Braddock Bay Restoration

2015 Water Quality Monitoring

US Army Corps of Engineers®
Buffalo District
BUILDING STRONG®

Great Lakes RESTORATION

Buffalo District
U.S. Army Corps of Engineers
1/6/2016

Abstract

In summer of 2015, water quality sampling was conducted at Braddock Bay for the purpose of providing a baseline to which future water quality monitoring results could be compared in support of adaptive management decision making. Water samples were analyzed for total phosphorus (TP), orthophosphate, total Kjeldahl nitrogen (TKN), nitrate-nitrite (NO2-NO3), ammonia (NH3), chlorophyll α, and total suspended solids (TSS). Concentrations of chlorophyll α and TP regularly exceeded pre-established target and action ecologic performance criteria (USACE 2015) during sampling events in the summer of 2015. The 2015 baseline sampling suggests that the current action and target criteria associated with chlorophyll α and TP may not be appropriate for determining if the trophic state of Braddock Bay is impacted by proposed restoration measures.

It is recommended that the adaptive management plan for Braddock Bay be adjusted as follows:

- The action criteria established for chlorophyll α of 30 ug/L should be increased to 55 ug/L to more accurately represent a threshold between the current condition and a more eutrophic condition.

- Rather than relying solely on exceedance of ecologic performance criteria, determinations of the necessity of adaptive management actions related to water quality should be based on an analysis of the year to year trends in TP and chlorophyll α data while also considering changes in the aquatic vegetation community.

- Yearly water quality sampling events should be increased from 4 to 6 events spread over the 4 month sampling period. In addition, priority should be given to avoiding storm influenced flows, rather than sampling on a pre-determined date.

1.0 Purpose and Background

This document presents the results of baseline water quality monitoring at Braddock Bay (the Bay) during the 2015 summer season. The purpose of this water quality monitoring effort was to provide a baseline to which future water quality monitoring results can be compared for the purpose of supporting adaptive management decisions.

As described in the Braddock Bay Restoration: Monitoring and Adaptive Management (Adaptive Management Plan; USACE, 2015), post-restoration monitoring data is to be compared to pre-determined ecologic performance criteria to assess the status of the resource and determine if adaptive management actions are required. Pre-determined performance criteria have been specified for all adaptive management components (USACE, 2015). The criteria for water quality were determined based off of available historic data.

2.0 Methods

In 2015, water quality sampling was conducted once a month for 4 months (June – September). During each sampling event, samples were collected from 8 sample locations within Braddock Bay, its tributaries, and the Lake Ontario littoral zone (Figure 1). Samples from within Braddock Bay (Bay Samples) were collected as composites of four subsamples from a 500 X 500 foot square sampling area centered on the sample point, and equally divided into four 250 ft^2 quadrats along cardinal directions; samples from the tributaries and Lake Ontario were single point samples.

Water samples were collected from 1 – 1.5 feet below the water surface, stored on ice, and immediately shipped to a lab for analysis of total phosphorus (TP), orthophosphate, total Kjeldahl nitrogen (TKN), nitrate-nitrite (NO_2-NO_3), ammonia (NH_3), chlorophyll α, and total suspended solids (TSS). All lab analyses were conducted by RTI Laboratories except for orthophosphate analysis which was conducted by ALS Environmental and chlorophyll α which was conducted by BSA Environmental Services, Inc. A Horiba multi-parameter water quality meter was used to measure temperature (F), pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), conductivity, and turbidity. Secchi disk depth was also measured in the field (Table 1).

Table 1. Water Chemistry Analysis

Water Chemistry	
Description	*Method*
Nitrogen - Total Kjeldahl - Liquid	EPA_351.2
Nitrogen - Ammonia - Liquid	SM_4500-NH3-D
Nitrogen – Nitrate/Nitrite - Liquid	SM_4500-NO3-H
Phosphorus, Total - Liquid	SM_4500-P-F
Phosphorus, Dissolved (Ortho)	365.1
Suspended Solids (TSS) - Liquid	SM_2540D
Chlorophyll a	APHA (2012) Method 10200H.2 (Spectrophotometric)
Temperature, pH, DO, ORP, Conductivity, Turbidity, Secchi Disk	Insitu-Horiba

In order to capture the seasonal summer trend in water quality at Braddock Bay during base flow, efforts were made to collect samples around the 15th of every month while also allowing for a period of stability of 3 days after storm events. In 2015, Braddock Bay was sampled on June 12th, July 16th, August 14th, and September 23rd. The June sample occurred several days after a large series of storms, and water quality conditions were likely influenced by these events. A small event was also recorded two days before the August sampling and may have influenced water quality conditions. The July and September sampling most likely represent base flow conditions as no storms occurred 2 weeks prior to the sampling. In the future, it is recommended

that more priority be given to avoiding stormflows than to trying to sample around a pre-determined date.

