TRANSMITTAL

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Michigan Department of Environmental Quality
Waste Management & Radiological Protection Division
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525 West Allegan, 4th Floor South
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September 5, 2018

Re: Monitoring Well Development
Alternative Source Demonstration
Marquette Board of Light and Power
400 East Hampton Street, Marquette, MI

Project No. 180827

☒ **FOR REVIEW**
☒ **FOR YOUR USE**
☐ **AS REQUESTED**

Sent By: Todd C. Campbell, CPG/aes

COPIES	DATE	DESCRIPTION
1	9/5/2018	Monitoring Well Development – Alternative Source Demonstration Report

COMMENTS

The next round of groundwater samples will be collected on September 20, 2018.

If you have any questions or require additional information, please contact me at 269.544.6948 or tccampbell@ftch.com.

By email
cc/att: Mr. John Schultz – Marquette Board of Light and Power
Mr. Joshua Hendrickson – Marquette Board of Light and Power
Mr. Tom Carpenter – Marquette Board of Light and Power
Mr. Tom Skewis – Marquette Board of Light and Power
Mr. Stephen J. MacDonald, PE – FTCH
Ms. Fernanda P. Wilson, Ph.D. – FTCH
Ms. Lillian L. Woolley, PE – FTCH
Ms. Elizabeth A. Marsh, PE, CHMM – FTCH

Monitoring Well Development
Alternative Source Demonstration

Marquette Board of Light and Power
400 East Hampton Street, Marquette, Michigan

Project No. 180827
September 5, 2018

Fishbeck, Thompson, Carr & Huber, Inc.
engineers | scientists | architects | constructors

Monitoring Well Development
Alternative Source Demonstration

Prepared For:
Marquette Board of Light & Power
400 East Hampton Street, Marquette, Michigan

September 5, 2018
Project No. 180827

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Grand Rapids, Michigan 49546

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Fishbeck, Thompson, Carr & Huber, Inc.
engineers I scientists I architects I constructors

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List of Abbreviations/Acronyms

ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
FTCH	Fishbeck, Thompson, Carr & Huber, Inc
GOF	good of fitness
MBLP	Marquette Board of Light & Power
SSI	statistically significant increase
UPL	upper prediction limit

1.0 Introduction

Fishbeck, Thompson, Carr & Huber, Inc. (FTCH) on behalf of Marquette Board of Light & Power (MBLP) has prepared this Alternative Source Demonstration (ASD) for the Shiras Steam Plant generating station located at 400 East Hampton Street, Marquette, Michigan; Ash Impoundment WDS ID 478988 (Shiras Steam Plant). This document provides a description of the redevelopment of the five monitoring wells located at the Shiras Steam Plant, pH data collected during and after well redevelopment, and the statistical analysis used to determine if the statistically significant increase (SSI) in pH for monitoring wells MW-2 and MW-3 (reported in the 2017 annual monitoring report) may be a result of a source(s) other than the Coal Combustion Residuals (CCR) unit. This report has been prepared in accordance with 40 Code of Federal Regulations (CFR) Part 257, Disposal of Coal Combustion Residuals from Electric Utilities (CCR rule) published in April 17, 2015.

2.0 Summary of Previous Investigations and Regulations Background

The Shiras Steam Plant is located at 400 East Hampton Street, in Marquette, Michigan, along the shoreline of Lake Superior, as shown on Figure 1. The Shiras Steam Plant has one CCR surface impoundment (aka holding pond) located north of the generating station. In January 2018, the MBLP completed the Annual Groundwater Monitoring and Corrective Action Report, which documented the 2017 activities in accordance with the CCR 257.90(e), including data from monitoring wells shown on Figure 2. According to the report, the Shiras Steam Plant Site data showed an SSI in the Appendix III parameter pH at MW-2 and MW-3 over the background (Marquette Board of Light and Power, 2017).

According to CCR 257.94(e) and 257.93(h), if a facility determines there is an SSI over background levels for one or more constituents within 90 days of detecting an SSI, the facility will establish an Assessment Monitoring Program and/or demonstrate an alternative explanation for the exceedance. Alternate explanations could include the existence of a source other than the CCR Unit that could have caused the SSI; the SSI resulted from errors in sampling, analysis, or statistical evaluation; and natural variation in groundwater quality. The owner/operator of the CCR must complete and produce a written document (ASD) that must be certified by a qualified professional engineer, and the CCR unit may continue with detection monitoring. The facility must also include the ASD in the annual groundwater monitoring and corrective action report required by CCR 257.90(e), in addition to certification by a qualified professional engineer.

If the SSI is identified and cannot be attributed to an ASD, the facility must begin assessment monitoring for the CCR Unit. Per the CCR Rule, assessment monitoring must begin within 90 days of identification of an SSI that is not attributed to an alternative source and also include the Appendix IV constituents in accordance to CCR 257.95(b).

3.0 Objective

To support collection of high quality data to address CCR 257.94 (e)(2), redevelopment of the existing five monitoring wells (MW-1 through MW-5) for pH was proposed. The objective of this report is to document the redevelopment of these wells and determine if an alternative source other than the CCR unit, previous well conditions, errors, or natural variation in groundwater quality can explain the SSI in pH for MW-2 and MW-3 over the background. According to CCR 257.94 (e)(2), “The owner or operator may demonstrate that a source other than the CCR unit caused the statistically significant increase over background levels for a constituent or

that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality." The current ASD investigated the following lines of evidence:

- Well conditions may affect pH readings. Redeveloping the wells could improve sampling conditions for more representative field parameters measurements.
- There is inherent error present in the equipment used to measure pH in the field.
- There is natural variation within pH ranges from both background wells (MW-4 and MW-5) and downgradient monitoring wells (MW-1, MW-2 and MW-3).

4.0 Alternative Source Demonstration Investigation

4.1 Well Redevelopment and Re-Evaluation of the Data

Redevelopment activities were originally scheduled to occur during April 2018; however, ice present in the area of the wells prevented safe access to complete the work. The delay in access to the monitoring wells was communicated to the Michigan Department of Environmental Quality (MDEQ) in an email from Mr. John Schultz (MBLP) on April 16, 2018. Ms. Margie Ring, MDEQ State Solid Waste Engineering Coordinator, responded via email that the MDEQ was in agreement with postponing sampling until the wells could be accessed safely. Ms. Ring recommended documenting the delay in the monitoring report if the samples were not collected by April 30, 2018.

Monitoring well redevelopment activities were executed on May 30, 2018, at all five wells within the monitoring network. Prior to redevelopment activities, static water levels were collected from monitoring wells MW-1 through MW-5 and the data was used to calculate groundwater elevations. The groundwater elevation data was then contoured and is shown on Figure 3. As depicted on Figure 3, groundwater flows toward the east and Lake Superior. During redevelopment, pH values were monitored for stabilization (+/- 0.1 SU over 3 consecutive readings) using a YSI Inc. Pro Plus handheld instrument containing a pH meter probe. The pH values were recorded on field documentation forms provided in Appendix A. Statistical analysis was completed on background and downgradient groundwater pH data. As established in the 2017 annual groundwater report, an inter-well approach was considered appropriate for statistical analysis, as the groundwater monitoring system for the WDS ID 478988 unit contains two upgradient (MW-4 and MW-5) and three downgradient wells (MW-1, MW-2, and MW-3 in Lake Superior), which were installed in the uppermost aquifer.

The pH data, obtained during redevelopment of the wells and 24 hours after redevelopment, were added to the existing pH database. The new pH data, except for pH data collected during redevelopment, were used in combination with the baseline data collected in 2017 for statistical analyses of the ASD. The redevelopment pH data was not used because this data is not representative of undisturbed steady-state conditions. All statistical evaluations were completed using the latest version of ProUCL 5.1 software developed by the USEPA (USEPA, 2016).

Initially, the detection frequencies for all wells were computed (Table 1). To establish the prediction limit, historical data and pH measurements collected 24 hours after the redevelopment for MW-4 and MW-5 were used for background calculations. To check for outliers, background data was plotted on a box plot, histogram, and Q-Q plot for a visual assessment of potential outliers followed by the calculations of the Dixon's outlier test (Appendix B). No outliers were detected with a one percent significance level. A good of fitness (GOF) test was used to determine the statistical distribution of the background data; to verify whether the dataset is normal, gamma, lognormal or nonparametrically distributed. The background dataset was identified to be normally distributed (Appendix C). The upper and lower prediction limit were calculated based on normal distribution and

results are shown on Table 2 (additional calculations executed by ProUCL regarding prediction limits are shown on Appendix D).

Historical downgradient data for pH (MW-1, MW-2, and MW-3) were compared with the prediction limit calculated for the updated background data (6.782-8.303) and are shown on Table 3. Among the data tested, only one measurement at MW-2 exceeded the updated prediction limit. This measurement was from the first sampling event on July of 2017 (pH = 8.41), which should not be a concern since many other measurements were taken afterwards. As discussed above, the redevelopment pH data was not used for statistical analysis due to the nature of redeveloping wells, which include mixing solutions, solids, and minerals to clean up the well. These unstable conditions, noticeable by the variability in values observed on each well throughout the redevelopment event, are not representative of undisturbed steady-state conditions. For that reason, the pH measurement collected 24 hours following redevelopment better represents the parameter in these wells. All three monitor wells' measurements, following the redevelopment (on May 31, 2018), were within the acceptable limits calculated for background (MW-1 = 7.62, MW-2 = 7.88 and MW-3 = 8.07). Thus, at this time, previous well conditions seem to explain the SSI for pH observed during the monitoring event of 2017. Figures 4, 5, and 6 display the Upgradient vs. Downgradient analysis for MW-1, MW-2, and MW-3.

4.2 Evaluation of Inherent Error

The potential of errors due to the calibration of the measurement instrument and the inherent error present due to accuracy limits of the instrument were also evaluated. An investigation of the field forms was conducted to verify if the calibration drifted throughout the course of the sampling event, if adequate amount of groundwater was withdrawn to obtain a representative sample from each monitoring well, and if pH readings were allowed to stabilize prior to sample collection. Additionally, the accuracy limitations of the instrument used to measure pH was assessed and compared to the baseline upper prediction limit (UPL) to ascertain if the margin of error for the pH measurements in questions is below UPL.

Investigation of the field notes/calibration forms showed little drift in pH value (7.06, 7.02 and 7.04 over the course of the day) and reported an adequate amount of water was used to obtain representative pH measurements; thus, these lines of evidence would not be able to explain the SSI for pH in MW-2 and MW-3. Regarding accuracy limitations of the instrument used to measure pH, the instrument manual reports an accuracy of ±0.2 (YSI, 2011). By accounting for the equipment accuracy, all pH values measured using this instrument during redevelopment and 24h after the redevelopment event would be actually ±0.2 S.U.

4.3 Evaluation of Natural Variation

Because no other Appendix III constituent exhibited an SSI in the 2017 monitoring event, the variation in pH data may be indicative of natural variation. Trend analysis of pH was executed using the Mann-Kendall test on ProUCL and results are shown on Appendix E. The purpose of the Mann-Kendall (MK) test (Mann 1945, Kendall 1975, Gilbert 1987) is to statistically assess if there is a monotonic upward or downward trend of the variable of interest over time. Similar to background, both MW-2 and MW-3 had insufficient evidence to identify a significant trend at the 0.01 level of significance (confidence coefficient 0.99).

5.0 Conclusions and Recommendations

- 24 hours after redevelopment of the wells, values greater than the prediction limit, set based on current background data, were not observed in MW-2 and MW-3.
- Based on the data, previous well conditions explain the evidence of SSI for pH previously reported.

- There is insufficient evidence to identify a significant increasing trend for pH at MW-2 and MW-3, this indicates that, to some extent, any difference between background field pH and downgradient may be naturally-occurring.

This ASD documents the re-assessment of the potential SSI of pH for the downgradient wells MW-2 and MW-3 at the Shiras Steam Plant. Based on all above, especially the statistical study executed after the redevelopment of the wells, previous well conditions explain the SSI. As no SSI was noted after redeveloping the wells, the 2018 monitoring program report will cover Appendix III parameters exclusively.

