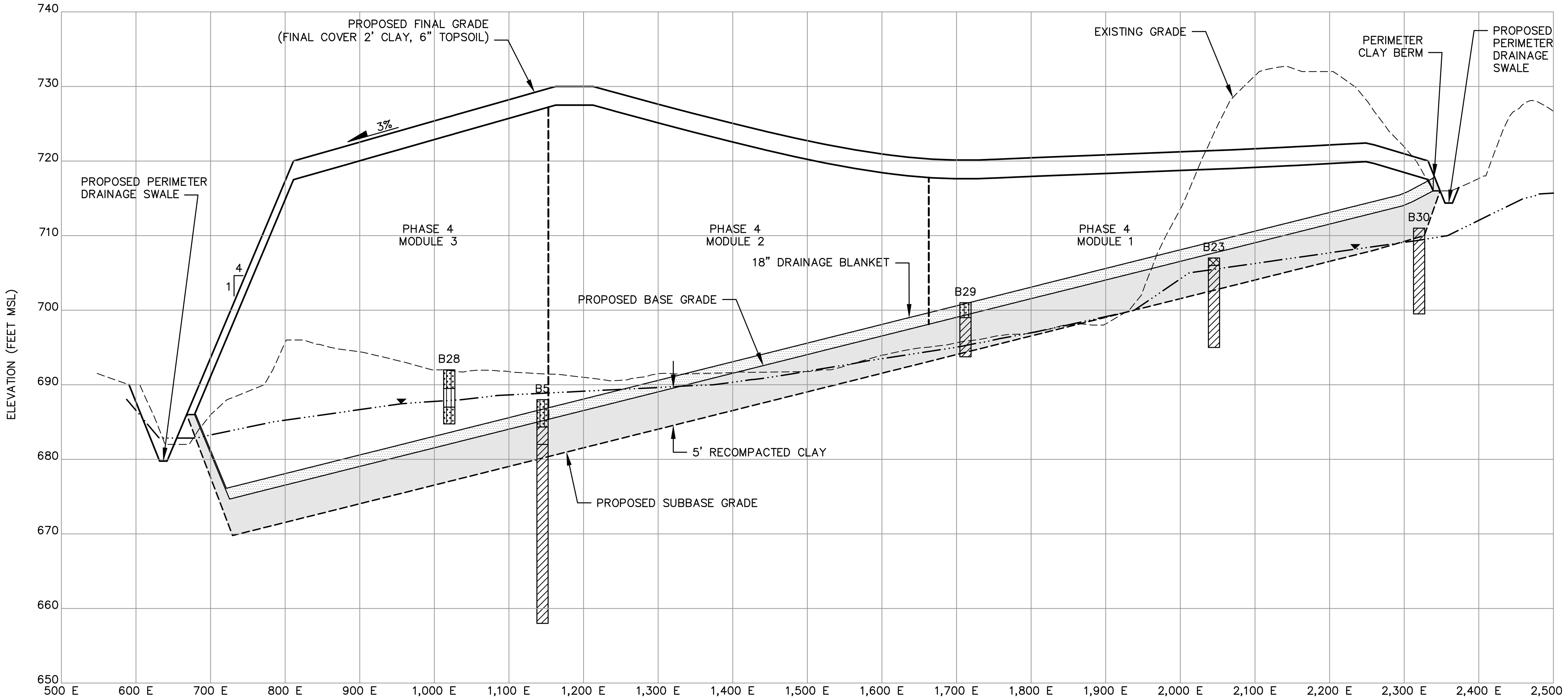
SITE: PLAN OF OPERATION PHASES 3 AND 4, EDGEWATER I-43 ASH DISPOSAL FACILITY, WILSON, WISCONSIN

CROSS SECTION 2,000 EAST

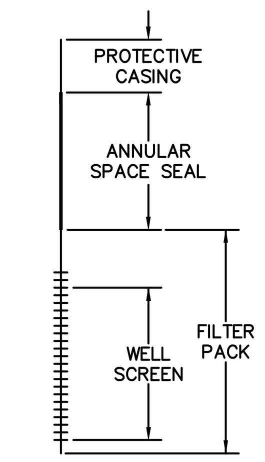
SHEET 13 of 17

LEGEND

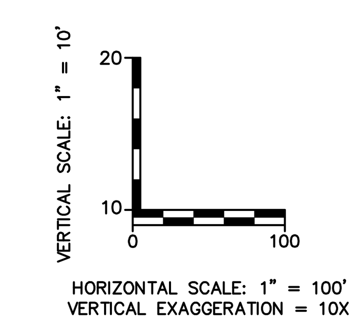
- FILL/TOPSOIL
- SILT (ML)
- LEAN CLAY (CL)
- SILTY SAND (SM)
- WATER TABLE ON APRIL 4, 2006



1,500 NORTH

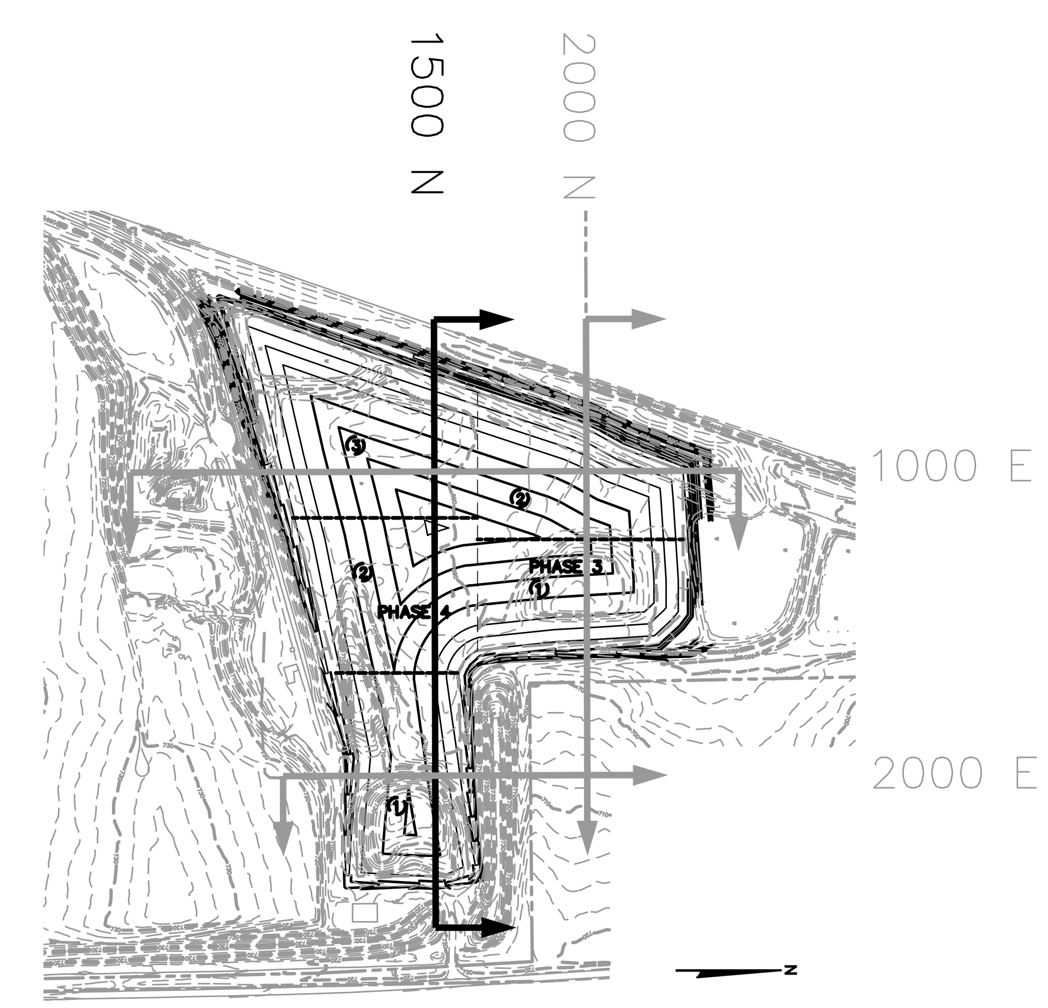


WELL DETAIL



NOTES:

1. BORINGS B5 AND B23 WERE INSTALLED BY SOILS & ENGINEERING SERVICES, INC. IN 1977 AND 1978.
2. BORINGS B28, B29, AND B30 WERE INSTALLED BY WARZYN ENGINEERING, INC. IN 1981.



CROSS SECTION LOCATION

1" = 500'

Note: Design information depicted here has been superseded by design updates in the March 2015 Plan of Operation Modification for Phases 3 and 4 prepared by SCS Engineers.

PROJECT NO.	3391	DRAWN BY:	KP		
DRAWN:	11/23/07	CHECKED BY:	KG		
REVISED:	12/10/07	APPROVED BY:			

ENGINEER: BT² inc, 2830 DAIRY DRIVE, MADISON, WI 53718-6751, PHONE: (608) 224-2830, FAX: (608) 224-2839

CLIENT: WISCONSIN POWER AND LIGHT, EDGEWATER GENERATING STATION, 3739 LAKESHORE DRIVE, SHEBOYGAN, WI 53081

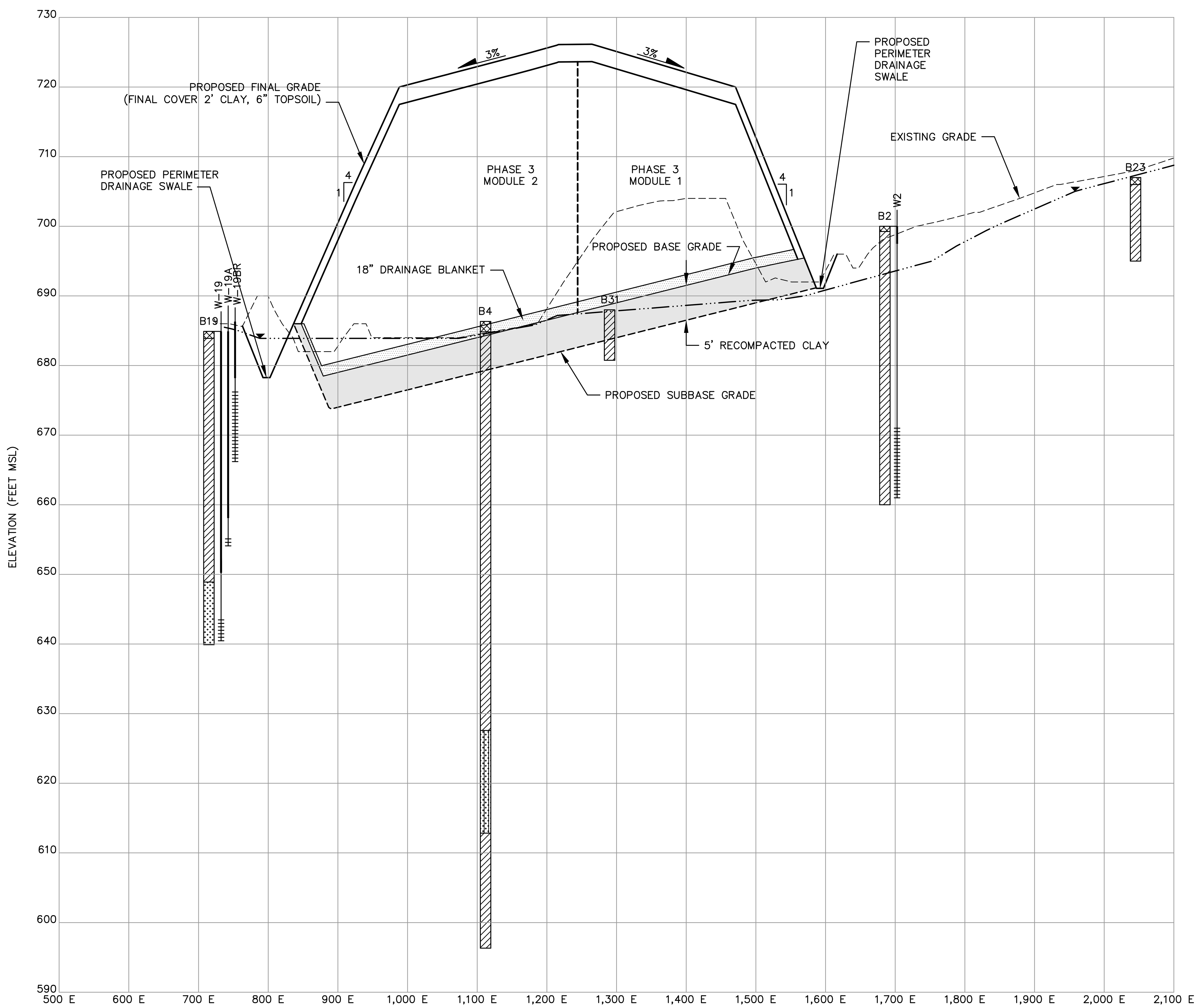
SITE: PLAN OF OPERATION PHASES 3 AND 4, EDGEWATER I-43 ASH DISPOSAL FACILITY, WILSON, WISCONSIN

CROSS SECTION 1,500 NORTH

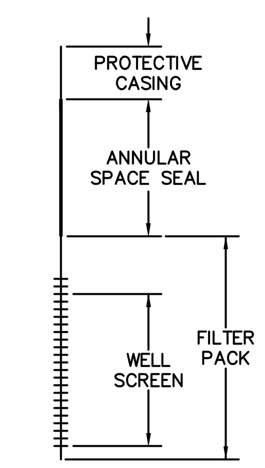
SHEET 14 of 17

LEGEND

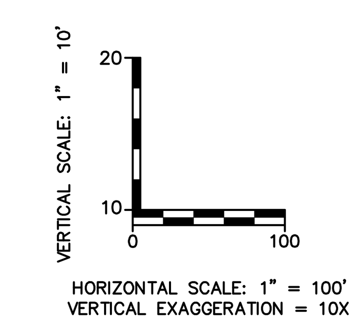
- FILL/TOPSOIL
- SILT (ML)
- LEAN CLAY (CL)
- SILTY SAND (SM)
- WATER TABLE ON APRIL 4, 2006



2,000 NORTH

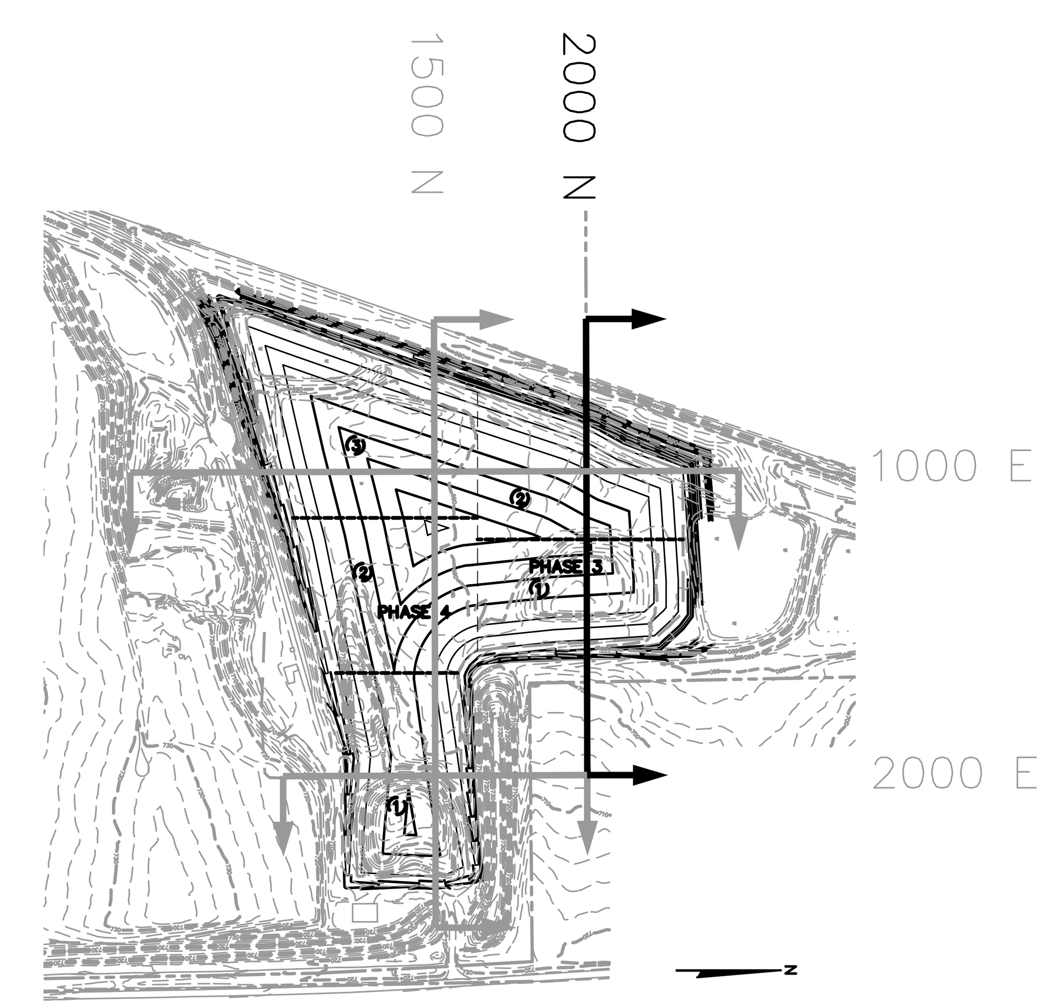


WELL DETAIL



NOTES:

1. BORINGS B2, B4, B19, AND B23 WERE INSTALLED BY SOILS & ENGINEERING SERVICES, INC. IN 1977 AND 1978.
2. BORING B31 WAS INSTALLED BY WARZYN ENGINEERING, INC. IN 1981.



CROSS SECTION LOCATION

1" = 500'

Note: Design information depicted here has been superseded by design updates in the March 2015 Plan of Operation Modification for Phases 3 and 4 prepared by SCS Engineers.

PROJECT NO.	3391	DRAWN BY:	KP		
DRAWN:	11/23/07	CHECKED BY:	KG		
REVISED:	12/10/07	APPROVED BY:			

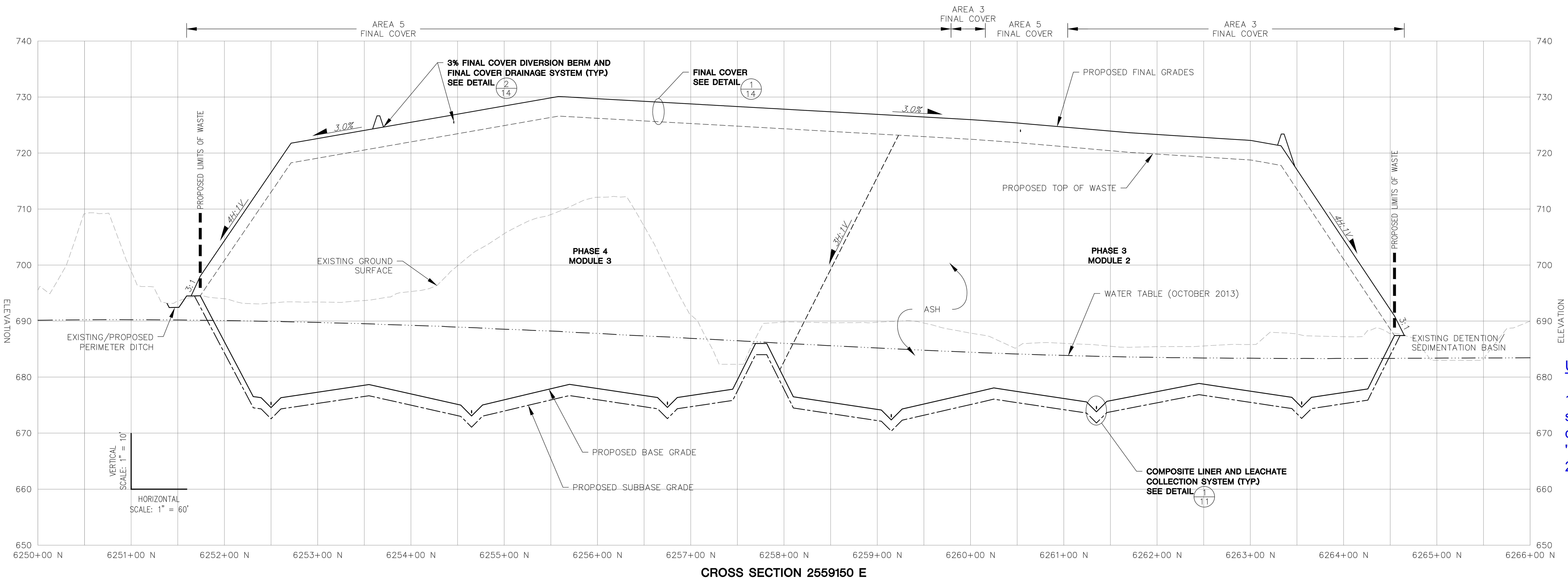
ENGINEER: BT² inc, 2830 DAIRY DRIVE, MADISON, WI 53718-6751, PHONE: (608) 224-2830, FAX: (608) 224-2839

CLIENT: WISCONSIN POWER AND LIGHT, EDGEWATER GENERATING STATION, 3739 LAKESHORE DRIVE, SHEBOYGAN, WI 53081

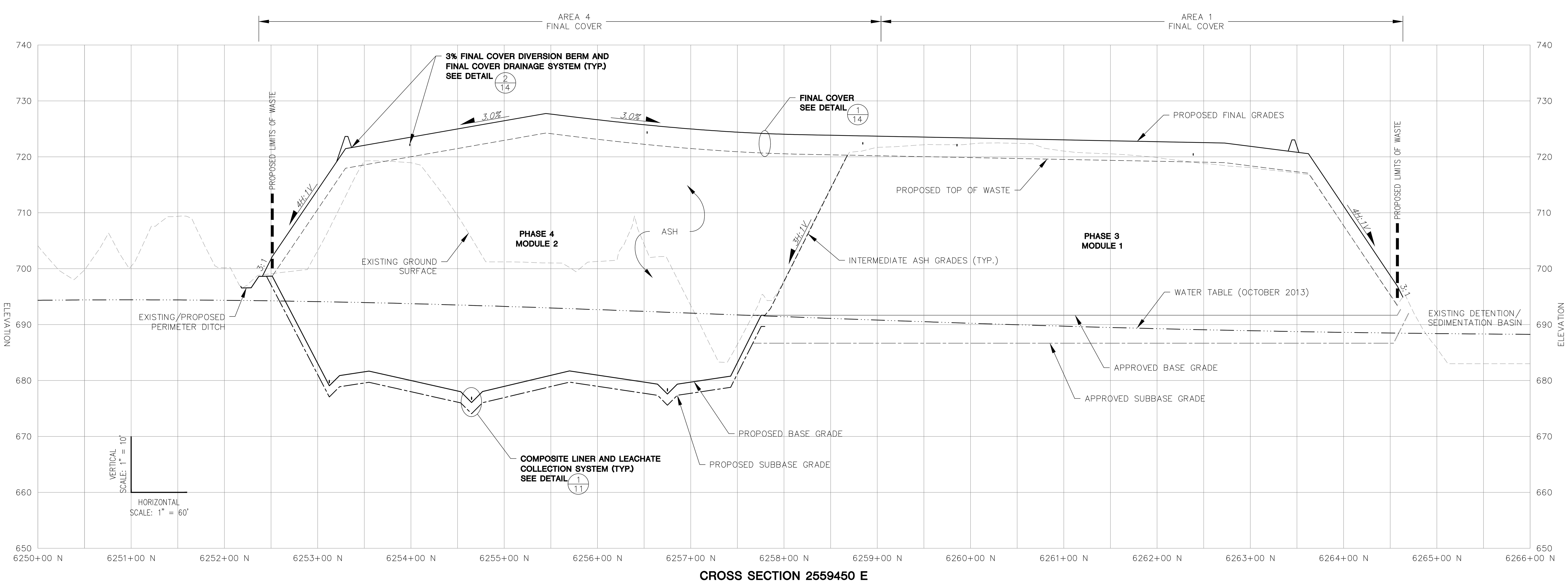
SITE: PLAN OF OPERATION PHASES 3 AND 4, EDGEWATER I-43 ASH DISPOSAL FACILITY, WILSON, WISCONSIN

CROSS SECTION 2,000 NORTH

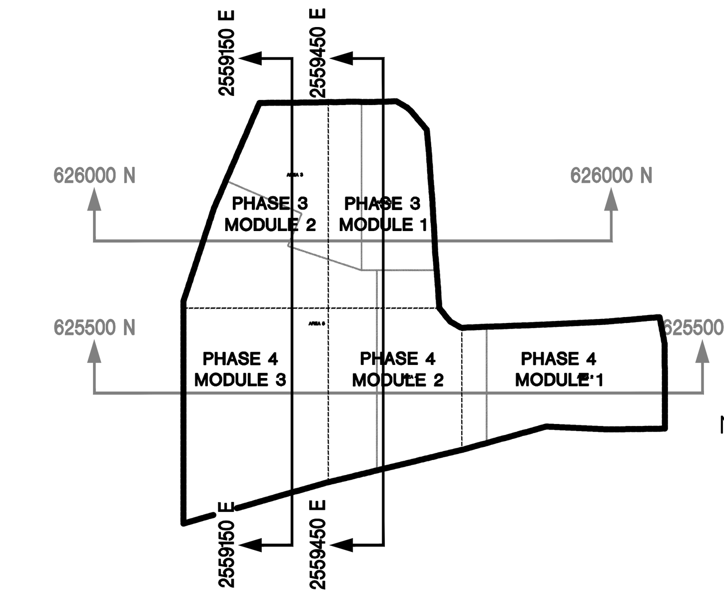
SHEET 15 of 17



CROSS SECTION 2559150 E



CROSS SECTION 2559450 E



CROSS SECTION LOCATION MAP

(SCALE: 1" = 500')

Unstable Areas Demonstration Notes:

1) The "Water Table" shown on these cross sections is present in unconsolidated deposits that do not meet the definition of the "Uppermost Aquifer" as defined in 40 CFR 257.53.

PROJECT NO.	25214060.00	DRAWN BY:	KP
DRAWN:	01/15/15	CHECKED BY:	KG/LAB
REVISED:	03/09/15	APPROVED BY:	LAB 03/09/15

WISCONSIN POWER AND LIGHT COMPANY
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081

CLIENT

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

ENGINEER

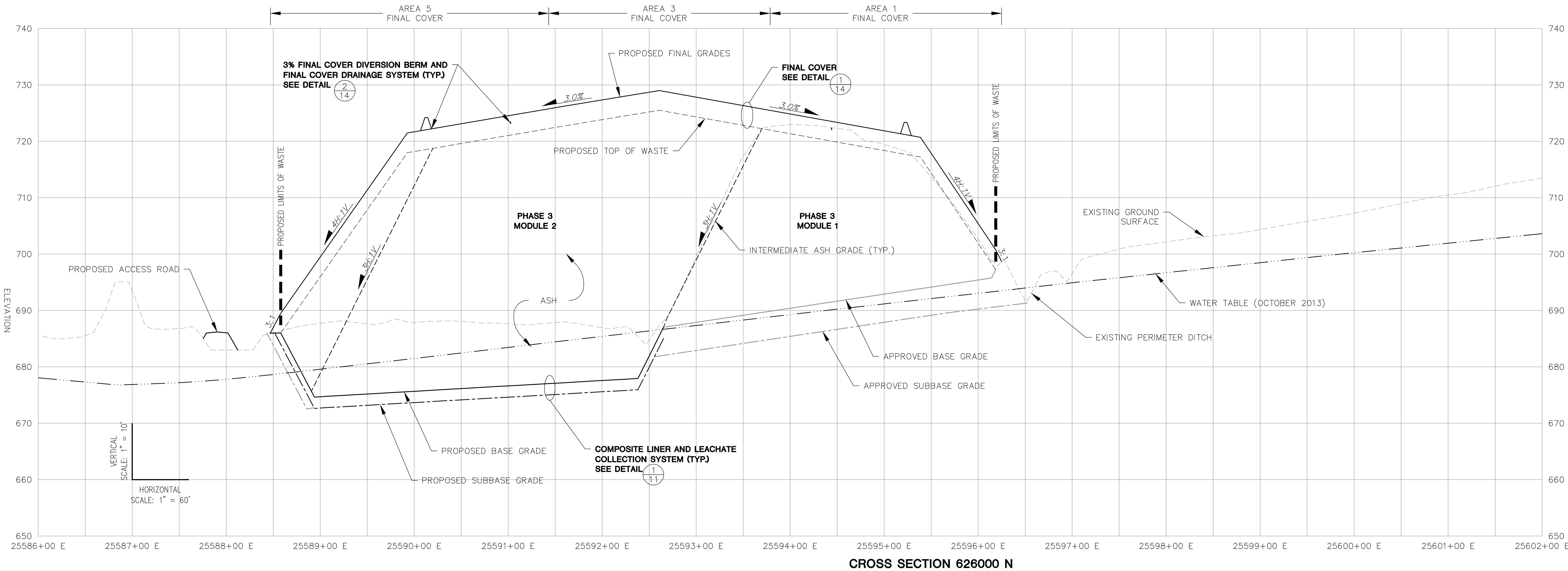
PLAN MODIFICATION
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

SITE

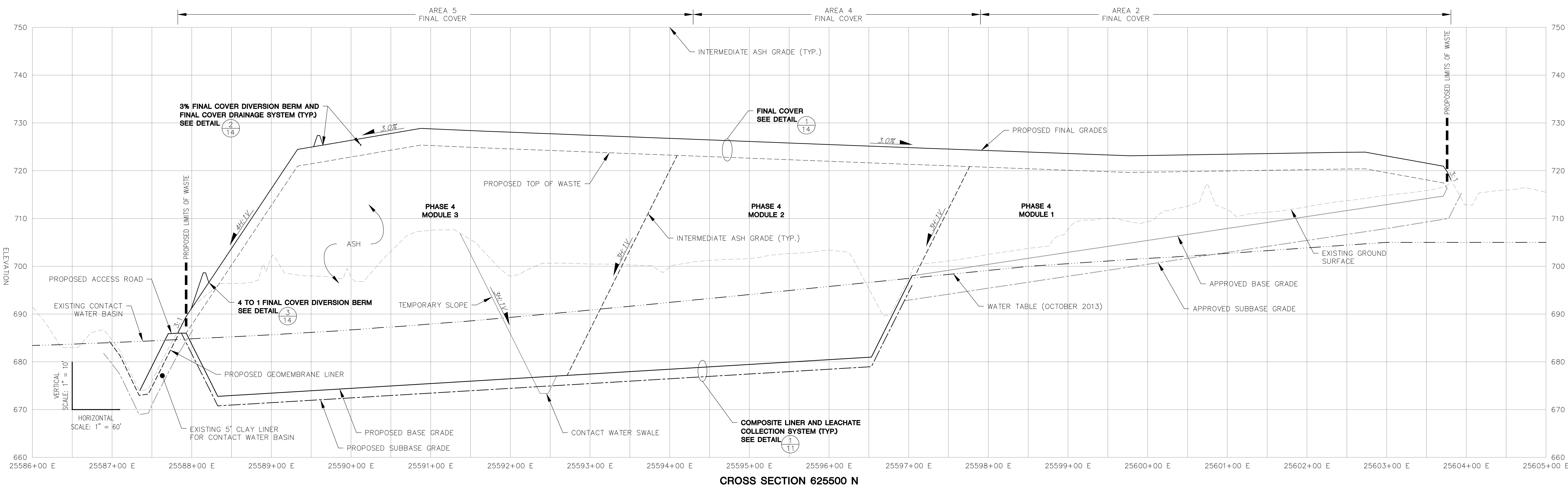
CROSS SECTIONS – 2,559,150 EAST AND 2,559,450 EAST

SHEET

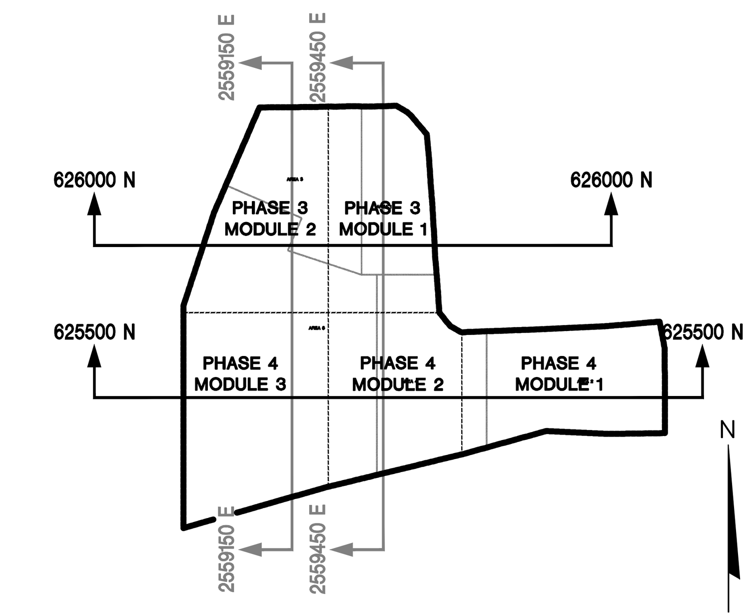
9 of 19



CROSS SECTION 626000 N



CROSS SECTION 625500 N



CROSS SECTION LOCATION MAP

(SCALE: 1" = 500')

Unstable Areas Demonstration Notes:

1) The "Water Table" shown on these cross sections is present in unconsolidated deposits that do not meet the definition of the "Uppermost Aquifer" as defined in 40 CFR 257.53.

PROJECT NO.	25214060.00
DRAWN:	01/15/15
REVISED:	03/09/15
DRAWN BY:	KP
CHECKED BY:	KG/LAB
APPROVED BY:	LAB 03/09/15

WISCONSIN POWER AND LIGHT COMPANY
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081

CLIENT

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

ENGINEER

PLAN MODIFICATION
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

SITE

CROSS SECTIONS – 625,500 NORTH AND 626,000 NORTH

SHEET

10 of 19

Appendix A7

Phase 3, Module 2 Interim Waste Slope Stability Analysis

Environmental Consultants
and Contractors

2830 Dairy Drive
Madison, WI 53718-6751

608 224-2830
FAX 608 224-2839
www.scsengineers.com

SCS ENGINEERS

September 26, 2018
File No. 25218091.00

TECHNICAL MEMORANDUM

ANALYSIS BY: Brandon Suchomel

REVIEWED BY: Deb Nelson
Phil Gearing

SUBJECT: Interim Waste Slope Stability Analyses
Unstable Areas Restriction Compliance Demonstration Report
Edgewater I-43 Ash Disposal Facility

PURPOSE

The purposes of the slope stability analyses were to evaluate:

- The interim 3H:1V west waste slope in Phase 3, Module 2 at the highest waste grade

CONCLUSION

The attached results confirm that the interim waste slope will be stable during the construction and operation of the disposal facility modules.

APPROACH

SCS Engineers (SCS) evaluated the waste mass slope stability of the west interim slope of Module 2 at the most critical/highest waste grade cross-section (i.e. at the time of final cover placement). The Module 2 interim 3H:1V waste slope analyzed at the west filling face has a maximum waste fill height of approximately 48 feet corresponding to a peak elevation of approximately 724 feet above mean sea level. The interim waste slope was evaluated for block and circular failure.

RESULTS

The calculated safety factors for each failure type are shown in the attached summary table.

SCS recommends a minimum safety factor of 1.3 for the interim waste slopes. The recommended safety factor of 1.3 for an interim waste slope is based on end-of-construction safety factors discussed in the U.S. Army Corps of Engineers engineer manual on slope stability (USACE 2003) and in Wisconsin Administrative Code Chapter NR 514.07(1)(b). The results indicate that the 3H:1V waste slope for Module 2 has an acceptable minimum safety factor of approximately 1.33.

REFERENCES

1. SCS Engineers, Edgewater I-43 Ash Disposal Facility, Plan Modification, 2015, module design interim waste grades.

2. SCS Engineers, Edgewater I-43 Ash Disposal Facility, Phase 3, Module 2 Liner and Area 1 Final Cover Construction – Construction Documentation Report, 2016, existing as-built composite liner grades, material properties for subbase, clay liner, drainage layer, and geosynthetics.

3. TRI/Environmental, Interface Friction Test Results, 2015, for 2015 Module 2 Liner Construction.

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

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

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

7. Geo-Slope International, Ltd., GeoStudio 2016, Version 8.16.2.14053, Slope/W slope stability software.

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

ASSUMPTIONS

- Circular and sliding block failure stability analyses are appropriate to evaluate the waste interim slope stability.

- Material properties are as shown in the table below, based on the indicated references and assumed values based on experience. Friction angles for soils are conservative assumed values based on soil type, published typical values, and SCS experience. The coal combustion residual (CCR) friction angle is a conservative assumed value based on published values and 2015 triaxial compression test results by TRI/Environmental for CCR.

Material	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)	Reference
Subbase Soil (Clay)	135	28	0	2
Clay Liner	130	28	0	2
Geosynthetics	58	19.5	0	3
Drainage Layer (Sand)	115	30	0	2
CCR	86	20	0	4, 5, 6

Attachments: Calculations organized as follows:

- Factor of Safety Summary Table
- Cross Section Location Figure
- Slope/W Outputs

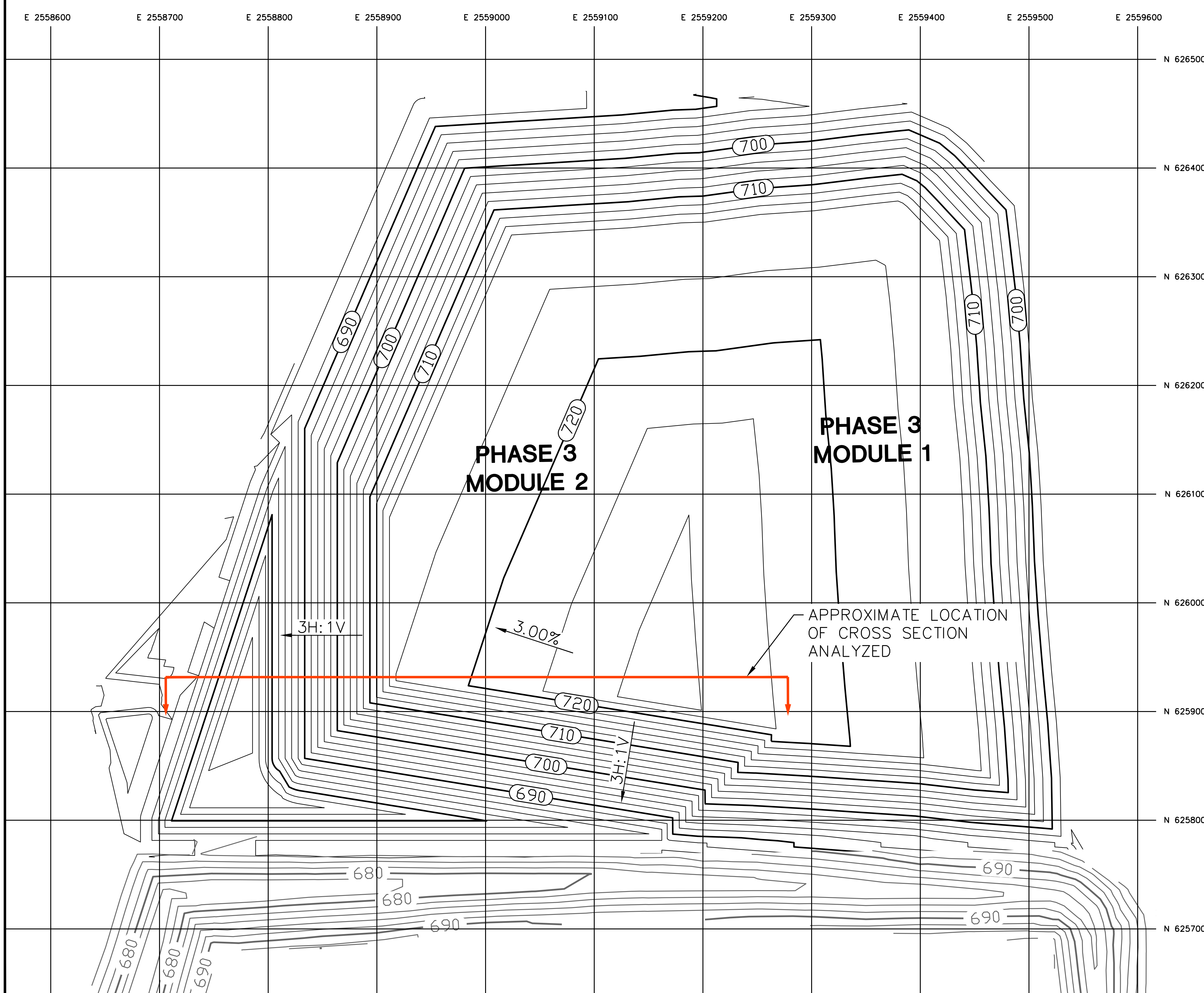
BSS/AJR/DLN/PEG
Coordinates checked by BJM

I:\25218091.00\Data and Calculations\Slope Stability_Deliverable Memo\Tech Memo_Unstable Areas Analysis_180926.docx

Slope Stability Analyses
Factors of Safety Results Summary
Edgewater I-43 Ash Disposal Facility - Location Restriction Compliance Demonstration

Phase 3, Module 2 Western Interim Waste Slope		
Failure Type	**Calculated Safety Factor**	**Recommended Min. Safety Factor**
Block	1.33	1.3
Circular	1.37	1.3

Created by: BSS, 8/28/18
Last Revision by: BSS, 9/5/18
Checked by:DLN, 9/5/18



LEGEND

690	EXISTING GRADE (10' INTERVAL)
	EXISTING GRADE (2' INTERVAL)
710	PROPOSED WASTE GRADE (10' INTERVAL)
	PROPOSED WASTE GRADE (2' INTERVAL)

NOTES:

1. PROPOSED GRADES REPRESENT PHASE 3 INTERIM WASTE GRADES.
2. EXISTING GRADES REPRESENT CONTACT WATER BASIN TOP OF STONE.

N

100 0 100

SCALE: 1" = 100'

PROJECT NO.	25218091.00	DRAWN BY:	BSS
DRAWN:	08/24/18	CHECKED BY:	PEG
REVISED:	09/10/18	APPROVED BY:	

ENGINEER

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

CLIENT

Wisconsin Power and Light Company

EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081

SITE

LOCATION RESTRICTION
COMPLIANCE DEMONSTRATION REPORT
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

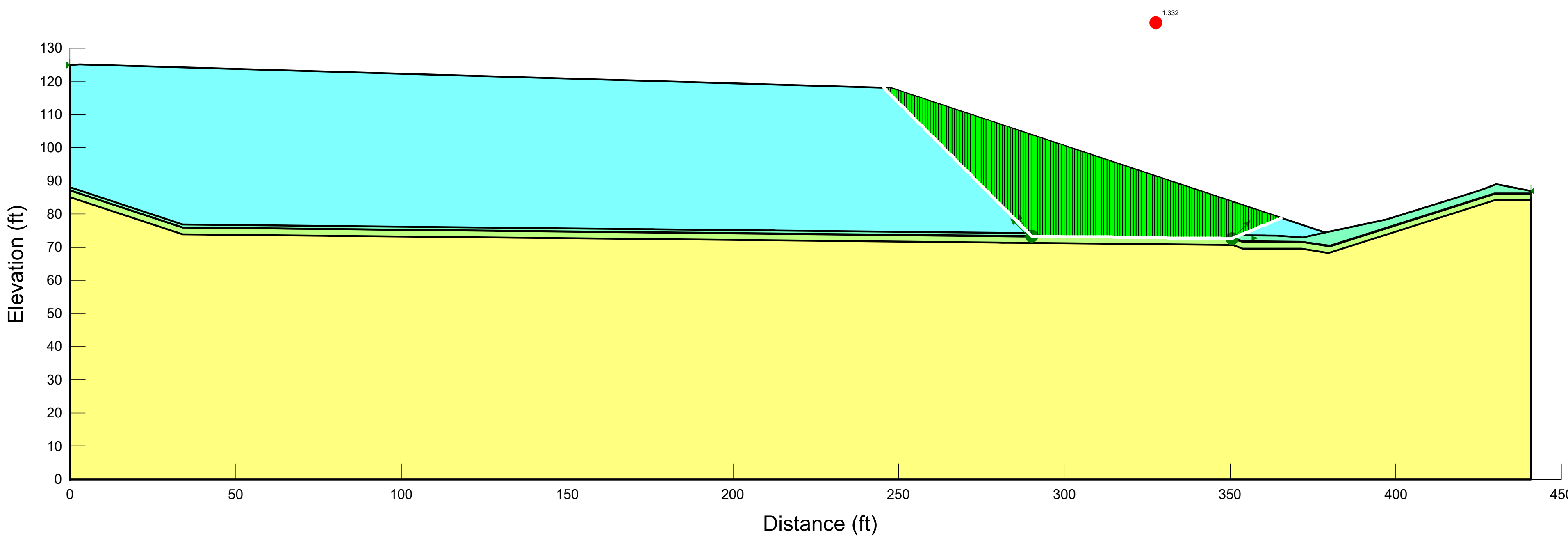
SLOPE STABILITY ANALYSIS
CROSS SECTION LOCATIONS

FIGURE

1 OF 1

I:\25218091.00\Drawings\Sections for Slope Stability.dwg, 9/10/2018 1:19:32 PM

Edgewater Unstable Areas Analysis 2018 - West Slope
Name: Block
F of S: 1.332



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	CCR	Mohr-Coulomb	86	0	20
	Clay Liner	Mohr-Coulomb	130	0	28
	Drainage Layer	Mohr-Coulomb	115	0	30
	Geosynthetics	Mohr-Coulomb	58	0	19.5
	Subbase	Mohr-Coulomb	135	0	28

Block

File Information

File Version: 8.16
Title: Edgewater Unstable Areas Analysis 2018 - West Slope
Comments: Running slope stability analysis on the west waste slope of Phase 3, Module 2 of the Edgewater I-43 Ash Disposal Facility. Location of analysis was selected based on longest and steepest slope at the time of peak waste placement within Module 2.
Created By: Suchomel, Brandon
Last Edited By: Suchomel, Brandon
Revision Number: 45
Date: 9/5/2018
Time: 1:09:20 PM
Tool Version: 8.16.3.14580
File Name: Western Slope of Module 2 Phase 3.gsz
Directory: I:\25218091.00\Data and Calculations\Slope Stability\
Last Solved Date: 9/5/2018
Last Solved Time: 1:13:42 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Block

Kind: SLOPE/W
Method: Janbu
Settings
    PWP Conditions Source: (none)
Slip Surface
    Direction of movement: Left to Right
    Use Passive Mode: No
    Slip Surface Option: Block
    Critical slip surfaces saved: 10
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °

Restrict Block Crossing: No
Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 150
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft

Materials

Subbase

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion': 0 psf
Phi': 28 °
Phi-B: 0 °

Clay Liner

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 28 °
Phi-B: 0 °

Geosynthetics

Model: Mohr-Coulomb
Unit Weight: 58 pcf
Cohesion': 0 psf
Phi': 19.5 °
Phi-B: 0 °

Drainage Layer

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °

CCR

Model: Mohr-Coulomb
Unit Weight: 86 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °

Slip Surface Limits

Left Coordinate: (0, 124.95) ft
Right Coordinate: (440.79, 86.91) ft

Slip Surface Block

Left Grid
- Upper Left: (289.08, 73.32) ft
- Lower Left: (289.08, 73.22) ft
- Lower Right: (292.05, 73.19) ft
- X Increments: 10
- Y Increments: 5
- Starting Angle: 115 °
- Ending Angle: 135 °
- Angle Increments: 2

Right Grid
- Upper Left: (350, 72.7) ft
- Lower Left: (349.99, 72.6) ft
- Lower Right: (350.8, 72.59) ft
- X Increments: 10
- Y Increments: 5
- Starting Angle: 0 °
- Ending Angle: 45 °
- Angle Increments: 2

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	87.05
Point 3	0	85.05
Point 4	0	87.15
Point 5	34.01	75.82
Point 6	34.01	73.82
Point 7	34.01	75.92
Point 8	350.8	72.59
Point 9	350.8	70.59
Point 10	350.8	72.69
Point 11	353.74	71.61
Point 12	353.74	69.61
Point 13	353.74	71.71
Point 14	371.54	71.58
Point 15	371.54	69.58
Point 16	371.54	71.68
Point 17	379.67	70.31
Point 18	379.67	68.31

Point 19	379.67	70.41
Point 20	380.33	70.37
Point 21	380.33	68.37
Point 22	380.33	70.47
Point 23	429.74	86.05
Point 24	429.74	84.05
Point 25	429.74	86.15
Point 26	440.79	86.05
Point 27	440.79	84.05
Point 28	440.79	86.15
Point 29	440.79	0
Point 30	0	88.06
Point 31	34.01	76.88
Point 32	364.01	73.53
Point 33	371.98	72.92
Point 34	378.75	74.32
Point 35	397.24	78.26
Point 36	425.51	87.13
Point 37	430.24	89.04
Point 38	440.79	86.91
Point 39	0	124.95
Point 40	2.89	125.01
Point 41	247.62	118.03

Regions

	Material	Points	Area (ft²)
Region 1	Subbase	1,3,6,9,12,15,18,21,24,27,29	32,320
Region 2	Clay Liner	3,2,5,8,11,14,17,20,23,26,27,24,21,18,15,12,9,6	881.58
Region 3	Geosynthetics	2,4,7,10,13,16,19,22,25,28,26,23,20,17,14,11,8,5	44.079
Region 4	Drainage Layer	4,30,31,32,33,34,35,36,37,38,28,25,22,19,16,13,10,7	551.77
Region 5	CCR	30,39,40,41,34,33,32,31	14,008

Current Slip Surface

Slip Surface: 22,397
F of S: 1.332
Volume: 2,037.6438 ft³
Weight: 176,875.14 lbs
Resisting Force: 59,709.489 lbs
Activating Force: 44,812.944 lbs
F of S Rank (Analysis): 1 of 39,204 slip surfaces
F of S Rank (Query): 1 of 39,204 slip surfaces
Exit: (365.43856, 78.757145) ft
Entry: (245.44394, 118.09206) ft
Radius: 65.463717 ft
Center: (315.11191, 127.92579) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	245.80661	117.72939	0	23.800692	8.6627436	0
Slice 2	246.53197	117.00403	0	71.402077	25.988231	0
Slice 3	247.25732	116.27868	0	119.00346	43.313718	0
Slice 4	248.02026	115.51574	0	160.82963	58.537199	0
Slice 5	248.82078	114.71522	0	196.88059	71.658675	0
Slice 6	249.6213	113.9147	0	232.93155	84.780151	0
Slice 7	250.42182	113.11418	0	268.98251	97.901626	0
Slice 8	251.22234	112.31366	0	305.03347	111.0231	0
Slice 9	252.02286	111.51314	0	341.08442	124.14458	0
Slice 10	252.82338	110.71262	0	377.13538	137.26605	0
Slice 11	253.6239	109.9121	0	413.18634	150.38753	0
Slice 12	254.42442	109.11158	0	449.2373	163.50901	0
Slice 13	255.22494	108.31106	0	485.28826	176.63048	0
Slice 14	256.02546	107.51054	0	521.33922	189.75196	0
	256.82598	106.71002	0	557.39017	202.87343	0

Slice 15						
Slice 16	257.6265	105.9095	0	593.44113	215.99491	0
Slice 17	258.42702	105.10898	0	629.49209	229.11638	0
Slice 18	259.22754	104.30846	0	665.54305	242.23786	0
Slice 19	260.02806	103.50794	0	701.59401	255.35934	0
Slice 20	260.82858	102.70742	0	737.64497	268.48081	0
Slice 21	261.6291	101.9069	0	773.69592	281.60229	0
Slice 22	262.42962	101.10638	0	809.74688	294.72376	0
Slice 23	263.23014	100.30586	0	845.79784	307.84524	0
Slice 24	264.03066	99.505339	0	881.8488	320.96671	0
Slice 25	264.83118	98.704819	0	917.89976	334.08819	0
Slice 26	265.6317	97.904299	0	953.95072	347.20967	0
Slice 27	266.43222	97.103779	0	990.00167	360.33114	0
Slice 28	267.23274	96.303259	0	1,026.0526	373.45262	0
Slice 29	268.03326	95.502739	0	1,062.1036	386.57409	0
Slice 30	268.83378	94.702219	0	1,098.1545	399.69557	0
Slice 31	269.6343	93.901699	0	1,134.2055	412.81704	0
Slice 32	270.43482	93.101179	0	1,170.2565	425.93852	0
Slice 33	271.23534	92.300658	0	1,206.3074	439.06	0
Slice 34	272.03586	91.500138	0	1,242.3584	452.18147	0
Slice 35	272.83638	90.699618	0	1,278.4093	465.30295	0
Slice 36	273.6369	89.899098	0	1,314.4603	478.42442	0
Slice 37	274.43742	89.098578	0	1,350.5113	491.5459	0
Slice 38	275.23794	88.298058	0	1,386.5622	504.66737	0

Slice 39	276.03846	87.497538	0	1,422.6132	517.78885	0
Slice 40	276.83898	86.697018	0	1,458.6641	530.91033	0
Slice 41	277.6395	85.896498	0	1,494.7151	544.0318	0
Slice 42	278.44002	85.095978	0	1,530.766	557.15328	0
Slice 43	279.24054	84.295458	0	1,566.817	570.27475	0
Slice 44	280.04106	83.494938	0	1,602.868	583.39623	0
Slice 45	280.84158	82.694418	0	1,638.9189	596.5177	0
Slice 46	281.6421	81.893898	0	1,674.9699	609.63918	0
Slice 47	282.44262	81.093378	0	1,711.0208	622.76066	0
Slice 48	283.24314	80.292858	0	1,747.0718	635.88213	0
Slice 49	284.04366	79.492338	0	1,783.1228	649.00361	0
Slice 50	284.84418	78.691818	0	1,819.1737	662.12508	0
Slice 51	285.6447	77.891298	0	1,855.2247	675.24656	0
Slice 52	286.44522	77.090777	0	1,891.2756	688.36803	0
Slice 53	287.24574	76.290257	0	1,927.3266	701.48951	0
Slice 54	288.04626	75.489737	0	1,963.3775	714.61099	0
Slice 55	288.84678	74.689217	0	1,999.4285	727.73246	0
Slice 56	289.73773	73.798273	0	1,821.5365	1,051.6646	0
Slice 57	290.65013	73.283295	0	2,602.4557	921.57791	0
Slice 58	291.47378	73.2545	0	2,612.8198	925.24804	0
Slice 59	292.27763	73.2455	0	2,590.5947	917.3777	0
Slice 60	293.08149	73.2365	0	2,568.3695	909.50736	0
Slice 61	293.88534	73.2275	0	2,546.1444	901.63702	0
Slice 62	294.68919	73.2185	0	2,523.9193	893.76668	0

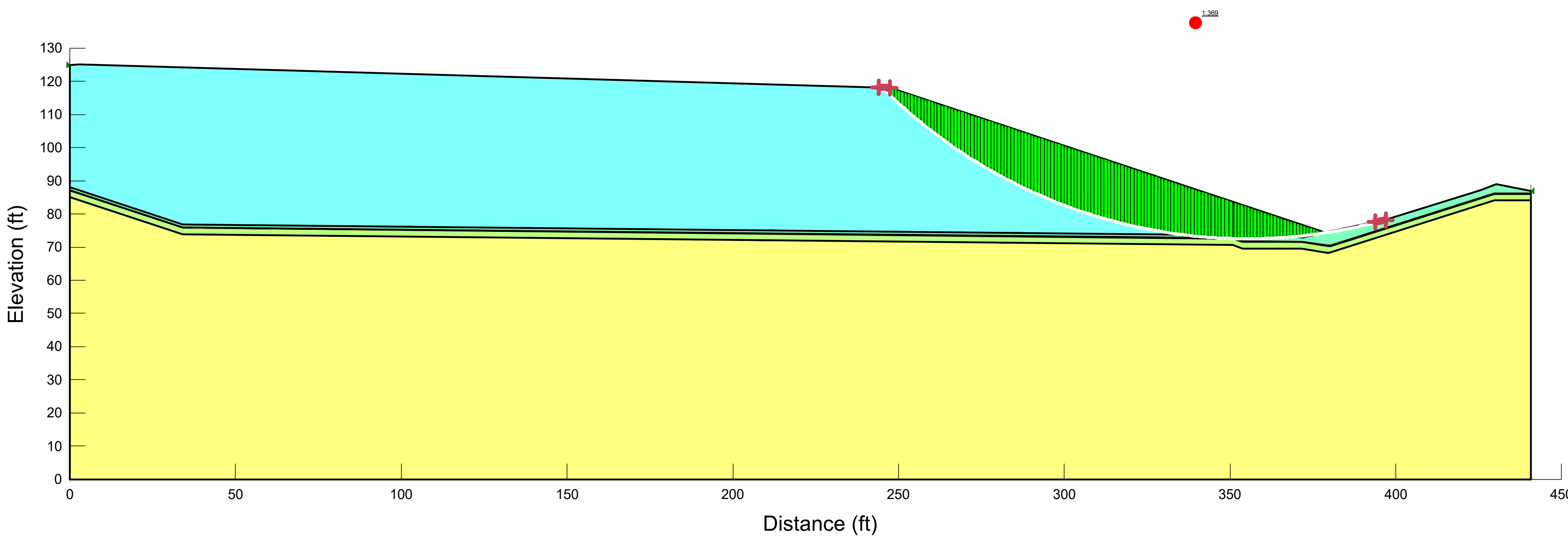
Slice 63	295.49305	73.2095	0	2,501.6941	885.89634	0
Slice 64	296.2969	73.2005	0	2,479.469	878.02601	0
Slice 65	297.10075	73.1915	0	2,457.2438	870.15567	0
Slice 66	297.90461	73.1825	0	2,435.0187	862.28533	0
Slice 67	298.70846	73.1735	0	2,412.7935	854.41499	0
Slice 68	299.51231	73.1645	0	2,390.5684	846.54465	0
Slice 69	300.31617	73.1555	0	2,368.3432	838.67432	0
Slice 70	301.12002	73.1465	0	2,346.1181	830.80398	0
Slice 71	301.92387	73.1375	0	2,323.8929	822.93364	0
Slice 72	302.72773	73.1285	0	2,301.6678	815.0633	0
Slice 73	303.53158	73.1195	0	2,279.4426	807.19296	0
Slice 74	304.33543	73.1105	0	2,257.2175	799.32262	0
Slice 75	305.13929	73.1015	0	2,234.9923	791.45229	0
Slice 76	305.94314	73.0925	0	2,212.7672	783.58195	0
Slice 77	306.74699	73.0835	0	2,190.542	775.71161	0
Slice 78	307.55085	73.0745	0	2,168.3169	767.84127	0
Slice 79	308.3547	73.0655	0	2,146.0917	759.97093	0
Slice 80	309.15855	73.0565	0	2,123.8666	752.1006	0
Slice 81	309.96241	73.0475	0	2,101.6414	744.23026	0
Slice 82	310.76626	73.0385	0	2,079.4163	736.35992	0
Slice 83	311.57011	73.0295	0	2,057.1911	728.48958	0
Slice 84	312.37397	73.0205	0	2,034.966	720.61924	0
Slice 85	313.17782	73.0115	0	2,012.7408	712.7489	0
Slice 86	313.98167	73.0025	0	1,990.5157	704.87857	0

Slice 87	314.78553	72.9935	0	1,968.2905	697.00823	0
Slice 88	315.58938	72.9845	0	1,946.0654	689.13789	0
Slice 89	316.39323	72.9755	0	1,923.8402	681.26755	0
Slice 90	317.19709	72.9665	0	1,901.6151	673.39721	0
Slice 91	318.00094	72.9575	0	1,879.3899	665.52688	0
Slice 92	318.80479	72.9485	0	1,857.1648	657.65654	0
Slice 93	319.60865	72.9395	0	1,834.9396	649.7862	0
Slice 94	320.4125	72.9305	0	1,812.7145	641.91586	0
Slice 95	321.21635	72.9215	0	1,790.4893	634.04552	0
Slice 96	322.02021	72.9125	0	1,768.2642	626.17518	0
Slice 97	322.82406	72.9035	0	1,746.039	618.30485	0
Slice 98	323.62791	72.8945	0	1,723.8139	610.43451	0
Slice 99	324.43177	72.8855	0	1,701.5887	602.56417	0
Slice 100	325.23562	72.8765	0	1,679.3636	594.69383	0
Slice 101	326.03947	72.8675	0	1,657.1384	586.82349	0
Slice 102	326.84333	72.8585	0	1,634.9133	578.95316	0
Slice 103	327.64718	72.8495	0	1,612.6881	571.08282	0
Slice 104	328.45103	72.8405	0	1,590.463	563.21248	0
Slice 105	329.25489	72.8315	0	1,568.2378	555.34214	0
Slice 106	330.05874	72.8225	0	1,546.0127	547.4718	0
Slice 107	330.86259	72.8135	0	1,523.7875	539.60146	0
Slice 108	331.66645	72.8045	0	1,501.5624	531.73113	0
Slice 109	332.4703	72.7955	0	1,479.3372	523.86079	0
Slice 110	333.27415	72.7865	0	1,457.1121	515.99045	0

Slice 111	334.07801	72.7775	0	1,434.8869	508.12011	0
Slice 112	334.88186	72.7685	0	1,412.6618	500.24977	0
Slice 113	335.68571	72.7595	0	1,390.4366	492.37944	0
Slice 114	336.48957	72.7505	0	1,368.2115	484.5091	0
Slice 115	337.29342	72.7415	0	1,345.9863	476.63876	0
Slice 116	338.09727	72.7325	0	1,323.7612	468.76842	0
Slice 117	338.90113	72.7235	0	1,301.536	460.89808	0
Slice 118	339.70498	72.7145	0	1,279.3109	453.02774	0
Slice 119	340.50883	72.7055	0	1,257.0857	445.15741	0
Slice 120	341.31269	72.6965	0	1,234.8606	437.28707	0
Slice 121	342.11654	72.6875	0	1,212.6354	429.41673	0
Slice 122	342.92039	72.6785	0	1,190.4103	421.54639	0
Slice 123	343.72425	72.6695	0	1,168.1851	413.67605	0
Slice 124	344.5281	72.6605	0	1,145.96	405.80572	0
Slice 125	345.33195	72.6515	0	1,123.7348	397.93538	0
Slice 126	346.13581	72.6425	0	1,101.5097	390.06504	0
Slice 127	346.93966	72.6335	0	1,079.2845	382.1947	0
Slice 128	347.74351	72.6245	0	1,057.0594	374.32436	0
Slice 129	348.54737	72.6155	0	1,034.8342	366.45402	0
Slice 130	349.35122	72.6065	0	1,012.6091	358.58369	0
Slice 131	350.15507	72.5975	0	990.38394	350.71335	0
Slice 132	350.6742	72.641544	0	1,096.7514	388.38005	0
Slice 133	351.17396	72.848554	0	1,146.2885	661.80996	0
Slice 134	351.93911	73.165487	0	1,074.8657	620.57398	0

Slice 135	352.70425	73.48242	0	1,003.4429	579.33801	0
Slice 136	353.49855	73.811429	0	865.52147	315.02405	0
Slice 137	354.322	74.152513	0	805.83033	293.29825	0
Slice 138	355.14545	74.493597	0	746.13919	271.57246	0
Slice 139	355.9689	74.83468	0	686.44806	249.84666	0
Slice 140	356.79234	75.175764	0	626.75692	228.12086	0
Slice 141	357.61579	75.516848	0	567.06579	206.39507	0
Slice 142	358.43924	75.857932	0	507.37465	184.66927	0
Slice 143	359.26269	76.199016	0	447.68352	162.94347	0
Slice 144	360.08614	76.5401	0	387.99238	141.21768	0
Slice 145	360.90959	76.881184	0	328.30125	119.49188	0
Slice 146	361.73304	77.222268	0	268.61011	97.766085	0
Slice 147	362.55649	77.563352	0	208.91897	76.040288	0
Slice 148	363.37994	77.904436	0	149.22784	54.314492	0
Slice 149	364.20339	78.24552	0	89.536703	32.588695	0
Slice 150	365.02684	78.586604	0	29.845568	10.862898	0

Edgewater Unstable Areas Analysis 2018 - West Slope
Name: Circular
F of S: 1.369



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	CCR	Mohr-Coulomb	86	0	20
	Clay Liner	Mohr-Coulomb	130	0	28
	Drainage Layer	Mohr-Coulomb	115	0	30
	Geosynthetics	Mohr-Coulomb	58	0	19.5
	Subbase	Mohr-Coulomb	135	0	28

Circular

File Information

File Version: 8.16
Title: Edgewater Unstable Areas Analysis 2018 - West Slope
Comments: Running slope stability analysis on the west waste slope of Phase 3, Module 2 of the Edgewater I-43 Ash Disposal Facility. Location of analysis was selected based on longest and steepest slope at the time of peak waste placement within Module 2.
Created By: Suchomel, Brandon
Last Edited By: Suchomel, Brandon
Revision Number: 45
Date: 9/5/2018
Time: 1:09:20 PM
Tool Version: 8.16.3.14580
File Name: Western Slope of Module 2 Phase 3.gsz
Directory: I:\25218091.00\Data and Calculations\Slope Stability\
Last Solved Date: 9/5/2018
Last Solved Time: 1:17:09 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Circular

Kind: SLOPE/W
Method: Bishop
Settings
- PWP Conditions Source: (none)

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 10
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °

Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 150
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft

Materials

Subbase
Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion': 0 psf
Phi': 28 °
Phi-B: 0 °

Clay Liner
Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 28 °
Phi-B: 0 °

Geosynthetics
Model: Mohr-Coulomb
Unit Weight: 58 pcf
Cohesion': 0 psf
Phi': 19.5 °
Phi-B: 0 °

Drainage Layer
Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °

CCR
Model: Mohr-Coulomb
Unit Weight: 86 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (243.97, 118.1341) ft
Left-Zone Right Coordinate: (247.34, 118.03799) ft
Left-Zone Increment: 100
Right Projection: Range
Right-Zone Left Coordinate: (393.76, 77.51845) ft
Right-Zone Right Coordinate: (396.92, 78.19181) ft
Right-Zone Increment: 100
Radius Increments: 30

Slip Surface Limits

Left Coordinate: (0, 124.95) ft
Right Coordinate: (440.79, 86.91) ft

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	87.05
Point 3	0	85.05
Point 4	0	87.15
Point 5	34.01	75.82
Point 6	34.01	73.82
Point 7	34.01	75.92
Point 8	350.8	72.59
Point 9	350.8	70.59
Point 10	350.8	72.69
Point 11	353.74	71.61
Point 12	353.74	69.61
Point 13	353.74	71.71
Point 14	371.54	71.58
Point 15	371.54	69.58
Point 16	371.54	71.68
Point 17	379.67	70.31
Point 18	379.67	68.31
Point 19	379.67	70.41
Point 20	380.33	70.37
Point 21	380.33	68.37
Point 22	380.33	70.47
Point 23	429.74	86.05
Point 24	429.74	84.05
Point 25	429.74	86.15
Point 26	440.79	86.05

Point 27	440.79	84.05
Point 28	440.79	86.15
Point 29	440.79	0
Point 30	0	88.06
Point 31	34.01	76.88
Point 32	364.01	73.53
Point 33	371.98	72.92
Point 34	378.75	74.32
Point 35	397.24	78.26
Point 36	425.51	87.13
Point 37	430.24	89.04
Point 38	440.79	86.91
Point 39	0	124.95
Point 40	2.89	125.01
Point 41	247.62	118.03

Regions

	Material	Points	Area (ft^2)
Region 1	Subbase	1,3,6,9,12,15,18,21,24,27,29	32,320
Region 2	Clay Liner	3,2,5,8,11,14,17,20,23,26,27,24,21,18,15,12,9,6	881.58
Region 3	Geosynthetics	2,4,7,10,13,16,19,22,25,28,26,23,20,17,14,11,8,5	44.079
Region 4	Drainage Layer	4,30,31,32,33,34,35,36,37,38,28,25,22,19,16,13,10,7	551.77
Region 5	CCR	30,39,40,41,34,33,32,31	14,008

Current Slip Surface

Slip Surface: 106,000
F of S: 1.369
Volume: 1,644.7877 ft^3
Weight: 142,278.76 lbs
Resisting Moment: 8,872,216.2 lbs-ft

Activating Moment: 6,479,605.3 lbs-ft
F of S Rank (Analysis): 1 of 316,231 slip surfaces
F of S Rank (Query): 1 of 316,231 slip surfaces
Exit: (396.4776, 78.097542) ft
Entry: (245.0821, 118.10238) ft
Radius: 155.79743 ft
Center: (355.19053, 228.32476) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	245.50508	117.68306	0	27.722323	10.0901	0
Slice 2	246.35105	116.85074	0	82.997012	30.208442	0
Slice 3	247.19702	116.03097	0	137.75366	50.138233	0
Slice 4	248.12298	115.14835	0	186.51865	67.887238	0
Slice 5	249.12894	114.20505	0	229.11109	83.389617	0
Slice 6	250.13491	113.27829	0	270.839	98.577333	0
Slice 7	251.14087	112.36765	0	311.71134	113.45365	0
Slice 8	252.14683	111.47278	0	351.73691	128.02177	0
Slice 9	253.1528	110.5933	0	390.92429	142.28481	0
Slice 10	254.15876	109.72888	0	429.28189	156.24583	0
Slice 11	255.16472	108.87918	0	466.8179	169.90782	0
Slice 12	256.17069	108.0439	0	503.54035	183.2737	0
Slice 13	257.17665	107.22274	0	539.45704	196.3463	0
Slice 14	258.18261	106.41541	0	574.5756	209.12842	0
Slice 15	259.18858	105.62164	0	608.90346	221.62273	0
Slice 16	260.19454	104.84117	0	642.44785	233.83189	0
Slice 17	261.2005	104.07374	0	675.21582	245.75846	0
Slice 18	262.20647	103.31912	0	707.21423	257.40493	0
Slice 19	263.21243	102.57708	0	738.44975	268.77373	0
Slice 20	264.21839	101.84739	0	768.92888	279.86723	0
Slice 21	265.22436	101.12984	0	798.65794	290.68772	0
Slice 22	266.23032	100.42424	0	827.64305	301.23744	0
	267.23628	99.730368	0	855.89019	311.51855	0

Slice 23						
Slice 24	268.24225	99.048052	0	883.40516	321.53318	0
Slice 25	269.24821	98.377107	0	910.19358	331.28337	0
Slice 26	270.25417	97.717356	0	936.26092	340.77111	0
Slice 27	271.26014	97.068632	0	961.61249	349.99832	0
Slice 28	272.2661	96.43077	0	986.25345	358.9669	0
Slice 29	273.27206	95.803616	0	1,010.1888	367.67865	0
Slice 30	274.27803	95.187016	0	1,033.4234	376.13535	0
Slice 31	275.28399	94.580825	0	1,055.9619	384.33869	0
Slice 32	276.28995	93.984903	0	1,077.8089	392.29035	0
Slice 33	277.29592	93.399112	0	1,098.9688	399.99193	0
Slice 34	278.30188	92.823322	0	1,119.4459	407.44499	0
Slice 35	279.30784	92.257406	0	1,139.2443	414.65103	0
Slice 36	280.31381	91.701241	0	1,158.3681	421.61152	0
Slice 37	281.31977	91.154709	0	1,176.8211	428.32787	0
Slice 38	282.32573	90.617694	0	1,194.6071	434.80144	0
Slice 39	283.3317	90.090086	0	1,211.7297	441.03356	0
Slice 40	284.33766	89.571777	0	1,228.1925	447.0255	0
Slice 41	285.34362	89.062664	0	1,243.9987	452.77849	0
Slice 42	286.34959	88.562646	0	1,259.1517	458.29373	0
Slice 43	287.35555	88.071625	0	1,273.6546	463.57237	0
Slice 44	288.36151	87.589509	0	1,287.5105	468.6155	0
Slice 45	289.36748	87.116204	0	1,300.7223	473.42419	0
Slice 46	290.37344	86.651624	0	1,313.2928	477.99948	0

Slice 47	291.3794	86.195683	0	1,325.2247	482.34234	0
Slice 48	292.38537	85.748297	0	1,336.5206	486.45373	0
Slice 49	293.39133	85.309386	0	1,347.1831	490.33455	0
Slice 50	294.39729	84.878873	0	1,357.2145	493.98568	0
Slice 51	295.40326	84.456682	0	1,366.6171	497.40795	0
Slice 52	296.40922	84.042741	0	1,375.3932	500.60217	0
Slice 53	297.41518	83.636977	0	1,383.5447	503.5691	0
Slice 54	298.42115	83.239324	0	1,391.0738	506.30946	0
Slice 55	299.42711	82.849713	0	1,397.9823	508.82395	0
Slice 56	300.43307	82.468081	0	1,404.2721	511.11323	0
Slice 57	301.43903	82.094366	0	1,409.9448	513.17793	0
Slice 58	302.445	81.728506	0	1,415.0021	515.01863	0
Slice 59	303.45096	81.370443	0	1,419.4455	516.63591	0
Slice 60	304.45692	81.02012	0	1,423.2765	518.03028	0
Slice 61	305.46289	80.677482	0	1,426.4964	519.20225	0
Slice 62	306.46885	80.342476	0	1,429.1066	520.15226	0
Slice 63	307.47481	80.01505	0	1,431.1081	520.88076	0
Slice 64	308.48078	79.695154	0	1,432.5022	521.38815	0
Slice 65	309.48674	79.382739	0	1,433.2897	521.67479	0
Slice 66	310.4927	79.077759	0	1,433.4717	521.74101	0
Slice 67	311.49867	78.780167	0	1,433.0489	521.58714	0
Slice 68	312.50463	78.48992	0	1,432.0221	521.21343	0
Slice 69	313.51059	78.206976	0	1,430.3921	520.62015	0
Slice 70	314.51656	77.931292	0	1,428.1594	519.80749	0

Slice 71	315.52252	77.66283	0	1,425.3244	518.77566	0
Slice 72	316.52848	77.40155	0	1,421.8877	517.52481	0
Slice 73	317.53445	77.147415	0	1,417.8496	516.05505	0
Slice 74	318.54041	76.90039	0	1,413.2103	514.3665	0
Slice 75	319.54637	76.66044	0	1,407.9701	512.45921	0
Slice 76	320.55234	76.427531	0	1,402.129	510.33322	0
Slice 77	321.5583	76.20163	0	1,395.687	507.98854	0
Slice 78	322.56426	75.982708	0	1,388.6442	505.42515	0
Slice 79	323.57023	75.770732	0	1,381.0003	502.643	0
Slice 80	324.57619	75.565676	0	1,372.7551	499.642	0
Slice 81	325.58215	75.36751	0	1,363.9084	496.42204	0
Slice 82	326.58812	75.176208	0	1,354.4596	492.98299	0
Slice 83	327.59408	74.991745	0	1,344.4085	489.32468	0
Slice 84	328.60004	74.814095	0	1,333.7544	485.44689	0
Slice 85	329.60601	74.643236	0	1,322.4966	481.34941	0
Slice 86	330.61197	74.479143	0	1,310.6346	477.03198	0
Slice 87	331.61793	74.321797	0	1,298.1674	472.4943	0
Slice 88	332.6239	74.171176	0	1,285.0942	467.73605	0
Slice 89	333.62986	74.02726	0	1,271.4141	462.75689	0
Slice 90	334.63582	73.890031	0	1,257.1259	457.55643	0
Slice 91	335.64716	73.75881	0	1,220.5462	704.68269	0
Slice 92	336.66386	73.633651	0	1,209.4867	698.29749	0
Slice 93	337.68056	73.51527	0	1,197.6162	691.44404	0
Slice 94	338.69727	73.403652	0	1,184.9305	684.11996	0

Slice 95	339.71397	73.298781	0	1,171.4254	676.32274	0
Slice 96	340.73068	73.200646	0	1,157.0963	668.04984	0
Slice 97	341.74738	73.109232	0	1,141.9387	659.29859	0
Slice 98	342.76408	73.024527	0	1,125.9478	650.06627	0
Slice 99	343.78079	72.946522	0	1,109.1188	640.35003	0
Slice 100	344.79749	72.875205	0	1,091.4466	630.14698	0
Slice 101	345.81419	72.810568	0	1,072.9259	619.45408	0
Slice 102	346.8309	72.752602	0	1,053.5515	608.26825	0
Slice 103	347.90876	72.698638	0	1,038.6508	367.80553	0
Slice 104	349.04779	72.649519	0	1,011.4207	358.16284	0
Slice 105	350.20865	72.608127	0	983.05651	348.11857	0
Slice 106	350.96459	72.584742	0	967.36629	342.56237	0
Slice 107	351.62459	72.568934	0	950.53176	548.78977	0
Slice 108	352.61542	72.549402	0	926.79715	535.08658	0
Slice 109	353.60625	72.536174	0	902.21312	520.89299	0
Slice 110	354.59709	72.529249	0	876.77337	506.20534	0
Slice 111	355.58792	72.528625	0	850.47144	491.01991	0
Slice 112	356.57875	72.534303	0	823.30065	475.33285	0
Slice 113	357.56959	72.546284	0	795.25415	459.1402	0
Slice 114	358.56042	72.564568	0	766.32486	442.43787	0
Slice 115	359.55125	72.589159	0	736.50553	425.22166	0
Slice 116	360.54208	72.620058	0	705.78865	407.48727	0
Slice 117	361.53292	72.65727	0	674.16654	389.23023	0
Slice 118	362.52375	72.7008	0	641.63126	370.44598	0

Slice 119	363.51458	72.750652	0	608.17464	351.12979	0
Slice 120	364.51354	72.807346	0	572.50478	330.53579	0
Slice 121	365.52063	72.870994	0	534.5874	308.64418	0
Slice 122	366.52771	72.941194	0	495.67986	286.1809	0
Slice 123	367.5348	73.017957	0	455.77241	263.14032	0
Slice 124	368.54188	73.101292	0	414.85499	239.51664	0
Slice 125	369.52968	73.189363	0	370.6537	134.90691	0
Slice 126	370.49818	73.281933	0	334.60383	121.78583	0
Slice 127	371.46668	73.380612	0	297.89026	108.42319	0
Slice 128	372.43518	73.485412	0	260.50822	94.817238	0
Slice 129	373.40369	73.596345	0	222.45278	80.966192	0
Slice 130	374.37219	73.713425	0	183.71888	66.868205	0
Slice 131	375.34069	73.836665	0	144.3013	52.521378	0
Slice 132	376.3092	73.96608	0	104.19466	37.923753	0
Slice 133	377.2777	74.101685	0	63.393407	23.073313	0
Slice 134	378.25597	74.244992	0	21.46659	7.8131999	0
Slice 135	379.24243	74.395891	0	3.5751225	2.0640979	0
Slice 136	380.2273	74.553012	0	10.097993	5.8300792	0
Slice 137	381.21217	74.716609	0	15.857989	9.1556139	0
Slice 138	382.19703	74.886701	0	20.845845	12.035354	0
Slice 139	383.1819	75.063311	0	25.052037	14.4638	0
Slice 140	384.16677	75.246461	0	28.466768	16.435296	0
Slice 141	385.15163	75.436174	0	31.079959	17.944023	0
Slice 142	386.1365	75.632476	0	32.881238	18.983992	0

Slice 143	387.12137	75.835391	0	33.859928	19.549038	0
Slice 144	388.10623	76.044946	0	34.005036	19.632817	0
Slice 145	389.0911	76.261168	0	33.30524	19.228789	0
Slice 146	390.07597	76.484086	0	31.748877	18.330223	0
Slice 147	391.06083	76.71373	0	29.323927	16.930177	0
Slice 148	392.0457	76.950129	0	26.018001	15.0215	0
Slice 149	393.03057	77.193316	0	21.818323	12.596815	0
Slice 150	394.01543	77.443324	0	16.711717	9.6485145	0
Slice 151	395.0003	77.700187	0	10.684588	6.1687499	0
Slice 152	395.98517	77.963939	0	3.7229049	2.1494202	0

Appendix A8

Seepage Potential and Karst Condition Assessment

Seepage Potential and Karst Condition Assessment

The disposal facility is designed and constructed to include storm water run-on and run-off management and leachate collection systems. The clay soils below the facility have a low permeability on the order of 5 x 10-8 cm/sec resulting in groundwater levels that are typically within 10 feet of the ground surface. Groundwater monitoring in 2016 and 2017 at monitoring wells adjacent to the facility show downward hydraulic gradients, confirming that groundwater movement resulting in unstable areas is not a concern. There are currently no concerns that storm water, leachate, or groundwater movement will impact the stability of the landfill.

