Windrush Creek CSI Project Report

Windrush Creek
St. Louis County, Missouri

April 2022 – March 2023

Prepared for:

Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program
Water Pollution Control Branch

Prepared by:

Missouri Department of Natural Resources
Division of Environmental Quality
Environmental Services Program
Water Quality Monitoring Section

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1.0 Introduction

Throughout the years 2022 and 2023, Randy Sarver of the Missouri Department of Natural Resources (**Department**), Environmental Services Program (**ESP**), Water Quality Monitoring Section (**WQMS**), coordinated a Cooperative Stream Investigation (**CSI**) project. The CSI Project was completed to assist the Department'**s** Water Protection Program (**WPP**) and the Missouri Botanical Garden, Deer Creek Watershed Alliance in collecting total nitrogen, total phosphorus, *E. coli*, total suspended solids, chloride, and discharge data from Windrush Creek, St. Louis County, Missouri.

2.0 Study Area

The Windrush Creek CSI Project was focused in the upper part of the Deer Creek watershed along a 0.7 mile Class C segment of a tributary locally known as Windrush Creek. Windrush Creek has been assigned the general purpose temporary Water Body Identification (**WBID**) number of 3960. The segment of Deer Creek that receives flow from Windrush Creek is assigned the permanent WBID 4078. Since Windrush Creek does not have a permanent WBID, the Deer Creek WBID 4078 is used to assign unique site locations for Windrush Creek.

Designated recreational uses for Windrush Creek are listed as Whole Body Contact – Category B (**WBC-B**) and Secondary Contact Recreation (**SCR**). The Missouri Water Quality Standard (**WQS**) *E. coli* criterion for WBC-B is 206 count/100 mL; and the SCR criterion is 1134 count/100 mL MPN. The WBC-B *E. coli* criterion is based on a geomean of at least five samples collected during the recreational season (April 1 – October 31). Windrush Creek is also designated for Protection of Aquatic Life.

2.1 Site Descriptions

Sampling was conducted at three locations on Windrush Creek. See Figure 1 for a map of site locations.

Site 4078/5.3/0.1 is located on Windrush Creek, immediately upstream from Villa Coublay Drive. Geographic Information System (**GIS**) derived Zone 15 UTM coordinates are: 724329 Easting and 4280897 Northing with 5 meter accuracy.

Site 4078/5.3/0.4 is located on Windrush Creek, immediately upstream from North Graeser Road. GIS derived Zone 15 UTM coordinates are: 724240 Easting and 4281292 Northing with 5 meter accuracy.

Site 4078/5.3/0.8 is located on Windrush Creek, immediately upstream from Ladue Road. GIS derived Zone 15 UTM coordinates are: 724133 Easting and 4281685 Northing with 5 meter accuracy.

3.0 Methods

3.1 Sample Collection

Ms. Stacy Arnold and Mr. Steve McCarthy carried out all sample collection and stream discharge measurements as detailed in the Windrush Creek CSI Project Plan that was finalized in January 2022 (a copy of the project plan is available from the author of this report upon request). Ms. Arnold is a Stream Team, Level 3, Volunteer Water Quality Monitoring (**VWQM**) Program volunteer, a member of Stream Teams 2926 and 4149, serves on the Board of Stream Teams United, and works as the Rainscaping and Deer Creek Watershed Initiative Coordinator for the Missouri Botanical Garden. Mr. McCarthy is a Stream Team, Level 3, VWQM volunteer with Stream Team 5099.

All samples were collected in accordance with the Department's Standard Operating Procedures (**SOP**) MDNR-ESP-001 (Required/Recommended Containers, Volume, Preservatives, Holding Times, and Special Sampling Considerations) and SOP MDNR-ESP-005, (General Sampling Considerations Including the Collection of Grab, Composite, and Modified Composite Samples from Stream and Wastewater Flows).

3.2 Chain-of-Custody

In accordance with Department's SOP MDNR-ESP-002 (Field Sheet and Chain-of-Custody Record) all samples received a numbered label and were placed on ice in a cooler. The corresponding label number was entered onto a chain-of-custody form indicating the date, time and location of collection, discharge measurements, and parameter to be analyzed. The VWQM sample collector maintained sample custody until total nitrogen, total phosphorus, total suspended solids, and chloride samples were delivered to the Missouri Department of Health courier shipping location, or until *E. coli* samples were delivered to Ms. Elisa Edge at the Department's Route 66 State Park satellite office.

3.3 Discharge Measurements

When possible, stream discharge was measured at all locations using a Hach FH950 portable flow meter. Measurements were taken across the most practicable section of stream at each sampling station. Discharge measurements followed Department SOP MDNR-ESP-113 (Flow Measurements in Open Channels). Results are reported as cubic feet per second (**cfs**).

3.4 Sample Analyses

Water samples collected for *E. coli* were analyzed by Ms. Elisa Edge, an Environmental Analyst with ESP. Bacterial sample analysis followed Department SOP MDNR-ESP-109 (Analysis of *E. coli* and Total Coliforms Using IDEXX Colilert and Quanti-Tray Test Method, based on United States Environmental Protection Agency methods). Because the IDEXX Colilert method was used for analysis, the results were labeled as Most Probable Number (**MPN**) per 100 mL.