6.0 Monitoring Schedule

Following the ASD study, two monitoring events are expected for the 2018 annual report. The first monitoring event occurred in May 31, 2018 (only pH data shown in this document) and the second sampling event is expected to occur in September 2018. The annual report will be submitted in January 2019 and, based on this ASD, the report will only include Appendix III parameters.

7.0 References

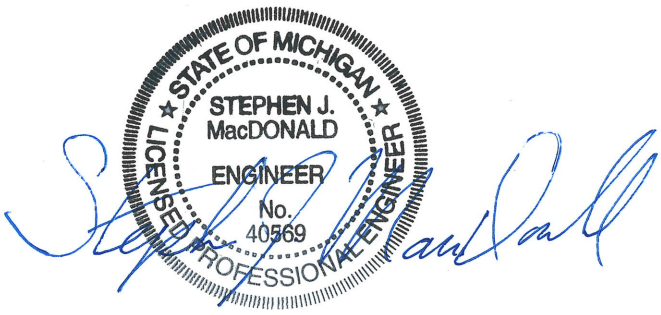
Marquette Board of Light and Power, 2017. First Annual CCR Groundwater Monitoring and Corrective Action Report 2017.

YSI, 2011. Professional Plus Water Quality Instrument – Specifications

USEPA, 2016. ProUCL Version 5.1 User Guide - Statistical Software for Environmental Applications for Data Sets with and without Non-detect Observations. https://www.epa.gov/sites/production/files/2016-05/documents/proucl_5.1_user-guide.pdf, accessed in July 2018.

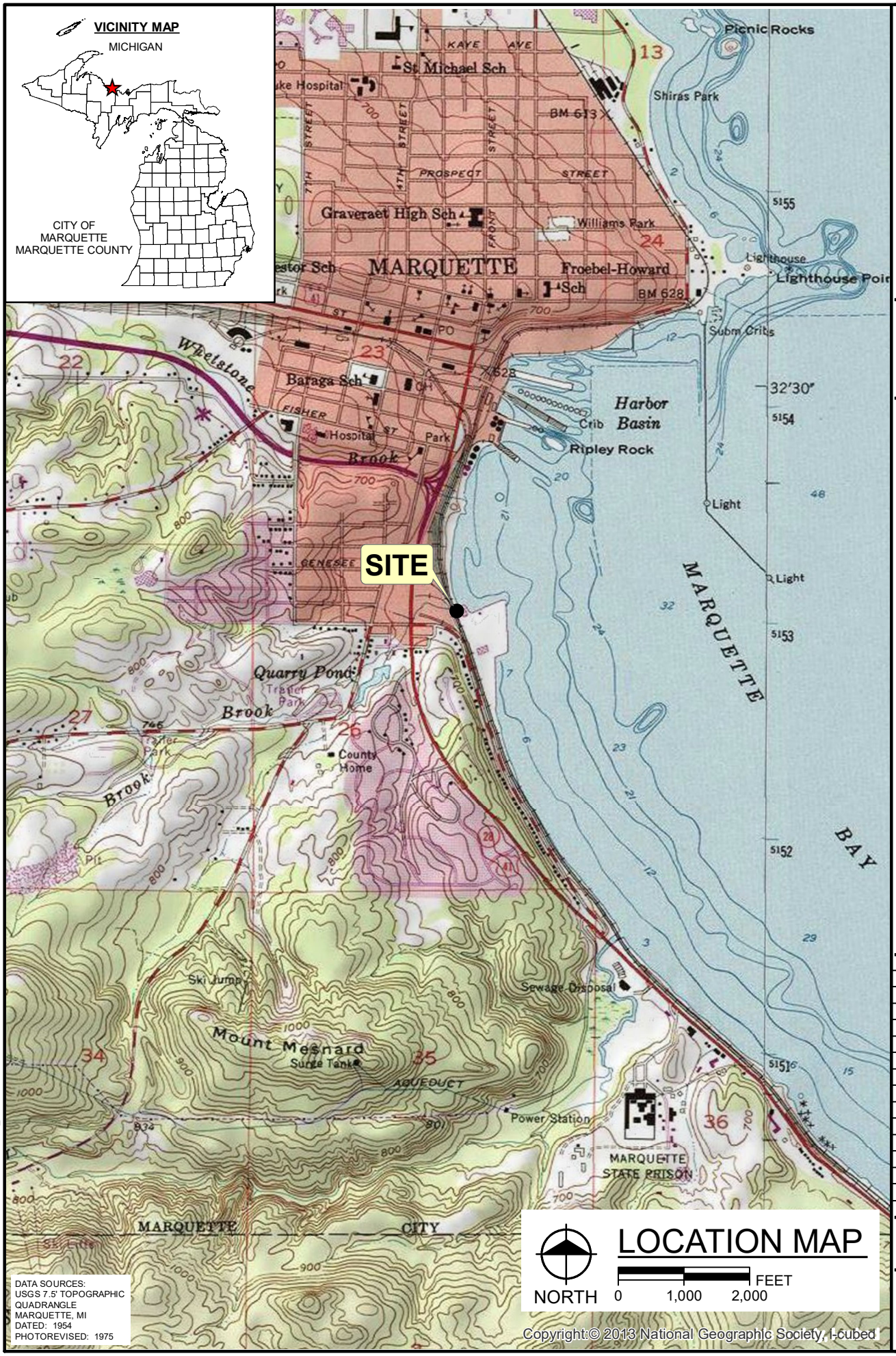
8.0 Certification

I, Stephen J. MacDonald, a qualified professional engineer, certify that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR ash Impoundment WDS ID 478988 at the Shiras Steam Plant.



Stephen J. MacDonald, PE License Number 40569
Senior Environmental Engineer
Date: September 5, 2018

Figures



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Marquette Board of Light and Power

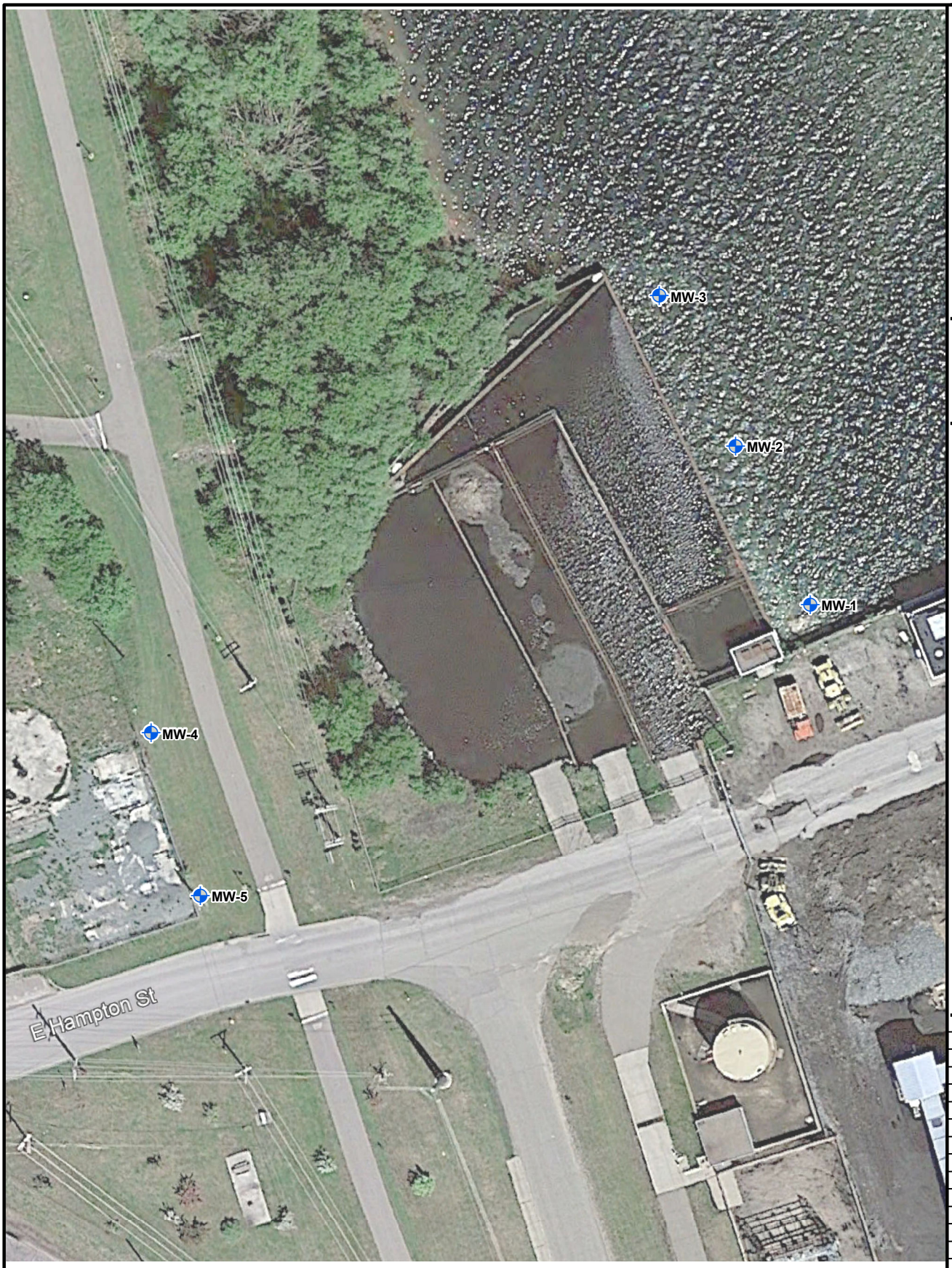
Shiras Steam Plant, Marquette, Michigan

Alternative Source Demonstration

PROJECT NO.
180827

FIGURE NO.
1

PLOT INFO: Z:\2018\180827\CAD\GIS\MAPDOC\FIG01_LOCATION MAP.mxd Date: 5/25/2018 8:35:25 AM User: ACS



LEGEND

Monitoring Well

NORTH

SITE PLAN

0 30 60 FEET

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Marquette Board of Light and Power