As noted in **Appendix A4**, karst features were not observed in the borings within and adjacent to the disposal facility. The borings encountered up to 90 feet of predominantly clay till. The total sequence of sediment is about 150 feet thick as indicated by water supply records in the area of the facility. Because of the multiple glacial advances and associated erosional and depositional processes resulting in a thick sediment layer overlying the bedrock, the area is not likely to be unstable due to karstic processes.

References

BT2, Inc., 2008, Plan of Operation, Edgewater I-43 Ash Disposal Facility, Phases 3 and 4.
SCS Engineers, 2018, Biennial Groundwater Monitoring Report for 2016-2017, Wisconsin Power and Light Company, Edgewater I-43 Ash Disposal Facility, Sheboygan, Wisconsin.

DLN/AJR/EJN
MJT, 12/7/2022

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Appendix A9

FEMA Flood Insurance Rate Map

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures.** Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 16. The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum.** For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242,** or visit its website at http://www.ngs.noaa.gov/.

Base map information shown on this FIRM was derived from the National Agriculture Imagery Program's (NAIP) digital orthoimagery produced by the USDA, Farm Service Agency at a resolution of 1 meter and collected during the summer of 2005.

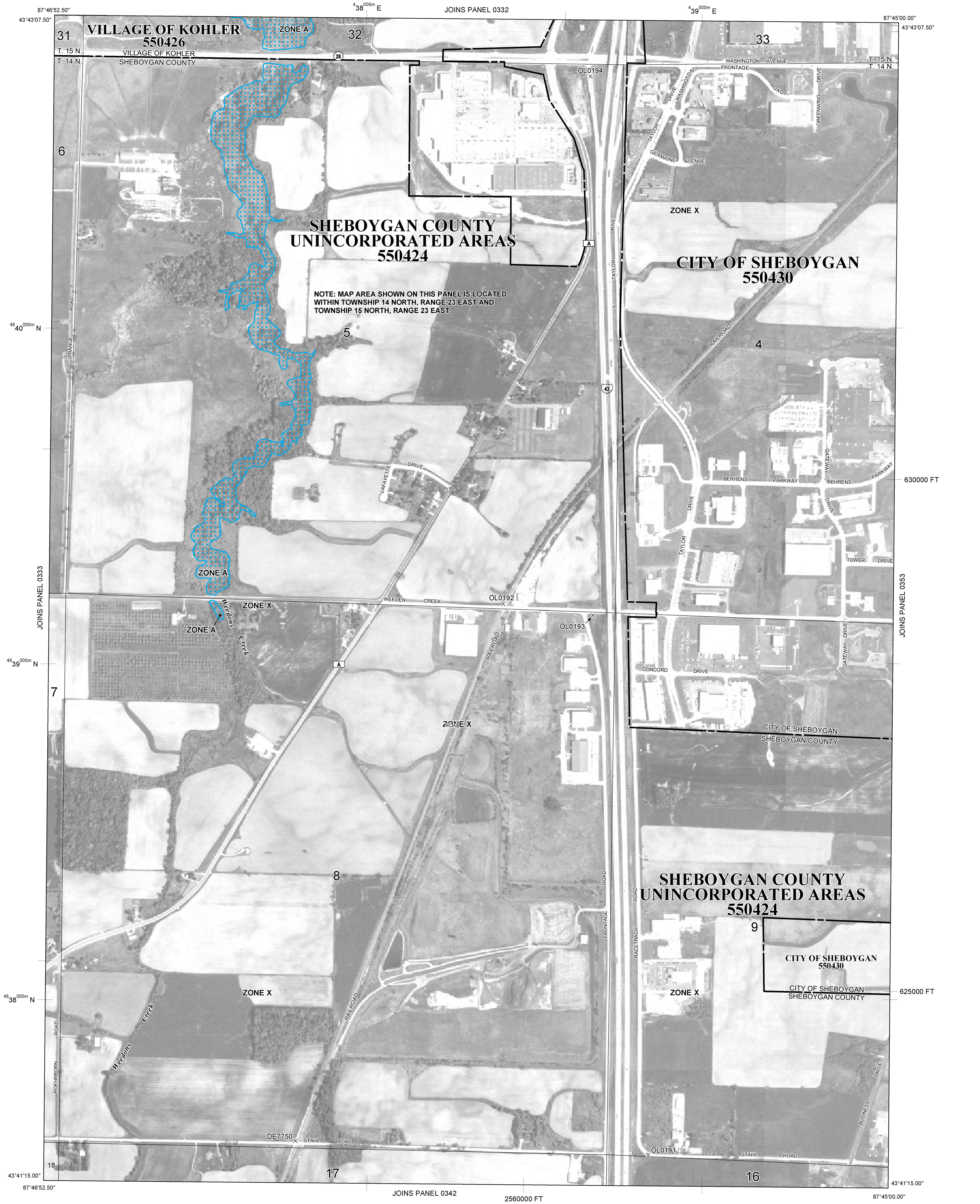
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data*) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 16
6000000 FT	5000-foot grid ticks: Wisconsin State Plane coordinate system, south zone (FIPSZONE 4803), Lambert Conformal Conic
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
April 2, 2009
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

PANEL 0334F

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

SHEBOYGAN COUNTY, WISCONSIN

AND INCORPORATED AREAS

PANEL 334 OF 495
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SHEBOYGAN COUNTY	550424	0334	F
KOHLER, VILLAGE OF	550426	0334	F
SHEBOYGAN, CITY OF	550430	0334	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
55117C0334F

EFFECTIVE DATE
APRIL 2, 2009

Federal Emergency Management Agency

Appendix B

Landfill Design Demonstration

Appendix B.1

Storm Water Management Calculations for Post Closure Conditions

Appendix B1.1

2008 Plan of Operation Storm Water Calculations

Appendix G
Surface Water Management Calculations

Purpose:

The purpose of the surface water runoff calculations is to demonstrate the following:

- The proposed Phase 3 and 4 landfill expansion surface water management system design meets the requirements of NR 504.09 Wis. Admin. Code.
- That the stormwater design features installed in 1984, (i.e., the detention/sedimentation basin, detention basin, outlet structures, and swales) are adequate for current regulations.

Existing Features:

There are two stormwater outlets for the site. These outlets are; 1) an 36-inch diameter culvert under the railroad tracks to the west of the site and 2) an 24-inch diameter culvert under the railroad tracks. The culverts are shown on Figure G1.

The detention/sedimentation basin, detention basin, run-on diversion swale, perimeter swales around Phases 1 and 2, and culverts were installed in 1984. Currently, runoff from the areas of Phase 1 and 2 of the landfill that are at final grades is directed to the detention/sedimentation basin for treatment and runoff from the active portion of Phase 1 and 2 is directed to the interior Southern Ash Contact Holding Basin for use as dust control water. When Phase 1 and 2 are complete, runoff will be directed to the detention/sedimentation basin. Stormwater from off-site of the landfill to the east is directed via the run-on diversion swale to the detention basin for treatment.

The detention/sedimentation basin discharges through a 24-inch riser outlet structure to the 36-inch diameter culvert under the railroad tracks to the west. The detention basin discharges through an 18-inch riser outlet structure to the 24-inch diameter culvert under the railroad tracks.

Methodologies:

Design of Stormwater Management Features:
To design the storm water management features, runoff hydrographs for the 25-year, 24-hour and 100-year, 24-hour storm event were developed. Hydrographs were developed using the TR-55 method contained within the Pond Pack® computer model developed by Bentley Systems, Inc. The TR-55 method for computing hydrographs is based on the methodologies presented in the Urban Hydrology for Small Watersheds manual developed by the Natural Resources Conservation Service (NRCS). The TR-55 model is designed to simulate the surface response of a watershed to a precipitation event. Input parameters for the model include precipitation depth for a given storm event, contributing drainage areas, runoff curve numbers, time of concentration, and travel time. The TR-55 model develops a runoff hydrograph for the watershed.

The following assumptions were used in the TR-55 model:

- The rainfall depths used were: 4.4 in for the 25-yr storm event and 5.1 in for the 100-yr event.
- A runoff curve number (CN) of 80 was used. This CN is for pasture in good condition (>75% ground cover) and a hydrologic soil group D.
- Sheet flow was assumed for the top of the landfill across the final grades.
- For flow in the perimeter swales, a mannings n value of 0.035 was used.

The hydrograph developed by TR-55 was routed through the existing detention/sedimentation basin and outlet using the Pond Pack® model to determine the outflow from the basin.

The sediment removal properties for the basins were evaluated using the P8 Urban Catchment Model. Wis. Admin. Code NR 504.09 requires sediment control measures be designed to settle 0.015 mm (15 micron) particle. Settling of the 15-micron particle corresponds to a trapping efficiency of 49%.

The design of the swales and culverts surrounding the landfill was evaluated using a channel and culvert calculator included in AutoCAD 2008. The channel calculator uses Manning's Equation to determine the maximum flow that a channel can carry given the geometry of the channel.

RESULTS:

The proposed surface water management system design meets the requirements of s. NR 504.09, Wis. Admin. Code. Further details are provided below.

Runoff Calculations

Runoff from Phases 1 and 2 of the landfill flows to the perimeter swales around the landfill and is directed to the sedimentation/detention basin.

Phase 3 & 4 of the landfill can be divided into 3 watersheds. The watersheds are shown on Figure G1. A southwest watershed that drains to the south and west perimeter swale of the landfill, a northeast watershed that drains to the north and northeast perimeter swale of the landfill, and a third watershed is located in the northern portion of the landfill and drains directly into the sedimentation/detention basin. This third watershed is small, approximately 2 acres, and considered insignificant and no runoff is calculated for this watershed.

Drainage Area	Area (acres)	Runoff Curve Number	Time of Concentration (hr)	25-yr Storm Peak Runoff
Phases 1&2	53.1	80	0.61	107.2 cfs
Ph 3&4 Southwest	32.0	80	0.78	55.4 cfs
PH 3&4 Northeast	13.3	80	0.51	30.7 cfs

Sedimentation / Detention Basin
All of these runoff from these watersheds is directed to the sedimentation / detention basin by the perimeter swales. The outlet structure of this basin is a 24-inch diameter riser outlet structure with a 25 foot wide emergency spillway located at elevation 685.0 ft with a top of berm elevation of 686.0 ft.

The flow through the sedimentation / detention basin was simulated using the Pond Pack® computer model. The peak inflow into the basin was 188.9 cfs for the 25-yr storm event. The peak outflow for the 25-yr storm event through the outlet structure was 37.3 cfs with a peak water elevation of 685.37. The 100-yr storm event was also modeled to ensure the emergency spillway was adequate, the peak elevation in the detention basin for the 100-yr storm was 685.79 ft.

Due to the water elevation during the 25-yr storm event (685.41) being above the elevation of the emergency spillway (685.0), a new outlet of the sedimentation/detention basin was designed. The new outlet design is shown on the detail drawings and consists of a 36-inch diameter CMP culvert with a 36-inch diameter CMP riser. This new outlet structure will need to be installed when the base grades for

Phase 4, Module 2 of the landfill is prepared. At the current rate of ash disposal, the outlet will not need to be replaced for approximately 10 years after disposal begins in Phase 3, Module 1.

The runoff for the site when Phase 3 Modules 1 and 2 and Phase 4 Module 1 are at final grades and contribute to the runoff going to the detention / sedimentation basin was also calculated to ensure the runoff from the 25-year storm event is contained within the basin using the existing outlet structure. The maximum water level obtained within the basin during the 25-yr storm event is 684.98 with a peak outflow of 19.8 cfs. The peak water level obtained during the 100-year storm event is 685.43 with a peak outflow of 41.6 cfs.

the proposed outlet structure for the detention / sedimentation basin was also modeled to ensure the 25-year storm event runoff from the entire Phase 3 and 4 can be contained within the basin. The maximum water level obtained within the basin during the 25-yr storm event is 684.99 with a peak outflow of 38.1 cfs. The peak water level obtained during the 100-year storm event is 685.45 with a peak outflow of 73.1 cfs. The basin will also take longer than 3 day to completely drain.

Detention Basin
Stormwater run-on is directed to the detention basin by the run-on diversion swale. The off-site area that contributes to run-on is approximately 91 acres. The outlet structure of the detention basin is an 18-inch diameter riser outlet structure with a 25-ft wide emergency spillway at elevation 691.0 and a top of berm elevation of 693.0 ft. The flow through the detention basin was simulated using the Pond Pack® computer model. The peak outflow for the 25-yr storm is 8.8 cfs with a peak elevation of 688.4 ft. The peak outflow for the 100-yr storm is 12.2 cfs with a peak elevation of 689.3 ft. The basin will also take longer than 3 day to completely drain.

Sediment Removal

The sediment removal properties for the basins were evaluated using the P8 Urban Catchment Model. Wis. Admin. Code NR 504.09 requires sediment control measures be designed to settle 0.015 mm (15 micron) particle. Settling of the 15-micron particle corresponds to a trapping efficiency of 49%.

The P8 model showed the sedimentation / detention basin will capture 69.9% of the total suspended solids (TSS) and the detention basin will capture 74.2% of the TSS.

Perimeter Swale Sizing

The design of the perimeter swales surrounding the landfill was evaluated using a channel calculator included in AutoCAD 2008. The channel calculator uses Manning's Equation to determine the maximum flow that a channel can carry given the geometry of the channel.

The channel calculator shows the swales can carry the 25-yr storm event with a minimum of 0.5 feet of freeboard.

There will be a culvert installed in the swale to provide access to the leachate pumpout riser. The culvert calculator shows that two 24-inch diameter corrugated metal pipes (CMP) culverts can carry the design flow.

Intermediate Diversion Swales

The Universal Soil Loss Equation (USLE) was used to determine if intermediate diversion berms were required on the final grades to prevent erosion. The equation showed that no berms were required.

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Runoff Calculation

Phase 1 & 2

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RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Phases 1&2	84	53.100			84.00
COMPOSITE AREA & WEIGHTED CN --->		53.100			84.00 (84)

Table of Contents

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TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

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Segment #1:  Tc: TR-55 Sheet

Mannings n            .2400
Hydraulic Length    170.00 ft
2yr, 24hr P         2.5000 in
Slope              .040000 ft/ft

Avg.Velocity           .15 ft/sec

                                        Segment #1 Time:      .3118 hrs
----------------------------------------------------------------------

Segment #2:  Tc: TR-55 Sheet

Mannings n            .2400
Hydraulic Length     50.00 ft
2yr, 24hr P         2.5000 in
Slope              .130000 ft/ft

Avg.Velocity           .19 ft/sec

                                        Segment #2 Time:      .0731 hrs
----------------------------------------------------------------------

Segment #3:  Tc: TR-55 Channel

Flow Area          13.5000 sq.ft
Wetted Perimeter     16.30 ft
Hydraulic Radius       .83 ft
Slope              .012000 ft/ft
Mannings n           .0350
Hydraulic Length   3350.00 ft

Avg.Velocity          4.11 ft/sec

                                        Segment #3 Time:      .2263 hrs
----------------------------------------------------------------------

                                              ========================
                                               Total Tc:     .6111 hrs
                                              ========================
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 year storm
Duration       = 24.0000 hrs     Rain Depth = 4.4000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID = work_pad.hyg - PHASE 1+2 Dev 25
Tc             = .6111 hrs
Drainage Area = 53.100 acres  Runoff CN= 84

============================================
Computational Time Increment   =   .08148 hrs
Computed Peak Time             =  12.2224 hrs
Computed Peak Flow             =   108.07 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.2500 hrs
Peak Flow, Interpolated Output =   107.19 cfs
============================================

              DRAINAGE AREA
             -------------------
             ID:PHASE 1+2
             CN    =   84
             Area =       53.100 acres
             S     =   1.9048 in
             0.2S =     .3810 in

              Cumulative Runoff
             -------------------
                     2.7267 in
                     12.066 ac-ft

HYG Volume...        12.065 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .61112 hrs (ID: PHASE 1+2)
Computational Incr, Tm =   .08148 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,           qp =    98.45 cfs
Unit peak time       Tp =   .40741 hrs
Unit receding limb, Tr =  1.62966 hrs
Total unit time,     Tb =  2.03707 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration       = 24.0000 hrs     Rain Depth = 5.1000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID  =  - TypeII  24hr
Unit Hyd Type  = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID  = work_pad.hyg - PHASE 1+2 Dev100
Tc             = .6111 hrs
Drainage Area  = 53.100 acres  Runoff CN= 84

============================================
Computational Time Increment   =   .08148 hrs
Computed Peak Time             =  12.2224 hrs
Computed Peak Flow             =   133.12 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.2500 hrs
Peak Flow, Interpolated Output =   131.89 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:PHASE 1+2
              CN    =   84
              Area  =     53.100 acres
              S     =   1.9048 in
              0.2S  =    .3810 in

               Cumulative Runoff
              -------------------
                      3.3620 in
                      14.877 ac-ft

HYG Volume...         14.876 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .61112 hrs (ID: PHASE 1+2)
Computational Incr, Tm =   .08148 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,           qp =    98.45 cfs
Unit peak time       Tp =   .40741 hrs
Unit receding limb,  Tr =  1.62966 hrs
Total unit time,     Tb =  2.03707 hrs
```

Runoff Calculation

Phase 3 & 4 Northeast Drainage Area

Table of Contents

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Northeast	84	13.300			84.00
COMPOSITE AREA & WEIGHTED CN --->		13.300			84.00 (84)

Table of Contents

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: TR-55 Sheet

Mannings n	.2400	
Hydraulic Length	160.00	ft
2yr, 24hr P	2.5000	in
Slope	.030000	ft/ft
Avg.Velocity	.13	ft/sec

Segment #1 Time: .3332 hrs

Segment #2: Tc: TR-55 Sheet

Mannings n	.2400	
Hydraulic Length	30.00	ft
2yr, 24hr P	2.5000	in
Slope	.250000	ft/ft
Avg.Velocity	.22	ft/sec

Segment #2 Time: .0374 hrs

Segment #3: Tc: TR-55 Channel

Flow Area	5.9000	sq.ft
Wetted Perimeter	13.60	ft
Hydraulic Radius	.43	ft
Slope	.025000	ft/ft
Mannings n	.0350	
Hydraulic Length	730.00	ft
Avg.Velocity	3.86	ft/sec

Segment #3 Time: .0526 hrs

Segment #4: Tc: TR-55 Channel

Flow Area	5.9000	sq.ft
Wetted Perimeter	13.60	ft
Hydraulic Radius	.43	ft
Slope	.010000	ft/ft
Mannings n	.0350	
Hydraulic Length	580.00	ft
Avg.Velocity	2.44	ft/sec

Segment #4 Time: .0660 hrs

Segment #5: Tc: TR-55 Channel

Flow Area	13.5000	sq.ft
Wetted Perimeter	16.30	ft
Hydraulic Radius	.83	ft
Slope	.025000	ft/ft
Mannings n	.0350	
Hydraulic Length	350.00	ft
Avg.Velocity	5.94	ft/sec

Segment #5 Time: .0164 hrs

Total Tc: .5056 hrs

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 year storm
Duration       = 24.0000 hrs     Rain Depth = 4.4000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID = work_pad.hyg - PHASE 3+4 NE Dev 25
Tc             = .5056 hrs
Drainage Area = 13.300 acres  Runoff CN= 84

============================================
Computational Time Increment   =   .06741 hrs
Computed Peak Time             =  12.2021 hrs
Computed Peak Flow             =    30.71 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.2000 hrs
Peak Flow, Interpolated Output =    30.69 cfs
============================================

                DRAINAGE AREA
              -------------------
              ID:PHASE 3+4 NE
              CN    =   84
              Area =       13.300 acres
              S     =   1.9048 in
              0.2S =     .3810 in

               Cumulative Runoff
              -------------------
                     2.7267 in
                      3.022 ac-ft

HYG Volume...           3.022 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .50561 hrs (ID: PHASE 3+4 NE)
Computational Incr, Tm =   .06741 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,           qp =    29.80 cfs
Unit peak time       Tp =   .33707 hrs
Unit receding limb, Tr =  1.34829 hrs
Total unit time,     Tb =  1.68537 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration       = 24.0000 hrs     Rain Depth = 5.1000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID = work_pad.hyg - PHASE 3+4 NE Dev100
Tc             = .5056 hrs
Drainage Area = 13.300 acres  Runoff CN= 84

============================================
Computational Time Increment   =   .06741 hrs
Computed Peak Time             =  12.2021 hrs
Computed Peak Flow             =    37.72 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.2000 hrs
Peak Flow, Interpolated Output =    37.70 cfs
============================================

                DRAINAGE AREA
              -------------------
              ID:PHASE 3+4 NE
              CN    =   84
              Area =      13.300 acres
              S     =   1.9048 in
              0.2S =     .3810 in

               Cumulative Runoff
              -------------------
                      3.3620 in
                       3.726 ac-ft

HYG Volume...           3.726 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .50561 hrs (ID: PHASE 3+4 NE)
Computational Incr, Tm =   .06741 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,           qp =    29.80 cfs
Unit peak time       Tp =   .33707 hrs
Unit receding limb, Tr =  1.34829 hrs
Total unit time,     Tb =  1.68537 hrs
```

Runoff Calculation

Phase 3 & 4 Southwest Drainage Area

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
Southwest Area	84	32.000			84.00
COMPOSITE AREA & WEIGHTED CN --->		32.000			84.00 (84)

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```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

----------------------------------------------------------------------

Segment #1:  Tc: TR-55 Sheet

Mannings n           .2400
Hydraulic Length   130.00 ft
2yr, 24hr P        2.5000 in
Slope             .030000 ft/ft

Avg.Velocity          .13 ft/sec

                                        Segment #1 Time:      .2822 hrs
----------------------------------------------------------------------

Segment #2:  Tc: TR-55 Sheet

Mannings n           .2400
Hydraulic Length    30.00 ft
2yr, 24hr P        2.5000 in
Slope             .250000 ft/ft

Avg.Velocity          .22 ft/sec

                                        Segment #2 Time:      .0374 hrs
----------------------------------------------------------------------

Segment #3:  Tc: TR-55 Channel

Flow Area          5.9000 sq.ft
Wetted Perimeter    13.60 ft
Hydraulic Radius      .43 ft
Slope             .015000 ft/ft
Mannings n          .0350
Hydraulic Length   940.00 ft

Avg.Velocity         2.99 ft/sec

                                        Segment #3 Time:      .0874 hrs
----------------------------------------------------------------------
```

Segment #4: Tc: TR-55 Channel

Flow Area	5.9000	sq.ft
Wetted Perimeter	13.60	ft
Hydraulic Radius	.43	ft
Slope	.014000	ft/ft
Mannings n	.0350	
Hydraulic Length	1300.00	ft

Avg.Velocity 2.89 ft/sec

Segment #4 Time: .1251 hrs

Segment #5: Tc: TR-55 Channel

Flow Area	13.5000	sq.ft
Wetted Perimeter	16.30	ft
Hydraulic Radius	.83	ft
Slope	.003300	ft/ft
Mannings n	.0350	
Hydraulic Length	1900.00	ft

Avg.Velocity 2.16 ft/sec

Segment #5 Time: .2447 hrs

Total Tc: .7768 hrs

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 year storm
Duration       = 24.0000 hrs     Rain Depth = 4.4000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID = work_pad.hyg - PHASE 3+4 SW Dev 25
Tc             = .7768 hrs
Drainage Area = 32.000 acres  Runoff CN= 84

============================================
Computational Time Increment   =   .10358 hrs
Computed Peak Time             =  12.3255 hrs
Computed Peak Flow             =    55.83 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.3500 hrs
Peak Flow, Interpolated Output =    55.41 cfs
============================================

                DRAINAGE AREA
              -------------------
              ID:PHASE 3+4 SW
              CN   =   84
              Area =      32.000 acres
              S    =   1.9048 in
              0.2S =    .3810 in

               Cumulative Runoff
              -------------------
                      2.7267 in
                       7.271 ac-ft

HYG Volume...          7.269 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .77682 hrs (ID: PHASE 3+4 SW)
Computational Incr, Tm =   .10358 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,           qp =    46.67 cfs
Unit peak time       Tp =   .51788 hrs
Unit receding limb, Tr =  2.07151 hrs
Total unit time,     Tb =  2.58939 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration       = 24.0000 hrs     Rain Depth = 5.1000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID = work_pad.hyg - PHASE 3+4 SW Dev100
Tc             = .7768 hrs
Drainage Area = 32.000 acres  Runoff CN= 84

============================================
Computational Time Increment   =   .10358 hrs
Computed Peak Time             =  12.3255 hrs
Computed Peak Flow             =    68.81 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.3500 hrs
Peak Flow, Interpolated Output =    68.24 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:PHASE 3+4 SW
              CN   =   84
              Area =      32.000 acres
              S    =   1.9048 in
              0.2S =    .3810 in

               Cumulative Runoff
              -------------------
                      3.3620 in
                       8.965 ac-ft

HYG Volume...          8.963 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .77682 hrs (ID: PHASE 3+4 SW)
Computational Incr, Tm =   .10358 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,           qp =    46.67 cfs
Unit peak time       Tp =   .51788 hrs
Unit receding limb, Tr =  2.07151 hrs
Total unit time,     Tb =  2.58939 hrs
```

Detention / Sedimentation Basin Routing
Existing Outlet Structure

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
681.46	-----	2.7500	.0000	.000	.000
682.00	-----	2.8800	8.4442	1.520	1.520
684.00	-----	3.2100	9.1305	6.087	7.607
686.00	-----	4.0000	10.7933	7.196	14.802

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 681.46 ft
Increment = .10 ft
Max. Elev.= 686.00 ft

****
OUTLET CONNECTIVITY
****

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Orifice-Area	O4	--->	C0	682.000	686.000
Orifice-Area	O5	--->	C0	682.250	686.000
Orifice-Area	O1	--->	C0	682.500	686.000
Orifice-Area	O6	--->	C0	682.750	686.000
Orifice-Area	O2	--->	C0	683.000	686.000
Orifice-Area	O7	--->	C0	683.250	686.000
Orifice-Area	O3	--->	C0	683.500	686.000
Stand Pipe	R0	--->	C0	684.030	686.000
Orifice-Area	O0	--->	C0	681.830	686.000
Culvert-Circular	C0	--->	TW	681.460	686.000
Weir-Rectangular	W0	--->	TW	685.000	686.000
TW SETUP, DS Channel					

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = O4
Structure Type     = Orifice-Area
------------------------------------
# of Openings      =        4
Invert Elev.       =    682.00 ft
Area               =     .0210 sq.ft
Top of Orifice     =       .00 ft
Datum Elev.        =    682.00 ft
Orifice Coeff.     =      .700


Structure ID       = O5
Structure Type     = Orifice-Area
------------------------------------
# of Openings      =        4
Invert Elev.       =    682.25 ft
Area               =     .0210 sq.ft
Top of Orifice     =       .00 ft
Datum Elev.        =    682.25 ft
Orifice Coeff.     =      .700


Structure ID       = O1
Structure Type     = Orifice-Area
------------------------------------
# of Openings      =        4
Invert Elev.       =    682.50 ft
Area               =     .0210 sq.ft
Top of Orifice     =       .00 ft
Datum Elev.        =    682.50 ft
Orifice Coeff.     =      .700
```

OUTLET STRUCTURE INPUT DATA

Structure ID = O6
Structure Type = Orifice-Area

# of Openings	=	4
Invert Elev.	=	682.75 ft
Area	=	.0210 sq.ft
Top of Orifice	=	.00 ft
Datum Elev.	=	682.75 ft
Orifice Coeff.	=	.700

Structure ID = O2
Structure Type = Orifice-Area

# of Openings	=	4
Invert Elev.	=	683.00 ft
Area	=	.0210 sq.ft
Top of Orifice	=	.00 ft
Datum Elev.	=	683.00 ft
Orifice Coeff.	=	.700

Structure ID = O7
Structure Type = Orifice-Area

# of Openings	=	4
Invert Elev.	=	683.25 ft
Area	=	.0210 sq.ft
Top of Orifice	=	.00 ft
Datum Elev.	=	683.25 ft
Orifice Coeff.	=	.700

Structure ID = O3
Structure Type = Orifice-Area

# of Openings	=	4
Invert Elev.	=	683.50 ft
Area	=	.0210 sq.ft
Top of Orifice	=	.00 ft
Datum Elev.	=	683.50 ft
Orifice Coeff.	=	.700

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = R0
Structure Type     = Stand Pipe
------------------------------------
# of Openings      =        1
Invert Elev.       =    684.03 ft
Diameter           =    2.0000 ft
Orifice Area       =    3.1416 sq.ft
Orifice Coeff.     =      .700
Weir Length        =      6.28 ft
Weir Coeff.        =     3.300
K, Reverse         =     1.000
Mannings n         =     .0000
Kev,Charged Riser  =      .000
Weir Submergence   = No
```

```
Structure ID       = O0
Structure Type     = Orifice-Area
------------------------------------
# of Openings      =        4
Invert Elev.       =    681.83 ft
Area               =     .0210 sq.ft
Top of Orifice     =       .00 ft
Datum Elev.        =    681.83 ft
Orifice Coeff.     =      .700
```

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = C0
Structure Type     = Culvert-Circular
------------------------------------
No. Barrels        =        1
Barrel Diameter    =   2.0000 ft
Upstream Invert    =   681.46 ft
Dnstream Invert    =   681.05 ft
Horiz. Length      =    30.00 ft
Barrel Length      =    30.00 ft
Barrel Slope       =   .01367 ft/ft

OUTLET CONTROL DATA...
Mannings n         =    .0240
Ke                 =    .5000  (forward entrance loss)
Kb                 =  .042300  (per ft of full flow)
Kr                 =    .5000  (reverse entrance loss)
HW Convergence     =     .001  +/- ft

INLET CONTROL DATA...
Equation form      =        1
Inlet Control K    =    .0078
Inlet Control M    =   2.0000
Inlet Control c    =   .03790
Inlet Control Y    =    .6900
T1 ratio (HW/D)    =    1.129
T2 ratio (HW/D)    =    1.290
Slope Factor       =    -.500
```

```
Use unsubmerged inlet control Form 1 equ. below T1 elev.
Use   submerged inlet control Form 1 equ. above T2 elev.

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...
At T1 Elev =     683.72 ft  --->  Flow =     15.55 cfs
At T2 Elev =     684.04 ft  --->  Flow =     17.77 cfs
```

```
OUTLET STRUCTURE INPUT DATA


Structure ID       = W0
Structure Type     = Weir-Rectangular
------------------------------------
# of Openings      =         1
Crest Elev.        =    685.00 ft
Weir Length        =     25.00 ft
Weir Coeff.        =  2.630000

Weir TW effects      (Use adjustment equation)



Structure ID       = TW
Structure Type     = TW SETUP, DS Channel
------------------------------------
FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations=    40
Min. TW tolerance =    .01 ft
Max. TW tolerance =    .01 ft
Min. HW tolerance =    .01 ft
Max. HW tolerance =    .01 ft
Min.  Q tolerance =    .00 cfs
Max.  Q tolerance =    .00 cfs
```

LEVEL POOL ROUTING SUMMARY

```
HYG Dir           = I:\3391\Calculations\Stormwater\
Inflow  HYG file = work_pad.hyg - DET / SED    IN  Dev 25
Outflow HYG file = work_pad.hyg - DET / SED    OUT Dev 25

Pond Node   Data = DET / SED
Pond Volume Data = DET / SED
Pond Outlet Data = Existing Outlet

No Infiltration

INITIAL CONDITIONS
----------------------------------
Starting WS Elev   =   681.46 ft
Starting Volume    =     .000 ac-ft
Starting Outflow   =      .00 cfs
Starting Infiltr.  =      .00 cfs
Starting Total Qout=      .00 cfs
Time Increment     =    .0500 hrs


INFLOW/OUTFLOW HYDROGRAPH SUMMARY
====================================================
Peak Inflow      =   188.91 cfs    at   12.2500 hrs
Peak Outflow     =    37.26 cfs    at   13.2000 hrs
----------------------------------------------------
Peak Elevation   =   685.37 ft
Peak Storage =       12.365 ac-ft
====================================================


MASS BALANCE (ac-ft)
--------------------------
+ Initial Vol  =        .000
+ HYG Vol IN   =      22.357
- Infiltration =        .000
- HYG Vol OUT  =      21.085
- Retained Vol =       1.272
                  ----------
Unrouted Vol =        -.000 ac-ft  (.002% of Inflow Volume)


WARNING: Outflow hydrograph truncated on right side.
```

Peak WATER Elevation is Above 685.0, the level of the emergency spillway. A new outlet Design is Required.

```
                 LEVEL POOL ROUTING SUMMARY

HYG Dir           = I:\3391\Calculations\Stormwater\
Inflow  HYG file = work_pad.hyg - DET / SED    IN  Dev100
Outflow HYG file = work_pad.hyg - DET / SED    OUT Dev100

Pond Node   Data = DET / SED
Pond Volume Data = DET / SED
Pond Outlet Data = Existing Outlet

No Infiltration

INITIAL CONDITIONS
----------------------------------
Starting WS Elev   =   681.46 ft
Starting Volume    =     .000 ac-ft
Starting Outflow   =      .00 cfs
Starting Infiltr.  =      .00 cfs
Starting Total Qout=      .00 cfs
Time Increment     =    .0500 hrs


INFLOW/OUTFLOW HYDROGRAPH SUMMARY
=====================================================
Peak Inflow       =    232.63 cfs    at   12.2500 hrs
Peak Outflow      =     71.28 cfs    at   12.9000 hrs
-----------------------------------------------------
Peak Elevation    =    685.79 ft
Peak Storage =         13.979 ac-ft
=====================================================


MASS BALANCE (ac-ft)
--------------------------
+ Initial Vol   =       .000
+ HYG Vol IN    =     27.565
- Infiltration =        .000
- HYG Vol OUT   =     26.281
- Retained Vol =       1.284
                  ----------
Unrouted Vol =        -.000 ac-ft   (.001% of Inflow Volume)


WARNING: Outflow hydrograph truncated on right side.
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 year storm
Duration       = 24.0000 hrs     Rain Depth = 4.4000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID = work_pad.hyg - PHASE 3+4 SW Dev 25
Tc             = .7768 hrs
Drainage Area = 14.800 acres  Runoff CN= 84

============================================
Computational Time Increment   =    .10358 hrs
Computed Peak Time             =   12.3255 hrs
Computed Peak Flow             =     25.82 cfs

Time Increment for HYG File    =     .0500 hrs
Peak Time, Interpolated Output =   12.3500 hrs
Peak Flow, Interpolated Output =     25.63 cfs
============================================

              DRAINAGE AREA
           -------------------
           ID:PHASE 3+4 SW
           CN   =   84
           Area =       14.800 acres
           S    =   1.9048 in
           0.2S =     .3810 in

            Cumulative Runoff
           -------------------
                  2.7267 in
                   3.363 ac-ft

HYG Volume...          3.362 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .77682 hrs (ID: PHASE 3+4 SW)
Computational Incr, Tm =   .10358 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,          qp =    21.59 cfs
Unit peak time      Tp =   .51788 hrs
Unit receding limb, Tr =  2.07151 hrs
Total unit time,    Tb =  2.58939 hrs
```

PHASE 3 MOD 1+2
AND PHASE 4-MOD1

LEVEL POOL ROUTING SUMMARY

```
HYG Dir           = I:\3391\Calculations\Stormwater\
Inflow  HYG file = work_pad.hyg - DET / SED    IN  Dev 25
Outflow HYG file = work_pad.hyg - DET / SED    OUT Dev 25

Pond Node   Data = DET / SED
Pond Volume Data = DET / SED
Pond Outlet Data = Existing Outlet

No Infiltration

INITIAL CONDITIONS
----------------------------------
Starting WS Elev   =   681.46 ft
Starting Volume    =     .000 ac-ft
Starting Outflow   =      .00 cfs
Starting Infiltr.  =      .00 cfs
Starting Total Qout=      .00 cfs
Time Increment     =    .0500 hrs


INFLOW/OUTFLOW HYDROGRAPH SUMMARY
=====================================================
Peak Inflow      =   160.65 cfs    at   12.2500 hrs
Peak Outflow     =    19.77 cfs    at   13.6000 hrs
-----------------------------------------------------
Peak Elevation   =   684.98 ft
Peak Storage =       10.946 ac-ft
=====================================================
```

← PEAK WATER ELEV.
25-yr STORM

```
MASS BALANCE (ac-ft)
--------------------------
+ Initial Vol   =        .000
+ HYG Vol IN    =      18.450
- Infiltration =        .000
- HYG Vol OUT   =      17.183
- Retained Vol =       1.266
                   ----------
  Unrouted Vol =       -.000 ac-ft  (.002% of Inflow Volume)

WARNING: Outflow hydrograph truncated on right side.
```

LEVEL POOL ROUTING SUMMARY

```
HYG Dir           = I:\3391\Calculations\Stormwater\
Inflow  HYG file = work_pad.hyg - DET / SED    IN  Dev100
Outflow HYG file = work_pad.hyg - DET / SED    OUT Dev100

Pond Node   Data = DET / SED
Pond Volume Data = DET / SED
Pond Outlet Data = Existing Outlet

No Infiltration

INITIAL CONDITIONS
----------------------------------
Starting WS Elev   =   681.46 ft
Starting Volume    =     .000 ac-ft
Starting Outflow   =      .00 cfs
Starting Infiltr.  =      .00 cfs
Starting Total Qout=      .00 cfs
Time Increment     =    .0500 hrs


INFLOW/OUTFLOW HYDROGRAPH SUMMARY
====================================================
Peak Inflow     =   197.69 cfs   at   12.2500 hrs
Peak Outflow    =    41.57 cfs   at   13.1000 hrs
----------------------------------------------------
Peak Elevation  =   685.43 ft
Peak Storage =      12.598 ac-ft
====================================================
```

← PEAK WATER ELEV.
100-yr STORM

```
 MASS BALANCE (ac-ft)
 --------------------------
+ Initial Vol  =      .000
+ HYG Vol IN   =    22.748
- Infiltration =      .000
- HYG Vol OUT  =    21.470
- Retained Vol =     1.278
                 ----------
 Unrouted Vol =     -.000 ac-ft  (.001% of Inflow Volume)


 WARNING: Outflow hydrograph truncated on right side.
```

Detention / Sedimentation Basin Routing
Proposed Outlet Structure

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 681.00 ft
Increment = .10 ft
Max. Elev.= 686.00 ft

****
OUTLET CONNECTIVITY
****

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Orifice-Circular	O1	--->	C0	681.750	686.000
Orifice-Circular	O4	--->	C0	682.250	686.000
Orifice-Circular	O5	--->	C0	682.750	686.000
Orifice-Circular	O2	--->	C0	683.250	686.000
Stand Pipe	R0	--->	C0	684.250	686.000
Orifice-Circular	O0	--->	C0	681.250	686.000
Culvert-Circular	C0	--->	TW	681.000	686.000
Weir-Rectangular	W0	--->	TW	685.000	686.000
TW SETUP, DS Channel					

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = O1
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =         4
Invert Elev.       =    681.75 ft
Diameter           =     .5000 ft
Orifice Coeff.     =      .700


Structure ID       = O4
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =         4
Invert Elev.       =    682.25 ft
Diameter           =     .5000 ft
Orifice Coeff.     =      .700


Structure ID       = O5
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =         4
Invert Elev.       =    682.75 ft
Diameter           =     .5000 ft
Orifice Coeff.     =      .700


Structure ID       = O2
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =         4
Invert Elev.       =    683.25 ft
Diameter           =     .5000 ft
Orifice Coeff.     =      .700
```

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = R0
Structure Type     = Stand Pipe
------------------------------------
# of Openings      =        1
Invert Elev.       =     684.25 ft
Diameter           =     3.0000 ft
Orifice Area       =     7.0686 sq.ft
Orifice Coeff.     =       .700
Weir Length        =       9.42 ft
Weir Coeff.        =      3.300
K, Reverse         =      1.000
Mannings n         =      .0000
Kev,Charged Riser  =       .000
Weir Submergence   = No


Structure ID       = O0
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =        4
Invert Elev.       =     681.25 ft
Diameter           =      .5000 ft
Orifice Coeff.     =       .700
```

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = C0
Structure Type     = Culvert-Circular
------------------------------------
No. Barrels        =        1
Barrel Diameter    =    3.0000 ft
Upstream Invert    =    681.00 ft
Dnstream Invert    =    680.50 ft
Horiz. Length      =     30.00 ft
Barrel Length      =     30.00 ft
Barrel Slope       =    .01667 ft/ft

OUTLET CONTROL DATA...
Mannings n         =     .0240
Ke                 =     .5000  (forward entrance loss)
Kb                 =   .024635  (per ft of full flow)
Kr                 =     .5000  (reverse entrance loss)
HW Convergence     =      .001  +/- ft

INLET CONTROL DATA...
Equation form      =        1
Inlet Control K    =     .0078
Inlet Control M    =    2.0000
Inlet Control c    =    .03790
Inlet Control Y    =     .6900
T1 ratio (HW/D)    =      .000
T2 ratio (HW/D)    =     1.288
Slope Factor       =     -.500
```

```
Use unsubmerged inlet control Form 1 equ. below T1 elev.
Use   submerged inlet control Form 1 equ. above T2 elev.

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...
At T1 Elev =     681.00 ft  --->  Flow =      42.85 cfs
At T2 Elev =     684.86 ft  --->  Flow =      48.97 cfs
```

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = WO
Structure Type     = Weir-Rectangular
------------------------------------
# of Openings      =         1
Crest Elev.        =    685.00 ft
Weir Length        =     25.00 ft
Weir Coeff.        =  2.630000

Weir TW effects      (Use adjustment equation)
```

```
Structure ID       = TW
Structure Type     = TW SETUP, DS Channel
------------------------------------
FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations=    40
Min. TW tolerance =    .01 ft
Max. TW tolerance =    .01 ft
Min. HW tolerance =    .01 ft
Max. HW tolerance =    .01 ft
Min.  Q tolerance =    .00 cfs
Max.  Q tolerance =    .00 cfs
```

LEVEL POOL ROUTING SUMMARY

```
HYG Dir          = I:\3391\Calculations\Stormwater\
Inflow  HYG file = work_pad.hyg - DET / SED    IN  Dev 25
Outflow HYG file = work_pad.hyg - DET / SED    OUT Dev 25

Pond Node   Data = DET / SED
Pond Volume Data = DET / SED
Pond Outlet Data = Proposed Outlet

No Infiltration

INITIAL CONDITIONS
----------------------------------
Starting WS Elev    =   681.25 ft
Starting Volume     =     .692 ac-ft
Starting Outflow    =      .00 cfs
Starting Infiltr.   =      .00 cfs
Starting Total Qout=       .00 cfs
Time Increment      =    .0500 hrs


INFLOW/OUTFLOW HYDROGRAPH SUMMARY
=====================================================
Peak Inflow       =    188.91 cfs    at   12.2500 hrs
Peak Outflow      =     38.05 cfs    at   13.2000 hrs
-----------------------------------------------------
Peak Elevation    =    684.99 ft
Peak Storage =         12.276 ac-ft
=====================================================
```

Peak Water Elevation
25-yr storm

```
MASS BALANCE (ac-ft)
--------------------------
+ Initial Vol   =        .692
+ HYG Vol IN    =      22.357
- Infiltration =         .000
- HYG Vol OUT   =      22.241
- Retained Vol =         .807
                   ----------
Unrouted Vol =        -.000 ac-ft  (.000% of Inflow Volume)


WARNING: Outflow hydrograph truncated on right side.
```

LEVEL POOL ROUTING SUMMARY

```
HYG Dir          = I:\3391\Calculations\Stormwater\
Inflow  HYG file = work_pad.hyg - DET / SED    IN  Dev100
Outflow HYG file = work_pad.hyg - DET / SED    OUT Dev100

Pond Node   Data = DET / SED
Pond Volume Data = DET / SED
Pond Outlet Data = Proposed Outlet

No Infiltration

INITIAL CONDITIONS
----------------------------------
Starting WS Elev   =   681.25 ft
Starting Volume    =     .692 ac-ft
Starting Outflow   =      .00 cfs
Starting Infiltr.  =      .00 cfs
Starting Total Qout=      .00 cfs
Time Increment     =    .0500 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY
=====================================================
Peak Inflow      =   232.63 cfs    at   12.2500 hrs
Peak Outflow     =    73.09 cfs    at   12.9000 hrs
-----------------------------------------------------
Peak Elevation   =   685.45 ft
Peak Storage =       13.977 ac-ft
=====================================================
```

← Peak water Elevation
100-yr STORM

```
  MASS BALANCE (ac-ft)
  --------------------------
+ Initial Vol  =        .692
+ HYG Vol IN   =      27.565
- Infiltration =        .000
- HYG Vol OUT  =      27.448
- Retained Vol =        .809
                  ----------
  Unrouted Vol =       -.000 ac-ft  (.000% of Inflow Volume)
```

WARNING: Outflow hydrograph truncated on right side.

File.... I:\3391\Calculations\Stormwater\Final Grades-new outlet.ppw
Storm... TypeII 24hr Tag: Dev 25

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0500 hrs
Time on left represents time for first value in each row.

Time hrs					
69.7000	.08	.08	.08	.08	.08
69.9500	.08	.08	.08	.08	.08
70.2000	.08	.08	.08	.08	.08
70.4500	.08	.08	.08	.08	.08
70.7000	.08	.08	.08	.08	.08
70.9500	.08	.08	.08	.08	.08
71.2000	.08	.08	.08	.08	.08
71.4500	.07	.07	.07	.07	.07
71.7000	.07	.07	.07	.07	.07
71.9500	.07	$\boxed{.07}$	.07	.07	.07
72.2000	.07	.07	.07	.07	.07
72.4500	.07	.07	.07	.07	.07
72.7000	.07	.07	.07	.07	.07
72.9500	.07	.07	.07	.07	.07
73.2000	.07	.07	.07	.07	.07
73.4500	.07	.07	.07	.07	.07
73.7000	.07	.07	.07	.07	.07
73.9500	.07	.07	.07	.06	.06
74.2000	.06	.06	.06	.06	.06
74.4500	.06	.06	.06	.06	.06
74.7000	.06	.06	.06	.06	.06
74.9500	.06	.06	.06	.06	.06
75.2000	.06	.06	.06	.06	.06
75.4500	.06	.06	.06	.06	.06
75.7000	.06	.06	.06	.06	.06
75.9500	.06	.06	.06	.06	.06
76.2000	.06	.06	.06	.06	.06
76.4500	.06	.06	.06	.06	.06
76.7000	.06	.06	.06	.06	.06
76.9500	.06	.06	.06	.06	.06
77.2000	.05	.05	.05	.05	.05
77.4500	.05	.05	.05	.05	.05
77.7000	.05	.05	.05	.05	.05
77.9500	.05	.05	.05	.05	.05
78.2000	.05	.05	.05	.05	.05
78.4500	.05	.05	.05	.05	.05
78.7000	.05	.05	.05	.05	.05
78.9500	.05	.05	.05	.05	.05
79.2000	.05	.05	.05	.05	.05
79.4500	.05	.05	.05	.05	.05
79.7000	.05	.05	.05	.05	.05
79.9500	.05	.05	.05	.05	.05
80.2000	.05	.05	.05	.05	.05
80.4500	.05	.05	.05	.05	.05
80.7000	.05	.05	.05	.05	.04

72.0 Hr

OUTFLOW AT 72.0 HRS (3 Days) = 0.07 CFS

∴ BASIN TAKES MORE THAN 3 DAYS TO DRAIN.

Detention Basin Routing

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Off-site	79	91.000			79.00
COMPOSITE AREA & WEIGHTED CN --->		91.000			79.00 (79)

Table of Contents (continued)

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: TR-55 Sheet

Mannings n	.2400	
Hydraulic Length	400.00	ft
2yr, 24hr P	2.5000	in
Slope	.010000	ft/ft
Avg.Velocity	.10	ft/sec

Segment #1 Time: 1.0763 hrs

Segment #2: Tc: TR-55 Channel

Flow Area	5.9000	sq.ft
Wetted Perimeter	13.60	ft
Hydraulic Radius	.43	ft
Slope	.010000	ft/ft
Mannings n	.0350	
Hydraulic Length	3600.00	ft
Avg.Velocity	2.44	ft/sec

Segment #2 Time: .4099 hrs

========================
Total Tc: 1.4862 hrs
========================

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 year storm
Duration       = 24.0000 hrs     Rain Depth = 4.4000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID =  - OFF-SITE AREA 25
Tc             = 1.4862 hrs
Drainage Area = 91.000 acres  Runoff CN= 79

============================================
Computational Time Increment   =   .19816 hrs
Computed Peak Time             =  12.8806 hrs
Computed Peak Flow             =    81.53 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.8500 hrs
Peak Flow, Interpolated Output =    81.27 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:OFF-SITE AREA
              CN   =   79
              Area =       91.000 acres
              S    =   2.6582 in
              0.2S =    .5316 in

               Cumulative Runoff
              -------------------
                      2.2928 in
                      17.387 ac-ft

HYG Volume...         17.386 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =  1.48623 hrs (ID: OFF-SITE AREA)
Computational Incr, Tm =   .19816 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,           qp =    69.38 cfs
Unit peak time       Tp =   .99082 hrs
Unit receding limb, Tr =  3.96327 hrs
Total unit time,     Tb =  4.95408 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration       = 24.0000 hrs     Rain Depth = 5.1000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID =  - OFF-SITE AREA 100
Tc             = 1.4862 hrs
Drainage Area = 91.000 acres  Runoff CN= 79

============================================
Computational Time Increment   =   .19816 hrs
Computed Peak Time             =  12.8806 hrs
Computed Peak Flow             =   103.19 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.8500 hrs
Peak Flow, Interpolated Output =   102.94 cfs
============================================

                DRAINAGE AREA
              -------------------
              ID:OFF-SITE AREA
              CN   =   79
              Area =       91.000 acres
              S    =   2.6582 in
              0.2S =    .5316 in

               Cumulative Runoff
              -------------------
                      2.8879 in
                      21.900 ac-ft

HYG Volume...         21.899 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =  1.48623 hrs (ID: OFF-SITE AREA)
Computational Incr, Tm =   .19816 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,           qp =    69.38 cfs
Unit peak time       Tp =   .99082 hrs
Unit receding limb, Tr =  3.96327 hrs
Total unit time,     Tb =  4.95408 hrs
```

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
685.50	-----	2.7000	.0000	.000	.000
686.00	-----	2.8800	8.3685	1.395	1.395
688.00	-----	3.5800	9.6710	6.447	7.842
690.00	-----	4.4900	12.0793	8.053	15.895
692.00	-----	6.5000	16.3923	10.928	26.823

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 685.50 ft
Increment = .10 ft
Max. Elev.= 692.00 ft

****

OUTLET CONNECTIVITY

****

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Orifice-Circular	O1	--->	C0	687.000	692.000
Orifice-Circular	O2	--->	C0	687.500	692.000
Orifice-Circular	O3	--->	C0	688.000	692.000
Orifice-Circular	O4	--->	C0	688.500	692.000
Orifice-Circular	O5	--->	C0	689.000	692.000
Stand Pipe	R0	--->	C0	689.880	692.000
Orifice-Circular	O0	--->	C0	686.230	692.000
Culvert-Circular	C0	--->	TW	685.500	692.000
Weir-Rectangular	W0	--->	TW	692.000	692.000
TW SETUP, DS Channel					

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = O1
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =         3
Invert Elev.       =    687.00 ft
Diameter           =     .0810 ft
Orifice Coeff.     =      .700


Structure ID       = O2
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =         3
Invert Elev.       =    687.50 ft
Diameter           =     .0810 ft
Orifice Coeff.     =      .700


Structure ID       = O3
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =         3
Invert Elev.       =    688.00 ft
Diameter           =     .0810 ft
Orifice Coeff.     =      .070


Structure ID       = O4
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =         3
Invert Elev.       =    688.50 ft
Diameter           =     .0810 ft
Orifice Coeff.     =      .700
```

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = O5
Structure Type     = Orifice-Circular
-----------------------------------
# of Openings      =        3
Invert Elev.       =    689.00 ft
Diameter           =     .0810 ft
Orifice Coeff.     =      .700


Structure ID       = R0
Structure Type     = Stand Pipe
-----------------------------------
# of Openings      =        1
Invert Elev.       =    689.88 ft
Diameter           =    1.5000 ft
Orifice Area       =    1.7671 sq.ft
Orifice Coeff.     =      .700
Weir Length        =      4.71 ft
Weir Coeff.        =     3.300
K, Reverse         =     1.000
Mannings n         =     .0000
Kev,Charged Riser  =      .000
Weir Submergence   = No


Structure ID       = O0
Structure Type     = Orifice-Circular
-----------------------------------
# of Openings      =        3
Invert Elev.       =    686.23 ft
Diameter           =     .0810 ft
Orifice Coeff.     =      .700
```

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = C0
Structure Type     = Culvert-Circular
------------------------------------
No. Barrels        =        1
Barrel Diameter    =    1.5000 ft
Upstream Invert    =    685.50 ft
Dnstream Invert    =    685.00 ft
Horiz. Length      =     65.00 ft
Barrel Length      =     65.00 ft
Barrel Slope       =    .00769 ft/ft

OUTLET CONTROL DATA...
Mannings n         =     .0240
Ke                 =     .5000  (forward entrance loss)
Kb                 =   .062076  (per ft of full flow)
Kr                 =     .5000  (reverse entrance loss)
HW Convergence     =      .001  +/- ft

INLET CONTROL DATA...
Equation form      =         1
Inlet Control K    =     .0078
Inlet Control M    =    2.0000
Inlet Control c    =    .03790
Inlet Control Y    =     .6900
T1 ratio (HW/D)    =     1.132
T2 ratio (HW/D)    =     1.293
Slope Factor       =     -.500
```

Use unsubmerged inlet control Form 1 equ. below T1 elev.
Use   submerged inlet control Form 1 equ. above T2 elev.

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...
At T1 Elev =   687.20 ft   ---> Flow =   7.58 cfs
At T2 Elev =   687.44 ft   ---> Flow =   8.66 cfs

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = W0
Structure Type     = Weir-Rectangular
------------------------------------
# of Openings      =        1
Crest Elev.        =    692.00 ft
Weir Length        =     25.00 ft
Weir Coeff.        =  2.630000

Weir TW effects      (Use adjustment equation)



Structure ID       = TW
Structure Type     = TW SETUP, DS Channel
------------------------------------
FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations=    40
Min. TW tolerance =    .01 ft
Max. TW tolerance =    .01 ft
Min. HW tolerance =    .01 ft
Max. HW tolerance =    .01 ft
Min.  Q tolerance =    .00 cfs
Max.  Q tolerance =    .00 cfs
```

```
                    LEVEL POOL ROUTING SUMMARY

HYG Dir            = I:\3391\Calculations\Stormwater\
Inflow  HYG file = NONE STORED - DETENTION     IN  25
Outflow HYG file = NONE STORED - DETENTION     OUT 25

Pond Node    Data = DETENTION
Pond Volume Data = DETENTION
Pond Outlet Data = Existing Outlet

No Infiltration

INITIAL CONDITIONS
----------------------------------
Starting WS Elev    =   685.50 ft
Starting Volume     =     .000 ac-ft
Starting Outflow    =      .00 cfs
Starting Infiltr.   =      .00 cfs
Starting Total Qout=      .00 cfs
Time Increment      =    .0500 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY
=====================================================
Peak Inflow       =     81.27 cfs    at   12.8500 hrs
Peak Outflow      =      2.30 cfs    at   24.8500 hrs
-----------------------------------------------------
Peak Elevation    =    690.10 ft
Peak Storage =        16.358 ac-ft
=====================================================

MASS BALANCE (ac-ft)
--------------------------
+ Initial Vol   =       .000
+ HYG Vol IN    =     17.386
- Infiltration =        .000
- HYG Vol OUT   =      5.359
- Retained Vol =      12.027
                  ----------
Unrouted Vol =        -.000 ac-ft  (.000% of Inflow Volume)

WARNING: Outflow hydrograph truncated on right side.
```

```
                 LEVEL POOL ROUTING SUMMARY

HYG Dir          = I:\3391\Calculations\Stormwater\
Inflow  HYG file = NONE STORED - DETENTION    IN  100
Outflow HYG file = NONE STORED - DETENTION    OUT 100

Pond Node   Data = DETENTION
Pond Volume Data = DETENTION
Pond Outlet Data = Existing Outlet

No Infiltration

INITIAL CONDITIONS
----------------------------------
Starting WS Elev   =   685.50 ft
Starting Volume    =     .000 ac-ft
Starting Outflow   =      .00 cfs
Starting Infiltr.  =      .00 cfs
Starting Total Qout=      .00 cfs
Time Increment     =    .0500 hrs


INFLOW/OUTFLOW HYDROGRAPH SUMMARY
====================================================
Peak Inflow      =   102.94 cfs    at   12.8500 hrs
Peak Outflow     =     6.35 cfs    at   19.9000 hrs
----------------------------------------------------
Peak Elevation   =   690.39 ft
Peak Storage =       17.718 ac-ft
====================================================


MASS BALANCE (ac-ft)
--------------------------
+ Initial Vol  =       .000
+ HYG Vol IN   =     21.899
- Infiltration =       .000
- HYG Vol OUT  =      9.716
- Retained Vol =     12.182
                 ----------
Unrouted Vol =       -.000 ac-ft  (.002% of Inflow Volume)


WARNING: Outflow hydrograph truncated on right side.
```

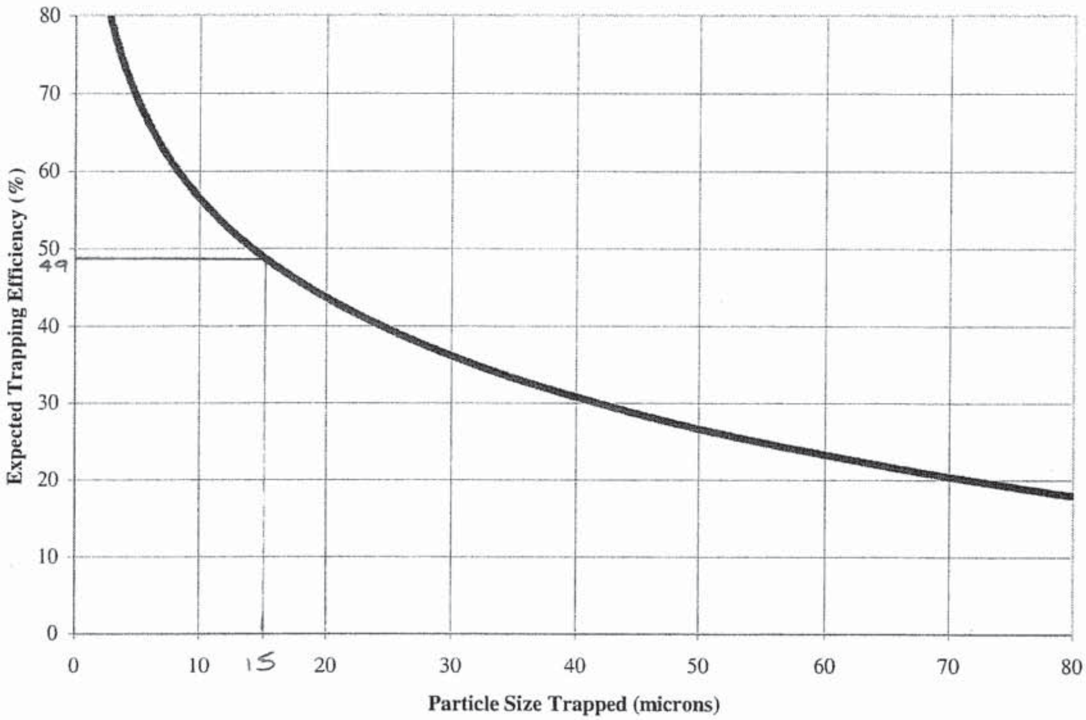
HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0500 hrs
Time on left represents time for first value in each row.

Time hrs					
71.4000	.56	.56	.56	.56	.56
71.6500	.56	.56	.56	.56	.56
71.9000	.56	.56	$\boxed{.56}$	.56	.56
72.1500	.56	.56	.56	.56	.56
72.4000	.56	.56	.56	.56	.56
72.6500	.56	.56	.56	.56	.56
72.9000	.56	.56	.56	.56	.56
73.1500	.56	.56	.56	.56	.56
73.4000	.56	.56	.56	.56	.56
73.6500	.56	.56	.56	.56	.56
73.9000	.56	.56	.56	.56	.56
74.1500	.56	.56	.56	.56	.56
74.4000	.56	.56	.56	.56	.56
74.6500	.56	.56	.56	.56	.56
74.9000	.56	.56	.56	.56	.56
75.1500	.55	.55	.55	.55	.55
75.4000	.55	.55	.55	.55	.55
75.6500	.55	.55	.55	.55	.55
75.9000	.55	.55	.55	.55	.55
76.1500	.55	.55	.55	.55	.55
76.4000	.55	.55	.55	.55	.55
76.6500	.55	.55	.55	.55	.55
76.9000	.55	.55	.55	.55	.55
77.1500	.55	.55	.55	.55	.55
77.4000	.55	.55	.55	.55	.55
77.6500	.55	.55	.55	.55	.55
77.9000	.55	.55	.55	.55	.55
78.1500	.55	.55	.55	.55	.55
78.4000	.55	.55	.55	.55	.55
78.6500	.55	.55	.55	.55	.55
78.9000	.55	.55	.55	.55	.55
79.1500	.55	.55	.55	.55	.55
79.4000	.55	.55	.55	.55	.54
79.6500	.54	.54	.54	.54	.54
79.9000	.54	.54	.54	.54	.54
80.1500	.54	.54	.54	.54	.54
80.4000	.54	.54	.54	.54	.54
80.6500	.54	.54	.54	.54	.54
80.9000	.54	.54	.54	.54	.54
81.1500	.54	.54	.54	.54	.54
81.4000	.54	.54	.54	.54	.54
81.6500	.54	.54	.54	.54	.54
81.9000	.54	.54	.54	.54	.54
82.1500	.54	.54	.54	.54	.54
82.4000	.54	.54	.54	.54	.54

72.0 Hr

OUTFLOW AT 72.0 Hr = 0.56 cfs
∴ BASIN TAKES MORE THAN 3 DAYS TO DRAIN.

Sediment Removal Analysis
(P8 Urban Catchment Model)



Convert the storage volume from the 1-year, 24-hour storm event into cubic feet. This volume of storage is then divided by the time required to settle the particle obtained by Stokes Law.

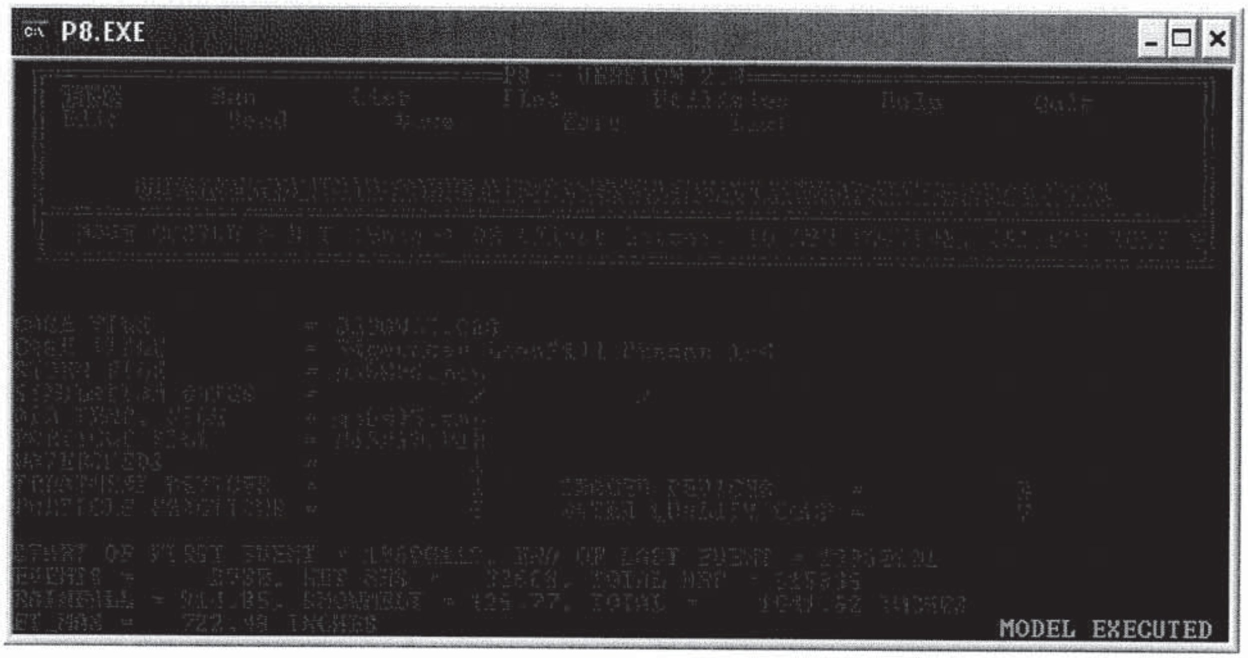
$$Q_{\max imum}(cfs) = \frac{V_{Storage}(ft^3)}{Time(\text{sec})}$$

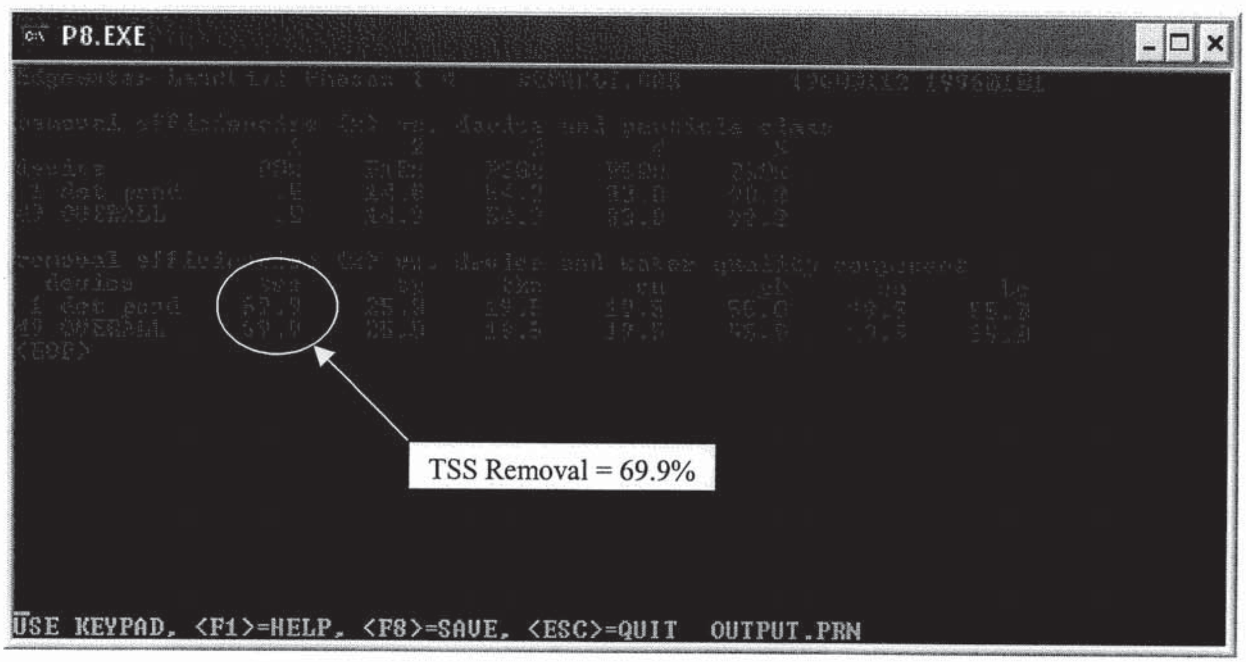
$Q_{maximum}$ is the rate at which the basin must be released in order to obtain the expected efficiency.