Figure 1 - Windrush Creek CSI Project Sampling Locations

Water samples collected for Total Nitrogen were analyzed by the ESP, Chemical Analyses Section (**CAS**) using the analytical method: USGS I-4650-03 - Modified by ESP.

Water samples collected for Total Phosphorus were analyzed by the ESP, CAS using the analytical method: NCASI TNTP-W10900 - Modified by ESP.

Water samples collected for Total Suspended Solids (TSS) were analyzed by the ESP, CAS using the analytical method: 2540, part D; Standard Methods for the Examination of Water and Wastewater, 23rd Edition, 2017.

Water samples collected for Chloride were analyzed by the ESP, CAS using the standard analytical method: L 10-117-07-1-A Mercuric Thiocyanate Flow Injection Analysis.

3.5 Quality Assurance/Quality Control (QA/QC)

3.5.1 QA/QC Methods

Sample collections, discharge measurements, and sample analyses were conducted in accordance with the applicable MDNR SOPs.

3.5.2 QA/QC Results

The project plan included QA objectives of conducting one field audit during the project and QC objectives of collecting and analyzing duplicates for at least 10% of all samples, plus analyzing negative controls for each set of *E. coli* samples.

The field audit was conducted on September 7, 2022. The results of the field audit were satisfactory. A copy is available from the report author upon request.

Field duplicate samples were collected for 30% (7 duplicates of 21 samples) of the *E. coli* samples (see Appendix A). A precision criterion for duplicates was calculated based on the formula in Standard Method for Examination of Water and Wasterwater (22nd Edition), Microbial Examination, QA/QC, Section 9.0 (e). The criterion value for a fiscal year is based on 15 samples collected by ESP, WQMS personel. After each set of samples was analyzed, a |R| value was calculated for each pair of duplicate sample results for comparison to the criterion. The value |R| is an absolute value calculated by subtracting the *logrithm* of each duplicate sample from the *logrithm* of the original sample. No *E. coli* duplicate sample |R| values exceeded the calculated criterion (FY 2022 = 0.2575; FY 2023 = 0.4197) (also see Appendix A).

All *E. coli* negative controls achieved results of <1.0 MPN/100 mL (also see Appendix A).

Field duplicate samples were collected for 33% (12 of 36 samples) of Total Nitrogen and Total Phosphorus samples (see Appendix C for Total Nitrogen and Appendix E for Total Phosphorus results). Total Nitrogen did not exceed the 20% relative difference criterion, but Total

Phosphorus exceeded the 20% relative difference criterion on three occasions. Audits for all exceedances were performed and attributed to natural variability and the ease of exceeding 20% relative difference between duplicates when concentrations are very low; no QC issues were discovered.

Field duplicate samples were collected for 33% (12 of 36 samples) of TSS samples (see Appendix G). One (1) duplicate sample for TSS exceeded the 20% relative difference criterion. An audit for the exceedance was performed and attributed to natural variability; no QC issues were discovered.

Field duplicate samples were collected for 33% (7 of 21 samples) of the chloride samples (see Appendix I). No duplicate samples for chloride exceeded the 20% relative difference criterion.

4.0 Data Results

Please refer to Appendix A for *E. coli* results, Appendix C for Total Nitrogen results, Appendix E for Total Phosphorus results, Appendix G for TSS results, Appendix I for chloride results, and Appendix K for discharge calculations.

5.0 Data Analysis

The major objectives of the Windrush Creek CSI Project were to provide monitoring and baseline data in support of the Missouri Botanical Garden, Deer Creek Watershed Alliance project to install vegetative best management practices; and to develop source tracking information for all monitored water quality parameters.

Standard analysis for *E. coli* data is the calculation of the geometric mean (**geomean**) of samples taken from a WBID, with a minimum of five samples taken during the recreational season within a single year (see below and Appendix A). Additional data analysis of maximum and minimum *E. coli* values were performed to help visualize the variability of *E. coli* loading to the stream (see Appendix A and B).

The *E. coli* geomean of samples collected during this project were as follows:

- Site 4078/5.3/0.1 = 1189.3 MPN/100 mL (n=7)
- Site 4078/5.3/0.4 = 832.0 MPN/100 mL (n=7)
- Site 4078/5.3/0.8 = 2053.0 MPN/100 mL (n=7)

Discharge data (see Appendix K) was also collected from all sampling stations during sampling events to assist in estimating load calculations for Windrush Creek.

Averages were also calculated for total nitrogen, total phosphorus, TSS, and chloride results from each station (see Appendix C for Total Nitrogen results; Appendix E for Total Phosphorus results; Appendix G for TSS results, and Appendix I for chloride results).

6.0 Discussion

The 2022 recreational season *E. coli* geomean results for all Windrush Creek sampling locations exceeded the WBC-B *E. coli* criterion (206 MPN/100 mL). When individual Windrush Creek sampling station concentrations are compared, the most upstream location (4078/5.3/0.8) at Ladue Road had the highest geomean and minimum values.

The results of Total Nitrogen sampling indicates that the highest concentrations came from the most upstream location (4078/5.3/0.8) at Ladue Road. The lowest Total Nitrogen came from the most downstream location (4078/5.3/0.1) at Villa Coublay Drive.

The results of Total Phosphorus sampling indicates that all locations had similar concentrations (range of average concentrations = 0.13 - 0.14 mg/L)

The results of TSS sampling indicate similar average results among all locations, but the most upstream location at Ladue Road (4078/5.3/0.8) had the highest maximum concentration (32.0 mg/L).

