Location Restrictions Demonstrations

DTE Electric Company
St. Clair Power Plant Bottom Ash Basins
Coal Combustion Residual Unit

4901 Pointe Drive
East China Township, Michigan

October 2018

Location Restrictions Demonstrations

DTE Electric Company
St. Clair Power Plant Bottom Ash Basins
Coal Combustion Residual Unit

4901 Pointe Drive
East China Township, Michigan

October 2018

Prepared For
DTE Electric Company

Graham Crockford, C.P.G.
Senior Project Geologist

David B. McKenzie, P.E.
Senior Project Engineer

TRC | DTE Electric Company
Final
X:\WPAAM\PJT2\296702\0000\04 SCPP\R296702-SCPP.DOCX

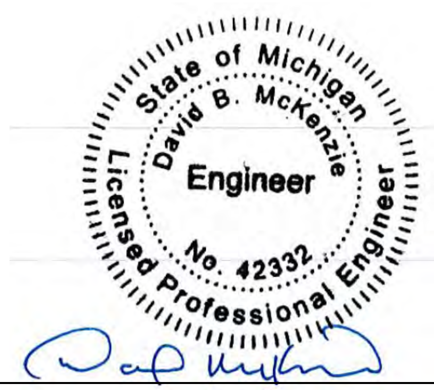
Table of Contents

List of Appendices

Certification

I, the undersigned Michigan Professional Engineer, hereby certify that I am familiar with the technical requirements of Title 40 Code of Federal Regulations Part 257 Subpart D (§257). I also certify that it is my professional opinion that, to the best of my knowledge, information, and belief, that the information in this demonstration is in accordance with current good and accepted engineering practice(s) and standard(s) and meets the requirements of §257.60 through §257.64.

For the purpose of this document, "certify" and "certification" shall be interpreted and construed to be a "statement of professional opinion." The certification is understood and intended to be an expression of my professional opinion as a Michigan Licensed Professional Engineer, based upon knowledge, information, and belief. The statement(s) of professional opinion are not and shall not be interpreted or construed to be a guarantee or a warranty of the analysis herein.



Seal/Date 10/15/18

David B McKenzie, P.E.

License No: 6201042332

Section 1
Background

The purpose of this document is to determine whether the Coal Combustion Residual (CCR) Bottom Ash Basins (BABs) at the St. Clair Power Plant (SCPP) are in compliance with the location restrictions outlined in the Environmental Protection Agency's (EPA) final CCR rule [Title 40 Code of Federal Regulations (CFR) Parts 257 and 261] Subpart D – "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments" (§257.60 through §257.64, federal rule). The BABs are considered CCR surface impoundments according to the federal rule (§257.53).

This document includes information from a desktop study and well installation activities and also includes engineering calculations to demonstrate that the BABs comply with placement above the uppermost aquifer criteria (§257.60), and with location criteria with respect to wetlands (§257.61), fault areas (§257.62), seismic impact zones (§257.63), and unstable areas (§257.64).

Supporting documents are provided as appendices to this demonstration.

1.1 Facility and CCR Unit Information

The two SCPP BABs are located in Section 19, Township 4 North, Range 17 East, at 4901 Pointe Drive, East China Township in St. Clair County, Michigan. The SCPP including the BABs CCR unit was constructed in the early 1950s. The power plant is located on the peninsula formed by the St. Clair and Belle Rivers, approximately three miles south of St. Clair, Michigan immediately to the west of the St. Clair River. The SCPP BABs are located just south of the main SCPP building.

The property has been used continuously as a coal-fired power plant since Detroit Edison Company (now DTE Electric) began power plant operations at SCPP in 1953. The power plant is constructed over a natural continuous clay-rich soil base as shown in soil borings performed at the SCPP property (Appendix A). The adjacent incised BABs have been used to collect bottom ash from coal combustion processes since the plant began operations. This collected CCR is routinely cleaned out of the BABs and either sold for beneficial reuse or disposed at the Range Road Landfill (RRLF).

In 1995, the impoundments were reconstructed by driving steel sheet-pile around each basin's perimeter to a depth of approximately 13 feet below ground surface (ft bgs) into the native clay-rich soil. The BAB perimeter sheet pile wall is tied-back to 10-ft long steel sheets located 15 ft behind the perimeter wall and connected with rods at 8 to 20-ft centers. The BABs receive bottom ash and other process water from the power plant; the ash and process water first flow to the East BAB and then to the West BAB through a connecting concrete canal. Discharge water from the basins flows with other site wastewater into the Overflow Canal in accordance with a National Pollution Discharge Elimination System (NPDES) permit.

1.2 Site Setting

A groundwater monitoring system has been established for the SCPP BABs CCR unit as detailed in the Groundwater Monitoring System Summary Report – DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit (GWMS Report) (TRC, October 2017). The detection monitoring well network for the BABs CCR unit currently consists of four monitoring wells that are screened in the uppermost aquifer. The monitoring well boring logs are included in Appendix A.

The SCPP BABs CCR unit is located immediately adjacent to and west of the St. Clair River. The geologic setting of the SCPP BABs is detailed in the *Annual Groundwater Monitoring Report* (TRC, January 2018). In summary, the SCPP CCR unit is underlain by glacial silty-clay till, with a few isolated sand lenses, and a silt and clay-rich hardpan base directly overlying shale bedrock (likely the Bedford Shale) which is generally encountered at depths greater than 130 ft bgs. No significant soil or gravel intervals were encountered at any of the groundwater monitoring system well locations. However, during soil boring advancement for the groundwater monitoring system well installations, some signs of saturation were observed throughout a 5-foot interval along the interface between the overlying till/hardpan and the underlying shale bedrock[1]. The underlying shale bedrock does not yield groundwater; rather, it is an aquiclude that prevents groundwater flow (i.e., is not an aquifer).

Hydraulic conductivities measured within the CCR monitoring wells using single well hydraulic conductivity tests (e.g., slug tests) range from approximately 0.009 to 0.017 feet/day with a mean of approximately 0.013 feet/day. Although the encountered zone of saturation along the till/hardpan and shale bedrock interface did not yield significant groundwater, it was conservatively interpreted as the first underlying saturated zone that would presumably become affected with CCR constituents. Since it was saturated, and although the hydraulic conductivity was low, it exhibited a much higher conductivity than the clay-rich soils between the bottom of the basin and the monitored zone. Therefore, the potential uppermost aquifer as described above, was present beneath at least 120 feet of vertically contiguous silty clay-rich till that serves as a natural confining hydraulic barrier that isolates the underlying uppermost potential aquifer from the BABs.

[1] The interface is located at a depth of approximately 130.5 ft to 132 ft below ground surface (bgs).

A definitive groundwater flow direction toward the east-southeast with a mean hydraulic gradient of 0.0036 foot/foot in calendar years 2016 and 2017 is evident in this identified uppermost aquifer around the SCPP CCR BABs CCR unit. However, based on the measured hydraulic conductivity and gradient, the potential groundwater flow within this uppermost aquifer is very slow (on the order of 0.05 feet per year).

Section 2
Location Restrictions

The location restrictions designated in the federal CCR rule are presented below with a corresponding demonstration to show compliance with each restriction. The location restrictions include placement above the uppermost aquifer, within wetlands, near fault areas, within seismic impact zones, and in unstable areas based on available geologic and geomorphologic information. Supporting information for the demonstrations is included in the appendices to this report.

2.1 §257.60 – Placement above the Uppermost Aquifer

The federal CCR rule requires that CCR units such as the SCPP BABs must be constructed with a base that is located no less than 1.52 meters (5 feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in the groundwater elevations (including the seasonal high water table). As stated in Section 1.1 (above), the perimeter of each BAB is constructed of steel sheet piling installed to a depth of approximately 13 ft bgs (approximately 570.5 ft. MSL based on site-specific datum). Pond bottom is maintained, by periodic dredging, at an elevation of approximately 572 ft MSL. The BABs are underlain by approximately 130 ft of silty clay with no significant zones of saturation. The uppermost aquifer is the silty clay hardpan/shale bedrock interface, located approximately 130.5 to 132 ft bgs. The base of the BABs and the uppermost aquifer are separated by approximately 120 ft of silty clay. Cross-sections showing the installation top and bottom elevation of the perimeter sheet pile and approximate pond bottom elevation for each BAB, the presence of low hydraulic conductivity clay, and the depth to the uppermost aquifer, are included in Appendix B.