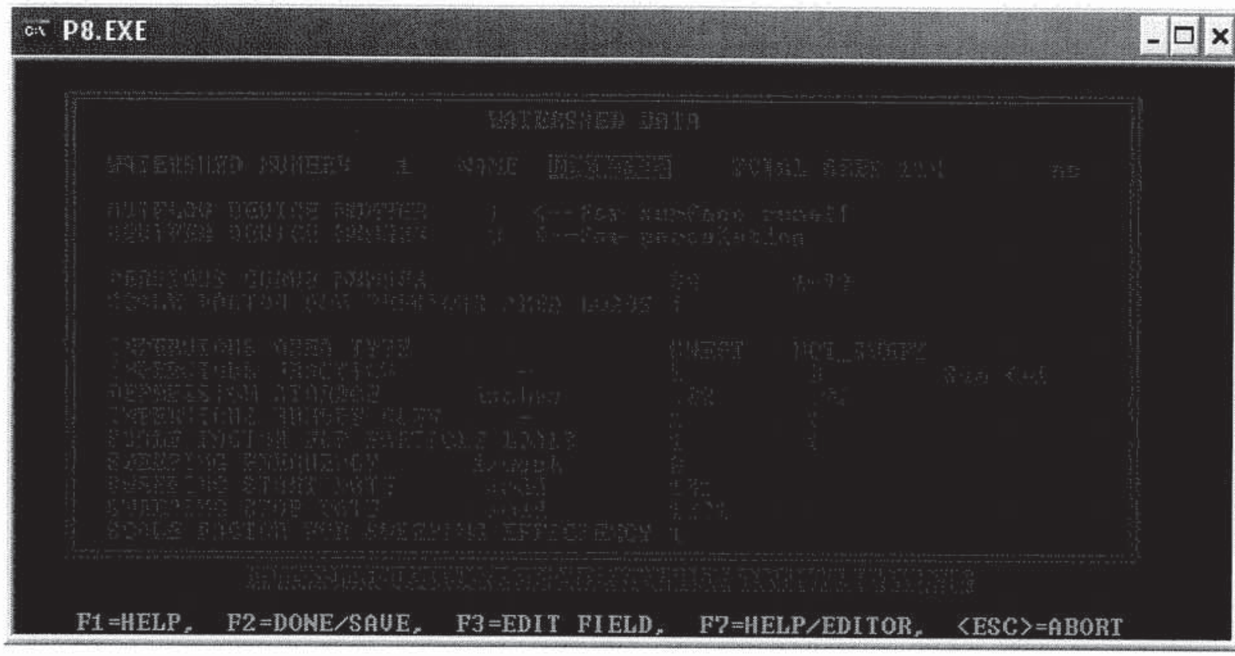
*See table on following page for particle settling velocities to calculate Time (sec)

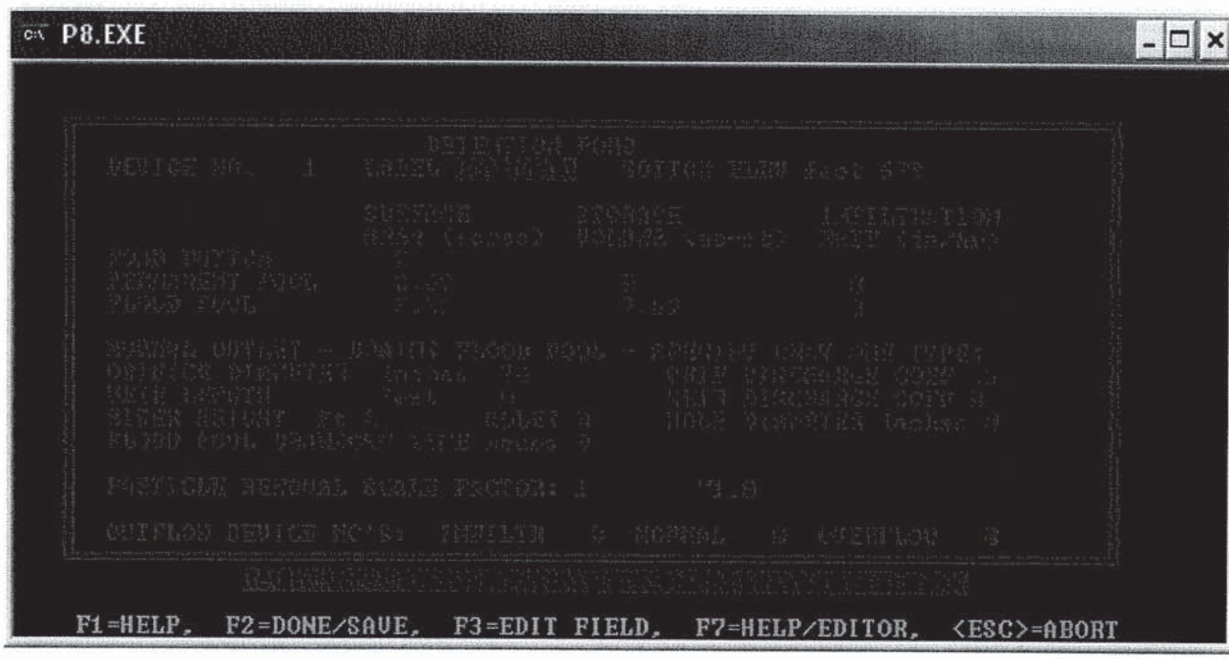
TO Trap the 15 micron particle, must HAVE
A Trapping efficiency of at least 49%

P8 - Sediment Removal Analysis
Sedimentation / Detention Basin
Edgewater Landfill









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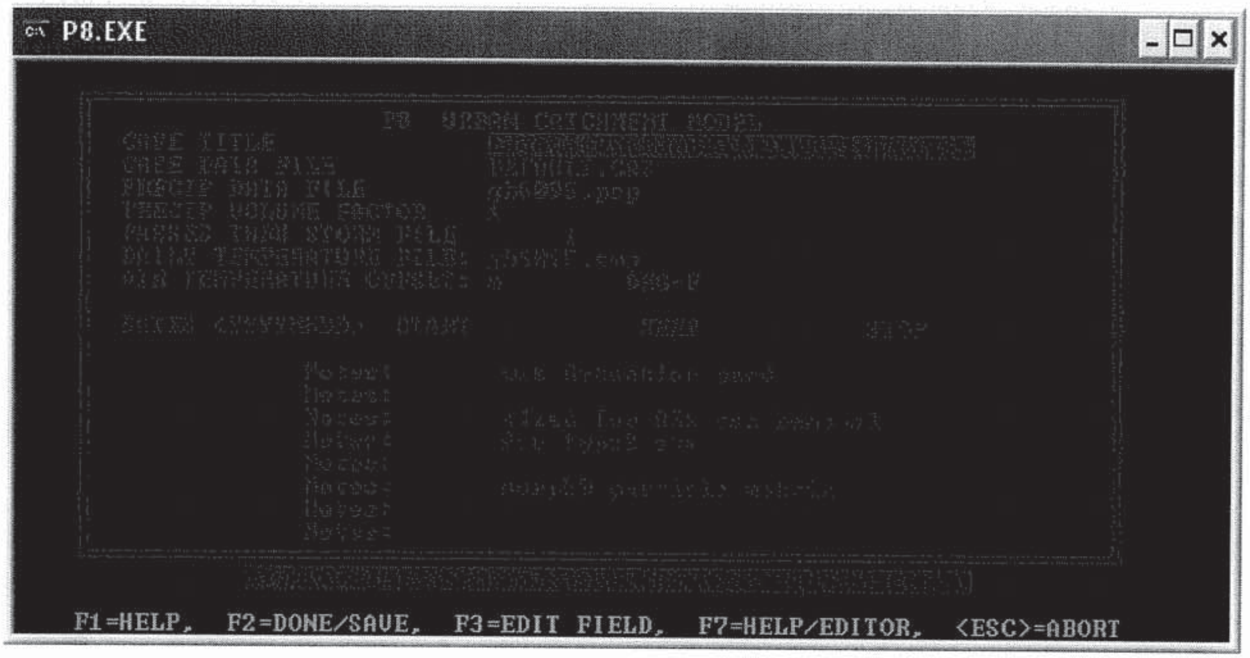
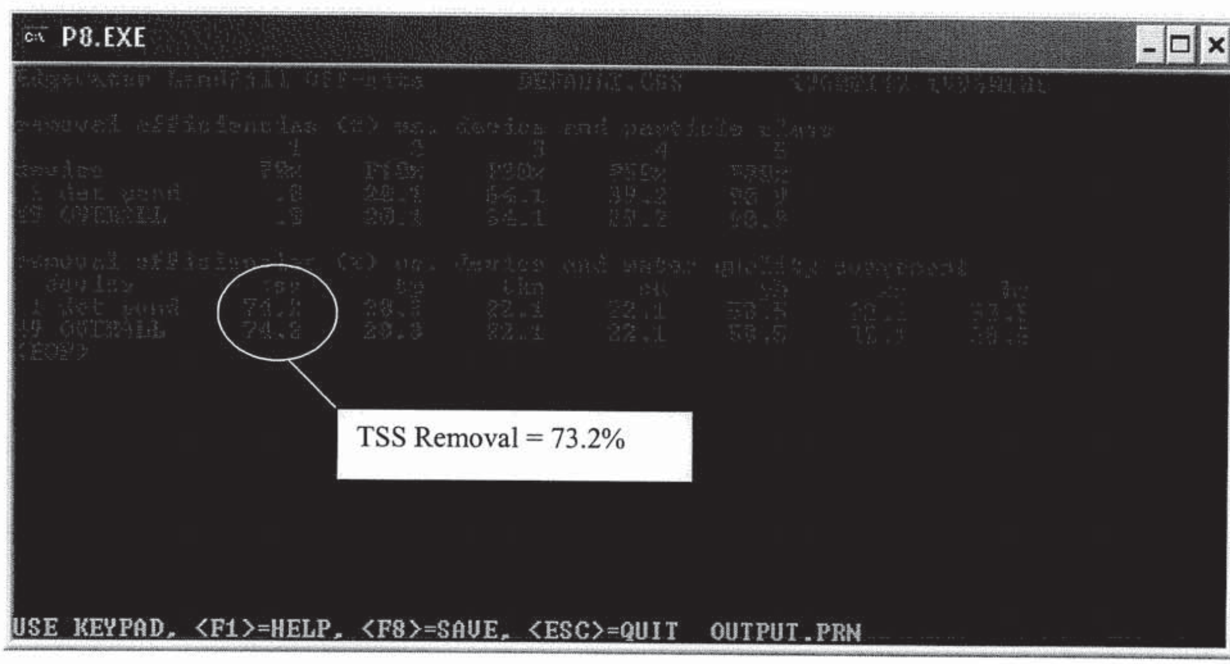
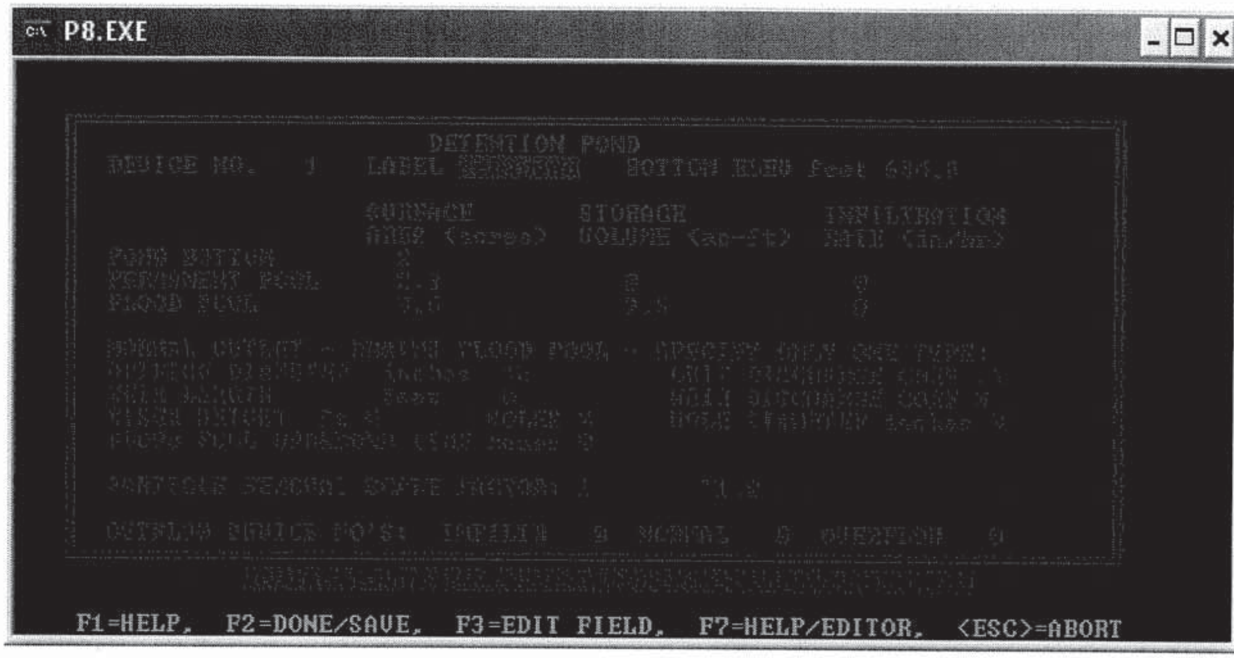
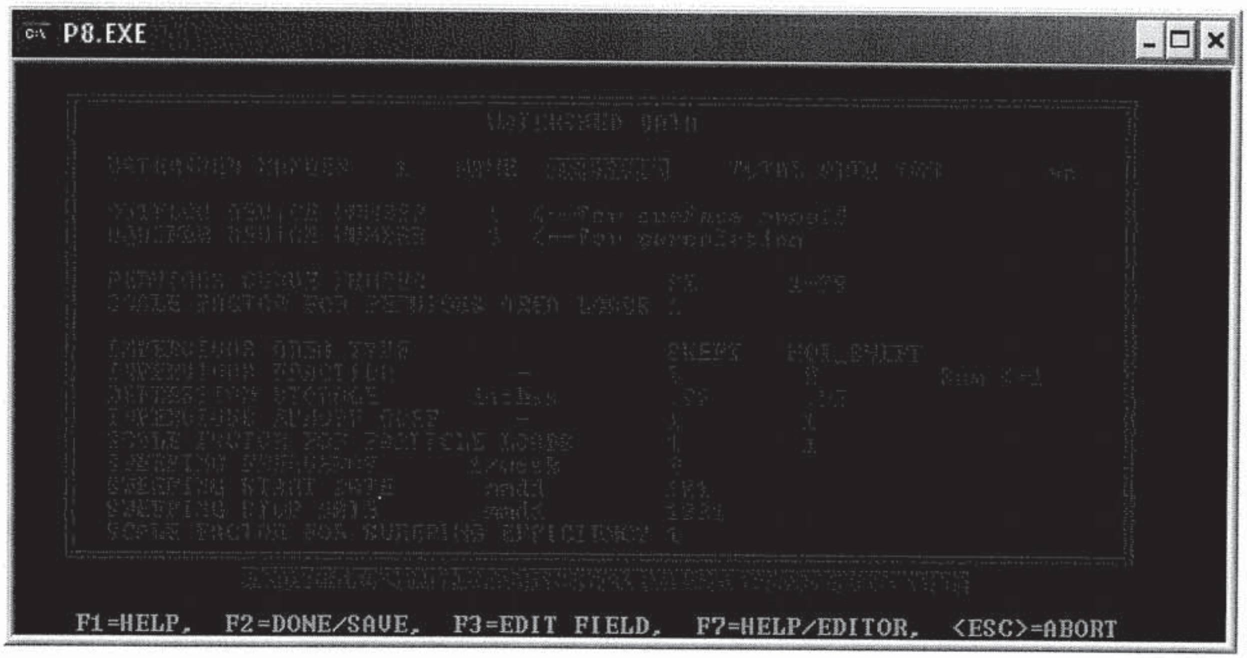
P8 Sediment Removal Analysis
Detention Basin for Off-site Stormwater Runon
Edgewater Landfill









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		Calc. No.
		Rev. No.
Job No. 3391	Job Edgewater Landfill	By KRG Date 12/4/07
Client	Subject	Chk'd. Date

Another method of checking sediment Removal is to Determine the surface Area of the basin and the discharge. This ratio can be compared to the Table below.

To settle the 0.015 mm particle, $A_n^{min.}$ Ratio of 3125 is required.

8.16 **Erosion and Sediment Control Handbook**

TABLE 8.1 Surface Area Requirements of Sediment Traps and Basins

Particle size, mm	Settling velocity, ft/sec (m/sec)	Surface area requirements, ft^2 per ft^3/sec discharge	(m^2 per m^3/sec discharge)
0.5 (coarse sand)	0.19 (0.058)	6.3	(20.7)
0.2 (medium sand)	0.067 (0.020)	17.9	(58.7)
0.1 (fine sand)	0.023 (0.0070)	52.2	(171.0)
0.05 (coarse silt)	0.0062 (0.0019)	193.6	(635.0)
0.02 (medium silt)	0.00096 (0.00029)	1,250.0	(4,101.0)
0.01 (fine silt)	0.00024 (0.000073)	5,000.0	(16,404.0)
0.005 (clay)	0.00006 (0.000018)	20,000.0	(65,617.0)

→ .015 3125.0 ←

With the proposed outlet, the outlet Flow From the 25-yr storm is 38.05 CFs at a elevation of 684.99. The surface area at this elevation = 3.6 Ac = 156816 Ft^2

$$\frac{156816\ Ft^2}{38.05\ Ft^3/sec} = 4121\ \frac{Ft^2}{Ft^3/sec}$$

∴ The basin will settle the 0.015 mm particle

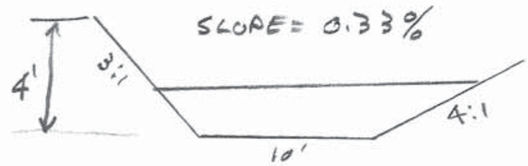
Swale and Culvert Calculations

Channel Calculator

SWALE LOCATED WEST OF PHASES 3+4

```
Given Input Data:
     Shape ..........................  Trapezoidal
     Solving for ....................  Depth of Flow
     Flowrate .......................  163.0000 cfs
     Slope ..........................  0.0033 ft/ft
     Manning's n ....................  0.0300
     Height .........................  48.0000 in
     Bottom width ...................  120.0000 in
     Left slope .....................  4.0000 ft/ft (V/H)
     Right slope ....................  3.0000 ft/ft (V/H)

Computed Results:
     Depth ..........................  38.3721 in
     Velocity .......................  4.6626 fps
     Full Flowrate ..................  230.0749 cfs
     Flow area ......................  34.9591 ft2
     Flow perimeter .................  200.0008 in
     Hydraulic radius ...............  25.1704 in
     Top width ......................  142.3837 in
     Area ...........................  44.6667 ft2
     Perimeter ......................  220.0737 in
     Percent full ...................  79.9419 %
```



25-YR STORM

PHASE 1+2 = 107.2
PHASE 3+4 SW = 55.4
162.6 CFS

SWALE CARRIES FLOW FROM PHASES 1+2 + PHASE 3+4 - SOUTHWEST

MAX FLOW DEPTH = 38.4"

FREE BOARD = 48" - 38.4" = 9.6"

Channel Calculator

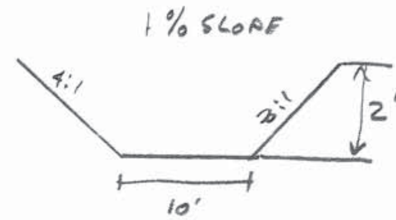
SWALE LOCATED
EAST OF PHASE 3

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	30.7000 cfs
Slope	0.0100 ft/ft
Manning's n	0.0300
Height	24.0000 in
Bottom width	120.0000 in
Left slope	4.0000 ft/ft (V/H)
Right slope	3.0000 ft/ft (V/H)

Computed Results:

Depth	9.3523 in ←
Velocity	3.8516 fps
Full Flowrate	137.0073 cfs
Flow area	7.9708 ft2
Flow perimeter	139.4984 in
Hydraulic radius	8.2280 in
Top width	125.4555 in
Area	21.1667 ft2
Perimeter	170.0369 in
Percent full	38.9680 %



25-YR STORM = 30.7 CFS

MAX Depth = 9.4"

Free Board = 14.6"

Manning Pipe Calculator

CULVERT NEAR LEACHATE PUMPOUT

Given Input Data:

```
     Shape ...........................  Circular
     Solving for .....................  Flowrate
     Diameter ........................  24.0000 in
     Depth ...........................  24.0000 in
     Slope ...........................  0.0140 ft/ft
     Manning's n .....................  0.0240
```

Computed Results:

```
     Flowrate ........................  14.4989 cfs
     Area ............................  3.1416 ft2
     Wetted Area .....................  3.1416 ft2
     Wetted Perimeter ................  75.3982 in
     Perimeter .......................  75.3982 in
     Velocity ........................  4.6151 fps
     Hydraulic Radius ................  6.0000 in
     Percent Full ....................  100.0000 %
     Full flow Flowrate ..............  14.4989 cfs
     Full flow velocity ..............  4.6151 fps
```

25-YR PEAK RUNOFF FOR PHASE 3+4 SW = 55.4 cfs

ONLY ½ OF this watershed will Flow through this culvert

DESIGN FLOW = 27.7 cFs

SLOPE = 1.4%
24" CMP
FLOW = 14.5 CFs

2 - 24" CMP CAN HANDLE 29 cFs ✓

Intermediate Diversion Berm Calculation

BT² inc.

Sheet No.	
Calc. No.	
Rev. No.	

Job No. 3391 Job Edgewater Landfill By KRG Date 12/3/07

Client Subject Chk'd. Date

Determine IF INTERMEDIATE DIVERSION BERMS ARE REQUIRED ON THE FINAL COVER.

MAINTAIN SOIL LOSS TO 3 TON/AC OR LESS.

UNIVERSAL SOIL LOSS Equation

$$A = R \times K \times LS \times C \times P$$

A = Average Annual Soil Loss, ton/AC.

R = Rainfall + Runoff Erosivity index

K = Soil Erodibility factor, ton/AC

LS = Slope Length + Steepness factor

C = cover management factor

P = Practice factor

For the top of the Final Grades, slope = 3%, length = 330 FT

R = 100

K = 0.29

LS = 0.41

C = 0.1

P = 0.9

$$A = (100)(0.29)(0.41)(0.1)(0.9)$$

$$= 1.07 \text{ ton/Ac}$$ ok

For SIDES OF Final Cover, SLOPE = 25%, length = 170'

R = 100

K = 0.29

LS = 7.66

C = 0.1

P = 0.9

$$A = (100)(0.29)(7.66)(0.1)(0.09)$$

$$A = 2.00 \text{ TON/AC}$$ ok.

∴ No Intermediate SWALE IS REQUIRED.

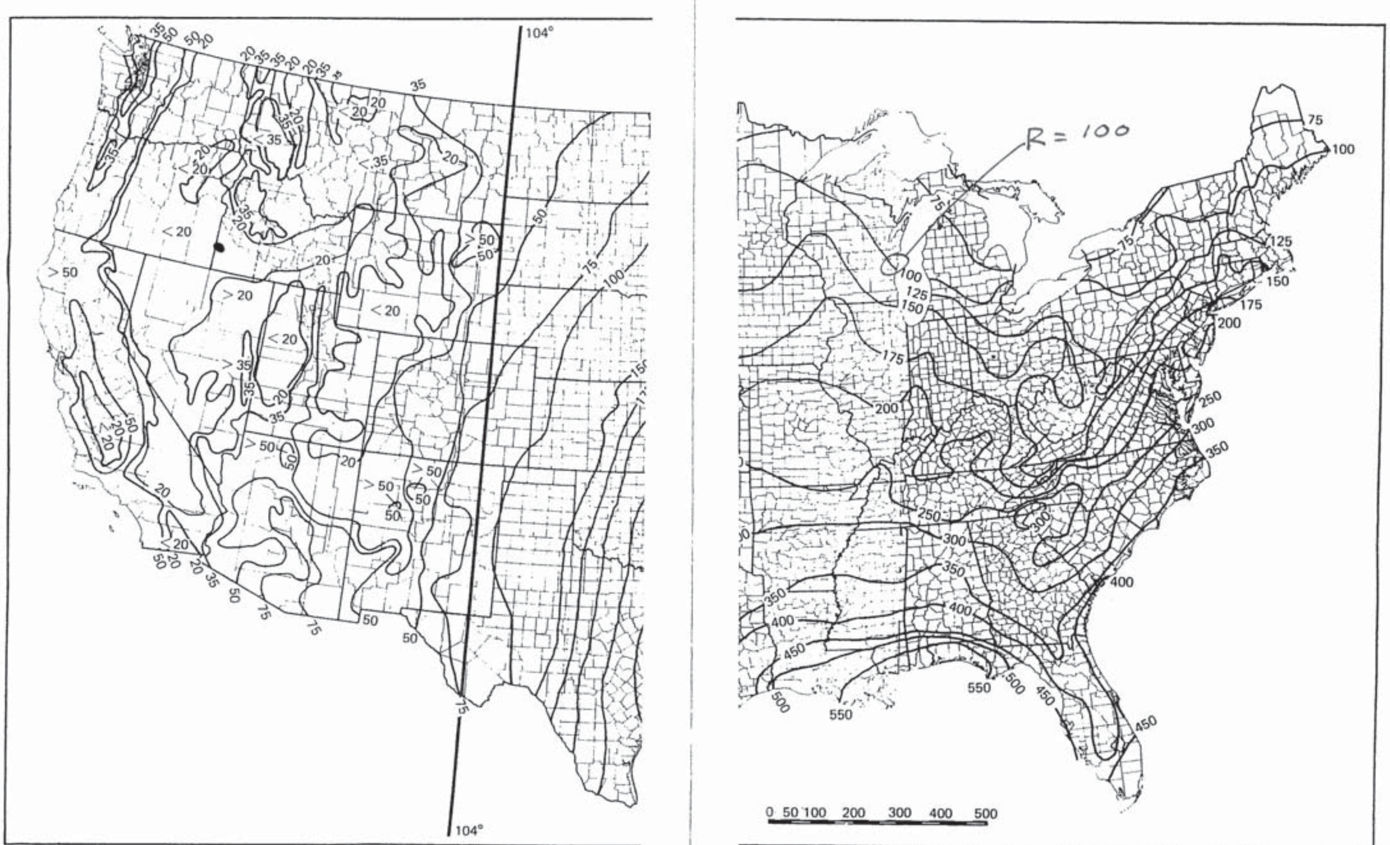


Fig. 5.2 *R* values for areas east of 104°. Because of irregular topography in the west United States, calculate *R* values in this region by using local rainfall data. *R* is in ui of 100 ft · tons/acre per in/hr. To convert *R* to units of 10^7 J/ha per mm/hr, multiply 1.70. (20) Scale is in miles.

TABLE 5.6 *C* Values for Soil Loss Equation*

Type of cover	*C* factor	Soil loss reduction, %
None	1.0	0
Native vegetation (undisturbed)	0.01	99
Temporary seedings:		
90% cover, annual grasses, no mulch	0.1	90
Wood fiber mulch, ¾ ton/acre (1.7 t/ha), with seed†	0.5	50
Excelsior mat, jute†	0.3	70
Straw mulch†		
1.5 tons/acre (3.4 t/ha), tacked down	0.2	80
4 tons/acre (9.0 t/ha), tacked down	0.05	95

*Adapted from Refs. 11, 15, and 20

†For slopes up to 2:1.

TABLE 5.7 *P* Factors for Construction Sites (Adapted from Ref. 15)

Surface condition	*P* value
Compacted and smooth	1.3
Trackwalked along contour*	1.2
Trackwalked up and down slope†	0.9
Punched straw	0.9
Rough, irregular cut	0.9
Loose to 12-in (30-cm) depth	0.8

*Tread marks oriented up and down slope.

†Tread marks oriented parallel to contours, as in Figs. 6.9 and 6.10.

TABLE 5. APPROXIMATE VALUES OF FACTOR K FOR USDA TEXTURAL CLASSES[11]

Texture class	Organic matter content <0.5% K	2% K	4% K
Sand	0.05	0.03	0.02
Fine sand	.16	.14	.10
Very fine sand	.42	.36	.28
Loamy sand	.12	.10	.08
Loamy fine sand	.24	.20	.16
Loamy very fine sand	.44	.38	.30
Sandy loam	.27	.24	.19
Fine sandy loam	.35	.30	.24
Very fine sandy loam	.47	.41	.33
Loam	.38	.34	.29
Silt loam	.48	.42	.33
Silt	.60	.52	.42
Sandy clay loam	.27	.25	.21
Clay loam	.28	.25	.21
Silty clay loam	.37	32	.26
Sandy clay	.14	.13	.12
Silty clay	.25	.23	.19
Clay		0.13-0.29	

Ave= 0,29

The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.

TABLE 5.5 LS Values* (10)

Slope ratio	Slope gradient s, %	LS values for following slope lengths l, ft (m)																					
		10 (3.0)	20 (6.1)	30 (9.1)	40 (12.2)	50 (15.2)	60 (18.3)	70 (21.3)	80 (24.4)	90 (27.4)	100 (30.5)	150 (46)	200 (61)	250 (76)	300 (91)	350 (107)	400 (122)	450 (137)	500 (152)	600 (183)	700 (213)	800 (244)	900 (274)
	0.5	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.15
100:1	1	0.08	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.12	0.12	0.14	0.14	0.15	0.16	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.19
	2	0.10	0.12	0.14	0.15	0.16	0.17	0.18	0.19	0.19	0.20	0.23	0.25	0.26	0.28	0.29	0.30	0.32	0.33	0.34	0.36	0.37	0.39
	3	0.14	0.18	0.20	0.22	0.23	0.25	0.26	0.27	0.28	0.29	0.32	0.35	0.38	0.40	0.42	0.43	0.45	0.46	0.49	0.51	0.54	0.55
	4	0.16	0.21	0.25	0.28	0.30	0.33	0.35	0.37	0.38	0.40	0.47	0.53	0.58	0.62	0.66	0.70	0.73	0.76	0.82	0.87	0.92	0.96
20:1	5	0.17	0.24	0.29	0.34	0.38	0.41	0.45	0.48	0.51	0.53	0.66	0.76	0.85	0.93	1.00	1.07	1.13	1.20	1.31	1.42	1.51	1.60
	6	0.21	0.30	0.37	0.43	0.48	0.52	0.56	0.60	0.64	0.67	0.82	0.95	1.06	1.16	1.26	1.34	1.43	1.50	1.65	1.78	1.90	2.02
	7	0.26	0.37	0.45	0.52	0.58	0.64	0.69	0.74	0.78	0.82	1.01	1.17	1.30	1.43	1.54	1.65	1.75	1.84	2.02	2.18	2.33	2.47
12½:1	8	0.31	0.44	0.54	0.63	0.70	0.77	0.83	0.89	0.94	0.99	1.21	1.40	1.57	1.72	1.85	1.98	2.10	2.22	2.43	2.62	2.80	2.97
	9	0.37	0.52	0.64	0.74	0.83	0.91	0.98	1.05	1.11	1.17	1.44	1.66	1.85	2.03	2.19	2.35	2.49	2.62	2.87	3.10	3.32	3.52
10:1	10	0.43	0.61	0.75	0.87	0.97	1.06	1.15	1.22	1.30	1.37	1.68	1.94	2.16	2.37	2.56	2.74	2.90	3.06	3.35	3.62	3.87	4.11
	11	0.50	0.71	0.86	1.00	1.12	1.22	1.32	1.41	1.50	1.58	1.93	2.23	2.50	2.74	2.95	3.16	3.35	3.53	3.87	4.18	4.47	4.74
8:1	12.5	0.61	0.86	1.05	1.22	1.36	1.49	1.61	1.72	1.82	1.92	2.35	2.72	3.04	3.33	3.59	3.84	4.08	4.30	4.71	5.08	5.43	5.76
	15	0.81	1.14	1.40	1.62	1.81	1.98	2.14	2.29	2.43	2.56	3.13	3.62	4.05	4.43	4.79	5.12	5.43	5.72	6.27	6.77	7.24	7.68
6:1	16.7	0.96	1.36	1.67	1.92	2.15	2.36	2.54	2.72	2.88	3.04	3.72	4.30	4.81	5.27	5.69	6.08	6.45	6.80	7.45	8.04	8.60	9.12
5:1	20	1.29	1.82	2.23	2.58	2.88	3.16	3.41	3.65	3.87	4.08	5.00	5.77	6.45	7.06	7.63	8.16	8.65	9.12	9.99	10.79	11.54	12.24
4½:1	22	1.51	2.13	2.61	3.02	3.37	3.69	3.99	4.27	4.53	4.77	5.84	6.75	7.54	8.26	8.92	9.54	10.12	10.67	11.68	12.62	13.49	14.31
4:1	25	1.86	2.63	3.23	3.73	4.16	4.56	4.93	5.27	5.59	5.89	7.21	8.33	9.31	10.20	11.02	11.78	12.49	13.17	14.43	15.58	16.66	17.67
	30	2.51	3.56	4.36	5.03	5.62	6.16	6.65	7.11	7.54	7.95	9.74	11.25	12.57	13.77	14.88	15.91	16.87	17.78	19.48	21.04	22.49	23.86
3:1	33.3	2.98	4.22	5.17	5.96	6.67	7.30	7.89	8.43	8.95	9.43	11.55	13.34	14.91	16.33	17.64	18.86	20.00	21.09	23.10	24.95	26.67	28.29
	35	3.23	4.57	5.60	6.46	7.23	7.92	8.55	9.14	9.70	10.22	12.52	14.46	16.16	17.70	19.12	20.44	21.68	22.86	25.04	27.04	28.91	30.67
2½:1	40	4.00	5.66	6.93	8.00	8.95	9.80	10.59	11.32	12.00	12.65	15.50	17.89	20.01	21.91	23.67	25.30	26.84	28.29	30.99	33.48	35.79	37.96
	45	4.81	6.80	8.33	9.61	10.75	11.77	12.72	13.60	14.42	15.20	18.62	21.50	24.03	26.33	28.44	30.40	32.24	33.99	37.23	40.22	42.99	45.60
2:1	50	5.64	7.97	9.76	11.27	12.60	13.81	14.91	15.94	16.91	17.82	21.83	25.21	28.18	30.87	33.34	35.65	37.81	39.85	43.66	47.16	50.41	53.47
	55	6.48	9.16	11.22	12.96	14.48	15.87	17.14	18.32	19.43	20.48	25.09	28.97	32.39	35.48	38.32	40.97	43.45	45.80	50.18	54.20	57.94	61.45
1¾:1	57	6.82	9.64	11.80	13.63	15.24	16.69	18.03	19.28	20.45	21.55	26.40	30.48	34.08	37.33	40.32	43.10	45.72	48.19	52.79	57.02	60.96	64.66
	60	7.32	10.35	12.68	14.64	16.37	17.93	19.37	20.71	21.96	23.15	28.35	32.74	36.60	40.10	43.31	46.30	49.11	51.77	56.71	61.25	65.48	69.45
1½:1	66.7	8.44	11.93	14.61	16.88	18.87	20.67	22.32	23.87	25.31	26.68	32.68	37.74	42.19	46.22	49.92	53.37	56.60	59.66	65.36	70.60	75.47	80.05
	70	8.98	12.70	15.55	17.96	20.08	21.99	23.75	25.39	26.93	28.39	34.77	40.15	44.89	49.17	53.11	56.78	60.23	63.48	69.54	75.12	80.30	85.17
	75	9.78	13.83	16.94	19.56	21.87	23.95	25.87	27.66	29.34	30.92	37.87	43.73	48.89	53.56	57.85	61.85	65.60	69.15	75.75	81.82	87.46	92.77
1¼:1	80	10.55	14.93	18.28	21.11	23.60	25.85	27.93	29.85	31.66	33.38	40.88	47.20	52.77	57.81	62.44	66.75	70.80	74.63	81.76	88.31	94.41	100.13
	85	11.30	15.98	19.58	22.61	25.27	27.69	29.90	31.97	33.91	35.74	43.78	50.55	56.51	61.91	66.87	71.48	75.82	79.92	87.55	94.57	101.09	107.23
	90	12.02	17.00	20.82	24.04	26.88	29.44	31.80	34.00	36.06	38.01	46.55	53.76	60.10	65.84	71.11	76.02	80.63	84.99	93.11	100.57	107.51	114.03
	95	12.71	17.97	22.01	25.41	28.41	31.12	33.62	35.94	38.12	40.18	49.21	56.82	63.53	69.59	75.17	80.36	85.23	89.84	98.42	106.30	113.64	120.54
1:1	100	13.36	18.89	23.14	26.72	29.87	32.72	35.34	37.78	40.08	42.24	51.74	59.74	66.79	73.17	79.03	84.49	89.61	94.46	103.48	111.77	119.48	126.73

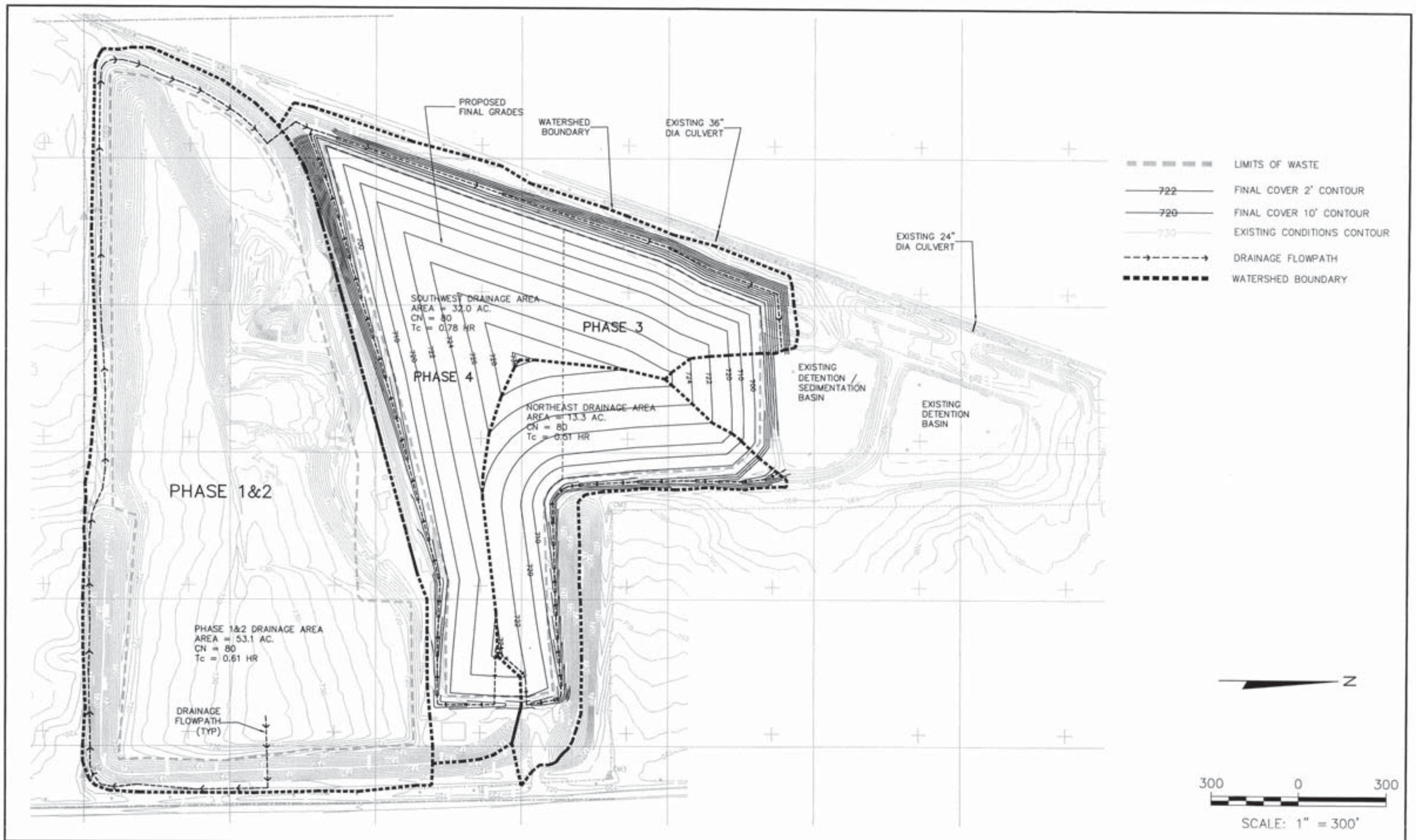
*Calculated from

$$LS = \left(\frac{65.41 \times s^2}{s^2 + 10{,}000} + \frac{4.56 \times s}{\sqrt{s^2 + 10{,}000}} + 0.065\right)\left(\frac{l}{72.5}\right)^m$$

LS = topographic factor
l = slope length, ft (m × 0.3048)
s = slope steepness,
m = exponent dependent upon slope steepness (0.2 for slopes < 1%, 0.3 for slopes 1 to 3%, 0.4 for slopes 3.5 to 4.5%, and 0.5 for slopes > 5%)

170' = 7.66

73 end



PROJECT NO.	3391	DRAWN BY:	KRG
DRAWN:	11/27/07	CHECKED BY:	TR
REVISED:		APPROVED BY:	

ENGINEER: BT² inc. — 2830 DAIRY DRIVE, MADISON, WI 53718-6751, PHONE: (608) 224-2830, FAX: (608) 224-2839

CLIENT: WISCONSIN POWER AND LIGHT, EDGEWATER GENERATING STATION, 3739 LAKESHORE DRIVE, SHEBOYGAN, WI 53081

SITE: PLAN OF OPERATION PHASES 3 AND 4, EDGEWATER I-43 ASH DISPOSAL FACILITY, WILSON, WISCONSIN

WATERSHED AND DRAINAGE PATH LOCATIONS

FIGURE G1

Appendix B1.2

2015 Plan of Operation Update Storm Water Calculations

Storm Water Management Calculations

Purpose:

The purpose of the storm water runoff calculations is to demonstrate that the proposed landfill surface water management system design meets the requirements of the Wisconsin Administrative Code, 504.09.

Existing Features:

Currently Phase 1 and 2 of the landfill have final cover in place. The final cover includes a grass surface. Phase 3, Module 1 has been constructed and is full of ash but does not have final cover in place. Phase 4, Module 1 was constructed in the summer of 2014 and is accepting ash.

Surface water runoff from final cover areas discharges to an existing sedimentation basin at the north end of the landfill. Surface water runoff that comes in contact with ash discharges to the contact water basin located along the western side of the facility, which is managed separately from the non-contact runoff (refer to Section 2.7 of the Plan Modification report). An additional existing detention basin is located north of the landfill detention/sedimentation basin to treat off-site runon. Because the plan modification does not affect off-site runon or the existing detention basin, these storm water management calculations do not include modeling of these areas/features.

From the discharge of the existing detention/sedimentation basins, runoff ultimately discharges off-site via two culverts: 1) a 36-inch diameter culvert under the railroad tracks to the west of the site and 2) a 24-inch diameter culvert under the railroad tracks to the west of the site. The culverts are shown on **Figure F1**.

Approach:

Final Cover Soil Loss

The Universal Soil Loss Equation (USLE) was used to estimate soil loss along the final cover slopes. The USLE estimates the final cover soil erosion based on the erodibility of the soil, the rainfall and runoff erosivity, the slope steepness, cover management, and soil practice factors. A maximum soil loss of 3 tons per acre is considered acceptable.

Hydrograph Generation

To properly size the storm water management features, runoff hydrographs for the 25-year, 24-hour, and 100-year, 24-hour, storm events were developed. HydroCAD was used to model the storm water management system and develop the hydrographs using TR-20 methodologies. The model is designed to simulate the surface runoff response of a watershed to a precipitation event. Input parameters for the model include precipitation depth for the design storm event, contributing drainage areas, runoff curve numbers, time of concentration, and travel time.

The final cover watersheds are shown on **Figures F-1** and **F-2**.

Perimeter Ditch and Diversion Berm Sizing

Perimeter ditches and diversion berms were sized for the 25-year, 24-hour storm event using the Manning's equation to determine the depth of flow and velocity in the berm/ditch based on the berm/ditch geometry and peak flow in the berm/ditch (as determined by the Hydrograph Generation calculations). The drainage areas for the diversion berms are included in **Figure F2**.

Downslope Flume and Energy Dissipator Sizing

The downslope flume inlets were sized for the 25-year, 24-hour storm event using the orifice equation. The downslope flume pipes were sized based on the peak flow conditions in the pipe using Manning's equation. Energy dissipators were sized using tables from the reference book "Hydraulic Design of Energy Dissipators for Culvert and Channels," US Department of Transportation, Federal Highway Administration, July 2006.

Culvert Sizing
The culverts were sized for the 25-year, 24-hour storm event using the HY-8 computer model developed by the US Department of Transportation, Federal Highway Administration. Culvert outlet protection was sized using guidance from the Wisconsin DOT Permissible Velocities for Riprap Lined Ditches, Procedure 13-30-10.

Sedimentation Basin Sizing
The sedimentation basin sizing process involved determining an appropriate ratio of surface area to flow rate that would allow particles to settle out during a design storm event. The sedimentation basins were sized for the 25-year, 24-hour storm event. The sedimentation basin emergency spillway were sized for the 100-year, 24-hour storm event.

A table presented in the "Erosion and Sediment Control Handbook" (Goldman, et. Al., 1986) provides the surface area-to-discharge ratio required to achieve settlement of the desired particle sizes.

The HydroCAD model was used in conjunction with accepted formulas and engineering calculations to evaluate the ability of the sedimentation basin to meet the requirements of NR 504.09.

Key Assumptions:

- Runoff curve numbers were based on tables presented in Urban Hydrology for Small Watersheds, and were assumed as follows

Cover Type	CN
Landfill final cover	79 – Open spaces (lawns, parks, etc) in fair condition with hydrologic soil group C
Sedimentation basin	98 – Water surface

- A Type II rainfall distribution was used, based on The NOAA Atlas 14, Precipitation Frequency Data Server for Sheboygan Falls, WI (page 4). The following precipitation depths were assumed.

Storm Event	Precipitation Depth (inches)
25-year, 24-hour	4.79
100-year, 24-hour	6.55

- Other assumptions are included with the calculations attached to this appendix.

Results:
The proposed landfill surface water management system design meets the requirements of the Wisconsin Administrative Code, 504.09. Further details are provided below.

Soil Loss
The USLE calculations indicate a minimal soil loss rate along the 3% and 4:1 final cover sideslopes. Although the calculations indicate no diversion berms are needed, berms have been designed upslope of the final cover slope transition. Experience has shown these transition points are sometimes more susceptible to erosion, so the added berms provide protection. Refer to the USLE Calculations section of this appendix for the detailed calculations.

Hydrograph Generation

The hydrograph modeling results for the 25-year and 100-year, 24-hour storm events are included the Hydrograph Generation section of this appendix.

Perimeter Ditch and Diversion Berm Sizing

The diversion berms will be constructed as shown on the plan set. The diversion berms will maintain a minimum 0.5 foot freeboard. Refer to the Diversion Berm and Ditch Sizing section of this appendix for the detailed calculations.

The perimeter ditches will be constructed as shown on the plan set. The perimeter ditches will contain the runoff from the 25-year, 24-hour storm event and maintain a minimum 0.5 foot of freeboard. Erosion matting will be used where ditch velocities exceed 5 feet per second. Refer to the Diversion Berm and Ditch Sizing section of this appendix for the detailed calculations.

Downslope Flume and Energy Dissipator Sizing

The downslope flumes will be constructed as shown on the plan set. The downslope flumes are designed to accommodate the surface water runoff from the final cover for a 25-year, 24-hour storm event. Energy dissipators at the bottom of the downslope flumes have been designed to handle the peak velocities, and additional riprap protection has been sized for the energy dissipator outlets. Refer to the Downslope Flume and Energy Dissipator Sizing section of this appendix for the detailed calculations.

Culvert Sizing

The culverts are designed to accommodate the flows from the perimeter ditches for the 25-year, 24-hour storm event. Riprap outlet protection has been sized based on the discharge rates and outlet velocities. Refer to the Culvert Sizing section of this appendix for the detailed calculations.

Sedimentation Basin Sizing

The outlet structure for the detention/sedimentation basin is sized to control runoff from the 25-year, 24-hour storm event, assuming the starting water elevation is at the bottom of the lowest outlet structure opening. The sedimentation basin is designed to settle out particles 0.01 microns and larger in diameter. Refer to the Sedimentation Basin Sizing section of this appendix for the detailed calculations. The emergency spillways have been designed to pass the 100-year, 24-hour storm event.

4

NOAA Atlas 14, Volume 8, Version 2
Location name: Sheboygan Falls, Wisconsin, US*
Latitude: 43.6942°, Longitude: -87.7645°
Elevation: 718 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.325** (0.258-0.409)	**0.388** (0.307-0.488)	**0.488** (0.385-0.615)	**0.568** (0.447-0.717)	**0.674** (0.514-0.858)	**0.753** (0.565-0.966)	**0.829** (0.607-1.07)	**0.903** (0.641-1.19)	**0.997** (0.688-1.33)	**1.06** (0.722-1.43)
10-min	**0.476** (0.377-0.599)	**0.568** (0.450-0.715)	**0.714** (0.564-0.900)	**0.832** (0.654-1.05)	**0.987** (0.753-1.26)	**1.10** (0.828-1.41)	**1.21** (0.889-1.57)	**1.32** (0.939-1.74)	**1.46** (1.01-1.94)	**1.56** (1.06-2.10)
15-min	**0.581** (0.460-0.730)	**0.693** (0.549-0.872)	**0.871** (0.688-1.10)	**1.01** (0.798-1.28)	**1.20** (0.918-1.53)	**1.34** (1.01-1.72)	**1.48** (1.08-1.92)	**1.61** (1.15-2.12)	**1.78** (1.23-2.37)	**1.90** (1.29-2.56)
30-min	**0.805** (0.638-1.01)	**0.963** (0.763-1.21)	**1.21** (0.959-1.53)	**1.41** (1.11-1.78)	**1.68** (1.28-2.13)	**1.87** (1.40-2.39)	**2.05** (1.50-2.66)	**2.23** (1.58-2.92)	**2.45** (1.69-3.26)	**2.60** (1.77-3.51)
60-min	**1.04** (0.823-1.31)	**1.24** (0.978-1.55)	**1.55** (1.23-1.96)	**1.81** (1.43-2.29)	**2.16** (1.66-2.76)	**2.43** (1.83-3.13)	**2.69** (1.98-3.50)	**2.96** (2.10-3.90)	**3.30** (2.28-4.41)	**3.56** (2.42-4.79)
2-hr	**1.27** (1.02-1.58)	**1.51** (1.21-1.87)	**1.89** (1.51-2.35)	**2.21** (1.76-2.75)	**2.65** (2.06-3.36)	**3.00** (2.28-3.82)	**3.34** (2.48-4.31)	**3.69** (2.65-4.83)	**4.16** (2.90-5.52)	**4.51** (3.08-6.04)
3-hr	**1.42** (1.15-1.75)	**1.67** (1.35-2.06)	**2.09** (1.69-2.58)	**2.45** (1.97-3.03)	**2.97** (2.33-3.75)	**3.38** (2.60-4.30)	**3.81** (2.85-4.90)	**4.25** (3.08-5.55)	**4.86** (3.41-6.44)	**5.34** (3.66-7.11)
6-hr	**1.69** (1.39-2.05)	**1.96** (1.61-2.39)	**2.45** (2.00-2.98)	**2.89** (2.35-3.52)	**3.54** (2.83-4.46)	**4.09** (3.19-5.17)	**4.67** (3.54-5.99)	**5.30** (3.88-6.90)	**6.19** (4.39-8.18)	**6.91** (4.77-9.15)
12-hr	**1.97** (1.64-2.36)	**2.27** (1.89-2.73)	**2.83** (2.34-3.40)	**3.35** (2.76-4.04)	**4.16** (3.38-5.21)	**4.85** (3.84-6.10)	**5.61** (4.31-7.15)	**6.44** (4.77-8.34)	**7.63** (5.46-10.0)	**8.60** (5.98-11.3)
24-hr	**2.26** (1.90-2.67)	**2.59** (2.18-3.07)	**3.23** (2.71-3.82)	**3.84** (3.20-4.56)	**4.79** (3.95-5.96)	**5.63** (4.51-7.01)	**6.55** (5.09-8.28)	**7.57** (5.66-9.73)	**9.04** (6.52-11.8)	**10.3** (7.18-13.4)
2-day	**2.57** (2.20-3.00)	**2.93** (2.50-3.42)	**3.63** (3.08-4.23)	**4.30** (3.63-5.04)	**5.37** (4.48-6.60)	**6.31** (5.12-7.79)	**7.36** (5.78-9.22)	**8.52** (6.43-10.9)	**10.2** (7.43-13.3)	**11.6** (8.18-15.1)
3-day	**2.82** (2.43-3.26)	**3.18** (2.73-3.67)	**3.87** (3.31-4.48)	**4.55** (3.88-5.29)	**5.65** (4.75-6.90)	**6.62** (5.41-8.11)	**7.70** (6.08-9.60)	**8.90** (6.76-11.3)	**10.7** (7.80-13.8)	**12.1** (8.58-15.7)
4-day	**3.03** (2.63-3.48)	**3.40** (2.93-3.90)	**4.10** (3.53-4.72)	**4.79** (4.11-5.54)	**5.91** (4.99-7.17)	**6.89** (5.66-8.40)	**7.99** (6.34-9.92)	**9.22** (7.02-11.7)	**11.0** (8.07-14.2)	**12.5** (8.86-16.1)
7-day	**3.55** (3.10-4.03)	**3.98** (3.48-4.53)	**4.80** (4.18-5.46)	**5.57** (4.82-6.36)	**6.77** (5.75-8.09)	**7.81** (6.46-9.39)	**8.95** (7.14-11.0)	**10.2** (7.81-12.8)	**12.0** (8.84-15.4)	**13.5** (9.62-17.3)
10-day	**4.01** (3.54-4.52)	**4.52** (3.98-5.10)	**5.43** (4.76-6.14)	**6.27** (5.47-7.11)	**7.54** (6.42-8.90)	**8.61** (7.14-10.3)	**9.77** (7.82-11.9)	**11.0** (8.46-13.7)	**12.8** (9.46-16.3)	**14.3** (10.2-18.2)
20-day	**5.45** (4.87-6.05)	**6.09** (5.44-6.77)	**7.20** (6.41-8.02)	**8.16** (7.21-9.12)	**9.54** (8.18-11.0)	**10.7** (8.91-12.4)	**11.8** (9.53-14.1)	**13.0** (10.1-16.0)	**14.7** (10.9-18.5)	**16.0** (11.6-20.4)
30-day	**6.71** (6.05-7.38)	**7.47** (6.73-8.23)	**8.74** (7.84-9.65)	**9.80** (8.74-10.9)	**11.3** (9.71-12.9)	**12.4** (10.4-14.4)	**13.6** (11.0-16.1)	**14.8** (11.5-17.9)	**16.4** (12.2-20.4)	**17.6** (12.7-22.2)
45-day	**8.35** (7.59-9.11)	**9.29** (8.44-10.1)	**10.8** (9.78-11.8)	**12.0** (10.8-13.2)	**13.7** (11.8-15.4)	**14.9** (12.6-17.0)	**16.1** (13.1-18.8)	**17.2** (13.4-20.7)	**18.7** (14.0-23.1)	**19.8** (14.4-24.9)
60-day	**9.78** (8.94-10.6)	**10.9** (9.96-11.8)	**12.7** (11.5-13.8)	**14.0** (12.7-15.3)	**15.8** (13.7-17.7)	**17.1** (14.5-19.4)	**18.3** (15.0-21.3)	**19.5** (15.2-23.3)	**20.9** (15.6-25.7)	**21.9** (15.9-27.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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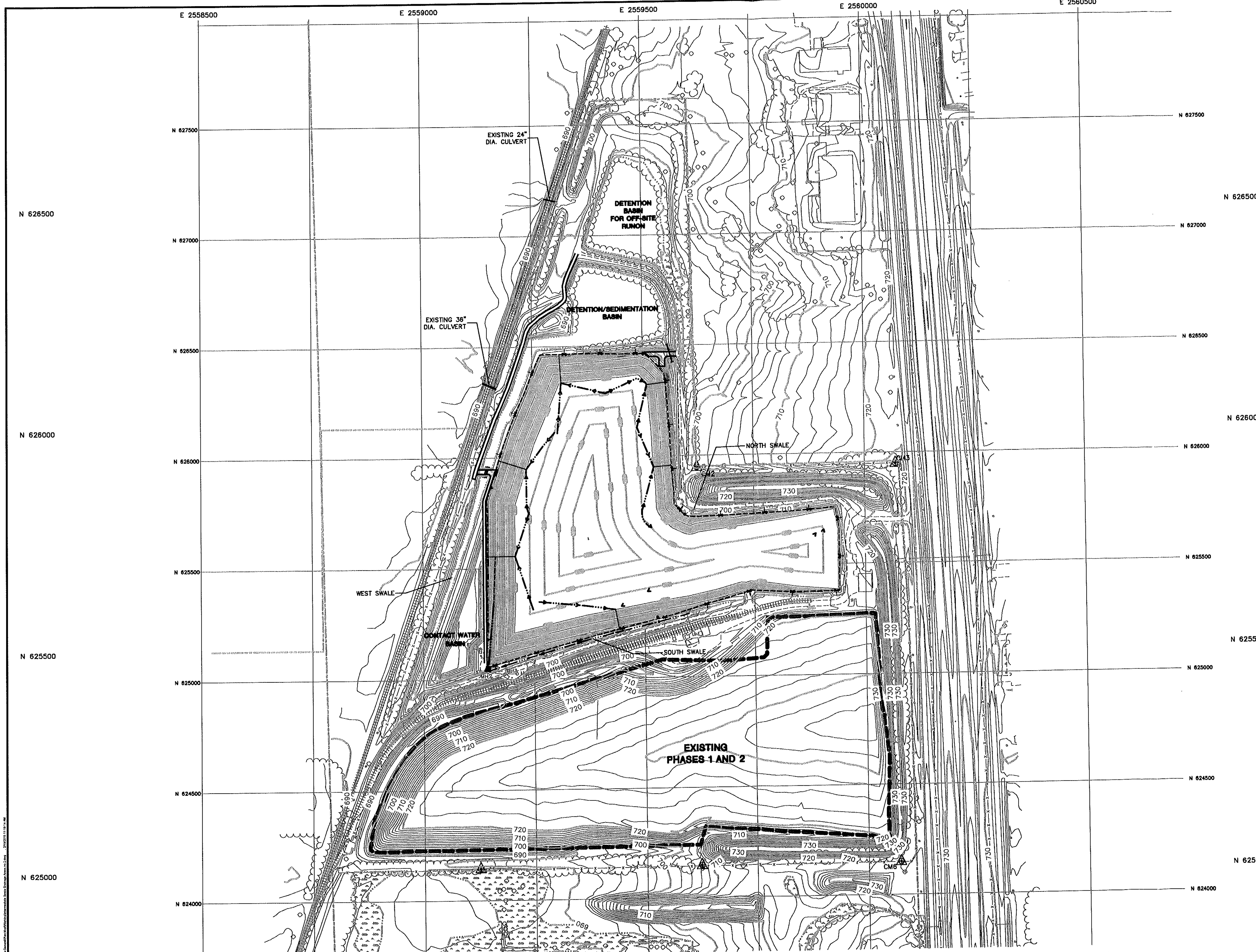

LEGEND

- APPROXIMATE PROPERTY LINE
- APPROVED LIMITS OF WASTE
- APPROVED MODULE LIMITS
- EXISTING GRADE (2' CONTOUR)
- 690 EXISTING GRADE (10' CONTOUR)
- 702 PROPOSED GRADE (2' CONTOUR)
- 700 PROPOSED GRADE (10' CONTOUR)
- PROPOSED PERIMETER DITCH
- PROPOSED CULVERT
- PROPOSED LEACHATE CLEANOUT
- PROPOSED LEACHATE HEADWELL
- PROPOSED ACCESS ROAD
- PROPOSED FINAL COVER DIVERSION BERM
- PROPOSED DOWNSLOPE FLUME
- PROPOSED ENERGY DISSIPATOR
- PROPOSED TOE DRAIN AND DISCHARGE PIPE

NOTES:

1. SEE SHEET 2 FOR ADDITIONAL BASE MAP LEGEND ITEMS AND NOTES.

N

100 0 100

SCALE: 1" = 100'

I:\25214060\Drawings-General\Plan Mod\Working\Intermediate Swale Drainage Areas no.2.dwg, 2/19/2015 11:19:12 AM

PROJECT NO.	25214060	DRAWN BY:	KRG
DRAWN:	02/06/15	CHECKED BY:	CHECKEDBY
REVISED:		APPROVED BY:	

WISCONSIN POWER AND LIGHT COMPANY
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SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
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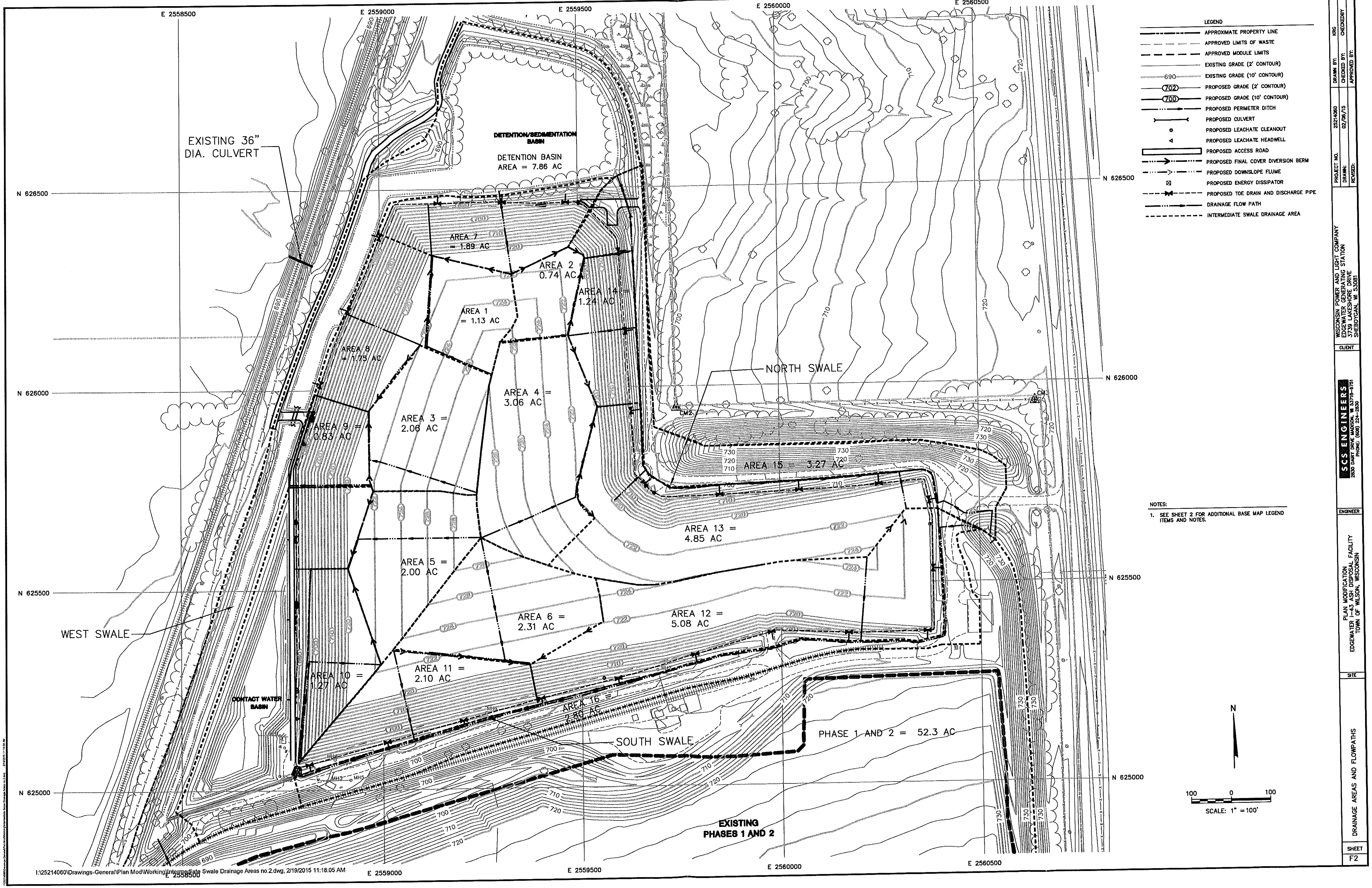
ENGINEER

PLAN MODIFICATION
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

SITE

PROPOSED FINAL GRADES AND DRAINAGE FEATURES

SHEET
F1


LEGEND
APPROXIMATE PROPERTY LINE
APPROVED LIMITS OF WASTE
APPROVED MODULE LIMITS
EXISTING GRADE (2' CONTOUR)
EXISTING GRADE (10' CONTOUR)
PROPOSED GRADE (2' CONTOUR)
PROPOSED GRADE (10' CONTOUR)
PROPOSED PERIMETER DITCH
PROPOSED CULVERT
PROPOSED LEACHATE CLEANOUT
PROPOSED LEACHATE HEADWELL
PROPOSED ACCESS ROAD
PROPOSED FINAL COVER DIVERSION BERM
PROPOSED DOWNSLOPE FLUME
PROPOSED ENERGY DISSIPATOR
PROPOSED TOE DRAIN AND DISCHARGE PIPE
DRAINAGE FLOW PATH
INTERMEDIATE SWALE DRAINAGE AREA
NOTES:
1. SEE SHEET 2 FOR ADDITIONAL BASE MAP LEGEND ITEMS AND NOTES.
EXISTING 36" DIA. CULVERT
DETENTION/SEDIMENTATION BASIN
DETENTION BASIN AREA = 7.86 AC
AREA 7 = 1.89 AC
AREA 2 = 0.74 AC
AREA 14 = 1.24 AC
AREA 1 = 1.13 AC
AREA 8 = 1.75 AC
AREA 4 = 3.06 AC
AREA 3 = 2.06 AC
AREA 9 = 0.83 AC
NORTH SWALE
AREA 15 = 3.27 AC
AREA 13 = 4.85 AC
AREA 5 = 2.00 AC
AREA 6 = 2.31 AC
AREA 12 = 5.08 AC
AREA 11 = 2.10 AC
AREA 10 = 1.27 AC
AREA 16 = 2.80 AC
WEST SWALE
CONTACT WATER BASIN
SOUTH SWALE
PHASE 1 AND 2 = 52.3 AC
EXISTING PHASES 1 AND 2
E 2558500
E 2559000
E 2559500
E 2560000
E 2560500
N 626500
N 626000
N 625500
N 625000
N
100 0 100
SCALE: 1" =100'
PROJECT NO. 25214060
DRAWN: 02/06/15
REVISED:
DRAWN BY: KRG
CHECKED BY:
APPROVED BY:
WISCONSIN POWER AND LIGHT COMPANY
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081
CLIENT
SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830
ENGINEER
PLAN MODIFICATION
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN
SITE
DRAINAGE AREAS AND FLOWPATHS
SHEET
F2
I:\25214060\Drawings-General\Plan Mod\Working\Intermediate Swale Drainage Areas no.2.dwg, 2/19/2015 11:18:05 AM

USLE Calculation

SCS ENGINEERS

		Sheet No.	1 of 6
		Calc. No.	
		Rev. No.	
Job No. 25214060	Job: I-43 Landfill Plan Modification	By: KRG	Date: 1/30/15
Client: Alient Energy	Subject: Soil Loss Along Final Cover	Chk'd:	Date:

Universal Soil Loss Equation (USLE) Calculation

Use USLE to estimate soil loss along the 3% final cover slope, with the goal of maintaining ≤ 3 ton/acre of soil loss along the final cover.

USLE Equation:

A = R * K * LS * C * P

where: A = Average annual soil loss, ton/acre
R = Rainfall and runoff erosivity index
K = Soil erodibility factor, tons/acre
LS = Slope length and steepness factor
C = Cover management factor
P = Practice factor

The LS factor is a function of the slope and flow length.

LS = L * S

where: L = Slope length factor = (l/72.6)^m
where: l = Slope length, feet
m = Slope-length exponent (m = 0.3 for slopes of 1% to 3%
m = 0.4 for slopes of 3.5% to 4.5%
m = 0.5 for slopes greater than 5%)

S = Slope steepness factor = (65.41s^2/(s^2 + 10,000)) + (4.56s/(SQRT(s^2 + 10,000))) + 0.065
where: s = Slope, in percent

The soil type chosen for selecting the appropriate K factor is an estimate of silt loam for the topsoil.

Data Entered		**Data Computed**	
Slope (%), s =	3	S =	0.26
l =	340	L =	1.6
m =	0.3	LS =	0.4

Calculate Average Annual Soil Loss, A:

R =	100	*
K =	0.42	*
LS =	0.4	
C =	0.004	*
P =	1.0	*

A = R * K * LS * C * P = 0.1 tons/acre

* See attached references for R, K, C, and P factors

Soil loss along the 3% slope of the final cover results in minimal soil loss.

Universal Soil Loss Equation (USLE) Calculation

Use USLE to estimate soil loss along the 4:1 final cover slope, with the goal of maintaining ≤ 3 ton/acre of soil loss along the final cover.

USLE Equation:

A = R * K * LS * C * P

where: A = Average annual soil loss, ton/acre
R = Rainfall and runoff erosivity index
K = Soil erodibility factor, tons/acre
LS = Slope length and steepness factor
C = Cover management factor
P = Practice factor

The LS factor is a function of the slope and flow length.

LS = L * S

where: L = Slope length factor = (l/72.6)^m
where: l = Slope length, feet
m = Slope-length exponent (m = 0.3 for slopes of 1% to 3%
m = 0.4 for slopes of 3.5% to 4.5%
m = 0.5 for slopes greater than 5%)

S = Slope steepness factor = (65.41s^2/(s^2 + 10,000)) + (4.56s/(SQRT(s^2 + 10,000))) + 0.065
where: s = Slope, in percent

The soil type chosen for selecting the appropriate K factor is an estimate of silt loam for the topsoil.

Data Entered		Data Computed	
Slope (%), s =	25	S =	5.02
l =	136	L =	1.4
m =	0.5	LS =	6.9

Calculate Average Annual Soil Loss, A:

R =	100	*
K =	0.42	*
LS =	6.9	
C =	0.004	*
P =	1.0	*

A = R * K * LS * C * P = 1.2 tons/acre

* See attached references for R, K, C, and P factors

Soil loss along the 4:1 slope of the final cover results in minimal soil loss.

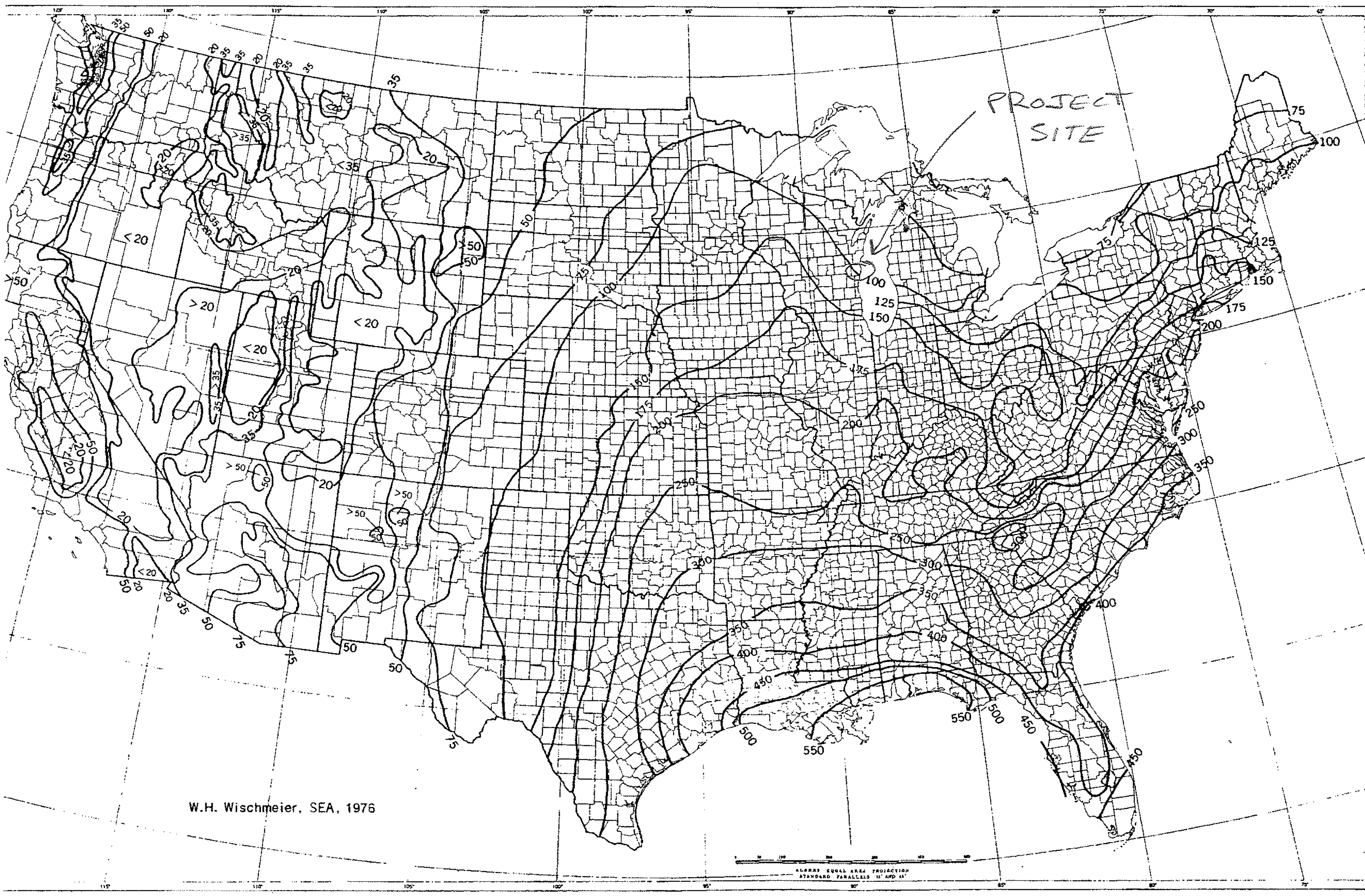


FIGURE 1.—Average annual values of the rainfall erosion index.

3

4

soil in a unit plot, pinpoints differences in erosion according to differences in soil type. Long-term plot studies under natural rainfall have produced K values generalized in Table 5 for the USDA soil types.

TABLE 5. APPROXIMATE VALUES OF FACTOR K FOR USDA TEXTURAL CLASSES[11]

Texture class	Organic matter content		
	<0.5%	2%	4%
	K	K	K
Sand	0.05	0.03	0.02
Fine sand	.16	.14	.10
Very fine sand	.42	.36	.28
Loamy sand	.12	.10	.08
Loamy fine sand	.24	.20	.16
Loamy very fine sand	.44	.38	.30
Sandy loam	.27	.24	.19
Fine sandy loam	.35	.30	.24
Very fine sandy loam	.47	.41	.33
Loam	.38	.34	.29
Silt loam	.48	.42	.33
Silt	.60	.52	.42
Sandy clay loam	.27	.25	.21
Clay loam	.28	.25	.21
Silty clay loam	.37	.32	.26
Sandy clay	.14	.13	.12
Silty clay	.25	.23	.19
Clay		0.13-0.29	

The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.

The evaluator must next consider the shape of the slope in terms of length and inclination. The appropriate LS factor is obtained from Table 6. A nonlinear slope may have to be evaluated as a series of segments, each with uniform gradient. Two or three segments should be sufficient for most engineered landfills, provided the segments are selected so that they are also of equal length (Table 6 can be used, with certain adjustments). Enter Table 6 with the total slope length and read LS values corresponding to the percent slope of each segment. For three segments, multiply the chart LS values for the upper, middle, and lower segments by 0.58, 1.06, and 1.37, respectively. The average of the three products is a good estimate of the

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TABLE 7. GENERALIZED VALUES OF FACTOR C FOR STATES EAST OF THE ROCKY MOUNTAINS[11]

Crop, rotation, and management	Productivity level High	Productivity level Mod.
	C value	
Base value: continuous fallow, tilled up and down slope	1.00	1.00
CORN		
C, RdR, fall TP, conv	0.54	0.62
C, RdR, spring TP, conv	.50	.59
C, RdL, fall TP, conv	.42	.52
C, RdR, wc seeding, spring TP, conv	.40	.49
C, RdL, standing, spring TP, conv	.38	.48
C-W-M-M, RdL, TP for C, disk for W	.039	.074
C-W-M-M-M, RdL, TP for C, disk for W	.032	.061
C, no-till pl in c-k sod, 95-80% rc	.017	.053
COTTON		
Cot, conv (Western Plains)	0.42	0.49
Cot, conv (South)	.34	.40
MEADOW		
Grass & Legume mix	0.004	0.01
Alfalfa, lespedeza or Sericia	.020	
Sweet clover	.025	
SORGHUM, GRAIN (Western Plains)		
RdL, spring TP, conv	0.43	0.53
No-till pl in shredded 70-50% rc	.11	.18
SOYBEANS		
B, RdL, spring TP, conv	0.48	0.54
C-B, TP annually, conv	.43	.51
B, no-till pl	.22	.28
C-B, no-till pl, fall shred C stalks	.18	.22
WHEAT		
W-F, fall TP after W	0.38	
W-F, stubble mulch, 500 lbs rc	.32	
W-F, stubble mulch, 1000 lbs rc	.21	

Abbreviations defined:

B - soybeans
C - corn
c-k - chemically killed
conv - conventional
cot - cotton
F - fallow
M - grass & legume hay
pl - plant
W - wheat
wc - winter cover

lbs rc - pounds of crop residue per acre remaining on surface after new crop seeding
% rc - percentage of soil surface covered by residue mulch after new crop seeding
70-50% rc - 70% cover for C values in first column; 50% for second column
RdR - residues (corn stover, straw, etc.) removed or burned
RdL - all residues left on field (on surface or incorporated)
TP - turn plowed (upper 5 or more inches of soil inverted, covering residues)

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are listed in Table 8. These values are based on rather limited field data, but P has a narrower range of possible values than the other five factors.

TABLE 8. VALUES OF FACTOR P[11]

Practice	Land slope (percent)				
	1.1-2	2.1-7	7.1-12	12.1-18	18.1-24
	(Factor P)				
Contouring (P_c)	0.60	0.50	0.60	0.80	0.90
Contour strip cropping (P_{sc})					
R-R-M-M[1]	0.30	0.25	0.30	0.40	0.45
R-W-M-M	0.30	0.25	0.30	0.40	0.45
R-R-W-M	0.45	0.38	0.45	0.60	0.68
R-W	0.52	0.44	0.52	0.70	0.90
R-O	0.60	0.50	0.60	0.80	0.90
Contour listing or ridge planting (P_{cl})	0.30	0.25	0.30	0.40	0.45
Contour terracing (P_t)[2]	[3] $0.6/\sqrt{n}$	$0.5/\sqrt{n}$	$0.6/\sqrt{n}$	$0.8/\sqrt{n}$	$0.9/\sqrt{n}$
No support practice	1.0	1.0	1.0	1.0	1.0

[1] R = rowcrop, W = fall-seeded grain, O = spring-seeded grain, M = meadow. The crops are grown in rotation and so arranged on the field that rowcrop strips are always separated by a meadow or winter-grain strip.

[2] These P_t values estimate the amount of soil eroded to the terrace channels and are used for conservation planning. For prediction of off-field sediment, the P_t values are multiplied by 0.2.

[3] n = number of approximately equal-length intervals into which the field slope is divided by the terraces. Tillage operations must be parallel to the terraces.

