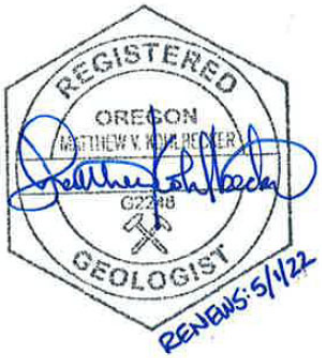
TECHNICAL MEMORANDUM

Concentration Trends in Monitoring Well PWB-1(lts): Review and Reanalysis of a Mann-Kendall Trend Analysis Performed by Geosyntec and Landau (2021)



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Date: April 27, 2021

This technical memorandum summarizes GSI Water Solution's (GSI)'s review and reanalysis of a Mann-Kendall analysis performed by Geosyntec Consultants (Geosyntec) and Landau Associates (Landau) (Geosyntec and Landau, 2021). The Mann-Kendall analysis was submitted to the Oregon Department of Environmental Quality (DEQ) to demonstrate that groundwater contaminant concentrations are stable in Zone A of the Troutdale Sandstone Aquifer (TSA) for the East Multnomah County (EMC) TSA Groundwater Remedy[1].

1. Introduction

In April 2020, the Boeing Company (Boeing) and Cascade Corporation (Cascade) submitted a request to DEQ for a partial No Further Action (NFA) at the EMC Site in Gresham, Oregon (Landau and Geosyntec, 2020). The partial NFA would apply to groundwater contamination in Zone A of the TSA and to the entire Sand and Gravel Aquifer (SGA). In July 2020, GSI reviewed the partial NFA request with a focus on trichloroethene (TCE) concentration trends at monitoring well PWB-1(lts), which is completed in Zone A of the TSA (GSI, 2020). TCE concentration trends are important because the Record of Decision (ROD) for the EMC Site requires that contaminant concentrations in groundwater be reduced to less than their respective Maximum Contaminant Levels (MCLs) (DEQ, 1996); while TCE concentrations in PWB-1(lts) *currently* meet the ROD standard of being less than the MCL of 5 micrograms per liter (ug/L)[2], an increasing trend in TCE concentrations would indicate that the ROD standard *may not be met* in the future. GSI's peer review concluded that, based on a Mann-Kendall analysis of TCE concentration trends, ". . . at the 95% confidence interval, there is statistically significant evidence of an increasing trend in TCE concentrations at monitoring well PWB-1(lts)" (GSI, pg. 5, 2020). GSI recommended that a conditional NFA (cNFA) would be more appropriate for the Site (a cNFA would provide DEQ with a mechanism to rescind the NFA if TCE concentrations increased to above ROD standards in the future).

[1] Environmental Cleanup Site Information (ECSI) Site 1479
[2] TCE concentrations in groundwater samples collected during 2019 ranged from 1.39 to 1.91 ug/L.

In February 2021, Geosyntec and Landau submitted an independent Mann-Kendall analysis to DEQ that evaluated TCE concentration trends at monitoring well PWB-1(lts). Geosyntec and Landau also clarified the dates that EMC extraction wells were shut down, and provided additional groundwater quality data from PWB-1(lts) collected by Boeing and Cascade that were not included in the GSI (2020) Mann-Kendall analysis. Geosyntec and Landau concluded that TCE concentrations in PWB-1(lts) ". . . are not statistically significantly increasing but rather are stable" (Geosyntec and Landau, pg. 12, 2021).

GSI appreciates the time and effort from Geosyntec and Landau to tabulate a comprehensive TCE dataset for monitoring wells PWB-1(lts), and the clarification on extraction well shut down dates. GSI reviewed the updated dataset and re-ran the Mann-Kendall analysis, per suggestion from Geosyntec and Landau in their response to Portland Water Bureau (PWB) and GSI comments.

The content of the remainder of this review and reanalysis of Geosyntec and Landau's Mann-Kendall analysis includes:

- An overview of the Mann-Kendall statistical test (Section 2),
- A review of the Geosyntec and Landau (2021) Mann-Kendall Analysis (Section 3), and
- An updated Mann-Kendall analysis using TCE concentrations in groundwater quality samples collected by PWB *and* Geosyntec and Landau (Section 4).