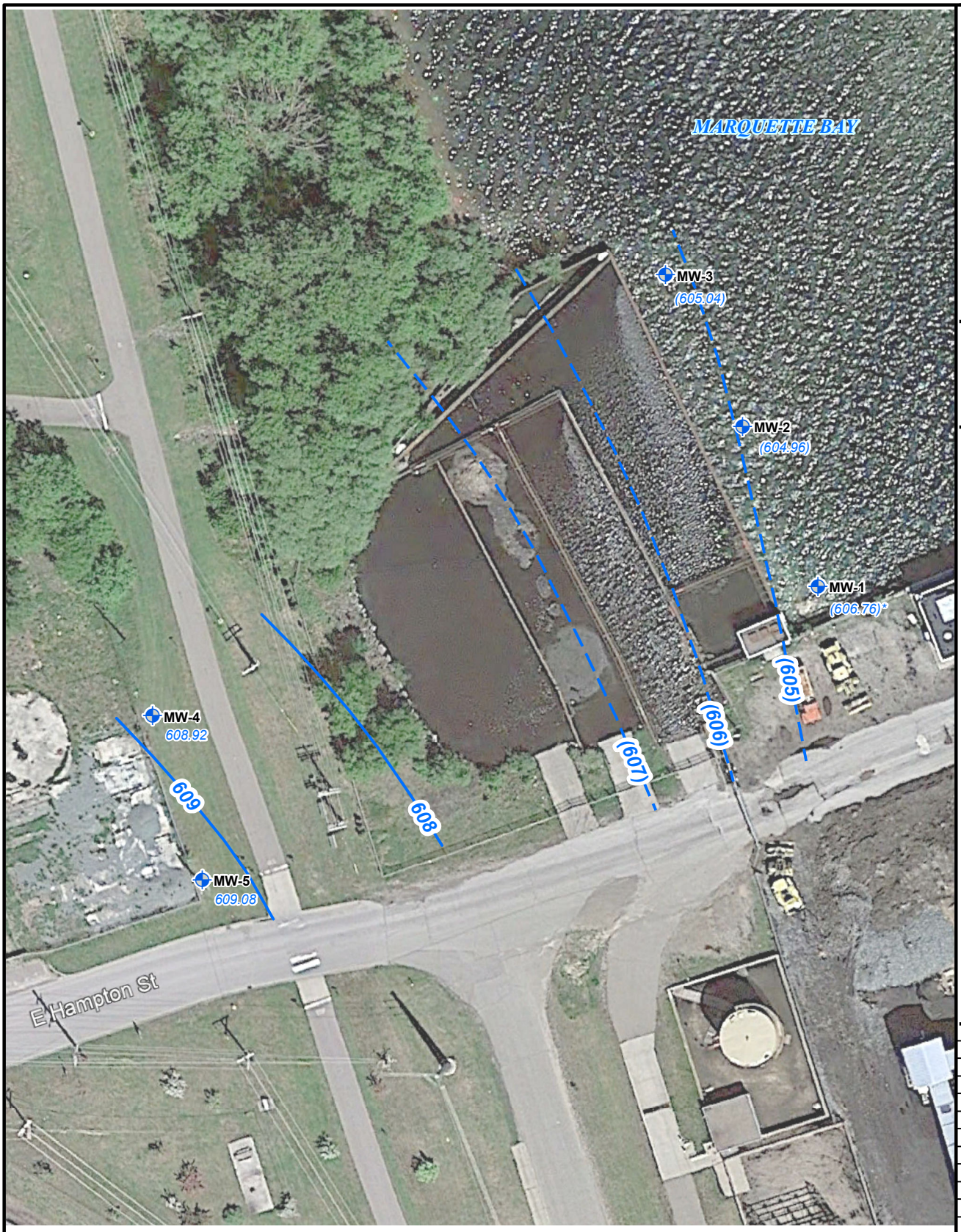
Shiras Steam Plant, Marquette, Michigan

Alternative Source Demonstration

PROJECT NO.
180827

FIGURE NO.
2

PLOT INFO: Z:\2018\180827\CAD\GIS\MAPDOC\FIG02_SITE MAP.mxd Date: 6/18/2018 4:05:55 PM User: ACS



LEGEND

- Monitoring Well
- Groundwater Contour (feet)-May 30, 2018
- Groundwater Contour (feet) Inferred
- 608.92 Groundwater Elevation (feet)-May 30, 2018
- (606.76)* SWL = (+0.30') Artesian Conditions (Not used in contour)

NORTH

0 30 60 FEET

GROUNDWATER CONTOUR MAP MAY 30, 2018

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Marquette Board of Light and Power

Shiras Steam Plant, Marquette, Michigan

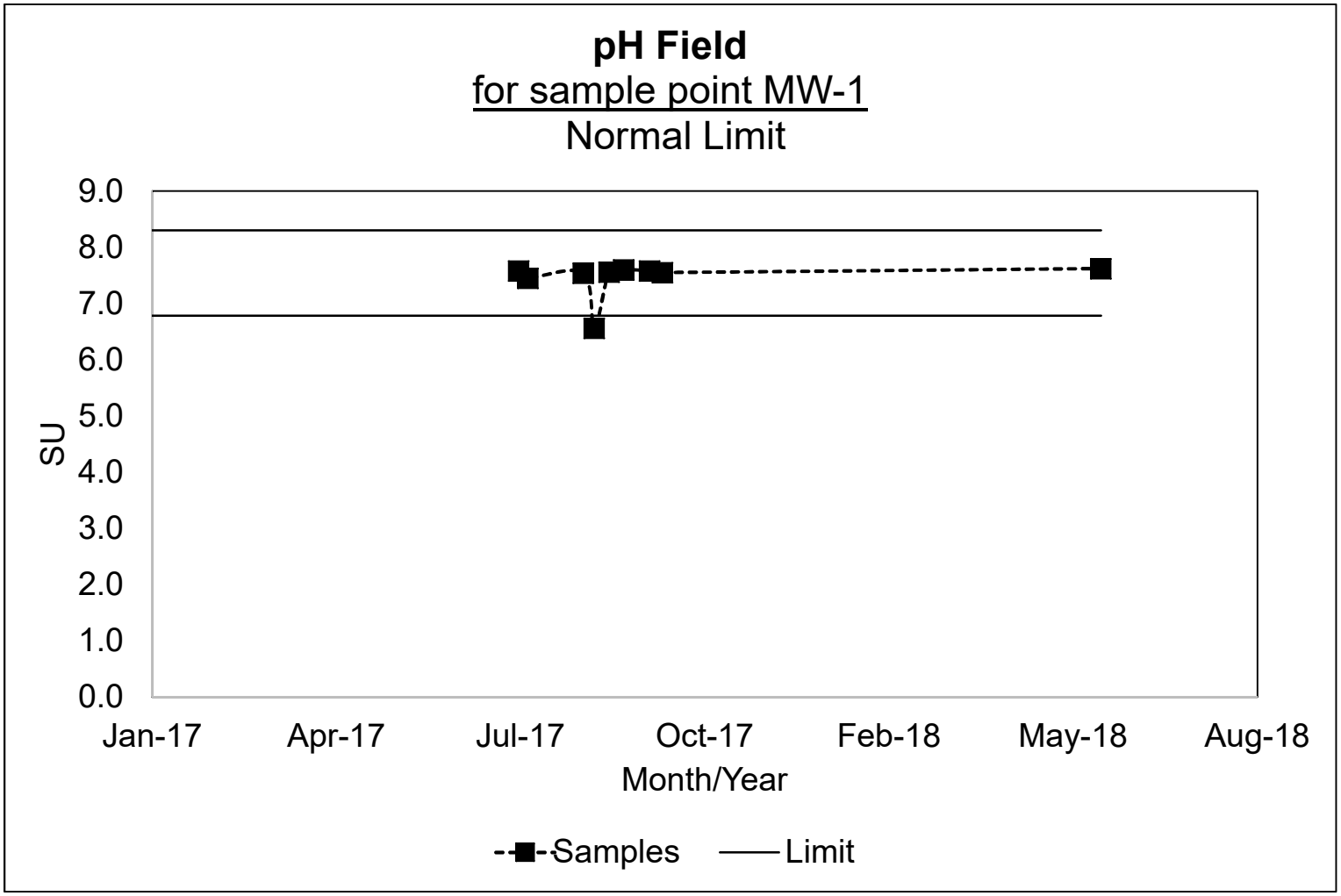
Alternative Source Demonstration

PROJECT NO.
180827

FIGURE NO.
3

PLOT INFO: Z:\2018\180827\CAD\GIS\MAPDOC\FIG03_MAY2018-GW CONTOUR MAP.mxd Date: 6/20/2018 10:22:23 AM User: ACS

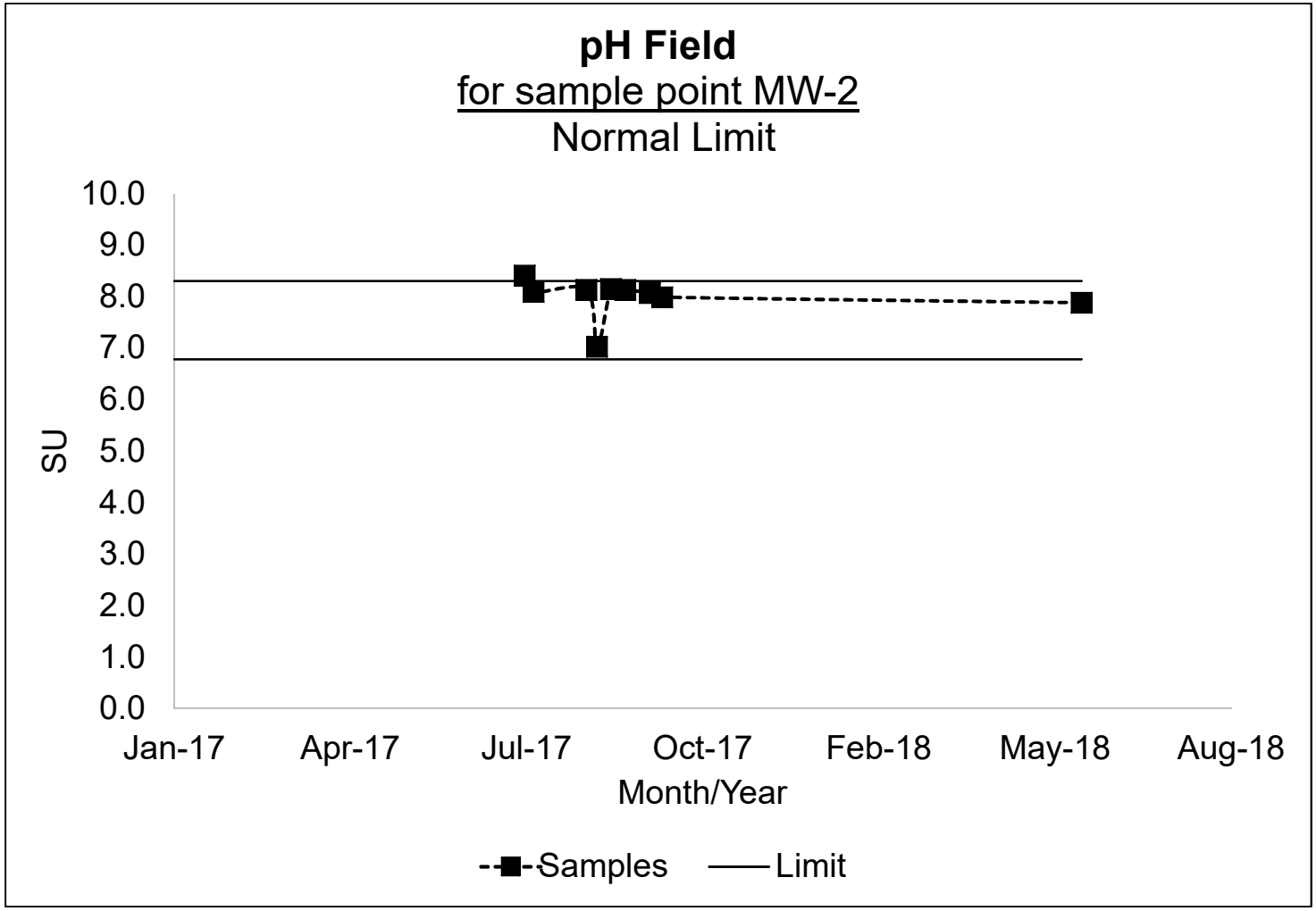
Up vs. Down Prediction Limits



**Measurements obtained during redevelopment of the wells on 5/30/2018 were not used in the statistical analysis because they are not representative of undisturbed steady-state conditions*