The Bay was divided up into 5 segments for sampling purposes. Sample SG2 corresponds to segment 2, SG3 to segment 3; and so forth. Samples BW1 and SW1 were taken from the Button Wood Creek and Salmon Creek tributaries, respectively. LO1 corresponds to a sample taken from the littoral area of Lake Ontario outside of Braddock Bay (Figure 1).

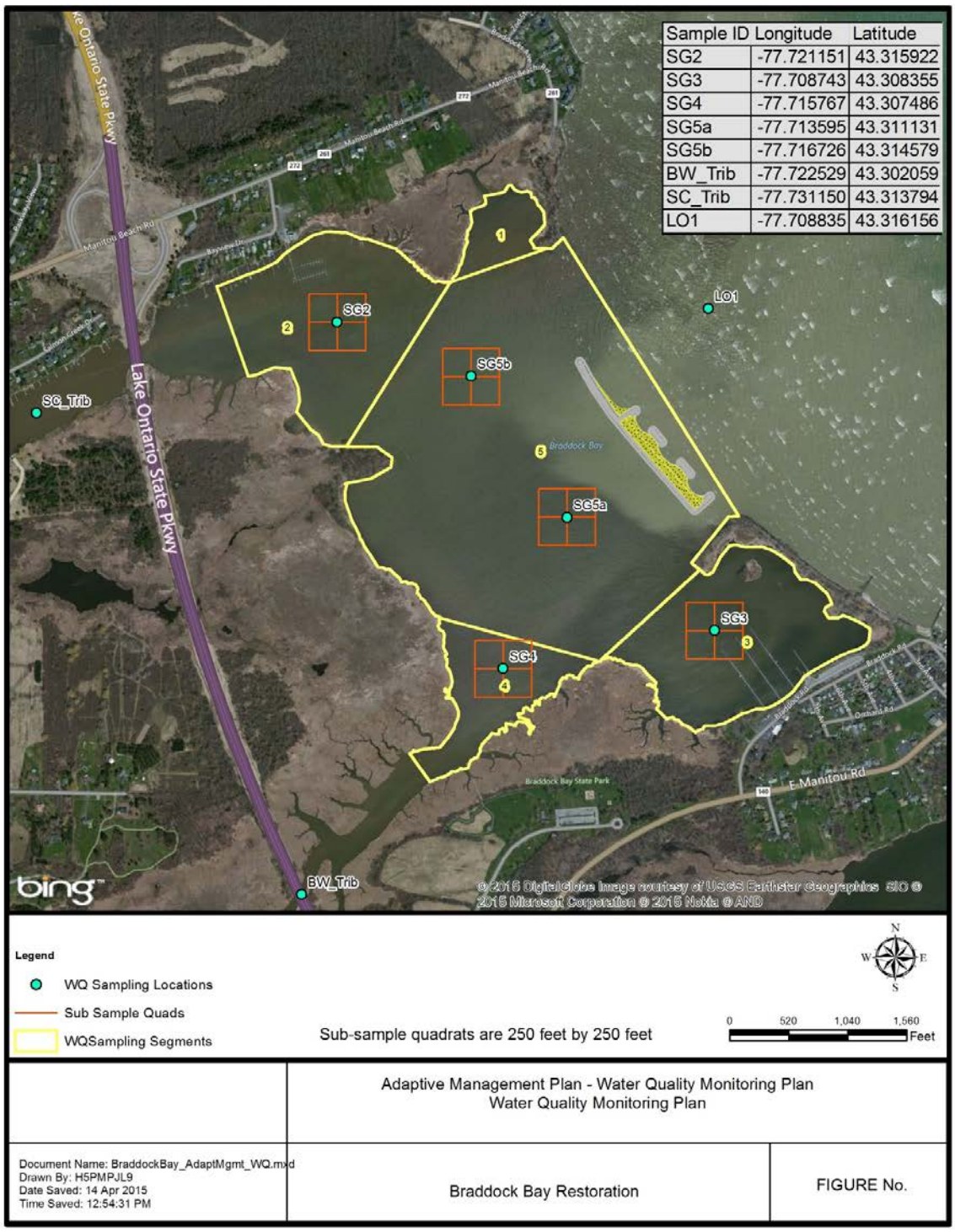

Figure 1. Water Quality Sampling Locations

3.0 Results and Discussion

The discussion of results primarily focuses on total phosphorus, Secchi Disk depth, and chlorophyll α, as these parameters have been recommended for determining if adaptive management actions are necessary by the Adaptive Management Plan (USACE, 2015). All analytical results are presented in Appendix A.