2. Overview of the Mann-Kendall Statistical Test

This section summarizes the primary elements of a Mann-Kendall statistical test as described in the *ProUCL Version 5.1 Technical Guide* (EPA, 2015) and other guidance documents [i.e., Alvarez and Illman (2006), Helsel et al. (2019), Gilbert (1987)]. These elements may need to be modified when applying the Mann-Kendall statistical test to environmental data because each analysis will ultimately rely on particulars of the dataset being evaluated and statistical guidance documents (e.g., EPA, 2015).The purpose of this summary is to establish and clearly document the framework used for our review of the Geosyntec and Landau (2021) Mann-Kendall test in Section 3.

The Mann-Kendall statistical test is a nonparametric method to evaluate whether there is evidence of statistically significant trends in time series data. According to EPA (2015) and Alvarez and Illman (2006), the primary elements of a Mann-Kendall analysis are: (1) evaluation of a trend line and (2) calculation of a Mann-Kendall Test Value (S) and comparison of a *p*-value to a level of significance (α, for example 0.05) corresponding to a confidence interval of 1-α (for example, the 95% confidence interval, if α = 0.05). Depending on the calculated value of *p* and common values of α used to evaluate environmental data, it may be appropriate to consider the coefficient of variation (COV). The following sections summarize these elements of a Mann-Kendall analysis in greater detail, as discussed in EPA (2015), Alvarez and Illman (2006), and Helsel et al. (2019).

2.1 Element 1: Regression Analysis

A regression analysis involves developing a regression line for the dataset. The regression analysis is an important tool for visually assessing the data to determine *potential* trends in contaminant concentration over time. The Mann-Kendall analysis is then used to confirm the *potential* trends.

2.2 Element 2: Mann-Kendall Test Value and *p*-value

Conclusions derived from a Mann-Kendall analysis are based on evaluation of: (1) the Mann-Kendall Test Value (S) and (2) the *p*-value.

The *ProUCL Version 5.1 Technical Guide* (EPA, 2015) provides guidance on interpretation of the Mann-Kendall Test Value (S) (EPA, 2015):

- If S > 0, the analysis suggests the presence of a potential upward and increasing trend over time.
- If S < 0, the analysis suggests the presence of a potential downward and decreasing trend over time.
- If S is close to zero, the analysis suggests that the data do not exhibit any evidence of an increasing or decreasing trend.

The *ProUCL Version 5.1 Technical Guide* (EPA, 2015) provides guidance on interpretation of the *p* value at a level of significance α and confidence interval 1-α.

- If S > 0 and α > *p* value, conclude that there is statistically significant evidence of an increasing trend at the α significance level.
- If S < 0 and α > *p* value, conclude that there is statistically significant evidence of a decreasing trend at the α significance level.
- If S is ~ 0 and α < *p* value, conclude that the data do not exhibit sufficient evidence of any significant trend at the α level of significance.

Note that Helsel et al. (2019) recommend against pre-specifying a value of α because decision-makers may have different risk tolerances. However, it is helpful to understand that, when evaluating environmental data, values of α that are $\leq$ 0.2 are generally acceptable for evidence of a statistically significant trend (i.e., an 80 percent confidence interval or higher) (Alvarez and Illman, 2006).

2.3 Element 3: Coefficient of Variation (If Appropriate)

The COV is the sample standard deviation divided by the sample mean. The COV is used to characterize the degree of variability in datasets (Helsel et al., 2019). Alvarez and Illman (2006) indicate that a COV of less than one may be used to evaluate the stability of time series data if the Mann-Kendall test does not indicate a statistically significant trend. In other words, if there is no upward or downward trend (S = 0) and no evidence of a statistically significant trend at the 80 percent or higher confidence level (i.e., *p*-value $\leq$ 0.20), then the COV may help determine whether the lack of a statistically significant increasing or decreasing trend is because of the variability of the dataset. Specifically, a COV less than 1 would indicate that the lack of an increasing or decreasing trend is real and not just due to scatter in the data.