Graph 1

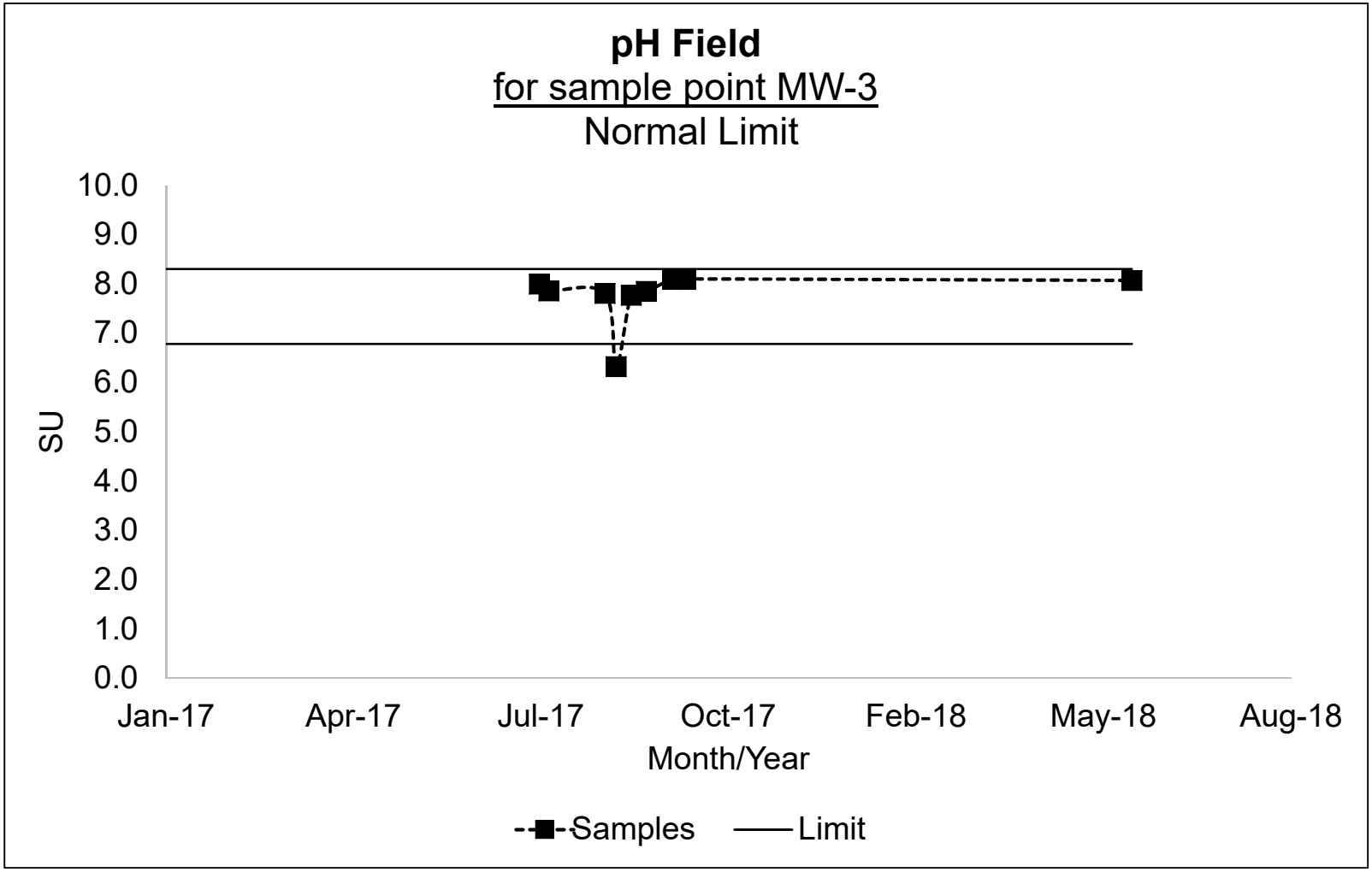
Up vs. Down Prediction Limits



**Measurements obtained during redevelopment of the wells on 5/30/2018 were not used in the statistical analysis because they are not representative of undisturbed steady-state conditions*

Graph 2

Up vs. Down Prediction Limits



**Measurements obtained during redevelopment of the wells on 5/30/2018 were not used in the statistical analysis because they are not representative of undisturbed steady-state conditions*

Graph 3

Tables

Table 1 - Summary of Detection Frequencies for Appendix III Parameter of pH

Marquette Board of Light and Power

Shiras Steam Plant

Parameter	Detection Frequency	MW-1	MW-2	MW-3	MW-4	MW-5
pH	n	9	9	9	9	9
	ND	0	0	0	0	0
	%ND	0%	0%	0%	0%	0%

Notes:

n - sample size

ND - count of nondetect values in sample

%ND - percentage of nondetects in sample

Table 2 - Summary Statistics and Prediction Limits

Marquette Board of Light and Power

Shiras Steam Plant

Parameter	Unit	Model Type	Sample Size	Detect	Mean	Standard Deviation	Student's T test critical value (.99 confidence)	Upper Prediction Limit	Lower Prediction Limit
pH	SU	Normal	18	18	7.541	0.289	2.567	8.303	6.782

Table 3 - Historical Downgradient Data for pH which Failed the Current Statistical Evaluation
Marquette Board of Power and Light
Shiras Steam Plant

Parameter	Unit	Well	Date	Result	Prediction Limit	SSI
pH	SU	MW-1	7/19/2017	7.58	6.861-8.211	
pH	SU	MW-1	7/24/2017	7.45	6.861-8.211	
pH	SU	MW-1	8/23/2017	7.54	6.861-8.211	
pH	SU	MW-1	8/29/2017	6.56	6.861-8.211	
pH	SU	MW-1	9/6/2017	7.56	6.861-8.211	
pH	SU	MW-1	9/14/2017	7.6	6.861-8.211	
pH	SU	MW-1	9/28/2017	7.58	6.861-8.211	
pH	SU	MW-1	10/5/2017	7.55	6.861-8.211	
*pH**	*SU*	*MW-1*	*5/30/2018*	*7.56*	*6.861-8.211*	
*pH**	*SU*	*MW-1*	*5/30/2018*	*8.11*	*6.861-8.211*	
*pH**	*SU*	*MW-1*	*5/30/2018*	*7.77*	*6.861-8.211*	
*pH**	*SU*	*MW-1*	*5/30/2018*	*9.54*	*6.861-8.211*	
pH	SU	MW-1	5/31/2018	7.62	6.861-8.211	
pH	SU	MW-2	7/19/2017	8.41	6.861-8.211	>PL
pH	SU	MW-2	7/24/2017	8.09	6.861-8.211	
pH	SU	MW-2	8/23/2017	8.13	6.861-8.211	
pH	SU	MW-2	8/29/2017	7.03	6.861-8.211	
pH	SU	MW-2	9/6/2017	8.15	6.861-8.211	
pH	SU	MW-2	9/14/2017	8.13	6.861-8.211	
pH	SU	MW-2	9/28/2017	8.07	6.861-8.211	
pH	SU	MW-2	10/5/2017	7.99	6.861-8.211	
*pH**	*SU*	*MW-2*	*5/30/2018*	*8.01*	*6.861-8.211*	
*pH**	*SU*	*MW-2*	*5/30/2018*	*7.89*	*6.861-8.211*	
*pH**	*SU*	*MW-2*	*5/30/2018*	*8.28*	*6.861-8.211*	
pH	SU	MW-2	5/31/2018	7.88	6.861-8.211	
pH	SU	MW-3	7/19/2017	8	6.861-8.211	
pH	SU	MW-3	7/24/2017	7.86	6.861-8.211	
pH	SU	MW-3	8/23/2017	7.81	6.861-8.211	
pH	SU	MW-3	8/29/2017	6.32	6.861-8.211	
pH	SU	MW-3	9/6/2017	7.77	6.861-8.211	
pH	SU	MW-3	9/14/2017	7.85	6.861-8.211	
pH	SU	MW-3	9/28/2017	8.09	6.861-8.211	
pH	SU	MW-3	10/5/2017	8.1	6.861-8.211	
*pH**	*SU*	*MW-3*	*5/30/2018*	*8.61*	*6.861-8.211*	
*pH**	*SU*	*MW-3*	*5/30/2018*	*6.95*	*6.861-8.211*	
*pH**	*SU*	*MW-3*	*5/30/2018*	*7.82*	*6.861-8.211*	
pH	SU	MW-3	5/31/2018	8.07	6.861-8.211	

**Measurements obtained during redevelopment of the wells on 5/30/2018 were not used in the statistical analysis because this data is not representative of undisturbed steady-state conditions*

Notes:

>PL - results exceeds prediction limit; significantly increased over background

Appendix A

FIELD NOTES

Project Name: MBLP/Shiras ASD & GW Monitoring

Project Number: 180827

Site Location: Marquette, MI

Date: 5/30/18

Weather Conditions: 62°, overcast

Purpose: MW development

7:20 : AO & APS onsite, calibrating

8:30 : Tom (MBLP) onsite to provide keys / observe

9:20 : MW-5 developed, ~17 gallons purged

9:45 : MW-4 purged dry at ~5 gal, ~~turbidity~~ AO turbidity and pH comparable to MW-5, will return tomorrow to sample

10:30 : launch boat at Cinder Pond Marina

11:20 : begin developing MW-3 - purged dry at ~5 gallons will let well recover and return after other 2 wells on the water - boat taking on water, used bilge pump

1145 : begin development of MW-2, purged dry at ~5 gallons boat taking on water seemingly quicker, plug is in, sealed well continue to intermittently use bilge pump will return after allowing time for MW-1 to recover

1219 : MW-1 purged dry at ~6 gal

1225 : middle pH cal check - 7.02 S.U.

1258 : MW-3 has recovered to ~~2~~ 9 AO below TOC, pumping again

1305 : MW-1 purged dry second time, after 4 gallons purged (9 gallons purged total), move to MW-2

Completed by: [signature] (signature)

5/30/18 (date)

FIELD NOTES

Project Name: MBLP/Shiras ASD & GW Monitoring

Project Number: 180827

Site Location: Marquette, MI

Date: 5/30/18

Weather Conditions:

Purpose: MW development

1319 - MW-2 has ~~quant~~ recovered to 5.55' below TOC, restarting purge

1322. MW-2 purged dry after 3 gallons - 8 gallons purged total will move to MW-1. boat fills with substantial amounts of water regularly - use bilge pump

1337 MW-1 recovered to 2.3' below TOC, will purge again

NOTE: MW-1, MW-2, MW-3 did not recover fully due to boat issues (leaks) and nearby thunderstorms

1342: MW-1 purged dry after 4 gallons on second attempt, 10 gal purged total Leave for marina

1446: restart purge at MW-4, SWL =

1449: MW-4 purged dry a second time, 3 additional gallons (8.5 gallons total) next task is repair boat if needed (Dockside Marina)

1530: Leaving Dockside Marina. They are keeping the boat for the night. Livewell was not plumbed allowing water into the boat through livewell drain. AD, APS done for the day

Completed by: AJ M (signature)

5/30/18 (date)

Fishbeck, Thompson, Carr & Huber, Inc.

MBLP/Shiras ASD & GW Monitoring.

Marquette, MI

FTC&H

Project No. 180827

Retention ponds, facing NNW.

Retention ponds, facing W.

frc&h	**Project No.:**	180827	**Date:**	5/31/2018	**Project Name:** MBLP/Shiras ASD & GW Monitoring.

Well development (MW-4)

Well development (MW-4)

fitch	**Project No.:**	180827	**Date:**	5/31/2018	**Project Name:** MBLP/Shiras ASD & GW Monitoring.

Equipment decon between locations.

Dumping of development water.

fitch	**Project No.:**	180827	**Date:**	5/31/2018	**Project Name:** MBLP/Shiras ASD & GW Monitoring.

Offshore wells (MW-3)

Development of offshore locations (MW-3)

Low flow sampling offshore location (MW-3)

Low flow sampling offshore location (MW-1)

Project No.:	180827	Date:	5/31/2018	Project Name:	MBLP/Shiras ASD & GW Monitoring.