The acute toxicity WQS criterion for chloride (860 mg/L) was exceeded on January 25, 2023, at the Graeser Road location (4078/5.3/0.4). The chronic toxicity WQS criterion for chloride (230 mg/L) was potentially exceeded on January 25, 2023, at the Ladue Road (4078/5.3/0.8) and Villa Coublay Drive (4078/5.3/0.1) locations.

In summary, the project results indicate that the Ladue Road (4078/5.3/0.8) sampling location identifies that the most upstream part of the watershed is the origin of the highest concentrations of non-point source pollutants such as *E. coli*, Total Nitrogen, and TSS.

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Dorothy Franklin, Saint Louis Regional Office

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Appendix A – Windrush Creek *E. coli* Data

Sampling Date	Site 4078/5.3/0.1 *E. coli* Results (MPN/100 mL)	Site 4078/5.3/0.4 *E. coli* Results (MPN/100 mL)	Site 4078/5.3/0.8 *E. coli* Results (MPN/100 mL)	Duplicate Sample Result	Duplicate Sample Site	*Duplicate Average	Negative Control Results	|R| for Duplicate Samples
4/6/2022	**>2419.6**	>2419.6	>2419.6	**>2419.6**	4078/5.3/0.1	>2419.6	<1.0	0.00
5/4/2022	2419.6	**920.8**	>2419.6	**648.8**	4078/5.3/0.4	784.8	<1.0	0.15
6/15/2022	**148.3**	260.3	1732.9	**209.8**	4078/5.3/0.1	179.1	<1.0	0.15
7/20/2022	613.1	**228.2**	1553.1	**198.9**	4078/5.3/0.4	213.6	<1.0	0.06
8/18/2022	1732.9	1413.6	**2419.6**	**1986.3**	4078/5.3/0.8	2203.0	<1.0	0.09
9/7/2022	**2419.6**	866.4	1553.1	**>2419.6**	4078/5.3/0.1	>2419.6	<1.0	0.00
10/12/2022	>2419.6	**>2419.6**	>2419.6	**>2419.6**	4078/5.3/0.4	>2419.6	<1.0	0.00
Maximum	2419.6	2419.6	2419.6					
Minimum	148.3	198.9	1553.1					
Geomean	1189.3	832.0	2053.0					
n	7	7	7					

Bold = duplicate sample values
>2419.6 values treated as = 2419.6 for calculation
*Duplicate Average used to calculate geomean

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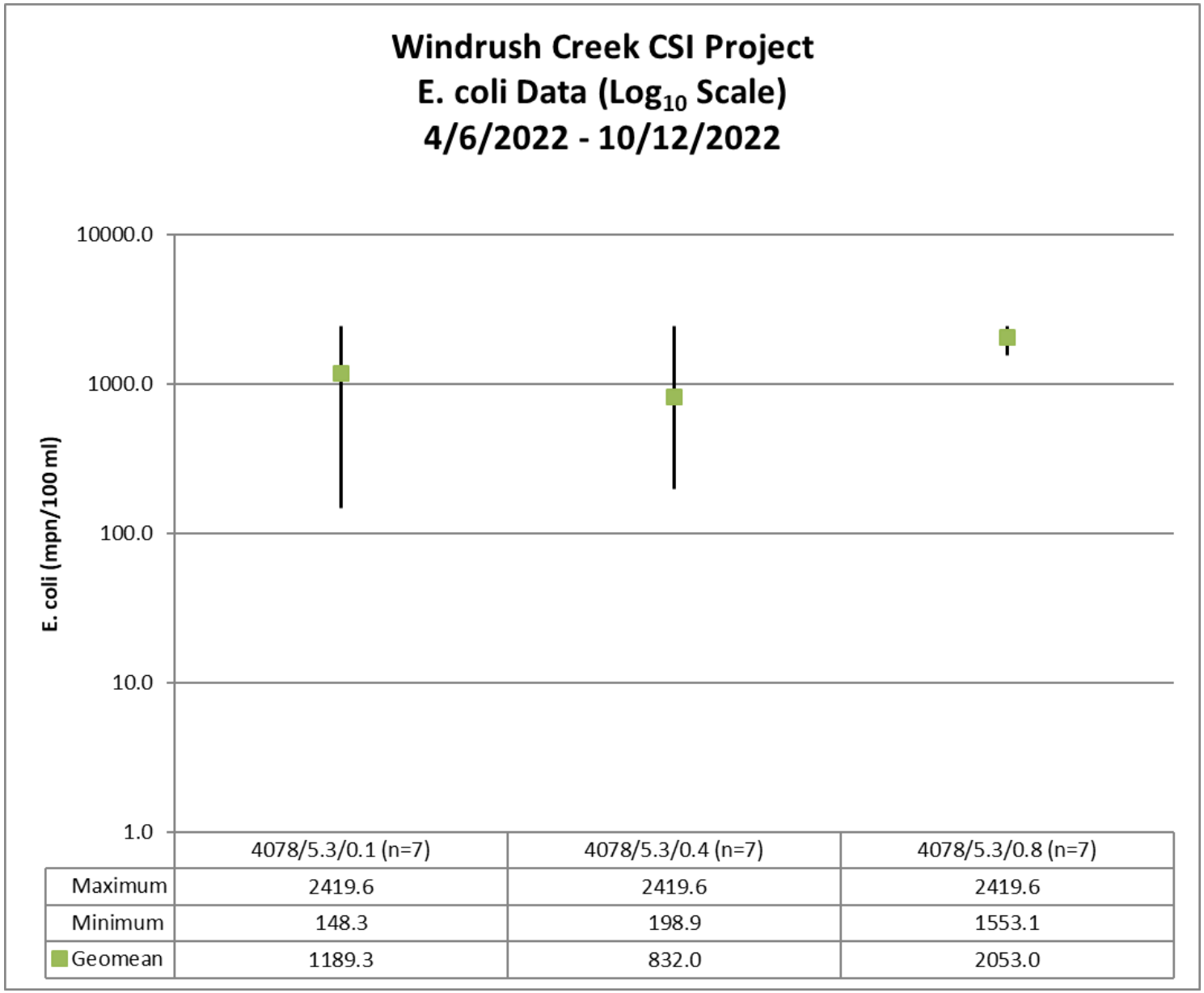
Appendix B – Windrush Creek Graph of *E. coli* Data