Based on this demonstration, the base of each BAB is located greater than 5 feet above the upper limit of the uppermost aquifer, and there is not a hydraulic connection between the BABs and the underlying groundwater caused by normal fluctuations in groundwater level. Therefore, each of the SCPP BABs is in compliance with the requirements of §257.60.

2.2 §257.61 – Wetlands

The CCR location standards restrict existing and new CCR surface impoundments from being located in wetlands, as defined at 40 CFR 232.2 (40 CFR 257.61(a)). Wetlands are defined in 40 CFR 232.2 *Waters of the United States (3)(iv)* as, "…those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." TRC reviewed National Wetland Inventory (NWI) Maps and Michigan Resource Information System (MIRIS) Land Cover Maps archived and available through Michigan Department of Natural Resources (MDNR) Michigan Resource Inventory Program (MRIP) to ascertain whether or not the SCPP BABs are located in wetlands.

As shown on the site map in Appendix C, soils at and in the vicinity of the site are designated primarily as wetland soils, most likely due to the proximity of the site to the St. Clair River. NWI (2005) recognizes one area located approximately 350 ft south-southwest of the BABs as a wetland. This area is not immediately adjacent to the BABs and is hydraulically separated by the silty clay confining layer surrounding and underlying the BABs, and therefore, there is no risk of impact to this area from the BAB operations.

Based on TRC's review of wetland inventory resources and current site conditions, TRC is of the opinion that the SCPP BABs are not located in an area exhibiting wetland characteristics, and any continued operations at the BABs will have no potential to impact any wetlands near the CCR unit. TRC also concludes that, due to their use as NPDES treatment units, these basins are not wetlands, as defined in 40 CFR 232.2.

2.3 §257.62 – Fault areas

The federal CCR rule requires that CCR units not be located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time (within the most recent 11,700 years) unless the owner or operator demonstrates that an alternative setback distance of less than 60 meters (200 feet) will not cause damage to the structural integrity of the CCR unit. As shown on the U.S. Quaternary Folds and Faults Database Map (USGS, accessed 9/7/2018) in Appendix D, no faults have been mapped near the SCPP BABs.

Evidence of active faulting during the Holocene in the SCPP BABs area is not supported by this determination; therefore, the existing BABs are in compliance with the requirements of §257.62.

2.4 §257.63 – Seismic Impact Zones

The federal CCR rule requires that CCR units not be located in seismic impact zones unless the owner or operator demonstrates that all structural components including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site. The federal CCR rule defines a seismic impact zone as "an area having a 2% or greater probability that the maximum expected horizontal acceleration, expressed as a percentage of the earth's gravitation pull (g), will exceed 0.10 g in 50 years."

To determine whether the existing SCPP BABs are located in a seismic impact zone, the USGS Earthquake Hazards Program was consulted to determine the earthquake hazard for the SCPP. The 2015 National Earthquake Hazards Reduction Program U.S. seismic design maps website (USGS 2015; Appendix E) indicates a mapped peak ground acceleration of 0.043 g for the SCPP BABs area. Using the default site adjustment factor results in a design peak ground acceleration of 0.068 g in 50 years. Since this calculation indicates that the design peak ground acceleration value will not exceed 0.10 g in 50 years, the SCPP BABs are not located in a seismic impact zone, and therefore, the BABs are in compliance with the requirements of §257.63.

2.5 §257.64 – Unstable Areas

The federal CCR rule requires that CCR units not be located in an unstable area unless the owner or operator demonstrates that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted. Factors associated with soil conditions resulting in significant differential settlement, geologic or geomorphologic features, and human-made features or events must be evaluated to determine compliance. This demonstration was performed by reviewing geotechnical data, local geology, topography, and evaluating human-made features in the area of the SCPP BABs.

Geotechnical explorations performed at the SCPP BAB area identified silty clay with traces of sand and gravel overlying an approximately 5-ft thick saturated hardpan which overlies a low permeability shale bedrock at a depth of approximately 130 ft bgs. These observations suggest that there are no unstable soil or underlying bedrock conditions proximal to the BABs. Additionally, the perimeter walls of the BABs are constructed of steel sheet pile driven into the stable clay-rich soils, and these perimeter walls are tied back to driven steel sheets located 15 feet behind the perimeter walls. These tie-backs further serve to stabilize the BAB walls and minimize potential for sidewall collapse.

Human-made features surrounding the BAB area include concrete pavement and a steel seawall along the St. Clair River shoreline. Both of these features significantly reduce any erosional forces on surficial and near-surficial soils caused by surface water drainage and river flow adjacent to the BABs. Geological and geomorphological changes near the SCPP were primarily caused by hydrologic forces imparted by the St. Clair River flow. These ongoing forces and any impact they might have on the BABs are negated by the facility's shoreline sea wall and are not contributing to any unstable areas at or near the BABs.

Evidence of unstable areas due to soil conditions resulting in significant differential settling, geologic or geomorphologic features, or human-made features or events is not supported by this determination; therefore, the SCPP BABs are not located in unstable areas. The BABs are in compliance with the requirements of §257.64.

Section 3
Conclusions

Based on the evaluation provided in this demonstration, the SCPP BABs CCR unit is in compliance with the location restrictions provided in §257.60 through §257.64 of the CCR rule. No additional action, justification, or demonstration is required to document compliance with the location restrictions provided in the CCR rule after this demonstration has been placed into the operating record, posted to the publicly-accessible website, and government notifications provided.

Section 4
References

TRC. January 2018. Annual Groundwater Monitoring Report – DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit.

TRC. October 2017. Groundwater Monitoring System Summary Report – DTE Electric Company St. Clair Power Plant Bottom Ash Basins Coal Combustion Residual Unit.

United States Fish and Wildlife Service. 2010. "Wetlands Mapper." National Wetlands Inventory. Available online at http://geohazards.usgs.gov/deaggint/2008/. Accessed [8/17/2018].

United States Geological Survey (USGS). 2015. U.S. Seismic Design Maps: 2015 National Earthquake Hazards Reduction Program Provisions. Available Online at http://earthquake.usgs.gov/designmaps/beta/us/. Accessed [8/16/2018].

USGS. U.S. Quaternary Faults and Fold Database. USGS Geologic Hazards Science Center, Golden, CO Available online at https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=db287853794f4555b8e93e42290e9716. Accessed [9/7/2018].

Appendix A
Monitoring Well Boring Logs

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-01

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE: Saint Clair Power Plant	3/31/16	3/31/16	231828.0004.0000

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	585.12	584.74	138.0	6

Boring Location:	Personnel	Drilling Equipment:
S side of median, in parking lot W of ash basin. N: 465440.66 E: 13631612.80	Logged By - J. Reed Driller - A. Goldsmith	Terrasonic

Civil Town/City/or Village:	County:	State:	Water Level Observations:
Saint Clair	Saint Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 4/8/16 08:45 ▼ Depth (ft bgs) 14.08

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
			0	**GRAVEL WITH SAND** mostly gravel, little sand, brown (10YR 5/3), no odor, moist.				
				CLAY mostly clay, few silt, grayish brown (10YR 5/2), no odor, moist, dense.				
			5					
1 CS	90		10	Change to medium dense at 10.0 feet.				
				Change to soft to medium dense at 12.5 feet.				
			▼					
			15					
			20		CL			
			25					
2 CS	95		30					
			35					

Signature: [signature] for J. Reed

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

Checked By: C. Scieszka

TRC

WELL CONSTRUCTION LOG

WELL NO. MW-16-01

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
3 ST				**CLAY** mostly clay, few silt, grayish brown (10YR 5/2), no odor, moist, soft to medium dense.				
				Change to few fine to coarse sand at 43.0 feet.				
			45					
4 CS	100		50	Change to gray (10YR 5/1) at 50.0 feet.				
			55					
			60		CL			
			65					
5 CS	100		70					
			75					
			80	Sand seam, 8 inches thick, mostly coarse sand, black (10YR 2/1) at 80.25 feet.	SP			
				CLAY WITH SAND mostly clay, little fine to coarse sand, few silt, gray (10YR 5/1), no odor, medium dense.	CL			
			85	Sand seam, 8 inches thick, mostly coarse sand, black (10YR 2/1) at 85.0 feet.	SP			
				CLAY WITH SAND mostly clay, little fine to coarse sand, few silt, gray (10YR 5/1), no odor, medium dense.	CL			
6 CS	100		90	Change to few to little fine to coarse sand at 90.0 feet.				