3. Review of the Geosyntec and Landau (2021) Mann-Kendall Analysis

Geosyntec and Landau's Mann-Kendall analysis concluded that TCE concentrations in monitoring well PWB-1(lts) are "stable" (Geosyntec and Landau; pgs. 3, 4, 6, and 12; 2021) and "steady state" at about half the MCL (Geosyntec and Landau, pg. 12, 2021). However, these conclusions in Geosyntec and Landau (2021) do not appear to be supported by their Mann-Kendall analysis. The values of the elements of a Mann-Kendall statistical test (i.e., the trend line, Mann-Kendall Test Value (S), *p*-value, and COV) from Geosyntec and Landau (2021) are summarized in Table 1. Also presented in Table 1 are the conclusions that Geosyntec and Landau (2021) made based on the elements of the Mann-Kendall statistical test, and GSI's re-interpretation of the conclusions.

Table 1. Review of Geosyntec and Landau (2021) Mann-Kendall Analysis.

MK Elements	Geosyntec and Landau (2021) Value	Geosyntec and Landau (2021) Conclusion	GSI Conclusion (this memo)
Trend Line	Positive Slope	None Given	Positive slope indicates a *potentially* increasing trend
M-K Test Value (S)	26	None Given	M-K Test Value is > 0, indicating a *potentially* increasing trend
p-value (p) alpha (α)	0.079 0.05	**No Trend in TCE.** Because $\alpha < p$, there is no statistically significant increasing trend at the 95% confidence interval. Therefore, trend can be analyzed using the COV.	**Statistically Significant Trend in TCE.** There is a statistically significant increasing trend in TCE concentrations at the 90% confidence interval (α=0.1) because 0.1 > p and S > 0.
COV	0.2	The COV indicates TCE concentrations are stable.	Because the Mann-Kendall analysis found a statistically significant trend at the 90% confidence interval, the COV should not be used for trend analysis.

Notes

COV = coefficient of variation

The following bullets summarize GSI's review and reinterpretation of the Geosyntec and Landau (2021) Mann-Kendall analysis:

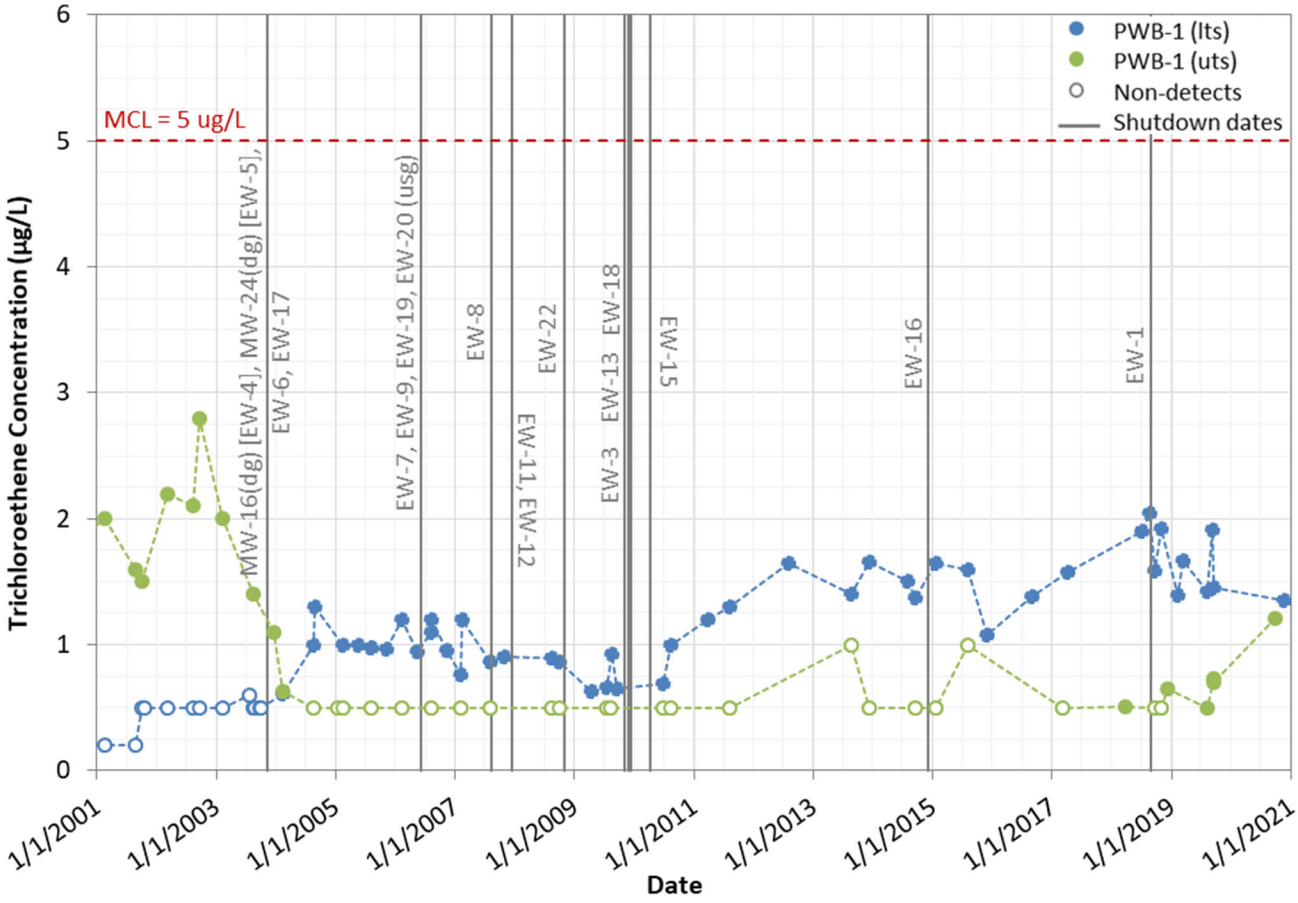
- Geosyntec and Landau (2021) did not evaluate the trend line or M-K Test Value (S), both of which indicate a *potentially* increasing trend in TCE concentrations at PWB-1(lts).
- Geosyntec and Landau (2021) conclude that there is no statistically significant trend at the 95% confidence interval based on their Mann-Kendall analysis. However, the fact that no statistically significant trend is present at the 95% confidence interval does not imply that concentrations are "stable" and "steady-state." In fact, the Mann-Kendall analysis presented by Geosyntec and Landau (2021) shows evidence of a statistically significant increasing trend in TCE concentrations at the 90% confidence interval.
- The Geosyntec and Landau (2021) evaluation of the COV is not relevant to this trend analysis because the Mann-Kendall analysis indicates that a trend is present at the 90% confidence interval.