	4078/5.3/0.1 (n=7)	4078/5.3/0.4 (n=7)	4078/5.3/0.8 (n=7)
Maximum	2419.6	2419.6	2419.6
Minimum	148.3	198.9	1553.1
Geomean	1189.3	832.0	2053.0

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Appendix C – Windrush Creek Total Nitrogen Data

Sampling Date	Site 4078/5.3/0.1 Total Nitrogen Results (mg/L)	Site 4078/5.3/0.4 Total Nitrogen Results (mg/L)	Site 4078/5.3/0.8 Total Nitrogen Results (mg/L)	Duplicate Value	*Duplicate Average	Duplicate Site	Duplicate RPD
4/6/2022	**1.29**	1.42	1.37	**1.32**	1.31	4078/5.3/0.1	2.3
5/4/2022	1.07	**0.90**	0.82	**0.90**	0.90	4078/5.3/0.4	0.0
6/15/2022	**0.81**	1.14	2.23	**0.84**	0.83	4078/5.3/0.1	3.6
7/20/2022	0.79	**0.86**	1.10	**0.84**	0.85	4078/5.3/0.4	2.4
8/18/2022	0.28	0.84	**0.82**	**0.82**	0.82	4078/5.3/0.8	0.0
9/7/2022	**0.88**	0.78	1.89	**0.87**	0.88	4078/5.3/0.1	1.1
10/12/2022	1.34	**1.97**	1.08	**2.11**	2.04	4078/5.3/0.4	6.9
11/2/2022	1.18	1.12	**0.90**	**0.88**	0.89	4078/5.3/0.8	2.2
12/14/2022	**1.52**	1.45	1.38	**1.55**	1.54	4078/5.3/0.1	2.0
1/4/2023	1.10	**1.03**	0.89	**0.89**	0.96	4078/5.3/0.4	14.60
2/23/2023	1.50	1.06	**0.83**	**0.82**	0.83	4078/5.3/0.8	1.20
3/8/2023	**0.65**	0.98	1.60	**0.62**	0.64	4078/5.3/0.1	4.72
Maximum	1.55	2.11	2.23				
Minimum	0.28	0.78	0.82				
Overall Average	1.04	1.14	1.16				
n	12	12	12				