3.1 Weather and Conditions During Sampling Events

The June 12th sampling occurred during a period several intermittent storm events. Heavy storms occurred 3 days prior to sampling and spotty thunderstorms occurred early in the morning. These storms likely influenced base flow. Conditions in the Bay and on the lake were choppy and resulted in very turbid conditions due to suspension of bed sediments within the Bay. Both Salmon Creek and Buttonwood creek appeared to have been backwelling during this sample event.

The July 16th, August 18th, sampling and the September 23rd sampling events occurred during calm days in which suspension of bottom sediments and backwelling of tributaries were not observed.

Visual evidence of blue-green algal blooms were not observed anywhere in the Bay during any sampling events; however, the cover of the floating aquatic vegetation, duckweed (*Lemna*), appeared to increase over the summer months along Buttonwood Creek, and near the shorelines of Segment 3.

3.2 Total Phosphorus

Concentrations of total phosphorus ranged from 30 ug/L to 170 ug/L in samples taken from the Bay, 140 ug/L to 330 ug/L in samples from the tributaries, and 5 to 22 ug/L in Lake Ontario near-shore samples (Figure 2 and Figure 3), with averages of 81 ug/L, 188 ug/L, and 11 ug/L respectively. The phosphorus concentrations observed in the Bay span the range considered to be eutrophic to hypereutrophic (Carlson, 1977) and are consistent with the range of historical water quality samples measured at Braddock Bay. Concentrations from samples within the Bay vary substantially by month and by Bay segment, but are generally lower than the inflow tributary concentrations and greater than the Lake Ontario concentrations. No month to month trend in TP concentrations is obvious for sampling locations within the Bay (Figure 4). The tributary concentrations appear to exhibit a slight increasing trend from June to September (Figure 2), and concentrations in Buttonwood Creek (mean = 220 ug/L) are consistently greater than the values from Salmon Creek (mean = 157.5 ug/L) in all months except June, during which they were equal. Segment 2 yielded the greatest TP concentrations in 3 of 4 months and the greatest average TP concentration of all points in the Bay with a concentration of 142.5 ug/ L (Figure 4). Segments 3, 4, 5a, 5b had similar average TP concentrations (61.25, 79.75, 52.5, and 71.75 ug/L respectively) and similar variability in month to month data. The high TP recorded in Segment

5b in June may not be representative of base flow conditions due to the storm events that preceded the June sampling.