EQUIPMENT CALIBRATION FORM

Project Name: MBLP/Shiras ASD & GW Monitoring

Project Number: 180827

Date/Time: 5/30/18 · 8:40

Initials: AD

NA = Not Applicable

Parameter	Standard	Lot Number	Units	Measured Value	Measurement Temperature (°C)	Calibration Verification Acceptance Window	Instrument Model/ID Number
pH	4.00	4612941-011117	S.U.	4.06	21.1	3.9 - 4.1	YSI PP #513
	7.00	4709695-110917	S.U.	7.06		6.9 - 7.1	
	10.00	4612804-011117	S.U.	9.99		9.9 - 10.1	
Specific Conductance	147		µmhos/cm			132 - 162	
	1412		µmhos/cm			1342 - 1484	
	2765		µmhos/cm			2628 - 2905	
Eh	Zobell's solution		mV				
Dissolved Oxygen	NA	NA	mg/L			±10% Theoretical:	
Turbidity	10 NTU	A6272	NTU	9.41	—	9 - 11	LaMotte 2020we #410

Notes:

EQUIPMENT CALIBRATION VERIFICATION FORM

Project Name: MBLP/Shiras ASD & GW Monitoring

Project Number: 180827

Date/Time: 5/30/18 1225

Initials: AD

NA = Not Applicable

Parameter	Standard	Lot Number	Units	Measured Value	Measurement Temperature (°C)	Calibration Verification Acceptance Window	Instrument Model/ ID Number
pH	7.00	4709C45-110817	S.U.	7.02	23.2	6.9 - 7.1	YSI Pro
Specific Conductance	1412		µmhos/cm			1342 - 1484	
Eh	Zobell's solution		mV				
Dissolved Oxygen	NA	NA	mg/L			±10% Theoretical:	
Turbidity	10 NTU		NTU		NA	9 - 11	

Notes:

EQUIPMENT CALIBRATION VERIFICATION FORM

Project Name: MBLP/Shiras ASD & GW Monitoring

Project Number: 180827

Date/Time: 5/30/18 1500

Initials: AB

NA = Not Applicable

Parameter	Standard	Lot Number	Units	Measured Value	Measurement Temperature (°C)	Calibration Verification Acceptance Window	Instrument Model/ ID Number
pH	7.00	4709C95-110817	S.U.	7.04	21.3	6.9 - 7.1	YSI, P.D. #~~3[illegible]~~ 513
Specific Conductance	~~1412~~		µmhos/cm			1342 - 1484	
Eh	Zobell's solution		mV				
Dissolved Oxygen	NA	NA	mg/L			±10% Theoretical:	
Turbidity	10 NTU	A6272	NTU	9.22	NA	9 - 11	1.2020 ML #4450

Notes:

EQUIPMENT CALIBRATION FORM

Project Name: MBLP/Shiras ASD & GW Monitoring

Project Number: 180827

Date/Time: 5/31/18 1000

Initials: APS

NA = Not Applicable

Parameter	Standard	Lot Number	Units	Measured Value	Measurement Temperature (°C)	Calibration Verification Acceptance Window	Instrument Model/ID Number
pH	4.00	4612941-011117	S.U.	3.98	18.5	3.9 - 4.1	YSI P.P. #429
	7.00	4708495-110317	S.U.	7.04		6.9 - 7.1	
	10.00	4612804-011117	S.U.	10.00		9.9 - 10.1	
Specific Conductance	147	SC180208-1C	µmhos/cm	161	18.7	132 - 162	↓
	1412	SC180208-2A	µmhos/cm	1410		1342 - 1484	
	2765	SC180103-3C	µmhos/cm	2802		2628 - 2905	
Eh	Zobell's solution	20B2045-1	mV	429.5	18.8	425.8-445.8	
Dissolved Oxygen	NA	NA	mg/L	9.20	19.8	±10% Theoretical: 9.09	↓
Turbidity	10 NTU	AG272	NTU	9.75	—	9 - 11	L.2020 [illegible]

Notes:

GROUNDWATER SAMPLE COLLECTION FORM - STANDARD

Project Name:	MBLP/Shiras ASD & GW Monitoring	**Monitoring Location:**	MW-1
Project Number:	180827	**Sample ID:**	NA
Site Location:	Marquette, MI	**Well Type:**	2" galvanized
Weather/Temp.:	74°, some clouds	**Key Number:**	0356

INSPECTION

Label on well?	YES / NO / REMEDIED	Is cement pad in good repair?	YES / NO / REMEDIED N/A
Is reference mark visible?	YES / NO / REMEDIED	Is protective casing locked and in good repair?	YES / NO / REMEDIED
Standing water present?	YES / NO / REMEDIED	Is inner cap in place and properly sealing well?	YES / NO / REMEDIED
Indication of surface runoff in well?	YES / NO / REMEDIED	Is well casing in visibly good repair?	YES / NO / REMEDIED
Repair Notes:			

STATIC WATER LEVEL DATE: 5/30/18 TIME: 1209

Top of Casing Elevation:	NM ft	Measured with:	Electronic tape / Chalked tape / Other:
Depth to Water:	+0.30 ft	Well depth verified?	YES / NO
Elevation of Water:	— ft		

WELL PURGING DATE: 5/30/18 TIME: 12:12

CALCULATION OF 3 CASING VOLUMES		PURGE METHOD:	
Depth of well from TOC	29.44 ft	Bailer / Grundfos / Peristaltic / Bladder / Other:	whale
Depth to water	-(0.30 ft	Equipment #:	603
Height of water column	= 29.74 ft		
Conversion factor	X(0.49)		
3 Water volumes	= 14.57 gallons		
Actual volume purged:	~10 gallons		

Conversion Factors (gallons/ft)	
1.25" well - 0.20	4" well - 1.96
2" well - 0.49	8" well - 7.83

WATER QUALITY STABILIZATION (If required)

Time	Volume Purged	pH	Spec Cond	Dissolved O_2	Temperature	Eh	Turbidity	
12:12	←start purge	(S.U.)	(µmhos/cm)	(mg/L)	(°C)	(mV)	(NTU)	
12:15	3	7.56	NA	NA	~~NA~~ 11.0	NA	~~NA~~ 201	
12:19	6	8.11	NA	NA	~~NA~~ 13.4	NA	~~NA~~ 118	purged dry at ~6 gal
1339	restart purge	—	NA	NA	NA	NA	NA	
1341	8	7.77	NA	NA	~~NA~~ 9.4	NA	~~NA~~ 1267	
1342	10	9.54	NA	NA	~~NA~~ 9.6	NA	~~NA~~ 951	purged dry at 10 gal total - second attempt
			NA	NA	NA	NA	NA	

FIELD ANALYSES DATE: TIME:

Temperature:	NA °C	Carbon Dioxide:	NA mg/L	HACH CA-DT (RL = 10mg/L)
pH:	S.U.	Sulfide:	NA mg/L	HACH HS-WR (RL = 0.05mg/L)
Specific Conductance:	NA µmhos/cm	Ferrous Iron (Fe^{+2}):	NA mg/L	HACH IR-18C (RL = 0.2mg/L)
Eh:	NA mV			
Dissolved O_2:	NA mg/L			
Turbidity:	NA NTU			

SAMPLE COLLECTION DATE: — TIME: —

Sample appearance:		Duplicate sample collected?	YES / NO
Collection method:	Bailer / Grundfos / Peristaltic / Bladder / Other:	MS/MSD sample collected?	YES / NO
Equipment #:		Chain of Custody Number:	
Filter used:	0.45 µm (8100) / 0.45 µm (8200) / NONE		

Quantity	Size	Type	Filtered	Preservative	Parameters
	40 mL	Glass	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	250 mL	Plas	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	1000 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	

Not Applicable

SAMPLING PERSONNEL

Name (SIGNATURE): Name (SIGNATURE):

GROUNDWATER SAMPLE COLLECTION FORM - STANDARD

Project Name:	MBLP/Shiras ASD & GW Monitoring	**Monitoring Location:**	MW-2
Project Number:	180827	**Sample ID:**	NA
Site Location:	Marquette, MI	**Well Type:**	2" Galvanized
Weather/Temp.:	70°, sunny	**Key Number:**	035b

INSPECTION

Label on well?	YES / (NO) / REMEDIED	Is cement pad in good repair?	YES / NO / REMEDIED NA
Is reference mark visible?	YES / (NO) / REMEDIED	Is protective casing locked and in good repair?	(YES) / NO / REMEDIED
Standing water present?	(YES) / NO / REMEDIED	Is inner cap in place and properly sealing well?	(YES) / NO / REMEDIED
Indication of surface runoff in well?	YES / (NO) / REMEDIED	Is well casing in visibly good repair?	(YES) / NO / REMEDIED

Repair Notes:

STATIC WATER LEVEL — DATE: 5/30/18 — TIME: 11.43

Top of Casing Elevation:	NM ft	Measured with:	(Electronic tape) / Chalked tape / Other:
Depth to Water:	0.70 ft	Well depth verified?	(YES) / NO
Elevation of Water:	— ft		

WELL PURGING — DATE: 5/30/18 — TIME: 1145

CALCULATION OF 3 CASING VOLUMES

Depth of well from TOC	28.92 ft	PURGE METHOD:	
Depth to water	−(0.70 ft	Bailer / Grundfos / Peristaltic / Bladder / Other:	whale
Height of water column	= 28.22 ✓ ft	Equipment #:	607
Conversion factor	X (0.49)		
3 Water volumes	= 13.83 ✓ gallons		
Actual volume purged:	8 (5+3) gallons		

Conversion Factors (gallons/ft)	
1.25" well - 0.20	4" well - 1.96
2" well - 0.49	8" well - 7.83

WATER QUALITY STABILIZATION (if required)

Time	Volume Purged	pH	Spec Cond	Dissolved O_2	Temperature	Eh	Turbidity	
	←start purge	(S.U.)	(µmhos/cm)	(mg/L)	(°C)	(mV)	(NTU)	
1145								
1149	5	8.01	NA	NA	~~NA~~ 12.9	NA	~~NA~~ 707 AU	purged dry at ~5 gal
1320	restart purge	—	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	
1321	6	7.89	NA	NA	~~NA~~ 10.0	NA	~~NA~~ 2,504 AU	
1322	8	8.28	NA	NA	~~NA~~ 10.1	NA	~~NA~~ 1055 AU	purged dry at 8 gallons total - second time.
			NA	NA	NA	NA	NA	
			NA	NA	NA	NA	NA	

FIELD ANALYSES — DATE: — TIME:

Temperature:	NA °C	Carbon Dioxide:	NA mg/L	HACH CA-DT (RL = 10mg/L)
pH:	S.U.	Sulfide:	NA mg/L	HACH HS-WR (RL = 0.05mg/L)
Specific Conductance:	NA µmhos/cm	Ferrous Iron (Fe^{+2}):	NA mg/L	HACH IR-18C (RL = 0.2mg/L)
Eh:	NA mV			
Dissolved O_2:	NA mg/L			
Turbidity:	NA NTU			

SAMPLE COLLECTION — DATE: — TIME: —

Sample appearance:		Duplicate sample collected?	YES / NO
Collection method:	Bailer / Grundfos / Peristaltic / Bladder / Other:	MS/MSD sample collected?	YES / NO
Equipment #:		Chain of Custody Number:	
Filter used:	0.45 µm (8100) / 0.45 µm (8200) / NONE		

Quantity	Size	Type	Filtered	Preservative	Parameters
	40 mL	Glass	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	250 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	1000 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	

Not Applicable

SAMPLING PERSONNEL

Name (SIGNATURE): — Name (SIGNATURE):

GROUNDWATER SAMPLE COLLECTION FORM - STANDARD

Project Name:	MBLP/Shiras ASD & GW Monitoring	**Monitoring Location:**	MW-3
Project Number:	180827	**Sample ID:**	N/A
Site Location:	Marquette, MI	**Well Type:**	2" galvanized
Weather/Temp.:		**Key Number:**	0356

INSPECTION

Label on well?	YES / (NO) / REMEDIED	Is cement pad in good repair?	YES / NO / REMEDIED N/A
Is reference mark visible?	YES / (NO) / REMEDIED	Is protective casing locked and in good repair?	(YES) / NO / REMEDIED
Standing water present?	(YES) / NO / REMEDIED	Is inner cap in place and properly sealing well?	(YES) / NO / REMEDIED
Indication of surface runoff in well?	YES / (NO) / REMEDIED	Is well casing in visibly good repair?	(YES) / NO / REMEDIED

Repair Notes:

STATIC WATER LEVEL DATE: 5/30/18 TIME: 11:10

Top of Casing Elevation:	NM ft	Measured with:	(Electronic tape) / Chalked tape / Other:
Depth to Water:	0.9 ft	Well depth verified?	(YES) / NO
Elevation of Water:	— ft		

WELL PURGING DATE: 5/30/18 TIME: 1120

CALCULATION OF 3 CASING VOLUMES

Depth of well from TOC	29.01 ft	PURGE METHOD:	
Depth to water	−(0.90 ft	Bailer / Grundfos / Peristaltic / Bladder / Other:	whale
Height of water column	= 28.11 ✓ ft	Equipment #:	B03
Conversion factor	X (0.49)		
3 Water volumes	= 13.77 ✓ gallons		
Actual volume purged:	5 (9) gallons total		

Conversion Factors (gallons/ft)	
1.25" well - 0.20	4" well - 1.96
2" well - 0.49	8" well - 7.83