Bold = duplicate sample values

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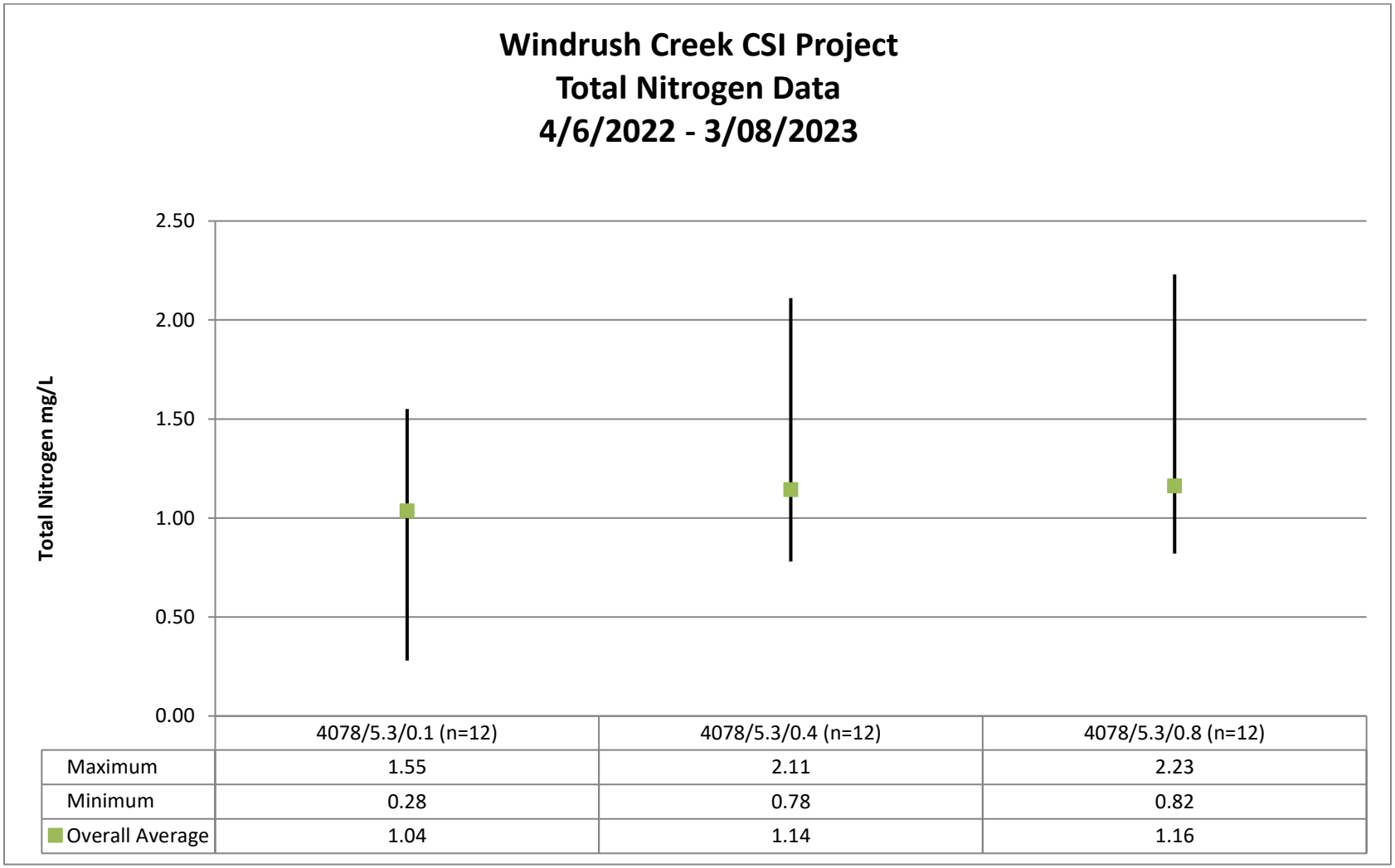
Appendix D – Windrush Creek Graph of Total Nitrogen Data



	4078/5.3/0.1 (n=12)	4078/5.3/0.4 (n=12)	4078/5.3/0.8 (n=12)
Maximum	1.55	2.11	2.23
Minimum	0.28	0.78	0.82
Overall Average	1.04	1.14	1.16

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Appendix E – Windrush Creek Total Phosphorus Data

Sampling Date	Site 4078/5.3/0.1 Total Phosphorus Results (mg/L)	Site 4078/5.3/0.4 Total Phosphorus Results (mg/L)	Site 4078/5.3/0.8 Total Phosphorus Results (mg/L)	Duplicate Value	*Duplicate Average	Duplicate Site	Duplicate RPD
4/6/2022	**0.14**	0.16	0.20	**0.08**	0.11	4078/5.3/0.1	54.5*
5/4/2022	0.09	**0.08**	0.07	**0.08**	0.08	4078/5.3/0.4	0.0
6/15/2022	**0.16**	0.21	0.11	**0.19**	0.18	4078/5.3/0.1	17.1
7/20/2022	0.14	**0.16**	0.14	**0.16**	0.16	4078/5.3/0.4	0.0
8/18/2022	0.06	0.11	**0.11**	**0.11**	0.11	4078/5.3/0.8	0.0
9/7/2022	**0.13**	0.09	0.20	**0.06**	0.10	4078/5.3/0.1	73.7*
10/12/2022	0.18	**0.21**	0.24	**0.25**	0.23	4078/5.3/0.4	17.4
11/2/2022	0.15	0.14	**0.12**	**0.12**	0.12	4078/5.3/0.8	0.0
12/14/2022	**0.26**	0.22	0.23	**0.27**	0.27	4078/5.3/0.1	3.8
1/4/2023	0.16	**0.14**	0.13	**0.10**	0.12	4078/5.3/0.4	33.30*
2/23/2023	0.14	0.09	**0.07**	**0.08**	0.08	4078/5.3/0.8	13.30
3/8/2023	**0.09**	0.08	0.09	**0.08**	0.09	4078/5.3/0.1	11.80
Maximum	0.27	0.25	0.24				
Minimum	0.06	0.08	0.07				
Overall Average	0.14	0.14	0.13				
n	12	12	12				