In summary, the Mann-Kendall analysis submitted by Geosyntec and Landau (2021) indicates that TCE concentrations in monitoring well PWB-1(lts) exhibit evidence of a statistically significant increasing trend at the 90% confidence level.

4. Updated Mann-Kendall Analysis

Figure 1 shows TCE concentrations at monitoring wells PWB-1(uts) (green data series) and PWB-1(lts) (blue data series) over time, along with the dates that extraction wells at the EMC Site were shut down. The plot includes all groundwater quality samples collected by Geosyntec and PWB at the PWB-1 well cluster (note that samples collected on the same day are averaged into a single value) and is included in Attachment A. Nondetects are represented by white-filled circles, and are equal to the method reporting limit. We note that TCE concentrations in PWB-1(lts) appear to begin rising in 2010, following the shutdown of several EMC extraction wells. In PWB-1(uts), concentrations appear to begin rising in 2018, after the shutdown of extraction well EW-1.

Figure 1. TCE Concentrations in PWB-1(lts) and PWB-1(uts), 2001 – 2020.



GSI completed an updated Mann-Kendall analysis at monitoring well PWB-1(lts) on data collected since 2010, when several extraction wells at the EMC site were shut down. The results of GSI's updated Mann-Kendall analysis are summarized in Table 2. A plot of GSI's updated Mann-Kendall analysis is provided in Attachment B.

Table 2. Updated Mann-Kendall Analysis.

Item	Value	Conclusion
Trend Line	Positive Slope	Positive slope indicates a *potentially* increasing trend
M-K Test Value (S)	87	M-K Test Value is > 0, indicating a *potentially* increasing trend
p-value (p) alpha (α)	0.0164 0.05	**Statistically Significant Trend in TCE.** There is a statistically significant increasing trend in TCE at the 95% confidence interval because $\alpha > p$ and S > 0
COV	NA	Because the Mann-Kendall analysis found a statistically significant trend at the 95% confidence interval, the COV should not be used to evaluate stability.

GSI's updated Mann-Kendall analysis indicates that TCE concentrations in monitoring well PWB-1(lts) exhibit a statistically significant evidence of an increasing trend at the 95% confidence interval.