WATER QUALITY STABILIZATION (if required)

Time	Volume Purged ←start purge	pH (S.U.)	Spec Cond (µmhos/cm)	Dissolved O_2 (mg/L)	Temperature (°C)	Eh (mV)	Turbidity (NTU)	
1120								
1124	5	8.61	NA	NA	11.6	NA	3677	purged dry @ 5 gal
1303 ← restart purge			NA	NA	NA	NA	NA	
1304	6	6.95	NA	NA	11.2	NA	1493	
1305	8	7.82	NA	NA	8.7	NA	98 NTU	purged dry at 9 gal (4 gal purged second time)
			NA	NA	NA	NA	NA	
			NA	NA	NA	NA	NA	

FIELD ANALYSES DATE: TIME:

Temperature:	NA °C	Carbon Dioxide:	NA mg/L	HACH CA-DT (RL = 10mg/L)
pH:	S.U.	Sulfide:	NA mg/L	HACH HS-WR (RL = 0.05mg/L)
Specific Conductance:	NA µmhos/cm	Ferrous Iron (Fe^{+2}):	NA mg/L	HACH IR-18C (RL = 0.2mg/L)
Eh:	NA mV			
Dissolved O_2:	NA mg/L			
Turbidity:	NA NTU			

SAMPLE COLLECTION DATE: — TIME: —

Sample appearance:		Duplicate sample collected?	YES / NO
Collection method:	Bailer / Grundfos / Peristaltic / Bladder / Other:	MS/MSD sample collected?	YES / NO
Equipment #:		Chain of Custody Number:	
Filter used:	0.45 µm (8100) / 0.45 µm (8200) / NONE		

Quantity	Size	Type	Filtered	Preservative	Parameters
	40 mL	Glass	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	250 mL	Plas	Y N	N H O_3 H_2SO_4 Na	
	500 mL	Plas	Y N	N H O_3 H_2SO_4 Na	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	1000 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	

Not Applicable

SAMPLING PERSONNEL

Name (SIGNATURE): Name (SIGNATURE):

GROUNDWATER SAMPLE COLLECTION FORM - STANDARD

Project Name:	MBLP/Shiras ASD & GW Monitoring	**Monitoring Location:**	MW-4
Project Number:	180827	**Sample ID:**	~~N/A~~
Site Location:	Marquette, MI	**Well Type:**	2" PVC FM
Weather/Temp.:	64°, overcast	**Key Number:**	N/A

INSPECTION

Label on well?	(YES) / NO / REMEDIED	Is cement pad in good repair?	(YES) / NO / REMEDIED
Is reference mark visible?	(YES) / NO / REMEDIED	Is protective casing locked and in good repair?	(YES) / NO / REMEDIED
Standing water present?	YES / (NO) / REMEDIED	Is inner cap in place and properly sealing well?	(YES) / NO / REMEDIED
Indication of surface runoff in well?	YES / (NO) / REMEDIED	Is well casing in visibly good repair?	(YES) / NO / REMEDIED

Repair Notes:

STATIC WATER LEVEL DATE: 5/30/18 TIME: 9:28

Top of Casing Elevation:	NM ft	Measured with:	(Electronic tape) / Chalked tape / Other:
Depth to Water:	15.35 ft	Well depth verified?	(YES) / NO
Elevation of Water:	— ft		

WELL PURGING DATE: 5/30/18 TIME: ~~0930~~ 0940 (ABS)

CALCULATION OF 3 CASING VOLUMES

Depth of well from TOC	46.73 ft	PURGE METHOD:	
Depth to water	−(15.35 ft	Bailer / Grundfos / Peristaltic / Bladder / Other:	whale
Height of water column	= 31.38 ft	Equipment #:	603
Conversion factor	X(0.49)		
3 Water volumes	= 15.39 gallons		
Actual volume purged:	8.5 (5.5 + 3) gallons		

Conversion Factors (gallons/ft)	
1.25" well - 0.20	4" well - 1.96
2" well - 0.49	8" well - 7.83

* 14:41 - purged dry a second time at 8.5 gal total (3 additional gallons purged)

WATER QUALITY STABILIZATION (if required)

Time	Volume Purged	pH	Spec Cond	Dissolved O_2	Temperature	Eh	Turbidity	
(ABS) ~~0930~~ 0940 *	←start purge	(S.U.)	(µmhos/cm)	(mg/L)	~~(ABS)~~ (°C)	(mV)	~~(ABS)~~ (NTU)	
0946	5.5	7.46	NA	NA	~~NA~~ 11.6	NA	~~NA~~ 23.6	*PURGED DRY @ 5.5 gal.
~~NA~~	"	NM	NA	NA	~~NA~~	NA	~~NA~~	WILL LET RECOVER AND
~~NA~~	~~1105~~	NM	NA	NA	~~NA~~	NA	~~NA~~	SAMPLE 5131.
1446	restart purge		NA	NA	NA	NA	NA	** RETURNED TO PURGE
1447	7	7.80	NA	NA	NA 9.9	NA	~~NA~~ 40.1	DRY A SECOND TIME
1448	8	7.70	NA	NA	NA 9.7	NA	NA 30.2	SWL = 22.33

FIELD ANALYSES DATE: — TIME: —

Temperature:	NA °C		Carbon Dioxide:	NA mg/L	HACH CA-DT (RL = 10mg/L)
pH:	NM S.U.		Sulfide:	NA mg/L	HACH HS-WR (RL = 0.05mg/L)
Specific Conductance:	NA µmhos/cm		Ferrous Iron (Fe^{+2}):	NA mg/L	HACH IR-18C (RL = 0.2mg/L)
Eh:	NA mV				
Dissolved O_2:	NA mg/L				
Turbidity:	NA NTU				

SAMPLE COLLECTION DATE: — TIME: —

Sample appearance:		Duplicate sample collected?	YES / NO
Collection method:	Bailer / Grundfos / Peristaltic / Bladder / Other:	MS/MSD sample collected?	YES / NO
Equipment #:		Chain of Custody Number:	
Filter used:	0.45 µm (8100) / 0.45 µm (8200) / NONE		

Quantity	Size	Type	Filtered	Preservative	Parameters
	40 mL	Glass	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	250 mL	Plas[illegible]	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plas[illegible]	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	1000 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	

Not Applicable

SAMPLING PERSONNEL

Name (SIGNATURE): [signature] Name (SIGNATURE):

GROUNDWATER SAMPLE COLLECTION FORM - STANDARD

Project Name:	MBLP/Shiras ASD & GW Monitoring	**Monitoring Location:**	MW-5
Project Number:	180827	**Sample ID:**	N/A
Site Location:	Marquette, MI	**Well Type:**	2" PVC
Weather/Temp.:	63°, overcast	**Key Number:**	N/A

INSPECTION

Label on well?	YES / NO / REMEDIED	Is cement pad in good repair?	YES / NO / REMEDIED
Is reference mark visible?	YES / NO / REMEDIED	Is protective casing locked and in good repair?	YES / NO / REMEDIED
Standing water present?	YES / NO / REMEDIED	Is inner cap in place and properly sealing well?	YES / NO / REMEDIED
Indication of surface runoff in well?	YES / NO / REMEDIED	Is well casing in visibly good repair?	YES / NO / REMEDIED

Repair Notes:

STATIC WATER LEVEL

DATE: 5/30/18 TIME: 8:50

Top of Casing Elevation:	- ft	Measured with:	Electronic tape / Chalked tape / Other:
Depth to Water:	14.79 ft	Well depth verified?	YES NO
Elevation of Water:	- ft		

WELL PURGING

DATE: 5/30/18 TIME: 8:59

CALCULATION OF 3 CASING VOLUMES

Depth of well from TOC	44.75 ft	PURGE METHOD:	
Depth to water	-(14.79 ft	Bailer / Grundfos / Peristaltic / Bladder / Other:	WHALE
Height of water column	= 29.96 ft	Equipment #:	# 603
Conversion factor	X(0.49)		
3 Water volumes	= 14.68 gallons		
Actual volume purged:	17.0 gallons		

Conversion Factors (gallons/ft)	
1.25" well - 0.20	4" well - 1.96
2" well - 0.49	8" well - 7.83

WATER QUALITY STABILIZATION (if required)

Time	Volume Purged	pH	Spec Cond	Dissolved O_2	Temperature	Eh	Turbidity	
8:59	←start purge	(S.U.)	(µmhos/cm)	(mg/L)	(°C)	(mV)	(NTU)	
0904	5	7.28	NA	NA	NA	NA	NA	TURBIDITY: 208N, TEMP: 11.1°C
0908	10	7.48	NA	NA	NA	NA	NA	TURBIDITY: 199 NTU TEMP: 11.0°C
0915	15	7.42	NA	NA	NA	NA	NA	TUR.: 11.5 NTU TEMP: 10.7°C
			NA	NA	NA	NA	NA	
			NA	NA	NA	NA	NA	
			NA	NA	NA	NA	NA	

FIELD ANALYSES

DATE: 5/30/18 TIME: 0917

Temperature:	10.2 ~~NA~~ °C	Carbon Dioxide:	NA mg/L	HACH CA-DT (RL = 10mg/L)
pH:	7.46 S.U.	Sulfide:	NA mg/L	HACH HS-WR (RL = 0.05mg/L)
Specific Conductance:	NA µmhos/cm	Ferrous Iron (Fe^{+2}):	NA mg/L	HACH IR-18C (RL = 0.2mg/L)
Eh:	NA mV			
Dissolved O_2:	NA mg/L			
Turbidity:	12.8 ~~NA~~ NTU			

SAMPLE COLLECTION

DATE: TIME:

Sample appearance:		Duplicate sample collected?	YES / NO
Collection method:	Bailer / Grundfos / Peristaltic / Bladder / Other:	MS/MSD sample collected?	YES / NO
Equipment #:		Chain of Custody Number:	
Filter used:	0.45 µm (8100) / 0.45 µm (8200) / NONE		

Quantity	Size	Type	Filtered	Preservative	Parameters
	40 mL	Glass	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	250 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	1000 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	

Not Applicable

SAMPLING PERSONNEL

Name (SIGNATURE): [signature] Name (SIGNATURE):

GROUNDWATER SAMPLE COLLECTION FORM - LOW FLOW

Project Name:	MBLP/Shiras ASD & GW Monitoring	**Monitoring Location:**	MW-1
Project Number:	180827	**Sample ID:**	MBLPS-18-05-MW-1(I/MS/MSD)
Site Location:	Marquette, MI	**Well Type:**	2" galvanized
Weather/Temp:	75, sunny, some clouds	**Key Number:**	0356

INSPECTION

Label on well?	YES / (NO) / REMEDIED	Is cement pad in good repair?	YES / NO / REMEDIED NA
Is reference mark visible?	YES / (NO) / REMEDIED	Is protective casing locked and in good repair?	(YES) / NO / REMEDIED
Standing water present?	(YES) / NO / REMEDIED	Is inner cap in place and properly sealing well?	(YES) / NO / REMEDIED
Indication of surface runoff in well?	YES / (NO) / REMEDIED	Is well casing in visibly good repair?	(YES) / NO / REMEDIED

Repair Notes: casing full of water to top, bailed out, Added 12" of M.F.

STATIC WATER LEVEL DATE: 5/31/18 TIME: 1553

Top of Casing Elevation:	NM ft	Measured with:	(Electronic tape) / Chalked tape / Other:
Depth to Water:	0.04 ft	Well depth verified?	YES / (NO)
Elevation of Water:	— ft		

*PURGED @ HIGH RATE FOR 10 MINS TO ATTEMPT TO STABILIZE H2O LEVEL.