Bold = duplicate sample values
*Duplicate exceeds 20% RPD

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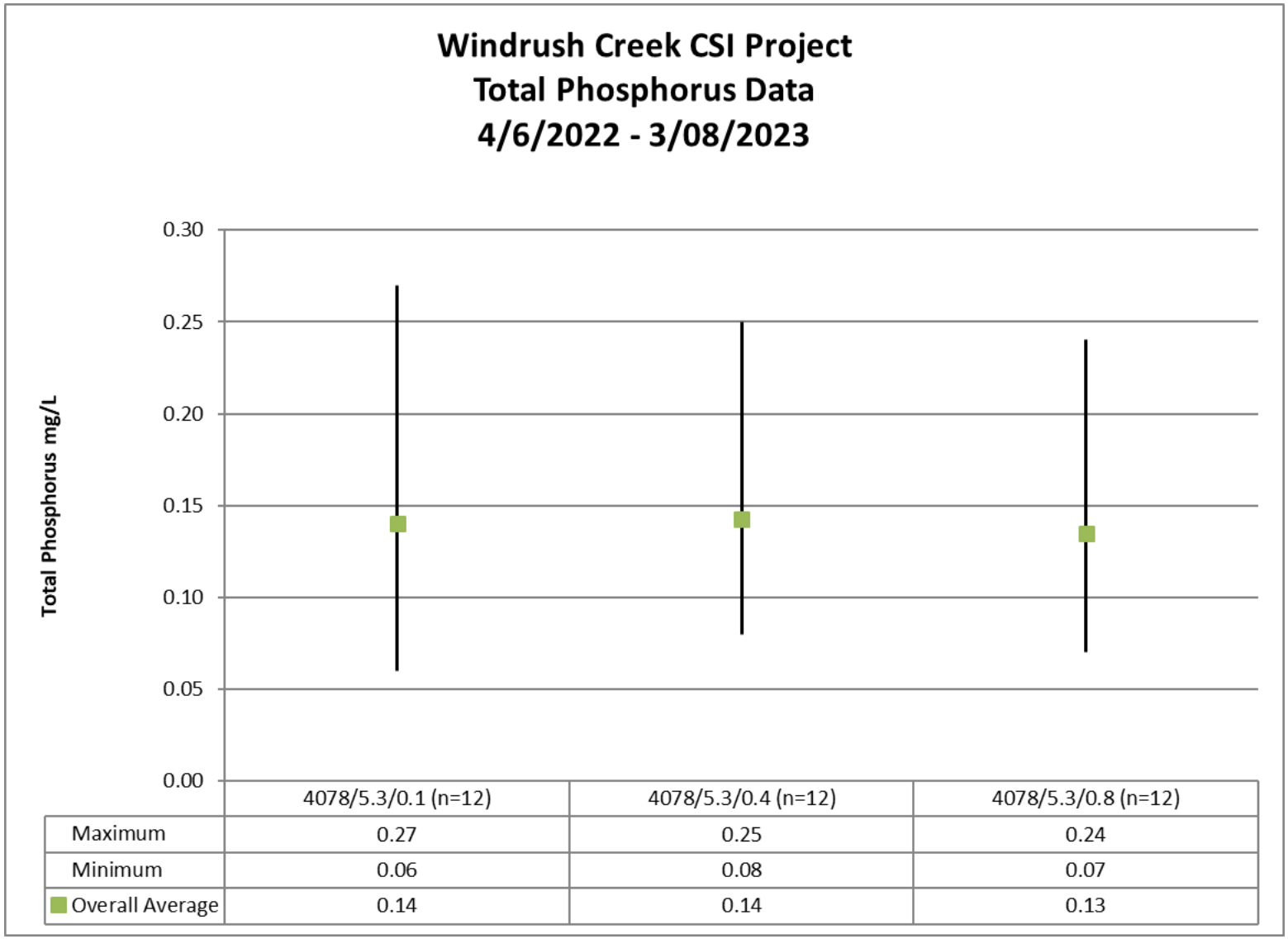
Appendix F – Windrush Creek Graph of Total Phosphorus Data



	4078/5.3/0.1 (n=12)	4078/5.3/0.4 (n=12)	4078/5.3/0.8 (n=12)
Maximum	0.27	0.25	0.24
Minimum	0.06	0.08	0.07
Overall Average	0.14	0.14	0.13

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Appendix G – Windrush Creek Total Suspended Solids Data

Sampling Date	Site 4078/5.3/0.1 TSS Results (mg/L)	Site 4078/5.3/0.4 TSS Results (mg/L)	Site 4078/5.3/0.8 TSS Results (mg/L)	Duplicate Value	*Duplicate Average	Duplicate Site	Duplicate RPD
4/6/2022	**19.0**	18.0	12.0	**17.0**	18.0	4078/5.3/0.1	11.1
5/4/2022	6.0	**<5.0**	<5.0	**<5.0**	<5.0	4078/5.3/0.4	0.0
6/15/2022	**<5.0**	21.0	<5.0	**<5.0**	<5.0	4078/5.3/0.1	0.0
7/20/2022	<5.0	**9.0**	21.0	**7.0**	8.0	4078/5.3/0.4	25.0*
8/18/2022	6.0	10.0	**<5.0**	**<5.0**	<5.0	4078/5.3/0.8	0.0
9/7/2022	**<5.0**	<5.0	32.0	**<5.0**	<5.0	4078/5.3/0.1	0.0
10/12/2022	<5.0	**<5.0**	<5.0	**<5.0**	<5.0	4078/5.3/0.4	0.0
11/2/2022	<5.0	<5.0	**<5.0**	**<5.0**	<5.0	4078/5.3/0.8	0.0
12/14/2022	**11.0**	9.0	14.0	**10.0**	10.5	4078/5.3/0.1	9.5
1/4/2023	7.0	**<5.0**	<5.0	**6.0**	<5.0	4078/5.3/0.4	0.0
2/23/2023	8.0	6.0	**<5.0**	**<5.0**	<5.0	4078/5.3/0.8	0.0
3/8/2023	**<5.0**	<5.0	7.0	**11.0**	8.0	4078/5.3/0.1	0.0
Maximum	19.0	21.0	32.0				
Minimum	5.0	5.0	5.0				
Overall Average	7.9	7.9	9.1				
n	12	12	12				

Bold = duplicate sample values; values of 5.0 used to calculate overall average when duplicates <5.0
*Duplicate exceeds 20% RPD