GSI also conducted an ordinary least squares (OLS) regression analysis on TCE concentrations at PWB-1(lts) using ProUCL version 5.1. The regression generated a line with a positive slope of 0.055 ug/L per year, with a corresponding *p*-value of 0.0033 that suggests a statistically significant upward trend in TCE

concentrations at the 95% confidence interval. Because the OLS is a parametric test (i.e., the test assumes variables follow a probability distribution), residuals must be normally distributed. GSI used ProUCL version 5.1 to conduct Shapiro-Wilkes and Lilliefors tests for normality on the OLS residuals, and found them to be normally distributed at the $p > 0.05$ significance level, indicating that the normality assumption for performing the OLS analysis was met.

5. Conclusions and Recommendations

Independent Mann-Kendall analyses conducted by Geosyntec and Landau (2021) and GSI (this memo) agree that TCE concentrations in monitoring well PWB-1(lts) exhibit statistically significant evidence of an increasing trend at the 90% and 95% confidence intervals, respectively. The least squares regression analysis conducted by GSI indicates that TCE concentrations in PWB-1(lts) are increasing at a rate of 0.055 ug/L per year.

Given this statistically significant increasing trend, there is uncertainty about whether TCE concentrations in Zone A of the TSA will remain below ROD standards in the future. It is important to note that that *the current rate* of TCE concentration increase in PWB-1(lts) is low: it would take about 60 years for the TCE concentrations to rise above the MCL at the current rate of increase[3]. The current, low rate of TCE increase reflects the hydrogeologic and contaminant transport conditions following the shutdown of extraction wells that have been taken offline to date. The rate of TCE concentration increase may change in the future as additional extraction wells are taken offline and hydrogeologic and contaminant transport conditions change (e.g., due to the potential for loss of TCE plume capture as extraction wells at the EMC Site are shut down, or a significant rebound in TCE concentrations as groundwater elevations recover). This analysis indicates the importance of continuing to monitor TCE concentrations at the PWB-1 cluster, and evaluating both TCE concentrations *as well as* the rate of TCE concentration increase.

Based on these conclusions, we recommend that DEQ require:

- Continued monitoring of TCE concentrations in PWB-1(lts) and PWB-1(uts) until five years after all extraction wells have been shut down,
- Evaluation of TCE concentrations in the PWB-1 well cluster for evidence of statistically significant increasing trends [note that there are currently not enough TCE detections at PWB-1(uts) to perform a Mann-Kendall analysis, but concentrations increased from nondetect (less than 0.5 ug/L) to 1.21 ug/L from 2018 to 2020].
- Evaluation of the rate of TCE concentration increases.

It would therefore appear that a cNFA, conditioned on continued groundwater monitoring in Zone A of the TSA, is appropriate for Zone A of the TSA. The cNFA should be conditioned on TCE concentrations remaining below the ROD standard and the rate of TCE concentration remaining low.

[3] The TCE concentration in PWB-1(lts) would need to rise from about 1.75 ug/L to 5 ug/L (a difference of 3.25 ug/L). At a rate of increase of 0.055 ug/L per year, it would take about 60 years for TCE concentrations in PWB-1(lts) to exceed the MCL (3.25 ug/L divided by 0.055 ug/L per year).

6. References

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ATTACHMENT A

Trichloroethene (TCE) Concentrations at Monitoring Wells PWB-1(lts) and PWB-1(uts)

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Table A.1. Trichloroethene (TCE) Concentrations at PWB-1 (lts)