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	COMMENTS
7 CS	100		93–120 (95, 100, 105, 110, 115, 120)	**CLAY WITH SAND** mostly clay, few to little fine to coarse sand, few silt, gray (10YR 5/1), no odor, medium dense.	CL	
8 CS	100		120–130 (125)	Change to soft at 120.0 feet.	CL	
			126.5–131.5 (130)	**SILTY CLAY** mostly clay, some silt, very dark gray, (10YR 3/1), no odor, dry to moist, hard.	CL-ML	
9 CS	100		131.5–138 (135)	**SHALE** very dark gray (10YR 3/1) to light gray (10YR 7/1), no odor, moist.		
			138–145 (140, 145)	End of boring at 138.0 feet below ground surface.		

WELL CONSTRUCTION LOG

WELL NO. MW-16-02

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE: Saint Clair Power Plant	3/28/16	3/28/16	231828.0004.0000

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	582.18	581.43	138.0	6

Boring Location:	Personnel	Drilling Equipment:
NE side of ash basin. N: 465503.41 E: 13632151.32	Logged By - A. Knutson Driller - A. Goldsmith	Terrasonic

Civil Town/City/or Village:	County:	State:	Water Level Observations:
Saint Clair	Saint Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 4/8/16 08:38 ▼ Depth (ft bgs) 1.76

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				GRAVEL mostly coarse gravel, few coarse sand, black (10YR 2/1), no odor, moist, loose.				
				▼ **SAND WITH GRAVEL** mostly fine to coarse sand, some fine to coarse gravel, brown (10YR 5/3), no odor, moist, loose.				
1 CS	95		5	**CLAY** mostly clay, few silt, grayish brown (10YR 5/1), no odor, moist, stiff.				
				Change to soft at 8.0 feet.				
			10					
2 CS	100		15					
			20		CL			
3 CS	100		25					
			30					
4 CS	100		35					

Signature: [signature] for A. Knutson

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan
734.971.7080
Fax 734.971.9022

Checked By: C. Scieszka

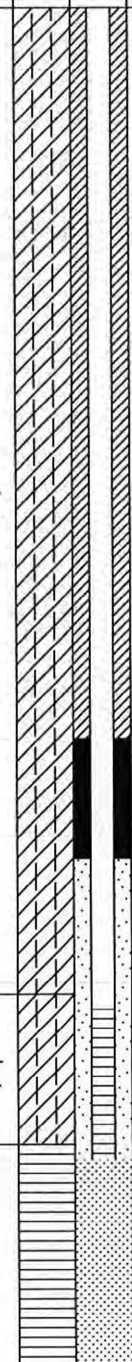
WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-02

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				CLAY mostly clay, few silt, grayish brown (10YR 5/1), no odor, moist, soft.				
5 CS	100							
			45	Change to few silt at 45.0 feet.				
				Change to no silt at 46.0 feet.	CL			
			50					
6 CS	100							
			55					
				SILTY CLAY mostly silt, little clay, dark grayish brown (10YR 5/3), no odor, moist, stiff.				
			60					
7 CS	100							
			65					
			70					
8 CS	100							
				Change to few fine to coarse sand at 73.5 feet.	CL-ML			
			75					
				Change to no sand at 76.5 feet.				
			80					
9 CS	100							
			85					
			90					

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
10 CS	100		95	**SILTY CLAY** mostly silt, little clay, dark grayish brown (10YR 5/3), no odor, moist, stiff.	CL-ML			
11 CS	100		100, 105					
12 CS	100		110, 115					
13 CS	80		120, 125					
				SILTY CLAY mostly clay, some silt, very dark gray (10YR 3/1), no odor, dry, hard.	CL-ML			
14 CS	100		130	**SHALE** very dark gray (10YR 3/1) to light gray (10YR 7/1), no odor, moist.				
			135					
			140, 145	End of boring at 138.0 feet below ground surface.				



WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-03

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE: Saint Clair Power Plant	3/24/16	3/24/16	231828.0004.0000

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	582.08	581.39	138.0	6

Boring Location:	Personnel	Drilling Equipment:
E side of ash basin. N: 465353.06 E: 13632114.23	Logged By - J. Reed Driller - A. Goldsmith	Terrasonic

Civil Town/City/or Village:	County:	State:	Water Level Observations:
Saint Clair	Saint Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 4/8/16 08:35 ▼ Depth (ft bgs) 2.16

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				GRAVEL WITH SAND mostly gravel, some sand, black (10YR 2/1), no odor, moist, loose.				
			▼	**SAND AND GRAVEL** brown (10YR 5/3), no odor, moist, loose.				
1 CS	95		5	**CLAY** mostly clay, few to little silt, grayish brown (10YR 5/2), no odor, moist, stiff.				
			10	Change to medium stiff at 10.0 feet.				
2 CS	100		15					
			20		CL			
3 CS	100		25					
			30	Change to trace to few sand at 30.0 feet.				
				Change to no sand at 32.5 feet.				
4 CS	100		35					

Signature: [signature] for J. Reed

Firm: TRC Environmental Corporation 1540 Eisenhower Place Ann Arbor, Michigan 734.971.7080 Fax 734.971.9022

Checked By: C. Scieszka

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 ST				**CLAY** mostly clay, few to little silt, grayish brown (10YR 5/2), no odor, moist, medium stiff.				
			45					
6 CS	100							
			50		CL			
7 CS	100		55					
			60	**SILTY CLAY** mostly clay, little silt, dark grayish brown (10YR 5/2), no odor, moist, dense.				
8 CS	100		65					
			70					
9 CS	100		75		CL-ML			
			80					
10 CS	100		85					
			90					

TRC

WELL CONSTRUCTION LOG

WELL NO. MW-16-03

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	100		95	**SILTY CLAY** mostly clay, little silt, dark grayish brown (10YR 5/2), no odor, moist, dense.				
			100					
12 CS	100		105					
			110		CL-ML			
13 CS	100		115					
			120					
14 CS	100		125					
			130	**SILTY CLAY HARDPAN AND SHALE** very dark gray (10YR 3/1), no odor, dry to slightly moist, hard.	CL-ML			
15 CS	100		135	**SHALE** very dark gray (10YR 3/1) to light gray (10YR 7/1), no odor, moist.				
			140	End of boring at 138.0 feet below ground surface.				
			145					

WELL CONSTRUCTION LOG

TRC

WELL NO. MW-16-04

Facility/Project Name:	Date Drilling Started:	Date Drilling Completed:	Project Number:
DTE: Saint Clair Power Plant	3/22/16	3/23/16	231828.0004.0000

Drilling Firm:	Drilling Method:	Surface Elev. (ft)	TOC Elevation (ft)	Total Depth (ft bgs)	Borehole Dia. (in)
Stock Drilling	Sonic	581.99	580.95	138.0	6

Boring Location:	Personnel	Drilling Equipment:
SE side of ash basin. N: 465173.94 E: 13632077.11	Logged By - J. Reed Driller - A. Goldsmith	Terrasonic

Civil Town/City/or Village:	County:	State:	Water Level Observations:
Saint Clair	Saint Clair	MI	While Drilling: Date/Time Depth (ft bgs) After Drilling: Date/Time 4/8/16 08:28 ▼ Depth (ft bgs) 2.19

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
				GRAVEL mostly gravel, few to little fine to coarse sand, very dark gray (10YR 3/1), no odor, moist.				
1 CS	80		5	**CLAY WITH SAND** mostly clay, little to some fine to coarse sand, dark grayish brown (10YR 4/2), no odor, moist, medium dense.	CL			
				SAND WITH CLAY mostly sand, little to some clay, dark grayish brown (10YR 4/2), no odor, moist.	SW-SC			
			10	**CLAY WITH SAND** mostly clay, little to some fine to coarse sand, medium plasticity, dark grayish brown (10YR 4/2), no odor, moist, medium dense.	CL			
2 CS	95		15	**CLAY** mostly clay, trace fine to medium sand, medium plasticity, grayish brown (10YR 5/2), no odor, moist, stiff.				
			20					
3 CS	100		25	Change to medium stiff at 25.0 feet.	CL			
			30					
4 CS	100		35					

Signature: [signature] for J. Reed.