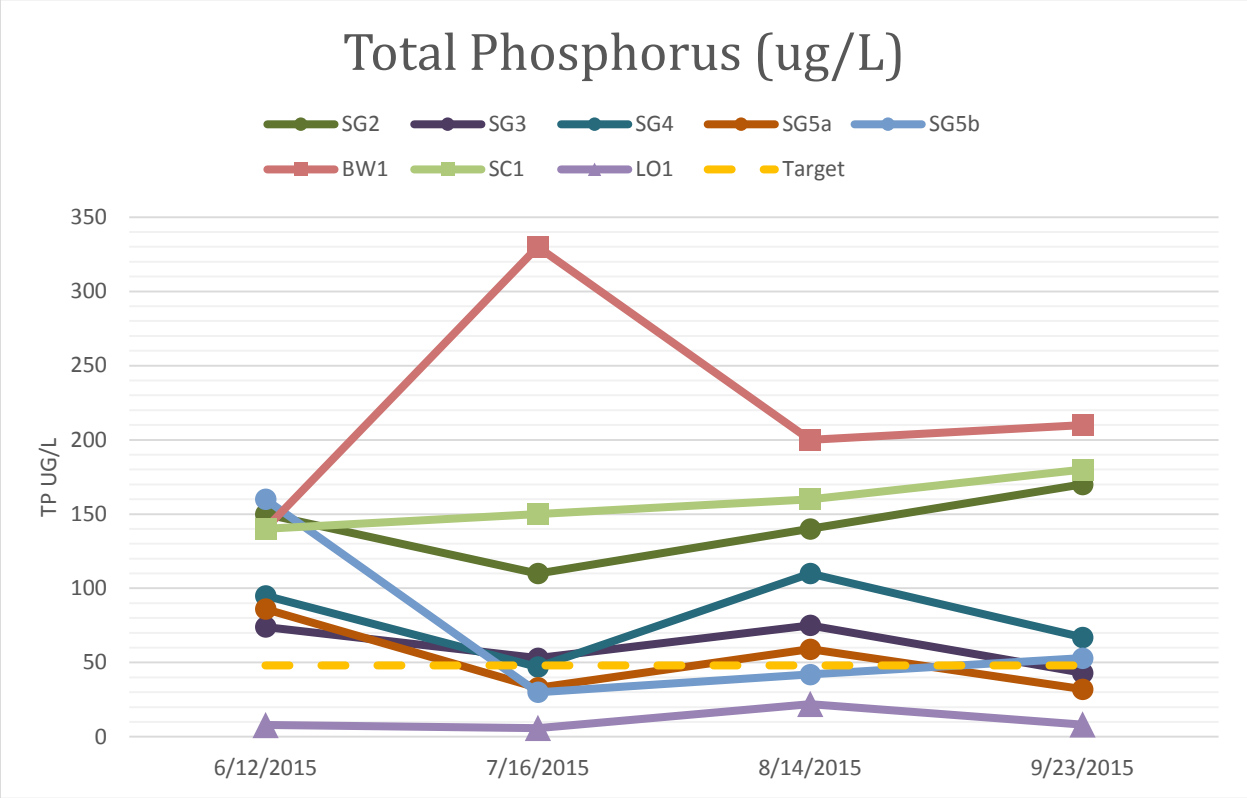

Figure 2. Total Phosphorus concentrations by month for all 2015 sampling points

Total phosphorus was consistent with historic levels observed during previous sampling (See USACE 2015, Appendix B). The target TP threshold established for adaptive management (48 ug/L) was exceeded in each Bay segments at least twice during the sampling months of 2015. This threshold was exceeded in Segment 2 in all months, Segment 3 in three months, Segment 4 in three months, Segment 5a in 2 months, and Segment 5b in 2 months. This threshold was exceeded in the tributaries during all months sampled, but was not exceeded by Lake Ontario samples during any months sampled (Figure 2).

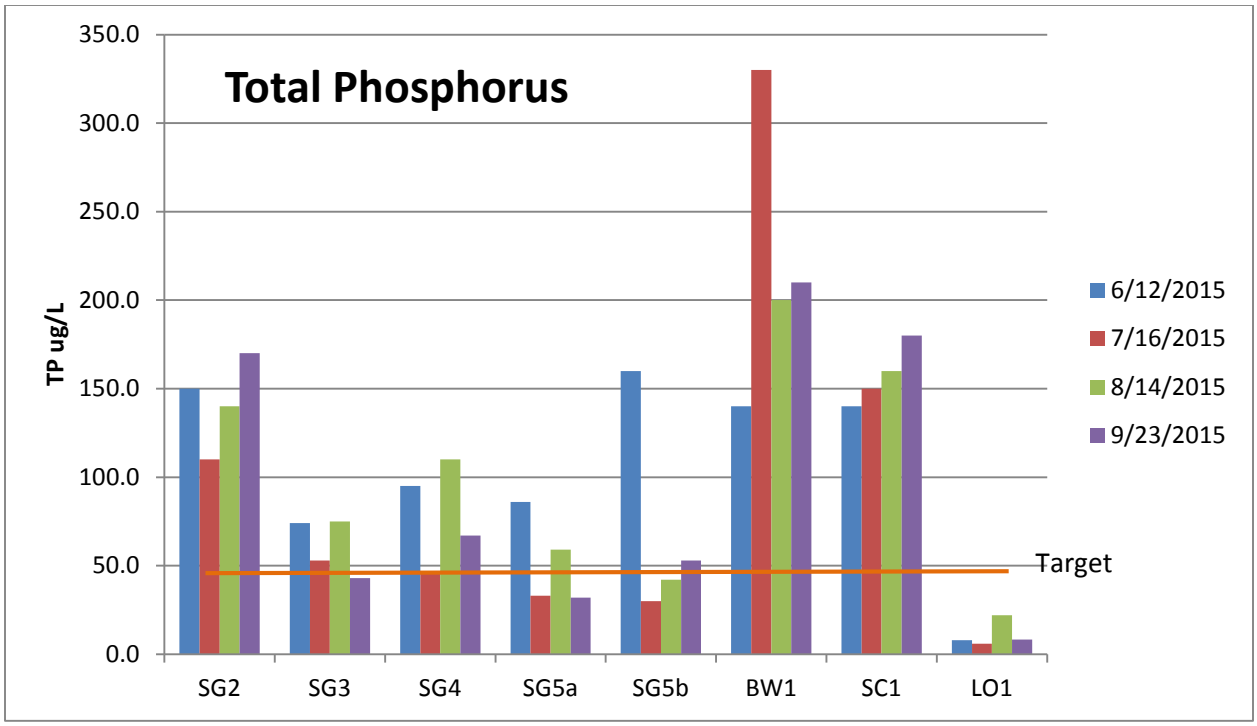

Figure 3. 2015 Braddock Bay Total Phosphorus concentrations.