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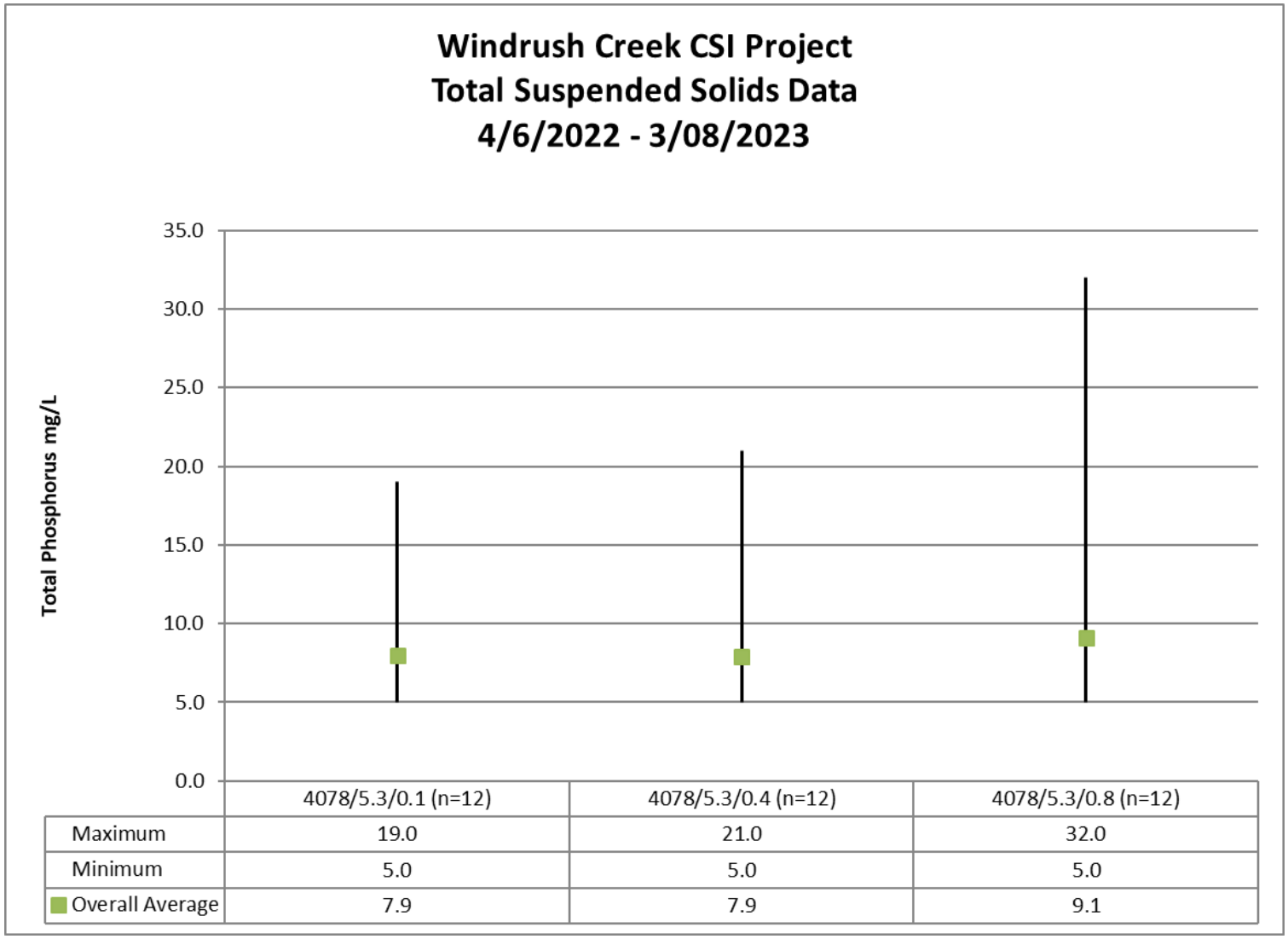
Appendix H – Windrush Creek Graph of Total Suspended Solids Data



	4078/5.3/0.1 (n=12)	4078/5.3/0.4 (n=12)	4078/5.3/0.8 (n=12)
Maximum	19.0	21.0	32.0
Minimum	5.0	5.0	5.0
Overall Average	7.9	7.9	9.1

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Appendix I – Windrush Creek Chloride Data

Sampling Date	Site 4078/5.3/0.1 Chloride Results (mg/L)	Site 4078/5.3/0.4 Chloride Results (mg/L)	Site 4078/5.3/0.8 Chloride Results (mg/L)	Duplicate Value	*Duplicate Average	Duplicate Site	Duplicate RPD
10/12/2022	133.0	210.0	26.8	212.0	211.0	4078/5.3/0.4	0.9
11/2/2022	90.3	219.0	109.0	109.0	109.0	4078/5.3/0.8	0.0
12/14/2022	39.0	44.8	48.9	38.9	39.0	4078/5.3/0.1	0.3
1/4/2023	163.0	187.0	193.0	188.0	187.5	4078/5.3/0.4	0.5
1/25/2023	690.0	971.0	494.0	975.0	734.5	4078/5.3/0.4	0.4
2/23/2023	86.2	146.0	148.0	147.0	146.5	4078/5.3/0.8	0.7
3/8/2023	134.0	91.7	227.0	135.0	134.5	4078/5.3/0.1	0.7
Maximum	690.0	975.0	494.0				
Minimum	38.9	44.8	26.8				
Overall Average	167.7	324.5	167.0				
n	7	7	7				