Firm: TRC Environmental Corporation 1540 Eisenhower Place Ann Arbor, Michigan 734.971.7080 Fax 734.971.9022

Checked By: C. Scieszka

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
5 ST					CL			
6 CS	100		45	**SILTY CLAY** mostly clay, little to some silt, few fine to coarse sand, dark grayish brown (10YR 5/2), no odor, moist, medium stiff.	CL-ML			
7 CS	100		50, 55					
8 CS	100		60, 65	**CLAY** mostly clay, few to little silt, few fine to coarse sand, grayish brown (10YR 5/2), no odor, moist, medium stiff.	CL			
9 CS	100		70, 75					
10 CS	100		80	Change to wet at 79.5 feet.				
				Change to moist at 83.0 feet.				
			85, 90					

TRC

WELL CONSTRUCTION LOG

WELL NO. MW-16-04

SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
11 CS	100		95	**CLAY** mostly clay, few to little silt, few fine to coarse sand, grayish brown (10YR 5/2), no odor, moist, medium stiff.	CL			
			100					
12 CS	100		105					
			110					
13 CS	100		115					
			120					
14 CS	100		125					
				SILTY CLAY HARDPAN/SHALE mostly clay and silt, very dark gray (10YR 3/1), no odor, dry to moist, hard.	CL-ML			
			130					
15 CS	100			**SHALE** light gray (10YR 7/1) to very dark gray (10YR 3/1), no odor, dry.				
			135					
				End of boring at 138.0 feet below ground surface.				
			140					
			145					

Appendix B
Hydrogeologic Cross Sections

LEGEND

- DOWN-GRADIENT WELL
- UP-GRADIENT WELL
- RIVER LEVEL MONITORING POINT
- CROSS SECTIONS

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO & PARTNERS, APRIL 2015.
2. WELL LOCATIONS SURVEYED BY BMJ ENGINEERS AND SURVEYORS INC. IN APRIL 2016.

N

0 100 200 Feet

1 " = 100 '

1:1,200

PROJECT:	DTE ELECTRIC COMPANY ST. CLAIR POWER PLANT 4901 POINTE DRIVE CHINA TOWNSHIP, MICHIGAN		
TITLE:	CROSS-SECTION LOCATOR MAP		
DRAWN BY:	B DEEGAN	PROJ NO.:	254222.0004
CHECKED BY:	S.HOLMSTROM	FIGURE B-1	
APPROVED BY:	V.BUENING		
DATE:	FEBRUARY 2017		

TRC

1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trcsolutions.com

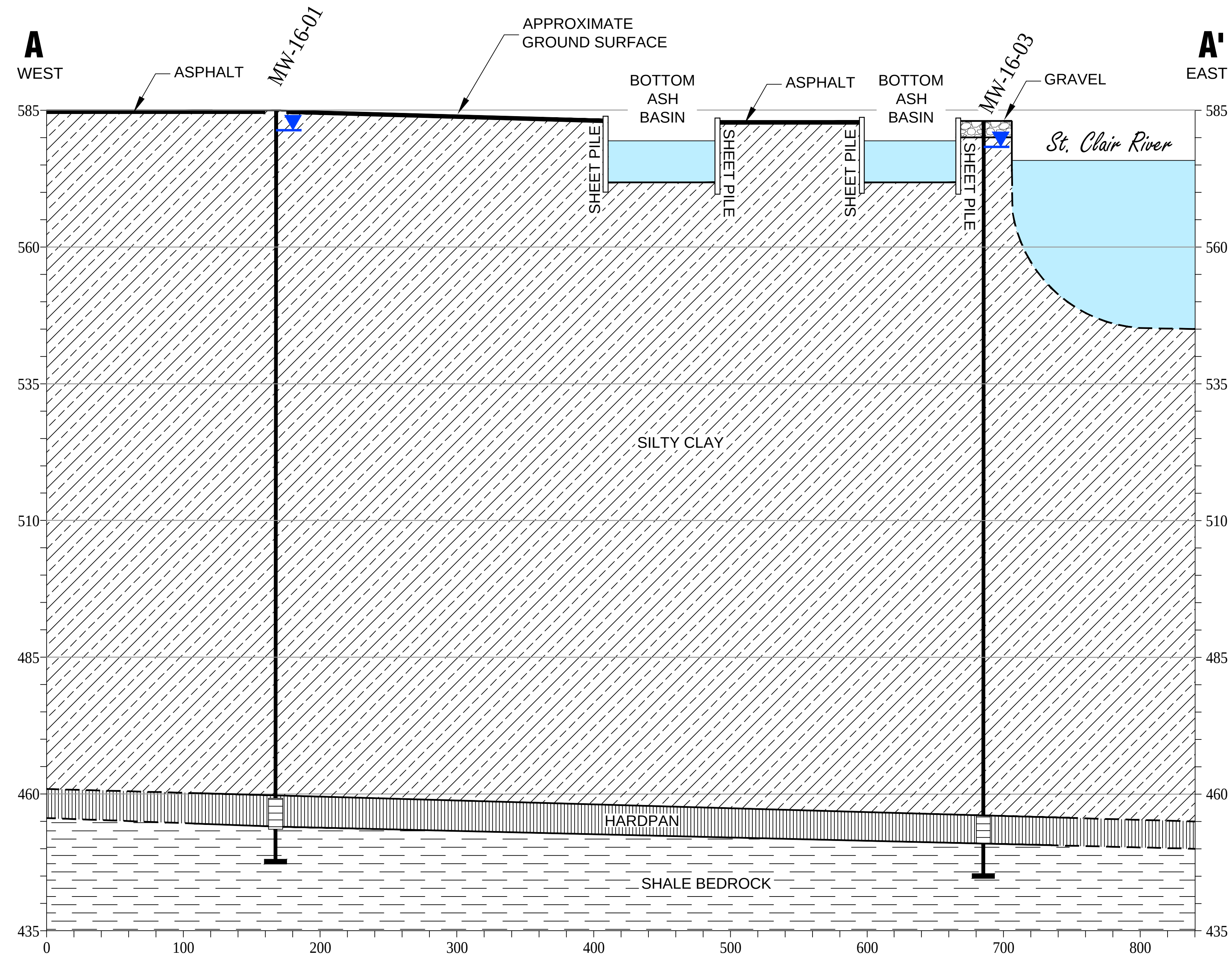
FILE NO.: 254222-0004-002.mxd

TRC - GIS

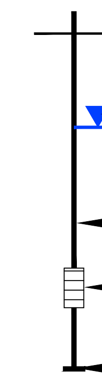
Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl (Foot)
Map Rotation: 0

Plot Date: 2/23/2017, 11:57:48 AM by BDEEGAN -- LAYOUT: ANSI B(11"x17")
Path: E:\DTE\CCR_Sites\2016_231828\254222-0004-002.mxd

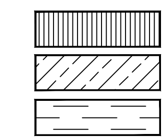
GENERALIZED GEOLOGIC CROSS-SECTION A-A'

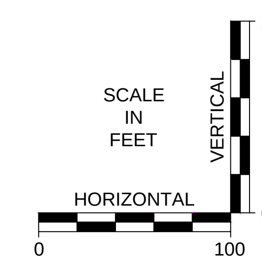


LEGEND



Lithology Key





PROJECT:

DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:

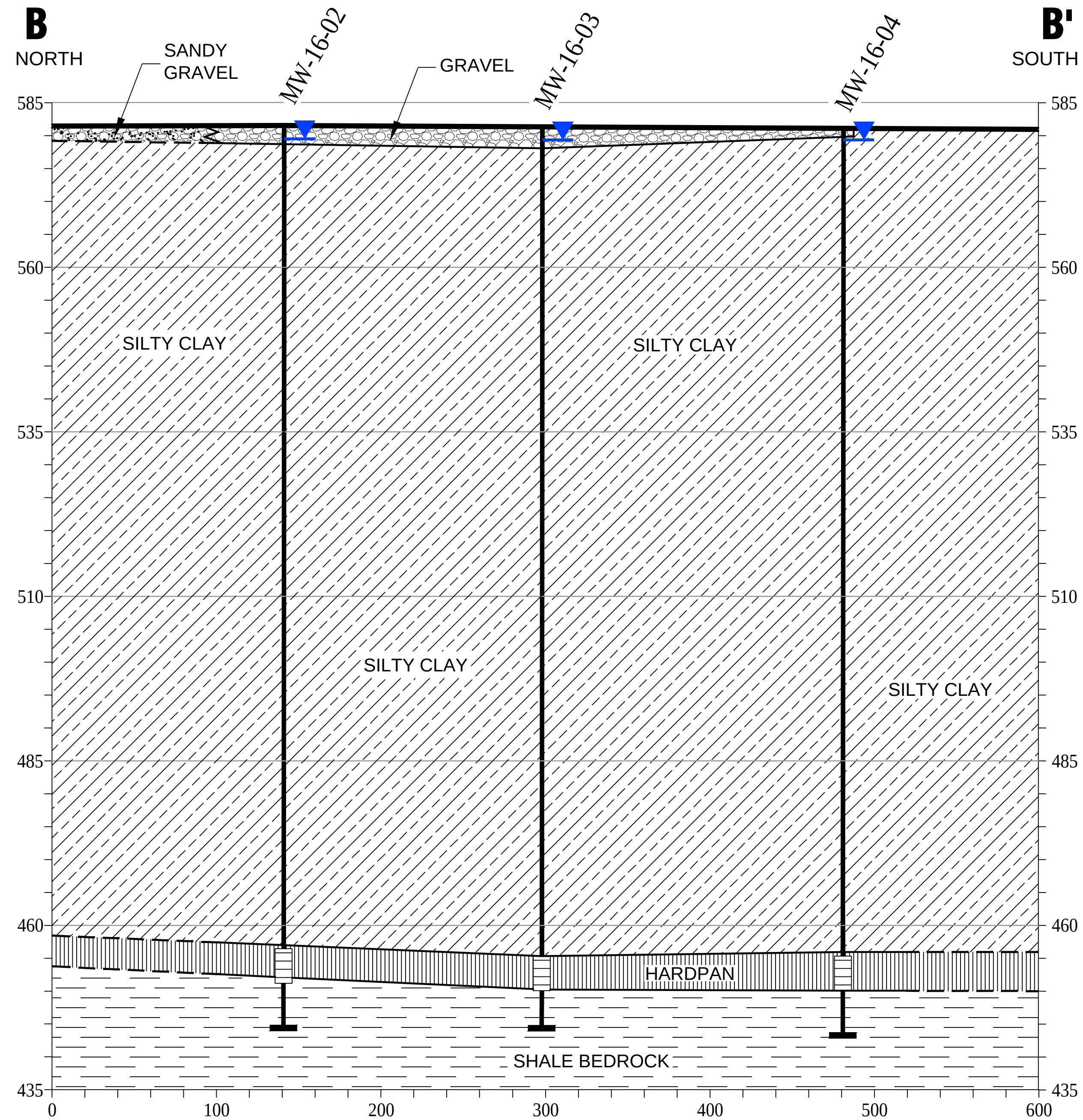
GENERALIZED GEOLOGIC CROSS-SECTION A-A'

DRAWN BY:	D.STEHLE	PROJ NO.:	265996.0004.01.01
CHECKED BY:	S.HOLMSTROM	**FIGURE B-2**	
APPROVED BY:	V.BUENING		
DATE:	SEPTEMBER 2017		

TRC
1540 Eisenhower Place
Ann Arbor, MI 48108
Phone: 734.971.7080
www.trcsolutions.com

FILE NO.: 265996.0004.01.01.04-05.dwg

GENERALIZED GEOLOGIC CROSS-SECTION B-B'

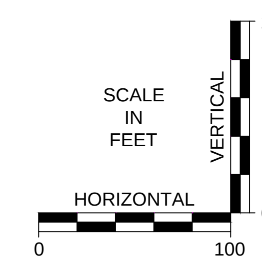


LEGEND

- STRATEGRAPHIC BOUNDARY (DASHED WHERE INFERRED)
- GROUNDWATER ELEVATION (COLLECTED 02/28/2017)
- SOIL BORING
- WELL SCREEN INTERVAL
- END OF BORING

Lithology Key

- HARDPAN
- SILTY CLAY
- SHALE BEDROCK
- GRAVEL
- SANDY GRAVEL



PROJECT:
DTE ELECTRIC COMPANY
ST. CLAIR POWER PLANT
EAST CHINA TOWNSHIP, MICHIGAN

TITLE:
GENERALIZED GEOLOGIC CROSS-SECTION B-B'

DRAWN BY:	D.STEHLE	PROJ NO.:	265996.0004.01.01
CHECKED BY:	S.HOLMSTROM	FIGURE B-3	
APPROVED BY:	V.BUENING		
DATE:	SEPTEMBER 2017		

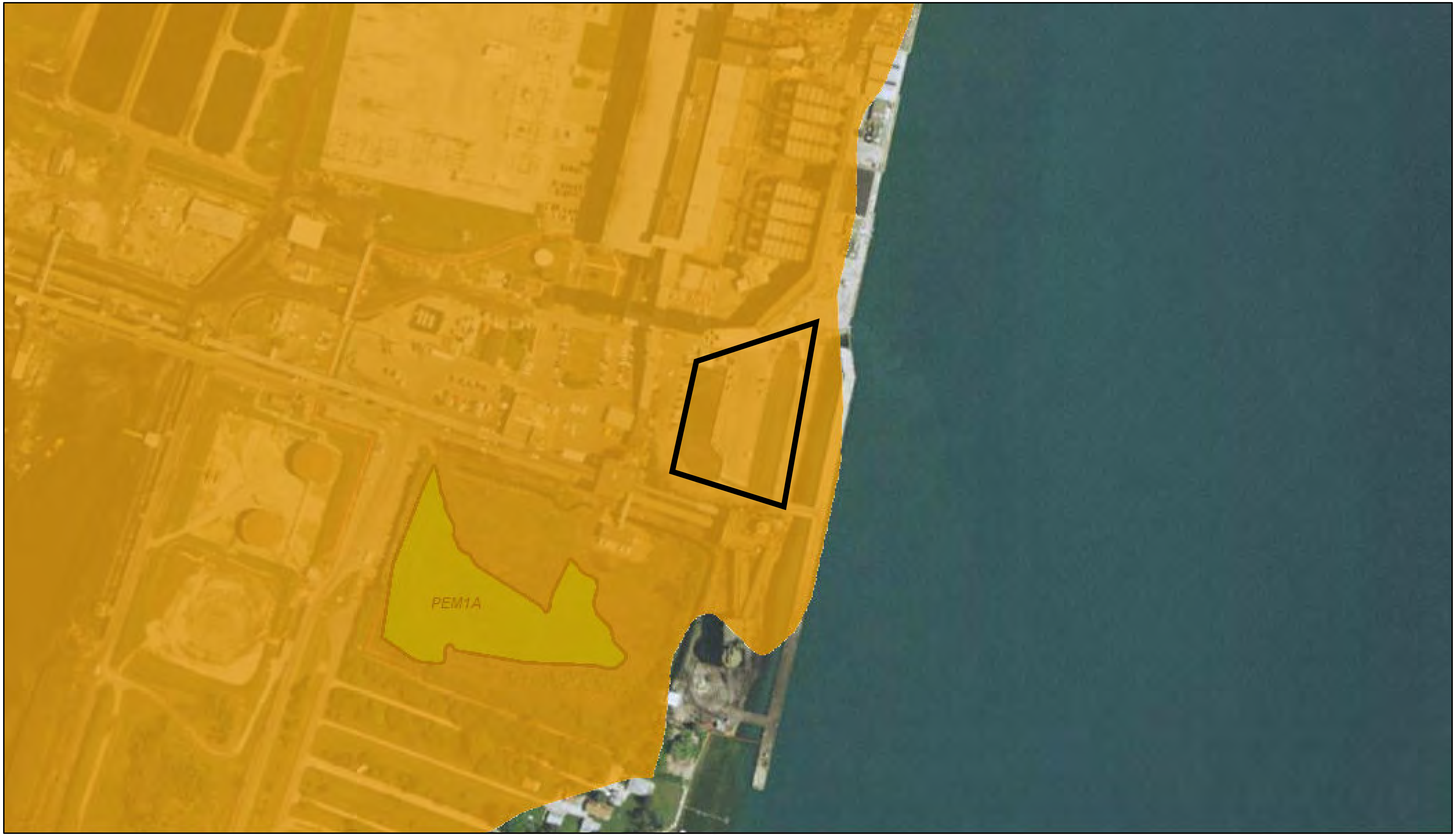
TRC
1540 Eisenhower Place
Ann Arbor, MI 48108
Phone: 734.971.7080
www.trcsolutions.com