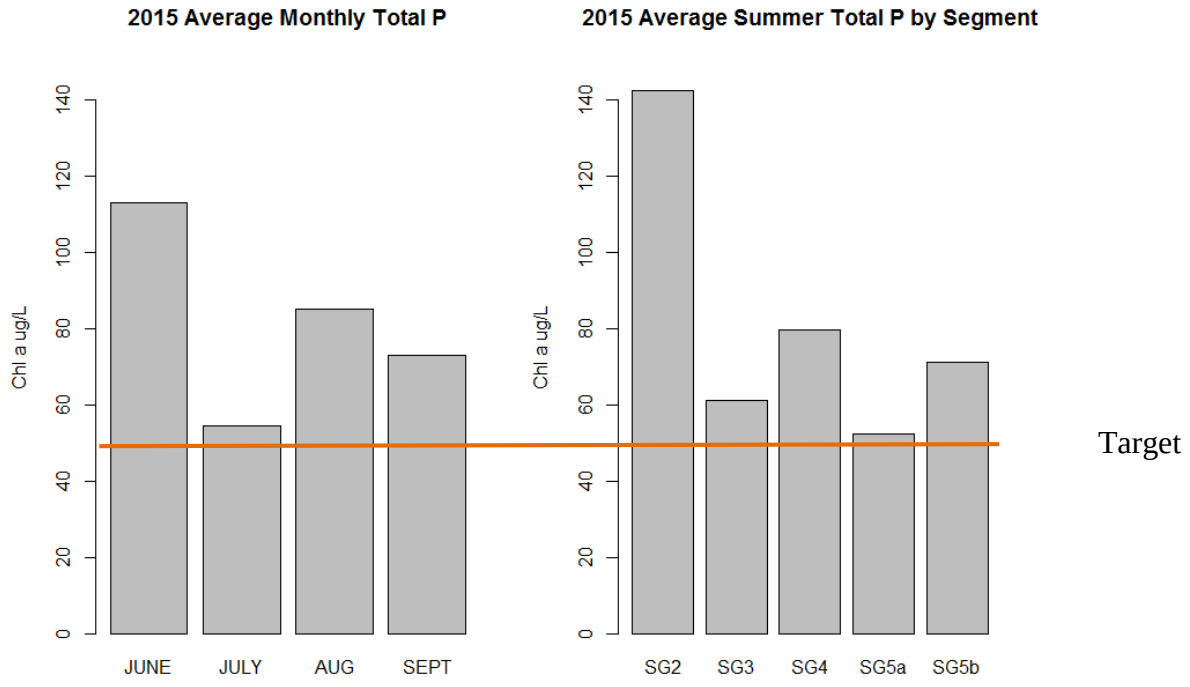

Figure 4. a) 2015 Average Monthly Total P for Braddock Bay; b) Average Summer Total P for Braddock Bay by segment.

3.3 Chlorophyll a

Concentrations of chlorophyll α ranged from 2 ug/L to 122 ug/L in the Bay, 1 ug/L to 30 ug/L in the tributaries, and 1 to 20 ug/L in Lake Ontario (Figure 5 and Figure 6) with averages of 35 ug/L, 7 ug/L, and 7 ug/L respectively (Figure 7). The highest concentration, was recorded in June from segment SG3 (122.82 ug/L). This extremely high value was inconsistent with the rest of the data, and thus was not included in the calculation of mean chlorophyll α concentrations in the Bay. This high concentration may have been due to the suspension of benthic algae from bed sediments resulting from the high wave energy during the time of sampling. The average concentrations of chlorophyll α for all Bay segments combined for the months of June, July, August, and September in 2015 were 26, 47, 32, and 34 ug/L respectively (Figure 7a). These mean monthly values were greater than the monthly averages recorded during a 2003-2009 study of water quality within Braddock Bay (Makarewicz 2010). This may be a result of differences in sampling methods, as the Makarewicz data was based on monthly data from a single location in the Bay. Comparison of monthly averages from samples taken within the Bay indicate that chlorophyll a concentrations peak in July with an average concentration of 47 ug/L (Figure 7a). Average summer chlorophyll a concentrations in the Bay are much greater than average summer concentrations in the Lake Ontario sample location (8 ug/L), Buttonwood Creek (4 ug/L), or Salmon Creek (11 ug/L).