WELL PURGING DATE: 5/31/18 TIME: 1555

Purge Method: (PERISTALTIC) / BLADDER / MICRO BLADDER / OTHER: Pump intake @ 2.5 ft from ____ TOC or ✓ bottom

Equipment No.: 552

Measured well depth: 29.44 ft Screen length: 5 ft Depth to screen midpoint: 26.94 ft

Time	Water Level (feet)	Drawdown (feet)	Pumping Rate (mL/min)	pH (S.U.)	Temp (°C)	Spec Cond (µmhos/cm)	Turbidity (NTU)	Eh (mV)	D.O. (mg/L)
1618	6.14	6.10	140	7.64	14.3	1357	14.0	472	0.29
1621	6.15	6.11	140	7.63	14.9	1361	21.0	471	0.30
1624	6.15	6.11	140	7.62	14.9	1378	21.2	471	0.30
1627	6.15	6.11	140	7.62	14.8	1370	20.0	470	0.29
Volume: 2.1	(Gallons)		Stabilization Criteria:	±0.1	±3%	±3%	±10% for values >20	±10 mV	±10% ✓

FIELD ANALYSES DATE: 5/31/18 TIME: 1628

Temperature:	14.9 °C	Carbon Dioxide:	NA mg/L	HACH CA-DT (RL = 10 mg/L)	
pH:	7.62 S.U.	Sulfide (S^{-2}):	NA mg/L	HACH HS-WR (RL = 0.05 mg/L)	
Specific Conductance:	1367 µmhos/cm	Ferrous Iron (Fe^{+2}):	NA mg/L	HACH IR-18C (RL = 0.2 mg/L)	
Eh:	469 mV				
Dissolved Oxygen:	0.29 mg/L				
Turbidity:	14.5 NTU				

SAMPLE COLLECTION DATE: 5/31/18 TIME: 1629 ✓

Sample appearance:	clear	Duplicate sample collected?	YES / (NO)
Collection method:	(PERISTALTIC) / BLADDER / MICRO BLADDER / OTHER:	MS/MSD sample collected?	(YES) / NO
Equipment No.:	552	Chain of Custody Number: Appx III	*604 2036 ✓
Filter used:	0.45 µm (8100) / 0.45 µm (8200) / (NONE)	Chain of Custody Number: Appx IV	✓ 604 2060 (Radium only)

✓ Designated MS/MSD location

Quantity	Size	Type	Filtered	Preservative	Parameters
	40 mL	Glass	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	125 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	6041501
3	500 mL	Plastic	No	None	Fl ✓
3	500 mL	Plastic	No	None	Boron, Calcium ✓ *
3	500 mL	Plastic	No	HNO_3	Cl, Fl, pH, TDS, SO_4 ✓ *
3	500 mL	Plastic	No	HNO_3	Sb, As, Ba, Be, Cd, Cr, Co, Pb, Hg, Mo, Se, Tl, Li ✓
9	1000 mL	Plastic	No	HNO_3	Radium 226, Radium 228 ✓
	1000 mL	Glass	Yes No	None HCl HNO_3 H_2SO_4 NaOH	

SAMPLING PERSONNEL

Name (SIGNATURE): [signature] Name (SIGNATURE):

Appendix B

Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.17/27/2018 2:26:36 PM
From File WorkSheet_a.xls
Full Precision OFF

Dixon's Outlier Test for Background

Number of Observations = 18
10% critical value: 0.424
5% critical value: 0.475
1% critical value: 0.561

1. Observation Value 7.93 is a Potential Outlier (Upper Tail)?

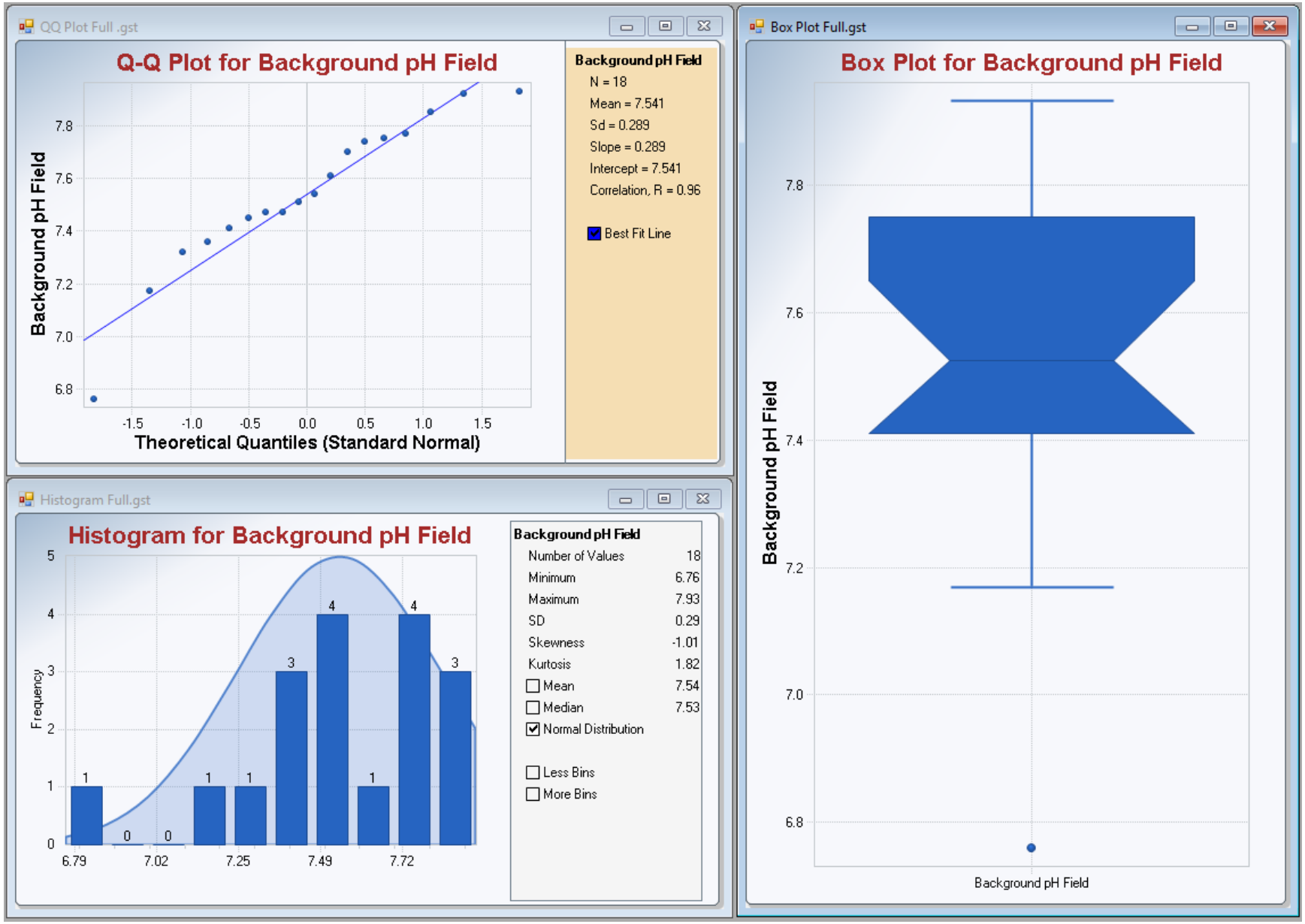
Test Statistic: 0.131

For 10% significance level, 7.93 is not an outlier.
For 5% significance level, 7.93 is not an outlier.
For 1% significance level, 7.93 is not an outlier.

2. Observation Value 6.76 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.514

For 10% significance level, 6.76 is an outlier.
For 5% significance level, 6.76 is an outlier.
For 1% significance level, 6.76 is not an outlier.



Data Visualization for detection of Potential Outliers

Appendix C

Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.17/27/2018 3:27:19 PM
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	0.99

Background

Raw Statistics

Number of Valid Observations	18
Number of Distinct Observations	17
Minimum	6.76
Maximum	7.93
Mean of Raw Data	7.541
Standard Deviation of Raw Data	0.289
Khat	701.7
Theta hat	0.0107
Kstar	584.8
Theta star	0.0129
Mean of Log Transformed Data	2.02
Standard Deviation of Log Transformed Data	0.0391

Normal GOF Test Results

Correlation Coefficient R	0.96
Shapiro Wilk Test Statistic	0.929
Shapiro Wilk Critical (0.01) Value	0.858
Approximate Shapiro Wilk P Value	0.182
Lilliefors Test Statistic	0.112
Lilliefors Critical (0.01) Value	0.235

Data appear Normal at (0.01) Significance Level

Gamma GOF Test Results

Correlation Coefficient R	0.958
A-D Test Statistic	0.387
A-D Critical (0.01) Value	1.006
K-S Test Statistic	0.11
K-S Critical(0.01) Value	0.236

Data appear Gamma Distributed at (0.01) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.953
Shapiro Wilk Test Statistic	0.917
Shapiro Wilk Critical (0.01) Value	0.858
Approximate Shapiro Wilk P Value	0.109
Lilliefors Test Statistic	0.118
Lilliefors Critical (0.01) Value	0.235

Data appear Lognormal at (0.01) Significance Level

Appendix D

Normal Background Statistics for Uncensored Full Data Sets

User Selected Options

Date/Time of Computation	ProUCL 5.17/27/2018 2:58:33 PM
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	99%
Coverage	99%
New or Future K Observations	1

Background

General Statistics

Total Number of Observations	18	Number of Distinct Observations	17
Minimum	6.76	First Quartile	7.42
Second Largest	7.92	Median	7.525
Maximum	7.93	Third Quartile	7.748
Mean	7.541	SD	0.289
Coefficient of Variation	0.0384	Skewness	-1.012
Mean of logged Data	2.02	SD of logged Data	0.0391

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	3.96	d2max (for USL)	2.821

Normal GOF Test

Shapiro Wilk Test Statistic	0.929	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.112	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.202	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Background Statistics Assuming Normal Distribution

99% UTL with 99% Coverage	8.686	90% Percentile (z)	7.911
99% UPL (t)	**8.303**	95% Percentile (z)	8.016
99% USL	8.356	99% Percentile (z)	8.213

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV

One Sample t-Test for Uncensored Full Data Sets without NDs

User Selected Options

Date/Time of Computation	ProUCL 5.17/27/2018 3:08:00 PM
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	99%
Substantial Difference	0
Action Level	0
Selected Null Hypothesis	Mean <= Action Level (Form 1)
Alternative Hypothesis	Mean > the Action Level

Background

One Sample t-Test

Raw Statistics	
Number of Valid Observations	18
Number of Distinct Observations	17
Minimum	6.76
Maximum	7.93
Mean	7.541
Median	7.525
SD	0.289
SE of Mean	0.0682

H0: Sample Mean <= 0 (Form 1)

Test Value	110.6
Degrees of Freedom	17
Critical Value (0.01)	**2.567**
P-Value	4.88E-26

Conclusion with Alpha = 0.01
Reject H0, Conclude Mean > 0
P-Value < Alpha (0.01)

Appendix E

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	ProUCL 5.17/27/2018 3:40:33 PM
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	0.99
Level of Significance	0.01

pH-mw-1

General Statistics	
Number of Events Reported (m)	9
Number of Missing Events	0
Number or Reported Events Used	9
Number Values Reported (n)	9
Minimum	6.56
Maximum	7.62
Mean	7.449
Geometric Mean	7.442
Median	7.56
Standard Deviation	0.337
Coefficient of Variation	0.0452

Mann-Kendall Test	
M-K Test Value (S)	13
Tabulated p-value	0.13
Standard Deviation of S	9.539
Standardized Value of S	1.258
Approximate p-value	0.104

Insufficient evidence to identify a significant trend at the specified level of significance.

pH-mw-2

General Statistics	
Number of Events Reported (m)	9
Number of Missing Events	0
Number or Reported Events Used	9
Number Values Reported (n)	9
Minimum	7.03
Maximum	8.41
Mean	7.987
Geometric Mean	7.978
Median	8.09
Standard Deviation	0.386
Coefficient of Variation	0.0483

Mann-Kendall Test	
M-K Test Value (S)	-17
Tabulated p-value	0.06
Standard Deviation of S	9.539
Standardized Value of S	-1.677
Approximate p-value	0.0467