FILE NO.: 265996.0004.01.01.04-05.dwg

11x17 --- ATTACHED XREFS: --- ATTACHED IMAGES:
DRAWING NAME: J:_TRC\DTE\St Clair PP\265996\0004\01\ 265996.0004.01.01.04-05.dwg --- PLOT DATE: October 12, 2017 - 12:03PM --- LAYOUT: FIG05 XS BB

Appendix C
National Wetland Inventory Map

Wetlands Map Viewer



August 17, 2018

Part 303 Final Wetlands Inventory

- Wetlands as identified on NWI and MIRIS maps
- Soil areas which include wetland soils
- Wetlands as identified on NWI and MIRIS maps and soil areas which include wetland soils
- Gage Stations
- National Wetlands Inventory 2005

1:3,809

0 0.0325 0.065 0.13 mi

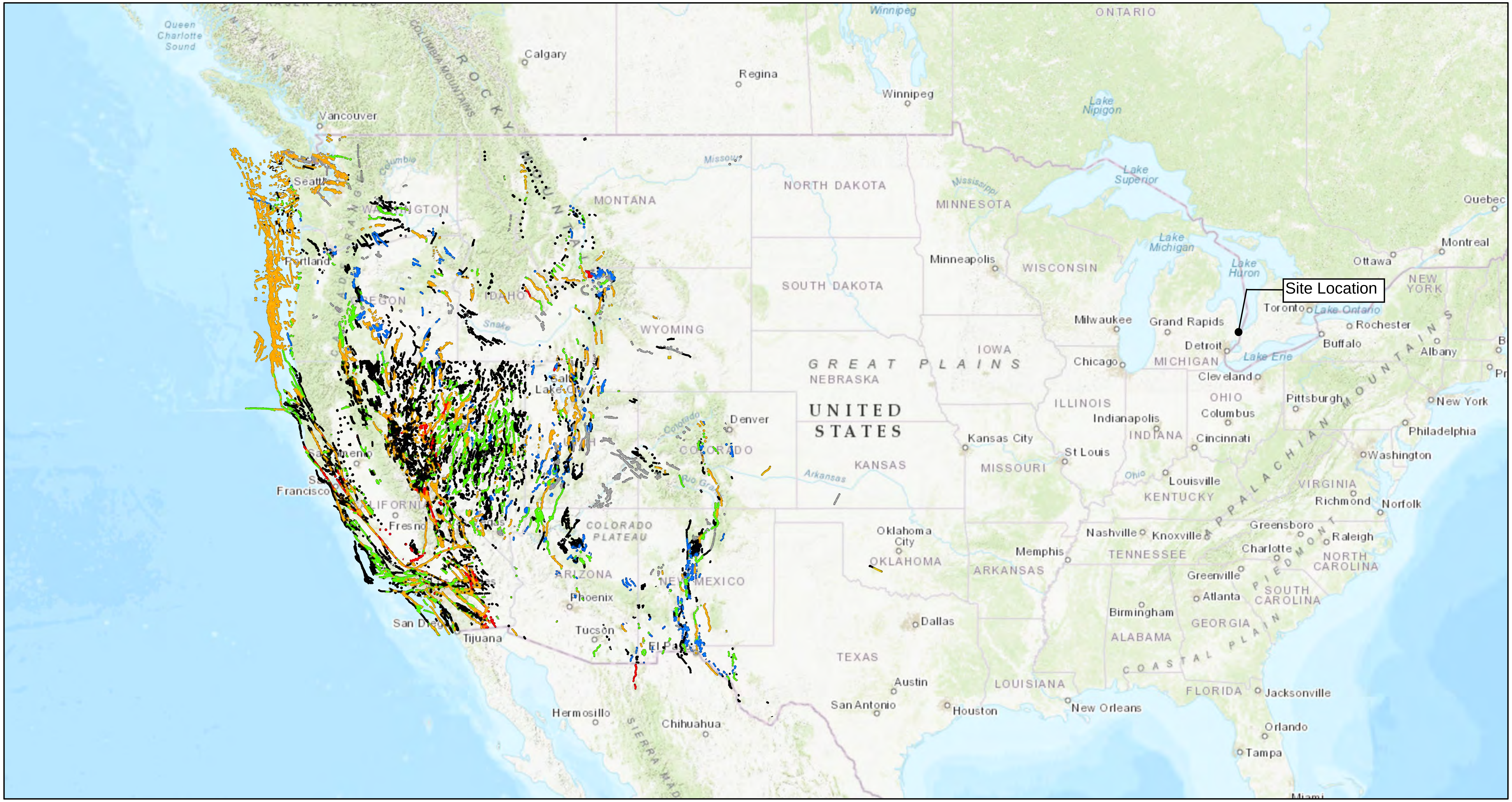
0 0.05 0.1 0.2 km

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Disclamer: This map is not intended to be used to determine the specific locations and jurisdictional boundaries of wetland areas subject to regulation. More information regarding this map, including how to obtain a copy can be accessed at www.michigan.gov/wetlands.
Map by: State of Michigan - CSS

Appendix D
U.S. Quaternary Faults and Folds Map

US Quaternary Faults and Folds



9/7/2018, 3:20:39 PM

Quaternary faults

- unspecified age, well constrained location
- unspecified age, moderately constrained location
- unspecified age, inferred location
- undifferentiated Quaternary (< 130,000 years), well constrained location
- undifferentiated Quaternary (< 130,000 years), moderately constrained location
- undifferentiated Quaternary (< 130,000 years), inferred location
- middle and late Quaternary (< 1.6 million years), well constrained location
- middle and late Quaternary (< 1.6 million years), moderately constrained location
- middle and late Quaternary (< 1.6 million 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

1:18,489,298

0 175 350 700 mi

0 275 550 1,100 km

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community, USGS

Web AppBuilder for ArcGIS
USGS | Esri, FAO, NOAA |

Appendix E
U.S. Seismic Design Maps and Calculations

U.S. Geological Survey - Earthquake Hazards Program

Due to insufficient resources and the recent development of similar web tools by third parties, this spring the USGS will be streamlining the two U.S. Seismic Design Maps web applications, including the one below. Whereas the current applications each interact with users through a graphical user interface (GUI), the new web services will receive the inputs (e.g. latitude and longitude) in the form of a web address and return the outputs (e.g. S_{DS} and S_{D1}) in text form, without supplementary graphics. Though designed primarily to be read by the aforementioned third-party web GUIs, the text outputs are also human-readable. To preview the new web services, please click here. Step-by-step instructions for using one of these web services, namely that for the recently published 2016 ASCE 7 Standard, are posted here.