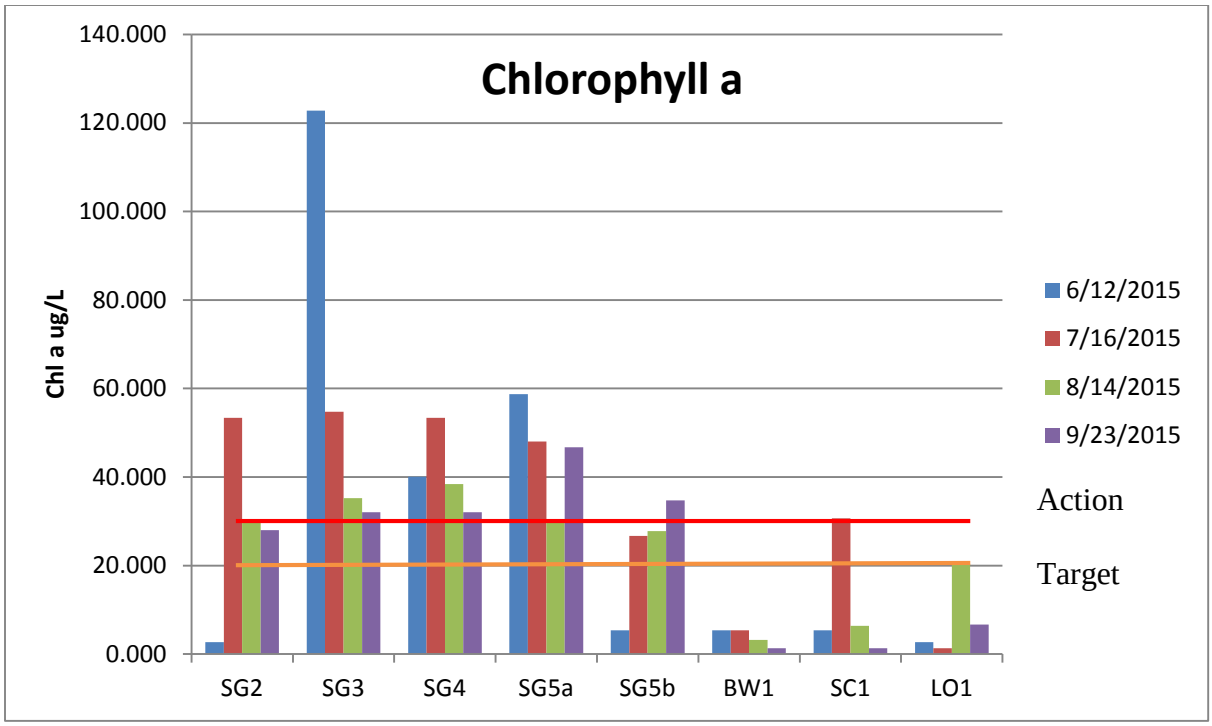

Figure 5. 2015 Braddock Bay chlorophyll a concentrations.

The highest summer average concentration of chlorophyll α in the Bay was observed in segment 5a (46 ug/L), followed by segments 3 and 4 (41 ug/L), segment 2 (28.5 ug/L), and segment 5b (24 ug/L; Figure 7b). Average chlorophyll a concentrations were greater in the southeastern segments of the Bay (SG3, SG4, SG5a) the northwestern part of the Bay (SG2, SG5b) in the summer. The monthly variability of chlorophyll α concentrations between locations within the Bay was greatest at the beginning of the summer (June), but converged as the summer progressed.

Average monthly concentrations of chlorophyll α in the Bay exceeded the 20 ug/L "target" threshold in all months (June – September) in 2015, and exceeded the 30 ug/L "action" threshold in July, August, and September (Figure 7). In total, the "target" threshold was exceeded by 19 of 20 samples collected within the Bay in the summer of 2015, and the "action" threshold was exceeded by 13 of 20 samples.

Concentrations of chlorophyll α from samples taken within the Bay did not exhibit any consistent temporal trends (Figure 6) or correlations with total phosphorus concentrations (Figure 8). The one exception was the Lake Ontario samples in which chlorophyll α concentrations were positively correlated with total phosphorus concentrations. Despite the very high concentration of TP in the tributaries, chlorophyll α concentrations in the tributaries were consistently low. This may be due to the flowing nature of the tributaries that do not allow enough residence time for phytoplankton growth.