Example: An owner/operator proposes to close one section of his small landfill with a sandy clay subsoil cover having the surface configuration shown in Figure 21. The factor R has been established as 200 for this locality. The evaluator questions anticipated erosion along the steep side and assigns the following values to the other factors in the USLE after inspecting Tables 5 through 8:

$$K = 0.14 \quad LS = 8.3 \quad C = 1.00 \quad P = 0.90$$

The rate of erosion for the steep slope of the landfill is calculated as follows:

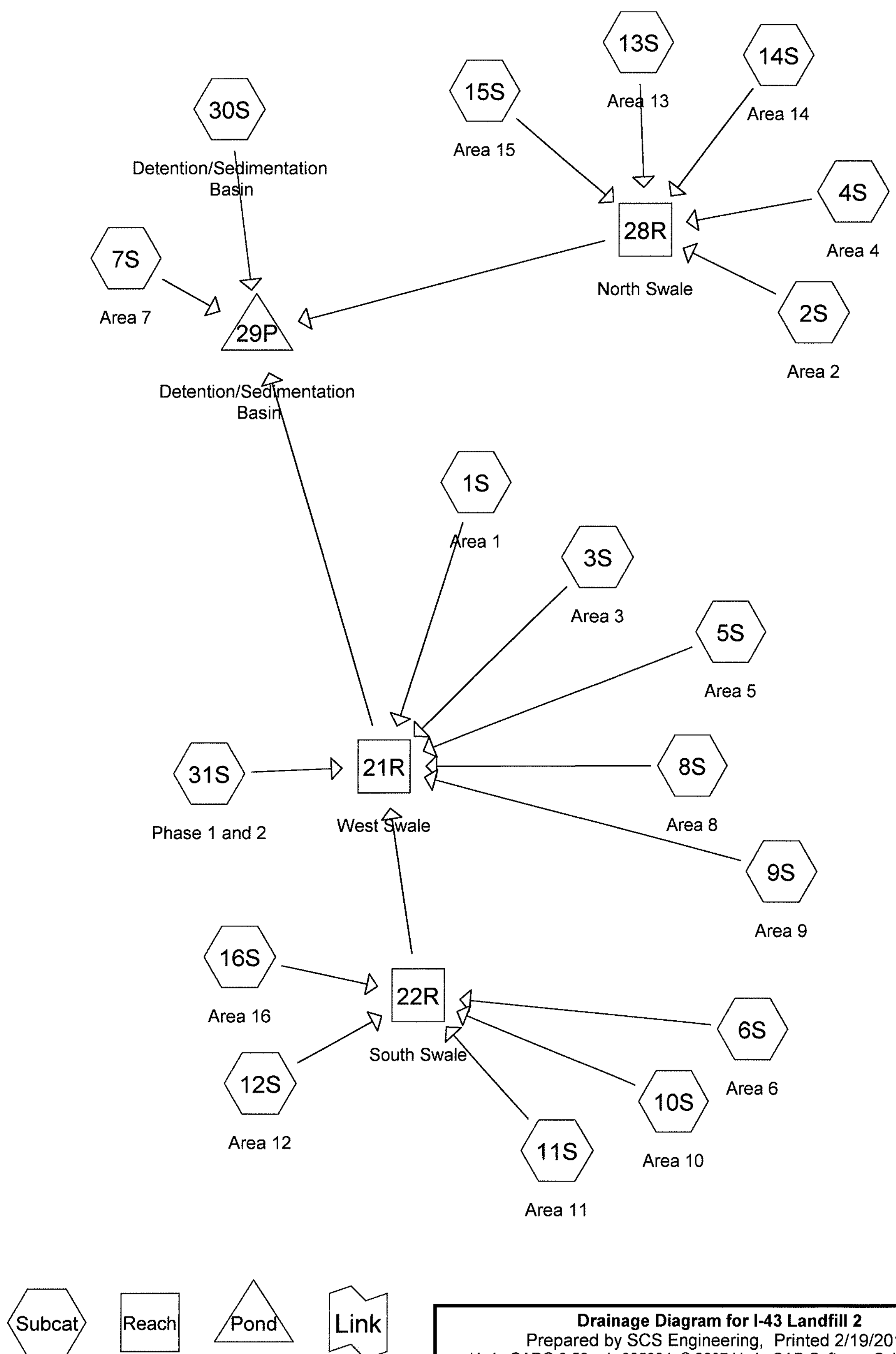
$$A = 200\ (0.14\ \text{tons/acre})\ (8.3)\ (1.00)\ (0.90)$$
$$= 209\ \text{tons/acre}$$

This erosion not only exceeds a limit recommended by the permitting authority but also indicates a potential

Hydrograph Generation

- 25-year, 24-hour Storm Event
- 100-year, 24-hour Storm Event

25-year, 24-hour Storm



Drainage Diagram for I-43 Landfill 2
Prepared by SCS Engineering, Printed 2/19/2015
HydroCAD® 8.50 s/n 005804 © 2007 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: Area 1

Runoff = 3.71 cfs @ 12.08 hrs, Volume= 0.227 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	1.130	79	
	1.130		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
1.1	78	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	223	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
15.8	401	Total			

Summary for Subcatchment 2S: Area 2

Runoff = 2.45 cfs @ 12.08 hrs, Volume= 0.149 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	0.740	79	
	0.740		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
1.0	70	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	196	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
15.5	366	Total			

Summary for Subcatchment 3S: Area 3

Runoff = 6.61 cfs @ 12.09 hrs, Volume= 0.414 af, Depth> 2.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	2.060	79	
	2.060		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
2.5	182	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	120	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.6	402	Total			

Summary for Subcatchment 4S: Area 4

Runoff = 9.76 cfs @ 12.09 hrs, Volume= 0.616 af, Depth> 2.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	3.060	79	
	3.060		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
2.1	155	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	232	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.8	487	Total			

Summary for Subcatchment 5S: Area 5

Runoff = 6.38 cfs @ 12.09 hrs, Volume= 0.402 af, Depth> 2.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	2.000	79	
	2.000		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
2.9	208	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	77	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.8	385	Total			

Summary for Subcatchment 6S: Area 6

Runoff = 7.37 cfs @ 12.09 hrs, Volume= 0.465 af, Depth> 2.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	2.310	79	
	2.310		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
3.0	215	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	62	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.8	377	Total			

Summary for Subcatchment 7S: Area 7

Runoff = 7.41 cfs @ 12.02 hrs, Volume= 0.381 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	1.890	79	
	1.890		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	65	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.7	144	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.3	209	Total			

Summary for Subcatchment 8S: Area 8

Runoff = 6.83 cfs @ 12.02 hrs, Volume= 0.353 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	1.750	79	
	1.750		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	67	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.6	136	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.4	203	Total			

Summary for Subcatchment 9S: Area 9

Runoff = 3.33 cfs @ 12.01 hrs, Volume= 0.167 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	0.830	79	
	0.830		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	60	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.7	145	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.7	205	Total			

Summary for Subcatchment 10S: Area 10

Runoff = 4.41 cfs @ 12.06 hrs, Volume= 0.256 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	1.270	79	
	1.270		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.5	82	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.5	96	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.1	242	0.0100	1.93	1.93	**Trap/Vee/Rect Channel Flow, Intermediate Swale on 4:1 Slope** Bot.W=0.00' D=0.50' Z= 4.0 '/' Top.W=4.00' n= 0.030
14.1	420	Total			

Summary for Subcatchment 11S: Area 11

Runoff = 7.24 cfs @ 12.06 hrs, Volume= 0.423 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	2.100	79	
	2.100		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.2	12	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	120	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.3	232	Total			

Summary for Subcatchment 12S: Area 12

Runoff = 14.68 cfs @ 12.13 hrs, Volume= 1.021 af, Depth> 2.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	5.080	79	
	5.080		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.9	163	0.0300	0.14		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.2	46	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
20.1	209	Total			

Summary for Subcatchment 13S: Area 13

Runoff = 15.91 cfs @ 12.08 hrs, Volume= 0.976 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	4.850	79	
	4.850		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
1.8	133	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	108	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
15.8	341	Total			

Summary for Subcatchment 14S: Area 14

Runoff = 4.97 cfs @ 12.01 hrs, Volume= 0.250 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	1.240	79	
	1.240		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	62	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.5	111	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.7	173	Total			

Summary for Subcatchment 15S: Area 15

[49] Hint: Tc<2dt may require smaller dt

Runoff = 15.87 cfs @ 11.95 hrs, Volume= 0.661 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	3.270	79	
	3.270		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	58	0.2700	0.27		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.6	145	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.2	203	Total			

Summary for Subcatchment 16S: Area 16

Runoff = 10.90 cfs @ 12.03 hrs, Volume= 0.579 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	2.870	79	
	2.870		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	44	0.0100	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.4	55	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
11.3	99	Total			

Summary for Subcatchment 30S: Detention/Sedimentation Basin

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 60.20 cfs @ 11.89 hrs, Volume= 2.833 af, Depth> 4.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

Area (ac)	CN	Description
7.860	98	Water Surface
7.860		Impervious Area

Summary for Subcatchment 31S: Phase 1 and 2

Runoff = 121.30 cfs @ 12.23 hrs, Volume= 10.476 af, Depth> 2.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	52.300	79	Closed Landfill
	52.300		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0	100	0.0400	0.14		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
4.8	400	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
12.1	2,976	0.0120	4.10	55.37	**Channel Flow, Perimeter Swale** Area= 13.5 sf Perim= 16.3' r= 0.83' n= 0.035 Earth, dense weeds
28.9	3,476	Total			

Summary for Reach 21R: West Swale

[62] Warning: Exceeded Reach 22R OUTLET depth by 1.93' @ 12.40 hrs

Inflow Area =	73.700 ac,	0.00% Impervious,	Inflow Depth > 2.40"	for 25-yr event	
Inflow =	167.13 cfs @	12.24 hrs,	Volume=	14.740 af	
Outflow =	146.77 cfs @	12.51 hrs,	Volume=	14.486 af,	Atten= 12%, Lag= 16.4 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.67 fps, Min. Travel Time= 9.8 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 26.7 min

Peak Storage= 86,617 cf @ 12.35 hrs, Average Depth at Peak Storage= 2.46'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 214.18 cfs

15.00' x 3.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 33.00'
Length= 1,570.0' Slope= 0.0013 '/'
Inlet Invert= 684.08', Outlet Invert= 682.00'

Summary for Reach 22R: South Swale

Inflow Area =	13.630 ac,	0.00% Impervious, Inflow Depth >	2.41"	for 25-yr event
Inflow =	42.53 cfs @	12.07 hrs, Volume=	2.743 af	
Outflow =	35.46 cfs @	12.29 hrs, Volume=	2.699 af,	Atten= 17%, Lag= 13.1 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.03 fps, Min. Travel Time= 8.0 min
Avg. Velocity = 1.27 fps, Avg. Travel Time= 25.2 min

Peak Storage= 17,162 cf @ 12.16 hrs, Average Depth at Peak Storage= 0.71'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 242.67 cfs

10.00' x 2.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 4.0 3.0 '/' Top Width= 24.00'
Length= 1,925.0' Slope= 0.0135 '/'
Inlet Invert= 710.00', Outlet Invert= 684.08'

Summary for Reach 28R: North Swale

Inflow Area = 13.160 ac, 0.00% Impervious, Inflow Depth > 2.42" for 25-yr event
Inflow = 39.81 cfs @ 12.00 hrs, Volume= 2.652 af
Outflow = 35.67 cfs @ 12.18 hrs, Volume= 2.620 af, Atten= 10%, Lag= 10.7 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.31 fps, Min. Travel Time= 6.0 min
Avg. Velocity = 1.37 fps, Avg. Travel Time= 19.0 min

Peak Storage= 12,884 cf @ 12.08 hrs, Average Depth at Peak Storage= 0.67'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 609.75 cfs

10.00' x 3.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 4.0 3.0 '/' Top Width= 31.00'
Length= 1,560.0' Slope= 0.0167 '/'
Inlet Invert= 708.00', Outlet Invert= 682.00'

100-year, 24-hour Storm

Summary for Subcatchment 1S: Area 1

Runoff = 5.86 cfs @ 12.08 hrs, Volume= 0.365 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	1.130	79	
	1.130		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
1.1	78	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	223	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
15.8	401	Total			

Summary for Subcatchment 2S: Area 2

Runoff = 3.88 cfs @ 12.07 hrs, Volume= 0.239 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	0.740	79	
	0.740		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
1.0	70	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	196	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
15.5	366	Total			

Summary for Subcatchment 3S: Area 3

Runoff = 10.45 cfs @ 12.09 hrs, Volume= 0.665 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	2.060	79	
	2.060		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
2.5	182	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	120	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.6	402	Total			

Summary for Subcatchment 4S: Area 4

Runoff = 15.43 cfs @ 12.09 hrs, Volume= 0.987 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	3.060	79	
	3.060		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
2.1	155	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	232	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.8	487	Total			

Summary for Subcatchment 5S: Area 5

Runoff = 10.09 cfs @ 12.09 hrs, Volume= 0.645 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	2.000	79	
	2.000		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
2.9	208	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	77	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.8	385	Total			

Summary for Subcatchment 6S: Area 6

Runoff = 11.65 cfs @ 12.09 hrs, Volume= 0.745 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	2.310	79	
	2.310		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
3.0	215	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	62	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.8	377	Total			

Summary for Subcatchment 7S: Area 7

Runoff = 11.66 cfs @ 12.02 hrs, Volume= 0.611 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	1.890	79	
	1.890		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	65	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.7	144	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.3	209	Total			

Summary for Subcatchment 8S: Area 8

Runoff = 10.75 cfs @ 12.02 hrs, Volume= 0.566 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	1.750	79	
	1.750		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	67	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.6	136	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.4	203	Total			

Summary for Subcatchment 9S: Area 9

Runoff = 5.23 cfs @ 12.01 hrs, Volume= 0.268 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	0.830	79	
	0.830		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	60	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.7	145	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.7	205	Total			

Summary for Subcatchment 10S: Area 10

Runoff = 6.96 cfs @ 12.06 hrs, Volume= 0.410 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	1.270	79	
	1.270		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.5	82	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.5	96	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.1	242	0.0100	1.93	1.93	**Trap/Vee/Rect Channel Flow, Intermediate Swale on 4:1 Slope** Bot.W=0.00' D=0.50' Z= 4.0 '/' Top.W=4.00' n= 0.030
14.1	420	Total			

Summary for Subcatchment 11S: Area 11

Runoff = 11.43 cfs @ 12.06 hrs, Volume= 0.678 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	2.100	79	
	2.100		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.2	12	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	120	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.3	232	Total			

Summary for Subcatchment 12S: Area 12

Runoff = 23.32 cfs @ 12.12 hrs, Volume= 1.638 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	5.080	79	
	5.080		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.9	163	0.0300	0.14		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.2	46	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
20.1	209	Total			

Summary for Subcatchment 13S: Area 13

Runoff = 25.14 cfs @ 12.08 hrs, Volume= 1.566 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	4.850	79	
	4.850		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
1.8	133	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	108	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
15.8	341	Total			

Summary for Subcatchment 14S: Area 14

Runoff = 7.82 cfs @ 12.01 hrs, Volume= 0.401 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	1.240	79	
	1.240		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	62	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.5	111	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.7	173	Total			

Summary for Subcatchment 15S: Area 15

[49] Hint: Tc<2dt may require smaller dt

Runoff = 24.79 cfs @ 11.95 hrs, Volume= 1.059 af, Depth> 3.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	3.270	79	
	3.270		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	58	0.2700	0.27		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.6	145	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.2	203	Total			

Summary for Subcatchment 16S: Area 16

Runoff = 17.15 cfs @ 12.03 hrs, Volume= 0.928 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	2.870	79	
	2.870		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	44	0.0100	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.4	55	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
11.3	99	Total			

Summary for Subcatchment 30S: Detention/Sedimentation Basin

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 82.51 cfs @ 11.89 hrs, Volume= 3.928 af, Depth> 6.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

Area (ac)	CN	Description
7.860	98	Water Surface
7.860		Impervious Area

Summary for Subcatchment 31S: Phase 1 and 2

Runoff = 193.11 cfs @ 12.23 hrs, Volume= 16.809 af, Depth> 3.86"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	52.300	79	Closed Landfill
	52.300		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0	100	0.0400	0.14		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
4.8	400	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
12.1	2,976	0.0120	4.10	55.37	**Channel Flow, Perimeter Swale** Area= 13.5 sf Perim= 16.3' r= 0.83' n= 0.035 Earth, dense weeds
28.9	3,476	Total			

Summary for Reach 21R: West Swale

[91] Warning: Storage range exceeded by 0.22'
[55] Hint: Peak inflow is 126% of Manning's capacity
[62] Warning: Exceeded Reach 22R OUTLET depth by 2.51' @ 12.35 hrs

Inflow Area = 73.700 ac, 0.00% Impervious, Inflow Depth > 3.85" for 100-yr event
Inflow = 270.76 cfs @ 12.22 hrs, Volume= 23.663 af
Outflow = 242.71 cfs @ 12.46 hrs, Volume= 23.342 af, Atten= 10%, Lag= 14.5 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.08 fps, Min. Travel Time= 8.5 min
Avg. Velocity = 1.09 fps, Avg. Travel Time= 23.9 min

Peak Storage= 124,154 cf @ 12.32 hrs, Average Depth at Peak Storage= 3.22'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 214.18 cfs

15.00' x 3.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 33.00'
Length= 1,570.0' Slope= 0.0013 '/'
Inlet Invert= 684.08', Outlet Invert= 682.00'

Summary for Reach 22R: South Swale

Inflow Area = 13.630 ac, 0.00% Impervious, Inflow Depth > 3.87" for 100-yr event
Inflow = 67.37 cfs @ 12.07 hrs, Volume= 4.399 af
Outflow = 58.27 cfs @ 12.26 hrs, Volume= 4.345 af, Atten= 14%, Lag= 11.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.71 fps, Min. Travel Time= 6.8 min
Avg. Velocity = 1.43 fps, Avg. Travel Time= 22.5 min

Peak Storage= 24,052 cf @ 12.14 hrs, Average Depth at Peak Storage= 0.94'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 242.67 cfs

10.00' x 2.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 4.0 3.0 '/' Top Width= 24.00'
Length= 1,925.0' Slope= 0.0135 '/'
Inlet Invert= 710.00', Outlet Invert= 684.08'

Summary for Reach 28R: North Swale

Inflow Area = 13.160 ac, 0.00% Impervious, Inflow Depth > 3.88" for 100-yr event
Inflow = 63.20 cfs @ 12.00 hrs, Volume= 4.252 af
Outflow = 57.58 cfs @ 12.16 hrs, Volume= 4.213 af, Atten= 9%, Lag= 9.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.04 fps, Min. Travel Time= 5.2 min
Avg. Velocity = 1.53 fps, Avg. Travel Time= 17.0 min

Peak Storage= 17,962 cf @ 12.07 hrs, Average Depth at Peak Storage= 0.88'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 609.75 cfs

10.00' x 3.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 4.0 3.0 '/' Top Width= 31.00'
Length= 1,560.0' Slope= 0.0167 '/'
Inlet Invert= 708.00', Outlet Invert= 682.00'

Perimeter Ditch and Diversion Berm Sizing

I-43 Landfill
Sheboygan, WI

Lining Type: Vegetation

Project ID: I-43 Landfill - Plan Modification		
Location: Sheboygan, WI		
Designer/Checker: KRG		
Date: 1/6/15		

	South Swale Q=25-yr	North Swale Q=25-yr	Int. Swale Q=25-yr
Channel/Ditch Geometry			
Channel Slope, S_o (ft/ft)	**0.013**	**0.025**	**0.01**
Channel Bottom Width, B (ft)	**10**	**6**	**0**
Channel Side Slope, z_1	**4**	**3**	**2**
Channel Side Slope, z_2	**3**	**2**	**0.03**
Flow Depth, d (ft) Solve iteratively	**0.89**	**0.86**	**1.65**
Safety Factor, SF	**1.5**	**1.5**	**1.5**
Vegetation/Soil Parameters			
Vegetation Retardance Class	**D**	**D**	**D**
Vegetation Condition	**good**	**good**	**good**
Vegetation Growth Form	**turf**	**turf**	**turf**
Soil Type	**cohesive**	**cohesive**	**cohesive**
D_{75} (in) (Set at 0.00 for cohesive soils)			
ASTM Soil Class	**SC**	**SC**	**SC**
Plasticity Index, PI	**16**	**16**	**16**
Results Summary			
Design Q (ft^3/s)	**35.5**	**35.7**	**4.9**
Calculated Q (ft^3/s)	35.8	35.7	4.8
Difference Between Design & Calc. Flow (%)	0.9%	0.0%	-0.5%
Stable (Yes or No)	YES	YES	YES
Channel Parameters			
Vegetation Height, h (ft)	0.33	0.33	0.33
Grass Roughness Coefficient, C_n	0.165	0.165	0.165
Cover Factor, C_f	0.90	0.90	0.90
Noncohesive Soil			
Soil Grain Roughness, n_s	0.016	0.016	0.016
Permissible Soil Shear Stress, τ_p (lb/ft^2)	N/A	N/A	N/A
Cohesive Soil			
Porosity, e	0.35	0.35	0.35
Soil Coefficient 1, c_1	1.0700	1.0700	1.0700
Soil Coefficient 2, c_2	14.30	14.30	14.30
Soil Coefficient 3, c_3	47.700	47.700	47.700
Soil Coefficient 4, c_4	1.42	1.42	1.42
Soil Coefficient 5, c_5	-0.61	-0.61	-0.61
Soil Coefficient 6, c_6	0.00010	0.00010	0.00010
Permissible Soil Shear Stress, τ_p (lb/ft^2)	0.080	0.080	0.080
Total Permissible Shear Stress, τ_p (lb/ft^2)	0.080	0.080	0.080
Cross Sectional Area, A (ft^2)	11.672	7.009	2.763
Wetted Perimeter, P (ft)	16.48	10.64	5.34
Hydraulic Radius, R (ft)	0.708	0.659	0.517
Top Width, T (ft)	16.23	10.30	3.35
Hydraulic Depth, D (ft)	0.719	0.680	0.825
Froude Number (Q design)	0.637	1.088	0.339
Channel Shear Stress, τ_o (lb/ft^2)	0.57	1.03	0.32
Actual Sheer Stress, τ_d (lb/ft^2)	0.72	1.34	1.03
Mannings n	0.044	0.035	0.055
Average Velocity, V (ft/s)	3.04	5.09	1.76
Calculated Flow, Q (ft^3/s)	35.8	35.7	4.8
Difference Between Design & Calc. Flow (%)	0.9%	0.0%	-0.5%
Effective Shear on Soil Surface, τ_e (lb/ft^2)	0.010	0.028	0.009
Total Permissible Shear on Veg., $\tau_{p\,veg}$ (lb/ft^2)	6.06	3.83	9.47
Stable (Y or N)	YES	YES	YES

SCS ENGINEERS

		Sheet No. 1/3	
		Calc. No.	
		Rev. No.	
Job No. 25214060	Job: I-43 Landfill	By: KRG	Date: 01/14/15
Client: Alliant Energy	Subject: Downslope Flume Sizing	Chk'd: ZB	Date: 02/09/15

Purpose: To size the downslope flume pipes to accommodate the flows expected from a 25-year, 24-hour storm event.

Approach: Use the orifice equation to size the downslope pipe inlet and Manning's equation to size the downslope pipes.

Calculations:

The runoff must first get into the down slope flume

The entrance to the flume is a Y with an open pipe on each branch of the Y.

1/2 of the flowrate of the 25-yr storm event for each drainage area will enter each branch of the flume.

An orifice equation calculates the flowrate of water that can enter the pipe.

Orifice Equation: $Q = C \times A \times (2 \times g \times h)^{0.5}$

Q = flow rate (cfs)

C = orifice coefficent = 0.63

A = area of orifice = 0.78 sf for 12" dia. pipe, 10" = 0.54 sf, 8" = 0.35 sf

g = acceleration due to gravity = 32.2 ft/sec^2

h = orifice head acting on centerline = 1.5 x pipe diameter = 1.5' for 12" dia. pipe, 1.25' for 10", 1.0

$Q_{12\text{" pipe}} = 0.63 \times .78 \times (2 \times 32.2 \times 1.5)^{0.5} =$ 4.83 cfs

$Q_{10\text{" pipe}} = 0.63 \times .54 \times (2 \times 32.2 \times 1.25)^{0.5} =$ 3.05 cfs

The downslope flume pipes have the following flow capacities at the designated slopes:

	Flow Capacity of Pipe*
Flume Size	25% slope
12" dia.	19.3 cfs
10" dia.	11.8 cfs

* See Sheets 2 - 3 for the Manning's flow calculations.

Results:

The downslope flumes will consist of the following sizes, as indicated on Plan Sheet 14.

Flume Number	Flow Rate (cfs)	1/2 the Flowrate (cfs)	Flume Size
Flume 1 (Area 1)	3.7	1.9	10 inch
Flume 2 (Area 2)	2.5	1.3	10 inch
Flume 3 (Area 3)	6.6	3.3	12 inch
Flume 4 (Area 4)	9.7	4.9	12 inch
Flume 5 (Area 5)	6.4	3.2	12 inch
Flume 6 (Area 6)	7.4	3.7	12 inch

2

Free Online Manning Pipe Flow Calculator

List of Calculators Hydraulics Language

Manning Formula Uniform Pipe Flow at Given Slope and Depth

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I-43 Landfill

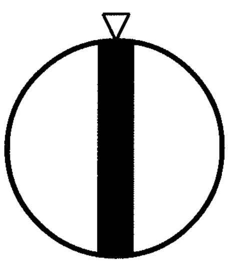
Down Slope Flumes

Set units: m mm ft inches

Pipe diameter, d_0	10 inches
Manning roughness, n ?	.012
Pressure slope (possibly ? equal to pipe slope), S_0	.25 rise/run
Percent of (or ratio to) full depth (100% or 1 if flowing full)	100 %

Results:

Flow, q	11.8668	cfs
Velocity, v	21.7580	ft/sec
Velocity head, h_v	88.2918	inches
Flow area	78.5400	sq. in.
Wetted perimeter	31.4159	inches
Hydraulic radius	2.5000	inches
Top width, T	0.0000	inches
Froude number, F	0.00	
Shear stress (tractive force), tau	13.0078	psf



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I-43 Landfill

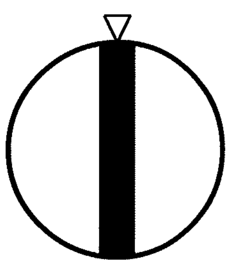
Down Slope Flumes

Set units: m mm ft inches

Pipe diameter, d_0	12 inches
Manning roughness, n ?	.012
Pressure slope (possibly ? equal to pipe slope), S_0	.25 rise/run
Percent of (or ratio to) full depth (100% or 1 if flowing full)	100 %

Results:

Flow, q	19.2967	cfs
Velocity, v	24.5700	ft/sec
Velocity head, h_v	112.5889	inches
Flow area	113.0976	sq. in.
Wetted perimeter	37.6991	inches
Hydraulic radius	3.0000	inches
Top width, T	0.0000	inches
Froude number, F	0.00	
Shear stress (tractive force), tau	15.6094	psf



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Downslope Flume and Energy Dissipator Sizing

Energy Dissipator Design

Design the Energy Dissipators located at the end of each downslope flume using the US Dept. of Transportation, Hydraulic Engineering Circular No. 14, "Hydraulic Design of Energy dissipators for Culverts and Channels", July 2006.

Pipe/Culvert: Flume 3, 4, 5, 6, and 7

* Peak flow in this flume from 25-year, 24-hour event is 9.7 cfs.

Flow is in a 12" dia. Flume

From an on-line Mannings Equation Calculator (see page 3)

Q = 9.7 cfs

n = 0.01

V = 28.2 ft/sec

A = 49.64 sq. in. = 0.34 sq. ft.

Fr = 8.58

Compute Equivalent Depth of Flow Entering Dissipator:

$Y_e = (A/2)^{1/2}$ where: Ye = Equivalent depth

A = Area (from above)

$Y_e =$ 0.42 ft

Compute Energy at End of Pipe:

$H_o = Y_e + V^2/2g$ where: H_o = Energy

Y_e = Equivalent depth (from above)

V = Velocity (from above)

g = Gravity constant (32.2 ft/sec)

Ho = 12.76 ft

Determine Width of Dissipator:

Use Froude Number computed above and Figure 9.14 (see page 5) from "Hydraulic Design of Energy Dissipators for Culverts and Channels" to obtain value for H_o/W. Given H_o above, compute W (width of dissipator).

From Figure 9.14, $H_o/W_B =$ 3.9 (interpolated)

$W_B =$ 3.3 ft

Determine Remaining Dimensions of the Dissipator:

Based on W determined above, use Table 9.2 (CU) (page 6) to determine the remaining dissipator dimensions. Round the value of W_B to the nearest entry in the table (interpolation is not necessary).

Note: the smallest W_B on Table 9.2 is 4.0 ft, so this dimension is used.

Energy Dissipator Design

Pipe/Culvert: Flume 1 and 2

* Peak flow in this flume from 25-year, 24-hour event is 4.0 cfs.

Flow is in a 10" dia. Flume

From an on-line Mannings Equation Calculator (see page 4)

Q = 4 cfs

n = 0.01

V = 22.4 ft/sec

A = 25.7 sq. in. = 0.18 sq. ft.

Fr = 8.5

Compute Equivalent Depth of Flow Entering Dissipator:

$Y_e = (A/2)^{1/2}$ where: Ye = Equivalent depth

A = Area (from above)

Y_e = 0.30 ft

Compute Energy at End of Pipe:

$H_o = Y_e + V^2/2g$ where: H_o = Energy

Y_e = Equivalent depth (from above)

V = Velocity (from above)

g = Gravity constant (32.2 ft/sec)

Ho = 8.09 ft

Determine Width of Dissipator:

Use Froude Number computed above and Figure 9.14 from "Hydraulic Design of Energy Dissipators for Culverts and Channels" to obtain value for H_o/W. Given H_o above, compute W (width of dissipator).

From Figure 9.14, H_o/W_B = 3.9 (interpolated)

W_B = 2.1 ft

Determine Remaining Dimensions of the Dissipator:

Based on W determined above, use Table 9.2 (CU) to determine the remaining dissipator dimensions. Round the value of W_B to the nearest entry in the table (interpolation is not necessary).

Note: the smallest W_B on Table 9.2 is 4.0 ft, so this dimension is used.

Free Online Manning Pipe Flow Calculator

List of Calculators Hydraulics Language

Manning Formula Uniform Pipe Flow at Given Slope and Depth

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I-43 Landfill

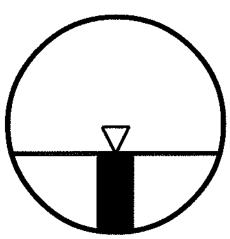
Down Slope Flumes 1,2,8,9,10

Set units: m mm ft inches

Pipe diameter, d_0	10	inches
Manning roughness, n ?	.01	
Pressure slope (possibly ? equal to pipe slope), S_0	.25	rise/run
Percent of (or ratio to) full depth (100% or 1 if flowing full)	36.3	%

Results:

Flow, q	4.0097	cfs
Velocity, v	22.4299	ft/sec
Velocity head, h_v	93.8297	inches
Flow area	25.7434	sq. in.
Wetted perimeter	12.9325	inches
Hydraulic radius	1.9906	inches
Top width, T	9.6173	inches
Froude number, F	8.50	
Shear stress (tractive force), tau	4.7218	psf



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shows the relationship of the Froude number to the ratio of the energy entering the dissipator to the width of dissipator required. The Los Angeles tests indicate that limited extrapolation of this curve is permissible.

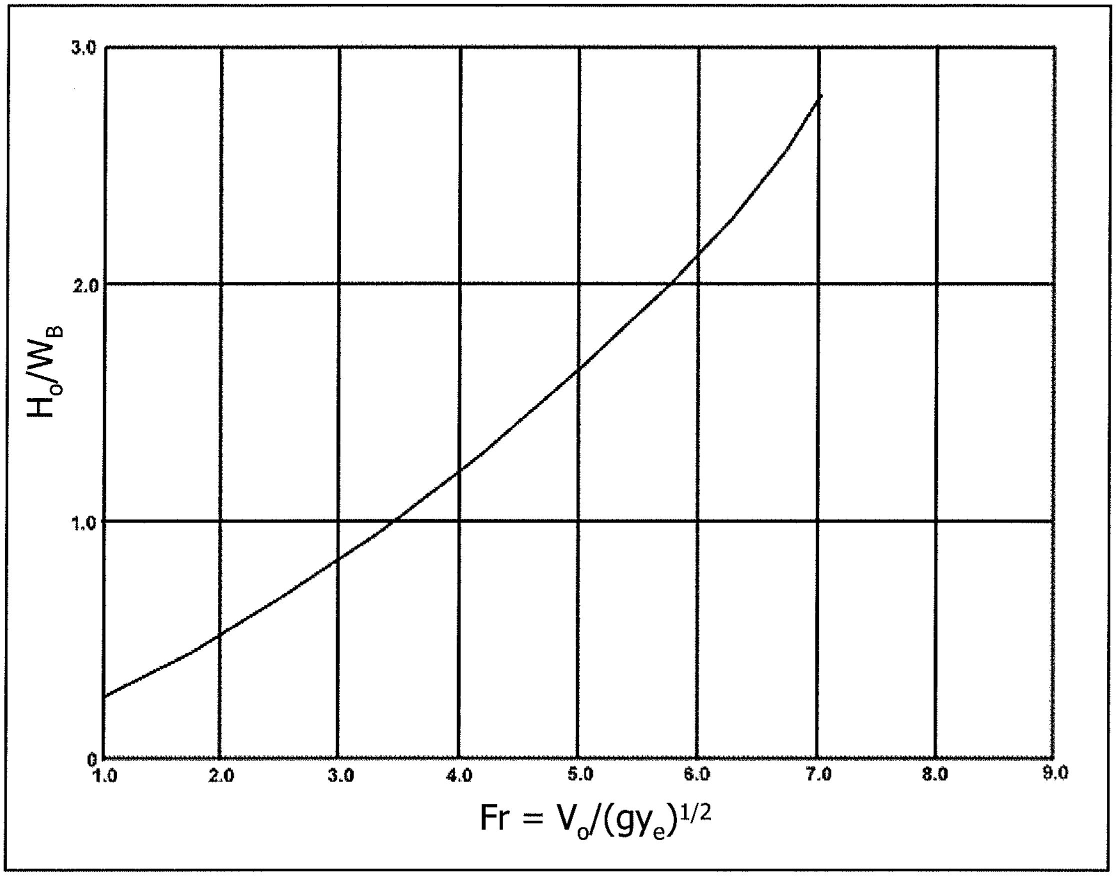

Figure 9.14. Design Curve for USBR Type VI Impact Basin

Once the basin width, W_B, has been determined, many of the other dimensions shown in Figure 9.13 follow according to Table 9.2. To use Table 9.2, round the value of W_B to the nearest entry in the table to determine the other dimensions. Interpolation is not necessary.

In calculating the energy and the Froude number, the equivalent depth of flow, $y_e = (A/2)^{1/2}$, entering the dissipator from a pipe or irregular-shaped conduit must be computed. In other words, the cross section flow area in the pipe is converted into an equivalent rectangular cross section in which the width is twice the depth of flow. The conduit preceding the dissipator can be open, closed, or of any cross section.

The effectiveness of the basin is best illustrated by comparing the energy losses within the structure to those in a natural hydraulic jump, Figure 9.15. The energy loss was computed based on depth and velocity measurements made in the approach pipe and also in the downstream channel with no tailwater. Compared with the natural hydraulic jump, the USBR Type VI impact basin shows a greater capacity for dissipating energy.

6

Table 9.2 (CU). USBR Type VI Impact Basin Dimensions (ft) (AASHTO, 2005)

W_B	h_1	h_2	h_3	h_4	L	L_1	L_2
4.	3.08	1.50	0.67	1.67	5.42	2.33	3.08
5.	3.83	1.92	0.83	2.08	6.67	2.92	3.83
6.	4.58	2.25	1.00	2.50	8.00	3.42	4.58
7.	5.42	2.58	1.17	2.92	9.42	4.00	5.42
8.	6.17	3.00	1.33	3.33	10.67	4.58	6.17
9.	6.92	3.42	1.50	3.75	12.00	5.17	6.92
10.	7.58	3.75	1.67	4.17	13.42	5.75	7.67
11.	8.42	4.17	1.83	4.58	14.58	6.33	8.42
12.	9.17	4.50	2.00	5.00	16.00	6.83	9.17
13.	10.17	4.92	2.17	5.42	17.33	7.42	10.00
14.	10.75	5.25	2.33	5.83	18.67	8.00	10.75
15.	11.50	5.58	2.50	6.25	20.00	8.50	11.50
16.	12.25	6.00	2.67	6.67	21.33	9.08	12.25
17.	13.00	6.33	2.83	7.08	21.50	9.67	13.00
18.	13.75	6.67	3.00	7.50	23.92	10.25	13.75
19.	14.58	7.08	3.17	7.92	25.33	10.83	14.58
20.	15.33	7.50	3.33	8.33	26.58	11.42	15.33

W_B	W_1	W_2	t_1	t_2	t_3	t_4	t_5
4.	0.33	1.08	0.50	0.50	0.50	0.50	0.25
5.	0.42	1.42	0.50	0.50	0.50	0.50	0.25
6.	0.50	1.67	0.50	0.50	0.50	0.50	0.25
7.	0.50	1.92	0.50	0.50	0.50	0.50	0.25
8.	0.58	2.17	0.50	0.58	0.58	0.50	0.25
9.	0.67	2.50	0.58	0.58	0.67	0.58	0.25
10.	0.75	2.75	0.67	0.67	0.75	0.67	0.25
11.	0.83	3.00	0.67	0.75	0.75	0.67	0.33
12.	0.92	3.00	0.67	0.83	0.83	0.75	0.33
13.	1.00	3.00	0.67	0.92	0.83	0.83	0.33
14.	1.08	3.00	0.67	1.00	0.92	0.92	0.42
15.	1.17	3.00	0.67	1.00	1.00	1.00	0.42
16.	1.25	3.00	0.75	1.00	1.00	1.00	0.50
17.	1.33	3.00	0.75	1.08	1.00	1.00	0.50
18.	1.33	3.00	0.75	1.08	1.08	1.08	0.58
19.	1.42	3.00	0.83	1.17	1.08	1.08	0.58
20.	1.50	3.00	0.83	1.17	1.17	1.17	0.67

Culvert Sizing

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 146 cfs

Maximum Flow: 270 cfs

Table 1 - Summary of Culvert Flows at Crossing: I-43 Landfill

Headwater Elevation (ft)	Total Discharge (cfs)	West Swale Culverts Discharge (cfs)	Roadway Discharge (cfs)	Iterations
678.70	0.00	0.00	0.00	1
680.07	27.00	27.00	0.00	1
680.67	54.00	54.00	0.00	1
681.15	81.00	81.00	0.00	1
681.63	108.00	108.00	0.00	1
682.07	135.00	135.00	0.00	1
682.23	146.00	146.00	0.00	1
683.11	189.00	189.00	0.00	1
683.47	216.00	216.00	0.00	1
683.81	243.00	243.00	0.00	1
684.16	270.00	270.00	0.00	1
686.00	392.66	392.66	0.00	Overtopping

Table 2 - Culvert Summary Table: West Swale Culverts

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
	0.00	0.00	678.70	0.000	0.000	0-NF	0.000	0.000	0.300	0.000	0.000
	27.00	27.00	680.07	1.369	0.951	1-JS1t	0.985	1.006	1.238	0.938	3.542
	54.00	54.00	680.67	1.973	1.427	1-JS1t	1.408	1.437	1.674	1.374	4.669
	81.00	81.00	681.15	2.451	1.828	1-JS1t	1.739	1.772	2.008	1.708	5.484
	108.00	108.00	681.63	2.934	2.200	1-JS1t	2.031	2.060	2.287	1.987	6.168
	135.00	135.00	682.07	3.369	2.563	1-JS1t	2.308	2.317	2.531	2.231	6.769
	146.00	146.00	682.23	3.535	2.322	1-JS1t	2.413	2.415	2.622	2.322	7.000
	189.00	189.00	683.11	4.141	4.412	3-M1t	2.822	2.760	2.947	2.647	7.847
	216.00	216.00	683.47	4.506	4.766	3-M1t	3.076	2.960	3.131	2.831	8.348
	243.00	243.00	683.81	4.872	5.114	3-M2t	3.341	3.145	3.301	3.001	8.834
	270.00	270.00	684.16	5.250	5.459	3-M2t	3.614	3.324	3.461	3.161	9.308

****

Straight Culvert

Inlet Elevation (invert): 678.70 ft, Outlet Elevation (invert): 678.40 ft

Culvert Length: 100.00 ft, Culvert Slope: 0.0030

****

Site Data - West Swale Culverts

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 678.70 ft

Outlet Station: 100.00 ft

Outlet Elevation: 678.40 ft

Number of Barrels: 2

Culvert Data Summary - West Swale Culverts

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: I-43 Landfill)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	678.70	0.00	0.00	0.00	0.00
27.00	679.64	0.94	2.25	0.18	0.45
54.00	680.07	1.37	2.78	0.26	0.48
81.00	680.41	1.71	3.13	0.32	0.49
108.00	680.69	1.99	3.40	0.37	0.50
135.00	680.93	2.23	3.63	0.42	0.51
146.00	681.02	2.32	3.71	0.43	0.51
189.00	681.35	2.65	3.98	0.50	0.52
216.00	681.53	2.83	4.13	0.53	0.52
243.00	681.70	3.00	4.26	0.56	0.53
270.00	681.86	3.16	4.38	0.59	0.53

Tailwater Channel Data - I-43 Landfill

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0300

Channel Invert Elevation: 678.70 ft

Roadway Data for Crossing: I-43 Landfill

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 686.00 ft

Roadway Surface: Gravel

Roadway Top Width: 20.00 ft

Sedimentation Basin Sizing

Sedimentation Basin Sizing

Performance Criteria

* Sedimentation basin is designed to settle out particles 15 microns and greater for the 25-year, 24-hour storm event
* Principal spillway is designed to pass the 25-year, 24-hour storm event.
* Emergency spillway is designed to pass the 100-yr, 24-hour storm event.

Use the Table 8.1 presented in Erosion and Sediment Control Handbook (Goldman, *et al*., 1986) that provides the surface area to discharge ratios required to achieve settlement of the desired particle sizes. The table is included below. From this table, use the surface area to flow ratio for the sedimentation to determine the maximum particle size settled.

The table below summarized the surface area to flow ratios for sedimentation basins. It also summarizes the free board for the 100-year, 24-hour storm event. The information is based on the HydroCAD model output included in this appendix.

TABLE 8.1 Surface Area Requirements of Sediment Traps and Basins

Particle size, mm	Settling velocity, ft/sec (m/sec)	Surface area requirements, ft^2 per ft^3/sec discharge	(m^2 per m^3/sec discharge)
0.5 (coarse sand)	0.19 (0.058)	6.3	(20.7)
0.2 (medium sand)	0.067 (0.020)	17.9	(58.7)
0.1 (fine sand)	0.023 (0.0070)	52.2	(171.0)
0.05 (coarse silt)	0.0062 (0.0019)	193.6	(635.0)
0.02 (medium silt)	0.00096 (0.00029)	1,250.0	(4,101.0)
0.01 (fine silt)	0.00024 (0.000073)	5,000.0	(16,404.0)
0.005 (clay)	0.00006 (0.000018)	20,000.0	(65,617.0)

The output from the HydroCAD model for the 25 and 100-yr storm event is included on Pages 2 - 3.

25-year, 24 hour Storm			Surface Area at Peak Water Surface Elevation, SA (sf)	SA/Q Ratio	Maximum Particle Size Settled (mm)	100-yr, 24-hr Storm Peak Water Surface Elevation	Top of Berm Elevation (Freeboard)	Basin Freeboard for 100-yr Storm (feet)
Peak Inflow (cfs)	Peak Discharge Q (cfs)	Peak Water Surface Elevation						
165.09	17.1	684.74	230,955	13,506	< 0.01	685.90	686.50	0.6

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Summary for Pond 29P: Detention/Sedimentation Basin

[63] Warning: Exceeded Reach 21R INLET depth by 0.10' @ 15.40 hrs
[62] Warning: Exceeded Reach 28R OUTLET depth by 2.62' @ 14.55 hrs

Inflow Area = 96.610 ac, 8.14% Impervious, Inflow Depth > 2.52" for 25-yr event
Inflow = 165.09 cfs @ 12.49 hrs, Volume= 20.321 af
Outflow = 17.07 cfs @ 14.38 hrs, Volume= 10.223 af, Atten= 90%, Lag= 113.9 min
Primary = 17.07 cfs @ 14.38 hrs, Volume= 10.223 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 684.74' @ 14.38 hrs Surf.Area= 5.302 ac Storage= 13.038 af

Plug-Flow detention time= 247.0 min calculated for 10.223 af (50% of inflow)
Center-of-Mass det. time= 161.9 min (963.6 - 801.6)

Volume	Invert	Avail.Storage	Storage Description
#1	681.46'	20.170 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
681.46	2.750	0.000	0.000
682.00	2.880	1.520	1.520
684.00	4.860	7.740	9.260
686.00	6.050	10.910	20.170

Device	Routing	Invert	Outlet Devices
#1	Primary	681.50'	**24.0" x 50.0' long Culvert** CMP, square edge headwall, Ke= 0.500 Outlet Invert= 681.00' S= 0.0100 '/' Cc= 0.900 n= 0.025 Corrugated metal
#2	Device 1	681.75'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#3	Device 1	682.25'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#4	Device 1	682.75'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#5	Device 1	683.25'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#6	Device 1	684.00'	**36.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#7	Secondary	685.00'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=17.07 cfs @ 14.38 hrs HW=684.74' (Free Discharge)
1=Culvert (Barrel Controls 17.07 cfs @ 5.43 fps)
2=Orifice/Grate (Passes < 6.26 cfs potential flow)
3=Orifice/Grate (Passes < 5.66 cfs potential flow)
4=Orifice/Grate (Passes < 4.99 cfs potential flow)
5=Orifice/Grate (Passes < 4.22 cfs potential flow)
6=Orifice/Grate (Passes < 19.76 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=681.46' (Free Discharge)
7=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Summary for Pond 29P: Detention/Sedimentation Basin

[63] Warning: Exceeded Reach 21R INLET depth by 0.92' @ 14.35 hrs
[62] Warning: Exceeded Reach 28R OUTLET depth by 3.71' @ 13.60 hrs

Inflow Area = 96.610 ac, 8.14% Impervious, Inflow Depth > 3.99" for 100-yr event
Inflow = 272.92 cfs @ 12.44 hrs, Volume= 32.094 af
Outflow = 44.56 cfs @ 13.47 hrs, Volume= 18.380 af, Atten= 84%, Lag= 62.0 min
Primary = 22.02 cfs @ 13.47 hrs, Volume= 13.215 af
Secondary = 22.55 cfs @ 13.47 hrs, Volume= 5.165 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 685.90' @ 13.47 hrs Surf.Area= 5.991 ac Storage= 19.576 af

Plug-Flow detention time= 214.7 min calculated for 18.331 af (57% of inflow)
Center-of-Mass det. time= 138.1 min (930.0 - 791.9)

Volume	Invert	Avail.Storage	Storage Description
#1	681.46'	20.170 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
681.46	2.750	0.000	0.000
682.00	2.880	1.520	1.520
684.00	4.860	7.740	9.260
686.00	6.050	10.910	20.170

Device	Routing	Invert	Outlet Devices
#1	Primary	681.50'	**24.0" x 50.0' long Culvert** CMP, square edge headwall, Ke= 0.500 Outlet Invert= 681.00' S= 0.0100 '/' Cc= 0.900 n= 0.025 Corrugated metal
#2	Device 1	681.75'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#3	Device 1	682.25'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#4	Device 1	682.75'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#5	Device 1	683.25'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#6	Device 1	684.00'	**36.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#7	Secondary	685.00'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=22.02 cfs @ 13.47 hrs HW=685.90' (Free Discharge)
└─**1=Culvert** (Barrel Controls 22.02 cfs @ 7.01 fps)
  ├─**2=Orifice/Grate** (Passes < 7.47 cfs potential flow)
  ├─**3=Orifice/Grate** (Passes < 6.97 cfs potential flow)
  ├─**4=Orifice/Grate** (Passes < 6.44 cfs potential flow)
  ├─**5=Orifice/Grate** (Passes < 5.86 cfs potential flow)
  └─**6=Orifice/Grate** (Passes < 46.93 cfs potential flow)

Secondary OutFlow Max=22.54 cfs @ 13.47 hrs HW=685.90' (Free Discharge)
└─**7=Broad-Crested Rectangular Weir** (Weir Controls 22.54 cfs @ 2.50 fps)

Appendix B1.3

2016 Contact Water Basin Calculations

Purpose:

The contact water basin at the I-43 landfill accommodates runoff pumped from contact water handling areas within each module and from other areas directly dischargin into the contact water basin during storm events. The purpose of this calculation is to determine the maximum starting water elevation in the contact water basin prior to a 25-year, 24-hour storm event in order to accommodate the volume of runoff from these two contributing sources.

Approach:

Determine the 25-year, 24-hour storm event runoff volumes contributing to the contact water basin for each phase of development, starting with Phase 3, Module 2. Use the HydroCAD model to calculate volumes. Drainage areas during each stage of development are shown on the attached figures.
Determine the remaining capacity of the contact water basin, assuming the basin has standing water at various intervals prior to the start of the storm event. One foot intervals were used.

Assumptions

A 25-year, 24-hour storm event = 4.80 inches, based on NOAA Atlas 14.
Assume a MSE4 storm distribution.
Assume 1' of freeboard will be maintained in the contact water basin.
Ash has a runoff curve number of 98.
Assume other site areas draining into the contact water basin are bare soil.

Results:

Phase 3 Module 2 Active

To accommodate the runoff volume (269,114 cf) resulting from a 25-year, 24-hour storm event, the starting water elevation in the pond should be 682.5 or lower.

Phase 4 Module 2

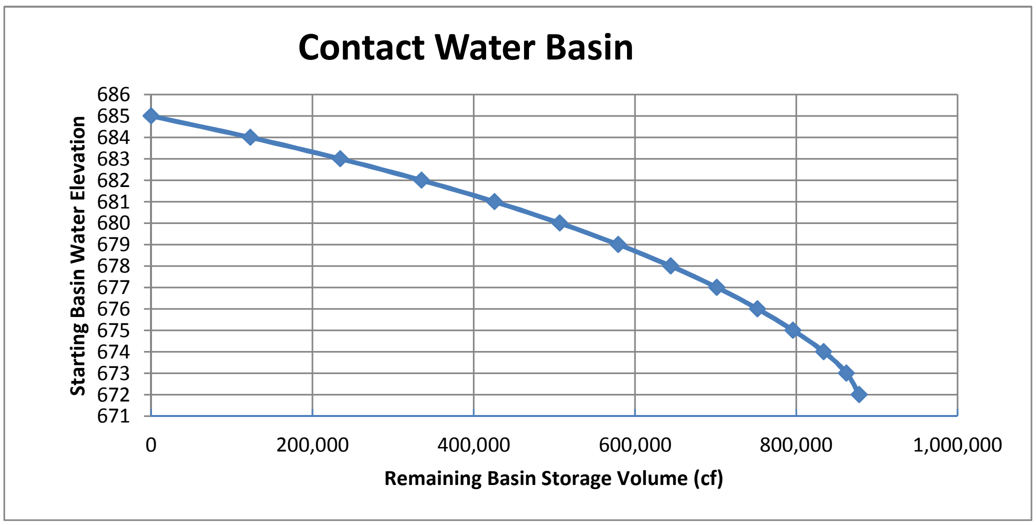
To accommodate the runoff volume (257,352 cf) resulting from a 25-year, 24-hour storm event, the starting water elevation in the pond should be 681.5 or lower.

Phase 4 Module 3

To accommodate the runoff volume (237,141 cf) resulting from a 25-year, 24-hour storm event, the starting water elevation in the pond should be 681.5 or lower.

Table 1
Operational Chart
Phase 3 Module 2
Contact Water Basin Outside Limits of Waste

Basin Elevation	Starting Water Depth (ft)	Area (sf)	Incremental Storage Volume (cf)	Cumulative Volume to Reach Basin Elevation 685 (cf)	Notes
686	14	140,337	-	-	Basin is full
685	13	128,481	0	0	Peak Elevation (1' freeboard)
684	12	117,241	122,861	122,861	
683	11	105,982	111,611	234,473	Elev 682.5 Cumulative Volume = 284,811 cf
682	10	95,370	100,676	335,149	
681	9	85,538	90,454	425,603	
680	8	76,769	81,154	506,756	
679	7	68,768	72,768	579,525	
678	6	60,958	64,863	644,388	
677	5	53,735	57,347	701,734	
676	4	47,129	50,432	752,166	
675	3	40,929	44,029	796,195	
674	2	35,173	38,051	834,246	
673	1	21,330	28,252	862,498	
672	0	10,036	15,683	878,181	Basin is empty

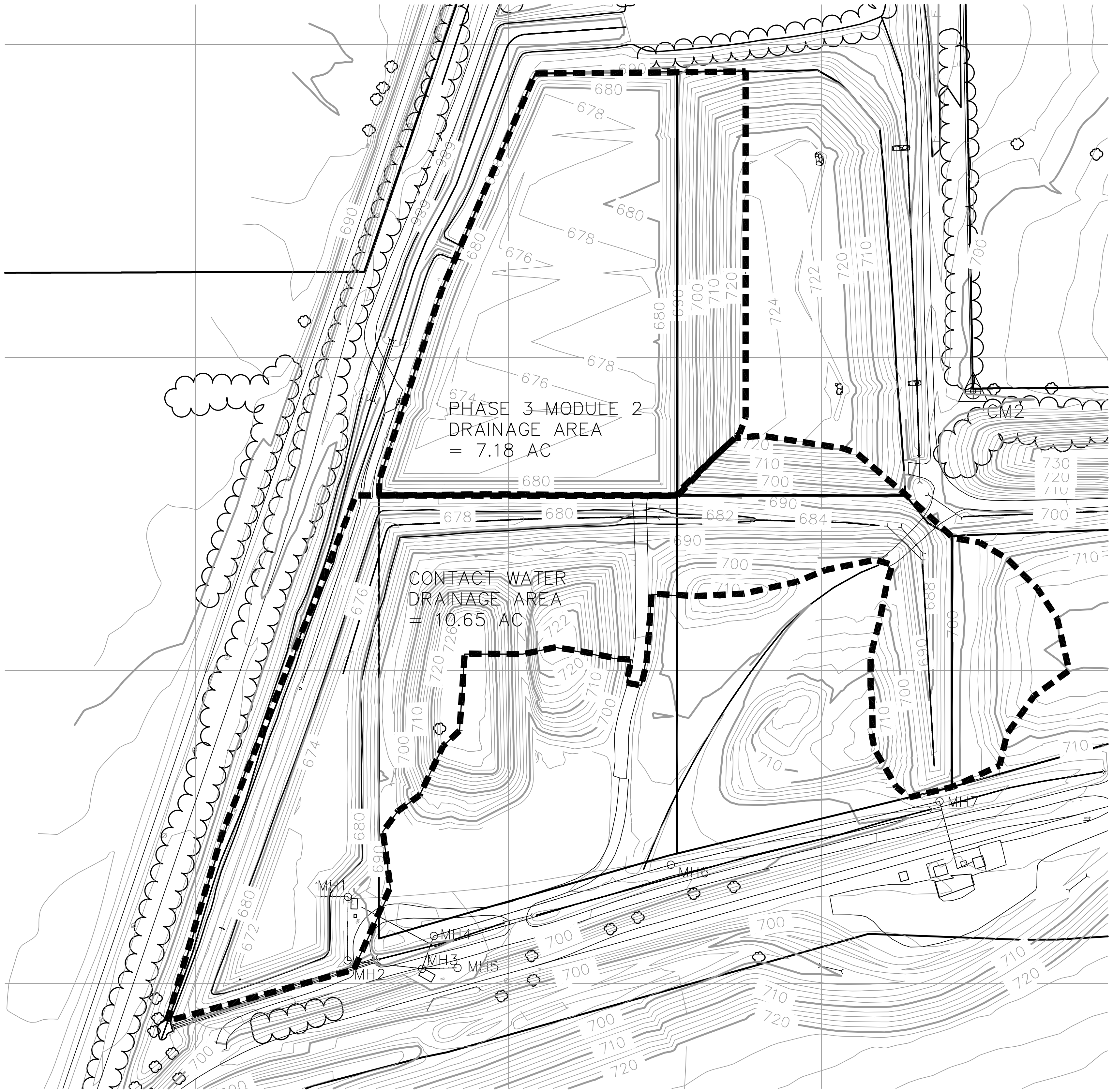


Before pumping water from any of the contact water holding features located within each module into the Contact Water Basin, make sure there is adaquate storage available.

Phase 3 Module 2 Runoff Volume:	112,733	cf (from HydroCAD model, 2.588 ac-ft)
Other Runoff Volume to Basin	156,380	cf (from HydroCAD model, 3.590 ac-ft)
Total:	269,114	cf

Based on the above runoff volume to the contact water basin, the starting water level in the basin should not be higher than 682.5 to accommodate the runoff from a 25-year, 24-hour storm event.

KRG/ 5/16/16



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LEGEND

WATER BASIN DRAINAGE AREA

200 0 200

SCALE: 1" = 200'

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SITE
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

PHASE 3 MODULE 2 CONTACT
WATER BASIN DRAINAGE AREAS

FIGURE
1

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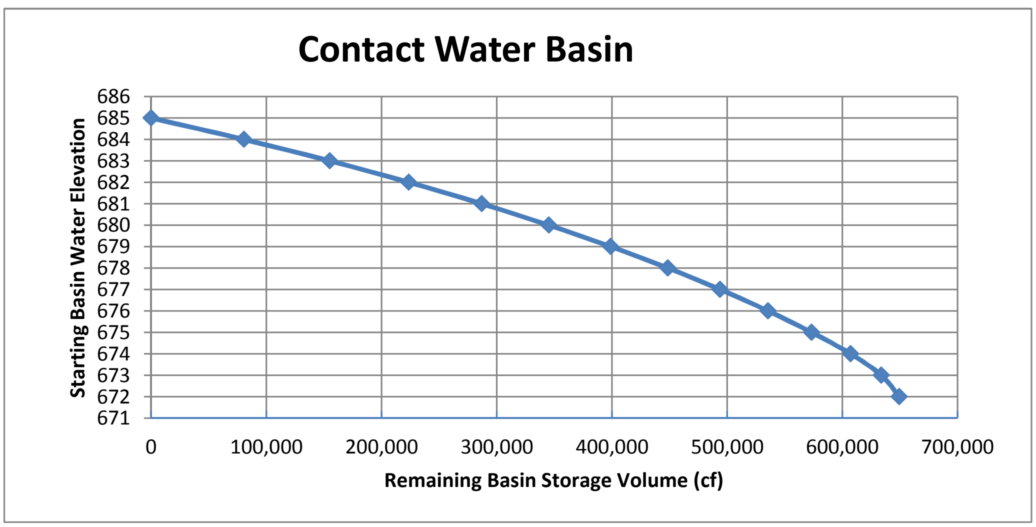
Table 2
Operational Chart
Phase 4 Module 2
Contact Water Basin Outside Limits of Waste

Basin Elevation	Starting Water Depth (ft)	Area (sf)	Incremental Storage Volume (cf)	Cumulative Volume to Reach Basin Elevation 685 (cf)	Notes
686	14	89,741	-	-	Basin is full
685	13	83,468	0	0	Peak Elevation (1' freeboard)
684	12	77,379	80,424	80,424	
683	11	71,511	74,445	154,869	
682	10	65,875	68,693	223,562	Elev 681.5 Cumulative Volume = 255,195 cf
681	9	60,657	63,266	286,828	
680	8	56,021	58,339	345,167	
679	7	51,631	53,826	398,994	
678	6	47,444	49,538	448,531	
677	5	43,448	45,446	493,977	
676	4	39,620	41,534	535,511	
675	3	35,881	37,751	573,262	
674	2	31,974	33,928	607,190	
673	1	21,330	26,652	633,841	
672	0	10,036	15,683	649,524	Basin is empty

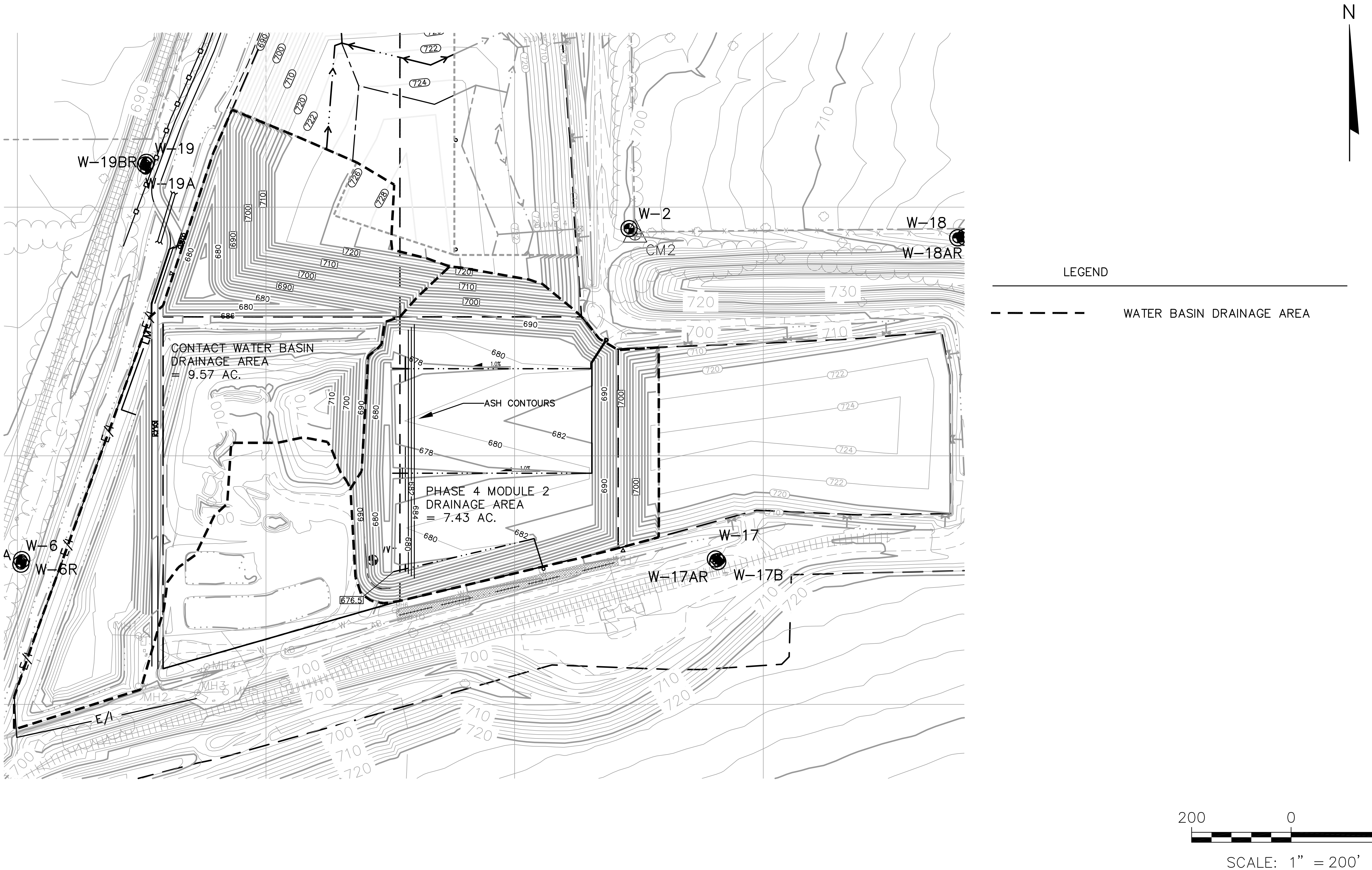


Before pumping water from any of the contact water holding features located within each module into the Contact Water Basin, make sure there is adaquate storage available:

Phase 4 Module 2 Runoff Volume:	116,697	cf (from HydroCAD model, 2.679 ac-ft)
Other Ruoff Volume to Basin:	140,655	cf (from HydroCAD model, 3.229 ac-ft)
Total:	257,352	cf

Based on the above runoff volume to the contact water basin, the starting water level in the basin should not be higher than 681.5 to accommodate the runoff from a 25-year, 24-hour storm event.

KRG/ 5/16/16



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SITE: PLAN MODIFICATION
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

PHASE 4 MODULE 2 CONTACT WATER BASIN DRAINAGE AREA

FIGURE 2

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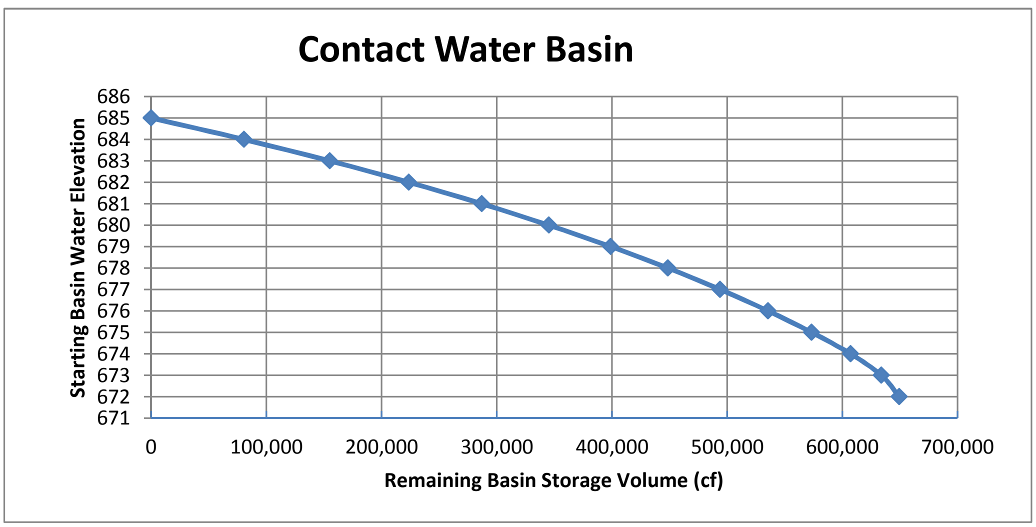
Table 3
Operational Chart
Phase 4 Module 3
Contact Water Basin Outside Limits of Waste

Basin Elevation	Starting Water Depth (ft)	Area (sf)	Incremental Storage Volume (cf)	Cumulative Volume to Reach Basin Elevation 685 (cf)	Notes
686	14	89,751	-	-	Basin is full
685	13	83,469	0	0	Peak Elevation (1' freeboard)
684	12	77,379	80,424	80,424	
683	11	71,512	74,446	154,870	
682	10	65,875	68,694	223,563	Elev 681.5 Cumulative Volume = 255,197 cf
681	9	60,658	63,266	286,830	
680	8	56,021	58,339	345,169	
679	7	51,632	53,827	398,996	
678	6	47,444	49,538	448,534	
677	5	43,458	45,451	493,985	
676	4	39,619	41,539	535,524	
675	3	35,880	37,750	573,274	
674	2	31,974	33,927	607,201	
673	1	21,330	26,652	633,853	
672	0	10,036	15,683	649,536	Basin is empty

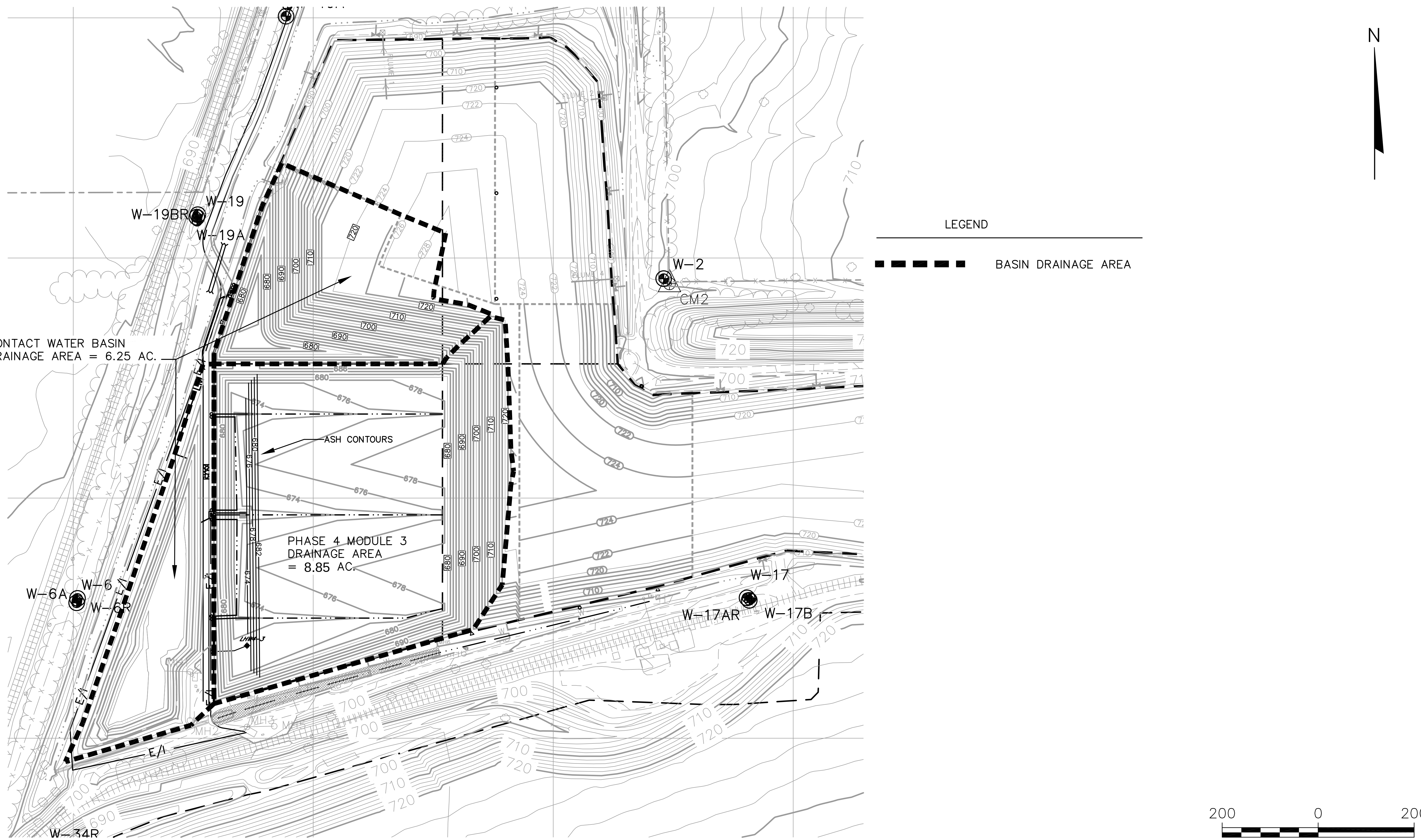


Before pumping water from any of the contact water holding features located within each module into the Contact Water Basin, make sure there is adaquate storage available:

Phase 4 Module 3 Runoff Volume:	139,000	cf (from HydroCAD model, 3.191 ac-ft)
Other Runoff Volume to Basin:	98,141	cf (from HydroCAD model, 2.253 ac-ft)
Total:	237,141	cf

Based on the above runoff volume to the contact water basin, the starting water level in the basin should not be higher than 681.5 to accommodate the runoff from a 25-year, 24-hour storm event.

KRG/ 5/16/16



PROJECT NO.	25214060	DRAWN BY:	KRG		
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SITE: PLAN MODIFICATION
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

PHASE 4 MODULE 3 CONTACT WATER BASIN
DRAINAGE AREA

FIGURE
3

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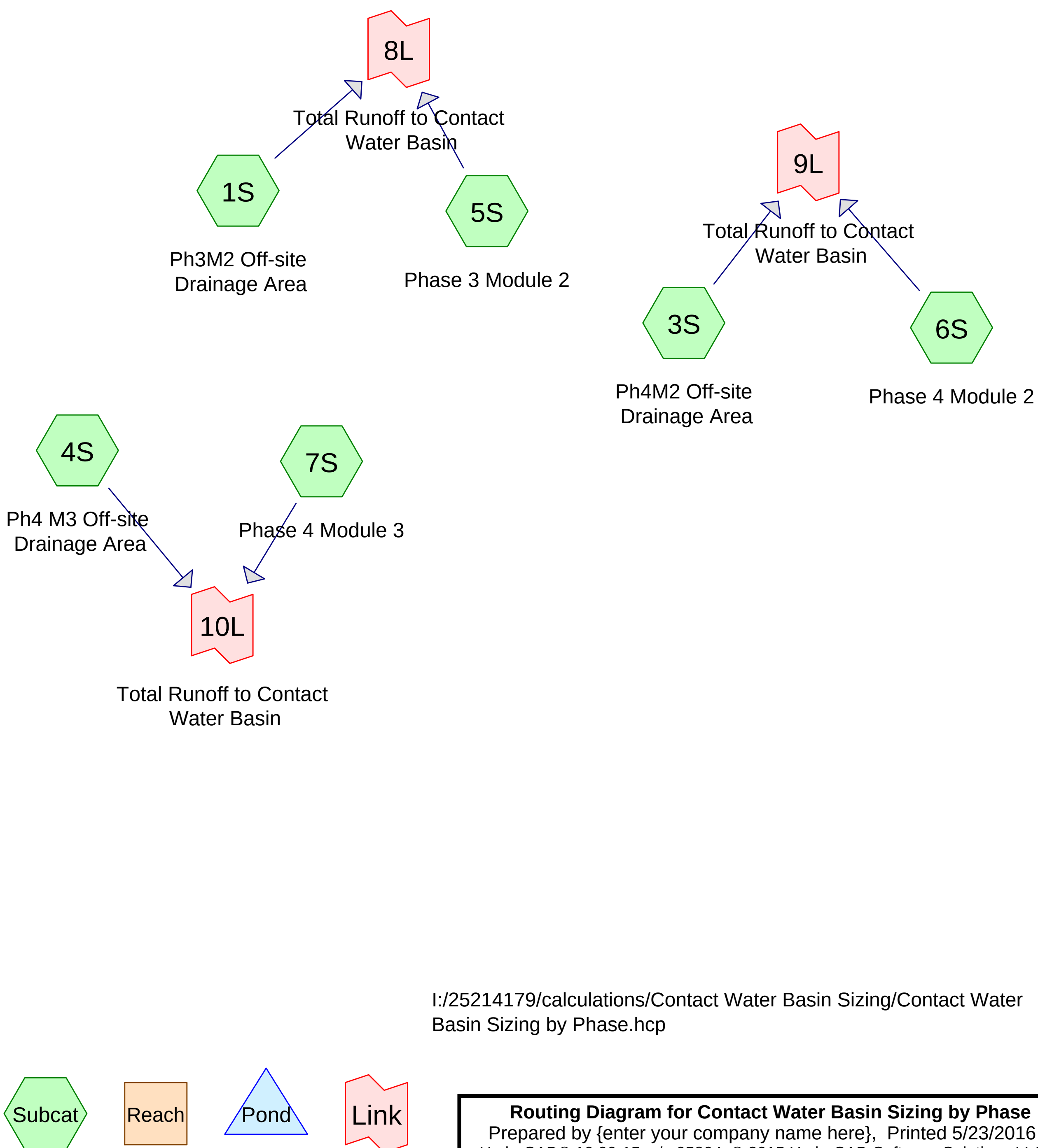

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Routing Diagram for Contact Water Basin Sizing by Phase
Prepared by {enter your company name here}, Printed 5/23/2016
HydroCAD® 10.00-15 s/n 05804 © 2015 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: Ph3M2 Off-site Drainage Area

[49] Hint: Tc<2dt may require smaller dt

Runoff = 69.57 cfs @ 12.09 hrs, Volume= 3.590 af, Depth> 4.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr Rainfall=4.80"

	Area (sf)	CN	Description
	323,363	94	Fallow, bare soil, HSG D
*	140,337	98	Water Surface (area of top of contact water basin)
	463,700	95	Weighted Average
	323,363		69.74% Pervious Area
	140,337		30.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.3300	3.80		**Sheet Flow, Phase 4 Mod 1** Smooth surfaces n= 0.011 P2= 2.59"
0.2	80	0.3300	5.74		**Shallow Concentrated Flow, Phase 4 Mod 1** Nearly Bare & Untilled Kv= 10.0 fps
2.8	980	0.0100	5.80	75.44	**Trap/Vee/Rect Channel Flow, Swale** Bot.W=10.00' D=1.00' Z= 3.0 '/' Top.W=16.00' n= 0.022 Earth, clean & straight
3.4	1,160	Total			

Summary for Subcatchment 3S: Ph4M2 Off-site Drainage Area

[49] Hint: Tc<2dt may require smaller dt

Runoff = 64.63 cfs @ 12.05 hrs, Volume= 3.229 af, Depth> 4.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr Rainfall=4.80"

	Area (ac)	CN	Description
	7.510	94	Fallow, bare soil, HSG D
*	2.060	98	Water Surface (area at top of contact water basin)
	9.570	95	Weighted Average
	7.510		78.47% Pervious Area
	2.060		21.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.3300	3.80		**Sheet Flow, Off-site Stockpiles** Smooth surfaces n= 0.011 P2= 2.59"
0.2	80	0.3300	5.74		**Shallow Concentrated Flow, Off-site Stockpiles** Nearly Bare & Untilled Kv= 10.0 fps
0.6	180	Total			

Summary for Subcatchment 4S: Ph4 M3 Off-site Drainage Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 43.43 cfs @ 12.04 hrs, Volume= 2.253 af, Depth> 4.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr Rainfall=4.80"

	Area (ac)	CN	Description
*	2.060	98	Water Surface (area at top of contact water basin)
*	4.190	98	Ash in Phase 3 Module 2
	6.250	98	Weighted Average
	6.250		100.00% Impervious Area

Summary for Subcatchment 5S: Phase 3 Module 2

[49] Hint: Tc<2dt may require smaller dt

Runoff = 50.45 cfs @ 12.08 hrs, Volume= 2.588 af, Depth> 4.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr Rainfall=4.80"

	Area (sf)	CN	Description
*	312,726	98	Open Cell
	312,726		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	100	0.2500	1.01		**Sheet Flow, Down Ash face in P3M1** Fallow n= 0.050 P2= 2.59"
0.1	33	0.2500	8.05		**Shallow Concentrated Flow, Down ash face in P3M1** Unpaved Kv= 16.1 fps
0.4	96	0.0500	3.60		**Shallow Concentrated Flow, Across Liner** Unpaved Kv= 16.1 fps
2.1	229	Total			

Summary for Subcatchment 6S: Phase 4 Module 2

[49] Hint: Tc<2dt may require smaller dt

Runoff = 51.57 cfs @ 12.06 hrs, Volume= 2.679 af, Depth> 4.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr Rainfall=4.80"

	Area (ac)	CN	Description
*	7.430	98	Ash
	7.430		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.3300	3.80		**Sheet Flow, Down ash face in P4M1** Smooth surfaces n= 0.011 P2= 2.59"
0.0	27	0.3300	9.25		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.3	68	0.0400	4.06		**Shallow Concentrated Flow, Base of Phase 4 Mod 2** Paved Kv= 20.3 fps
0.7	195	Total			

Summary for Subcatchment 7S: Phase 4 Module 3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 61.61 cfs @ 12.06 hrs, Volume= 3.191 af, Depth> 4.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr Rainfall=4.80"

	Area (ac)	CN	Description
*	8.850	98	
	8.850		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.3300	3.80		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.59"
0.1	42	0.3300	11.66		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	78	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.0	220	Total			

Summary for Link 8L: Total Runoff to Contact Water Basin

Inflow Area = 17.824 ac, 58.35% Impervious, Inflow Depth > 4.16" for 25-yr event
Inflow = 119.38 cfs @ 12.09 hrs, Volume= 6.178 af
Primary = 119.38 cfs @ 12.09 hrs, Volume= 6.178 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Link 9L: Total Runoff to Contact Water Basin

Inflow Area = 17.000 ac, 55.82% Impervious, Inflow Depth > 4.17" for 25-yr event
Inflow = 116.20 cfs @ 12.05 hrs, Volume= 5.907 af
Primary = 116.20 cfs @ 12.05 hrs, Volume= 5.907 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Link 10L: Total Runoff to Contact Water Basin

Inflow Area = 15.100 ac,100.00% Impervious, Inflow Depth > 4.33" for 25-yr event
Inflow = 104.32 cfs @ 12.05 hrs, Volume= 5.444 af
Primary = 104.32 cfs @ 12.05 hrs, Volume= 5.444 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Appendix C

Operational Plans

Appendix C1

Fugitive Dust Control Plan

Wisconsin Power and Light Company

Edgewater Generating Station (EDG) I-43 Ash Disposal Facility

Coal Combustion Residuals (CCR) Fugitive Dust Control Plan

February 1, 2023

The procedures in this plan apply to the following CCR units at this facility:

CCR Landfill

EDG I-43 Ash Disposal Facility (Phase 3, Modules 1-2; Phase 4, Module 1)

Coal Combustion Residuals (CCR) Fugitive Dust Control Plan for CCR Landfills

February 1, 2023

Purpose of CCR Fugitive Dust Control Plan

This plan describes the measures used to minimize fugitive CCR dust from facilities with CCR landfills[1], the procedure for logging citizen complaints involving CCR fugitive dust events, and the procedure for periodic review of this plan. This plan has been developed in accordance with 40 CFR 257.80(b) and NR 514.07(10)(a).

Measures for Controlling Fugitive Dust

The following measures are appropriate for minimizing CCR from becoming airborne at this facility:

- Establishing and enforcing a vehicle speed limit of 15 mph or less. Reduced speeds minimize fugitive dust generated from vehicle traffic.
- Covering all open-bodied vehicles that are transporting CCR to minimize the generation of fugitive dust during transport of CCR.
- Minimizing fall distances when handling or transferring CCR. The facility uses best practices when handling CCR with end loaders, and other best management practices, to minimize the generation of fugitive dust.
- Promptly collecting CCR that is observed in vehicle loading/unloading areas to minimize the potential for CCR to become airborne.
- Applying water directly to CCR using a water truck or irrigation system. Moistened CCR is less likely to become airborne.
- Suspending CCR management activities, including placement of CCR, during excessively windy conditions to minimize CCR from becoming airborne.
- Placement of soil and/or vegetated cover to minimize exposure of CCR in inactive landfill areas to conditions that could lead to fugitive dust.

These measures are applicable to the CCR managed at this facility and appropriate for the conditions at this site because they are compatible with current operations and they effectively minimize the generation of fugitive dust.

Procedure for Conditioning CCR Prior to Placement

CCR is routinely conditioned with water prior to placement to prevent wind dispersal. Conditioning of scrubber by-products occurs through the use of a pug mill within an enclosed building. Conditioning may also occur by wetting with a water truck as material is placed in the CCR landfill. Conditioning will not result in free liquids.

[1] "CCR" and "CCR landfill" are defined at 40 CFR 257.53 and NR 500.03.

Procedure for Logging Citizen Complaints

Citizen complaints pertaining to fugitive dust will be managed in accordance with Alliant Corporate Policy ENV-107. Specifically, the complaint must be reported to Environmental Services (1) via phone call and (2) in writing by submitting a completed Environmental Incident Report to Environmental Services within 10 business days. Citizen complaints will be tracked within the Alliant Environmental Management Information System ("ENVIANCE").

Visual Inspections

In accordance with NR 514.07(10)(a)(3), the owner/operator will perform visual inspections of the landfill surface at least every 7 days. If fugitive dust concerns are observed during the inspection, action will be taken to remedy the situation. Visual fugitive dust inspections will not be performed if the CCR disposal area is covered by intermediate or final cover and there is no potential for CCR to become airborne.