Collection Date	TCE*, µg/L		Detection Limit	Data Source
8/14/1992	5.4		--	Boeing Company
8/20/1992	5.7		--	Boeing Company
8/27/1992	5.9		--	Boeing Company
9/3/1992	6.5		--	Boeing Company
9/10/1992	7.9		--	Boeing Company
9/17/1992	6.8		--	Boeing Company
9/23/1992	6.4		--	Boeing Company
10/1/1992	3.7		--	Boeing Company
10/8/1992	8.4		--	Boeing Company
10/14/1992	7.8		--	Boeing Company
11/15/1992	5.9		--	Boeing Company
11/18/1992	7.6		--	Boeing Company
3/18/1993	11		--	Boeing Company
3/18/1993	8.8		--	Boeing Company
5/11/1993	8.1		--	Boeing Company
12/1/1993	23		--	Boeing Company
3/4/1994	24		--	Boeing Company
7/28/1994	26	J	--	Boeing Company
11/28/1995	26		--	Boeing Company
12/6/1995	29		--	Boeing Company
12/13/1995	25		--	Boeing Company
12/22/1995	35		--	Boeing Company
2/8/1996	29		--	Boeing Company
2/12/1996	30		--	Boeing Company
8/29/1996	31		--	Boeing Company
9/12/1996	34		--	Boeing Company
9/19/1996	37		--	Boeing Company
9/26/1996	41		--	Boeing Company
8/19/1997	42		--	Boeing Company
2/16/1998	34		--	Boeing Company
8/14/1998	0.4		--	Boeing Company
2/10/1999	0.5		--	Boeing Company
8/16/1999	0.3		--	Boeing Company
2/10/2000	0.2		--	Boeing Company
8/18/2000	0.2	U	0.2	Boeing Company
2/15/2001	0.2	U	0.2	Boeing Company
8/22/2001	0.2	U	0.2	Boeing Company
10/5/2001	0.50	A	--	City of Portland
10/18/2001	0.50	A	--	City of Portland
3/13/2002	0.5	U	0.5	Boeing Company
8/12/2002	0.5	U	0.5	Boeing Company
9/24/2002	0.50	A	--	City of Portland
2/13/2003	0.5	U	0.5	Boeing Company
7/21/2003	0.60		--	City of Portland

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Table A.1. Trichloroethene (TCE) Concentrations at PWB-1 (lts)

Collection Date	TCE*, µg/L		Detection Limit	Data Source
8/19/2003	0.5	U	0.5	Boeing Company
8/25/2003	0.50	A	--	City of Portland
9/24/2003	0.5	U	0.5	Boeing Company
10/2/2003	0.50	A	--	City of Portland
2/11/2004	0.61		--	Boeing Company
8/19/2004	1		--	Boeing Company
8/25/2004	1.30		--	City of Portland
2/14/2005	1		--	Boeing Company
5/23/2005	1		--	Boeing Company
8/7/2005	0.97		--	Boeing Company
8/7/2005	0.97		--	Boeing Company
11/8/2005	0.96		--	Boeing Company
2/9/2006	1.2		--	Boeing Company
5/11/2006	0.94		--	Boeing Company
8/9/2006	1.1		--	Boeing Company
8/9/2006	1.2		--	Boeing Company
11/8/2006	0.95		--	Boeing Company
2/5/2007	0.76		--	City of Portland
2/13/2007	1.2		--	Boeing Company
8/8/2007	0.86		--	Boeing Company
10/26/2007	0.90		--	City of Portland
8/11/2008	0.89		--	Boeing Company
9/29/2008	0.86		--	City of Portland
4/13/2009	0.63		--	City of Portland
7/16/2009	0.66		--	City of Portland
8/17/2009	0.92		--	Boeing Company
9/14/2009	0.65		--	City of Portland
6/23/2010	0.69		--	City of Portland
8/11/2010	1		--	Boeing Company
3/28/2011	1.20		--	City of Portland
8/11/2011	1.2		--	Boeing Company
8/11/2011	1.4		--	Boeing Company
7/31/2012	1.7		--	Boeing Company
7/31/2012	1.6		--	Boeing Company
8/21/2013	1.4		--	Boeing Company
12/10/2013	1.66		--	City of Portland
8/5/2014	1.5		--	Boeing Company
9/19/2014	1.37		--	City of Portland
1/23/2015	1.65		--	City of Portland
8/5/2015	1.6		--	Boeing Company
12/1/2015	1.08		--	City of Portland
9/1/2016	1.38		--	City of Portland
4/10/2017	1.58		--	City of Portland
7/2/2018	1.9		--	Boeing Company

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Table A.1. Trichloroethene (TCE) Concentrations at PWB-1 (lts)

Collection Date	TCE*, µg/L	Detection Limit	Data Source
8/24/2018	2.04	--	Boeing Company
9/20/2018	1.59	--	Boeing Company
11/1/2018	2.02	--	City of Portland
11/1/2018	1.82	--	Boeing Company
2/6/2019	1.39	--	Boeing Company
3/15/2019	1.67	--	City of Portland
8/6/2019	1.42	--	Boeing Company
9/5/2019	1.91	--	City of Portland
9/17/2019	1.45	--	Boeing Company
11/18/2020	1.35	--	City of Portland