SCPP BABs - Seismic Impact Zone

Latitude = 42.761°N, Longitude = 82.472°W

Location

Reference Document

2015 NEHRP Provisions

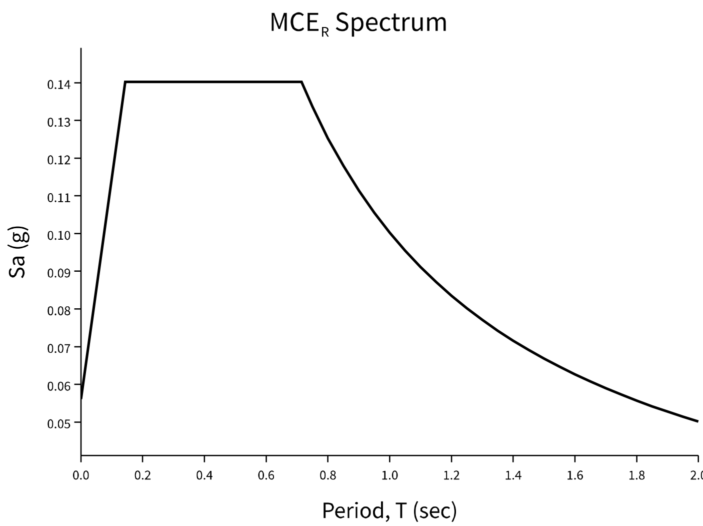
Site Class

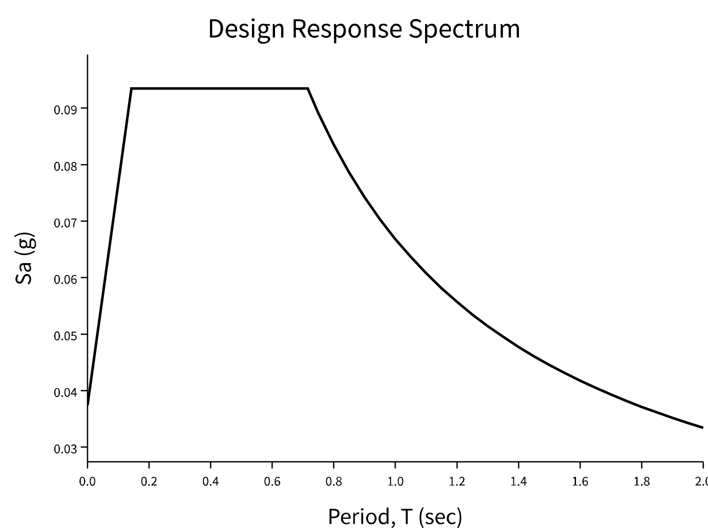
D (default): Stiff Soil

Risk Category

I or II or III

S_S =	0.088 g	S_{MS} =	0.140 g	S_{DS} =	0.093 g
S_1 =	0.042 g	S_{M1} =	0.100 g	S_{D1} =	0.067 g


MCE$_R$ Spectrum
Sa (g)
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0
Period, T (sec)


Design Response Spectrum
Sa (g)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0
Period, T (sec)

Mapped Acceleration Parameters, Long-Period Transition Periods, and Risk Coefficients

Note: The S_S and S_1 ground motion maps provided below are for the direction of maximmum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) 1.3 (to obtain S_1).

- FIGURE 22-1 S_S Risk-Targeted Maximum Considered Earthquake (MCE_R) Ground Motion Parameter for the Conterminous United States for 0.2 s Spectral Response Acceleration (5% of Critical Damping), Site Class B
- FIGURE 22-2 S_1 Risk-Targeted Maximum Considered Earthquake (MCE_R) Ground Motion Parameter for the Conterminous United States for 1.0 s Spectral Response Acceleration (5% of Critical Damping), Site Class B
- FIGURE 22-9 Maximum Considered Earthquake Geometric Mean (MCE_G) PGA, %g, Site Class B for the Conterminous United States
- FIGURE 22-14 Mapped Long-Period Transition Period, T_L (s), for the Conterminous United States
- FIGURE 22-18 Mapped Risk Coefficient at 0.2 s Spectral Response Period, C_{RS}
- FIGURE 22-19 Mapped Risk Coefficient at 1.0 s Spectral Response Period, C_{R1}

Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site class as Site Class , based on the site soil properties in accordance with Chapter 20.

Table 20.3-1 Site Classification

Site Class	$\bar{v}_S$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index PI > 20 • Moisture content w ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		
For SI: 1ft/s = 0.3048 m/s 1lb/ft^2 = 0.0479 kN/m^2			

Site Coefficients and Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Risk-targeted Ground Motion (0.2 s)

$C_{RS}S_{SUH} = 0.935 \times 0.094 = 0.088$ g

Deterministic Ground Motion (0.2 s)

$S_{SD} = 1.500$ g

$S_S \equiv$ "Lesser of $C_{RS}S_{SUH}$ and S_{SD}" = 0.088 g

Risk-targeted Ground Motion (1.0 s)

$C_{R1}S_{1UH} = 0.910 \times 0.046 = 0.042$ g

Deterministic Ground Motion (1.0 s)

$S_{1D} = 0.600$ g

$S_1 \equiv$ "Lesser of $C_{R1}S_{1UH}$ and S_{1D}" = 0.042 g

Table 11.4-1: Site Coefficient F_a

Site Class	Spectral Reponse Acceleration Parameter at Short Period					
	$S_S \le 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S = 1.25$	$S_S \ge 1.50$
A	0.8	0.8	0.8	0.8	0.8	0.8
B (measured)	0.9	0.9	0.9	0.9	0.9	0.9
B (unmeasured)	1.0	1.0	1.0	1.0	1.0	1.0
C	1.3	1.3	1.2	1.2	1.2	1.2
D (determined)	1.6	1.4	1.2	1.1	1.0	1.0
D (default)	1.6	1.4	1.2	1.2	1.2	1.2
E	2.4	1.7	1.3	1.2 *	1.2 *	1.2 *
F	See Section 11.4.7					

* For Site Class E and $S_S \ge 1.0$ g, see the requirements for site-specific ground motions in Section 11.4.7 of the 2015 NEHRP Provisions. Here the exception to those requirements allowing F_a to be taken as equal to that of Site Class C has been invoked.

Note: Use straight-line interpolation for intermediate values of S_S.

Note: Where Site Class B is selected, but site-specific velocity measurements are not made, the value of F_a shall be taken as 1.0 per Section 11.4.2.

Note: Where Site Class D is selected as the default site class per Section 11.4.2, the value of F_a shall not be less than 1.2 per Section 11.4.3.

For Site Class = D (default) and S_S = 0.088 g, F_a = 1.600

Table 11.4-2: Site Coefficient F_V

Site Class	Spectral Response Acceleration Parameter at 1-Second Period					
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 = 0.50$	$S_1 \geq 0.60$
A	0.8	0.8	0.8	0.8	0.8	0.8
B (measured)	0.8	0.8	0.8	0.8	0.8	0.8
B (unmeasured)	1.0	1.0	1.0	1.0	1.0	1.0
C	1.5	1.5	1.5	1.5	1.5	1.4
D (determined)	2.4	2.2 [1]	2.0 [1]	1.9 [1]	1.8 [1]	1.7 [1]
D (default)	2.4	2.2 [1]	2.0 [1]	1.9 [1]	1.8 [1]	1.7 [1]
E	4.2	3.3 [1]	2.8 [1]	2.4 [1]	2.2 [1]	2.0 [1]
F	See Section 11.4.7					

[1] For Site Class D or E and $S_1 \geq 0.2$ g, site-specific ground motions might be required. See Section 11.4.7 of the 2015 NEHRP Provisions.

Note: Use straight-line interpolation for intermediate values of S_1.

Note: Where Site Class B is selected, but site-specific velocity measurements are not made, the value of F_V shall be taken as 1.0 per Section 11.4.2.

For Site Class = D (default) and S_1 = 0.042 g, F_V = 2.400

Site-adjusted MCE_R (0.2 s)

$S_{MS} = F_a S_S = 1.600 \times 0.088 = 0.140$ g

Site-adjusted MCE_R (1.0 s)

$S_{M1} = F_V S_1 = 2.400 \times 0.042 = 0.100$ g

Design Spectral Acceleration Parameters

Design Ground Motion (0.2 s)