Procedure for Periodic Review of CCR Fugitive Dust Control Plan

The CCR Fugitive Dust Control Plan will be reviewed annually, and updated as necessary, in conjunction with preparation of the Annual CCR Fugitive Dust Control Report [40 CFR 257.80(c) and NR 514.07(10)(a)(5)]. The Annual CCR Fugitive Dust Control Report will be included in the annual report in accordance with NR 506.20(3)(a) and include a description of the actions taken by the owner or operator to control CCR fugitive dust, a record of all citizen complaints, and a summary of any corrective measures taken.

During the periodic review, staff will evaluate each measure for controlling fugitive dust to ensure that it is still appropriate for minimizing CCR from becoming airborne at the facility, will verify that the procedures for conditioning CCR prior to landfilling and the procedure for logging complaints are sufficient, and will evaluate other operations changes at the facility to determine whether additional dust control measures should be added.

In accordance with NR 514.07(10)(a)(4), the CCR Fugitive Dust Control Plan will be modified in accordance with NR 514.04(6) whenever there is a change in conditions that may substantially affect the plan of operation.

- END -

P.E. Certification

I, Phillip Gearing, hereby certify that I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of ch. A−E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A−E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 538, Wis. Adm. Code.

Specifically,

- This CCR Fugitive Dust Control Plan was prepared by me or under my direct supervision and meets the requirements of 40 CFR 257.80(b) and NR 514.07 (10)(a)

Signature

WISCONSIN
PHILLIP E.
GEARING
E-45115
SUN PRAIRIE,
WIS.
PROFESSIONAL ENGINEER

February 1, 2023
Date

2/1/23

License number E-45115

My license renewal date is July 31, 2024.

Appendix C2

Run-on and Run-off Control System Plan

Run-On and Run-Off Control Plan Update - I-43 Phase 3 Module 1, Phase 3 Module 2, and Phase 4 Module 1

Edgewater I-43 Ash Disposal Facility
Sheboygan, Wisconsin 53081

Prepared for:

Wisconsin Power and Light Company
Edgewater Generating Station
3739 Lakeshore Drive
Sheboygan, Wisconsin 53081-7233

SCS ENGINEERS

25222259.00 | February 1, 2023

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

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Figures

Appendix

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PE CERTIFICATION

WISCONSIN
PHILLIP E.
GEARING
E-45115
SUN PRAIRIE,
WIS.
PROFESSIONAL ENGINEER

2/1/23

I, Phillip Gearing, hereby certify that I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of ch. A–E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A–E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 538, Wis. Adm. Code.

Specifically,

- This Run-On and Run-Off Control Plan Update was prepared by me or under my direct supervision and meets the requirements of 40 CFR 257.81(c) and NR 514.07(10)(b)

February 1, 2023

(signature) (date)

Phillip E. Gearing

(printed or typed name)

License number E-45115

My license renewal date is July 31, 2024.

Pages or sheets covered by this seal:

ALL

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1.0 INTRODUCTION AND PROJECT SUMMARY

The I-43 facility includes a closed coal combustion residual (CCR) landfill, which consists of disposal Phase 1 and Phase 2, and an active CCR landfill. The active CCR landfill currently consists of an existing CCR unit in disposal Phase 3 and Phase 4. The two landfills are located on the same property, but are not contiguous. The federal CCR Rule [40 CFR 257.50-107] and the Wisconsin CCR Landfill Rules in chapters NR 500 to 538 do not apply to Phase 1 and Phase 2, because they ceased receiving CCR prior to October 19, 2015.

The active CCR landfill at I-43 includes the following modules, which are the subject of this Run-On and Run-Off Control Plan. These modules are listed below along with their current status as it relates to the Run-On and Run-Off Control Plan:

- **Phase 3, Module 1** – This module has received some final cover over completed outer sideslope areas that will no longer receive additional CCR.

- **Phase 3, Module 2** – This module is currently being filled.

- **Phase 4, Module 1** – This module has received some final cover over completed outer sideslope areas that will no longer receive additional CCR.

Two future CCR modules (Phase 4, Module 2 and Phase 4, Module 3) are permitted with the Wisconsin Department of Natural Resources (WDNR), but are not planned for development currently.

Refer to **Figure 1** for the site location. **Figure 2** shows the run-on and run-off drainage areas.

On behalf of Wisconsin Power and Light Company (WPL), SCS Engineers (SCS) has prepared this Run-on and Run-off Control Plan Update for the I-43 Ash Disposal Facility (ADF) in accordance with 40 CFR 257.81(c)(1) and NR 514.07(10)(b) as follows.

40 CFR 257.81(c)(4). *"The owner or operator of the CCR unit must prepare periodic run-on and run-off control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first subsequent plan. The owner or operator may complete any required plan prior to the required deadline provided the owner or operator places the completed plan into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing a subsequent plan is based on the date of completing the previous plan. For purposes of this paragraph (c)(4), the owner or operator has completed a periodic run-on and run-off control system plan when the plan has been placed in the facility's operating record as required by §257.105(g)(3)."*

NR 514.07(10)(b)(4). *"Modification every 5 years from the date of the most recent plan approval or whenever there is a change in conditions that may substantially affect the written plan in effect. The modification shall be requested by the owner or operator in accordance with s. NR 514.04 (6) prior to the 5-year deadline."*

The initial Run-on and Run-off Control Plan was completed in 2016 and updated in 2021 to meet federal requirements.

1.1 PERIODIC PLAN UPDATES

The following items have been updated in this periodic plan update:

- No changes impacting the run-on and run-off controls have been identified with this update.
- The purpose of this update is to incorporate the requirements of NR 514.07(10)(b), which became effective August 1, 2022.

2.0 RUN-ON AND RUN-OFF CONTROL PLAN

40 CFR 257.81(a). *"The owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill must design, construct, operate, and maintain:*

(1) A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm."

NR 514.07(10)(b). *"A run–on and run–off control system plan that includes all of the following:*

(1) A run–on and run–off control system designed in accordance with the requirements under s. NR 504.12 (2)."

NR 504.12 (2). *"An existing or new CCR landfill or any lateral expansion of a CCR landfill shall be designed, constructed, operated, and maintained with a run–off and run–on control system in accordance with the requirements under s. NR 504.09 (1) (f) and (g) and all of the following:*

(a) A run–on control system shall prevent flow onto the active portion of the CCR landfill during the peak discharge from a 24–hour, 25–year storm."

The entire facility has run-on and run-off control in place, as approved by the WDNR and further described below. Run-on is controlled by berms and swales around the perimeter of the landfill that divert storm water away from the landfill and to the detention basin on the north end of the property.

> 40 CFR 257.81(a)(2) *"A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm."*
>
> NR 504.12(2)(b) *"A run–off control system from the active portion of the CCR landfill shall collect and control, at a minimum, the water volume resulting from a 24–hour, 25–year storm."*

Run-off from the active portions (contact water) of the existing CCR units at the facility is handled as leachate and is collected by a leachate collection system or internal swales, which route the contact water to a composite-lined contact water basin. The contact water in the basin is used for ash conditioning, and other applications within the CCR units. Water in the contact water basin is also pumped through a force main to the sanitary sewer then on to the local waste water treatment facility for disposal. Per 40 CFR 257.81(b), this is consistent with the surface water requirements under 40 CFR 257.3-3.

Run-off from areas of the existing CCR units where intermediate/final cover is in place (which prevents contact with CCR) is diverted into the perimeter drainage swales, which drain to the on-site detention/sedimentation basin. Intermediate swales/berms, downslope flumes, and energy dissipaters on the final cover help minimize erosion of the final cover and divert water to the perimeter drainage system, and ultimately to the on-site detention/sedimentation basin. Per 40 CFR 257.81(b), this is consistent with the surface water requirements under 40 CFR 257.3-3.

2.1 DESIGN CRITERIA

The storm water features described above are designed to handle run-on and run-off from a 25-year, 24-hour storm event as required by 40 CFR 257.81(a)(1) and (2) and NR 504.12 (2)(a) and (b). Storm water run-off calculations were updated in 2015. The calculations were performed assuming a 25-year, 24-hour precipitation depth of 4.79 inches, based on National Oceanic and Atmospheric Administration (NOAA) Atlas 14 precipitation data published in April 2013. The detention basin and detention/sedimentation basin outlet structures are designed to safely pass run-off from a 100-year, 24-hour storm event.

2.2 DESIGN WITH CALCULATIONS

Storm water management design calculations (as described above) from the WDNR approved Plan of Operation (2008) and Plan of Operation Modification (2015) for Phase 3 and Phase 4 at the I-43 ADF are contained in Appendix A, as required by 40 CFR 257.81(c)(1) and NR 514.07(10)(b)(2). Design calculations include Phase 4, Modules 2 and 3, which are not currently planned for development.

As described in Section 2.1, the calculations from the 2008 Plan of Operation describe the storm water management design and provide calculations showing that the run-on control system will prevent flow onto the active portion of the CCR units during the peak discharge from a 25-year, 24-hour storm. The calculations from the 2015 Plan of Operation Modification describe the updated storm water management design features from the 2008 Plan of Operation and provide calculations showing that the run-off control system for the active portions of the CCR units will collect and control the water volume resulting from a 25-year, 24-hour storm.

A calculation (2016) was also completed to determine the maximum starting water elevation in the contact water basin prior to a 25-year, 24-hour storm event in order to accommodate the volume from the active landfill area (contact water handling areas) and direct discharges into the contact water basin (Appendix A). The contact water basin storage calculation is conservative due to the installation of a force main in 2019 that allows WPL to discharge contact water collected in the basin to the local sanitary sewer. The pumping of contact water into the force main allows for maintenance of water levels in the contact water basin and assists with providing sufficient water storage between storm events. The calculations were performed by or overseen by a professional engineer licensed in the State of Wisconsin.

Currently available design storm event data from National Oceanic and Atmospheric Administration NOAA Atlas 14, Volume 8, Version 2 and the design calculations described above were reviewed at the time of this update and the data does not substantially affect the results of design calculations provided in Appendix A.

2.3 CONSTRUCTION

Existing storm water management features were constructed to site specifications with construction oversight directed by a professional engineer licensed in the State of Wisconsin. Construction documentation reports for the storm water management features were prepared, submitted to the

WDNR, and approved by the WDNR. Any future construction features will have been previously approved.

3.0 CERTIFICATIONS

40 CFR 257.81(c)(5). "*The owner or operator must obtain a certification from a qualified professional engineer stating that the initial and periodic run-on and run-off control system plans meet the requirements of this section.*"

Mr. Phillip Gearing, PE, a licensed professional engineer in the State of Wisconsin, has overseen the preparation of this Run-on and Run-off Control Plan Update. A certification statement is provided on **page iii** of this plan.

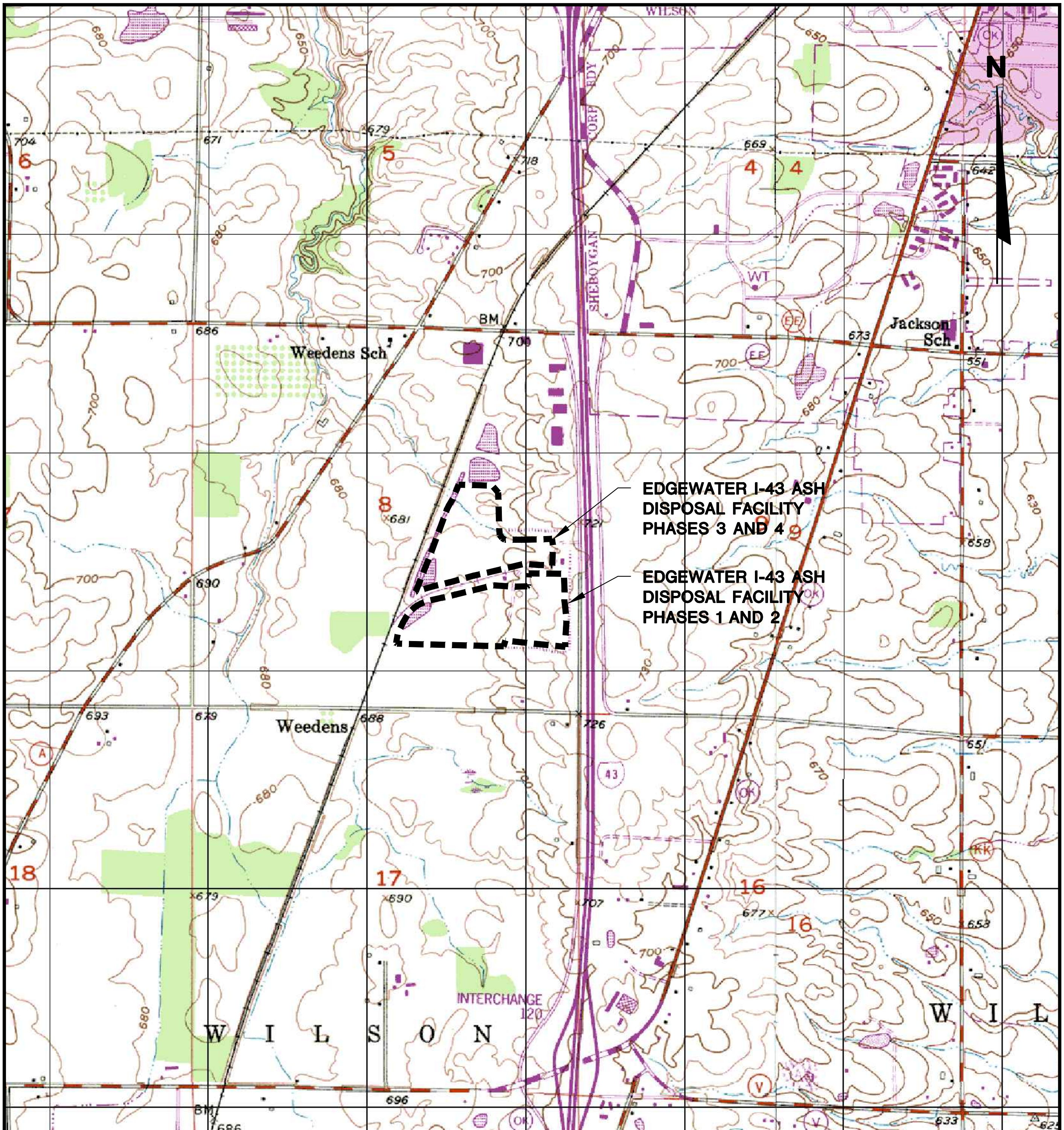
4.0 RECORDKEEPING AND PERIOD UPDATES

40 CFR257.81(d). *"The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in section 257.105(g), the notification requirements specified in section 257.106(g), and the internet requirements specified in section 257.107(g)."*

This Run-On and Run-Off Control Plan Update, and all additional periodic plans, will be placed in the facility's operating record and on Alliant Energy's CCR Rule Compliance Data and Information website, as well as all amendments. Periodic plans will be completed every 5 years per 40 CFR 257.81(c)(4) and NR 514.07(10)(b)(4).

Notification will be provided to State Director when this Run-On and Run-Off Control Plan Update, and all subsequent updates are available in the facility's operating record and on the facility's website per 40 CFR 257.105(g), 257.106(g), and 257.107(g) and NR 506.17(2) and (3).

Figures



SHEBOYGAN HILLS QUADRANGLE
WISCONSIN–SHEBOYGAN CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SCALE: 1" = 2,000'

CLIENT	SITE	
WISCONSIN POWER AND LIGHT COMPANY EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081	RUN–ON AND RUN–OFF CONTROL PLAN EDGEWATER I–43 ASH DISPOSAL FACILITY TOWN OF WILSON, WISCONSIN	SITE LOCATION MAP

				ENGINEER	
PROJECT NO.	25222259.00	DRAWN BY:	AHB/RJG	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718–6751 PHONE: (608) 224–2830	FIGURE
DRAWN:	08/09/16	CHECKED BY:	PG		1
REVISED:	07/16/21	APPROVED BY:	PG 1/31/23		

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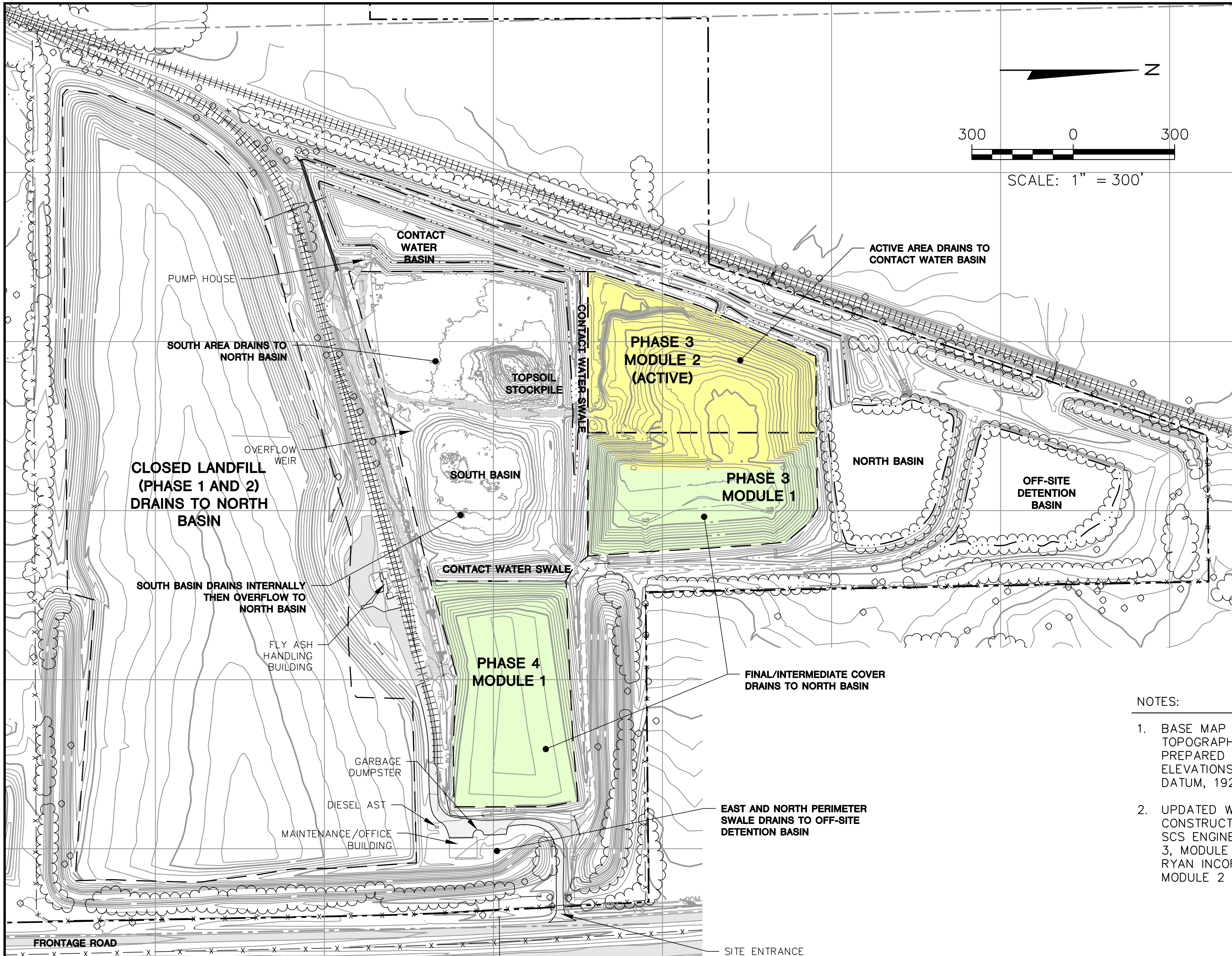

LEGEND

- APPROXIMATE PROPERTY LINE
- LIMITS OF WASTE
- MODULE LIMITS
- GRADE (2' CONTOUR)
- 690 GRADE (10' CONTOUR)
- EDGE OF WATER
- SWALE
- WETLAND
- CULVERT
- MH MANHOLE
- W CONTACT WATER TRANSFER PIPE
- AB ABANDONED 3" DIA. HDPE PIPE
- FM CONTACT WATER FORCEMAIN
- E/I ELECTRIC/INSTRUMENTATION
- TREELINE/TREES
- PAVED ROAD
- UNPAVED ACCESS ROAD
- CONCRETE
- RAILROAD TRACKS
- FENCE
- UTILITY/LIGHT POLE
- CONTROL MONUMENT
- ACTIVE LANDFILL DRAINAGE AREA
- FINAL/INTERMEDIATE COVER DRAINAGE AREA

NOTES:

1. BASE MAP PREPARED BY KBM, INC. BASED ON AERIAL TOPOGRAPHIC SURVEY FLOWN DECEMBER 1, 2014. BASE MAP PREPARED USING WISCONSIN STATE PLANE COORDINATES. ELEVATIONS BASED ON USGS NATIONAL GEODETIC VERTICAL DATUM, 1929.
2. UPDATED WITH 2015 CONSTRUCTION AS-BUILT GRADES, 2016 CONSTRUCTION AS-BUILT GRADES FOR PHASE 4, MODULE 1 BY SCS ENGINEERS, DECEMBER 23, 2020 DRONE SURVEY OF PHASE 3, MODULE 2 ASH GRADES AND FUTURE PHASE 4 AREAS BY RYAN INCORPORATED CENTRAL, APRIL 11, 2022 PHASE 3 MODULE 2 SURVEY BY SCS ENGINEERS.

PROJECT NO.	25222259.00	DRAWN BY:	AHB/RJG
DRAWN:	08/09/16	CHECKED BY:	PG
REVISED:	01/26/23	APPROVED BY:	PG 1/31/23

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

CLIENT: WISCONSIN POWER AND LIGHT COMPANY, EDGEWATER GENERATING STATION, 3739 LAKESHORE DRIVE, SHEBOYGAN, WI 53081

SITE: RUN-ON AND RUN-OFF CONTROL PLAN, EDGEWATER I-43 ASH DISPOSAL FACILITY, TOWN OF WILSON, WISCONSIN

RUN-ON AND RUN-OFF CONTROL PLAN

FIGURE 2

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Appendix A

Drainage Design Calculations

2008 Plan of Operation
Drainage Design Calculations

APPENDIX G

Stormwater Control Design Calculations

Appendix G
Surface Water Management Calculations

Purpose:

The purpose of the surface water runoff calculations is to demonstrate the following:

- The proposed Phase 3 and 4 landfill expansion surface water management system design meets the requirements of NR 504.09 Wis. Admin. Code.
- That the stormwater design features installed in 1984, (i.e., the detention/sedimentation basin, detention basin, outlet structures, and swales) are adequate for current regulations.

Existing Features:

There are two stormwater outlets for the site. These outlets are; 1) an 36-inch diameter culvert under the railroad tracks to the west of the site and 2) an 24-inch diameter culvert under the railroad tracks. The culverts are shown on Figure G1.

The detention/sedimentation basin, detention basin, run-on diversion swale, perimeter swales around Phases 1 and 2, and culverts were installed in 1984. Currently, runoff from the areas of Phase 1 and 2 of the landfill that are at final grades is directed to the detention/sedimentation basin for treatment and runoff from the active portion of Phase 1 and 2 is directed to the interior Southern Ash Contact Holding Basin for use as dust control water. When Phase 1 and 2 are complete, runoff will be directed to the detention/sedimentation basin. Stormwater from off-site of the landfill to the east is directed via the run-on diversion swale to the detention basin for treatment.

The detention/sedimentation basin discharges through a 24-inch riser outlet structure to the 36-inch diameter culvert under the railroad tracks to the west. The detention basin discharges through an 18-inch riser outlet structure to the 24-inch diameter culvert under the railroad tracks.

Methodologies:

Design of Stormwater Management Features:
To design the storm water management features, runoff hydrographs for the 25-year, 24-hour and 100-year, 24-hour storm event were developed. Hydrographs were developed using the TR-55 method contained within the Pond Pack® computer model developed by Bentley Systems, Inc. The TR-55 method for computing hydrographs is based on the methodologies presented in the Urban Hydrology for Small Watersheds manual developed by the Natural Resources Conservation Service (NRCS). The TR-55 model is designed to simulate the surface response of a watershed to a precipitation event. Input parameters for the model include precipitation depth for a given storm event, contributing drainage areas, runoff curve numbers, time of concentration, and travel time. The TR-55 model develops a runoff hydrograph for the watershed.

The following assumptions were used in the TR-55 model:

- The rainfall depths used were: 4.4 in for the 25-yr storm event and 5.1 in for the 100-yr event.
- A runoff curve number (CN) of 80 was used. This CN is for pasture in good condition (>75% ground cover) and a hydrologic soil group D.
- Sheet flow was assumed for the top of the landfill across the final grades.
- For flow in the perimeter swales, a mannings n value of 0.035 was used.

The hydrograph developed by TR-55 was routed through the existing detention/sedimentation basin and outlet using the Pond Pack® model to determine the outflow from the basin.

The sediment removal properties for the basins were evaluated using the P8 Urban Catchment Model. Wis. Admin. Code NR 504.09 requires sediment control measures be designed to settle 0.015 mm (15 micron) particle. Settling of the 15-micron particle corresponds to a trapping efficiency of 49%.

The design of the swales and culverts surrounding the landfill was evaluated using a channel and culvert calculator included in AutoCAD 2008. The channel calculator uses Manning's Equation to determine the maximum flow that a channel can carry given the geometry of the channel.

RESULTS:

The proposed surface water management system design meets the requirements of s. NR 504.09, Wis. Admin. Code. Further details are provided below.

Runoff Calculations

Runoff from Phases 1 and 2 of the landfill flows to the perimeter swales around the landfill and is directed to the sedimentation/detention basin.

Phase 3 & 4 of the landfill can be divided into 3 watersheds. The watersheds are shown on Figure G1. A southwest watershed that drains to the south and west perimeter swale of the landfill, a northeast watershed that drains to the north and northeast perimeter swale of the landfill, and a third watershed is located in the northern portion of the landfill and drains directly into the sedimentation/detention basin. This third watershed is small, approximately 2 acres, and considered insignificant and no runoff is calculated for this watershed.

Drainage Area	Area (acres)	Runoff Curve Number	Time of Concentration (hr)	25-yr Storm Peak Runoff
Phases 1&2	53.1	80	0.61	107.2 cfs
Ph 3&4 Southwest	32.0	80	0.78	55.4 cfs
PH 3&4 Northeast	13.3	80	0.51	30.7 cfs

Sedimentation / Detention Basin
All of these runoff from these watersheds is directed to the sedimentation / detention basin by the perimeter swales. The outlet structure of this basin is a 24-inch diameter riser outlet structure with a 25 foot wide emergency spillway located at elevation 685.0 ft with a top of berm elevation of 686.0 ft.

The flow through the sedimentation / detention basin was simulated using the Pond Pack® computer model. The peak inflow into the basin was 188.9 cfs for the 25-yr storm event. The peak outflow for the 25-yr storm event through the outlet structure was 37.3 cfs with a peak water elevation of 685.37. The 100-yr storm event was also modeled to ensure the emergency spillway was adequate, the peak elevation in the detention basin for the 100-yr storm was 685.79 ft.

Due to the water elevation during the 25-yr storm event (685.41) being above the elevation of the emergency spillway (685.0), a new outlet of the sedimentation/detention basin was designed. The new outlet design is shown on the detail drawings and consists of a 36-inch diameter CMP culvert with a 36-inch diameter CMP riser. This new outlet structure will need to be installed when the base grades for

Phase 4, Module 2 of the landfill is prepared. At the current rate of ash disposal, the outlet will not need to be replaced for approximately 10 years after disposal begins in Phase 3, Module 1.

The runoff for the site when Phase 3 Modules 1 and 2 and Phase 4 Module 1 are at final grades and contribute to the runoff going to the detention / sedimentation basin was also calculated to ensure the runoff from the 25-year storm event is contained within the basin using the existing outlet structure. The maximum water level obtained within the basin during the 25-yr storm event is 684.98 with a peak outflow of 19.8 cfs. The peak water level obtained during the 100-year storm event is 685.43 with a peak outflow of 41.6 cfs.

the proposed outlet structure for the detention / sedimentation basin was also modeled to ensure the 25-year storm event runoff from the entire Phase 3 and 4 can be contained within the basin. The maximum water level obtained within the basin during the 25-yr storm event is 684.99 with a peak outflow of 38.1 cfs. The peak water level obtained during the 100-year storm event is 685.45 with a peak outflow of 73.1 cfs. The basin will also take longer than 3 day to completely drain.

Detention Basin
Stormwater run-on is directed to the detention basin by the run-on diversion swale. The off-site area that contributes to run-on is approximately 91 acres. The outlet structure of the detention basin is an 18-inch diameter riser outlet structure with a 25-ft wide emergency spillway at elevation 691.0 and a top of berm elevation of 693.0 ft. The flow through the detention basin was simulated using the Pond Pack® computer model. The peak outflow for the 25-yr storm is 8.8 cfs with a peak elevation of 688.4 ft. The peak outflow for the 100-yr storm is 12.2 cfs with a peak elevation of 689.3 ft. The basin will also take longer than 3 day to completely drain.

Sediment Removal

The sediment removal properties for the basins were evaluated using the P8 Urban Catchment Model. Wis. Admin. Code NR 504.09 requires sediment control measures be designed to settle 0.015 mm (15 micron) particle. Settling of the 15-micron particle corresponds to a trapping efficiency of 49%.

The P8 model showed the sedimentation / detention basin will capture 69.9% of the total suspended solids (TSS) and the detention basin will capture 74.2% of the TSS.

Perimeter Swale Sizing

The design of the perimeter swales surrounding the landfill was evaluated using a channel calculator included in AutoCAD 2008. The channel calculator uses Manning's Equation to determine the maximum flow that a channel can carry given the geometry of the channel.

The channel calculator shows the swales can carry the 25-yr storm event with a minimum of 0.5 feet of freeboard.

There will be a culvert installed in the swale to provide access to the leachate pumpout riser. The culvert calculator shows that two 24-inch diameter corrugated metal pipes (CMP) culverts can carry the design flow.

Intermediate Diversion Swales

The Universal Soil Loss Equation (USLE) was used to determine if intermediate diversion berms were required on the final grades to prevent erosion. The equation showed that no berms were required.

KRG/krg/TR
I:\3391\Calculations\Stormwater\Summary.doc

Runoff Calculation

Phase 1 & 2

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Phases 1&2	84	53.100			84.00
COMPOSITE AREA & WEIGHTED CN --->		53.100			84.00 (84)

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```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

----------------------------------------------------------------------

Segment #1:  Tc: TR-55 Sheet

Mannings n            .2400
Hydraulic Length    170.00 ft
2yr, 24hr P         2.5000 in
Slope             .040000 ft/ft

Avg.Velocity           .15 ft/sec

                                        Segment #1 Time:     .3118 hrs
----------------------------------------------------------------------

Segment #2:  Tc: TR-55 Sheet

Mannings n            .2400
Hydraulic Length     50.00 ft
2yr, 24hr P         2.5000 in
Slope             .130000 ft/ft

Avg.Velocity           .19 ft/sec

                                        Segment #2 Time:     .0731 hrs
----------------------------------------------------------------------

Segment #3:  Tc: TR-55 Channel

Flow Area          13.5000 sq.ft
Wetted Perimeter     16.30 ft
Hydraulic Radius       .83 ft
Slope             .012000 ft/ft
Mannings n            .0350
Hydraulic Length   3350.00 ft

Avg.Velocity          4.11 ft/sec

                                        Segment #3 Time:     .2263 hrs
----------------------------------------------------------------------

                                                ========================
                                                 Total Tc:     .6111 hrs
                                                ========================
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 year storm
Duration       = 24.0000 hrs     Rain Depth = 4.4000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID  =  - TypeII  24hr
Unit Hyd Type  = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID  = work_pad.hyg - PHASE 1+2 Dev 25
Tc             = .6111 hrs
Drainage Area  = 53.100 acres  Runoff CN= 84

============================================
Computational Time Increment   =   .08148 hrs
Computed Peak Time             =  12.2224 hrs
Computed Peak Flow             =   108.07 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.2500 hrs
Peak Flow, Interpolated Output =   107.19 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:PHASE 1+2
              CN    =   84
              Area  =      53.100 acres
              S     =   1.9048 in
              0.2S  =    .3810 in

               Cumulative Runoff
              -------------------
                      2.7267 in
                      12.066 ac-ft

HYG Volume...         12.065 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .61112 hrs (ID: PHASE 1+2)
Computational Incr, Tm =   .08148 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,          qp =    98.45 cfs
Unit peak time      Tp =   .40741 hrs
Unit receding limb, Tr =  1.62966 hrs
Total unit time,    Tb =  2.03707 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration       = 24.0000 hrs     Rain Depth = 5.1000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID = work_pad.hyg - PHASE 1+2 Dev100
Tc             = .6111 hrs
Drainage Area = 53.100 acres  Runoff CN= 84

============================================
Computational Time Increment   =   .08148 hrs
Computed Peak Time             =  12.2224 hrs
Computed Peak Flow             =   133.12 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.2500 hrs
Peak Flow, Interpolated Output =   131.89 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:PHASE 1+2
              CN   =   84
              Area =      53.100 acres
              S    =   1.9048 in
              0.2S =     .3810 in

               Cumulative Runoff
              -------------------
                      3.3620 in
                      14.877 ac-ft

HYG Volume...         14.876 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .61112 hrs (ID: PHASE 1+2)
Computational Incr, Tm =   .08148 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,           qp =    98.45 cfs
Unit peak time       Tp =   .40741 hrs
Unit receding limb,  Tr =  1.62966 hrs
Total unit time,     Tb =  2.03707 hrs
```

Runoff Calculation

Phase 3 & 4 Northeast Drainage Area

Table of Contents

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Northeast	84	13.300			84.00
COMPOSITE AREA & WEIGHTED CN --->		13.300			84.00 (84)

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```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

------------------------------------------------------------------------

Segment #1:  Tc: TR-55 Sheet

Mannings n           .2400
Hydraulic Length   160.00 ft
2yr, 24hr P        2.5000 in
Slope             .030000 ft/ft

Avg.Velocity          .13 ft/sec

                                         Segment #1 Time:      .3332 hrs
------------------------------------------------------------------------

Segment #2:  Tc: TR-55 Sheet

Mannings n           .2400
Hydraulic Length    30.00 ft
2yr, 24hr P        2.5000 in
Slope             .250000 ft/ft

Avg.Velocity          .22 ft/sec

                                         Segment #2 Time:      .0374 hrs
------------------------------------------------------------------------

Segment #3:  Tc: TR-55 Channel

Flow Area          5.9000 sq.ft
Wetted Perimeter    13.60 ft
Hydraulic Radius      .43 ft
Slope             .025000 ft/ft
Mannings n          .0350
Hydraulic Length   730.00 ft

Avg.Velocity         3.86 ft/sec

                                         Segment #3 Time:      .0526 hrs
------------------------------------------------------------------------
```

Segment #4: Tc: TR-55 Channel

Flow Area	5.9000	sq.ft
Wetted Perimeter	13.60	ft
Hydraulic Radius	.43	ft
Slope	.010000	ft/ft
Mannings n	.0350	
Hydraulic Length	580.00	ft
Avg.Velocity	2.44	ft/sec

Segment #4 Time: .0660 hrs

Segment #5: Tc: TR-55 Channel

Flow Area	13.5000	sq.ft
Wetted Perimeter	16.30	ft
Hydraulic Radius	.83	ft
Slope	.025000	ft/ft
Mannings n	.0350	
Hydraulic Length	350.00	ft
Avg.Velocity	5.94	ft/sec

Segment #5 Time: .0164 hrs

Total Tc: .5056 hrs

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 year storm
Duration       = 24.0000 hrs     Rain Depth = 4.4000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID = work_pad.hyg - PHASE 3+4 NE Dev 25
Tc             = .5056 hrs
Drainage Area = 13.300 acres  Runoff CN= 84

============================================
Computational Time Increment   =   .06741 hrs
Computed Peak Time             =  12.2021 hrs
Computed Peak Flow             =    30.71 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.2000 hrs
Peak Flow, Interpolated Output =    30.69 cfs
============================================

                DRAINAGE AREA
              -------------------
              ID:PHASE 3+4 NE
              CN   =   84
              Area =      13.300 acres
              S    =   1.9048 in
              0.2S =    .3810 in

               Cumulative Runoff
              -------------------
                      2.7267 in
                       3.022 ac-ft

HYG Volume...          3.022 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .50561 hrs (ID: PHASE 3+4 NE)
Computational Incr, Tm =   .06741 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,           qp =    29.80 cfs
Unit peak time       Tp =   .33707 hrs
Unit receding limb, Tr =  1.34829 hrs
Total unit time,     Tb =  1.68537 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration       = 24.0000 hrs     Rain Depth = 5.1000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID = work_pad.hyg - PHASE 3+4 NE Dev100
Tc             = .5056 hrs
Drainage Area = 13.300 acres  Runoff CN= 84

============================================
Computational Time Increment   =   .06741 hrs
Computed Peak Time             =  12.2021 hrs
Computed Peak Flow             =    37.72 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.2000 hrs
Peak Flow, Interpolated Output =    37.70 cfs
============================================

              DRAINAGE AREA
             -------------------
             ID:PHASE 3+4 NE
             CN   =   84
             Area =      13.300 acres
             S    =   1.9048 in
             0.2S =    .3810 in

              Cumulative Runoff
             -------------------
                     3.3620 in
                      3.726 ac-ft

HYG Volume...           3.726 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .50561 hrs (ID: PHASE 3+4 NE)
Computational Incr, Tm =   .06741 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,          qp =    29.80 cfs
Unit peak time      Tp =   .33707 hrs
Unit receding limb, Tr =  1.34829 hrs
Total unit time,    Tb =  1.68537 hrs
```

Runoff Calculation

Phase 3 & 4 Southwest Drainage Area

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Southwest Area	84	32.000			84.00
COMPOSITE AREA & WEIGHTED CN --->		32.000			84.00 (84)

Table of Contents

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: TR-55 Sheet

Mannings n	.2400	
Hydraulic Length	130.00	ft
2yr, 24hr P	2.5000	in
Slope	.030000	ft/ft
Avg.Velocity	.13	ft/sec

Segment #1 Time: .2822 hrs

Segment #2: Tc: TR-55 Sheet

Mannings n	.2400	
Hydraulic Length	30.00	ft
2yr, 24hr P	2.5000	in
Slope	.250000	ft/ft
Avg.Velocity	.22	ft/sec

Segment #2 Time: .0374 hrs

Segment #3: Tc: TR-55 Channel

Flow Area	5.9000	sq.ft
Wetted Perimeter	13.60	ft
Hydraulic Radius	.43	ft
Slope	.015000	ft/ft
Mannings n	.0350	
Hydraulic Length	940.00	ft
Avg.Velocity	2.99	ft/sec

Segment #3 Time: .0874 hrs

Segment #4: Tc: TR-55 Channel

Flow Area	5.9000 sq.ft
Wetted Perimeter	13.60 ft
Hydraulic Radius	.43 ft
Slope	.014000 ft/ft
Mannings n	.0350
Hydraulic Length	1300.00 ft
Avg.Velocity	2.89 ft/sec

Segment #4 Time: .1251 hrs

Segment #5: Tc: TR-55 Channel

Flow Area	13.5000 sq.ft
Wetted Perimeter	16.30 ft
Hydraulic Radius	.83 ft
Slope	.003300 ft/ft
Mannings n	.0350
Hydraulic Length	1900.00 ft
Avg.Velocity	2.16 ft/sec

Segment #5 Time: .2447 hrs

Total Tc: .7768 hrs

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 year storm
Duration       = 24.0000 hrs     Rain Depth = 4.4000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID = work_pad.hyg - PHASE 3+4 SW Dev 25
Tc             = .7768 hrs
Drainage Area = 32.000 acres  Runoff CN= 84

============================================
Computational Time Increment   =   .10358 hrs
Computed Peak Time             =  12.3255 hrs
Computed Peak Flow             =    55.83 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.3500 hrs
Peak Flow, Interpolated Output =    55.41 cfs
============================================

                  DRAINAGE AREA
                 -------------------
                 ID:PHASE 3+4 SW
                 CN   =   84
                 Area =       32.000 acres
                 S    =   1.9048 in
                 0.2S =    .3810 in

                  Cumulative Runoff
                 -------------------
                         2.7267 in
                          7.271 ac-ft

HYG Volume...            7.269 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .77682 hrs (ID: PHASE 3+4 SW)
Computational Incr, Tm =   .10358 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,          qp =     46.67 cfs
Unit peak time      Tp =    .51788 hrs
Unit receding limb, Tr =  2.07151 hrs
Total unit time,    Tb =  2.58939 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration      = 24.0000 hrs    Rain Depth = 5.1000 in
Rain Dir      = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir       = I:\3391\Calculations\Stormwater\
HYG File - ID = work_pad.hyg - PHASE 3+4 SW Dev100
Tc            = .7768 hrs
Drainage Area = 32.000 acres  Runoff CN= 84

============================================
Computational Time Increment   =   .10358 hrs
Computed Peak Time             =  12.3255 hrs
Computed Peak Flow             =    68.81 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.3500 hrs
Peak Flow, Interpolated Output =    68.24 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:PHASE 3+4 SW
              CN   =   84
              Area =      32.000 acres
              S    =   1.9048 in
              0.2S =    .3810 in

               Cumulative Runoff
              -------------------
                      3.3620 in
                       8.965 ac-ft

HYG Volume...          8.963 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .77682 hrs (ID: PHASE 3+4 SW)
Computational Incr, Tm =   .10358 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,            qp =    46.67 cfs
Unit peak time        Tp =   .51788 hrs
Unit receding limb, Tr =  2.07151 hrs
Total unit time,      Tb =  2.58939 hrs
```

Detention / Sedimentation Basin Routing
Existing Outlet Structure

~~8~~ 22

File.... I:\3391\Calculations\Stormwater\Final Grades.ppw

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
681.46	-----	2.7500	.0000	.000	.000
682.00	-----	2.8800	8.4442	1.520	1.520
684.00	-----	3.2100	9.1305	6.087	7.607
686.00	-----	4.0000	10.7933	7.196	14.802

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

REQUESTED POND WS ELEVATIONS:

Min. Elev.=	681.46 ft
Increment =	.10 ft
Max. Elev.=	686.00 ft

****
OUTLET CONNECTIVITY
****

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Orifice-Area	O4	--->	C0	682.000	686.000
Orifice-Area	O5	--->	C0	682.250	686.000
Orifice-Area	O1	--->	C0	682.500	686.000
Orifice-Area	O6	--->	C0	682.750	686.000
Orifice-Area	O2	--->	C0	683.000	686.000
Orifice-Area	O7	--->	C0	683.250	686.000
Orifice-Area	O3	--->	C0	683.500	686.000
Stand Pipe	R0	--->	C0	684.030	686.000
Orifice-Area	O0	--->	C0	681.830	686.000
Culvert-Circular	C0	--->	TW	681.460	686.000
Weir-Rectangular	W0	--->	TW	685.000	686.000
TW SETUP, DS Channel					

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = O4
Structure Type     = Orifice-Area
------------------------------------
# of Openings      =       4
Invert Elev.       =    682.00 ft
Area               =     .0210 sq.ft
Top of Orifice     =       .00 ft
Datum Elev.        =    682.00 ft
Orifice Coeff.     =      .700


Structure ID       = O5
Structure Type     = Orifice-Area
------------------------------------
# of Openings      =       4
Invert Elev.       =    682.25 ft
Area               =     .0210 sq.ft
Top of Orifice     =       .00 ft
Datum Elev.        =    682.25 ft
Orifice Coeff.     =      .700


Structure ID       = O1
Structure Type     = Orifice-Area
------------------------------------
# of Openings      =       4
Invert Elev.       =    682.50 ft
Area               =     .0210 sq.ft
Top of Orifice     =       .00 ft
Datum Elev.        =    682.50 ft
Orifice Coeff.     =      .700
```

OUTLET STRUCTURE INPUT DATA

Structure ID = O6
Structure Type = Orifice-Area

# of Openings	=	4
Invert Elev.	=	682.75 ft
Area	=	.0210 sq.ft
Top of Orifice	=	.00 ft
Datum Elev.	=	682.75 ft
Orifice Coeff.	=	.700

Structure ID = O2
Structure Type = Orifice-Area

# of Openings	=	4
Invert Elev.	=	683.00 ft
Area	=	.0210 sq.ft
Top of Orifice	=	.00 ft
Datum Elev.	=	683.00 ft
Orifice Coeff.	=	.700

Structure ID = O7
Structure Type = Orifice-Area

# of Openings	=	4
Invert Elev.	=	683.25 ft
Area	=	.0210 sq.ft
Top of Orifice	=	.00 ft
Datum Elev.	=	683.25 ft
Orifice Coeff.	=	.700

Structure ID = O3
Structure Type = Orifice-Area

# of Openings	=	4
Invert Elev.	=	683.50 ft
Area	=	.0210 sq.ft
Top of Orifice	=	.00 ft
Datum Elev.	=	683.50 ft
Orifice Coeff.	=	.700

OUTLET STRUCTURE INPUT DATA

Structure ID = R0
Structure Type = Stand Pipe

# of Openings	=	1
Invert Elev.	=	684.03 ft
Diameter	=	2.0000 ft
Orifice Area	=	3.1416 sq.ft
Orifice Coeff.	=	.700
Weir Length	=	6.28 ft
Weir Coeff.	=	3.300
K, Reverse	=	1.000
Mannings n	=	.0000
Kev,Charged Riser	=	.000
Weir Submergence	=	No

Structure ID = O0
Structure Type = Orifice-Area

# of Openings	=	4
Invert Elev.	=	681.83 ft
Area	=	.0210 sq.ft
Top of Orifice	=	.00 ft
Datum Elev.	=	681.83 ft
Orifice Coeff.	=	.700

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = C0
Structure Type     = Culvert-Circular
------------------------------------
No. Barrels        =        1
Barrel Diameter    =   2.0000 ft
Upstream Invert    =   681.46 ft
Dnstream Invert    =   681.05 ft
Horiz. Length      =    30.00 ft
Barrel Length      =    30.00 ft
Barrel Slope       =   .01367 ft/ft

OUTLET CONTROL DATA...
Mannings n         =    .0240
Ke                 =    .5000  (forward entrance loss)
Kb                 =  .042300  (per ft of full flow)
Kr                 =    .5000  (reverse entrance loss)
HW Convergence     =     .001  +/- ft

INLET CONTROL DATA...
Equation form      =        1
Inlet Control K    =    .0078
Inlet Control M    =   2.0000
Inlet Control c    =   .03790
Inlet Control Y    =    .6900
T1 ratio (HW/D)    =    1.129
T2 ratio (HW/D)    =    1.290
Slope Factor       =    -.500
```

```
Use unsubmerged inlet control Form 1 equ. below T1 elev.
Use   submerged inlet control Form 1 equ. above T2 elev.

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...
At T1 Elev =    683.72 ft  ---> Flow =     15.55 cfs
At T2 Elev =    684.04 ft  ---> Flow =     17.77 cfs
```

```
OUTLET STRUCTURE INPUT DATA


Structure ID       = W0
Structure Type     = Weir-Rectangular
-----------------------------------
# of Openings      =        1
Crest Elev.        =    685.00 ft
Weir Length        =     25.00 ft
Weir Coeff.        =  2.630000

Weir TW effects      (Use adjustment equation)



Structure ID       = TW
Structure Type     = TW SETUP, DS Channel
-----------------------------------
FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations=    40
Min. TW tolerance =    .01 ft
Max. TW tolerance =    .01 ft
Min. HW tolerance =    .01 ft
Max. HW tolerance =    .01 ft
Min.  Q tolerance =    .00 cfs
Max.  Q tolerance =    .00 cfs
```

```
                    LEVEL POOL ROUTING SUMMARY

 HYG Dir           = I:\3391\Calculations\Stormwater\
 Inflow  HYG file = work_pad.hyg - DET / SED    IN  Dev 25
 Outflow HYG file = work_pad.hyg - DET / SED    OUT Dev 25

 Pond Node    Data = DET / SED
 Pond Volume Data = DET / SED
 Pond Outlet Data = Existing Outlet

 No Infiltration

 INITIAL CONDITIONS
 ----------------------------------
 Starting WS Elev    =   681.46 ft
 Starting Volume     =     .000 ac-ft
 Starting Outflow    =      .00 cfs
 Starting Infiltr.   =      .00 cfs
 Starting Total Qout=      .00 cfs
 Time Increment      =    .0500 hrs


 INFLOW/OUTFLOW HYDROGRAPH SUMMARY
 =====================================================
 Peak Inflow       =    188.91 cfs    at   12.2500 hrs
 Peak Outflow      =     37.26 cfs    at   13.2000 hrs
 -----------------------------------------------------
 Peak Elevation    =    685.37 ft
 Peak Storage =         12.365 ac-ft
 =====================================================


 MASS BALANCE (ac-ft)
 --------------------------
+ Initial Vol   =        .000
+ HYG Vol IN    =      22.357
- Infiltration =        .000
- HYG Vol OUT   =      21.085
- Retained Vol =       1.272
                   ----------
 Unrouted Vol =       -.000 ac-ft  (.002% of Inflow Volume)


 WARNING: Outflow hydrograph truncated on right side.
```

Peak WATER Elevation is Above 685.0, the level of the emergency Spillway. A new outlet Design is Required.

LEVEL POOL ROUTING SUMMARY

```
HYG Dir            = I:\3391\Calculations\Stormwater\
Inflow  HYG file = work_pad.hyg - DET / SED    IN  Dev100
Outflow HYG file = work_pad.hyg - DET / SED    OUT Dev100

Pond Node   Data = DET / SED
Pond Volume Data = DET / SED
Pond Outlet Data = Existing Outlet

No Infiltration

INITIAL CONDITIONS
----------------------------------
Starting WS Elev    =   681.46 ft
Starting Volume     =     .000 ac-ft
Starting Outflow    =      .00 cfs
Starting Infiltr.   =      .00 cfs
Starting Total Qout=       .00 cfs
Time Increment      =    .0500 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY
=====================================================
Peak Inflow       =    232.63 cfs    at   12.2500 hrs
Peak Outflow      =     71.28 cfs    at   12.9000 hrs
-----------------------------------------------------
Peak Elevation    =    685.79 ft
Peak Storage =         13.979 ac-ft
=====================================================

MASS BALANCE (ac-ft)
--------------------------
+ Initial Vol   =        .000
+ HYG Vol IN    =      27.565
- Infiltration =         .000
- HYG Vol OUT   =      26.281
- Retained Vol =        1.284
                   ----------
Unrouted Vol =         -.000 ac-ft  (.001% of Inflow Volume)

WARNING: Outflow hydrograph truncated on right side.
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 year storm
Duration       = 24.0000 hrs     Rain Depth = 4.4000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID = work_pad.hyg - PHASE 3+4 SW Dev 25
Tc             = .7768 hrs
Drainage Area = 14.800 acres  Runoff CN= 84
```

PHASE 3 MOD 1+2
AND PHASE 4-MOD1

```
============================================
Computational Time Increment   =   .10358 hrs
Computed Peak Time             =  12.3255 hrs
Computed Peak Flow             =    25.82 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.3500 hrs
Peak Flow, Interpolated Output =    25.63 cfs
============================================

                DRAINAGE AREA
             -------------------
             ID:PHASE 3+4 SW
             CN   =   84
             Area =      14.800 acres
             S    =   1.9048 in
             0.2S =    .3810 in

              Cumulative Runoff
             -------------------
                    2.7267 in
                     3.363 ac-ft

HYG Volume...           3.362 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .77682 hrs (ID: PHASE 3+4 SW)
Computational Incr, Tm =   .10358 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,           qp =    21.59 cfs
Unit peak time       Tp =   .51788 hrs
Unit receding limb,  Tr =  2.07151 hrs
Total unit time,     Tb =  2.58939 hrs
```

```
                  LEVEL POOL ROUTING SUMMARY

 HYG Dir           = I:\3391\Calculations\Stormwater\
 Inflow  HYG file = work_pad.hyg - DET / SED    IN  Dev 25
 Outflow HYG file = work_pad.hyg - DET / SED    OUT Dev 25

 Pond Node   Data = DET / SED
 Pond Volume Data = DET / SED
 Pond Outlet Data = Existing Outlet

 No Infiltration

 INITIAL CONDITIONS
 ----------------------------------
 Starting WS Elev   =    681.46 ft
 Starting Volume    =      .000 ac-ft
 Starting Outflow   =       .00 cfs
 Starting Infiltr.  =       .00 cfs
 Starting Total Qout=       .00 cfs
 Time Increment     =     .0500 hrs

 INFLOW/OUTFLOW HYDROGRAPH SUMMARY
 =====================================================
 Peak Inflow       =    160.65 cfs    at   12.2500 hrs
 Peak Outflow      =     19.77 cfs    at   13.6000 hrs
 -----------------------------------------------------
 Peak Elevation    =    684.98 ft                       <- PEAK WATER ELEV.
 Peak Storage =         10.946 ac-ft                       25-yr STORM
 =====================================================

 MASS BALANCE (ac-ft)
 --------------------------
+ Initial Vol   =       .000
+ HYG Vol IN    =     18.450
- Infiltration  =       .000
- HYG Vol OUT   =     17.183
- Retained Vol  =      1.266
                  ----------
  Unrouted Vol =       -.000 ac-ft  (.002% of Inflow Volume)

 WARNING: Outflow hydrograph truncated on right side.
```

LEVEL POOL ROUTING SUMMARY

```
HYG Dir           = I:\3391\Calculations\Stormwater\
Inflow  HYG file  = work_pad.hyg - DET / SED    IN  Dev100
Outflow HYG file  = work_pad.hyg - DET / SED    OUT Dev100

Pond Node    Data = DET / SED
Pond Volume  Data = DET / SED
Pond Outlet  Data = Existing Outlet

No Infiltration

INITIAL CONDITIONS
----------------------------------
Starting WS Elev   =   681.46 ft
Starting Volume    =     .000 ac-ft
Starting Outflow   =      .00 cfs
Starting Infiltr.  =      .00 cfs
Starting Total Qout=      .00 cfs
Time Increment     =    .0500 hrs


INFLOW/OUTFLOW HYDROGRAPH SUMMARY
=====================================================
Peak Inflow    =   197.69 cfs   at   12.2500 hrs
Peak Outflow   =    41.57 cfs   at   13.1000 hrs
-----------------------------------------------------
Peak Elevation =   685.43 ft
Peak Storage =     12.598 ac-ft
=====================================================
```

← PEAK WATER ELEV.
100-yr STORM

```
MASS BALANCE (ac-ft)
--------------------------
+ Initial Vol  =       .000
+ HYG Vol IN   =     22.748
- Infiltration =       .000
- HYG Vol OUT  =     21.470
- Retained Vol =      1.278
                 ----------
Unrouted Vol =        -.000 ac-ft  (.001% of Inflow Volume)


WARNING: Outflow hydrograph truncated on right side.
```

Detention / Sedimentation Basin Routing
Proposed Outlet Structure

File.... I:\3391\Calculations\Stormwater\Final Grades-new outlet.ppw

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 681.00 ft
Increment = .10 ft
Max. Elev.= 686.00 ft

****
OUTLET CONNECTIVITY
****

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Orifice-Circular	O1	--->	C0	681.750	686.000
Orifice-Circular	O4	--->	C0	682.250	686.000
Orifice-Circular	O5	--->	C0	682.750	686.000
Orifice-Circular	O2	--->	C0	683.250	686.000
Stand Pipe	R0	--->	C0	684.250	686.000
Orifice-Circular	O0	--->	C0	681.250	686.000
Culvert-Circular	C0	--->	TW	681.000	686.000
Weir-Rectangular	W0	--->	TW	685.000	686.000
TW SETUP, DS Channel					

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = O1
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =        4
Invert Elev.       =    681.75 ft
Diameter           =     .5000 ft
Orifice Coeff.     =      .700


Structure ID       = O4
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =        4
Invert Elev.       =    682.25 ft
Diameter           =     .5000 ft
Orifice Coeff.     =      .700


Structure ID       = O5
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =        4
Invert Elev.       =    682.75 ft
Diameter           =     .5000 ft
Orifice Coeff.     =      .700


Structure ID       = O2
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =        4
Invert Elev.       =    683.25 ft
Diameter           =     .5000 ft
Orifice Coeff.     =      .700
```

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = R0
Structure Type     = Stand Pipe
------------------------------------
# of Openings      =        1
Invert Elev.       =    684.25 ft
Diameter           =    3.0000 ft
Orifice Area       =    7.0686 sq.ft
Orifice Coeff.     =      .700
Weir Length        =      9.42 ft
Weir Coeff.        =     3.300
K, Reverse         =     1.000
Mannings n         =     .0000
Kev,Charged Riser  =      .000
Weir Submergence   = No


Structure ID       = O0
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =        4
Invert Elev.       =    681.25 ft
Diameter           =     .5000 ft
Orifice Coeff.     =      .700
```

```
OUTLET STRUCTURE INPUT DATA


Structure ID        = C0
Structure Type      = Culvert-Circular
------------------------------------
No. Barrels         =        1
Barrel Diameter     =    3.0000 ft
Upstream Invert     =    681.00 ft
Dnstream Invert     =    680.50 ft
Horiz. Length       =     30.00 ft
Barrel Length       =     30.00 ft
Barrel Slope        =    .01667 ft/ft

OUTLET CONTROL DATA...
Mannings n          =     .0240
Ke                  =     .5000  (forward entrance loss)
Kb                  =   .024635  (per ft of full flow)
Kr                  =     .5000  (reverse entrance loss)
HW Convergence      =      .001  +/- ft

INLET CONTROL DATA...
Equation form       =        1
Inlet Control K     =     .0078
Inlet Control M     =    2.0000
Inlet Control c     =    .03790
Inlet Control Y     =     .6900
T1 ratio (HW/D)     =      .000
T2 ratio (HW/D)     =     1.288
Slope Factor        =     -.500

Use unsubmerged inlet control Form 1 equ. below T1 elev.
Use   submerged inlet control Form 1 equ. above T2 elev.

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...
At T1 Elev =     681.00 ft  --->  Flow =     42.85 cfs
At T2 Elev =     684.86 ft  --->  Flow =     48.97 cfs
```

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = WO
Structure Type     = Weir-Rectangular
------------------------------------
# of Openings      =         1
Crest Elev.        =    685.00 ft
Weir Length        =     25.00 ft
Weir Coeff.        =  2.630000

Weir TW effects      (Use adjustment equation)
```

```
Structure ID       = TW
Structure Type     = TW SETUP, DS Channel
------------------------------------
FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations=    40
Min. TW tolerance =    .01 ft
Max. TW tolerance =    .01 ft
Min. HW tolerance =    .01 ft
Max. HW tolerance =    .01 ft
Min.  Q tolerance =    .00 cfs
Max.  Q tolerance =    .00 cfs
```

```
                  LEVEL POOL ROUTING SUMMARY

HYG Dir           = I:\3391\Calculations\Stormwater\
Inflow  HYG file = work_pad.hyg - DET / SED    IN  Dev 25
Outflow HYG file = work_pad.hyg - DET / SED    OUT Dev 25

Pond Node   Data = DET / SED
Pond Volume Data = DET / SED
Pond Outlet Data = Proposed Outlet

No Infiltration

INITIAL CONDITIONS
---------------------------------
Starting WS Elev    =   681.25 ft
Starting Volume     =     .692 ac-ft
Starting Outflow    =      .00 cfs
Starting Infiltr.   =      .00 cfs
Starting Total Qout=       .00 cfs
Time Increment      =    .0500 hrs


INFLOW/OUTFLOW HYDROGRAPH SUMMARY
==================================================
Peak Inflow        =   188.91 cfs    at   12.2500 hrs
Peak Outflow       =    38.05 cfs    at   13.2000 hrs
--------------------------------------------------
Peak Elevation     =   684.99 ft
Peak Storage =         12.276 ac-ft
==================================================
```

Peak Water Elevation
25-yr storm

```
MASS BALANCE (ac-ft)
--------------------------
+ Initial Vol   =        .692
+ HYG Vol IN    =      22.357
- Infiltration =         .000
- HYG Vol OUT   =      22.241
- Retained Vol =         .807
                   ----------
Unrouted Vol =        -.000 ac-ft  (.000% of Inflow Volume)


WARNING: Outflow hydrograph truncated on right side.
```

LEVEL POOL ROUTING SUMMARY

```
HYG Dir           = I:\3391\Calculations\Stormwater\
Inflow  HYG file = work_pad.hyg - DET / SED    IN  Dev100
Outflow HYG file = work_pad.hyg - DET / SED    OUT Dev100

Pond Node   Data = DET / SED
Pond Volume Data = DET / SED
Pond Outlet Data = Proposed Outlet

No Infiltration

INITIAL CONDITIONS
----------------------------------
Starting WS Elev   =   681.25 ft
Starting Volume    =     .692 ac-ft
Starting Outflow   =      .00 cfs
Starting Infiltr.  =      .00 cfs
Starting Total Qout=      .00 cfs
Time Increment     =    .0500 hrs

INFLOW/OUTFLOW HYDROGRAPH SUMMARY
=====================================================
Peak Inflow      =   232.63 cfs   at   12.2500 hrs
Peak Outflow     =    73.09 cfs   at   12.9000 hrs
-----------------------------------------------------
Peak Elevation   =   685.45 ft
Peak Storage =       13.977 ac-ft
=====================================================
```

← Peak water Elevation 100-yr storm

```
  MASS BALANCE (ac-ft)
  --------------------------
+ Initial Vol   =        .692
+ HYG Vol IN    =      27.565
- Infiltration  =        .000
- HYG Vol OUT   =      27.448
- Retained Vol  =        .809
                   ----------
  Unrouted Vol  =       -.000 ac-ft   (.000% of Inflow Volume)

  WARNING: Outflow hydrograph truncated on right side.
```

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0500 hrs
Time on left represents time for first value in each row.

Time hrs					
69.7000	.08	.08	.08	.08	.08
69.9500	.08	.08	.08	.08	.08
70.2000	.08	.08	.08	.08	.08
70.4500	.08	.08	.08	.08	.08
70.7000	.08	.08	.08	.08	.08
70.9500	.08	.08	.08	.08	.08
71.2000	.08	.08	.08	.08	.08
71.4500	.07	.07	.07	.07	.07
71.7000	.07	.07	.07	.07	.07
71.9500	.07	.07	.07	.07	.07
72.2000	.07	.07	.07	.07	.07
72.4500	.07	.07	.07	.07	.07
72.7000	.07	.07	.07	.07	.07
72.9500	.07	.07	.07	.07	.07
73.2000	.07	.07	.07	.07	.07
73.4500	.07	.07	.07	.07	.07
73.7000	.07	.07	.07	.07	.07
73.9500	.07	.07	.07	.06	.06
74.2000	.06	.06	.06	.06	.06
74.4500	.06	.06	.06	.06	.06
74.7000	.06	.06	.06	.06	.06
74.9500	.06	.06	.06	.06	.06
75.2000	.06	.06	.06	.06	.06
75.4500	.06	.06	.06	.06	.06
75.7000	.06	.06	.06	.06	.06
75.9500	.06	.06	.06	.06	.06
76.2000	.06	.06	.06	.06	.06
76.4500	.06	.06	.06	.06	.06
76.7000	.06	.06	.06	.06	.06
76.9500	.06	.06	.06	.06	.06
77.2000	.05	.05	.05	.05	.05
77.4500	.05	.05	.05	.05	.05
77.7000	.05	.05	.05	.05	.05
77.9500	.05	.05	.05	.05	.05
78.2000	.05	.05	.05	.05	.05
78.4500	.05	.05	.05	.05	.05
78.7000	.05	.05	.05	.05	.05
78.9500	.05	.05	.05	.05	.05
79.2000	.05	.05	.05	.05	.05
79.4500	.05	.05	.05	.05	.05
79.7000	.05	.05	.05	.05	.05
79.9500	.05	.05	.05	.05	.05
80.2000	.05	.05	.05	.05	.05
80.4500	.05	.05	.05	.05	.05
80.7000	.05	.05	.05	.05	.04

72.0 Hr

OUTFLOW AT 72.0 HRS (3 Days) = 0.07 CFS

∴ BASIN TAKES MORE THAN 3 DAYS TO DRAIN.

Detention Basin Routing

File.... I:\3391\Calculations\Stormwater\off-site.ppw

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Off-site	79	91.000			79.00
COMPOSITE AREA & WEIGHTED CN --->		91.000			79.00 (79)

Table of Contents (continued)

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

------------------------------------------------------------------------

Segment #1:  Tc: TR-55 Sheet

Mannings n             .2400
Hydraulic Length     400.00 ft
2yr, 24hr P          2.5000 in
Slope               .010000 ft/ft

Avg.Velocity            .10 ft/sec

                                        Segment #1 Time:    1.0763 hrs
------------------------------------------------------------------------

Segment #2:  Tc: TR-55 Channel

Flow Area            5.9000 sq.ft
Wetted Perimeter      13.60 ft
Hydraulic Radius        .43 ft
Slope               .010000 ft/ft
Mannings n             .0350
Hydraulic Length    3600.00 ft

Avg.Velocity           2.44 ft/sec

                                        Segment #2 Time:     .4099 hrs
------------------------------------------------------------------------

                                             =========================
                                              Total Tc:     1.4862 hrs
                                             =========================
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 year storm
Duration       = 24.0000 hrs     Rain Depth = 4.4000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID =  - OFF-SITE AREA 25
Tc             = 1.4862 hrs
Drainage Area = 91.000 acres  Runoff CN= 79

============================================
Computational Time Increment   =   .19816 hrs
Computed Peak Time             =  12.8806 hrs
Computed Peak Flow             =    81.53 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.8500 hrs
Peak Flow, Interpolated Output =    81.27 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:OFF-SITE AREA
              CN   =   79
              Area =       91.000 acres
              S    =   2.6582 in
              0.2S =    .5316 in

               Cumulative Runoff
              -------------------
                      2.2928 in
                      17.387 ac-ft

HYG Volume...         17.386 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =  1.48623 hrs (ID: OFF-SITE AREA)
Computational Incr, Tm =   .19816 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,            qp =    69.38 cfs
Unit peak time        Tp =   .99082 hrs
Unit receding limb, Tr = 3.96327 hrs
Total unit time,      Tb = 4.95408 hrs
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 100 year storm
Duration       = 24.0000 hrs     Rain Depth = 5.1000 in
Rain Dir       = I:\3391\Calculations\Stormwater\
Rain File -ID =  - TypeII  24hr
Unit Hyd Type = Default Curvilinear
HYG Dir        = I:\3391\Calculations\Stormwater\
HYG File - ID =  - OFF-SITE AREA 100
Tc             = 1.4862 hrs
Drainage Area = 91.000 acres  Runoff CN= 79

============================================
Computational Time Increment   =   .19816 hrs
Computed Peak Time             =  12.8806 hrs
Computed Peak Flow             =   103.19 cfs

Time Increment for HYG File    =    .0500 hrs
Peak Time, Interpolated Output =  12.8500 hrs
Peak Flow, Interpolated Output =   102.94 cfs
============================================

              DRAINAGE AREA
              -------------------
              ID:OFF-SITE AREA
              CN   =   79
              Area =       91.000 acres
              S    =   2.6582 in
              0.2S =    .5316 in

              Cumulative Runoff
              -------------------
                      2.8879 in
                      21.900 ac-ft

HYG Volume...         21.899 ac-ft (area under HYG curve)

***** SCS UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =  1.48623 hrs (ID: OFF-SITE AREA)
Computational Incr, Tm =   .19816 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =    .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =   .7491)

Unit peak,           qp =    69.38 cfs
Unit peak time       Tp =   .99082 hrs
Unit receding limb, Tr =  3.96327 hrs
Total unit time,     Tb =  4.95408 hrs
```

Elevation (ft)	Planimeter (sq.in)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	Volume (ac-ft)	Volume Sum (ac-ft)
685.50	-----	2.7000	.0000	.000	.000
686.00	-----	2.8800	8.3685	1.395	1.395
688.00	-----	3.5800	9.6710	6.447	7.842
690.00	-----	4.4900	12.0793	8.053	15.895
692.00	-----	6.5000	16.3923	10.928	26.823

POND VOLUME EQUATIONS

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

where: EL1, EL2 = Lower and upper elevations of the increment
Area1,Area2 = Areas computed for EL1, EL2, respectively
Volume = Incremental volume between EL1 and EL2

REQUESTED POND WS ELEVATIONS:

Min. Elev.= 685.50 ft
Increment = .10 ft
Max. Elev.= 692.00 ft

****
OUTLET CONNECTIVITY
****

---> Forward Flow Only (UpStream to DnStream)
<--- Reverse Flow Only (DnStream to UpStream)
<---> Forward and Reverse Both Allowed

Structure	No.		Outfall	E1, ft	E2, ft
Orifice-Circular	O1	--->	C0	687.000	692.000
Orifice-Circular	O2	--->	C0	687.500	692.000
Orifice-Circular	O3	--->	C0	688.000	692.000
Orifice-Circular	O4	--->	C0	688.500	692.000
Orifice-Circular	O5	--->	C0	689.000	692.000
Stand Pipe	R0	--->	C0	689.880	692.000
Orifice-Circular	O0	--->	C0	686.230	692.000
Culvert-Circular	C0	--->	TW	685.500	692.000
Weir-Rectangular	W0	--->	TW	692.000	692.000
TW SETUP, DS Channel					

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = O1
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =         3
Invert Elev.       =    687.00 ft
Diameter           =     .0810 ft
Orifice Coeff.     =      .700


Structure ID       = O2
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =         3
Invert Elev.       =    687.50 ft
Diameter           =     .0810 ft
Orifice Coeff.     =      .700


Structure ID       = O3
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =         3
Invert Elev.       =    688.00 ft
Diameter           =     .0810 ft
Orifice Coeff.     =      .070


Structure ID       = O4
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =         3
Invert Elev.       =    688.50 ft
Diameter           =     .0810 ft
Orifice Coeff.     =      .700
```

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = O5
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =        3
Invert Elev.       =    689.00 ft
Diameter           =     .0810 ft
Orifice Coeff.     =      .700


Structure ID       = R0
Structure Type     = Stand Pipe
------------------------------------
# of Openings      =        1
Invert Elev.       =    689.88 ft
Diameter           =    1.5000 ft
Orifice Area       =    1.7671 sq.ft
Orifice Coeff.     =      .700
Weir Length        =      4.71 ft
Weir Coeff.        =     3.300
K, Reverse         =     1.000
Mannings n         =     .0000
Kev,Charged Riser  =      .000
Weir Submergence   = No


Structure ID       = O0
Structure Type     = Orifice-Circular
------------------------------------
# of Openings      =        3
Invert Elev.       =    686.23 ft
Diameter           =     .0810 ft
Orifice Coeff.     =      .700
```

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = CO
Structure Type     = Culvert-Circular
-----------------------------------
No. Barrels        =        1
Barrel Diameter    =    1.5000 ft
Upstream Invert    =    685.50 ft
Dnstream Invert    =    685.00 ft
Horiz. Length      =     65.00 ft
Barrel Length      =     65.00 ft
Barrel Slope       =    .00769 ft/ft

OUTLET CONTROL DATA...
Mannings n         =     .0240
Ke                 =     .5000  (forward entrance loss)
Kb                 =   .062076  (per ft of full flow)
Kr                 =     .5000  (reverse entrance loss)
HW Convergence     =      .001  +/- ft

INLET CONTROL DATA...
Equation form      =        1
Inlet Control K    =     .0078
Inlet Control M    =    2.0000
Inlet Control c    =    .03790
Inlet Control Y    =     .6900
T1 ratio (HW/D)    =     1.132
T2 ratio (HW/D)    =     1.293
Slope Factor       =     -.500
```

Use unsubmerged inlet control Form 1 equ. below T1 elev.
Use   submerged inlet control Form 1 equ. above T2 elev.

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...
At T1 Elev =   687.20 ft   ---> Flow =   7.58 cfs
At T2 Elev =   687.44 ft   ---> Flow =   8.66 cfs

OUTLET STRUCTURE INPUT DATA

```
Structure ID       = W0
Structure Type     = Weir-Rectangular
------------------------------------
# of Openings      =          1
Crest Elev.        =     692.00 ft
Weir Length        =      25.00 ft
Weir Coeff.        =   2.630000

Weir TW effects      (Use adjustment equation)
```

```
Structure ID       = TW
Structure Type     = TW SETUP, DS Channel
------------------------------------
FREE OUTFALL CONDITIONS SPECIFIED

CONVERGENCE TOLERANCES...
Maximum Iterations=     40
Min. TW tolerance =     .01 ft
Max. TW tolerance =     .01 ft
Min. HW tolerance =     .01 ft
Max. HW tolerance =     .01 ft
Min.  Q tolerance =     .00 cfs
Max.  Q tolerance =     .00 cfs
```

LEVEL POOL ROUTING SUMMARY

```
HYG Dir          = I:\3391\Calculations\Stormwater\
Inflow  HYG file = NONE STORED - DETENTION      IN  25
Outflow HYG file = NONE STORED - DETENTION      OUT 25

Pond Node   Data = DETENTION
Pond Volume Data = DETENTION
Pond Outlet Data = Existing Outlet

No Infiltration

INITIAL CONDITIONS
----------------------------------
Starting WS Elev   =   685.50 ft
Starting Volume    =     .000 ac-ft
Starting Outflow   =      .00 cfs
Starting Infiltr.  =      .00 cfs
Starting Total Qout=      .00 cfs
Time Increment     =    .0500 hrs


INFLOW/OUTFLOW HYDROGRAPH SUMMARY
=====================================================
Peak Inflow      =     81.27 cfs    at   12.8500 hrs
Peak Outflow     =      2.30 cfs    at   24.8500 hrs
-----------------------------------------------------
Peak Elevation   =    690.10 ft
Peak Storage =        16.358 ac-ft
=====================================================


MASS BALANCE (ac-ft)
--------------------------
+ Initial Vol  =       .000
+ HYG Vol IN   =     17.386
- Infiltration =       .000
- HYG Vol OUT  =      5.359
- Retained Vol =     12.027
                 ----------
  Unrouted Vol =      -.000 ac-ft  (.000% of Inflow Volume)


WARNING: Outflow hydrograph truncated on right side.
```

```
                    LEVEL POOL ROUTING SUMMARY

 HYG Dir            = I:\3391\Calculations\Stormwater\
 Inflow  HYG file = NONE STORED - DETENTION     IN  100
 Outflow HYG file = NONE STORED - DETENTION     OUT 100

 Pond Node   Data = DETENTION
 Pond Volume Data = DETENTION
 Pond Outlet Data = Existing Outlet

 No Infiltration

 INITIAL CONDITIONS
 ----------------------------------
 Starting WS Elev    =   685.50 ft
 Starting Volume     =     .000 ac-ft
 Starting Outflow    =      .00 cfs
 Starting Infiltr.   =      .00 cfs
 Starting Total Qout=       .00 cfs
 Time Increment      =    .0500 hrs


 INFLOW/OUTFLOW HYDROGRAPH SUMMARY
 ====================================================
 Peak Inflow       =    102.94 cfs    at   12.8500 hrs
 Peak Outflow      =      6.35 cfs    at   19.9000 hrs
 ----------------------------------------------------
 Peak Elevation    =    690.39 ft
 Peak Storage =         17.718 ac-ft
 ====================================================


 MASS BALANCE (ac-ft)
 -------------------------
+ Initial Vol   =        .000
+ HYG Vol IN    =      21.899
- Infiltration =         .000
- HYG Vol OUT   =       9.716
- Retained Vol =       12.182
                    ----------
 Unrouted Vol =        -.000 ac-ft  (.002% of Inflow Volume)