Bold = duplicate sample values

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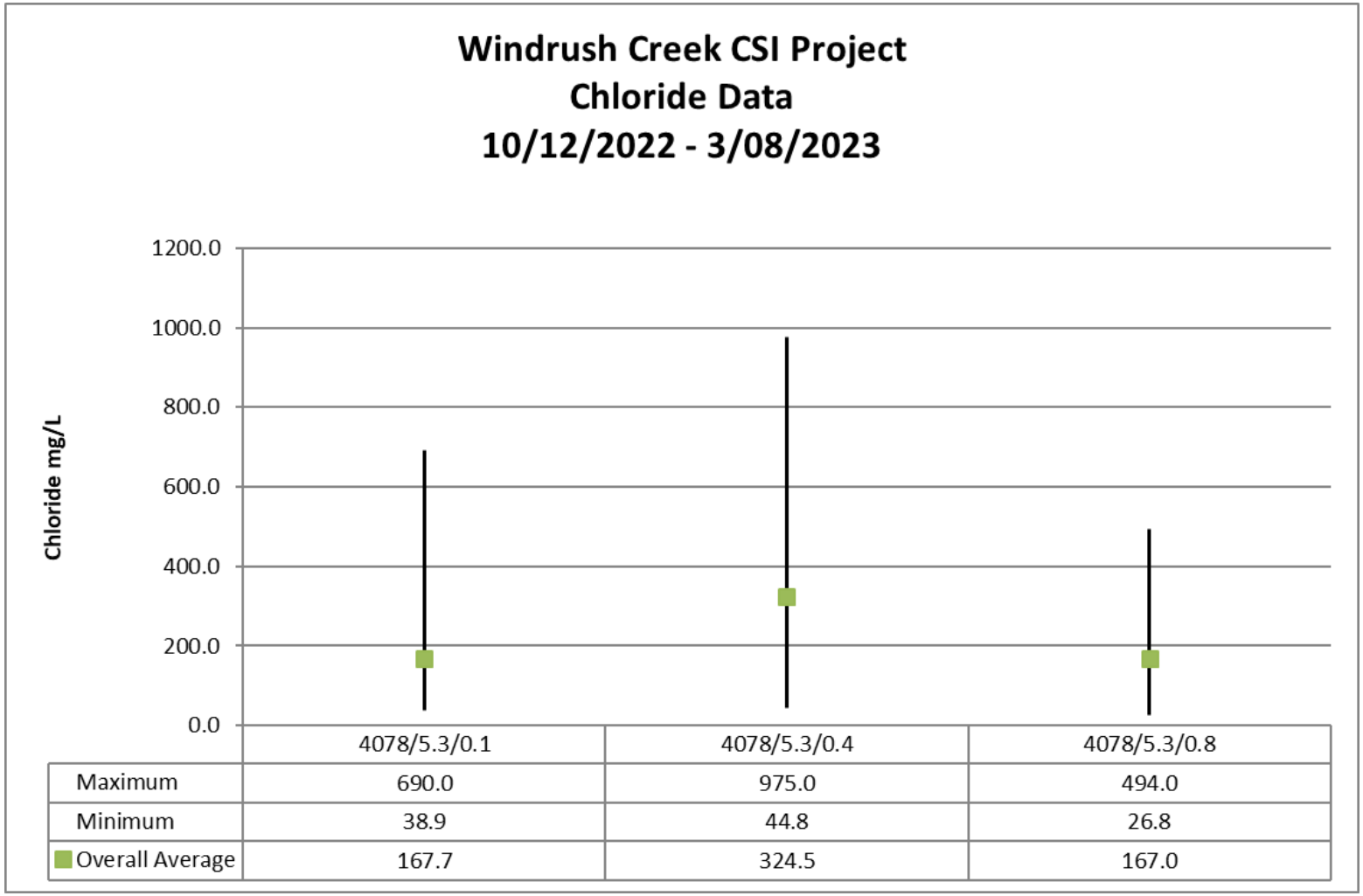
Appendix J – Windrush Creek Graph of Chloride Data



	4078/5.3/0.1	4078/5.3/0.4	4078/5.3/0.8
Maximum	690.0	975.0	494.0
Minimum	38.9	44.8	26.8
Overall Average	167.7	324.5	167.0

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Appendix K – Windrush Creek Discharge Data

Sampling Date	Site 4078/5.3/0.1 Discharge Results (cfs)	Site 4078/5.3/0.4 Discharge Results (cfs)	Site 4078/5.3/0.8 Discharge Results (cfs)
4/6/2022	2.56	1.35	0.83
5/4/2022	0.21	0.19	0.18
6/15/2022	0.06	0.05	0.09
7/20/2022	0.04	0.02	0.05
8/18/2022	0.09	0.07	0.06
9/7/2022	0.28	0.16	0.27
10/12/2022	1.12	0.33	0.20
11/2/2022	0.09	0.10	0.12
12/14/2022	2.34	1.48	1.03
1/4/2023	0.31	0.30	0.15
2/23/2023	0.36	0.25	0.18
3/8/2023	1.93	1.61	0.66
4/6/2022	2.56	1.35	0.83