Notes:

* the MCL for TCE is 5 µg/L

-- = not reported

A = assumed non-detect

J = estimated

U = not detected above the reported detection limit

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Table A.2. Trichloroethene (TCE) Concentrations at PWB-1 (uts)

Collection Date	TCE, µg/L		Detection Limit	Data Source
8/20/1992	29		--	Boeing
8/27/1992	36		--	Boeing
9/3/1992	31		--	Boeing
9/10/1992	40		--	Boeing
9/10/1992	43		--	Boeing
9/17/1992	36		--	Boeing
9/23/1992	47		--	Boeing
10/1/1992	49		--	Boeing
10/1/1992	55		--	Boeing
11/15/1992	42.3		--	Boeing
5/11/1993	49		--	Boeing
5/11/1993	55		--	Boeing
12/1/1993	56		--	Boeing
3/4/1994	49		--	Boeing
7/28/1994	49		--	Boeing
8/19/1997	48		--	Boeing
2/16/1998	11		--	Boeing
8/14/1998	38		--	Boeing
2/10/1999	14		--	Boeing
8/16/1999	14		--	Boeing
2/10/2000	4.8		--	Boeing
8/17/2000	1.8		--	Boeing
2/16/2001	2		--	Boeing
8/22/2001	1.6		--	Boeing
10/3/2001	1.5		0.5	City of Portland
3/13/2002	2.2		--	Boeing
8/12/2002	2.1		--	Boeing
9/24/2002	2.8		0.6	City of Portland
2/13/2003	2		--	Boeing
8/19/2003	1.4		--	Boeing
12/16/2003	1.1		0.5	City of Portland
2/11/2004	0.63		--	Boeing
8/19/2004	0.5	U	0.5	Boeing
1/11/2005	0.5	A	0.5	City of Portland
2/14/2005	0.5	U	0.5	Boeing
8/7/2005	0.5	U	0.5	Boeing
2/9/2006	0.5	U	0.5	Boeing
8/9/2006	0.5	U	0.5	Boeing
2/5/2007	0.5	A	0.5	City of Portland
8/8/2007	0.5	U	0.5	Boeing
8/11/2008	0.5	U	0.5	Boeing
9/29/2008	0.5	A	0.5	City of Portland
7/16/2009	0.5	A	0.5	City of Portland
8/13/2009	0.5	U	0.5	Boeing

Table A.2. Trichloroethene (TCE) Concentrations at PWB-1 (uts)

Collection Date	TCE, µg/L		Detection Limit	Data Source
6/23/2010	0.5	A	0.5	City of Portland
8/10/2010	0.5	U	0.5	Boeing
8/10/2011	0.5	U	0.5	Boeing
8/20/2013	1	U	1	Boeing
12/10/2013	0.5	A	0.5	City of Portland
9/19/2014	0.5	A	0.5	City of Portland
1/23/2015	0.5	A	0.5	City of Portland
8/5/2015	1	U	1	Boeing
3/9/2017	0.5	A	0.5	City of Portland
3/28/2018	0.51		0.5	City of Portland
9/20/2018	0.5	U	0.5	Boeing
11/2/2018	0.5	U	0.5	Boeing
12/6/2018	0.65		0.5	City of Portland
8/6/2019	0.5	U	0.5	Boeing
9/17/2019	0.73		0.5	City of Portland
9/17/2019	0.703		--	Boeing
9/30/2020	1.21		--	City of Portland

Notes:

-- = not reported

< = not detected above the reported value

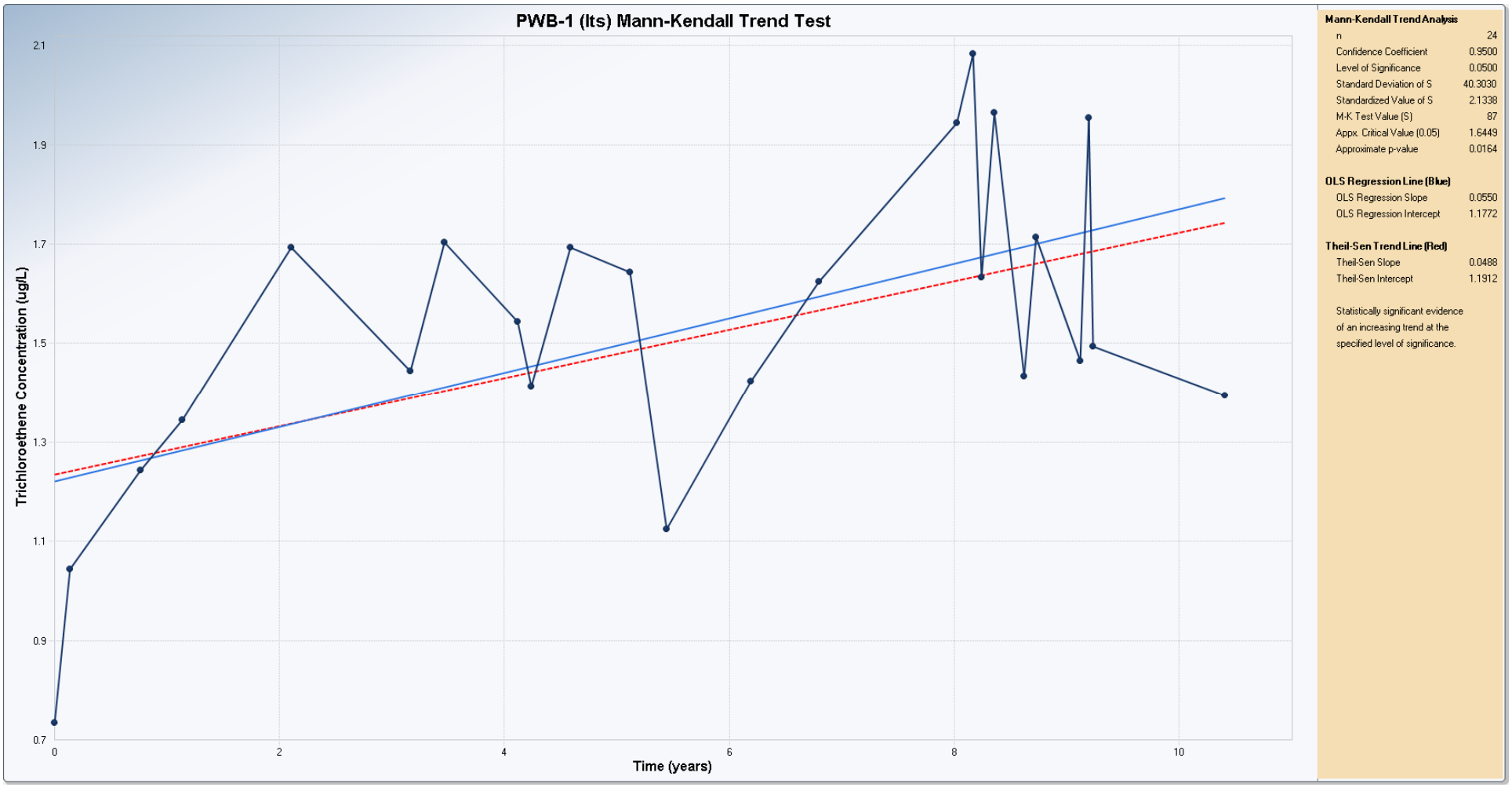
J = estimated

TCE = Trichloroethene

* the MCL for TCE is 5 µg/L

ATTACHMENT B

Mann-Kendall Statistical Analysis and Ordinary Least Squares Regression Analysis


PWB-1 (lts) Mann-Kendall Trend Test
Trichloroethene Concentration (ug/L)
Time (years)
2.1
1.9
1.7
1.5
1.3
1.1
0.9
0.7
0
2
4
6
8
10
Mann-Kendall Trend Analysis
n 24
Confidence Coefficient 0.9500
Level of Significance 0.0500
Standard Deviation of S 40.3030
Standardized Value of S 2.1338
M-K Test Value (S) 87
Appx. Critical Value (0.05) 1.6449
Approximate p-value 0.0164
OLS Regression Line (Blue)
OLS Regression Slope 0.0550
OLS Regression Intercept 1.1772
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0488
Theil-Sen Intercept 1.1912
Statistically significant evidence of an increasing trend at the specified level of significance.