 WARNING: Outflow hydrograph truncated on right side.
```

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0500 hrs
Time on left represents time for first value in each row.

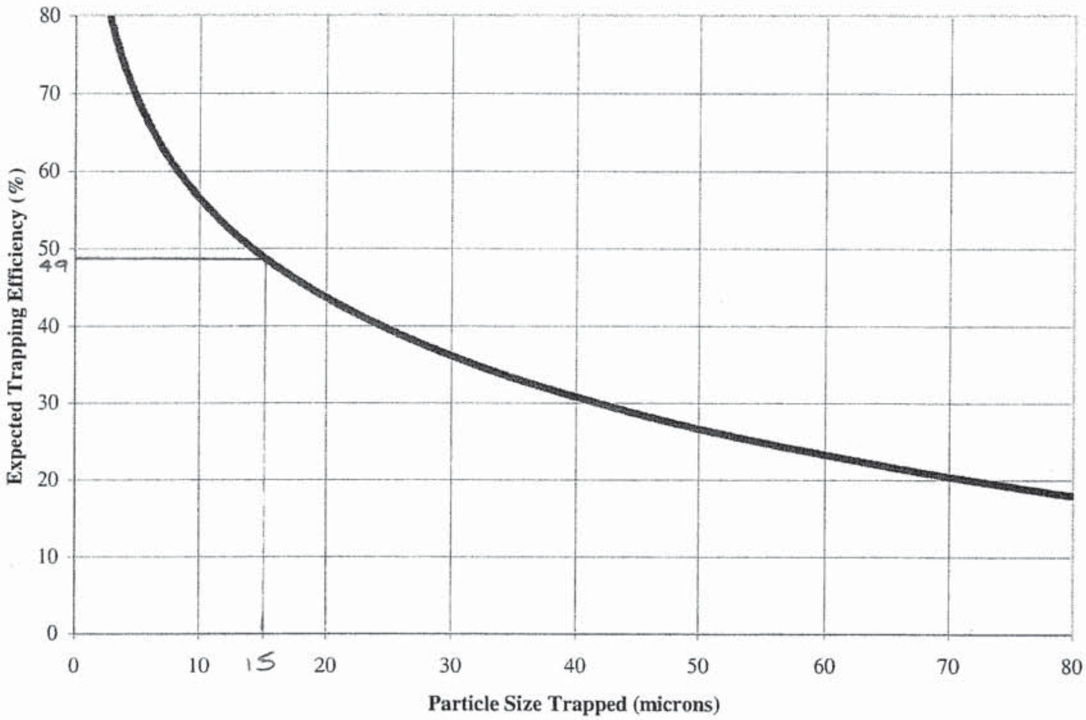
Time hrs					
71.4000	.56	.56	.56	.56	.56
71.6500	.56	.56	.56	.56	.56
71.9000	.56	.56	$\boxed{.56}$	.56	.56
72.1500	.56	.56	.56	.56	.56
72.4000	.56	.56	.56	.56	.56
72.6500	.56	.56	.56	.56	.56
72.9000	.56	.56	.56	.56	.56
73.1500	.56	.56	.56	.56	.56
73.4000	.56	.56	.56	.56	.56
73.6500	.56	.56	.56	.56	.56
73.9000	.56	.56	.56	.56	.56
74.1500	.56	.56	.56	.56	.56
74.4000	.56	.56	.56	.56	.56
74.6500	.56	.56	.56	.56	.56
74.9000	.56	.56	.56	.56	.56
75.1500	.55	.55	.55	.55	.55
75.4000	.55	.55	.55	.55	.55
75.6500	.55	.55	.55	.55	.55
75.9000	.55	.55	.55	.55	.55
76.1500	.55	.55	.55	.55	.55
76.4000	.55	.55	.55	.55	.55
76.6500	.55	.55	.55	.55	.55
76.9000	.55	.55	.55	.55	.55
77.1500	.55	.55	.55	.55	.55
77.4000	.55	.55	.55	.55	.55
77.6500	.55	.55	.55	.55	.55
77.9000	.55	.55	.55	.55	.55
78.1500	.55	.55	.55	.55	.55
78.4000	.55	.55	.55	.55	.55
78.6500	.55	.55	.55	.55	.55
78.9000	.55	.55	.55	.55	.55
79.1500	.55	.55	.55	.55	.55
79.4000	.55	.55	.55	.55	.54
79.6500	.54	.54	.54	.54	.54
79.9000	.54	.54	.54	.54	.54
80.1500	.54	.54	.54	.54	.54
80.4000	.54	.54	.54	.54	.54
80.6500	.54	.54	.54	.54	.54
80.9000	.54	.54	.54	.54	.54
81.1500	.54	.54	.54	.54	.54
81.4000	.54	.54	.54	.54	.54
81.6500	.54	.54	.54	.54	.54
81.9000	.54	.54	.54	.54	.54
82.1500	.54	.54	.54	.54	.54
82.4000	.54	.54	.54	.54	.54

72.0 Hr

OUTFLOW AT 72.0 Hr = 0.56 cfs

∴ BASIN TAKES MORE THAN 3 DAYS TO DRAIN.

Sediment Removal Analysis
(P8 Urban Catchment Model)



Convert the storage volume from the 1-year, 24-hour storm event into cubic feet. This volume of storage is then divided by the time required to settle the particle obtained by Stokes Law.

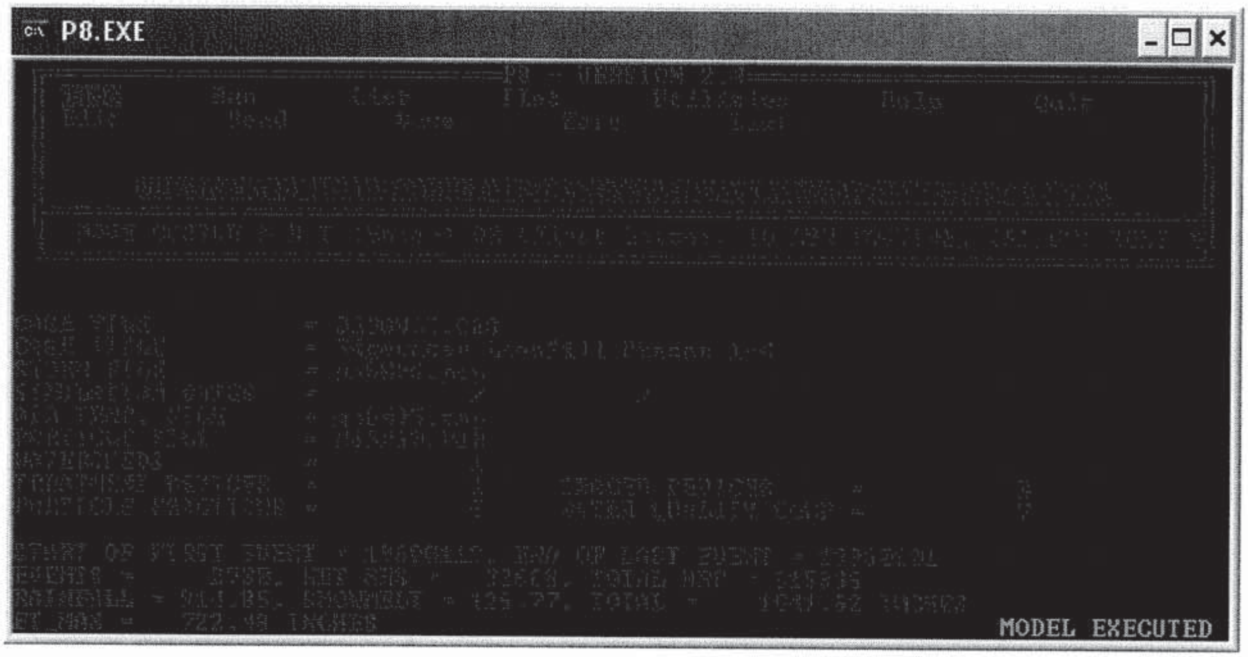
$$Q_{\max imum}(cfs) = \frac{V_{Storage}(ft^3)}{Time(\sec)}$$

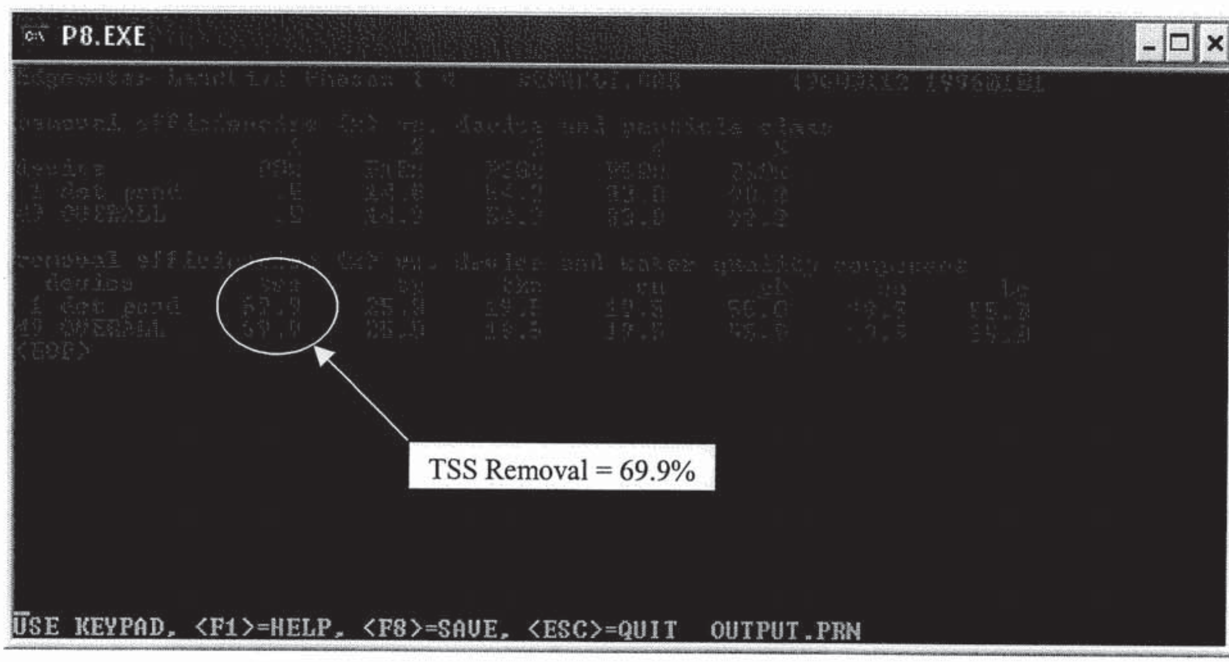
Q $_{maximum}$ is the rate at which the basin must be released in order to obtain the expected efficiency.

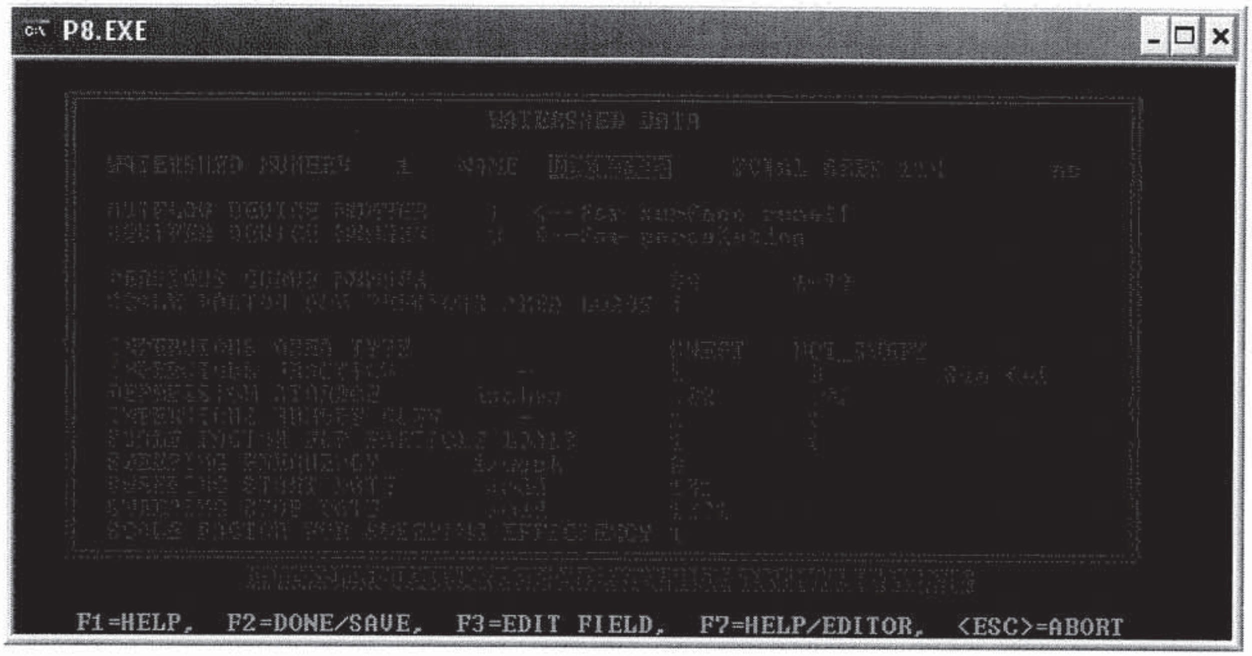
*See table on following page for particle settling velocities to calculate Time (sec)

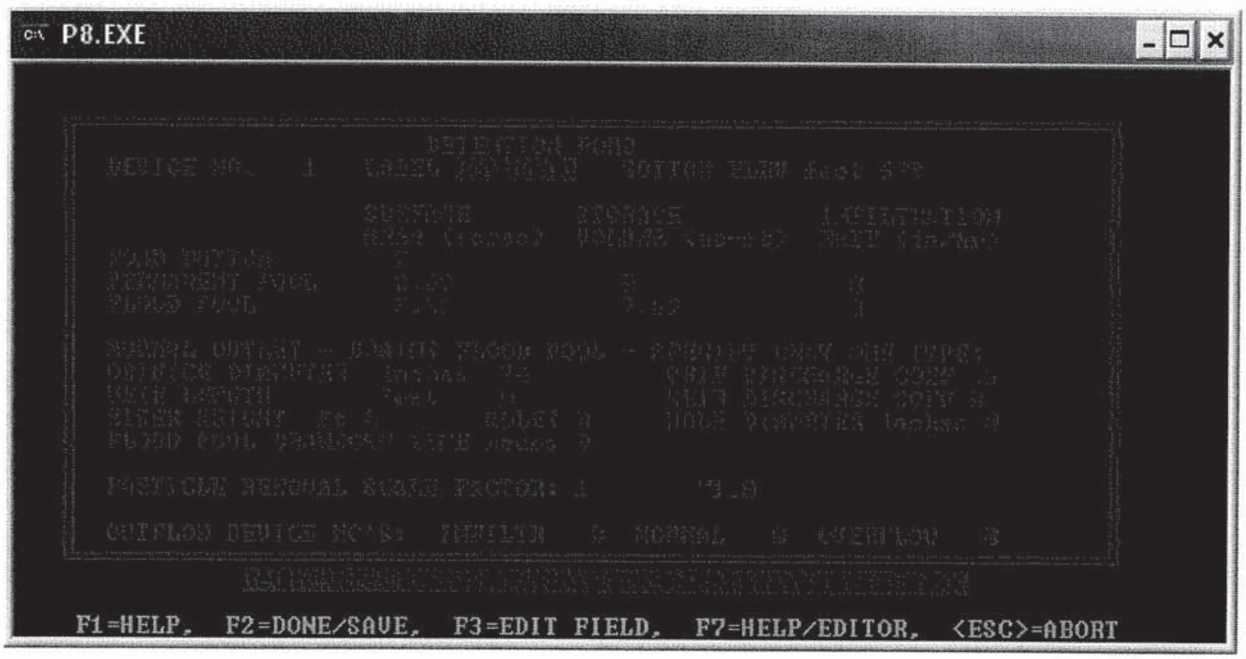
TO Trap the 15 Micron particle, MUST HAVE A Trapping efficiency of at least 49%

P8 - Sediment Removal Analysis
Sedimentation / Detention Basin
Edgewater Landfill









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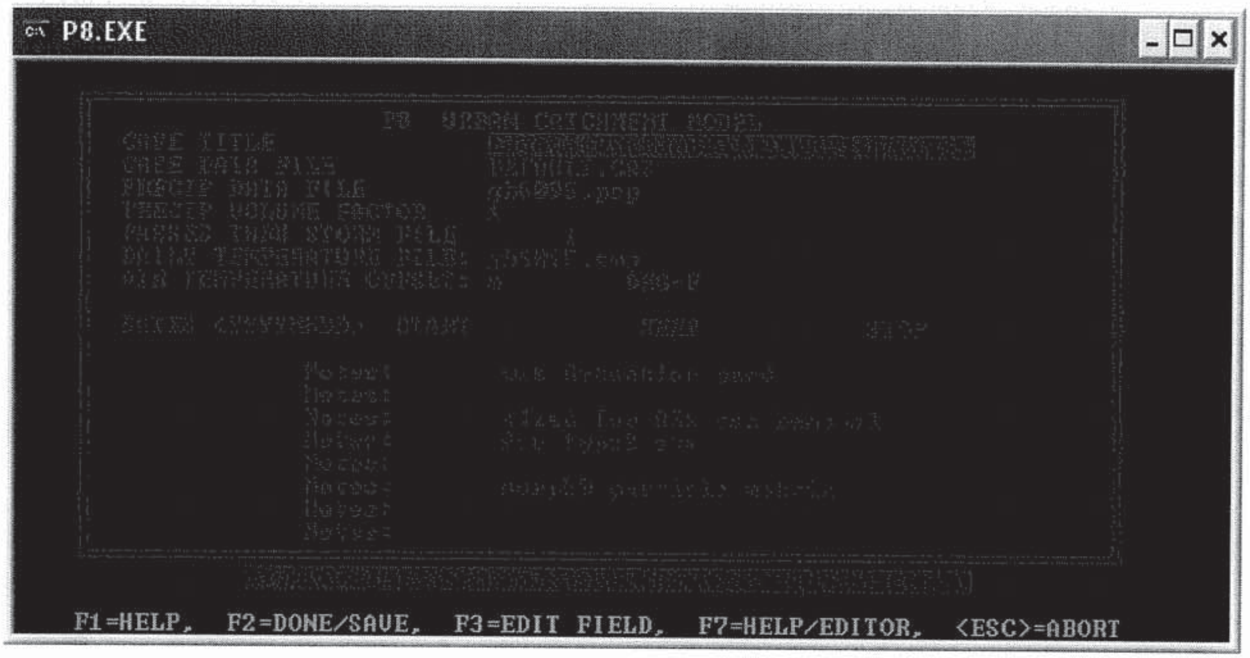
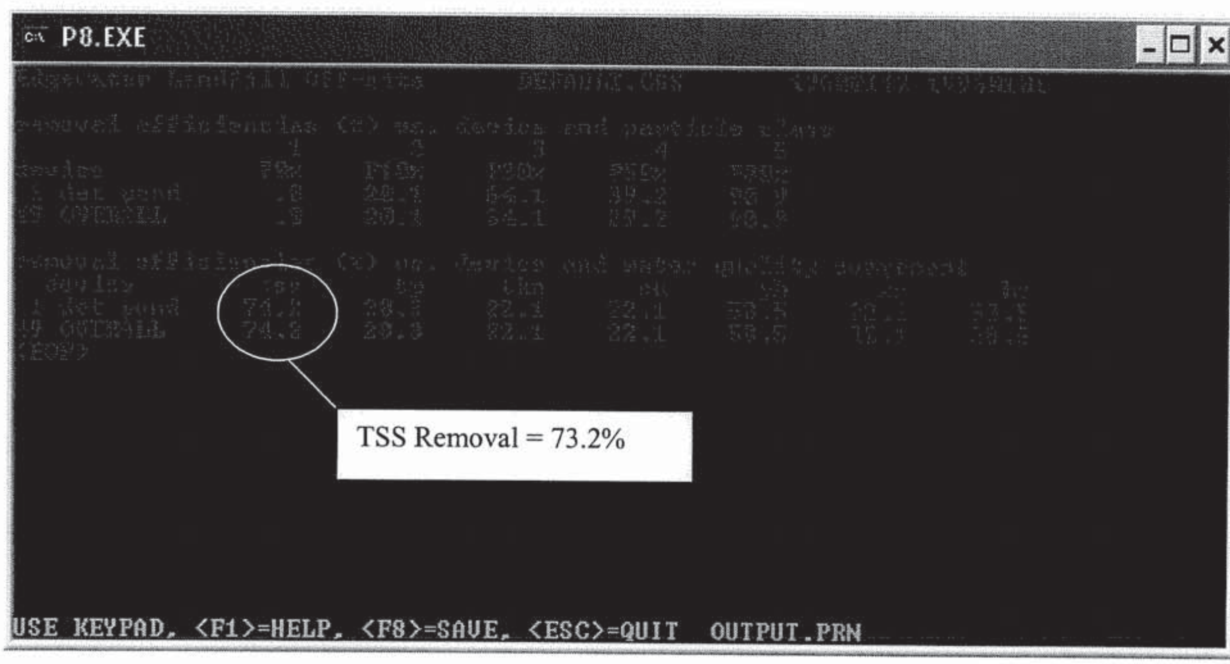
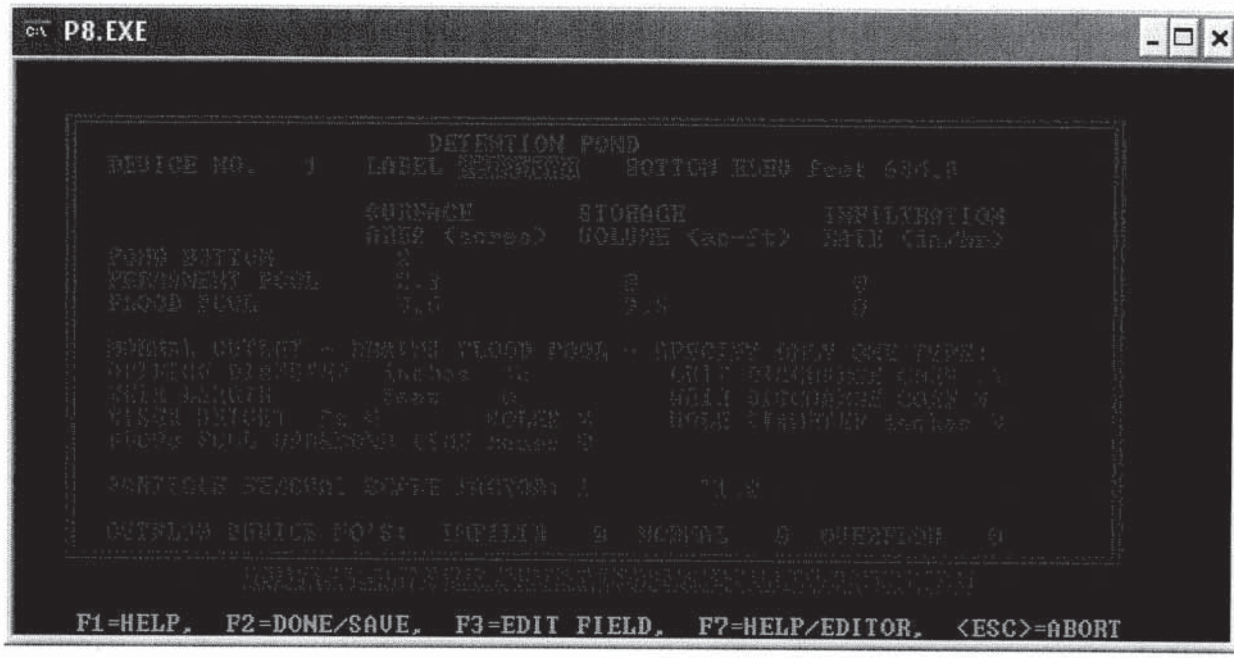
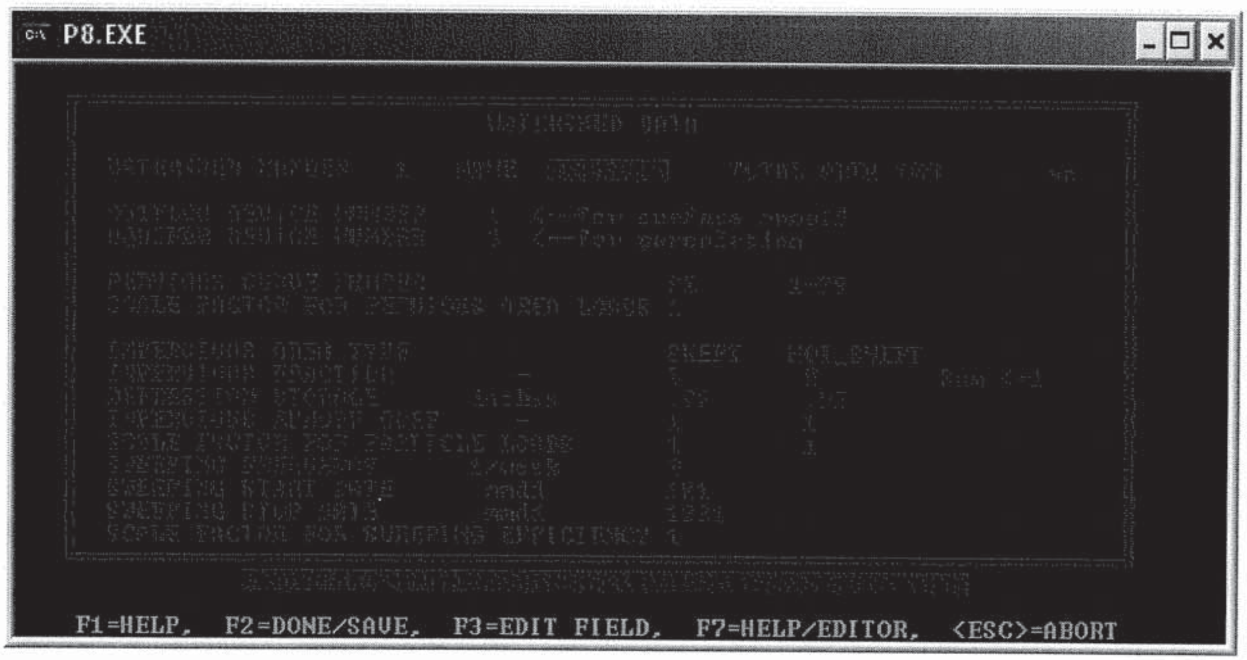
P8 Sediment Removal Analysis
Detention Basin for Off-site Stormwater Runon
Edgewater Landfill









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BT² inc.		Sheet No.	
		Calc. No.	
		Rev. No.	
Job No. 3391	Job Edgewater Landfill	By KRG	Date 12/4/07
Client	Subject	Chk'd.	Date

Another method of checking sediment Removal is to Determine the surface Area of the basin and the discharge. This ratio can be compared to the Table below.

To settle the 0.015 mm particle, A_n min. Ratio of 3125 is required.

TABLE 8.1 Surface Area Requirements of Sediment Traps and Basins

Particle size, mm	Settling velocity, ft/sec (m/sec)	Surface area requirements, ft² per ft³/sec discharge	(m² per m³/sec discharge)
0.5 (coarse sand)	0.19 (0.058)	6.3	(20.7)
0.2 (medium sand)	0.067 (0.020)	17.9	(58.7)
0.1 (fine sand)	0.023 (0.0070)	52.2	(171.0)
0.05 (coarse silt)	0.0062 (0.0019)	193.6	(635.0)
0.02 (medium silt)	0.00096 (0.00029)	1,250.0	(4,101.0)
0.01 (fine silt)	0.00024 (0.000073)	5,000.0	(16,404.0)
0.005 (clay)	0.00006 (0.000018)	20,000.0	(65,617.0)
→ .015		3125.0 ←	

With the proposed outlet, the outlet Flow From the 25-yr storm is 38.05 CFS at a elevation of 684.99. The surface area at this elevation = 3.6 Ac = 156816 Ft²

$$\frac{156816 \text{ Ft}^2}{38.05 \text{ Ft}^3/\text{sec}} = 4121 \frac{\text{Ft}^2}{\text{Ft}^3/\text{sec}}$$

∴ The basin will settle the 0.015 mm particle

Swale and Culvert Calculations

65 ~~10~~

Channel Calculator

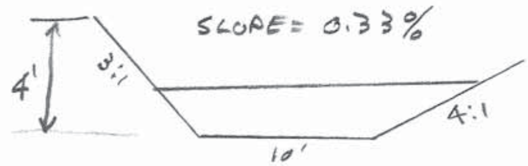
SWALE LOCATED WEST OF PHASES 3+4

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	163.0000 cfs
Slope	0.0033 ft/ft
Manning's n	0.0300
Height	48.0000 in
Bottom width	120.0000 in
Left slope	4.0000 ft/ft (V/H)
Right slope	3.0000 ft/ft (V/H)

Computed Results:

Depth	38.3721 in
Velocity	4.6626 fps
Full Flowrate	230.0749 cfs
Flow area	34.9591 ft2
Flow perimeter	200.0008 in
Hydraulic radius	25.1704 in
Top width	142.3837 in
Area	44.6667 ft2
Perimeter	220.0737 in
Percent full	79.9419 %



25-YR STORM

PHASE 1+2 = 107.2
PHASE 3+4 SW= 55.4
162.6 CFS

SWALE CARRIES FLOW FROM PHASES 1+2 + PHASE 3+4 -SOUTHWEST

MAX FLOW DEPTH = 38.4"

FREE BOARD = 48" - 38.4" = 9.6"

Channel Calculator

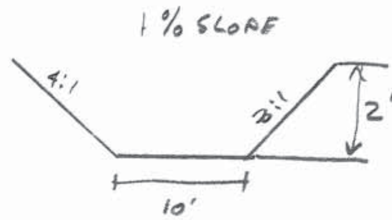
SWALE LOCATED
EAST OF PHASE 3

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	30.7000 cfs
Slope	0.0100 ft/ft
Manning's n	0.0300
Height	24.0000 in
Bottom width	120.0000 in
Left slope	4.0000 ft/ft (V/H)
Right slope	3.0000 ft/ft (V/H)

Computed Results:

Depth	9.3523 in ←
Velocity	3.8516 fps
Full Flowrate	137.0073 cfs
Flow area	7.9708 ft2
Flow perimeter	139.4984 in
Hydraulic radius	8.2280 in
Top width	125.4555 in
Area	21.1667 ft2
Perimeter	170.0369 in
Percent full	38.9680 %



25-YR STORM = 30.7 CFS

MAX Depth = 9.4"

Free Board = 14.6"

Manning Pipe Calculator

CULVERT NEAR LEACHATE PUMPOUT

```
Given Input Data:
     Shape ...........................  Circular
     Solving for .....................  Flowrate
     Diameter ........................  24.0000 in
     Depth ...........................  24.0000 in
     Slope ...........................  0.0140 ft/ft
     Manning's n .....................  0.0240