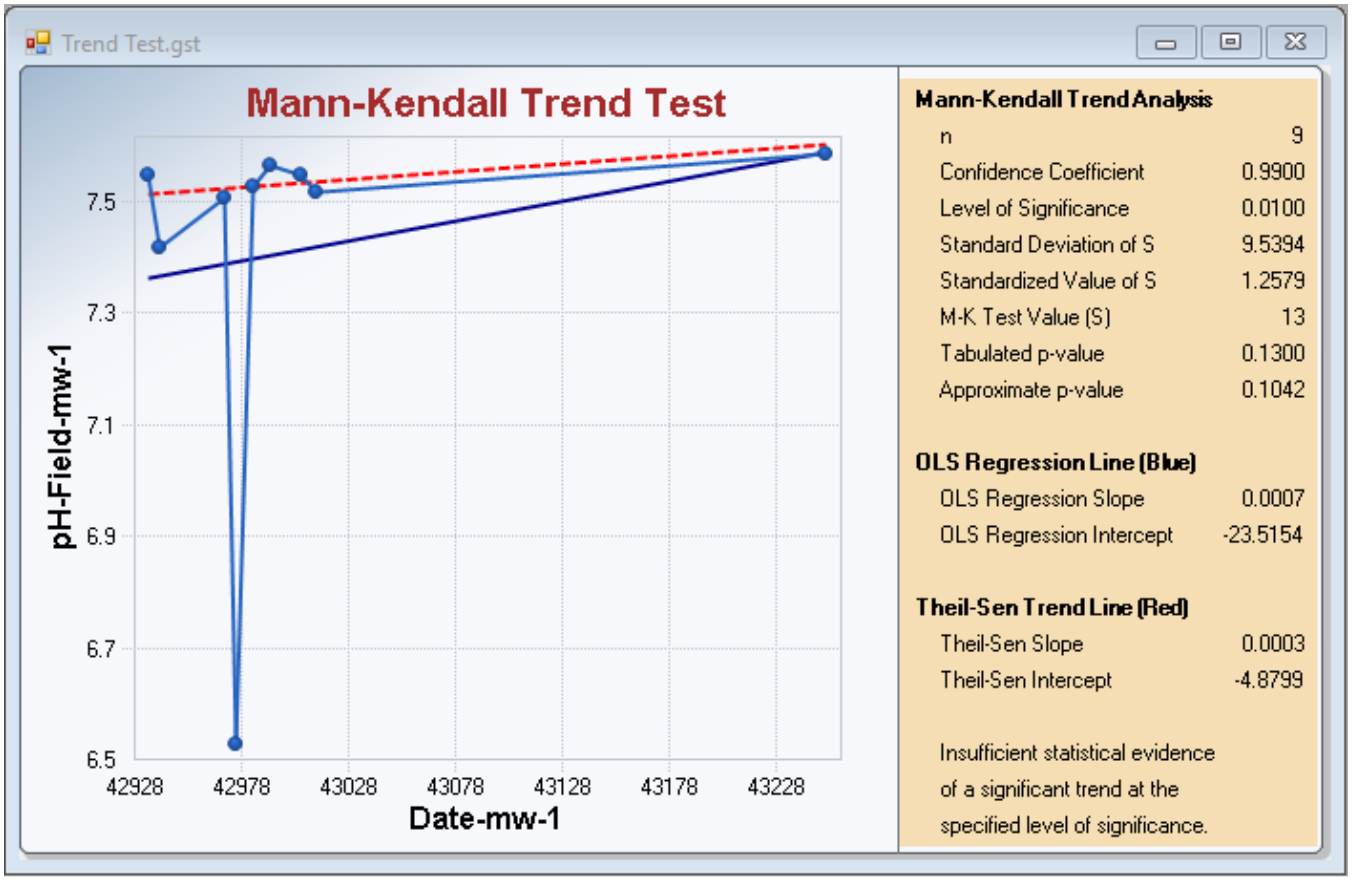
Insufficient evidence to identify a significant trend at the specified level of significance.

pH-mw-3

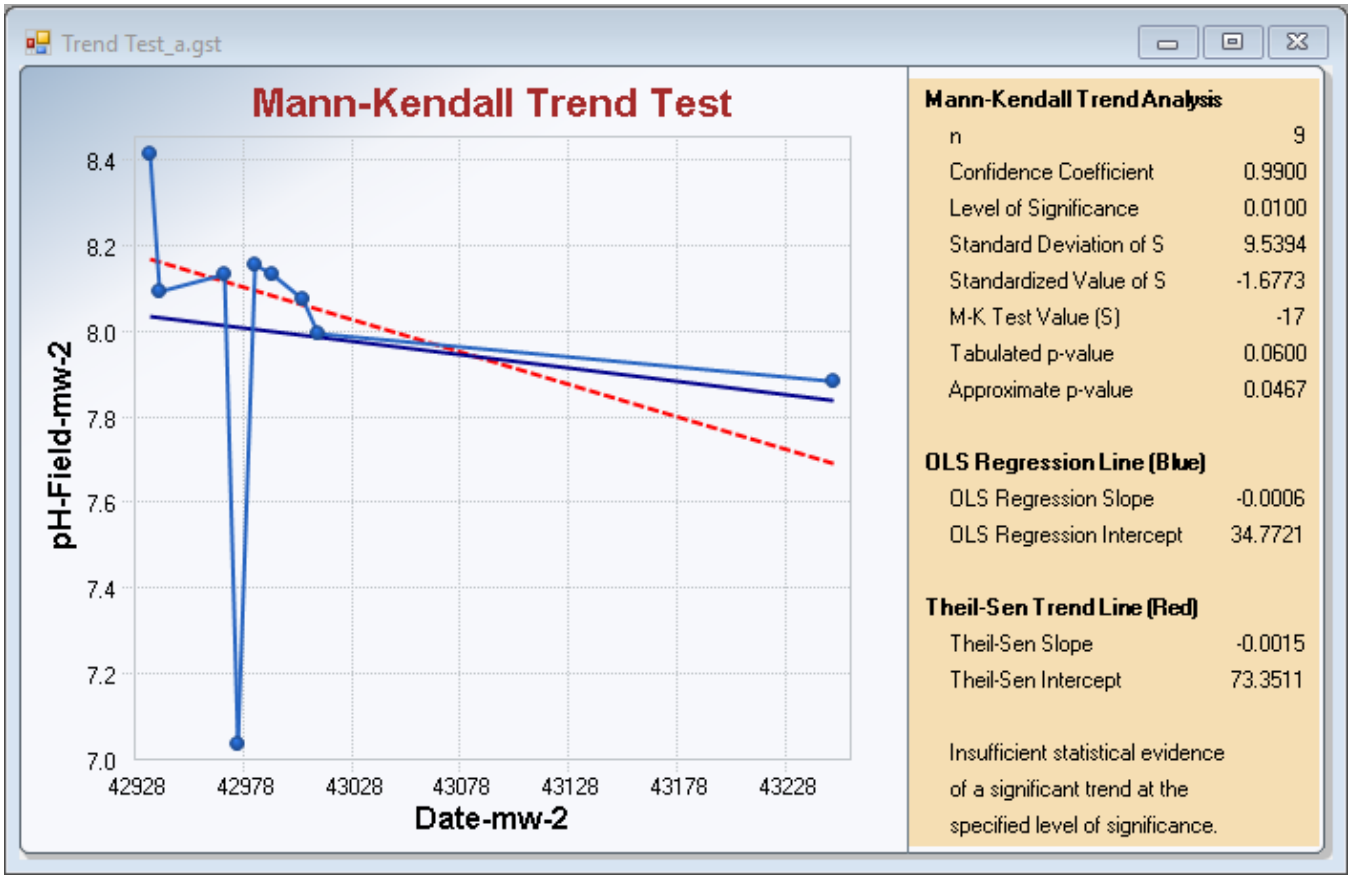
General Statistics	
Number of Events Reported (m)	9
Number of Missing Events	0
Number or Reported Events Used	9
Number Values Reported (n)	9
Minimum	6.32
Maximum	8.1
Mean	7.763
Geometric Mean	7.744
Median	7.86
Standard Deviation	0.556
Coefficient of Variation	0.0716

Mann-Kendall Test	
M-K Test Value (S)	10
Tabulated p-value	0.179
Standard Deviation of S	9.592
Standardized Value of S	0.938
Approximate p-value	0.174

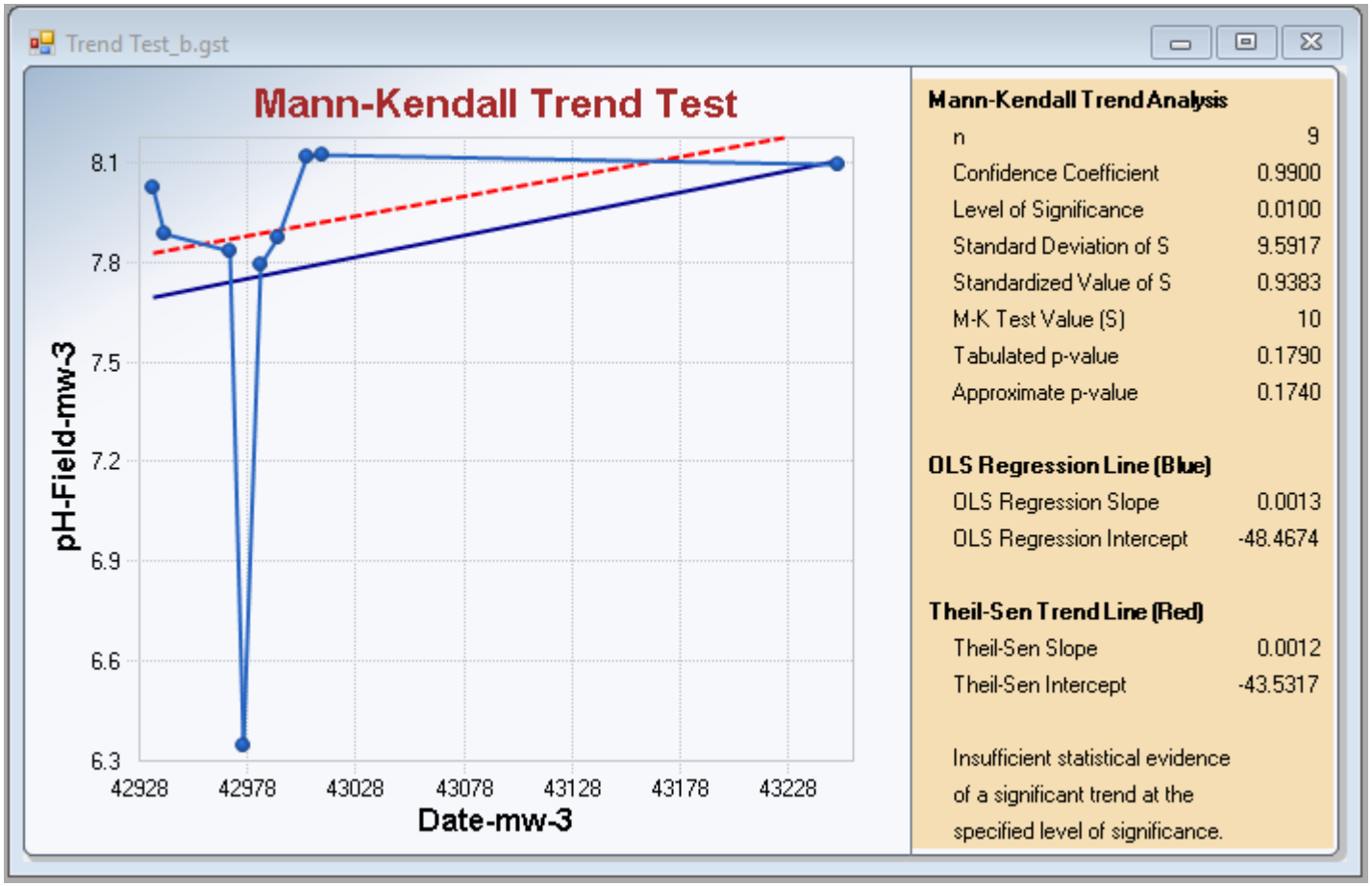
Insufficient evidence to identify a significant trend at the specified level of significance.



Trend Analysis for MW-1



Trend Analysis for MW-1



Trend Analysis for MW-1