$S_{DS} = ⅔\ S_{MS} = ⅔ \times 0.140 = 0.093$ g

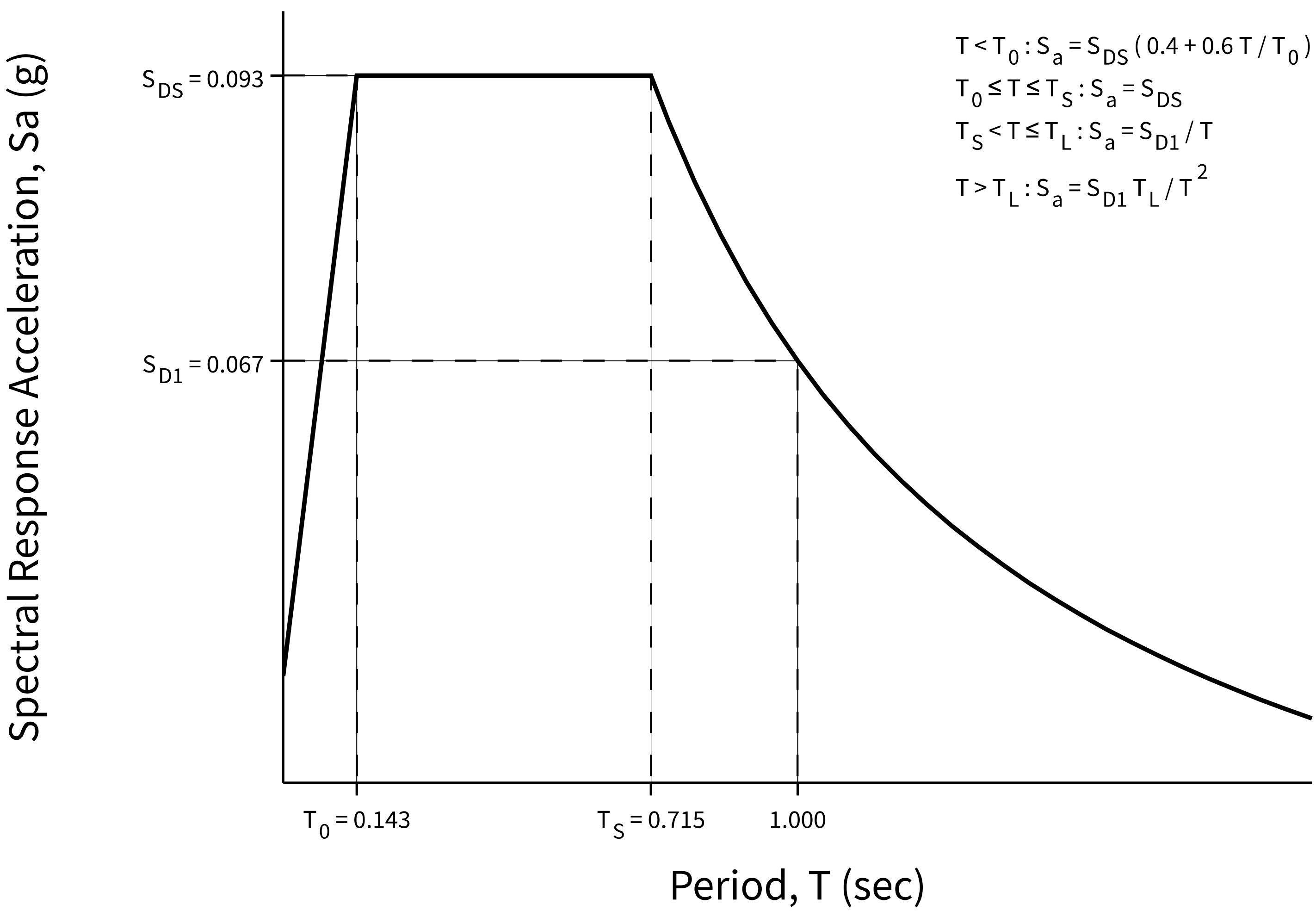
Design Ground Motion (1.0 s)

$S_{D1} = ⅔\ S_{M1} = ⅔ \times 0.100 = 0.067$ g

Design Response Spectrum

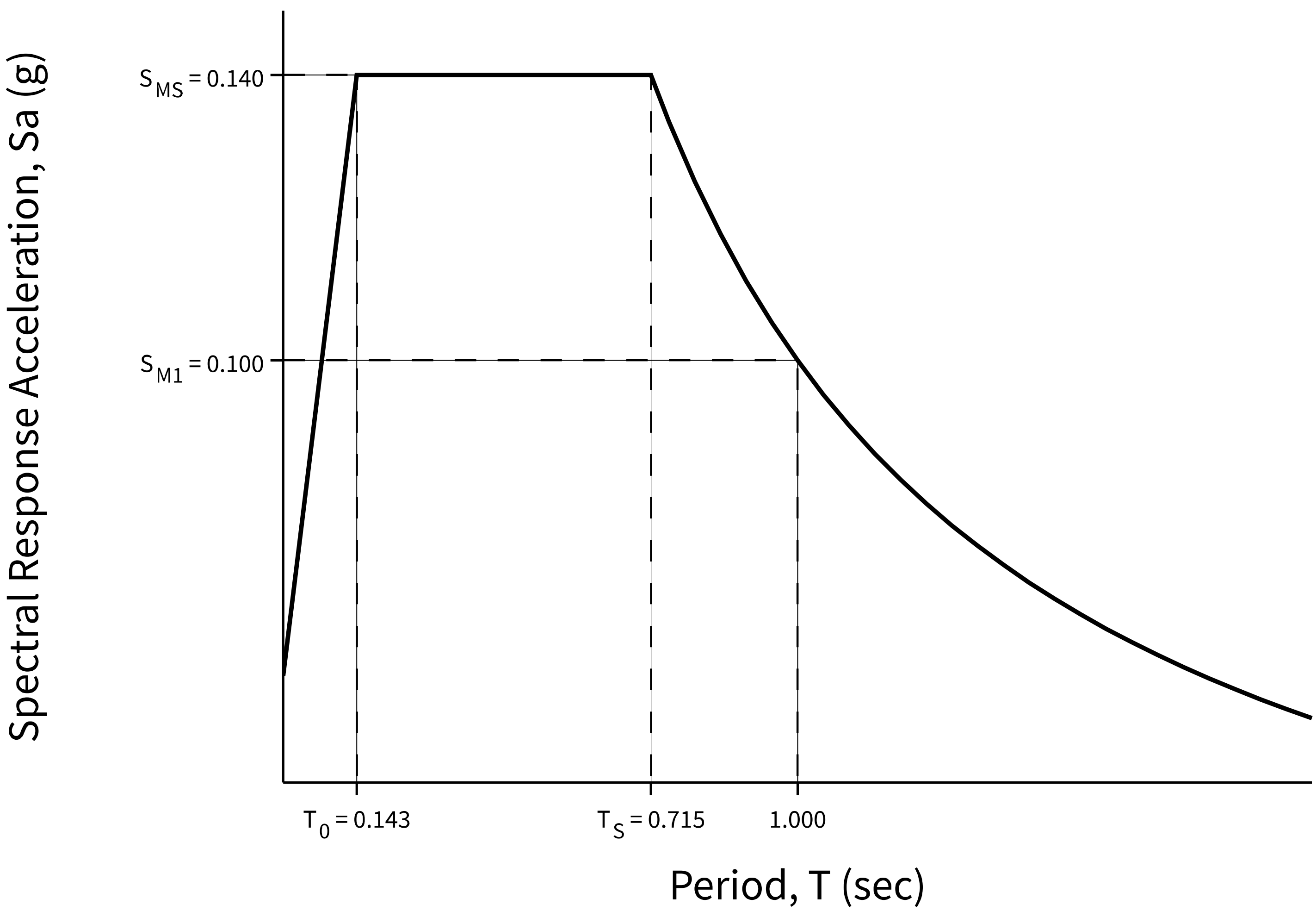
Long-Period Transition Period = T_L = 12 s

Figure 11.4-1: Design Response Spectrum



MCE_R Response Spectrum

The MCE_R response spectrum is determined by multiplying the design response spectrum above by 1.5.



Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

Table 11.8-1: Site Coefficient for F_{PGA}

Site Class	Mapped MCE Geometric Mean (MCE_G) Peak Ground Acceleration					
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA = 0.50	PGA ≥ 0.60
A	0.8	0.8	0.8	0.8	0.8	0.8
B (measured)	0.9	0.9	0.9	0.9	0.9	0.9
B (unmeasured)	1.0	1.0	1.0	1.0	1.0	1.0
C	1.3	1.2	1.2	1.2	1.2	1.2
D (determined)	1.6	1.4	1.3	1.2	1.1	1.1
D (default)	1.6	1.4	1.3	1.2	1.2	1.2
E	2.4	1.9	1.6	1.4	1.2	1.1
F	See Section 11.4.7					

Note: Use straight-line interpolation for intermediate values of PGA

Note: Where Site Class D is selected as the default site class per Section 11.4.2, the value of F_{pga} shall not be less than 1.2.

For Site Class = D (default) and PGA = 0.043 g, F_{PGA} = 1.600

Mapped MCE_G

PGA = 0.043 g

Site-adjusted MCE_G

$PGA_M = F_{PGA}PGA = 1.600 \times 0.043 = 0.068$ g