Computed Results:
     Flowrate ........................  14.4989 cfs
     Area ............................  3.1416 ft2
     Wetted Area .....................  3.1416 ft2
     Wetted Perimeter ................  75.3982 in
     Perimeter .......................  75.3982 in
     Velocity ........................  4.6151 fps
     Hydraulic Radius ................  6.0000 in
     Percent Full ....................  100.0000 %
     Full flow Flowrate ..............  14.4989 cfs
     Full flow velocity ..............  4.6151 fps
```

25-YR PEAK RUNOFF FOR PHASE 3+4 SW = 55.4 cfs

ONLY ½ of this watershed will flow through this culvert

DESIGN FLOW = 27.7 cFs

SLOPE = 1.4%
24" CMP
FLOW = 14.5 CFs

2 - 24" CMP CAN HANDLE 29 cFs ✓

Intermediate Diversion Berm Calculation

BT² inc.

	Sheet No.
	Calc. No.
	Rev. No.
Job No. 3391 Job Edgewater Landfill	By KRG Date 12/3/07
Client Subject	Chk'd. Date

Determine if INTERMEDIATE DIVERSION BERMS ARE REQUIRED ON THE FINAL COVER.
MAINTAIN SOIL LOSS TO 3 TON/AC OR LESS.

UNIVERSAL SOIL LOSS Equation

$$A = R \times K \times LS \times C \times P$$

A = Average Annual Soil Loss, ton/AC.
R = Rainfall + Runoff Erosivity index
K = Soil Erodibility factor, ton/AC
LS = Slope length + Steepness factor
C = cover management factor
P = Practice factor

For the top of the Final Grades, slope = 3%, length = 330 FT

R = 100
K = 0.29
LS = 0.41 $\quad A = (100)(0.29)(0.41)(0.1)(0.9)$
C = 0.1
P = 0.9 $\quad = 1.07$ ton/Ac ok

For SIDES OF Final Cover, SLOPE = 25%, length = 170'

R = 100
K = 0.29 $\quad A = (100)(0.29)(7.66)(0.1)(0.09)$
LS = 7.66
C = 0.1 $\quad A = 2.00$ TON/AC ok.
P = 0.9

∴ No Intermediate SWALE IS REQUIRED.

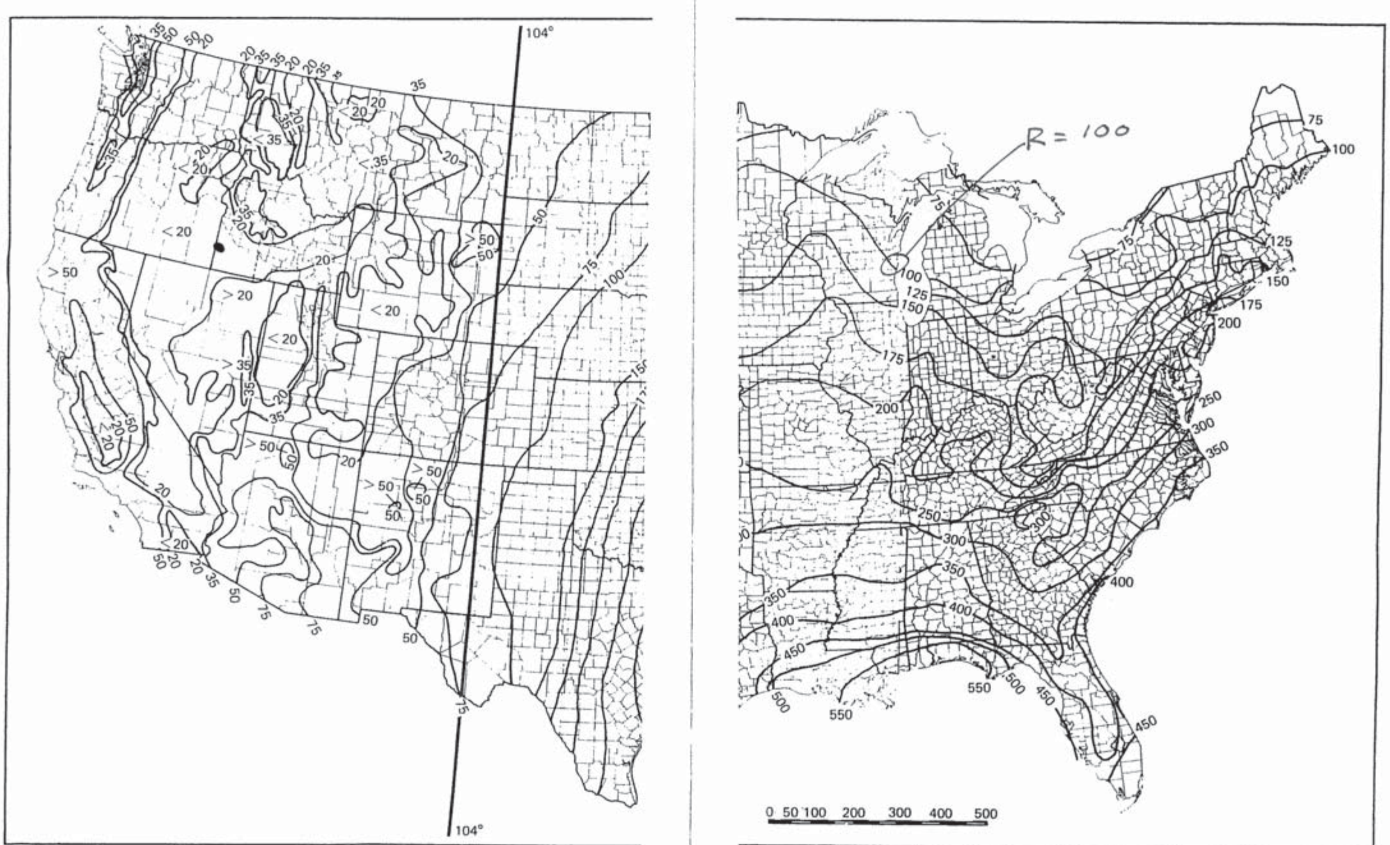


Fig. 5.2 R values for areas east of 104°. Because of irregular topography in the west United States, calculate R values in this region by using local rainfall data. R is in u of 100 ft · tons/acre per in/hr. To convert R to units of 10^7 J/ha per mm/hr, multiply 1.70. (20) Scale is in miles.

TABLE 5.6 *C* Values for Soil Loss Equation*

Type of cover	*C* factor	Soil loss reduction, %
None	1.0	0
Native vegetation (undisturbed)	0.01	99
Temporary seedings:		
90% cover, annual grasses, no mulch	0.1	90
Wood fiber mulch, ¾ ton/acre (1.7 t/ha), with seed†	0.5	50
Excelsior mat, jute†	0.3	70
Straw mulch†		
1.5 tons/acre (3.4 t/ha), tacked down	0.2	80
4 tons/acre (9.0 t/ha), tacked down	0.05	95

*Adapted from Refs. 11, 15, and 20

†For slopes up to 2:1.

TABLE 5.7 *P* Factors for Construction Sites (Adapted from Ref. 15)

Surface condition	*P* value
Compacted and smooth	1.3
Trackwalked along contour*	1.2
Trackwalked up and down slope†	0.9
Punched straw	0.9
Rough, irregular cut	0.9
Loose to 12-in (30-cm) depth	0.8

*Tread marks oriented up and down slope.

†Tread marks oriented parallel to contours, as in Figs. 6.9 and 6.10.

TABLE 5. APPROXIMATE VALUES OF FACTOR K FOR USDA TEXTURAL CLASSES[11]

Texture class	Organic matter content		
	<0.5%	2%	4%
	K	K	K
Sand	0.05	0.03	0.02
Fine sand	.16	.14	.10
Very fine sand	.42	.36	.28
Loamy sand	.12	.10	.08
Loamy fine sand	.24	.20	.16
Loamy very fine sand	.44	.38	.30
Sandy loam	.27	.24	.19
Fine sandy loam	.35	.30	.24
Very fine sandy loam	.47	.41	.33
Loam	.38	.34	.29
Silt loam	.48	.42	.33
Silt	.60	.52	.42
Sandy clay loam	.27	.25	.21
Clay loam	.28	.25 Ave= 0,29	.21
Silty clay loam	.37	.32	.26
Sandy clay	.14	.13	.12
Silty clay	.25	.23	.19
Clay		0.13-0.29	

The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.

TABLE 5.5 LS Values* (10)

Slope ratio	Slope gradient s, %	LS values for following slope lengths l, ft (m): 10 (3.0)	20 (6.1)	30 (9.1)	40 (12.2)	50 (15.2)	60 (18.3)	70 (21.3)	80 (24.4)	90 (27.4)	100 (30.5)
	0.5	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.09	0.10
100:1	1	0.08	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.12	0.12
	2	0.10	0.12	0.14	0.15	0.16	0.17	0.18	0.19	0.19	0.20
	3	0.14	0.18	0.20	0.22	0.23	0.25	0.26	0.27	0.28	0.29
	4	0.16	0.21	0.25	0.28	0.30	0.33	0.35	0.37	0.38	0.40
20:1	5	0.17	0.24	0.29	0.34	0.38	0.41	0.45	0.48	0.51	0.53
	6	0.21	0.30	0.37	0.43	0.48	0.52	0.56	0.60	0.64	0.67
	7	0.26	0.37	0.45	0.52	0.58	0.64	0.69	0.74	0.78	0.82
12½:1	8	0.31	0.44	0.54	0.63	0.70	0.77	0.83	0.89	0.94	0.99
	9	0.37	0.52	0.64	0.74	0.83	0.91	0.98	1.05	1.11	1.17
10:1	10	0.43	0.61	0.75	0.87	0.97	1.06	1.15	1.22	1.30	1.37
	11	0.50	0.71	0.86	1.00	1.12	1.22	1.32	1.41	1.50	1.58
8:1	12.5	0.61	0.86	1.05	1.22	1.36	1.49	1.61	1.72	1.82	1.92
	15	0.81	1.14	1.40	1.62	1.81	1.98	2.14	2.29	2.43	2.56
6:1	16.7	0.96	1.36	1.67	1.92	2.15	2.36	2.54	2.72	2.88	3.04
5:1	20	1.29	1.82	2.23	2.58	2.88	3.16	3.41	3.65	3.87	4.08
4½:1	22	1.51	2.13	2.61	3.02	3.37	3.69	3.99	4.27	4.53	4.77
4:1	25	1.86	2.63	3.23	3.73	4.16	4.56	4.93	5.27	5.59	5.89
	30	2.51	3.56	4.36	5.03	5.62	6.16	6.65	7.11	7.54	7.95
3:1	33.3	2.98	4.22	5.17	5.96	6.67	7.30	7.89	8.43	8.95	9.43
	35	3.23	4.57	5.60	6.46	7.23	7.92	8.55	9.14	9.70	10.22
2½:1	40	4.00	5.66	6.93	8.00	8.95	9.80	10.59	11.32	12.00	12.65
	45	4.81	6.80	8.33	9.61	10.75	11.77	12.72	13.60	14.42	15.20
2:1	50	5.64	7.97	9.76	11.27	12.60	13.81	14.91	15.94	16.91	17.82
	55	6.48	9.16	11.22	12.96	14.48	15.87	17.14	18.32	19.43	20.48
1¾:1	57	6.82	9.64	11.80	13.63	15.24	16.69	18.03	19.28	20.45	21.55
	60	7.32	10.35	12.68	14.64	16.37	17.93	19.37	20.71	21.96	23.15
1½:1	66.7	8.44	11.93	14.61	16.88	18.87	20.67	22.32	23.87	25.31	26.68
	70	8.98	12.70	15.55	17.96	20.08	21.99	23.75	25.39	26.93	28.39
	75	9.78	13.83	16.94	19.56	21.87	23.95	25.87	27.66	29.34	30.92
1¼:1	80	10.55	14.93	18.28	21.11	23.60	25.85	27.93	29.85	31.66	33.38
	85	11.30	15.98	19.58	22.61	25.27	27.69	29.90	31.97	33.91	35.74
	90	12.02	17.00	20.82	24.04	26.88	29.44	31.80	34.00	36.06	38.01
	95	12.71	17.97	22.01	25.41	28.41	31.12	33.62	35.94	38.12	40.18
1:1	100	13.36	18.89	23.14	26.72	29.87	32.72	35.34	37.78	40.08	42.24

Slope gradient s, %	LS values for following slope lengths l, ft (m): 150 (46)	200 (61)	250 (76)	300 (91)	350 (107)	400 (122)	450 (137)	500 (152)	600 (183)	700 (213)	800 (244)	900 (274)
0.5	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.15
1	0.14	0.14	0.15	0.16	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.19
2	0.23	0.25	0.26	0.28	0.29	0.30	0.32	0.33	0.34	0.36	0.37	0.39
3	0.32	0.35	0.38	0.40	0.42	0.43	0.45	0.46	0.49	0.51	0.54	0.55
4	0.47	0.53	0.58	0.62	0.66	0.70	0.73	0.76	0.82	0.87	0.92	0.96
5	0.66	0.76	0.85	0.93	1.00	1.07	1.13	1.20	1.31	1.42	1.51	1.60
6	0.82	0.95	1.06	1.16	1.26	1.34	1.43	1.50	1.65	1.78	1.90	2.02
7	1.01	1.17	1.30	1.43	1.54	1.65	1.75	1.84	2.02	2.18	2.33	2.47
8	1.21	1.40	1.57	1.72	1.85	1.98	2.10	2.22	2.43	2.62	2.80	2.97
9	1.44	1.66	1.85	2.03	2.19	2.35	2.49	2.62	2.87	3.10	3.32	3.52
10	1.68	1.94	2.16	2.37	2.56	2.74	2.90	3.06	3.35	3.62	3.87	4.11
11	1.93	2.23	2.50	2.74	2.95	3.16	3.35	3.53	3.87	4.18	4.47	4.74
12.5	2.35	2.72	3.04	3.33	3.59	3.84	4.08	4.30	4.71	5.08	5.43	5.76
15	3.13	3.62	4.05	4.43	4.79	5.12	5.43	5.72	6.27	6.77	7.24	7.68
16.7	3.72	4.30	4.81	5.27	5.69	6.08	6.45	6.80	7.45	8.04	8.60	9.12
20	5.00	5.77	6.45	7.06	7.63	8.16	8.65	9.12	9.99	10.79	11.54	12.24
22	5.84	6.75	7.54	8.26	8.92	9.54	10.12	10.67	11.68	12.62	13.49	14.31
25	7.21	8.33	9.31	10.20	11.02	11.78	12.49	13.17	14.43	15.58	16.66	17.67
30	9.74	11.25	12.57	13.77	14.88	15.91	16.87	17.78	19.48	21.04	22.49	23.86
33.3	11.55	13.34	14.91	16.33	17.64	18.86	20.00	21.09	23.10	24.95	26.67	28.29
35	12.52	14.46	16.16	17.70	19.12	20.44	21.68	22.86	25.04	27.04	28.91	30.67
40	15.50	17.89	20.01	21.91	23.67	25.30	26.84	28.29	30.99	33.48	35.79	37.96
45	18.62	21.50	24.03	26.33	28.44	30.40	32.24	33.99	37.23	40.22	42.99	45.60
50	21.83	25.21	28.18	30.87	33.34	35.65	37.81	39.85	43.66	47.16	50.41	53.47
55	25.09	28.97	32.39	35.48	38.32	40.97	43.45	45.80	50.18	54.20	57.94	61.45
57	26.40	30.48	34.08	37.33	40.32	43.10	45.72	48.19	52.79	57.02	60.96	64.66
60	28.35	32.74	36.60	40.10	43.31	46.30	49.11	51.77	56.71	61.25	65.48	69.45
66.7	32.68	37.74	42.19	46.22	49.92	53.37	56.60	59.66	65.36	70.60	75.47	80.05
70	34.77	40.15	44.89	49.17	53.11	56.78	60.23	63.48	69.54	75.12	80.30	85.17
75	37.87	43.73	48.89	53.56	57.85	61.85	65.60	69.15	75.75	81.82	87.46	92.77
80	40.88	47.20	52.77	57.81	62.44	66.75	70.80	74.63	81.76	88.31	94.41	100.13
85	43.78	50.55	56.51	61.91	66.87	71.48	75.82	79.92	87.55	94.57	101.09	107.23
90	46.55	53.76	60.10	65.84	71.11	76.02	80.63	84.99	93.11	100.57	107.51	114.03
95	49.21	56.82	63.53	69.59	75.17	80.36	85.23	89.84	98.42	106.30	113.64	120.54
100	51.74	59.74	66.79	73.17	79.03	84.49	89.61	94.46	103.48	111.77	119.48	126.73

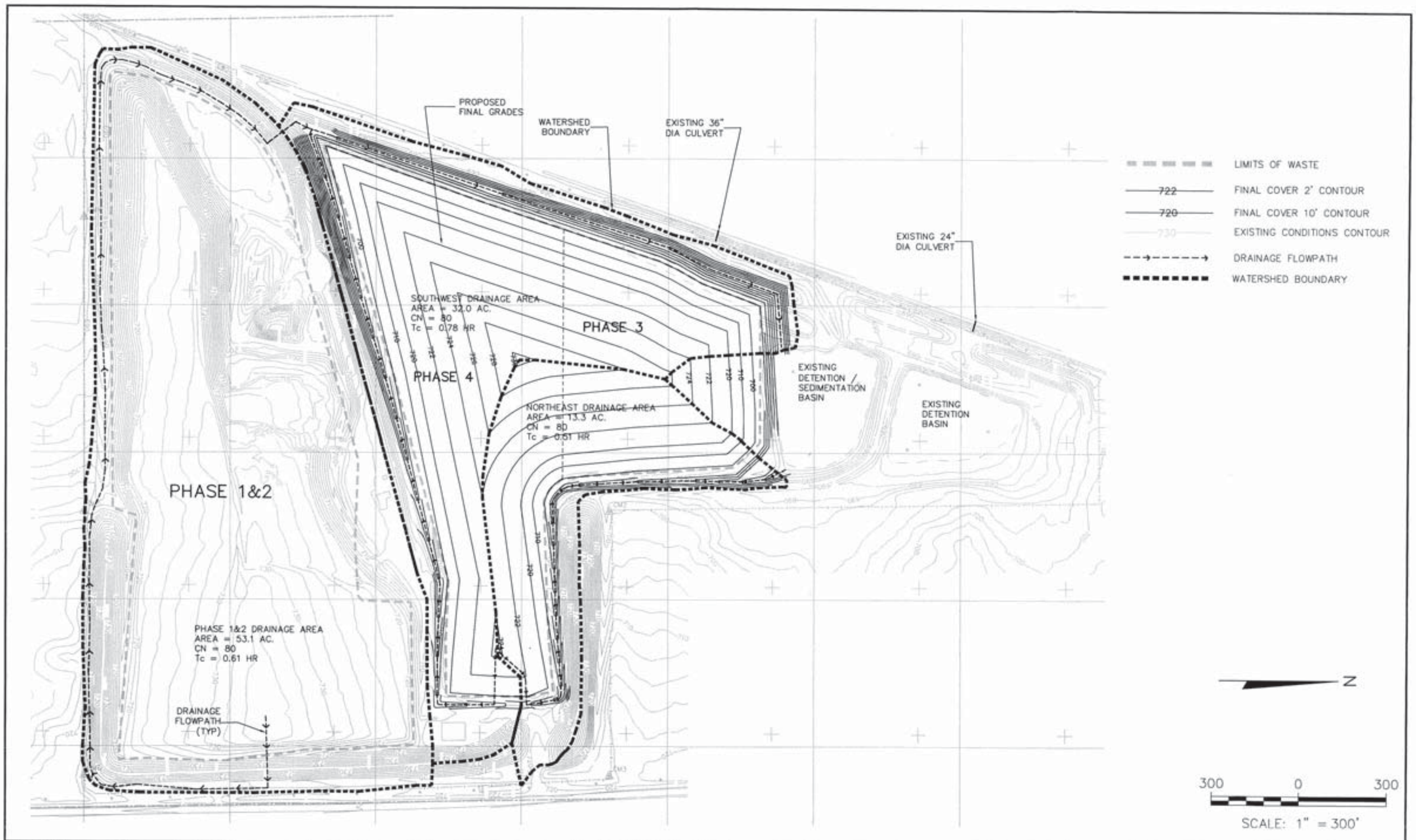
170' = 7.66

73 end

*Calculated from

$$LS = \left(\frac{65.41 \times s^2}{s^2 + 10{,}000} + \frac{4.56 \times s}{\sqrt{s^2 + 10{,}000}} + 0.065\right)\left(\frac{l}{72.5}\right)^m$$

LS = topographic factor
l = slope length, ft (m × 0.3048)
s = slope steepness,
m = exponent dependent upon slope steepness (0.2 for slopes < 1%, 0.3 for slopes 1 to 3%, 0.4 for slopes 3.5 to 4.5%, and 0.5 for slopes > 5%)



PROJECT NO. 3391	DRAWN BY: KRG	ENGINEER BT² inc.	2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830 FAX: (608) 224-2839	CLIENT WISCONSIN POWER AND LIGHT EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081	SITE PLAN OF OPERATION PHASES 3 AND 4 EDGEWATER I-43 ASH DISPOSAL FACILITY WILSON, WISCONSIN	WATERSHED AND DRAINAGE PATH LOCATIONS
DRAWN: 11/27/07	CHECKED BY: TR					FIGURE
REVISED:	APPROVED BY:					G1

2015 Plan of Operation Modification
Drainage Design Calculations

Storm Water Management Calculations

Purpose:

The purpose of the storm water runoff calculations is to demonstrate that the proposed landfill surface water management system design meets the requirements of the Wisconsin Administrative Code, 504.09.

Existing Features:

Currently Phase 1 and 2 of the landfill have final cover in place. The final cover includes a grass surface. Phase 3, Module 1 has been constructed and is full of ash but does not have final cover in place. Phase 4, Module 1 was constructed in the summer of 2014 and is accepting ash.

Surface water runoff from final cover areas discharges to an existing sedimentation basin at the north end of the landfill. Surface water runoff that comes in contact with ash discharges to the contact water basin located along the western side of the facility, which is managed separately from the non-contact runoff (refer to Section 2.7 of the Plan Modification report). An additional existing detention basin is located north of the landfill detention/sedimentation basin to treat off-site runon. Because the plan modification does not affect off-site runon or the existing detention basin, these storm water management calculations do not include modeling of these areas/features.

From the discharge of the existing detention/sedimentation basins, runoff ultimately discharges off-site via two culverts: 1) a 36-inch diameter culvert under the railroad tracks to the west of the site and 2) a 24-inch diameter culvert under the railroad tracks to the west of the site. The culverts are shown on **Figure F1**.

Approach:

Final Cover Soil Loss

The Universal Soil Loss Equation (USLE) was used to estimate soil loss along the final cover slopes. The USLE estimates the final cover soil erosion based on the erodibility of the soil, the rainfall and runoff erosivity, the slope steepness, cover management, and soil practice factors. A maximum soil loss of 3 tons per acre is considered acceptable.

Hydrograph Generation

To properly size the storm water management features, runoff hydrographs for the 25-year, 24-hour, and 100-year, 24-hour, storm events were developed. HydroCAD was used to model the storm water management system and develop the hydrographs using TR-20 methodologies. The model is designed to simulate the surface runoff response of a watershed to a precipitation event. Input parameters for the model include precipitation depth for the design storm event, contributing drainage areas, runoff curve numbers, time of concentration, and travel time.

The final cover watersheds are shown on **Figures F-1** and **F-2**.

Perimeter Ditch and Diversion Berm Sizing

Perimeter ditches and diversion berms were sized for the 25-year, 24-hour storm event using the Manning's equation to determine the depth of flow and velocity in the berm/ditch based on the berm/ditch geometry and peak flow in the berm/ditch (as determined by the Hydrograph Generation calculations). The drainage areas for the diversion berms are included in **Figure F2**.

Downslope Flume and Energy Dissipator Sizing

The downslope flume inlets were sized for the 25-year, 24-hour storm event using the orifice equation. The downslope flume pipes were sized based on the peak flow conditions in the pipe using Manning's equation. Energy dissipators were sized using tables from the reference book "Hydraulic Design of Energy Dissipators for Culvert and Channels," US Department of Transportation, Federal Highway Administration, July 2006.

Culvert Sizing
The culverts were sized for the 25-year, 24-hour storm event using the HY-8 computer model developed by the US Department of Transportation, Federal Highway Administration. Culvert outlet protection was sized using guidance from the Wisconsin DOT Permissible Velocities for Riprap Lined Ditches, Procedure 13-30-10.

Sedimentation Basin Sizing
The sedimentation basin sizing process involved determining an appropriate ratio of surface area to flow rate that would allow particles to settle out during a design storm event. The sedimentation basins were sized for the 25-year, 24-hour storm event. The sedimentation basin emergency spillway were sized for the 100-year, 24-hour storm event.

A table presented in the "Erosion and Sediment Control Handbook" (Goldman, et. Al., 1986) provides the surface area-to-discharge ratio required to achieve settlement of the desired particle sizes.

The HydroCAD model was used in conjunction with accepted formulas and engineering calculations to evaluate the ability of the sedimentation basin to meet the requirements of NR 504.09.

Key Assumptions:

- Runoff curve numbers were based on tables presented in Urban Hydrology for Small Watersheds, and were assumed as follows

Cover Type	CN
Landfill final cover	79 – Open spaces (lawns, parks, etc) in fair condition with hydrologic soil group C
Sedimentation basin	98 – Water surface

- A Type II rainfall distribution was used, based on The NOAA Atlas 14, Precipitation Frequency Data Server for Sheboygan Falls, WI (page 4). The following precipitation depths were assumed.

Storm Event	Precipitation Depth (inches)
25-year, 24-hour	4.79
100-year, 24-hour	6.55

- Other assumptions are included with the calculations attached to this appendix.

Results:
The proposed landfill surface water management system design meets the requirements of the Wisconsin Administrative Code, 504.09. Further details are provided below.

Soil Loss
The USLE calculations indicate a minimal soil loss rate along the 3% and 4:1 final cover sideslopes. Although the calculations indicate no diversion berms are needed, berms have been designed upslope of the final cover slope transition. Experience has shown these transition points are sometimes more susceptible to erosion, so the added berms provide protection. Refer to the USLE Calculations section of this appendix for the detailed calculations.

Hydrograph Generation

The hydrograph modeling results for the 25-year and 100-year, 24-hour storm events are included the Hydrograph Generation section of this appendix.

Perimeter Ditch and Diversion Berm Sizing

The diversion berms will be constructed as shown on the plan set. The diversion berms will maintain a minimum 0.5 foot freeboard. Refer to the Diversion Berm and Ditch Sizing section of this appendix for the detailed calculations.

The perimeter ditches will be constructed as shown on the plan set. The perimeter ditches will contain the runoff from the 25-year, 24-hour storm event and maintain a minimum 0.5 foot of freeboard. Erosion matting will be used where ditch velocities exceed 5 feet per second. Refer to the Diversion Berm and Ditch Sizing section of this appendix for the detailed calculations.

Downslope Flume and Energy Dissipator Sizing

The downslope flumes will be constructed as shown on the plan set. The downslope flumes are designed to accommodate the surface water runoff from the final cover for a 25-year, 24-hour storm event. Energy dissipators at the bottom of the downslope flumes have been designed to handle the peak velocities, and additional riprap protection has been sized for the energy dissipator outlets. Refer to the Downslope Flume and Energy Dissipator Sizing section of this appendix for the detailed calculations.

Culvert Sizing

The culverts are designed to accommodate the flows from the perimeter ditches for the 25-year, 24-hour storm event. Riprap outlet protection has been sized based on the discharge rates and outlet velocities. Refer to the Culvert Sizing section of this appendix for the detailed calculations.

Sedimentation Basin Sizing

The outlet structure for the detention/sedimentation basin is sized to control runoff from the 25-year, 24-hour storm event, assuming the starting water elevation is at the bottom of the lowest outlet structure opening. The sedimentation basin is designed to settle out particles 0.01 microns and larger in diameter. Refer to the Sedimentation Basin Sizing section of this appendix for the detailed calculations. The emergency spillways have been designed to pass the 100-year, 24-hour storm event.

4

NOAA Atlas 14, Volume 8, Version 2
Location name: Sheboygan Falls, Wisconsin, US*
Latitude: 43.6942°, Longitude: -87.7645°
Elevation: 718 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.325 (0.258-0.409)	0.388 (0.307-0.488)	0.488 (0.385-0.615)	0.568 (0.447-0.717)	0.674 (0.514-0.858)	0.753 (0.565-0.966)	0.829 (0.607-1.07)	0.903 (0.641-1.19)	0.997 (0.688-1.33)	1.06 (0.722-1.43)
10-min	0.476 (0.377-0.599)	0.568 (0.450-0.715)	0.714 (0.564-0.900)	0.832 (0.654-1.05)	0.987 (0.753-1.26)	1.10 (0.828-1.41)	1.21 (0.889-1.57)	1.32 (0.939-1.74)	1.46 (1.01-1.94)	1.56 (1.06-2.10)
15-min	0.581 (0.460-0.730)	0.693 (0.549-0.872)	0.871 (0.688-1.10)	1.01 (0.798-1.28)	1.20 (0.918-1.53)	1.34 (1.01-1.72)	1.48 (1.08-1.92)	1.61 (1.15-2.12)	1.78 (1.23-2.37)	1.90 (1.29-2.56)
30-min	0.805 (0.638-1.01)	0.963 (0.763-1.21)	1.21 (0.959-1.53)	1.41 (1.11-1.78)	1.68 (1.28-2.13)	1.87 (1.40-2.39)	2.05 (1.50-2.66)	2.23 (1.58-2.92)	2.45 (1.69-3.26)	2.60 (1.77-3.51)
60-min	1.04 (0.823-1.31)	1.24 (0.978-1.55)	1.55 (1.23-1.96)	1.81 (1.43-2.29)	2.16 (1.66-2.76)	2.43 (1.83-3.13)	2.69 (1.98-3.50)	2.96 (2.10-3.90)	3.30 (2.28-4.41)	3.56 (2.42-4.79)
2-hr	1.27 (1.02-1.58)	1.51 (1.21-1.87)	1.89 (1.51-2.35)	2.21 (1.76-2.75)	2.65 (2.06-3.36)	3.00 (2.28-3.82)	3.34 (2.48-4.31)	3.69 (2.65-4.83)	4.16 (2.90-5.52)	4.51 (3.08-6.04)
3-hr	1.42 (1.15-1.75)	1.67 (1.35-2.06)	2.09 (1.69-2.58)	2.45 (1.97-3.03)	2.97 (2.33-3.75)	3.38 (2.60-4.30)	3.81 (2.85-4.90)	4.25 (3.08-5.55)	4.86 (3.41-6.44)	5.34 (3.66-7.11)
6-hr	1.69 (1.39-2.05)	1.96 (1.61-2.39)	2.45 (2.00-2.98)	2.89 (2.35-3.52)	3.54 (2.83-4.46)	4.09 (3.19-5.17)	4.67 (3.54-5.99)	5.30 (3.88-6.90)	6.19 (4.39-8.18)	6.91 (4.77-9.15)
12-hr	1.97 (1.64-2.36)	2.27 (1.89-2.73)	2.83 (2.34-3.40)	3.35 (2.76-4.04)	4.16 (3.38-5.21)	4.85 (3.84-6.10)	5.61 (4.31-7.15)	6.44 (4.77-8.34)	7.63 (5.46-10.0)	8.60 (5.98-11.3)
24-hr	2.26 (1.90-2.67)	2.59 (2.18-3.07)	3.23 (2.71-3.82)	3.84 (3.20-4.56)	4.79 (3.95-5.96)	5.63 (4.51-7.01)	6.55 (5.09-8.28)	7.57 (5.66-9.73)	9.04 (6.52-11.8)	10.3 (7.18-13.4)
2-day	2.57 (2.20-3.00)	2.93 (2.50-3.42)	3.63 (3.08-4.23)	4.30 (3.63-5.04)	5.37 (4.48-6.60)	6.31 (5.12-7.79)	7.36 (5.78-9.22)	8.52 (6.43-10.9)	10.2 (7.43-13.3)	11.6 (8.18-15.1)
3-day	2.82 (2.43-3.26)	3.18 (2.73-3.67)	3.87 (3.31-4.48)	4.55 (3.88-5.29)	5.65 (4.75-6.90)	6.62 (5.41-8.11)	7.70 (6.08-9.60)	8.90 (6.76-11.3)	10.7 (7.80-13.8)	12.1 (8.58-15.7)
4-day	3.03 (2.63-3.48)	3.40 (2.93-3.90)	4.10 (3.53-4.72)	4.79 (4.11-5.54)	5.91 (4.99-7.17)	6.89 (5.66-8.40)	7.99 (6.34-9.92)	9.22 (7.02-11.7)	11.0 (8.07-14.2)	12.5 (8.86-16.1)
7-day	3.55 (3.10-4.03)	3.98 (3.48-4.53)	4.80 (4.18-5.46)	5.57 (4.82-6.36)	6.77 (5.75-8.09)	7.81 (6.46-9.39)	8.95 (7.14-11.0)	10.2 (7.81-12.8)	12.0 (8.84-15.4)	13.5 (9.62-17.3)
10-day	4.01 (3.54-4.52)	4.52 (3.98-5.10)	5.43 (4.76-6.14)	6.27 (5.47-7.11)	7.54 (6.42-8.90)	8.61 (7.14-10.3)	9.77 (7.82-11.9)	11.0 (8.46-13.7)	12.8 (9.46-16.3)	14.3 (10.2-18.2)
20-day	5.45 (4.87-6.05)	6.09 (5.44-6.77)	7.20 (6.41-8.02)	8.16 (7.21-9.12)	9.54 (8.18-11.0)	10.7 (8.91-12.4)	11.8 (9.53-14.1)	13.0 (10.1-16.0)	14.7 (10.9-18.5)	16.0 (11.6-20.4)
30-day	6.71 (6.05-7.38)	7.47 (6.73-8.23)	8.74 (7.84-9.65)	9.80 (8.74-10.9)	11.3 (9.71-12.9)	12.4 (10.4-14.4)	13.6 (11.0-16.1)	14.8 (11.5-17.9)	16.4 (12.2-20.4)	17.6 (12.7-22.2)
45-day	8.35 (7.59-9.11)	9.29 (8.44-10.1)	10.8 (9.78-11.8)	12.0 (10.8-13.2)	13.7 (11.8-15.4)	14.9 (12.6-17.0)	16.1 (13.1-18.8)	17.2 (13.4-20.7)	18.7 (14.0-23.1)	19.8 (14.4-24.9)
60-day	9.78 (8.94-10.6)	10.9 (9.96-11.8)	12.7 (11.5-13.8)	14.0 (12.7-15.3)	15.8 (13.7-17.7)	17.1 (14.5-19.4)	18.3 (15.0-21.3)	19.5 (15.2-23.3)	20.9 (15.6-25.7)	21.9 (15.9-27.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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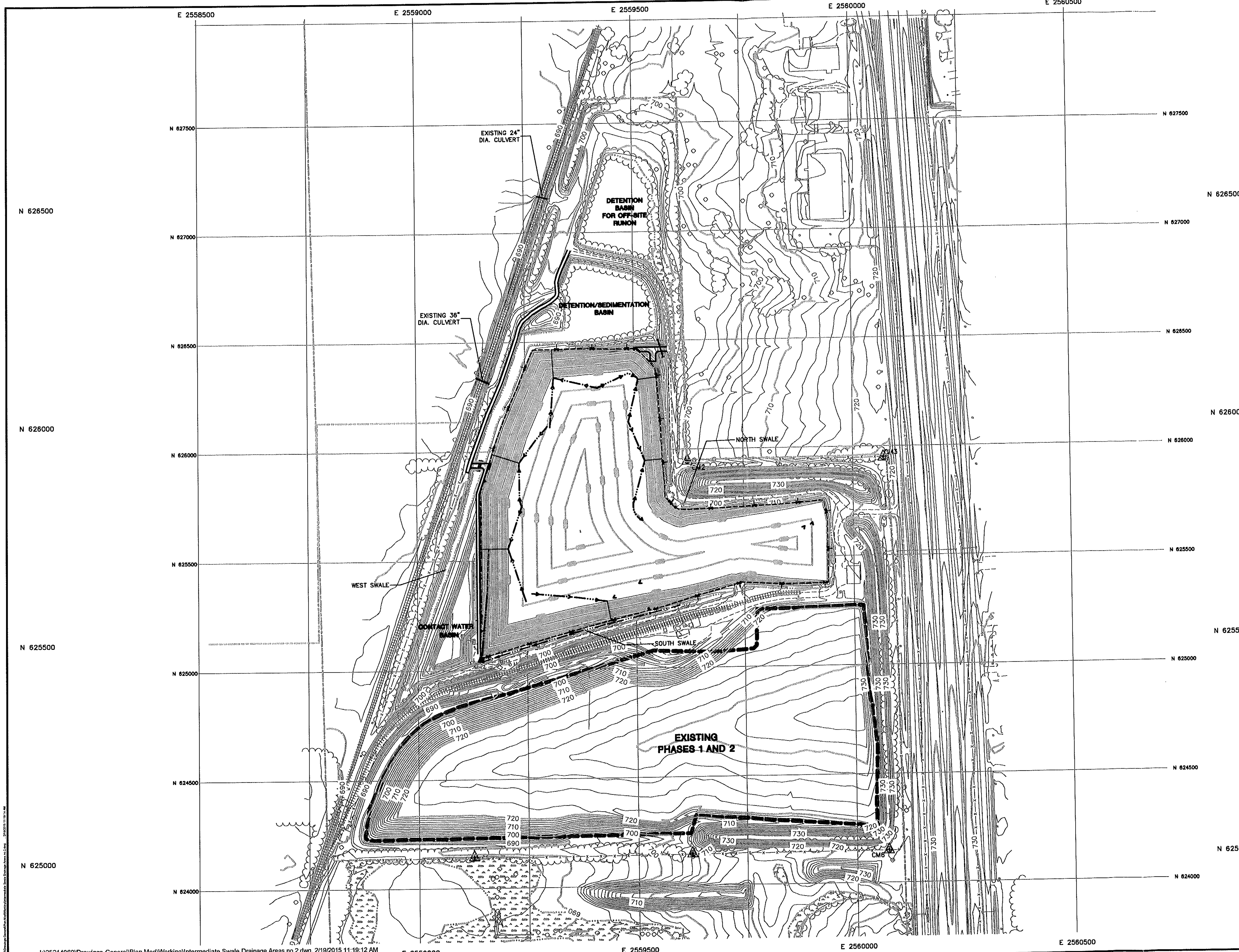

LEGEND

- APPROXIMATE PROPERTY LINE
- APPROVED LIMITS OF WASTE
- APPROVED MODULE LIMITS
- EXISTING GRADE (2' CONTOUR)
- 690 EXISTING GRADE (10' CONTOUR)
- 702 PROPOSED GRADE (2' CONTOUR)
- 700 PROPOSED GRADE (10' CONTOUR)
- PROPOSED PERIMETER DITCH
- PROPOSED CULVERT
- PROPOSED LEACHATE CLEANOUT
- PROPOSED LEACHATE HEADWELL
- PROPOSED ACCESS ROAD
- PROPOSED FINAL COVER DIVERSION BERM
- PROPOSED DOWNSLOPE FLUME
- PROPOSED ENERGY DISSIPATOR
- PROPOSED TOE DRAIN AND DISCHARGE PIPE

NOTES:

1. SEE SHEET 2 FOR ADDITIONAL BASE MAP LEGEND ITEMS AND NOTES.

PROJECT NO.	25214060	DRAWN BY:	KRG
DRAWN:	02/06/15	CHECKED BY:	CHECKEDBY
REVISED:		APPROVED BY:	

WISCONSIN POWER AND LIGHT COMPANY
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SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

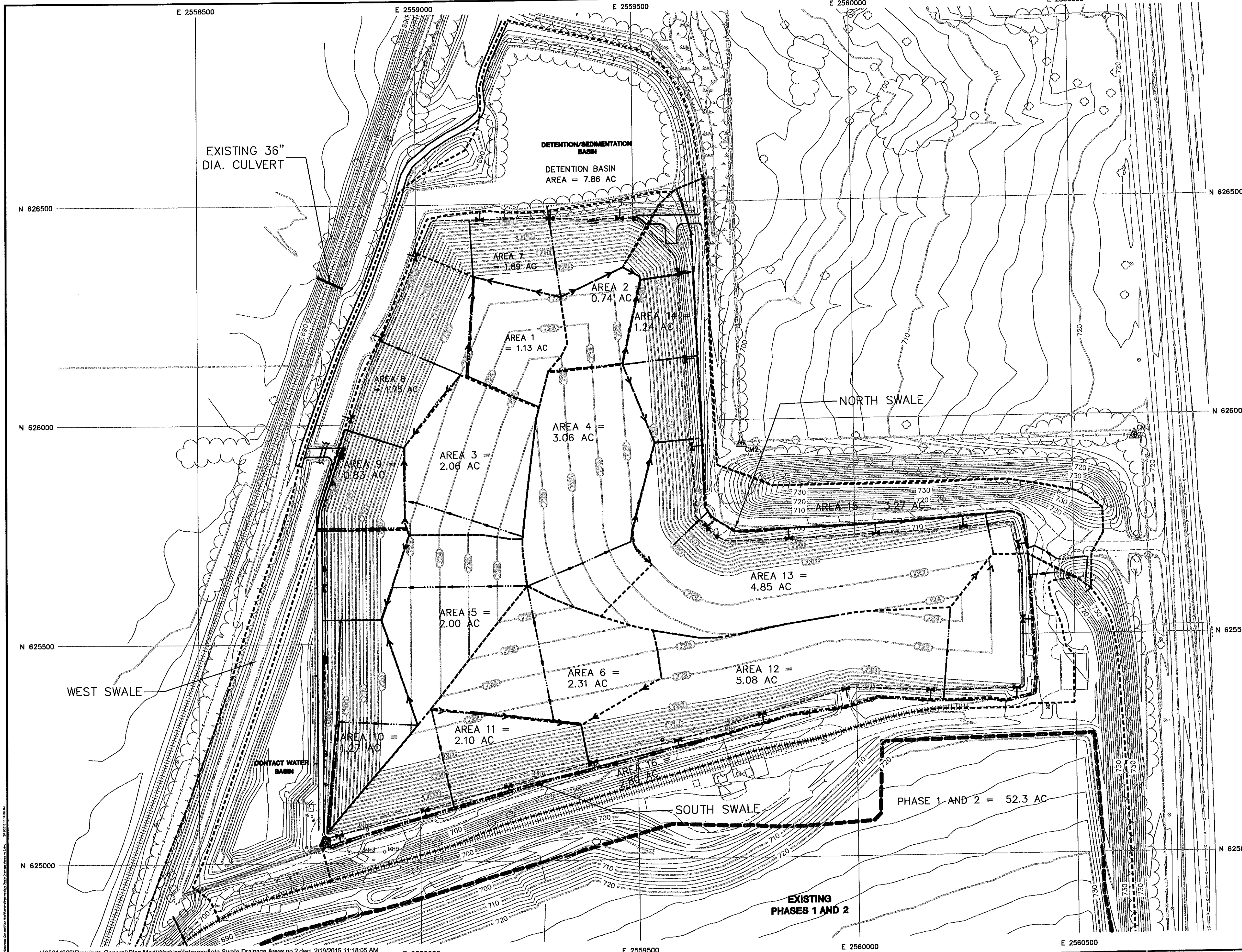
PLAN MODIFICATION
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

SITE

PROPOSED FINAL GRADES AND DRAINAGE FEATURES

SHEET
F1

I:\25214060\Drawings-General\Plan Mod\Working\Intermediate Swale Drainage Areas no.2.dwg, 2/19/2015 11:19:12 AM



LEGEND
APPROXIMATE PROPERTY LINE
APPROVED LIMITS OF WASTE
APPROVED MODULE LIMITS
EXISTING GRADE (2' CONTOUR)
690 EXISTING GRADE (10' CONTOUR)
702 PROPOSED GRADE (2' CONTOUR)
700 PROPOSED GRADE (10' CONTOUR)
PROPOSED PERIMETER DITCH
PROPOSED CULVERT
PROPOSED LEACHATE CLEANOUT
PROPOSED LEACHATE HEADWELL
PROPOSED ACCESS ROAD
PROPOSED FINAL COVER DIVERSION BERM
PROPOSED DOWNSLOPE FLUME
PROPOSED ENERGY DISSIPATOR
PROPOSED TOE DRAIN AND DISCHARGE PIPE
DRAINAGE FLOW PATH
INTERMEDIATE SWALE DRAINAGE AREA

NOTES:

1. SEE SHEET 2 FOR ADDITIONAL BASE MAP LEGEND ITEMS AND NOTES.

N

100 0 100

SCALE: 1" =100'

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PROJECT NO. 25214060	DRAWN BY: KRG		
DRAWN: 02/06/15	CHECKED BY: CHECKEDBY		
REVISED:	APPROVED BY:		

CLIENT: WISCONSIN POWER AND LIGHT COMPANY
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081

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

SITE: PLAN MODIFICATION
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

DRAINAGE AREAS AND FLOWPATHS

SHEET F2

USLE Calculation

SCS ENGINEERS

		Sheet No.	1 of 6
		Calc. No.	
		Rev. No.	
Job No. 25214060	Job: I-43 Landfill Plan Modification	By: KRG	Date: 1/30/15
Client: Alient Energy	Subject: Soil Loss Along Final Cover	Chk'd:	Date:

Universal Soil Loss Equation (USLE) Calculation

Use USLE to estimate soil loss along the 3% final cover slope, with the goal of maintaining ≤ 3 ton/acre of soil loss along the final cover.

USLE Equation:

A = R * K * LS * C * P

where: A = Average annual soil loss, ton/acre
R = Rainfall and runoff erosivity index
K = Soil erodibility factor, tons/acre
LS = Slope length and steepness factor
C = Cover management factor
P = Practice factor

The LS factor is a function of the slope and flow length.

LS = L * S

where: L = Slope length factor = (l/72.6)^m
where: l = Slope length, feet
m = Slope-length exponent (m = 0.3 for slopes of 1% to 3%
m = 0.4 for slopes of 3.5% to 4.5%
m = 0.5 for slopes greater than 5%)

S = Slope steepness factor = (65.41s^2/(s^2 + 10,000)) + (4.56s/(SQRT(s^2 + 10,000))) + 0.065
where: s = Slope, in percent

The soil type chosen for selecting the appropriate K factor is an estimate of silt loam for the topsoil.

Data Entered		**Data Computed**	
Slope (%), s =	3	S =	0.26
l =	340	L =	1.6
m =	0.3	LS =	0.4

Calculate Average Annual Soil Loss, A:

R =	100	*
K =	0.42	*
LS =	0.4	
C =	0.004	*
P =	1.0	*

A = R * K * LS * C * P = 0.1 tons/acre

* See attached references for R, K, C, and P factors

Soil loss along the 3% slope of the final cover results in minimal soil loss.

Sheet No.	2 of 6
Calc. No.	
Rev. No.	

Job No. 25214060	Job: I-43 Landfill Plan Modification	By: KRG	Date: 1/30/15
Client: Alient Energy	Subject: Soil Loss Along Final Cover	Chk'd:	Date:

Universal Soil Loss Equation (USLE) Calculation

Use USLE to estimate soil loss along the 4:1 final cover slope, with the goal of maintaining ≤ 3 ton/acre of soil loss along the final cover.

USLE Equation:

A = R * K * LS * C * P

where: A = Average annual soil loss, ton/acre
R = Rainfall and runoff erosivity index
K = Soil erodibility factor, tons/acre
LS = Slope length and steepness factor
C = Cover management factor
P = Practice factor

The LS factor is a function of the slope and flow length.

LS = L * S

where: L = Slope length factor = (l/72.6)^m
where: l = Slope length, feet
m = Slope-length exponent (m = 0.3 for slopes of 1% to 3%
m = 0.4 for slopes of 3.5% to 4.5%
m = 0.5 for slopes greater than 5%)

S = Slope steepness factor = (65.41s^2/(s^2 + 10,000)) + (4.56s/(SQRT(s^2 + 10,000))) + 0.065
where: s = Slope, in percent

The soil type chosen for selecting the appropriate K factor is an estimate of silt loam for the topsoil.

Data Entered		**Data Computed**	
Slope (%), s =	25	S =	5.02
l =	136	L =	1.4
m =	0.5	LS =	6.9

Calculate Average Annual Soil Loss, A:

R =	100	*
K =	0.42	*
LS =	6.9	
C =	0.004	*
P =	1.0	*

A = R * K * LS * C * P = 1.2 tons/acre

* See attached references for R, K, C, and P factors

Soil loss along the 4:1 slope of the final cover results in minimal soil loss.

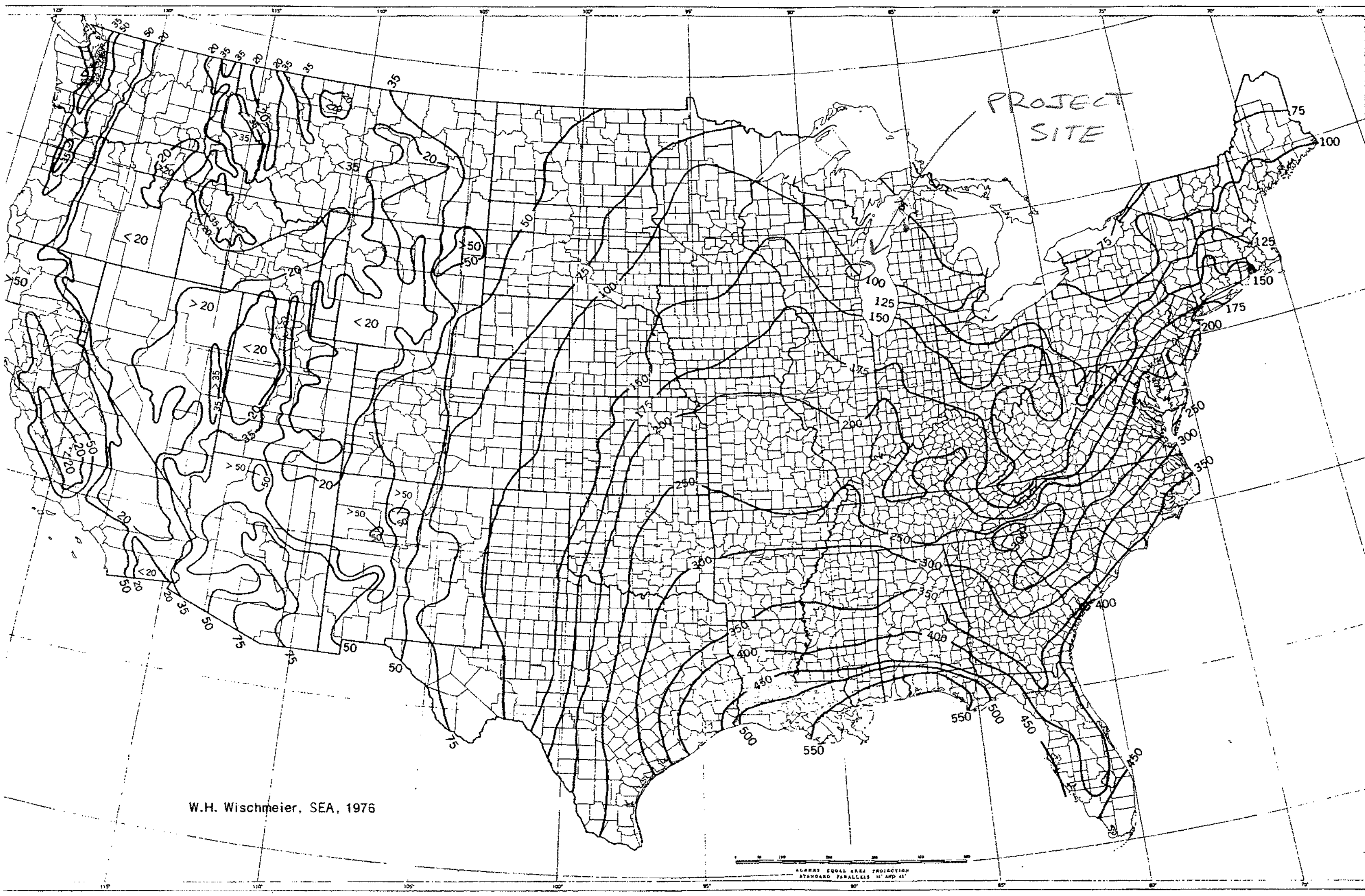


FIGURE 1.—Average annual values of the rainfall erosion index.

3

4

soil in a unit plot, pinpoints differences in erosion according to differences in soil type. Long-term plot studies under natural rainfall have produced K values generalized in Table 5 for the USDA soil types.

TABLE 5. APPROXIMATE VALUES OF FACTOR K FOR USDA TEXTURAL CLASSES[11]

Texture class	Organic matter content <0.5% K	2% K	4% K
Sand	0.05	0.03	0.02
Fine sand	.16	.14	.10
Very fine sand	.42	.36	.28
Loamy sand	.12	.10	.08
Loamy fine sand	.24	.20	.16
Loamy very fine sand	.44	.38	.30
Sandy loam	.27	.24	.19
Fine sandy loam	.35	.30	.24
Very fine sandy loam	.47	.41	.33
Loam	.38	.34	.29
Silt loam	.48	.42	.33
Silt	.60	.52	.42
Sandy clay loam	.27	.25	.21
Clay loam	.28	.25	.21
Silty clay loam	.37	.32	.26
Sandy clay	.14	.13	.12
Silty clay	.25	.23	.19
Clay		0.13-0.29	

The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.

The evaluator must next consider the shape of the slope in terms of length and inclination. The appropriate LS factor is obtained from Table 6. A nonlinear slope may have to be evaluated as a series of segments, each with uniform gradient. Two or three segments should be sufficient for most engineered landfills, provided the segments are selected so that they are also of equal length (Table 6 can be used, with certain adjustments). Enter Table 6 with the total slope length and read LS values corresponding to the percent slope of each segment. For three segments, multiply the chart LS values for the upper, middle, and lower segments by 0.58, 1.06, and 1.37, respectively. The average of the three products is a good estimate of the

5

TABLE 7. GENERALIZED VALUES OF FACTOR C FOR STATES EAST OF THE ROCKY MOUNTAINS[11]

Crop, rotation, and management	Productivity level: High	Productivity level: Mod.
	C value	
Base value: continuous fallow, tilled up and down slope	1.00	1.00
CORN		
C, RdR, fall TP, conv	0.54	0.62
C, RdR, spring TP, conv	.50	.59
C, RdL, fall TP, conv	.42	.52
C, RdR, wc seeding, spring TP, conv	.40	.49
C, RdL, standing, spring TP, conv	.38	.48
C-W-M-M, RdL, TP for C, disk for W	.039	.074
C-W-M-M-M, RdL, TP for C, disk for W	.032	.061
C, no-till pl in c-k sod, 95-80% rc	.017	.053
COTTON		
Cot, conv (Western Plains)	0.42	0.49
Cot, conv (South)	.34	.40
MEADOW		
Grass & Legume mix	0.004	0.01
Alfalfa, lespedeza or Sericia	.020	
Sweet clover	.025	
SORGHUM, GRAIN (Western Plains)		
RdL, spring TP, conv	0.43	0.53
No-till pl in shredded 70-50% rc	.11	.18
SOYBEANS		
B, RdL, spring TP, conv	0.48	0.54
C-B, TP annually, conv	.43	.51
B, no-till pl	.22	.28
C-B, no-till pl, fall shred C stalks	.18	.22
WHEAT		
W-F, fall TP after W	0.38	
W-F, stubble mulch, 500 lbs rc	.32	
W-F, stubble mulch, 1000 lbs rc	.21	

Abbreviations defined:

B - soybeans
C - corn
c-k - chemically killed
conv - conventional
cot - cotton
F - fallow
M - grass & legume hay
pl - plant
W - wheat
wc - winter cover

lbs rc - pounds of crop residue per acre remaining on surface after new crop seeding
% rc - percentage of soil surface covered by residue mulch after new crop seeding
70-50% rc - 70% cover for C values in first column; 50% for second column
RdR - residues (corn stover, straw, etc.) removed or burned
RdL - all residues left on field (on surface or incorporated)
TP - turn plowed (upper 5 or more inches of soil inverted, covering residues)

6

are listed in Table 8. These values are based on rather limited field data, but P has a narrower range of possible values than the other five factors.

TABLE 8. VALUES OF FACTOR P[11]

Practice	Land slope (percent) 1.1-2	2.1-7	7.1-12	12.1-18	18.1-24
	(Factor P)				
Contouring (P_c)	0.60	0.50	0.60	0.80	0.90
Contour strip cropping (P_{sc})					
R-R-M-M[1]	0.30	0.25	0.30	0.40	0.45
R-W-M-M	0.30	0.25	0.30	0.40	0.45
R-R-W-M	0.45	0.38	0.45	0.60	0.68
R-W	0.52	0.44	0.52	0.70	0.90
R-O	0.60	0.50	0.60	0.80	0.90
Contour listing or ridge planting (P_{cl})	0.30	0.25	0.30	0.40	0.45
Contour terracing (P_t)[2]	[3] $0.6/\sqrt{n}$	$0.5/\sqrt{n}$	$0.6/\sqrt{n}$	$0.8/\sqrt{n}$	$0.9/\sqrt{n}$
No support practice	1.0	1.0	1.0	1.0	1.0

[1] R = rowcrop, W = fall-seeded grain, O = spring-seeded grain, M = meadow. The crops are grown in rotation and so arranged on the field that rowcrop strips are always separated by a meadow or winter-grain strip.

[2] These P_t values estimate the amount of soil eroded to the terrace channels and are used for conservation planning. For prediction of off-field sediment, the P_t values are multiplied by 0.2.

[3] n = number of approximately equal-length intervals into which the field slope is divided by the terraces. Tillage operations must be parallel to the terraces.

Example: An owner/operator proposes to close one section of his small landfill with a sandy clay subsoil cover having the surface configuration shown in Figure 21. The factor R has been established as 200 for this locality. The evaluator questions anticipated erosion along the steep side and assigns the following values to the other factors in the USLE after inspecting Tables 5 through 8:

$$K = 0.14 \quad LS = 8.3 \quad C = 1.00 \quad P = 0.90$$

The rate of erosion for the steep slope of the landfill is calculated as follows:

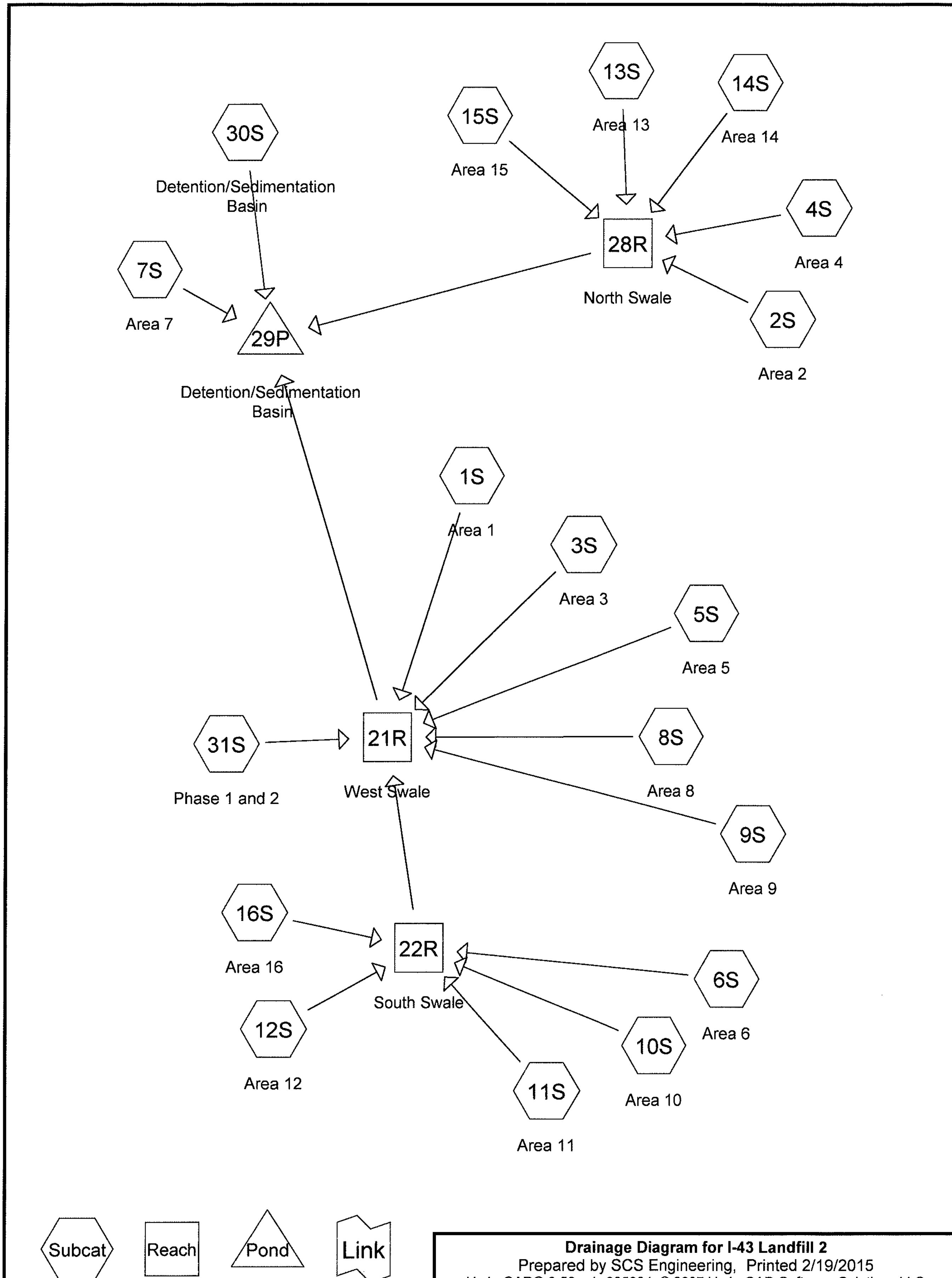
$$A = 200\ (0.14\ \text{tons/acre})\ (8.3)\ (1.00)\ (0.90) = 209\ \text{tons/acre}$$

This erosion not only exceeds a limit recommended by the permitting authority but also indicates a potential

Hydrograph Generation

- 25-year, 24-hour Storm Event
- 100-year, 24-hour Storm Event

25-year, 24-hour Storm



Drainage Diagram for I-43 Landfill 2
Prepared by SCS Engineering, Printed 2/19/2015
HydroCAD® 8.50 s/n 005804 © 2007 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: Area 1

Runoff = 3.71 cfs @ 12.08 hrs, Volume= 0.227 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	1.130	79	
	1.130		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
1.1	78	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	223	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
15.8	401	Total			

Summary for Subcatchment 2S: Area 2

Runoff = 2.45 cfs @ 12.08 hrs, Volume= 0.149 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	0.740	79	
	0.740		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
1.0	70	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	196	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
15.5	366	Total			

Summary for Subcatchment 3S: Area 3

Runoff = 6.61 cfs @ 12.09 hrs, Volume= 0.414 af, Depth> 2.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	2.060	79	
	2.060		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
2.5	182	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	120	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.6	402	Total			

Summary for Subcatchment 4S: Area 4

Runoff = 9.76 cfs @ 12.09 hrs, Volume= 0.616 af, Depth> 2.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	3.060	79	
	3.060		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
2.1	155	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	232	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.8	487	Total			

Summary for Subcatchment 5S: Area 5

Runoff = 6.38 cfs @ 12.09 hrs, Volume= 0.402 af, Depth> 2.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	2.000	79	
	2.000		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
2.9	208	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	77	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.8	385	Total			

Summary for Subcatchment 6S: Area 6

Runoff = 7.37 cfs @ 12.09 hrs, Volume= 0.465 af, Depth> 2.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	2.310	79	
	2.310		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
3.0	215	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	62	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.8	377	Total			

Summary for Subcatchment 7S: Area 7

Runoff = 7.41 cfs @ 12.02 hrs, Volume= 0.381 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	1.890	79	
	1.890		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	65	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.7	144	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.3	209	Total			

Summary for Subcatchment 8S: Area 8

Runoff = 6.83 cfs @ 12.02 hrs, Volume= 0.353 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	1.750	79	
	1.750		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	67	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.6	136	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.4	203	Total			

Summary for Subcatchment 9S: Area 9

Runoff = 3.33 cfs @ 12.01 hrs, Volume= 0.167 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	0.830	79	
	0.830		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	60	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.7	145	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.7	205	Total			

Summary for Subcatchment 10S: Area 10

Runoff = 4.41 cfs @ 12.06 hrs, Volume= 0.256 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	1.270	79	
	1.270		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.5	82	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.5	96	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.1	242	0.0100	1.93	1.93	**Trap/Vee/Rect Channel Flow, Intermediate Swale on 4:1 Slope** Bot.W=0.00' D=0.50' Z= 4.0 '/' Top.W=4.00' n= 0.030
14.1	420	Total			

Summary for Subcatchment 11S: Area 11

Runoff = 7.24 cfs @ 12.06 hrs, Volume= 0.423 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	2.100	79	
	2.100		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.2	12	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	120	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.3	232	Total			

Summary for Subcatchment 12S: Area 12

Runoff = 14.68 cfs @ 12.13 hrs, Volume= 1.021 af, Depth> 2.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	5.080	79	
	5.080		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.9	163	0.0300	0.14		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.2	46	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
20.1	209	Total			

Summary for Subcatchment 13S: Area 13

Runoff = 15.91 cfs @ 12.08 hrs, Volume= 0.976 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	4.850	79	
	4.850		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
1.8	133	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	108	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
15.8	341	Total			

Summary for Subcatchment 14S: Area 14

Runoff = 4.97 cfs @ 12.01 hrs, Volume= 0.250 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	1.240	79	
	1.240		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	62	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.5	111	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.7	173	Total			

Summary for Subcatchment 15S: Area 15

[49] Hint: Tc<2dt may require smaller dt

Runoff = 15.87 cfs @ 11.95 hrs, Volume= 0.661 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	3.270	79	
	3.270		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	58	0.2700	0.27		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.6	145	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.2	203	Total			

Summary for Subcatchment 16S: Area 16

Runoff = 10.90 cfs @ 12.03 hrs, Volume= 0.579 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	2.870	79	
	2.870		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	44	0.0100	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.4	55	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
11.3	99	Total			

Summary for Subcatchment 30S: Detention/Sedimentation Basin

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 60.20 cfs @ 11.89 hrs, Volume= 2.833 af, Depth> 4.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

Area (ac)	CN	Description
7.860	98	Water Surface
7.860		Impervious Area

Summary for Subcatchment 31S: Phase 1 and 2

Runoff = 121.30 cfs @ 12.23 hrs, Volume= 10.476 af, Depth> 2.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=4.79"

	Area (ac)	CN	Description
*	52.300	79	Closed Landfill
	52.300		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0	100	0.0400	0.14		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
4.8	400	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
12.1	2,976	0.0120	4.10	55.37	**Channel Flow, Perimeter Swale** Area= 13.5 sf Perim= 16.3' r= 0.83' n= 0.035 Earth, dense weeds
28.9	3,476	Total			

Summary for Reach 21R: West Swale

[62] Warning: Exceeded Reach 22R OUTLET depth by 1.93' @ 12.40 hrs

Inflow Area = 73.700 ac, 0.00% Impervious, Inflow Depth > 2.40" for 25-yr event
Inflow = 167.13 cfs @ 12.24 hrs, Volume= 14.740 af
Outflow = 146.77 cfs @ 12.51 hrs, Volume= 14.486 af, Atten= 12%, Lag= 16.4 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.67 fps, Min. Travel Time= 9.8 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 26.7 min

Peak Storage= 86,617 cf @ 12.35 hrs, Average Depth at Peak Storage= 2.46'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 214.18 cfs

15.00' x 3.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 33.00'
Length= 1,570.0' Slope= 0.0013 '/'
Inlet Invert= 684.08', Outlet Invert= 682.00'

Summary for Reach 22R: South Swale

Inflow Area = 13.630 ac, 0.00% Impervious, Inflow Depth > 2.41" for 25-yr event
Inflow = 42.53 cfs @ 12.07 hrs, Volume= 2.743 af
Outflow = 35.46 cfs @ 12.29 hrs, Volume= 2.699 af, Atten= 17%, Lag= 13.1 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.03 fps, Min. Travel Time= 8.0 min
Avg. Velocity = 1.27 fps, Avg. Travel Time= 25.2 min

Peak Storage= 17,162 cf @ 12.16 hrs, Average Depth at Peak Storage= 0.71'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 242.67 cfs

10.00' x 2.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 4.0 3.0 '/' Top Width= 24.00'
Length= 1,925.0' Slope= 0.0135 '/'
Inlet Invert= 710.00', Outlet Invert= 684.08'

Summary for Reach 28R: North Swale

Inflow Area = 13.160 ac, 0.00% Impervious, Inflow Depth > 2.42" for 25-yr event
Inflow = 39.81 cfs @ 12.00 hrs, Volume= 2.652 af
Outflow = 35.67 cfs @ 12.18 hrs, Volume= 2.620 af, Atten= 10%, Lag= 10.7 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.31 fps, Min. Travel Time= 6.0 min
Avg. Velocity = 1.37 fps, Avg. Travel Time= 19.0 min

Peak Storage= 12,884 cf @ 12.08 hrs, Average Depth at Peak Storage= 0.67'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 609.75 cfs

10.00' x 3.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 4.0 3.0 '/' Top Width= 31.00'
Length= 1,560.0' Slope= 0.0167 '/'
Inlet Invert= 708.00', Outlet Invert= 682.00'

100-year, 24-hour Storm

Summary for Subcatchment 1S: Area 1

Runoff = 5.86 cfs @ 12.08 hrs, Volume= 0.365 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	1.130	79	
	1.130		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
1.1	78	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	223	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
15.8	401	Total			

Summary for Subcatchment 2S: Area 2

Runoff = 3.88 cfs @ 12.07 hrs, Volume= 0.239 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	0.740	79	
	0.740		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
1.0	70	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	196	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
15.5	366	Total			

Summary for Subcatchment 3S: Area 3

Runoff = 10.45 cfs @ 12.09 hrs, Volume= 0.665 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	2.060	79	
	2.060		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
2.5	182	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	120	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.6	402	Total			

Summary for Subcatchment 4S: Area 4

Runoff = 15.43 cfs @ 12.09 hrs, Volume= 0.987 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	3.060	79	
	3.060		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
2.1	155	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	232	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.8	487	Total			

Summary for Subcatchment 5S: Area 5

Runoff = 10.09 cfs @ 12.09 hrs, Volume= 0.645 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	2.000	79	
	2.000		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
2.9	208	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	77	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.8	385	Total			

Summary for Subcatchment 6S: Area 6

Runoff = 11.65 cfs @ 12.09 hrs, Volume= 0.745 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	2.310	79	
	2.310		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
3.0	215	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	62	0.0100	3.11	57.58	**Trap/Vee/Rect Channel Flow, Intermediate Swale** Bot.W=0.00' D=1.00' Z= 4.0 & 33.0 '/' Top.W=37.00' n= 0.030 Short grass
16.8	377	Total			

Summary for Subcatchment 7S: Area 7

Runoff = 11.66 cfs @ 12.02 hrs, Volume= 0.611 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	1.890	79	
	1.890		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	65	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.7	144	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.3	209	Total			

Summary for Subcatchment 8S: Area 8

Runoff = 10.75 cfs @ 12.02 hrs, Volume= 0.566 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	1.750	79	
	1.750		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	67	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.6	136	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.4	203	Total			

Summary for Subcatchment 9S: Area 9

Runoff = 5.23 cfs @ 12.01 hrs, Volume= 0.268 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	0.830	79	
	0.830		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	60	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.7	145	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.7	205	Total			

Summary for Subcatchment 10S: Area 10

Runoff = 6.96 cfs @ 12.06 hrs, Volume= 0.410 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	1.270	79	
	1.270		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.5	82	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.5	96	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.1	242	0.0100	1.93	1.93	**Trap/Vee/Rect Channel Flow, Intermediate Swale on 4:1 Slope** Bot.W=0.00' D=0.50' Z= 4.0 '/' Top.W=4.00' n= 0.030
14.1	420	Total			

Summary for Subcatchment 11S: Area 11

Runoff = 11.43 cfs @ 12.06 hrs, Volume= 0.678 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	2.100	79	
	2.100		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.2	12	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	120	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
14.3	232	Total			

Summary for Subcatchment 12S: Area 12

Runoff = 23.32 cfs @ 12.12 hrs, Volume= 1.638 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	5.080	79	
	5.080		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.9	163	0.0300	0.14		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.2	46	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
20.1	209	Total			

Summary for Subcatchment 13S: Area 13

Runoff = 25.14 cfs @ 12.08 hrs, Volume= 1.566 af, Depth> 3.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	4.850	79	
	4.850		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5	100	0.0300	0.12		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
1.8	133	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	108	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
15.8	341	Total			

Summary for Subcatchment 14S: Area 14

Runoff = 7.82 cfs @ 12.01 hrs, Volume= 0.401 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	1.240	79	
	1.240		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	62	0.0300	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.5	111	0.2500	3.50		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.7	173	Total			

Summary for Subcatchment 15S: Area 15

[49] Hint: Tc<2dt may require smaller dt

Runoff = 24.79 cfs @ 11.95 hrs, Volume= 1.059 af, Depth> 3.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	3.270	79	
	3.270		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	58	0.2700	0.27		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.6	145	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.2	203	Total			

Summary for Subcatchment 16S: Area 16

Runoff = 17.15 cfs @ 12.03 hrs, Volume= 0.928 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	2.870	79	
	2.870		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	44	0.0100	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
0.4	55	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
11.3	99	Total			

Summary for Subcatchment 30S: Detention/Sedimentation Basin

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 82.51 cfs @ 11.89 hrs, Volume= 3.928 af, Depth> 6.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

Area (ac)	CN	Description
7.860	98	Water Surface
7.860		Impervious Area

Summary for Subcatchment 31S: Phase 1 and 2

Runoff = 193.11 cfs @ 12.23 hrs, Volume= 16.809 af, Depth> 3.86"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=6.55"

	Area (ac)	CN	Description
*	52.300	79	Closed Landfill
	52.300		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0	100	0.0400	0.14		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.59"
4.8	400	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
12.1	2,976	0.0120	4.10	55.37	**Channel Flow, Perimeter Swale** Area= 13.5 sf Perim= 16.3' r= 0.83' n= 0.035 Earth, dense weeds
28.9	3,476	Total			

Summary for Reach 21R: West Swale

[91] Warning: Storage range exceeded by 0.22'
[55] Hint: Peak inflow is 126% of Manning's capacity
[62] Warning: Exceeded Reach 22R OUTLET depth by 2.51' @ 12.35 hrs

Inflow Area = 73.700 ac, 0.00% Impervious, Inflow Depth > 3.85" for 100-yr event
Inflow = 270.76 cfs @ 12.22 hrs, Volume= 23.663 af
Outflow = 242.71 cfs @ 12.46 hrs, Volume= 23.342 af, Atten= 10%, Lag= 14.5 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.08 fps, Min. Travel Time= 8.5 min
Avg. Velocity = 1.09 fps, Avg. Travel Time= 23.9 min

Peak Storage= 124,154 cf @ 12.32 hrs, Average Depth at Peak Storage= 3.22'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 214.18 cfs

15.00' x 3.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 33.00'
Length= 1,570.0' Slope= 0.0013 '/'
Inlet Invert= 684.08', Outlet Invert= 682.00'

Summary for Reach 22R: South Swale

Inflow Area = 13.630 ac, 0.00% Impervious, Inflow Depth > 3.87" for 100-yr event
Inflow = 67.37 cfs @ 12.07 hrs, Volume= 4.399 af
Outflow = 58.27 cfs @ 12.26 hrs, Volume= 4.345 af, Atten= 14%, Lag= 11.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.71 fps, Min. Travel Time= 6.8 min
Avg. Velocity = 1.43 fps, Avg. Travel Time= 22.5 min

Peak Storage= 24,052 cf @ 12.14 hrs, Average Depth at Peak Storage= 0.94'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 242.67 cfs

10.00' x 2.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 4.0 3.0 '/' Top Width= 24.00'
Length= 1,925.0' Slope= 0.0135 '/'
Inlet Invert= 710.00', Outlet Invert= 684.08'

Summary for Reach 28R: North Swale

Inflow Area = 13.160 ac, 0.00% Impervious, Inflow Depth > 3.88" for 100-yr event
Inflow = 63.20 cfs @ 12.00 hrs, Volume= 4.252 af
Outflow = 57.58 cfs @ 12.16 hrs, Volume= 4.213 af, Atten= 9%, Lag= 9.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.04 fps, Min. Travel Time= 5.2 min
Avg. Velocity = 1.53 fps, Avg. Travel Time= 17.0 min

Peak Storage= 17,962 cf @ 12.07 hrs, Average Depth at Peak Storage= 0.88'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 609.75 cfs

10.00' x 3.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 4.0 3.0 '/' Top Width= 31.00'
Length= 1,560.0' Slope= 0.0167 '/'
Inlet Invert= 708.00', Outlet Invert= 682.00'

Perimeter Ditch and Diversion Berm Sizing

I-43 Landfill
Sheboygan, WI

Lining Type: Vegetation

Project ID: I-43 Landfill - Plan Modification		
Location: Sheboygan, WI		
Designer/Checker: KRG		
Date: 1/6/15		

	South Swale Q=25-yr	North Swale Q=25-yr	Int. Swale Q=25-yr
Channel/Ditch Geometry			
Channel Slope, S_o (ft/ft)	**0.013**	**0.025**	**0.01**
Channel Bottom Width, B (ft)	**10**	**6**	**0**
Channel Side Slope, z_1	**4**	**3**	**2**
Channel Side Slope, z_2	**3**	**2**	**0.03**
Flow Depth, d (ft) Solve iteratively	**0.89**	**0.86**	**1.65**
Safety Factor, SF	**1.5**	**1.5**	**1.5**
Vegetation/Soil Parameters			
Vegetation Retardance Class	**D**	**D**	**D**
Vegetation Condition	**good**	**good**	**good**
Vegetation Growth Form	**turf**	**turf**	**turf**
Soil Type	**cohesive**	**cohesive**	**cohesive**
D_{75} (in) (Set at 0.00 for cohesive soils)			
ASTM Soil Class	**SC**	**SC**	**SC**
Plasticity Index, PI	**16**	**16**	**16**
Results Summary			
Design Q (ft^3/s)	**35.5**	**35.7**	**4.9**
Calculated Q (ft^3/s)	35.8	35.7	4.8
Difference Between Design & Calc. Flow (%)	0.9%	0.0%	-0.5%
Stable (Yes or No)	YES	YES	YES
Channel Parameters			
Vegetation Height, h (ft)	0.33	0.33	0.33
Grass Roughness Coefficient, C_n	0.165	0.165	0.165
Cover Factor, C_f	0.90	0.90	0.90
Noncohesive Soil			
Soil Grain Roughness, n_s	0.016	0.016	0.016
Permissible Soil Shear Stress, τ_p (lb/ft^2)	N/A	N/A	N/A
Cohesive Soil			
Porosity, e	0.35	0.35	0.35
Soil Coefficient 1, c_1	1.0700	1.0700	1.0700
Soil Coefficient 2, c_2	14.30	14.30	14.30
Soil Coefficient 3, c_3	47.700	47.700	47.700
Soil Coefficient 4, c_4	1.42	1.42	1.42
Soil Coefficient 5, c_5	-0.61	-0.61	-0.61
Soil Coefficient 6, c_6	0.00010	0.00010	0.00010
Permissible Soil Shear Stress, τ_p (lb/ft^2)	0.080	0.080	0.080
Total Permissible Shear Stress, τ_p (lb/ft^2)	0.080	0.080	0.080
Cross Sectional Area, A (ft^2)	11.672	7.009	2.763
Wetted Perimeter, P (ft)	16.48	10.64	5.34
Hydraulic Radius, R (ft)	0.708	0.659	0.517
Top Width, T (ft)	16.23	10.30	3.35
Hydraulic Depth, D (ft)	0.719	0.680	0.825
Froude Number (Q design)	0.637	1.088	0.339
Channel Shear Stress, τ_o (lb/ft^2)	0.57	1.03	0.32
Actual Sheer Stress, τ_d (lb/ft^2)	0.72	1.34	1.03
Mannings n	0.044	0.035	0.055
Average Velocity, V (ft/s)	3.04	5.09	1.76
Calculated Flow, Q (ft^3/s)	35.8	35.7	4.8
Difference Between Design & Calc. Flow (%)	0.9%	0.0%	-0.5%
Effective Shear on Soil Surface, τ_e (lb/ft^2)	0.010	0.028	0.009
Total Permissible Shear on Veg., $\tau_{p\,veg}$ (lb/ft^2)	6.06	3.83	9.47
Stable (Y or N)	YES	YES	YES

SCS ENGINEERS

		Sheet No. 1/3	
		Calc. No.	
		Rev. No.	
Job No. 25214060	Job: I-43 Landfill	By: KRG	Date: 01/14/15
Client: Alliant Energy	Subject: Downslope Flume Sizing	Chk'd: ZB	Date: 02/09/15

Purpose: To size the downslope flume pipes to accommodate the flows expected from a 25-year, 24-hour storm event.

Approach: Use the orifice equation to size the downslope pipe inlet and Manning's equation to size the downslope pipes.

Calculations:

The runoff must first get into the down slope flume
The entrance to the flume is a Y with an open pipe on each branch of the Y.
1/2 of the flowrate of the 25-yr storm event for each drainage area will enter each branch of the flume.
An orifice equation calculates the flowrate of water that can enter the pipe.

Orifice Equation: $Q = C \times A \times (2 \times g \times h)^{0.5}$

Q = flow rate (cfs)
C = orifice coefficent = 0.63
A = area of orifice = 0.78 sf for 12" dia. pipe, 10" = 0.54 sf, 8" = 0.35 sf
g = acceleration due to gravity = 32.2 ft/sec^2
h = orifice head acting on centerline = 1.5 x pipe diameter = 1.5' for 12" dia. pipe, 1.25' for 10", 1.0
$Q_{12''\ pipe} = 0.63 \times .78 \times (2 \times 32.2 \times 1.5)^{0.5} =$ 4.83 cfs
$Q_{10''\ pipe} = 0.63 \times .54 \times (2 \times 32.2 \times 1.25)^{0.5} =$ 3.05 cfs

The downslope flume pipes have the following flow capacities at the designated slopes:

	Flow Capacity of Pipe*
Flume Size	25% slope
12" dia.	19.3 cfs
10" dia.	11.8 cfs

* See Sheets 2 - 3 for the Manning's flow calculations.

Results:

The downslope flumes will consist of the following sizes, as indicated on Plan Sheet 14.

Flume Number	Flow Rate (cfs)	1/2 the Flowrate (cfs)	Flume Size
Flume 1 (Area 1)	3.7	1.9	10 inch
Flume 2 (Area 2)	2.5	1.3	10 inch
Flume 3 (Area 3)	6.6	3.3	12 inch
Flume 4 (Area 4)	9.7	4.9	12 inch
Flume 5 (Area 5)	6.4	3.2	12 inch
Flume 6 (Area 6)	7.4	3.7	12 inch

2

Free Online Manning Pipe Flow Calculator

List of Calculators Hydraulics Language

Manning Formula Uniform Pipe Flow at Given Slope and Depth

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I-43 Landfill

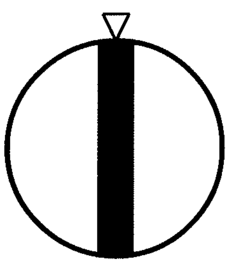
Down Slope Flumes

Set units: m mm ft inches

Pipe diameter, d_0	10 inches
Manning roughness, n ?	.012
Pressure slope (possibly ? equal to pipe slope), S_0	.25 rise/run
Percent of (or ratio to) full depth (100% or 1 if flowing full)	100 %

Results:

Flow, q	11.8668	cfs
Velocity, v	21.7580	ft/sec
Velocity head, h_v	88.2918	inches
Flow area	78.5400	sq. in.
Wetted perimeter	31.4159	inches
Hydraulic radius	2.5000	inches
Top width, T	0.0000	inches
Froude number, F	0.00	
Shear stress (tractive force), tau	13.0078	psf



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I-43 Landfill

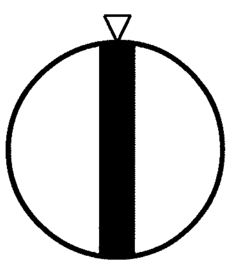
Down Slope Flumes

Set units: m mm ft inches

Pipe diameter, d_0	12	inches
Manning roughness, n ?	.012	
Pressure slope (possibly ? equal to pipe slope), S_0	.25	rise/run
Percent of (or ratio to) full depth (100% or 1 if flowing full)	100	%

Results:

Flow, q	19.2967	cfs
Velocity, v	24.5700	ft/sec
Velocity head, h_v	112.5889	inches
Flow area	113.0976	sq. in.
Wetted perimeter	37.6991	inches
Hydraulic radius	3.0000	inches
Top width, T	0.0000	inches
Froude number, F	0.00	
Shear stress (tractive force), tau	15.6094	psf



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Downslope Flume and Energy Dissipator Sizing

Energy Dissipator Design

Design the Energy Dissipators located at the end of each downslope flume using the US Dept. of Transportation, Hydraulic Engineering Circular No. 14, "Hydraulic Design of Energy dissipators for Culverts and Channels", July 2006.

Pipe/Culvert: Flume 3, 4, 5, 6, and 7

* Peak flow in this flume from 25-year, 24-hour event is 9.7 cfs.

Flow is in a 12" dia. Flume

From an on-line Mannings Equation Calculator (see page 3)

Q = 9.7 cfs

n = 0.01

V = 28.2 ft/sec

A = 49.64 sq. in. = 0.34 sq. ft.

Fr = 8.58

Compute Equivalent Depth of Flow Entering Dissipator:

$Y_e = (A/2)^{1/2}$ where: Ye = Equivalent depth

A = Area (from above)

Y_e = 0.42 ft

Compute Energy at End of Pipe:

$H_o = Y_e + V^2/2g$ where: H_o = Energy

Y_e = Equivalent depth (from above)

V = Velocity (from above)

g = Gravity constant (32.2 ft/sec)

Ho = 12.76 ft

Determine Width of Dissipator:

Use Froude Number computed above and Figure 9.14 (see page 5) from "Hydraulic Design of Energy Dissipators for Culverts and Channels" to obtain value for H_o/W. Given H_o above, compute W (width of dissipator).

From Figure 9.14, H_o/W_B = 3.9 (interpolated)

W_B = 3.3 ft

Determine Remaining Dimensions of the Dissipator:

Based on W determined above, use Table 9.2 (CU) (page 6) to determine the remaining dissipator dimensions. Round the value of W_B to the nearest entry in the table (interpolation is not necessary).

Note: the smallest W_B on Table 9.2 is 4.0 ft, so this dimension is used.

Energy Dissipator Design

Pipe/Culvert: Flume 1 and 2

* Peak flow in this flume from 25-year, 24-hour event is 4.0 cfs.

Flow is in a 10" dia. Flume

From an on-line Mannings Equation Calculator (see page 4)

Q = 4 cfs

n = 0.01

V = 22.4 ft/sec

A = 25.7 sq. in. = 0.18 sq. ft.

Fr = 8.5

Compute Equivalent Depth of Flow Entering Dissipator:

$Y_e = (A/2)^{1/2}$ where: Ye = Equivalent depth

A = Area (from above)

$Y_e =$ 0.30 ft

Compute Energy at End of Pipe:

$H_o = Y_e + V^2/2g$ where: H_o = Energy

Y_e = Equivalent depth (from above)

V = Velocity (from above)

g = Gravity constant (32.2 ft/sec)

Ho = 8.09 ft

Determine Width of Dissipator:

Use Froude Number computed above and Figure 9.14 from "Hydraulic Design of Energy Dissipators for Culverts and Channels" to obtain value for H_o/W. Given H_o above, compute W (width of dissipator).

From Figure 9.14, $H_o/W_B =$ 3.9 (interpolated)

$W_B =$ 2.1 ft

Determine Remaining Dimensions of the Dissipator:

Based on W determined above, use Table 9.2 (CU) to determine the remaining dissipator dimensions. Round the value of W_B to the nearest entry in the table (interpolation is not necessary).

Note: the smallest W_B on Table 9.2 is 4.0 ft, so this dimension is used.

Free Online Manning Pipe Flow Calculator

List of Calculators Hydraulics Language

Manning Formula Uniform Pipe Flow at Given Slope and Depth

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I-43 Landfill

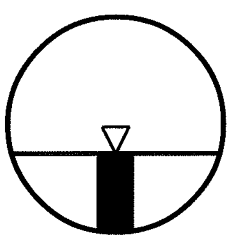
Down Slope Flumes 1,2,8,9,10

Set units: m mm ft inches

Pipe diameter, d_0	10 inches ▼
Manning roughness, n ?	.01
Pressure slope (possibly ? equal to pipe slope), S_0	.25 rise/run ▼
Percent of (or ratio to) full depth (100% or 1 if flowing full)	36.3 % ▼

Results:

Flow, q	4.0097	cfs ▼
Velocity, v	22.4299	ft/sec ▼
Velocity head, h_v	93.8297	inches ▼
Flow area	25.7434	sq. in. ▼
Wetted perimeter	12.9325	inches ▼
Hydraulic radius	1.9906	inches ▼
Top width, T	9.6173	inches ▼
Froude number, F	8.50	
Shear stress (tractive force), tau	4.7218	psf ▼



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shows the relationship of the Froude number to the ratio of the energy entering the dissipator to the width of dissipator required. The Los Angeles tests indicate that limited extrapolation of this curve is permissible.

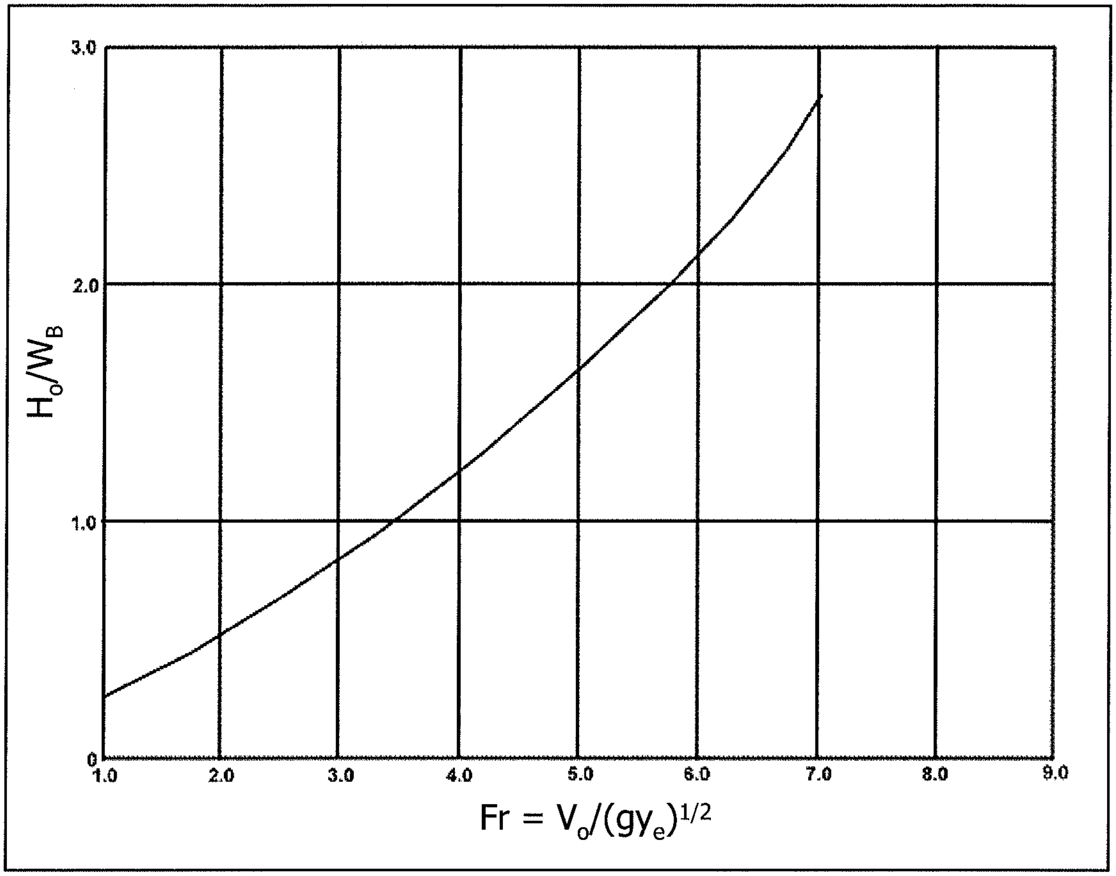


Figure 9.14. Design Curve for USBR Type VI Impact Basin

Once the basin width, W_B, has been determined, many of the other dimensions shown in Figure 9.13 follow according to Table 9.2. To use Table 9.2, round the value of W_B to the nearest entry in the table to determine the other dimensions. Interpolation is not necessary.

In calculating the energy and the Froude number, the equivalent depth of flow, $y_e = (A/2)^{1/2}$, entering the dissipator from a pipe or irregular-shaped conduit must be computed. In other words, the cross section flow area in the pipe is converted into an equivalent rectangular cross section in which the width is twice the depth of flow. The conduit preceding the dissipator can be open, closed, or of any cross section.

The effectiveness of the basin is best illustrated by comparing the energy losses within the structure to those in a natural hydraulic jump, Figure 9.15. The energy loss was computed based on depth and velocity measurements made in the approach pipe and also in the downstream channel with no tailwater. Compared with the natural hydraulic jump, the USBR Type VI impact basin shows a greater capacity for dissipating energy.

Table 9.2 (CU). USBR Type VI Impact Basin Dimensions (ft) (AASHTO, 2005)

W_B	h_1	h_2	h_3	h_4	L	L_1	L_2
4.	3.08	1.50	0.67	1.67	5.42	2.33	3.08
5.	3.83	1.92	0.83	2.08	6.67	2.92	3.83
6.	4.58	2.25	1.00	2.50	8.00	3.42	4.58
7.	5.42	2.58	1.17	2.92	9.42	4.00	5.42
8.	6.17	3.00	1.33	3.33	10.67	4.58	6.17
9.	6.92	3.42	1.50	3.75	12.00	5.17	6.92
10.	7.58	3.75	1.67	4.17	13.42	5.75	7.67
11.	8.42	4.17	1.83	4.58	14.58	6.33	8.42
12.	9.17	4.50	2.00	5.00	16.00	6.83	9.17
13.	10.17	4.92	2.17	5.42	17.33	7.42	10.00
14.	10.75	5.25	2.33	5.83	18.67	8.00	10.75
15.	11.50	5.58	2.50	6.25	20.00	8.50	11.50
16.	12.25	6.00	2.67	6.67	21.33	9.08	12.25
17.	13.00	6.33	2.83	7.08	21.50	9.67	13.00
18.	13.75	6.67	3.00	7.50	23.92	10.25	13.75
19.	14.58	7.08	3.17	7.92	25.33	10.83	14.58
20.	15.33	7.50	3.33	8.33	26.58	11.42	15.33

W_B	W_1	W_2	t_1	t_2	t_3	t_4	t_5
4.	0.33	1.08	0.50	0.50	0.50	0.50	0.25
5.	0.42	1.42	0.50	0.50	0.50	0.50	0.25
6.	0.50	1.67	0.50	0.50	0.50	0.50	0.25
7.	0.50	1.92	0.50	0.50	0.50	0.50	0.25
8.	0.58	2.17	0.50	0.58	0.58	0.50	0.25
9.	0.67	2.50	0.58	0.58	0.67	0.58	0.25
10.	0.75	2.75	0.67	0.67	0.75	0.67	0.25
11.	0.83	3.00	0.67	0.75	0.75	0.67	0.33
12.	0.92	3.00	0.67	0.83	0.83	0.75	0.33
13.	1.00	3.00	0.67	0.92	0.83	0.83	0.33
14.	1.08	3.00	0.67	1.00	0.92	0.92	0.42
15.	1.17	3.00	0.67	1.00	1.00	1.00	0.42
16.	1.25	3.00	0.75	1.00	1.00	1.00	0.50
17.	1.33	3.00	0.75	1.08	1.00	1.00	0.50
18.	1.33	3.00	0.75	1.08	1.08	1.08	0.58
19.	1.42	3.00	0.83	1.17	1.08	1.08	0.58
20.	1.50	3.00	0.83	1.17	1.17	1.17	0.67

Culvert Sizing

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 146 cfs

Maximum Flow: 270 cfs

Table 1 - Summary of Culvert Flows at Crossing: I-43 Landfill

Headwater Elevation (ft)	Total Discharge (cfs)	West Swale Culverts Discharge (cfs)	Roadway Discharge (cfs)	Iterations
678.70	0.00	0.00	0.00	1
680.07	27.00	27.00	0.00	1
680.67	54.00	54.00	0.00	1
681.15	81.00	81.00	0.00	1
681.63	108.00	108.00	0.00	1
682.07	135.00	135.00	0.00	1
682.23	146.00	146.00	0.00	1
683.11	189.00	189.00	0.00	1
683.47	216.00	216.00	0.00	1
683.81	243.00	243.00	0.00	1
684.16	270.00	270.00	0.00	1
686.00	392.66	392.66	0.00	Overtopping

Table 2 - Culvert Summary Table: West Swale Culverts

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
	0.00	0.00	678.70	0.000	0.000	0-NF	0.000	0.000	0.300	0.000	0.000
	27.00	27.00	680.07	1.369	0.951	1-JS1t	0.985	1.006	1.238	0.938	3.542
	54.00	54.00	680.67	1.973	1.427	1-JS1t	1.408	1.437	1.674	1.374	4.669
	81.00	81.00	681.15	2.451	1.828	1-JS1t	1.739	1.772	2.008	1.708	5.484
	108.00	108.00	681.63	2.934	2.200	1-JS1t	2.031	2.060	2.287	1.987	6.168
	135.00	135.00	682.07	3.369	2.563	1-JS1t	2.308	2.317	2.531	2.231	6.769
	146.00	146.00	682.23	3.535	2.322	1-JS1t	2.413	2.415	2.622	2.322	7.000
	189.00	189.00	683.11	4.141	4.412	3-M1t	2.822	2.760	2.947	2.647	7.847
	216.00	216.00	683.47	4.506	4.766	3-M1t	3.076	2.960	3.131	2.831	8.348
	243.00	243.00	683.81	4.872	5.114	3-M2t	3.341	3.145	3.301	3.001	8.834
	270.00	270.00	684.16	5.250	5.459	3-M2t	3.614	3.324	3.461	3.161	9.308

****

Straight Culvert

Inlet Elevation (invert): 678.70 ft, Outlet Elevation (invert): 678.40 ft

Culvert Length: 100.00 ft, Culvert Slope: 0.0030

****

Site Data - West Swale Culverts

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 678.70 ft

Outlet Station: 100.00 ft

Outlet Elevation: 678.40 ft

Number of Barrels: 2

Culvert Data Summary - West Swale Culverts

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: I-43 Landfill)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	678.70	0.00	0.00	0.00	0.00
27.00	679.64	0.94	2.25	0.18	0.45
54.00	680.07	1.37	2.78	0.26	0.48
81.00	680.41	1.71	3.13	0.32	0.49
108.00	680.69	1.99	3.40	0.37	0.50
135.00	680.93	2.23	3.63	0.42	0.51
146.00	681.02	2.32	3.71	0.43	0.51
189.00	681.35	2.65	3.98	0.50	0.52
216.00	681.53	2.83	4.13	0.53	0.52
243.00	681.70	3.00	4.26	0.56	0.53
270.00	681.86	3.16	4.38	0.59	0.53

Tailwater Channel Data - I-43 Landfill

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0030

Channel Manning's n: 0.0300

Channel Invert Elevation: 678.70 ft

Roadway Data for Crossing: I-43 Landfill

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 686.00 ft

Roadway Surface: Gravel

Roadway Top Width: 20.00 ft

Sedimentation Basin Sizing

Sedimentation Basin Sizing

Performance Criteria

* Sedimentation basin is designed to settle out particles 15 microns and greater for the 25-year, 24-hour storm event
* Principal spillway is designed to pass the 25-year, 24-hour storm event.
* Emergency spillway is designed to pass the 100-yr, 24-hour storm event.

Use the Table 8.1 presented in Erosion and Sediment Control Handbook (Goldman, *et al*., 1986) that provides the surface area to discharge ratios required to achieve settlement of the desired particle sizes. The table is included below. From this table, use the surface area to flow ratio for the sedimentation to determine the maximum particle size settled.

The table below summarized the surface area to flow ratios for sedimentation basins. It also summarizes the free board for the 100-year, 24-hour storm event. The information is based on the HydroCAD model output included in this appendix.

TABLE 8.1 Surface Area Requirements of Sediment Traps and Basins

Particle size, mm	Settling velocity, ft/sec (m/sec)	Surface area requirements, ft^2 per ft^3/sec discharge	(m^2 per m^3/sec discharge)
0.5 (coarse sand)	0.19 (0.058)	6.3	(20.7)
0.2 (medium sand)	0.067 (0.020)	17.9	(58.7)
0.1 (fine sand)	0.023 (0.0070)	52.2	(171.0)
0.05 (coarse silt)	0.0062 (0.0019)	193.6	(635.0)
0.02 (medium silt)	0.00096 (0.00029)	1,250.0	(4,101.0)
0.01 (fine silt)	0.00024 (0.000073)	5,000.0	(16,404.0)
0.005 (clay)	0.00006 (0.000018)	20,000.0	(65,617.0)

The output from the HydroCAD model for the 25 and 100-yr storm event is included on Pages 2 - 3.

25-year, 24 hour Storm			Surface Area at Peak Water Surface Elevation, SA (sf)	SA/Q Ratio	Maximum Particle Size Settled (mm)	100-yr, 24-hr Storm Peak Water Surface Elevation	Top of Berm Elevation (Freeboard)	Basin Freeboard for 100-yr Storm (feet)
Peak Inflow (cfs)	Peak Discharge Q (cfs)	Peak Water Surface Elevation						
165.09	17.1	684.74	230,955	13,506	< 0.01	685.90	686.50	0.6

Summary for Pond 29P: Detention/Sedimentation Basin

[63] Warning: Exceeded Reach 21R INLET depth by 0.10' @ 15.40 hrs
[62] Warning: Exceeded Reach 28R OUTLET depth by 2.62' @ 14.55 hrs

Inflow Area = 96.610 ac, 8.14% Impervious, Inflow Depth > 2.52" for 25-yr event
Inflow = 165.09 cfs @ 12.49 hrs, Volume= 20.321 af
Outflow = 17.07 cfs @ 14.38 hrs, Volume= 10.223 af, Atten= 90%, Lag= 113.9 min
Primary = 17.07 cfs @ 14.38 hrs, Volume= 10.223 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 684.74' @ 14.38 hrs Surf.Area= 5.302 ac Storage= 13.038 af

Plug-Flow detention time= 247.0 min calculated for 10.223 af (50% of inflow)
Center-of-Mass det. time= 161.9 min (963.6 - 801.6)

Volume	Invert	Avail.Storage	Storage Description
#1	681.46'	20.170 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
681.46	2.750	0.000	0.000
682.00	2.880	1.520	1.520
684.00	4.860	7.740	9.260
686.00	6.050	10.910	20.170

Device	Routing	Invert	Outlet Devices
#1	Primary	681.50'	**24.0" x 50.0' long Culvert** CMP, square edge headwall, Ke= 0.500 Outlet Invert= 681.00' S= 0.0100 '/' Cc= 0.900 n= 0.025 Corrugated metal
#2	Device 1	681.75'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#3	Device 1	682.25'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#4	Device 1	682.75'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#5	Device 1	683.25'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#6	Device 1	684.00'	**36.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#7	Secondary	685.00'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=17.07 cfs @ 14.38 hrs HW=684.74' (Free Discharge)
└─**1=Culvert** (Barrel Controls 17.07 cfs @ 5.43 fps)
  ├─**2=Orifice/Grate** (Passes < 6.26 cfs potential flow)
  ├─**3=Orifice/Grate** (Passes < 5.66 cfs potential flow)
  ├─**4=Orifice/Grate** (Passes < 4.99 cfs potential flow)
  ├─**5=Orifice/Grate** (Passes < 4.22 cfs potential flow)
  └─**6=Orifice/Grate** (Passes < 19.76 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=681.46' (Free Discharge)
└─**7=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 29P: Detention/Sedimentation Basin

[63] Warning: Exceeded Reach 21R INLET depth by 0.92' @ 14.35 hrs
[62] Warning: Exceeded Reach 28R OUTLET depth by 3.71' @ 13.60 hrs

```
Inflow Area =     96.610 ac,   8.14% Impervious,  Inflow Depth >  3.99"   for  100-yr event
Inflow      =    272.92 cfs @  12.44 hrs,  Volume=        32.094 af
Outflow     =     44.56 cfs @  13.47 hrs,  Volume=        18.380 af,  Atten= 84%,  Lag= 62.0 min
Primary     =     22.02 cfs @  13.47 hrs,  Volume=        13.215 af
Secondary   =     22.55 cfs @  13.47 hrs,  Volume=         5.165 af
```

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 685.90' @ 13.47 hrs Surf.Area= 5.991 ac Storage= 19.576 af

Plug-Flow detention time= 214.7 min calculated for 18.331 af (57% of inflow)
Center-of-Mass det. time= 138.1 min (930.0 - 791.9)

Volume	Invert	Avail.Storage	Storage Description
#1	681.46'	20.170 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
681.46	2.750	0.000	0.000
682.00	2.880	1.520	1.520
684.00	4.860	7.740	9.260
686.00	6.050	10.910	20.170

Device	Routing	Invert	Outlet Devices
#1	Primary	681.50'	**24.0" x 50.0' long Culvert** CMP, square edge headwall, Ke= 0.500 Outlet Invert= 681.00' S= 0.0100 '/' Cc= 0.900 n= 0.025 Corrugated metal
#2	Device 1	681.75'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#3	Device 1	682.25'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#4	Device 1	682.75'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#5	Device 1	683.25'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#6	Device 1	684.00'	**36.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#7	Secondary	685.00'	**10.0' long x 30.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=22.02 cfs @ 13.47 hrs HW=685.90' (Free Discharge)
└─**1=Culvert** (Barrel Controls 22.02 cfs @ 7.01 fps)
  ├─**2=Orifice/Grate** (Passes < 7.47 cfs potential flow)
  ├─**3=Orifice/Grate** (Passes < 6.97 cfs potential flow)
  ├─**4=Orifice/Grate** (Passes < 6.44 cfs potential flow)
  ├─**5=Orifice/Grate** (Passes < 5.86 cfs potential flow)
  └─**6=Orifice/Grate** (Passes < 46.93 cfs potential flow)

Secondary OutFlow Max=22.54 cfs @ 13.47 hrs HW=685.90' (Free Discharge)
└─**7=Broad-Crested Rectangular Weir** (Weir Controls 22.54 cfs @ 2.50 fps)

2016 Contact Water Basin
Storage Calculation

Purpose:

The contact water basin at the I-43 landfill accommodates runoff pumped from contact water handling areas within each module and from other areas directly dischargin into the contact water basin during storm events. The purpose of this calculation is to determine the maximum starting water elevation in the contact water basin prior to a 25-year, 24-hour storm event in order to accommodate the volume of runoff from these two contributing sources.

Approach:

Determine the 25-year, 24-hour storm event runoff volumes contributing to the contact water basin for each phase of development, starting with Phase 3, Module 2. Use the HydroCAD model to calculate volumes. Drainage areas during each stage of development are shown on the attached figures.

Determine the remaining capacity of the contact water basin, assuming the basin has standing water at various intervals prior to the start of the storm event. One foot intervals were used.

Assumptions

A 25-year, 24-hour storm event = 4.80 inches, based on NOAA Atlas 14.

Assume a MSE4 storm distribution.

Assume 1' of freeboard will be maintained in the contact water basin.

Ash has a runoff curve number of 98.

Assume other site areas draining into the contact water basin are bare soil.

Results:

Phase 3 Module 2 Active

To accommodate the runoff volume (269,114 cf) resulting from a 25-year, 24-hour storm event, the starting water elevation in the pond should be 682.5 or lower.

Phase 4 Module 2

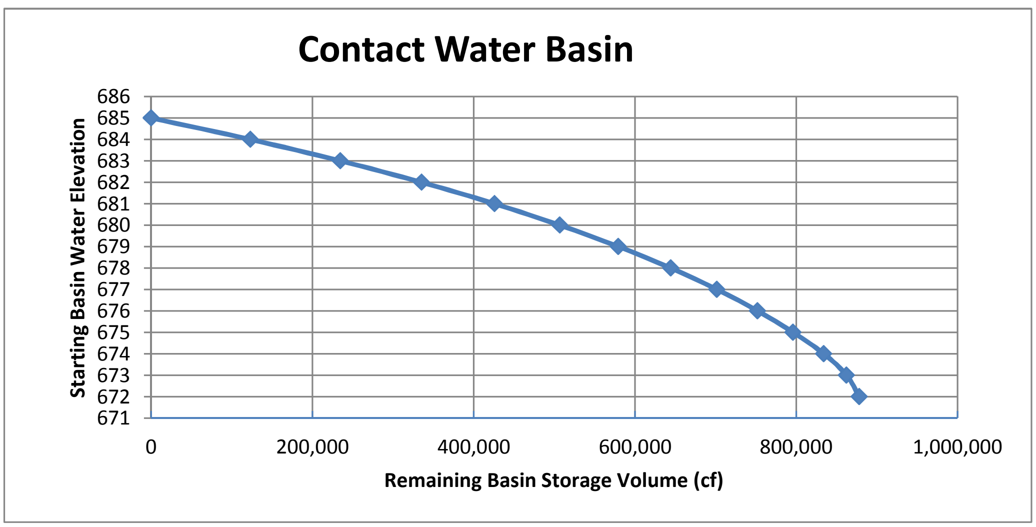
To accommodate the runoff volume (257,352 cf) resulting from a 25-year, 24-hour storm event, the starting water elevation in the pond should be 681.5 or lower.

Phase 4 Module 3

To accommodate the runoff volume (237,141 cf) resulting from a 25-year, 24-hour storm event, the starting water elevation in the pond should be 681.5 or lower.

Table 1
Operational Chart
Phase 3 Module 2
Contact Water Basin Outside Limits of Waste

Basin Elevation	Starting Water Depth (ft)	Area (sf)	Incremental Storage Volume (cf)	Cumulative Volume to Reach Basin Elevation 685 (cf)	Notes
686	14	140,337	-	-	Basin is full
685	13	128,481	0	0	Peak Elevation (1' freeboard)
684	12	117,241	122,861	122,861	
683	11	105,982	111,611	234,473	Elev 682.5 Cumulative Volume = 284,811 cf
682	10	95,370	100,676	335,149	
681	9	85,538	90,454	425,603	
680	8	76,769	81,154	506,756	
679	7	68,768	72,768	579,525	
678	6	60,958	64,863	644,388	
677	5	53,735	57,347	701,734	
676	4	47,129	50,432	752,166	
675	3	40,929	44,029	796,195	
674	2	35,173	38,051	834,246	
673	1	21,330	28,252	862,498	
672	0	10,036	15,683	878,181	Basin is empty

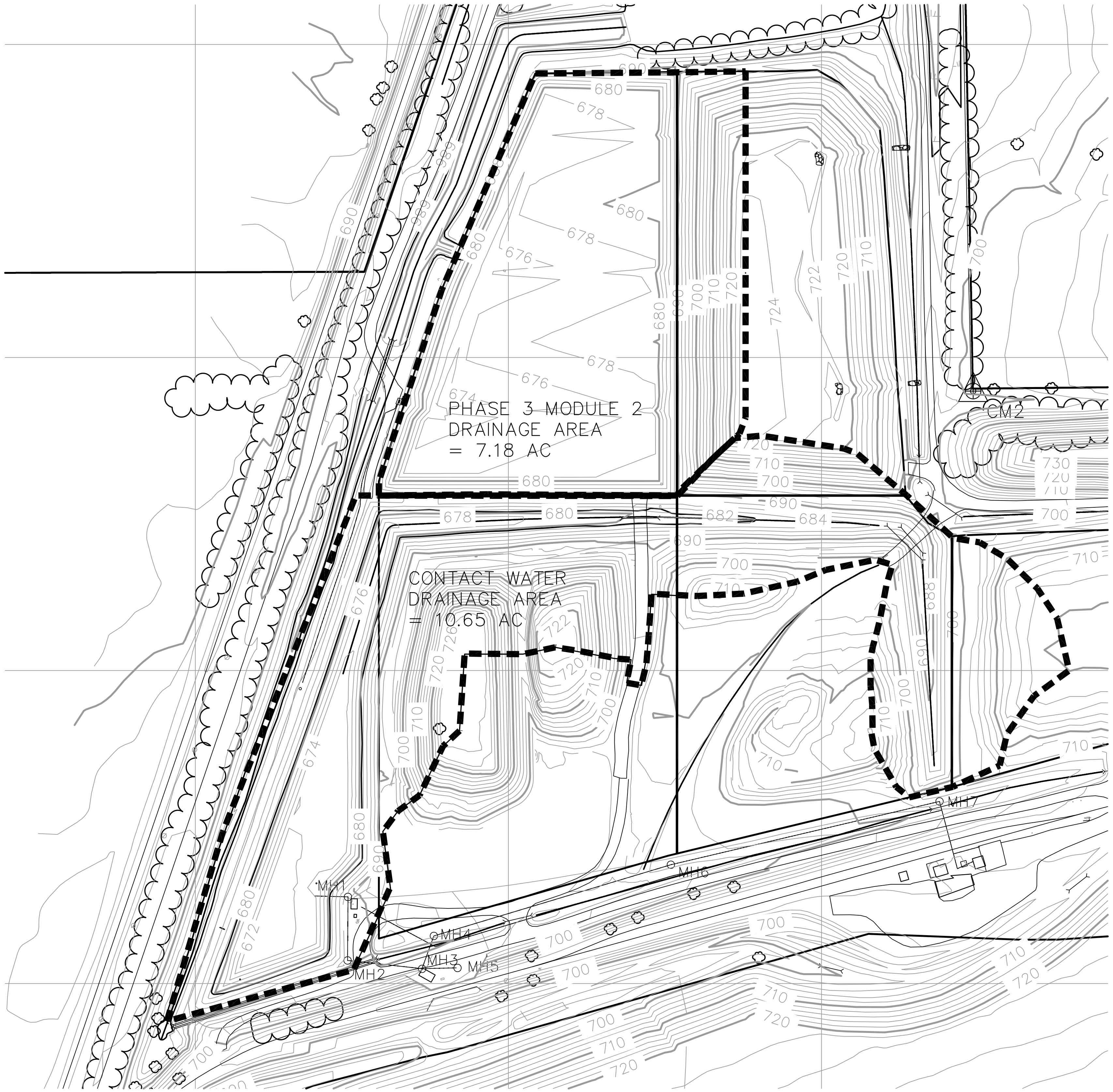


Before pumping water from any of the contact water holding features located within each module into the Contact Water Basin, make sure there is adaquate storage available.

Phase 3 Module 2 Runoff Volume:	112,733	cf (from HydroCAD model, 2.588 ac-ft)
Other Runoff Volume to Basin	156,380	cf (from HydroCAD model, 3.590 ac-ft)
Total:	269,114	cf

Based on the above runoff volume to the contact water basin, the starting water level in the basin should not be higher than 682.5 to accommodate the runoff from a 25-year, 24-hour storm event.

KRG/ 5/16/16



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LEGEND

WATER BASIN DRAINAGE AREA

200 0 200

SCALE: 1" = 200'

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TOWN OF WILSON, WISCONSIN

PHASE 3 MODULE 2 CONTACT
WATER BASIN DRAINAGE AREAS

FIGURE
1

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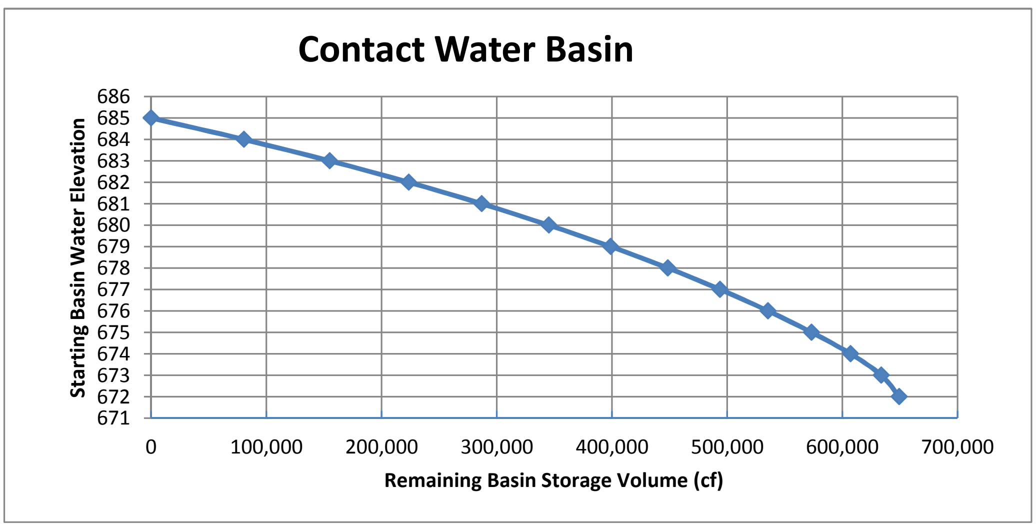
Table 2
Operational Chart
Phase 4 Module 2
Contact Water Basin Outside Limits of Waste

Basin Elevation	Starting Water Depth (ft)	Area (sf)	Incremental Storage Volume (cf)	Cumulative Volume to Reach Basin Elevation 685 (cf)	Notes
686	14	89,741	-	-	Basin is full
685	13	83,468	0	0	Peak Elevation (1' freeboard)
684	12	77,379	80,424	80,424	
683	11	71,511	74,445	154,869	
682	10	65,875	68,693	223,562	Elev 681.5 Cumulative Volume = 255,195 cf
681	9	60,657	63,266	286,828	
680	8	56,021	58,339	345,167	
679	7	51,631	53,826	398,994	
678	6	47,444	49,538	448,531	
677	5	43,448	45,446	493,977	
676	4	39,620	41,534	535,511	
675	3	35,881	37,751	573,262	
674	2	31,974	33,928	607,190	
673	1	21,330	26,652	633,841	
672	0	10,036	15,683	649,524	Basin is empty

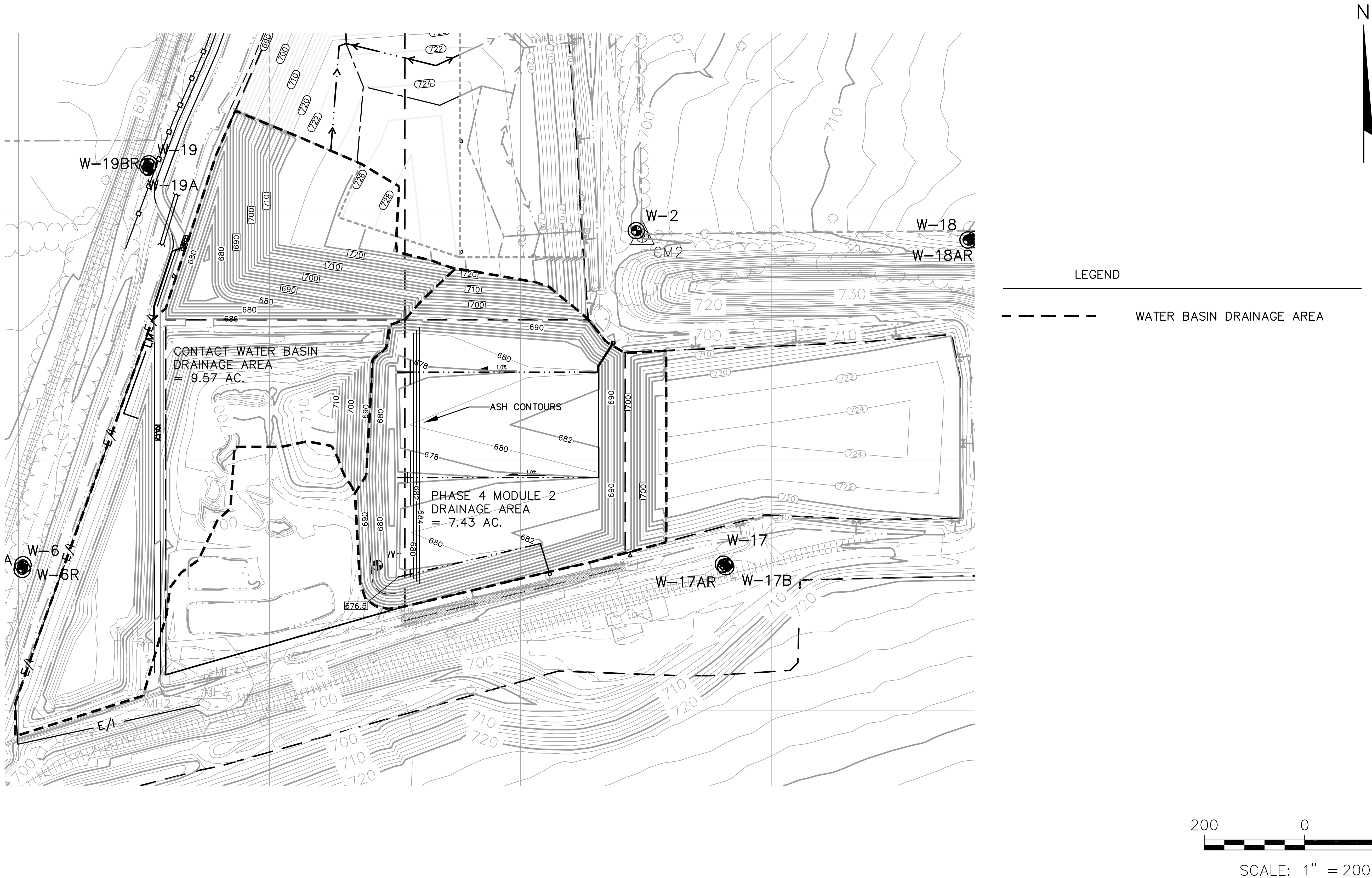


Before pumping water from any of the contact water holding features located within each module into the Contact Water Basin, make sure there is adaquate storage available:

Phase 4 Module 2 Runoff Volume:	116,697	cf (from HydroCAD model, 2.679 ac-ft)
Other Ruoff Volume to Basin:	140,655	cf (from HydroCAD model, 3.229 ac-ft)
Total:	257,352	cf

Based on the above runoff volume to the contact water basin, the starting water level in the basin should not be higher than 681.5 to accommodate the runoff from a 25-year, 24-hour storm event.

KRG/ 5/16/16



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SITE: PLAN MODIFICATION
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

PHASE 4 MODULE 2 CONTACT WATER BASIN DRAINAGE AREA

FIGURE 2

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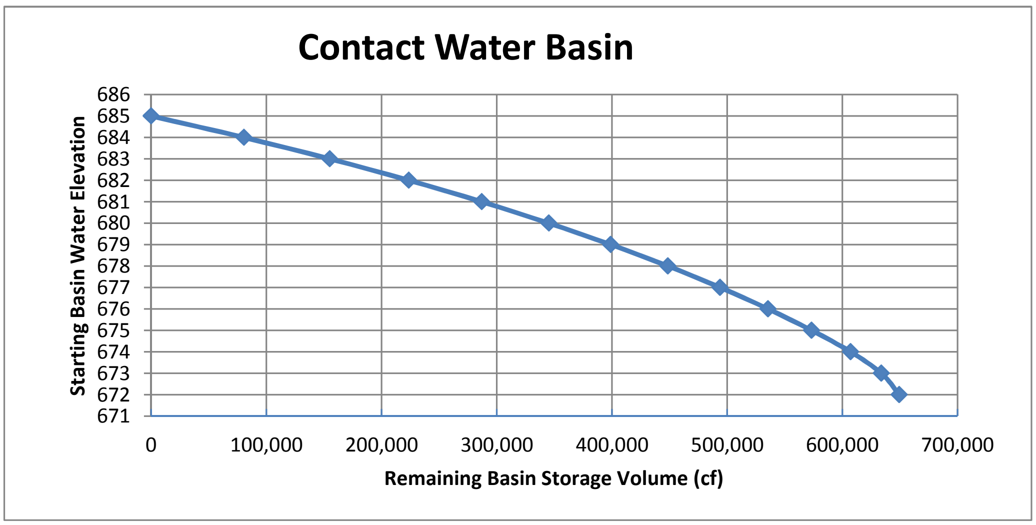
Table 3
Operational Chart
Phase 4 Module 3
Contact Water Basin Outside Limits of Waste

Basin Elevation	Starting Water Depth (ft)	Area (sf)	Incremental Storage Volume (cf)	Cumulative Volume to Reach Basin Elevation 685 (cf)	Notes
686	14	89,751	-	-	Basin is full
685	13	83,469	0	0	Peak Elevation (1' freeboard)
684	12	77,379	80,424	80,424	
683	11	71,512	74,446	154,870	
682	10	65,875	68,694	223,563	Elev 681.5 Cumulative Volume = 255,197 cf
681	9	60,658	63,266	286,830	
680	8	56,021	58,339	345,169	
679	7	51,632	53,827	398,996	
678	6	47,444	49,538	448,534	
677	5	43,458	45,451	493,985	
676	4	39,619	41,539	535,524	
675	3	35,880	37,750	573,274	
674	2	31,974	33,927	607,201	
673	1	21,330	26,652	633,853	
672	0	10,036	15,683	649,536	Basin is empty

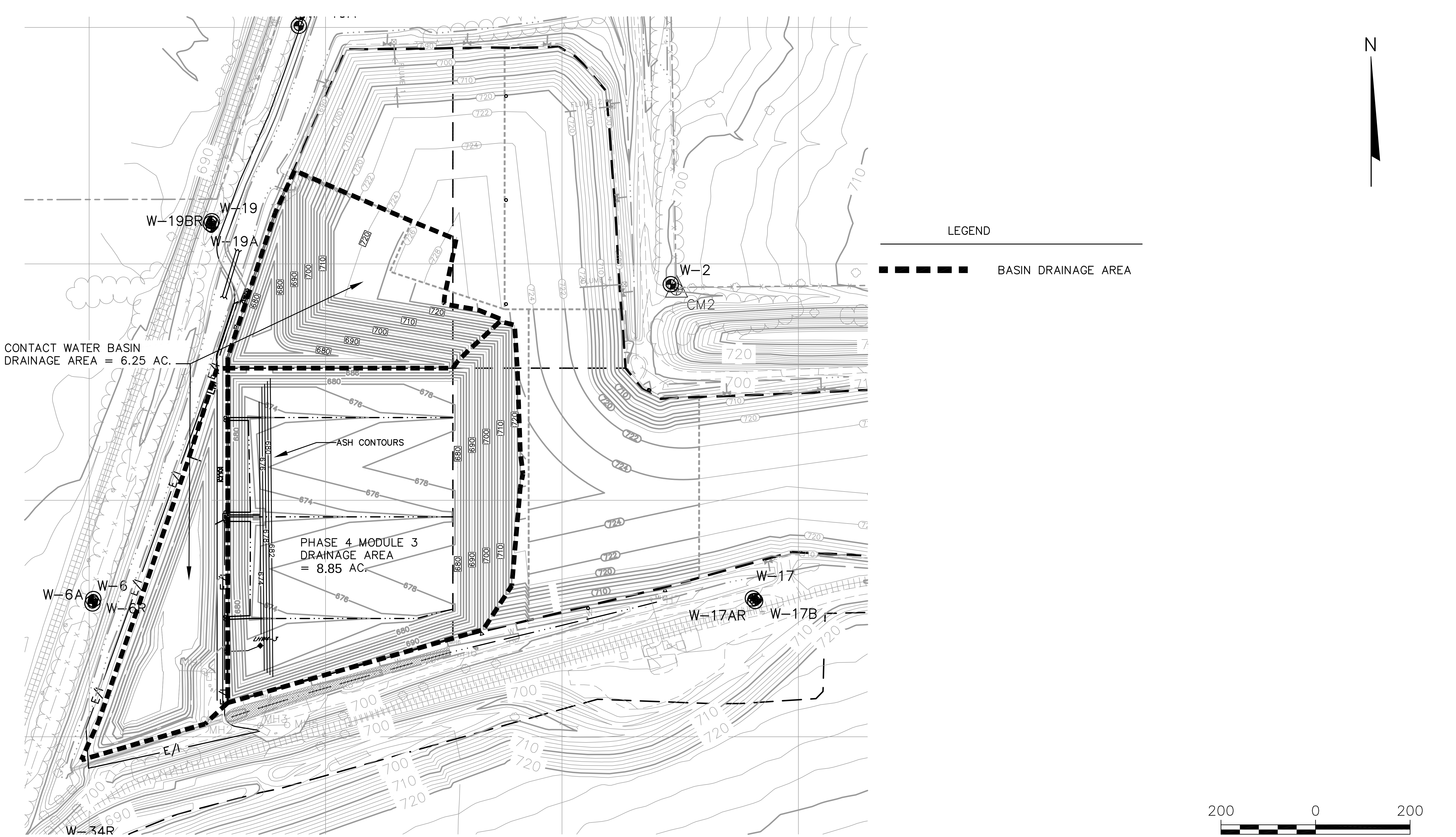


Before pumping water from any of the contact water holding features located within each module into the Contact Water Basin, make sure there is adaquate storage available:

Phase 4 Module 3 Runoff Volume:	139,000	cf (from HydroCAD model, 3.191 ac-ft)
Other Runoff Volume to Basin:	98,141	cf (from HydroCAD model, 2.253 ac-ft)
Total:	237,141	cf

Based on the above runoff volume to the contact water basin, the starting water level in the basin should not be higher than 681.5 to accommodate the runoff from a 25-year, 24-hour storm event.

KRG/ 5/16/16



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PHASE 4 MODULE 3 CONTACT WATER BASIN DRAINAGE AREA

FIGURE 3

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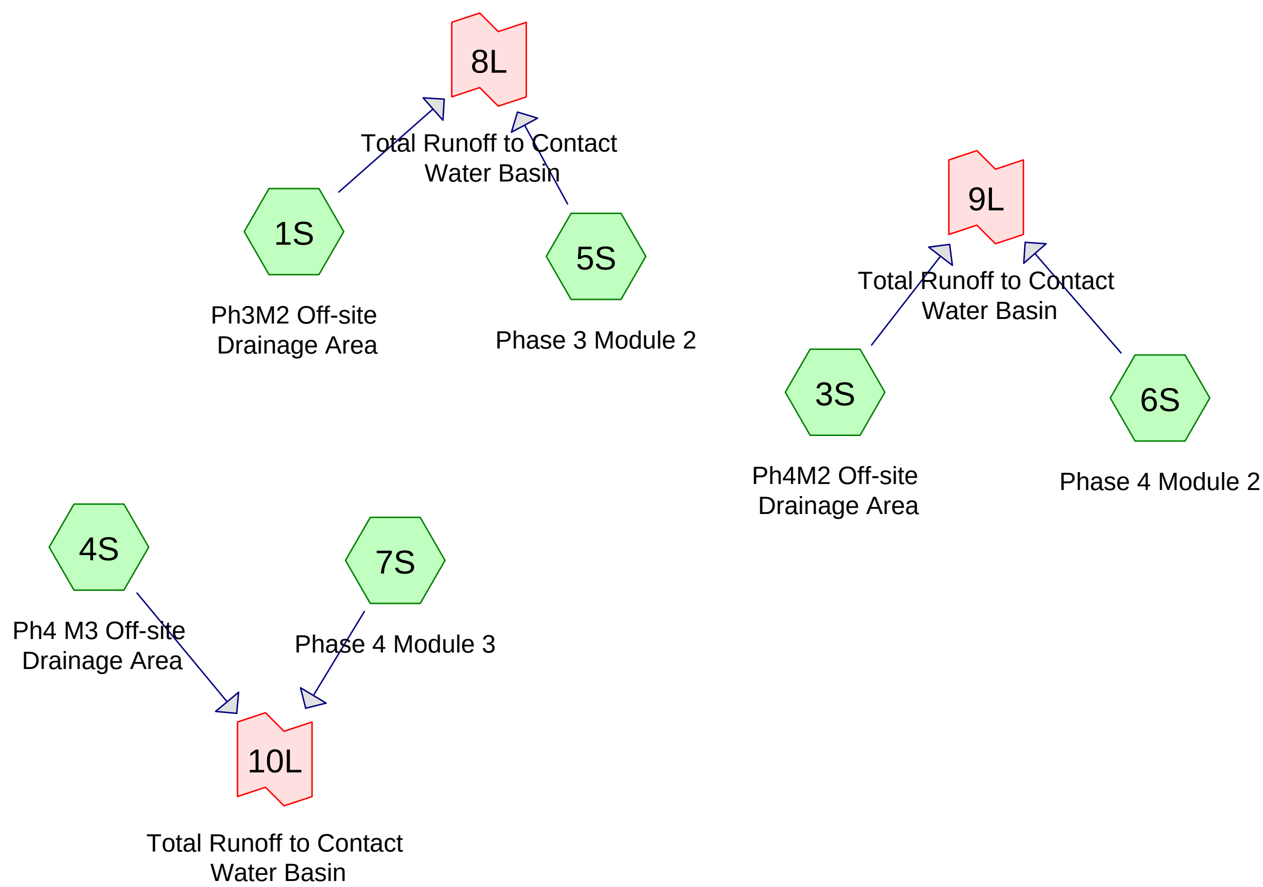

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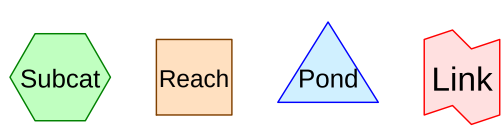

Routing Diagram for Contact Water Basin Sizing by Phase
Prepared by {enter your company name here}, Printed 5/23/2016
HydroCAD® 10.00-15 s/n 05804 © 2015 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: Ph3M2 Off-site Drainage Area

[49] Hint: Tc<2dt may require smaller dt

Runoff = 69.57 cfs @ 12.09 hrs, Volume= 3.590 af, Depth> 4.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr Rainfall=4.80"

	Area (sf)	CN	Description
	323,363	94	Fallow, bare soil, HSG D
*	140,337	98	Water Surface (area of top of contact water basin)
	463,700	95	Weighted Average
	323,363		69.74% Pervious Area
	140,337		30.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.3300	3.80		**Sheet Flow, Phase 4 Mod 1**
					Smooth surfaces n= 0.011 P2= 2.59"
0.2	80	0.3300	5.74		**Shallow Concentrated Flow, Phase 4 Mod 1**
					Nearly Bare & Untilled Kv= 10.0 fps
2.8	980	0.0100	5.80	75.44	**Trap/Vee/Rect Channel Flow, Swale**
					Bot.W=10.00' D=1.00' Z= 3.0 '/' Top.W=16.00'
					n= 0.022 Earth, clean & straight
3.4	1,160	Total			

Summary for Subcatchment 3S: Ph4M2 Off-site Drainage Area

[49] Hint: Tc<2dt may require smaller dt

Runoff = 64.63 cfs @ 12.05 hrs, Volume= 3.229 af, Depth> 4.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr Rainfall=4.80"

	Area (ac)	CN	Description
	7.510	94	Fallow, bare soil, HSG D
*	2.060	98	Water Surface (area at top of contact water basin)
	9.570	95	Weighted Average
	7.510		78.47% Pervious Area
	2.060		21.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.3300	3.80		**Sheet Flow, Off-site Stockpiles**
					Smooth surfaces n= 0.011 P2= 2.59"
0.2	80	0.3300	5.74		**Shallow Concentrated Flow, Off-site Stockpiles**
					Nearly Bare & Untilled Kv= 10.0 fps
0.6	180	Total			

Summary for Subcatchment 4S: Ph4 M3 Off-site Drainage Area

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 43.43 cfs @ 12.04 hrs, Volume= 2.253 af, Depth> 4.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr Rainfall=4.80"

	Area (ac)	CN	Description
*	2.060	98	Water Surface (area at top of contact water basin)
*	4.190	98	Ash in Phase 3 Module 2
	6.250	98	Weighted Average
	6.250		100.00% Impervious Area

Summary for Subcatchment 5S: Phase 3 Module 2

[49] Hint: Tc<2dt may require smaller dt

Runoff = 50.45 cfs @ 12.08 hrs, Volume= 2.588 af, Depth> 4.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr Rainfall=4.80"

	Area (sf)	CN	Description
*	312,726	98	Open Cell
	312,726		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	100	0.2500	1.01		**Sheet Flow, Down Ash face in P3M1** Fallow n= 0.050 P2= 2.59"
0.1	33	0.2500	8.05		**Shallow Concentrated Flow, Down ash face in P3M1** Unpaved Kv= 16.1 fps
0.4	96	0.0500	3.60		**Shallow Concentrated Flow, Across Liner** Unpaved Kv= 16.1 fps
2.1	229	Total			

Summary for Subcatchment 6S: Phase 4 Module 2

[49] Hint: Tc<2dt may require smaller dt

Runoff = 51.57 cfs @ 12.06 hrs, Volume= 2.679 af, Depth> 4.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr Rainfall=4.80"

	Area (ac)	CN	Description
*	7.430	98	Ash
	7.430		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.3300	3.80		**Sheet Flow, Down ash face in P4M1** Smooth surfaces n= 0.011 P2= 2.59"
0.0	27	0.3300	9.25		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.3	68	0.0400	4.06		**Shallow Concentrated Flow, Base of Phase 4 Mod 2** Paved Kv= 20.3 fps
0.7	195	Total			

Summary for Subcatchment 7S: Phase 4 Module 3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 61.61 cfs @ 12.06 hrs, Volume= 3.191 af, Depth> 4.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr Rainfall=4.80"

	Area (ac)	CN	Description
*	8.850	98	
	8.850		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.3300	3.80		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.59"
0.1	42	0.3300	11.66		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	78	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.0	220	Total			

Summary for Link 8L: Total Runoff to Contact Water Basin

Inflow Area = 17.824 ac, 58.35% Impervious, Inflow Depth > 4.16" for 25-yr event
Inflow = 119.38 cfs @ 12.09 hrs, Volume= 6.178 af
Primary = 119.38 cfs @ 12.09 hrs, Volume= 6.178 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Link 9L: Total Runoff to Contact Water Basin

Inflow Area = 17.000 ac, 55.82% Impervious, Inflow Depth > 4.17" for 25-yr event
Inflow = 116.20 cfs @ 12.05 hrs, Volume= 5.907 af
Primary = 116.20 cfs @ 12.05 hrs, Volume= 5.907 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Summary for Link 10L: Total Runoff to Contact Water Basin

Inflow Area = 15.100 ac,100.00% Impervious, Inflow Depth > 4.33" for 25-yr event
Inflow = 104.32 cfs @ 12.05 hrs, Volume= 5.444 af
Primary = 104.32 cfs @ 12.05 hrs, Volume= 5.444 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Appendix C3

Written Closure Plan

Closure Plan

Edgewater I-43 Ash Disposal Facility

Phase 3 Module 1
Phase 3 Module 2
Phase 4 Module 1

Prepared for:

Wisconsin Power and Light Company
Edgewater Generating Station
3739 Lakeshore Drive
Sheboygan, Wisconsin 53081-7233

SCS ENGINEERS

25222259.00 | February 1, 2023

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

Table of Contents

Section Page

Figures

Appendices

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PE CERTIFICATION

WISCONSIN
PHILLIP E.
GEARING
E-45115
SUN PRAIRIE,
WIS.
PROFESSIONAL ENGINEER

2/1/23

I, Phillip Gearing, hereby certify that I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of ch. A–E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A–E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 538, Wis. Adm. Code.

Specifically,

- This Closure Plan was prepared by me or under my direct supervision and meets the requirements of 40 CFR 257.102(b) and NR 514.07(10)(c)

February 1, 2023

(signature) (date)

(printed or typed name)

License number E-45115

My license renewal date is July 31, 2024.

Pages or sheets covered by this seal:

ALL

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1.0 INTRODUCTION AND PROJECT SUMMARY

On behalf of Wisconsin Power and Light (WPL), SCS Engineers (SCS) has prepared this Closure Plan for the I-43 Ash Disposal Facility (I-43) Phase 3, Modules 1 and 2 and Phase 4, Module 1 as required by 40 Code of Federal Regulations (CFR) 257.102(b) and Wisconsin Administrative Code NR 514.07(10)(c), as stated below.

<u>40 CFR 257.102(b)</u> *"Written closure plan—(1) Content of the plan. The owner or operator of a CCR unit must prepare a written closure plan that describes the steps necessary to close the CCR unit at any point during the active life of the CCR unit consistent with recognized and generally accepted good engineering practices. The written closure plan must include, at a minimum, the information specified in paragraphs (b)(1)(i) through (vi) of this section."*

<u>NR 517.07(10)(c)</u> *"A written closure plan in accordance with the requirements under s. NR 514.06 (10) and all of the following: (1) A narrative description of how the CCR landfill will be closed, including a description of the steps necessary to close the CCR unit at any point during the active life of the CCR unit, consistent with recognized and generally accepted good engineering practices."*

The I-43 facility includes a closed coal combustion residual (CCR) landfill, which consists of disposal Phase 1 and Phase 2, and an active CCR landfill. The active CCR landfill currently consists of an existing CCR unit in disposal Phase 3 and Phase 4. The two landfills are located on the same property, but are not contiguous. The federal CCR Rule [40 CFR 257.50-107] and the Wisconsin CCR Landfill Rules in chapters NR 500 to 538 do not apply to Phase 1 and Phase 2, because they ceased receiving CCR prior to October 19, 2015.

The active CCR landfill at I-43 includes the following modules, which are the subject of this Closure Plan. These modules are listed below along with their current status as it relates to the Closure Plan:

- **Phase 3, Module 1** – This module has received some final cover over completed outer sideslope areas that will no longer receive additional CCR.
- **Phase 3, Module 2** – This module is currently being filled.
- **Phase 4, Module 1** – This module has received some final cover over completed outer sideslope areas that will no longer receive additional CCR.

Two future CCR modules (Phase 4, Module 2 and Phase 4, Module 3) are permitted with the Wisconsin Department of Natural Resources (WDNR), but are not planned for development currently.

Figure 1 shows the site location. **Figure 2** shows the closure areas. A detail of the final cover system is also included on **Figure 2**.

2.0 PROPOSED CLOSURE PLAN NARRATIVE

40 CFR 257.102(b)(1)(i) *"A narrative description of how the CCR unit will be closed in accordance with this section."*

NR 517.07(10)(c)(1) *"A narrative description of how the CCR landfill will be closed, including a description of the steps necessary to close the CCR unit at any point during the active life of the CCR unit, consistent with recognized and generally accepted good engineering practices."*

When CCR placement is completed in a CCR unit, or if early closure is required, the unit will be closed by covering the CCR with the final cover system described in Section 3.0. Prior to final cover system construction, the CCR surfaces will be graded and compacted to establish a firm subgrade for final cover construction. In addition, all required notifications will be submitted to the Wisconsin Department of Natural Resources (WDNR, or "Department"), and WPL will obtain all additional necessary permits (for example, general permit coverage for construction storm water management). WPL may also engage in procurement activities to secure services for installing the final cover system.

The timing for completion of CCR placement in the unit that are addressed with this closure plan will depend on CCR generation and disposal rates. Future CCR unit development will also impact the timing of closure. If early closure of the unit were required, final cover will be placed in the active landfill areas shown on Figure 2. A closure schedule is discussed in Section 6.0 and presented in Appendix B.

The initiation of closure activities will commence no later than 30 days after the known final receipt of CCR as required by 40 CFR 257.102(e)(1) and NR 506.083(2)(a), or in accordance with 40 CFR 257.102(e)(2) and NR 506.083(2)(b).

3.0 FINAL COVER SYSTEM AND PERFORMANCE

40 CFR 257.102(b)(1)(iii) *"If closure of the CCR unit will be accomplished by leaving CCR in place, a description of the final cover system, designed in accordance with paragraph (d) of this section, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in paragraph (d) of this section."*

40 CFR 257.102(d) *"Closure performance standard when leaving CCR in place.*

40 CFR 257.102(d)(1) *"The owner or operator of a CCR unit must ensure that, at a minimum, the CCR unit is closed in a manner that will:"*

> 40 CFR 257.102(d)(1)(i) *"Control, minimize, or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;"*

NR 514.07(10)(c)(3) *"A demonstration, including a narrative discussion, of how final closure will meet the performance standards under s. NR 506.083(6)."*

NR 506.083(6) *"Closure performance standards when leaving CCR in place. An owner or operator of a CCR landfill shall ensure that, at a minimum the CCR landfill is closed in a manner that will achieve all of the following performance standards:"*

> NR 506.083(6)(a) *"Control, minimization or elimination, to the maximum extent feasible, of post-closure infiltration of liquids into the waste and of releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere."*

The final cover system design will minimize or eliminate infiltration, as further described below.

> 40 CFR 257.102(d)(1)(ii) *"Preclude the probability of future impoundment of water, sediment, or slurry;"*

> NR 506.083(6)(b) *"Prevention of the impoundment of water, sediment or slurry."*

The final cover system will meet these criteria, as further described below.

> 40 CFR 257.102(d)(1)(iii) *"Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period;"*

> NR 506.083(6)(c) *"Slope stability to prevent the sloughing or movement of the final cover system during the closure and long-term care period.*

The final cover system is designed to provide slope stability and to prevent sloughing or movement during the closure and post-closure care period. Stability of the final cover system was assessed as part of the WDNR landfill permitting process and is further addressed below.

> 40 CFR 257.102(d)(1)(iv) *"Minimize the need for further maintenance of the CCR unit; and"*

> NR 506.083(6)(d) *"Minimization of the need for long-term maintenance of the CCR landfill."*

Maintenance of the final cover will be minimized by the establishment of vegetative cover and the erosion control systems, which are further described below.

> 40 CFR 257.102(d)(1)(v) *"Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices."*

> NR 506.083(6)(e) *"Complete closure in the shortest amount of time consistent with recognized and generally accepted good engineering practices."*

All closure activities for the CCR unit will be completed within 6 months, as stated in **Section 7.0** below.

40 CFR 257.102(d)(2) *"Drainage and stabilization of CCR surface impoundments."*

This does not apply to the I-43 CCR landfill unit.

40 CFR 257.102(d)(3) *"Final cover system"*

NR 517.07(10)(c)(2) *"A description of the final cover system, designed in accordance with s. NR 504.07, and the methods and procedures to be used to install the final cover."*

NR 504.12(4)(b) *"The owner or operator of a new or existing CCR landfill or a lateral expansion of a CCR landfill may propose an alternative final cover system design within a written closure plan in accordance with s. NR 504.10 and all of the following:"*

The final cover system (see **Figure 2**) that is currently in place on portions of Phase 3, Module 1 and Phase 4, Module 1 that have reached final grades will also be installed in the remaining areas of this CCR unit. This final cover system will also be installed in Phase 3, Module 2. The final cover system is as follows from the bottom up:

- Two feet of clay, compacted to a permeability of $1x10^{-7}$ cm/sec
- Forty-mil low density polyethylene geomembrane
- Geonet geocomposite drainage layer
- Twelve inches of rooting zone soils
- Six inches of topsoil

This final cover meets and exceeds the minimum requirements of 40 CFR 257.102(d)(3)(i)(A) through (D) and NR 504.12(4)(b)(1) through (4) as follows:

- Per 257.102(d)(3)(i)(A) and NR 504.12(4)(b)(1), the permeability of the final cover system is less than or equal to the permeability of the bottom liner system and is less than $1x10^{-5}$ cm/sec required by the Rules. The final cover system 2-foot-thick clay cap is compacted to $1x10^{-7}$ cm/sec permeability. The geomembrane above the 2-foot clay cap makes the cover system even less permeable.

The bottom liner system for the CCR Unit is as follows:

- Phase 3, Module 1:
  - Five feet of clay, compacted to a permeability of $1x10^{-7}$ cm/sec.

The Phase 3, Module 1 liner system does not include a geomembrane and therefore is not as impermeable as the final cover system.

- Phase 3, Module 2:
  - Two feet of clay, compacted to a permeability of 1x10-7 cm/sec
  - Sixty-mil High Density Polyethylene (HDPE) geomembrane

Based on the design slopes and drainage system components in the liner system and final cover system (described in greater detail below), the final cover system is at least equivalent in permeability when compared to the liner system in Phase 3, Module 2.

- Phase 4, Module 1:
  - Five feet of clay, compacted to a permeability of $1x10^{-7}$ cm/sec.

The Phase 4, Module 1 liner system does not include a geomembrane and therefore is not as impermeable as the final cover system.

- Per 257.102(d)(3)(i)(B), the final cover system includes 2 feet of compacted clay, which is greater than the 18 inches of earthen material required to minimize infiltration.

- Per NR 504.12(4)(b)(2), the proposed final cover contains an infiltration layer (2 feet of clay) that meets the requirements of s. NR 504.07(4) and achieves an equivalent reduction in infiltration as the layers specified under s. NR 504.07(4). Water infiltrating the final cover will be contained in the drainage layer (geonet geocomposite), which will limit infiltration further through the final cover system.

- Per 257.102(d)(3)(i)(C) and NR 504.12(4)(b)(3), the erosion of the final cover system is minimized with a vegetative support layer consisting of 12 inches of uncompacted rooting zone material and 6 inches of topsoil. This provides more than the required 6-inch thickness for plant growth.

Also, this final cover system limits infiltration while promoting surface water runoff in a controlled manner to minimize erosion and promote stability. The surface layer of 18 inches of soil supports vegetation that assists with erosion control. Water that infiltrates through the vegetative support layers is collected by the lateral drainage layer (geonet geocomposite) and routed to the perimeter drainage system.

In addition, the surface has intermediate drainage swales to reduce the flow lengths down the final cover slope, also aiding in erosion control. Where needed, the intermediate drainage swales are connected to downslope flumes and energy dissipaters to control storm water runoff and prevent erosion of the final cover.

- Per 257.102(d)(3)(i)(D) and NR 504.12(4)(b)(4), the design of the final cover system minimizes disruptions to the final cover system. Stability of the final cover system was assessed as part of the WDNR landfill permitting process. The stability calculations are included in **Attachment A**.

The design of the final cover system accommodates settling and subsidence of the CCR fill below the cover. The CCR at I-43 is placed dry and is compacted in place. CCR continues to consolidate and gain strength as filling progresses prior to final cover placement. The final cover system is designed with a maximum slope of 25 percent (4 horizontal to 1 vertical). Because the final cover has a relatively large positive slope and the CCR has been gaining strength over time, the final cover is expected to easily accommodate the remaining relatively minor settlement potential of the CCR fill when fill placement ends and the landfill is closed.

All final cover materials will be tested to confirm they meet specifications and construction will be overseen and documented by a licensed engineer. Clay material placement will be tested for compaction, permeability, and thickness. Rooting zone and topsoil layers will be checked for thickness. All areas will be restored after final cover is placed. Vegetation will be monitored and maintained.

4.0 MAXIMUM INVENTORY OF CCR

<u>40 CFR 257.102(b)(1)(iv)</u> *"An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit."*

<u>NR 514.07(10)(c)(4)</u> *"An estimate of the maximum volume in cubic yards of CCR that will be disposed on–site over the active life of the CCR landfill."*

The following table reflects the estimated maximum volumes of CCR in each CCR module at the I-43 facility.

Area	Capacity (cy)
Phase 3, Module 1	193,523
Phase 3, Module 2	312,984
Phase 4, Module 1	87,291
Total Maximum CCR Quantity	**593,798**

The estimated maximum inventory of CCR ever on site over the active life of the CCR Unit is based on the design capacity of each module. The design capacity of each module is defined in the WDNR approved 2008 Plan of Operation and as revised by the March 2015 Plan of Operation Modification.

5.0 LARGEST AREA OF CCR UNIT REQUIRING FINAL COVER

<u>40 CFR 257.102(b)(1)(v)</u> *"An estimate of the largest area of the CCR unit ever requiring a final cover as required by paragraph (d) of this section at any time during the CCR unit's active life."*

<u>NR 514.07(10)(c)(5)</u> *"An estimate of the largest area of the CCR landfill that will require a final cover at any time during the CCR landfill's active life."*

The largest area of each module requiring final cover is the open area shown on **Figure 2**, with areas as follows:

Area	Acres
Phase 3, Module 1	2.4
Phase 3, Module 2	5.6
Phase 4, Module 1	0.74
Total	**8.74**

6.0 SCHEDULE OF SEQUENTIAL CLOSURE ACTIVITIES

40 CFR 257.102(b)(1)(vi) *"A schedule for completing all activities necessary to satisfy the closure criteria in this section, including an estimate of the year in which all closure activities for the CCR unit will be completed."*

NR 514.07(10)(c)(6) *"A schedule for completion of all closure activities, including an estimate of the year in which all closure activities for the CCR landfill will be completed."*

CCR placement is anticipated to permanently end at this facility following retirement of the Edgewater Generating Station by June 2025, as announced by WPL. Some CCR disposal activity may be necessary following retirement of Edgewater Unit 4 as part of decommissioning efforts (for example, cleaning of ducts and other equipment that may contain CCR following retirement). Closure activities are expected to be complete by the end of 2026.The potential schedule for closure of the existing CCR modules is provided in **Appendix B**.

7.0 COMPLETION OF CLOSURE ACTIVITIES

40 CFR 257.102(f)(1)(i) *"For existing and new CCR landfills and any lateral expansion of a CCR landfill, within six months of commencing closure activities."*

NR 506.083(3)(a) *"The owner or operator shall complete closure of the CCR landfill within 6 months of commencing closure activities."*

As shown on the enclosed schedule, closure of the CCR unit will be completed within 6 months of commencement of closure activities.

40 CFR 257.102(f)(3) *"Upon completion, the owner or operator of the CCR unit must obtain a certification from a qualified professional engineer verifying that closure has been completed in accordance with the closure plan specified in paragraph (b) of this section and the requirements of this section."*

NR 506.083(1)(b) *"Within 30 days following completion of closure of a CCR landfill under sub. (3), the owner or operator shall prepare and submit a notification of closure to the department and place a copy in the facility's operating record. The notification shall include the certification required under s. NR 516.04(3)(d)."*

A qualified licensed engineer will oversee final cover construction. The engineer will verify final cover materials and methods and oversee material testing. At the end of construction, the engineer will provide a report summarizing and documenting construction and will certify compliance with the requirements.

8.0 CERTIFICATION

40 CFR 257.102(b)(4) *"The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer that the initial and any amendment of the written closure plan meets the requirement of this section."*

NR 500.05 *"Unless otherwise specified, all submittals for review and approval of any initial site report, feasibility report, plan of operation site investigation report, remedial action options report,* *construction documentation report, or closure plan, or any modifications to those plans, shall include all of the following:*

> *(4) CERTIFICATION. (a) The reports and plan sheets shall be under the seal of a licensed professional engineer."*

Phillip Gearing, PE, a licensed professional engineer in the State of Wisconsin, has overseen the preparation of this Closure Plan. A certification statement is provided on page iii of this plan.

40 CFR 257.102(d)(3)(iii) *"The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer that the design of the final cover system meets the requirement of this section."*

Phillip Gearing, PE, a licensed professional engineer in the State of Wisconsin has reviewed the final cover design and certifies that the design meets the requirements of 40 CFR 257.102(d). The certification statement is provided on page iii of this plan.

9.0 RECORDKEEPING AND REPORTING

40 CFR 257.102(b)(2)(iii) *"The owner or operator has completed the written closure plan when the plan including the certification required by paragraph (b)(4) of this section, has been placed in the facility's operating record as required by Section 257.105(i)(4)."*

NR 506.17(2)(e) *"The written operating record shall contain the plan of operation, plan modifications, construction documentation, department approvals, annual reports, inspection records, monitoring and corrective action records, notifications to the department, and records of public comments received during any public comment period."*

The Closure Plan will be placed in the facility's operating record and on Alliant Energy's CCR Rule Compliance Data and Information website.

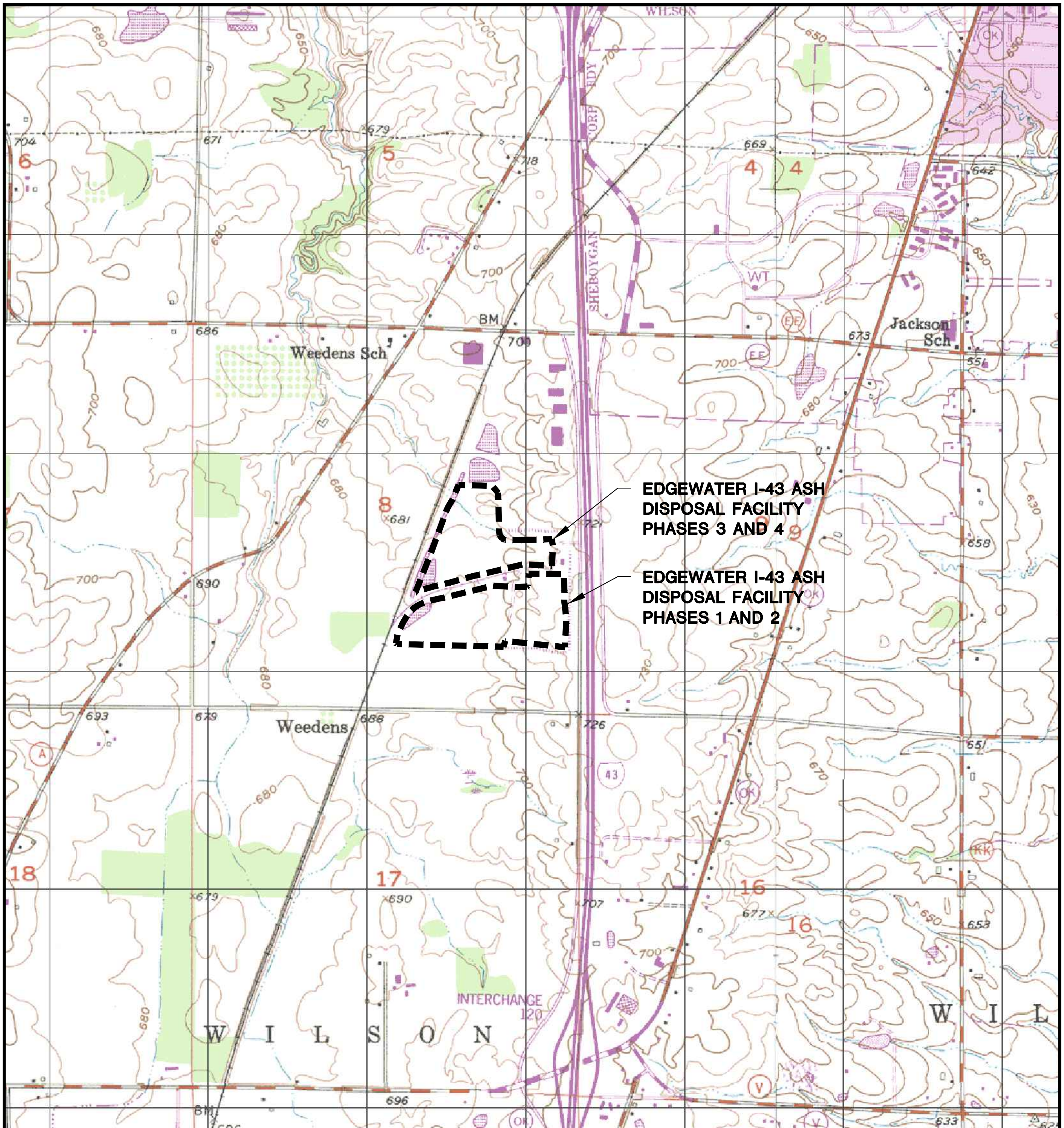
Amendments to the written closure plan will be done when a new module is constructed, when there is a change in the operation of the CCR unit that affects the plan, or when unanticipated events warrant revision to the written Closure Plan, as required by 40 CFR 257.102(b)(3) and NR 514.07(10)(c)(7).

WPL will provide notification as follows:

- Intent to initiate closure
- Closure completion
- Availability of the written closure plan and any amendments.

All of the above notifications will be placed in the facility's operating record and on the website per 40 CFR 257.105(i), 257.106(i), 257.107(i), and NR 506.17(2).

Figures



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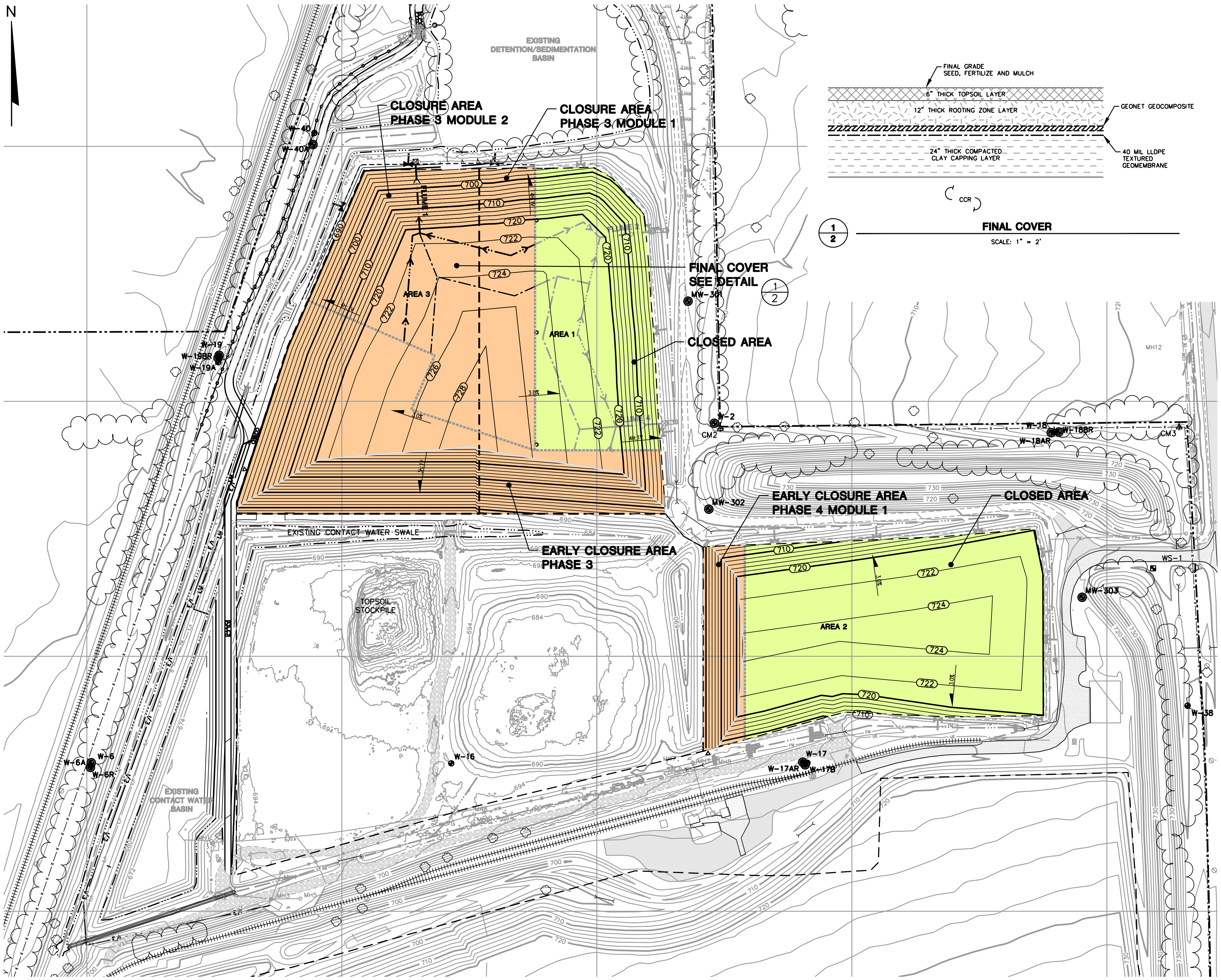
SHEBOYGAN HILLS QUADRANGLE
WISCONSIN–SHEBOYGAN CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SCALE: 1" = 2,000'

CLIENT	WISCONSIN POWER AND LIGHT COMPANY EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081	SITE	CLOSURE PLAN EDGEWATER I-43 ASH DISPOSAL FACILITY TOWN OF WILSON, WISCONSIN

SITE LOCATION MAP

PROJECT NO.	25222259.00	DRAWN BY:	AHB	ENGINEER: SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830	FIGURE
DRAWN:	08/09/16	CHECKED BY:	LB		1
REVISED:	01/17/23	APPROVED BY:	PG 1/31/23		

I:\25222259.00\Drawings\Closure Plan\1_Site Location Map.dwg, 1/31/2023 11:30:36 AM



LEGEND

- APPROXIMATE PROPERTY LINE
- LIMITS OF WASTE
- MODULE LIMITS
- EXISTING GRADE (2' CONTOUR)
- EXISTING GRADE (10' CONTOUR)
- EDGE OF WATER
- SWALE
- WETLAND
- CULVERT
- MANHOLE
- CONTACT WATER TRANSFER PIPE
- ABANDONED 3" DIA. HDPE PIPE
- CONTACT WATER FORCEMAIN
- ELECTRIC/INSTRUMENTATION
- TREELINE/TREES
- PAVED ROAD
- ACCESS ROAD
- CONCRETE
- RAILROAD TRACKS
- FENCE
- UTILITY/LIGHT POLE
- CONTROL MONUMENT
- MONITORING WELL
- PIEZOMETER
- LEACHATE HEADWELL
- PRIVATE WATER SUPPLY WELL
- PROPOSED FINAL GRADE (10' CONTOUR)
- SLOPE AND DIRECTION
- PROPOSED 6" DIA. LEACHATE FORCEMAIN
- PROPOSED LEACHATE VAULT
- PROPOSED ELECTRIC AND INSTRUMENT CONDUITS
- PROPOSED ACCESS ROAD
- PROPOSED FINAL COVER DRAINAGE SYSTEM PIPE
- PROPOSED FINAL COVER DIVERSION BERM
- PROPOSED DOWNSLOPE FLUME
- PROPOSED ENERGY DISSIPATOR
- PROPOSED TOE DRAIN AND DISCHARGE PIPE
- CONCEPTUAL FINAL COVER SEQUENCE LIMITS
- AREA 1 CONCEPTUAL FINAL COVER AREA
- PROPOSED INITIAL WASTE PLACEMENT LIMIT
- AREAS TO BE CLOSED
- CLOSED AREAS

NOTES:

1. BASE MAP PREPARED BY KBM, INC. BASED ON AERIAL TOPOGRAPHIC SURVEY FLOWN DECEMBER 1, 2014. BASE MAP PREPARED USING WISCONSIN STATE PLANE COORDINATES. ELEVATIONS BASED ON USGS NATIONAL GEODETIC VERTICAL DATUM, 1929. UPDATED WITH 2015 CONSTRUCTION AS-BUILT GRADES, 2016 CONSTRUCTION AS-BUILT GRADES FOR PHASE 4, MODULE 1 BY SCS ENGINEERS, DECEMBER 23, 2020 DRONE SURVEY OF PHASE 3, MODULE 2 ASH GRADES AND FUTURE PHASE 4 AREAS BY RYAN INCORPORATED CENTRAL, APRIL 11, 2022 PHASE 3 MODULE 2 SURVEY BY SCS ENGINEERS.
2. CONTOUR INTERVAL IS 2 FEET.
3. MONITORING WELL LOCATIONS BASED ON WELL INFORMATION FORM COORDINATES AND EXISTING CONDITIONS MAP F11 PREPARED BY WARZYN, INC. USING LOCAL COORDINATES.

FINAL COVER PLACEMENT

1. DOCUMENT FINAL ASH ELEVATIONS AND SURFACE IN PREPARATION OF COMPOSITE COVER PLACEMENT.
2. INSTALL COMPACTED SELECT CLAY FILL.
3. INSTALL GEOMEMBRANE, GEOCOMPOSITE, GEOCOMPOSITE DRAINS, AND GEOCOMPOSITE TOE DRAINS.
4. INSTALL ROOTING ZONE MATERIAL.
5. INSTALL FINAL GRADE SWALES, DOWNSLOPE FLUMES, AND ENERGY DISSIPATORS.
6. INSTALL TOPSOIL.
7. SEED, FERTILIZE, AND MULCH TOPSOIL AND DISTURBED AREAS.

200 0 200

SCALE: 1" = 200'

CLIENT: WISCONSIN POWER AND LIGHT COMPANY
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081

SITE: SITE CLOSURE PLAN
EDGEWATER I-43 ASH DISPOSAL FACILITY
TOWN OF WILSON, WISCONSIN

PROJECT NO. 25222259.00	DRAWN BY: KP		
DRAWN: 08/09/16	CHECKED BY: LB		
REVISED: 01/26/23	APPROVED BY: PG 1/31/23		

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

CLOSURE PLAN

FIGURE 2

Appendix A

Stability Calculations

SCS ENGINEERS

		Sheet No.	1 of 3
		Calc. No.	
		Rev. No.	
Job No. 25214060	Job: Edgewater	By: BJM	Date: 1/22/15
Client: Wisconsin Power & Light Company	Subject: Unit Gradient Calculation (3%)	Chk'd ZB	Date: 01/27/15

Purpose: To determine the maximum length of 3% slope that the final cover plateau drainage geocomposite can carry infiltrating water and maintain the flow within the geocomposite.

Approach: Use the unit gradient method to determine the maximum slope length.

References: Landfill Design.com

"GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001.

"Beyond a factor-of-safety value, i.e., the probability of failure". GRI Newsletter/Report, Vol. 15, no.3.

"Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.

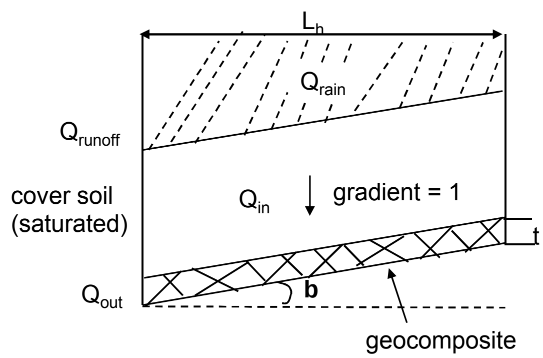
"Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J.P. Giroud, J.G. Zornberg and A. Zhao, *Geosynthetics International*, Vol. 7, Nos 4-5.

"Lateral Drainage Design update - part 2". G.N. Richardson, J.P. Giroud and A. Zhao, *Geotechnical Fabrics Report*, March, 2002

Giroud, Zornberg, and Zhao, 2000, "Hydraulic Design of Liquid Collection Layers", Geosynthetics International

HELP Model "User's Guide" Table 4 - Default Soil, Waste, and Geosynthetic Characteristics

Soong, T.Y. and Koerner, R.M. (1997), "The Design of Drainage Systems over Geosynthetically Lined Slopes", Geosynthetics Research Institute, Report #19.



With Darcy's Law:
$Q = k * i * A$

Inflow of water in the geocomposite
$Q_{in} = k_{veg} * i * A = k_{veg} * 1 * L_h * 1$

Outflow of water from the geocomposite at the toe of the slope
$Q_{out} = k_{comp} * i * A = k_{comp} * i * t * 1 = \theta_{required} * \sin \mathbf{b}$

Inflow equals outflow (Factor of Safety = 1)
$Q_{in} = Q_{out} = \theta * i * 1$ where $\theta = k_{comp} * t$ (minimum allowable outflow to keep head within geocomposite)

This results in a required transmissivity of the geocomposite of:

$$\theta_{required} = \frac{k_{veg} * Lh}{\sin \mathbf{b}}$$

Which results in the ultimate transmissivity after multiplying by the Total Servicability Factor (TSF)
$\theta_{ultimate} = \theta_{required} * FS_d * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$

		Sheet No.	2 of 3
		Calc. No.	
		Rev. No.	
Job No. 25214060	Job: Edgewater	By: BJM	Date: 1/22/15
Client: Wisconsin Power & Light Company	Subject: Unit Gradient Calculation (3%)	Chk'd ZB	Date: 01/27/15

Calculation:

L_h= Drainage pipe spacing or length of slope measured horizontally	=	See Below	
k_{veg} = Permeability of the vegetative supporting soil	=	1.9E-05 cm/sec	
S = The liner's slope, S = tan**b**	=	3%	**b** (degrees) = 1.7 °

FSd = Overall factor of safety for drainage	=	2
RF_{in} = Intrusion Reduction Factor	=	1.1
RF_{cr} = Creep Reduction Factor	=	1.2
RF_{cc} = Chemical Clogging Reduction Factor	=	1.1
RF_{bc} = Biological Clogging Reduction Factor	=	1.4

Determine the maximum slope length for transmissivities of example products currently available

L_h (feet)	L_h (meter)	Θ_{ult} (m^2/sec)	
319	97	2.5E-03	GSE FabriNet TRx Geocomposite (Double-Sided), 300 mil
115	35	9.0E-04	GSE FabriNet Geocomposite (Double-Sided), 300 mil
64	19	5.0E-04	GSE FabriNet Geocomposite (Double-Sided), 250 mil
13	4	1.0E-04	GSE FabriNet Geocomposite (Double-Sided), 200 mil

Determine the ultimate transmissivity based on a given slope length

L_h (feet)	L_h (meter)	Θ_{ult} (m^2/sec)	
335	102	2.6E-03	~ Total slope length (3% slope only)

Assumptions:

1. Soil hydraulic gradient j = 1.
2. Typical topsoil in the site area is classified as silty clay based on the Preliminary Site Feasibility Report. Prepared by Meand and Hunt, inc. in December 1977. Estimated permeability of 1.9E-05 cm/sec is from the HELP Model User's Guide.
3. Geocomposite hydraulic gradient = sinβ where β=2° (3% final cover slope).
4. Factor of safety and transmissivity reduction factors are from recommended values in GRI report #19 (Leachate collection system example) and HELP model "Users Guide".
5. Maximum horizontal final cover slope length at 3% is 335 feet as shown on the expansion final grades plan sheet.
6. Geocomposite transmissivities for GSE products were tested at a gradient of 0.1 and normal load of 10,000 psf.

SCS ENGINEERS

				Sheet No.	3 of 3
				Calc. No.	
				Rev. No.	
Job No.	25214060	Job: Edgewater		By: BJM	Date: 1/22/15
Client:	Wisconsin Power & Light Company	Subject: Unit Gradient Calculation (3%)		Chk'd: ZB	Date: 01/27/15

Conclusions: For the proposed design with a toe-of-slope drainage outlet and the assumed vegetative layer hydraulic conductivity, a minimum transmissivity of 2.63E-03 m^2/sec is required. Since this transmissivity is not achieved by the GSE FabriNet TRx Geocomposite (Double-Sided), 300 mil, a pipe system has been designed to provide the necessary drainage for the final cover plateau. The drainage pipe system layout will maintain the flow within the geocomposite when the flow length to the drainage outlet is a maximum of 319 feet and the geocomposite minimum transmissivity is 2.5E-03 m^2/sec.

SCS ENGINEERS

		Sheet No.	1 of 3
		Calc. No.	
		Rev. No.	
Job No. 25214060	Job: Edgewater	By: BJM	Date: 01/22/15
Client: Wisconsin Power & Light Company	Subject: Unit Gradient Calculation (4:1)	Chk'd ZB	Date: 01/27/15

Purpose: To determine the maximum length of 4H:1V slope that the final cover side slope drainage geocomposite can carry infiltrating water and remain stable, and the recommended minimum interface friction angle for final cover side-slope stability.

Approach: Use the unit gradient method to determine the maximum slope length.

References: Landfill Design.com

"GRI-GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite". Geosynthetics Research Institute, 2001.

"Beyond a factor-of-safety value, i.e., the probability of failure". GRI Newsletter/Report, Vol. 15, no.3.

"Designing with Geosynthetics". R.M. Koerner, Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.

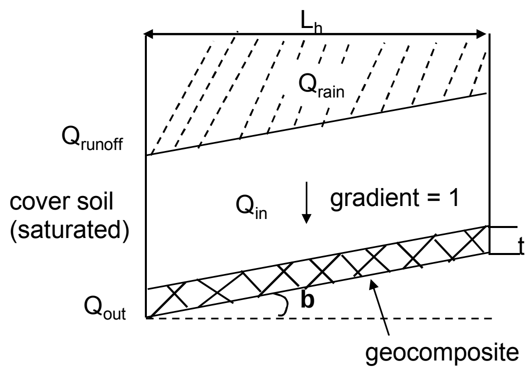
"Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". J.P. Giroud, J.G. Zornberg and A. Zhao, *Geosynthetics International* , Vol. 7, Nos 4-5.

"Lateral Drainage Design update - part 2". G.N. Richardson, J.P. Giroud and A. Zhao, *Geotechnical Fabrics Report* , March, 2002

Giroud, Zornberg, and Zhao, 2000, "Hydraulic Design of Liquid Collection Layers", Geosynthetics International

HELP Model "User's Guide" Table 4 - Default Soil, Waste, and Geosynthetic Characteristics

Soong, T.Y. and Koerner, R.M. (1997), "The Design of Drainage Systems over Geosynthetically Lined Slopes", Geosynthetics Research Institute, Report #19.



With Darcy's Law:
$Q = k * i * A$

Inflow of water in the geocomposite
$Qin = k_{veg} * i * A = k_{veg} * 1 * L_h * 1$

Outflow of water from the geocomposite at the toe of the slope
$Q_{out} = k_{comp} * i * A = k_{comp} * i * t * 1 = \theta_{required} * \sin\mathbf{b}$

Inflow equals outflow (Factor of Safety = 1)
$Q_{in} = Q_{out} = \theta * i * 1$ where $\theta = k_{comp} * t$ (minimum allowable outflow to keep head within geocomposite)

This results in a required transmissivity of the geocomposite of:

$$\theta_{required} = \frac{k_{veg} * Lh}{\sin\mathbf{b}}$$

Which results in the ultimate transmissivity after multiplying by the Total Servicability Factor (TSF)
$\theta_{ultimate} = \theta_{required} * FS_d * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$

Calculation:

L_h= Drainage pipe spacing or length of slope measured horizontally	=	See Below		
k_{veg} = Permeability of the vegetative supporting soil	=	1.9E-05	cm/sec	
S = The liner's slope, S = tan**b**	=	25%	**b** (degrees) =	14 °
FS_{slope} = Minimum factor of safety against sliding, for soil/geocomposite or geocomposite/geomembrane interfaces	=	1.5		

$ð_{req'd}$ = Minimum interface friction angle = $\tan^{-1}$(FS*tan(**b**))	=	20.6	degrees

FSd = Overall factor of safety for drainage	=	2
RF_{in} = Intrusion Reduction Factor	=	1.1
RF_{cr} = Creep Reduction Factor	=	1.2
RF_{cc} = Chemical Clogging Reduction Factor	=	1.1
RF_{bc} = Biological Clogging Reduction Factor	=	1.4

Determine the maximum slope length for transmissivities of example products currently available

L_h (feet)	L_h (meter)	Θ_{ult} (m^2/sec)	
2655	809	2.5E-03	GSE FabriNet TRx Geocomposite (Double-Sided), 300 mil
956	291	9.0E-04	GSE FabriNet Geocomposite (Double-Sided), 300 mil
531	162	5.0E-04	GSE FabriNet Geocomposite (Double-Sided), 250 mil
106	32	1.0E-04	GSE FabriNet Geocomposite (Double-Sided), 200 mil

Determine the ultimate transmissivity based on a given slope length

L_h (feet)	L_h (meter)	Θ_{ult} (m^2/sec)	
128	39	1.2E-04	~ Total slope length (4H:1V slope only)

Assumptions:

1. Soil hydraulic gradient i = 1.
2. Typical topsoil in the site area is assumed to be silty clay based on the Preliminary Site Feasibility Report prepared by Mead and Hunt, Inc. in December 1977. Estimated permeability of 1.9E-05 cm/sec is from the HELP Model User's Guide.
3. Geocomposite hydraulic gradient = sinβ where β= 14 ° (25% final cover slope).
4. Factor of safety and transmissivity reduction factors are from recommended values in GRI report #19 (Leachate collection system example) and HELP model "Users Guide".
5. Maximum horizontal final cover slope length at 25% is 128 feet as shown on the expansion final grades plan sheet.
6. Geocomposite transmissivities for GSE products were tested at a gradient of 0.1 and normal load of 10,000 psf.

Conclusions: For the proposed design with a toe-of-slope drainage outlet and the assumed vegetative layer hydraulic conductivity, a minimum transmissivity of 1.21E-04 m^2/sec is required for the final cover sideslopes. For ease of construction, the same drainage geocomposite required for the 3% final cover plateau could also be used on the final cover sideslopes.

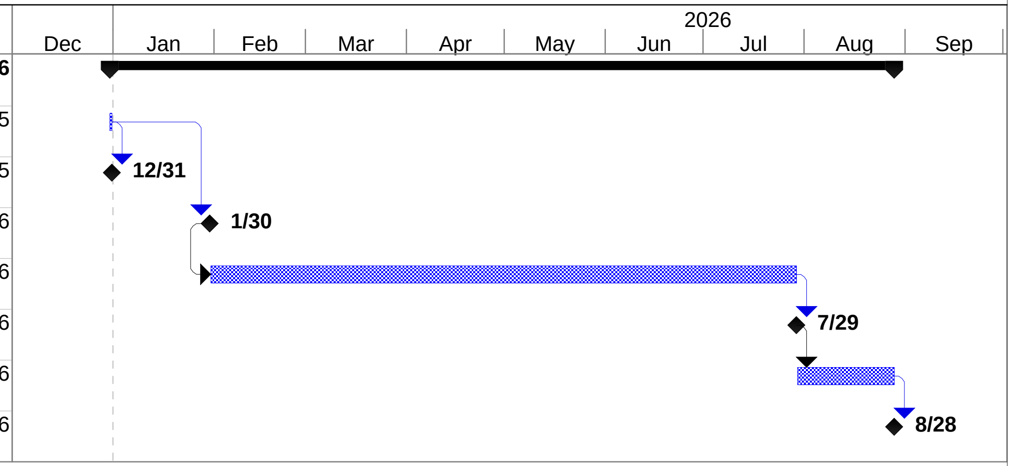
A minimum interface friction angle of 20.6 degrees is required to achieve a minimum recommended final cover slope stability safety factor of 1.5.

Appendix B

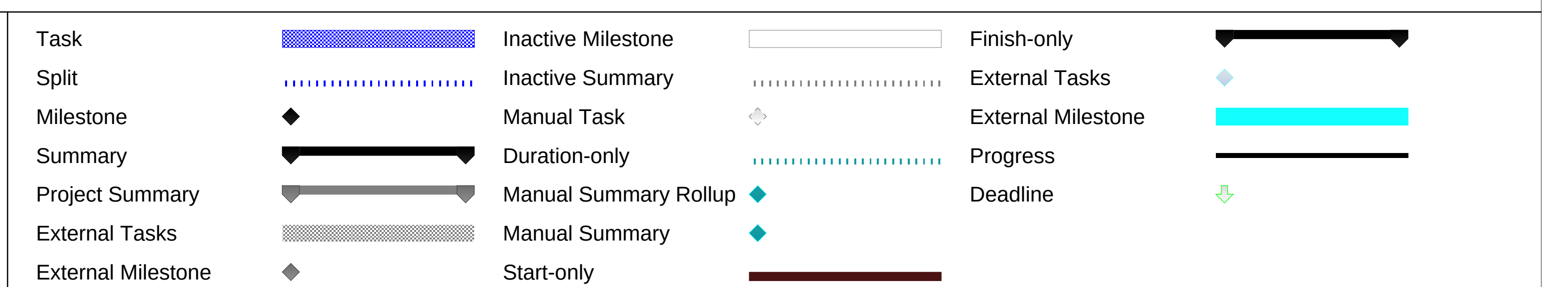
Schedule

Closure Plan Schedule

ID	Task Name	Duration	Start	Finish
1	**Closure of I43 Landfill**	**241 days**	**Wed 12/31/25**	**Fri 8/28/26**
2	Ash filling ceases	1 day	Wed 12/31/25	Wed 12/31/25
3	Other regulatory permits - none	0 days	Wed 12/31/25	Wed 12/31/25
4	Notification of Intent to Close	0 days	Fri 1/30/26	Fri 1/30/26
5	Construction Activities	180 days	Sat 1/31/26	Wed 7/29/26
6	Notification of Closure Completion	0 days	Wed 7/29/26	Wed 7/29/26
7	Documentation	30 days	Thu 7/30/26	Fri 8/28/26
8	State Submittal:Documentation Report	0 days	Fri 8/28/26	Fri 8/28/26



Project: Closure Plan



Appendix C4

Written Long-Term Care Plan

Post-Closure Care Plan

Edgewater I-43 Ash Disposal Facility

Phase 3 Module 1
Phase 3 Module 2
Phase 4 Module 1

Prepared for:

Wisconsin Power and Light Company
Edgewater Generating Station
3739 Lakeshore Drive
Sheboygan, Wisconsin 53081-7233

SCS ENGINEERS

25222259.00 | February 1, 2023

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

Table of Contents

Section Page

Figures

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PE CERTIFICATION

WISCONSIN
PHILLIP E.
GEARING
E-45115
SUN PRAIRIE,
WIS.
PROFESSIONAL ENGINEER

2/1/23

I, Phillip Gearing, hereby certify that I am a licensed professional engineer in the State of Wisconsin in accordance with the requirements of ch. A–E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A–E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 500 to 538, Wis. Adm. Code.

Specifically,

- This Post-Closure Care Plan was prepared by me or under my direct supervision and meets the requirements of 40 CFR 257.104(d) and NR 514.07(10)(d)

February 1, 2023

(signature) (date)

Phillip E. Gearing

(printed or typed name)

License number E-45115

My license renewal date is July 31, 2024.

Pages or sheets covered by this seal:

ALL

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1.0 INTRODUCTION AND PROJECT SUMMARY

On behalf of Wisconsin Power and Light Company (WPL), SCS Engineers (SCS) has prepared this Post-Closure Care Plan for the I-43 Ash Disposal Facility (I-43) Phase 3, Modules 1 and 2 and Phase 4, Module 1 in accordance with 40 Code of Federal Regulations (CFR) 257.104 and Wisconsin Administrative Code NR 514.07(10)(d), as stated below.

40 CFR 257.104(d). *"Written post-closure plan – (1) Content of the plan. The owner or operator of a CCR unit must prepare a written post-closure plan that includes, as a minimum, the information specified in paragraphs (d)(1)(i) through (iii) of this section."*

NR 517.07 (10)(d). *"A written long−term care plan that addresses all of the following: 1. A description of the monitoring and maintenance activities and the frequency at which those activities will be performed. The activities shall include, at a minimum, all of the following:"*

The I-43 facility includes a closed coal combustion residual (CCR) landfill, which consists of disposal Phase 1 and Phase 2, and an active CCR landfill. The active CCR landfill currently consists of an existing CCR unit in disposal Phase 3 and Phase 4. The two landfills are located on the same property, but are not contiguous. The federal CCR Rule [40 CFR 257.50-107] and the Wisconsin CCR Landfill Rules in chapters NR 500 to 538 do not apply to Phase 1 and Phase 2, because they ceased receiving CCR prior to October 19, 2015.

The active CCR landfill at I-43 includes the following modules, which are the subject of this Post-Closure Care Plan. These modules are listed below along with their current status as it relates to the Post-Closure Care Plan:

- **Phase 3, Module 1** – This module has received some final cover over completed outer sideslope areas that will no longer receive additional CCR.

- **Phase 3, Module 2** – This module is currently being filled.

- **Phase 4, Module 1** – This module has received some final cover over completed outer sideslope areas that will no longer receive additional CCR.

Two future CCR modules (Phase 4, Module 2 and Phase 4, Module 3) are permitted with the Wisconsin Department of Natural Resources (WDNR), but are not planned for development currently. The site location is shown on **Figure 1**. **Figure 2** shows proposed final cover grades and monitoring locations.

Phase 3, Module 1 and Phase 4, Module 1 have been partially closed with a final cover as described in the Closure Plan. The remaining open areas of these CCR modules will be closed when CCR materials reach final waste grades. The future final cover system is planned to be the same as the existing final cover system. Following the closure of the existing CCR modules at the I-43 Ash Disposal Facility, WPL will conduct post-closure care in accordance with 40 CFR 257.104(b) for the required 30 years and with NR 514.07(10)(d) for the required 40 years per NR 506.084(2).

2.0 MONITORING AND MAINTENANCE ACTIVITIES

<u>40 CFR 257.104(d)(1)(i).</u> *"A description of the monitoring and maintenance activities required in paragraph (b) of this section for the CCR unit, and the frequency at which these activities will be performed."*

<u>NR 514.07(10)(d)(1).</u> *"A description of the monitoring and maintenance activities and the frequency at which those activities will be performed."*

Monitoring and Maintenance Activities	Frequency
Mowing	Semi-Annually
Inspections by Owner/Operator	Quarterly
Repair to Final Cover for Erosion Concerns	As needed, determined by inspection
Sedimentation Basin Cleaning	As needed, determined by inspection
Leachate Collection Line Cleaning	Annually
Environmental Monitoring (groundwater, leachate)	Semi-Annually

The owner/operator will perform quarterly inspections of the landfill surface, leachate control system, and groundwater monitoring systems. If issues are noticed during the inspection, action will be taken to remedy the situation. Eroded areas will be repaired and reseeded. Repairs or replacement will be performed on the groundwater monitoring system as needed.

2.1 FINAL COVER MAINTENANCE

Mowing will be performed semi-annually during the growing season unless additional mowing is required in response to the vegetation growth rate. During quarterly inspections, if eroded areas are noted, WPL will repair and reseed the area.

2.2 LEACHATE COLLECTION AND REMOVAL SYSTEM MAINTENANCE

The leachate collection and removal system for the existing CCR landfill will be maintained to meet state requirements including leachate collection line cleaning, leachate collection video inspection, and any needed repairs to the existing system.

2.3 GROUNDWATER MONITORING AND SYSTEM MAINTENANCE

All CCR Wells, as defined by NR 500.03(26y) and approved by the Department, will be maintained and sampled semi-annually for the parameters listed in Appendix III to Part 257 listed in Appendix I, Table 1A to NR 507, and in accordance with 40 CFR 257.90-98 and NR 507.15 (3).

Non-CCR monitoring wells at the site will be maintained and sampled as approved by the Department in writing.

3.0 POST-CLOSURE PERIOD CONTACTS

<u>40 CFR 257.104(d)(1)(ii).</u> *"The name, address, telephone number, and email address of the person or office to contact about the facility during the post-closure period."*

NR 514.07(10)(d)(2). *"The name, address, telephone number, and email address of the person or office to contact about the facility during long–term care."*

Currently, the contact information for I-43 Ash Disposal Facility during the post-closure/long-term care period is as follows:

Edgewater Generating Station
Attn: Plant Manager
3739 Lakeshore Drive
Sheboygan, WI 53081
(920) 459-6182
CCRProgram@alliantenergy.com

4.0 POST-CLOSURE PERIOD SITE USE

40 CFR 257.104(d)(1)(iii). *"A description of the planned uses of the property during the post-closure period. Post-closure use of the property shall not disturb the integrity of the final cover, liner(s), or any other component of the containment system or the function of the monitoring systems unless necessary to comply with the requirements of the subpart..."*

NR 514.07(10)(d)(3). *"A description of the planned uses of the property during long–term care. Post–closure uses may not disturb the integrity of the final cover, liner, or any other component of the landfill, or the function of the monitoring systems unless approved in writing by the department...."*

The final use of the I-43 Ash Disposal Facility will be privately owned green space. With this use, there will be no disturbance of the final cover or any other landfill-related components.

5.0 CERTIFICATIONS

40 CFR 257.104(d)(4). *"The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer that the initial and any amendment of the written post-closure plan meets the requirements of this section."*

NR 500.05. *"Unless otherwise specified, all submittals for review and approval of any initial site report, feasibility report, plan of operation site investigation report, remedial action options report, construction documentation report, or closure plan, or any modifications to those plans, shall include all of the following:*

(4) CERTIFICATION. (a) The reports and plan sheets shall be under the seal of a licensed professional engineer."

Phillip Gearing, PE, a licensed profession engineer in the State of Wisconsin, has overseen the preparation of this Post-Closure Care Plan. A certification statement is provided on **page iii** of this plan.

6.0 RECORDKEEPING AND REPORTING

40 CFR 257.104(b)(2)(iii). *"The owner or operator has completed the written post-closure plan when the plan including the certification required by paragraph (d)(4) of this section, has been placed in the facility's operating record as required by Section 257.105(i)(4)."*

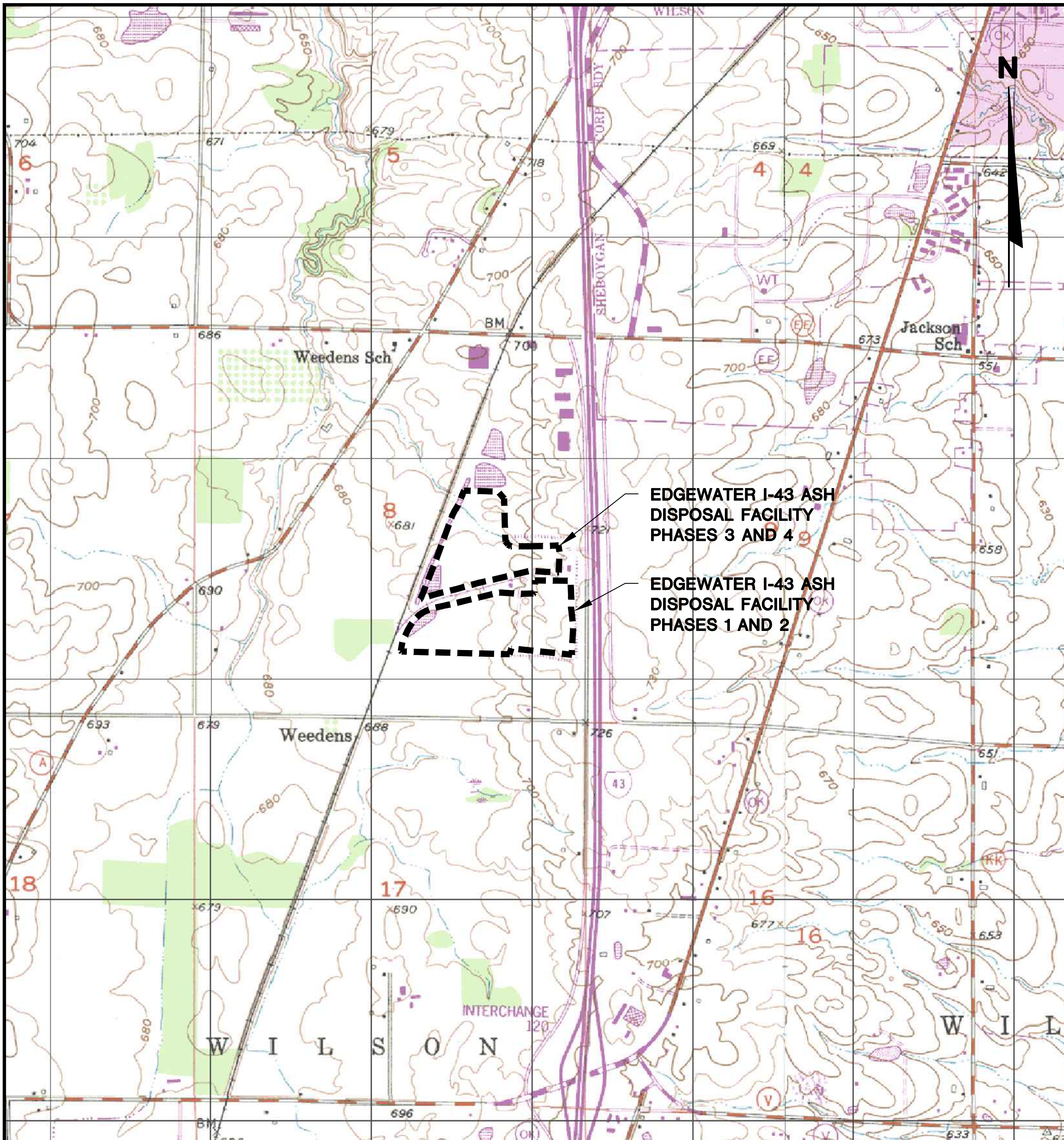
NR 506.17(2)(e). *"The written operating record shall contain the plan of operation, plan modifications, construction documentation, department approvals, annual reports, inspection records, monitoring and corrective action records, notifications to the department, and records of public comments received during any public comment period."*

The Post-Closure Care Plan will be placed in the facility's operating record and on Alliant Energy's CCR Rule Compliance Data and Information website, as will all amendments if any.

WPL will amend the Post-Closure Care Plan if there is a change in operation of the CCR unit that affects the written Post-Closure Care Plan or, if after post-closure activities have started, unexpected events cause a revision of the plan.

WPL will provide notification of completion of the post-closure care no later than 60 days following the completion of the post-closure care period. The notification will include certification by a qualified professional engineer verifying that post-closure care has been completed in accordance with the plan. The notification will be placed in the facility's operating record and on the website.

Figures



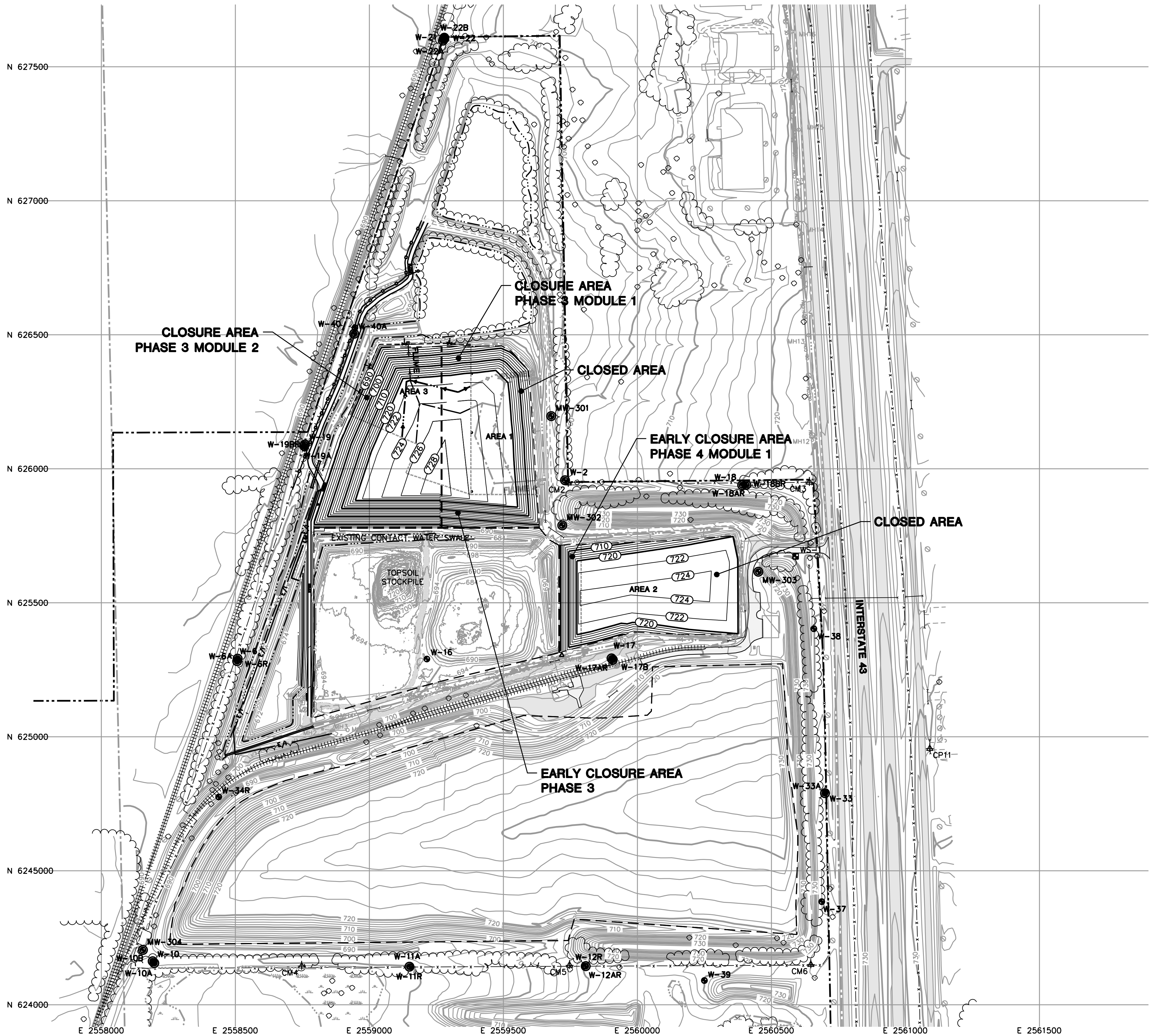
N

SHEBOYGAN HILLS QUADRANGLE
WISCONSIN–SHEBOYGAN CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SCALE: 1" = 2,000'

CLIENT	SITE	
WISCONSIN POWER AND LIGHT COMPANY EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081	POST–CLOSURE CARE PLAN EDGEWATER I–43 ASH DISPOSAL FACILITY TOWN OF WILSON, WISCONSIN	SITE LOCATION MAP

				ENGINEER	
PROJECT NO.	25222259.00	DRAWN BY:	AHB	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718–6751 PHONE: (608) 224–2830	FIGURE
DRAWN:	08/09/16	CHECKED BY:	LB		1
REVISED:	08/09/16	APPROVED BY:	PG 1/31/23		

I:\25222259.00\Drawings\Post-Closure Care Plan\Fig 1_Site Location Map.dwg, 1/31/2023 11:39:58 AM

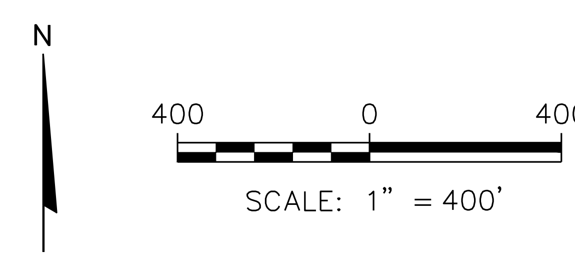


LEGEND

- APPROXIMATE PROPERTY LINE
- LIMITS OF WASTE
- MODULE LIMITS
- EXISTING GRADE (2' CONTOUR)
- 690 EXISTING GRADE (10' CONTOUR)
- EDGE OF WATER
- SWALE
- WETLAND
- CULVERT
- MH MANHOLE
- W CONTACT WATER TRANSFER PIPE
- AB ABANDONED 3" DIA. HDPE PIPE
- FM CONTACT WATER FORCEMAIN
- E/I ELECTRIC/INSTRUMENTATION
- TREELINE/TREES
- PAVED ROAD
- ACCESS ROAD
- CONCRETE
- RAILROAD TRACKS
- FENCE
- UTILITY/LIGHT POLE
- CONTROL MONUMENT
- MONITORING WELL
- PIEZOMETER
- LEACHATE HEADWELL
- PRIVATE WATER SUPPLY WELL
- 720 PROPOSED FINAL GRADE (10' CONTOUR)
- 3.0% SLOPE AND DIRECTION
- LM PROPOSED 6" DIA. LEACHATE FORCEMAIN
- PROPOSED LEACHATE VAULT
- E/I PROPOSED ELECTRIC AND INSTRUMENT CONDUITS
- PROPOSED ACCESS ROAD
- PROPOSED FINAL COVER DRAINAGE SYSTEM PIPE
- PROPOSED FINAL COVER DIVERSION BERM
- PROPOSED DOWNSLOPE FLUME
- PROPOSED ENERGY DISSIPATOR
- PROPOSED TOE DRAIN AND DISCHARGE PIPE
- CONCEPTUAL FINAL COVER SEQUENCE LIMITS
- AREA 1 CONCEPTUAL FINAL COVER AREA

NOTES:

1. BASE MAP PREPARED BY KBM, INC. BASED ON AERIAL TOPOGRAPHIC SURVEY FLOWN DECEMBER 1, 2014. BASE MAP PREPARED USING WISCONSIN STATE PLANE COORDINATES. ELEVATIONS BASED ON USGS NATIONAL GEODETIC VERTICAL DATUM, 1929. UPDATED WITH 2015 CONSTRUCTION AS-BUILT GRADES, 2016 CONSTRUCTION AS-BUILT GRADES FOR PHASE 4, MODULE 1 BY SCS ENGINEERS, DECEMBER 23, 2020 DRONE SURVEY OF PHASE 3, MODULE 2 ASH GRADES AND FUTURE PHASE 4 AREAS BY RYAN INCORPORATED CENTRAL, APRIL 11, 2022 PHASE 3 MODULE 2 SURVEY BY SCS ENGINEERS.
2. CONTOUR INTERVAL IS 2 FEET.
3. MONITORING WELL LOCATIONS BASED ON WELL INFORMATION FORM COORDINATES AND EXISTING CONDITIONS MAP F11 PREPARED BY WARZYN, INC. USING LOCAL COORDINATES.



SCALE: 1" = 400'

CLIENT	WISCONSIN POWER AND LIGHT COMPANY EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081
PROJECT NO.	25222259.00
DRAWN:	08/09/16
REVISED:	01/26/23
DRAWN BY:	KP
CHECKED BY:	LB
APPROVED BY:	PG 1/31/23
SITE	POST-CLOSURE CARE PLAN EDGEWATER I-43 ASH DISPOSAL FACILITY TOWN OF WILSON, WISCONSIN
ENGINEER	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830

POST-CLOSURE CARE PLAN

FIGURE 2