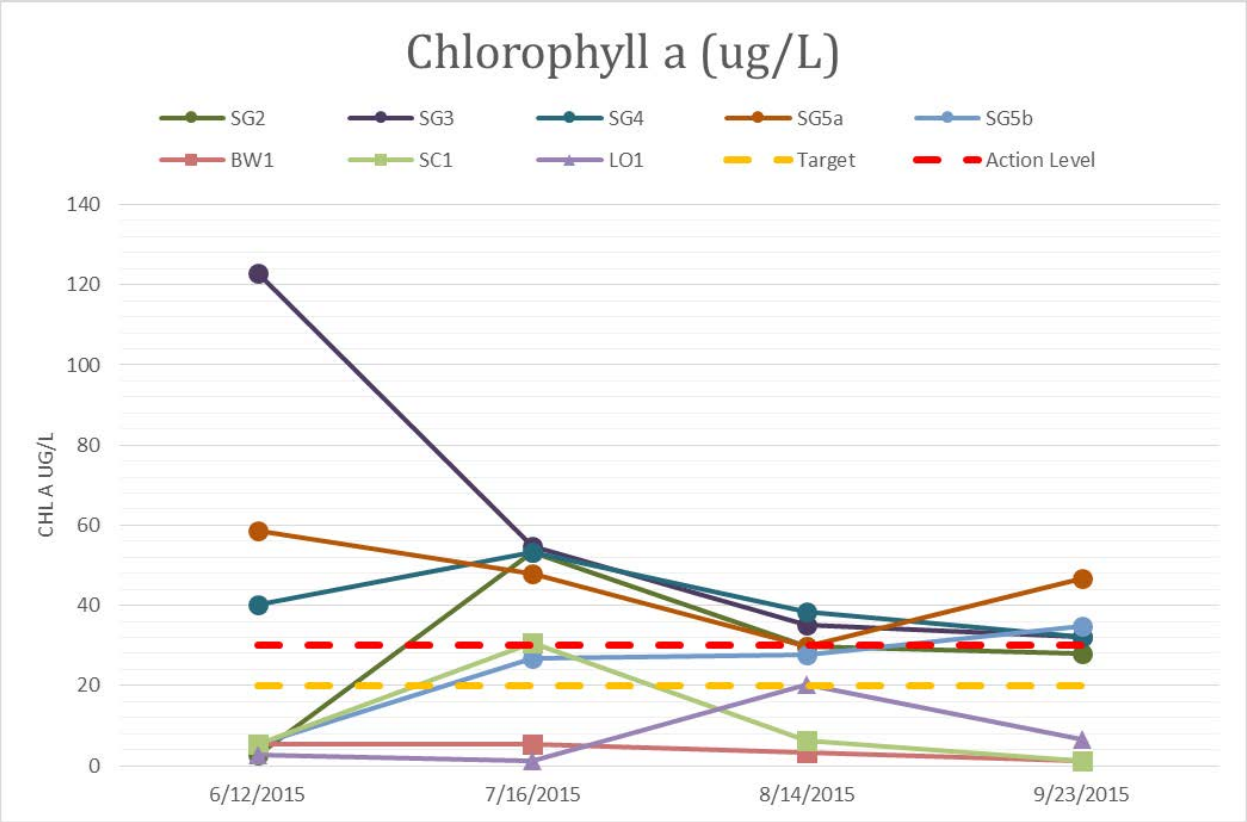

Figure 6. Chlorophyll a concentrations by month for all 2015 sampling points

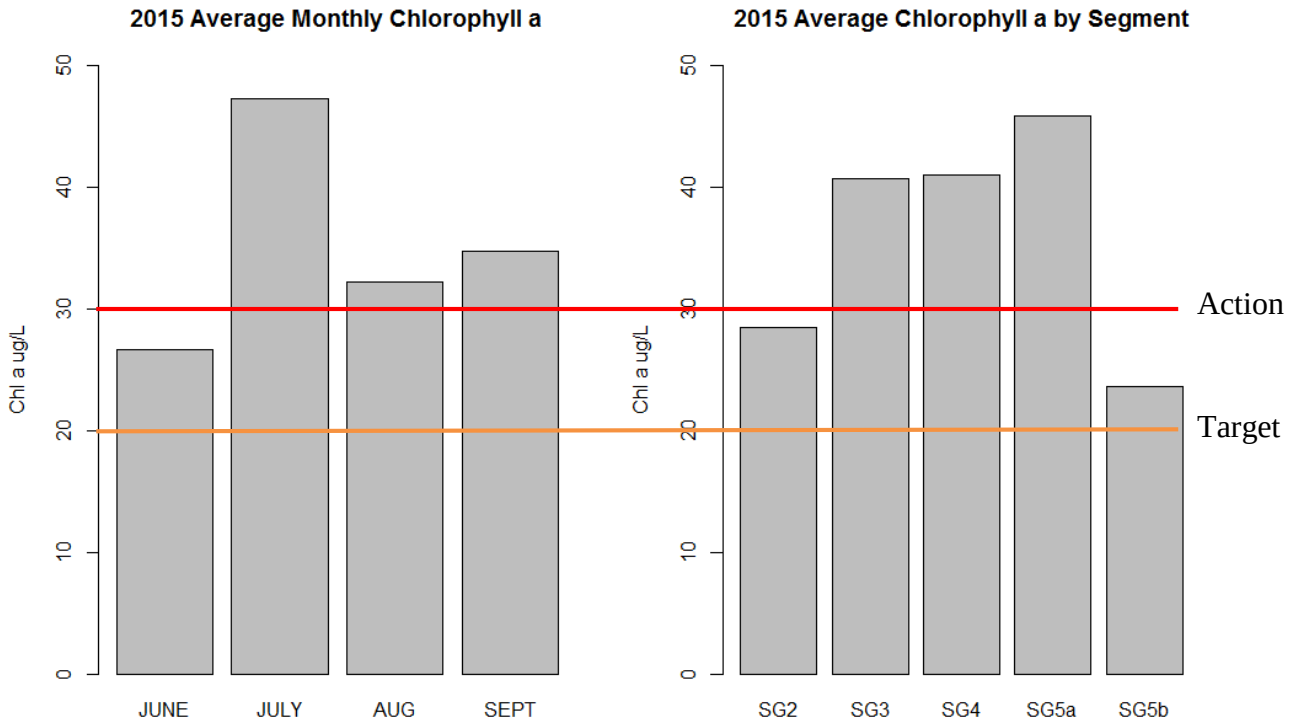

Figure 7. a) 2015 Average summer monthly chlorophyll a concentrations for Braddock Bay; b) Average summer chlorophyll a concentrations for Braddock Bay by segment.

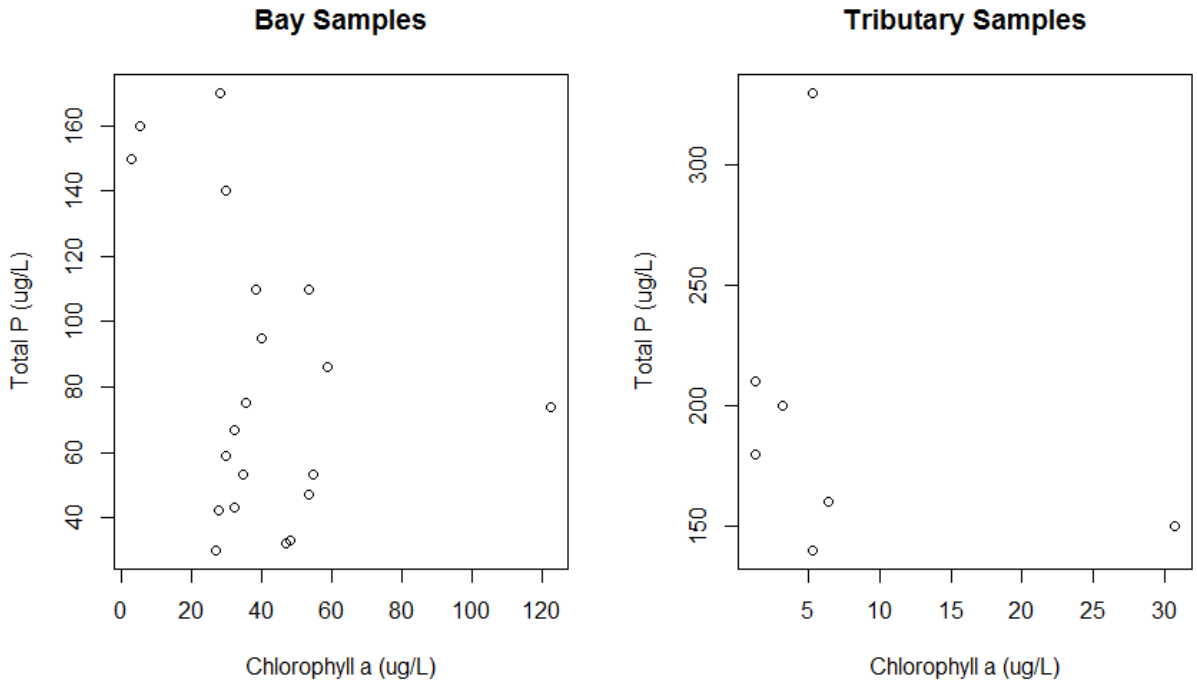

Figure 8. Plot of Chlorophyll a vs TP from Bay and tributary sample locations showing no correlation

3.4 Secchi Disk Depth

A Secchi disk is a tool used for measuring water clarity. The greater the recorded depth, the greater the water clarity and lower the turbidity. In many lakes, Secchi disk depth is strongly correlated with concentrations of algal biomass and chlorophyll a. These relationships can be complicated by the presence of sediments in the water column resulting from wave suspension or tributary inflows. Secchi disk depth was selected as a potential metric for adaptive management, because it is easy data to collect, does not require lab analysis, and may be useful in determining shift in the trophic status of the Bay.

Secchi disk depth in the Bay ranged from 0.30 to 0.99 meters (Figure 9). No sample locations recorded depths of Secchi disk visibility extend below the 1 meter "target" criteria, indicating that the Bay is consistently more turbid, than what would be expected based solely on Carlson's Trophic State Index (See USACE 2015, Appendix B). Secchi disk depths in the Lake Ontario sample location and tributaries extended deeper (higher visibility) than those of the Bay. The average Secchi disk depth for the Bay was 0.595 m and was similar between Bay segments.

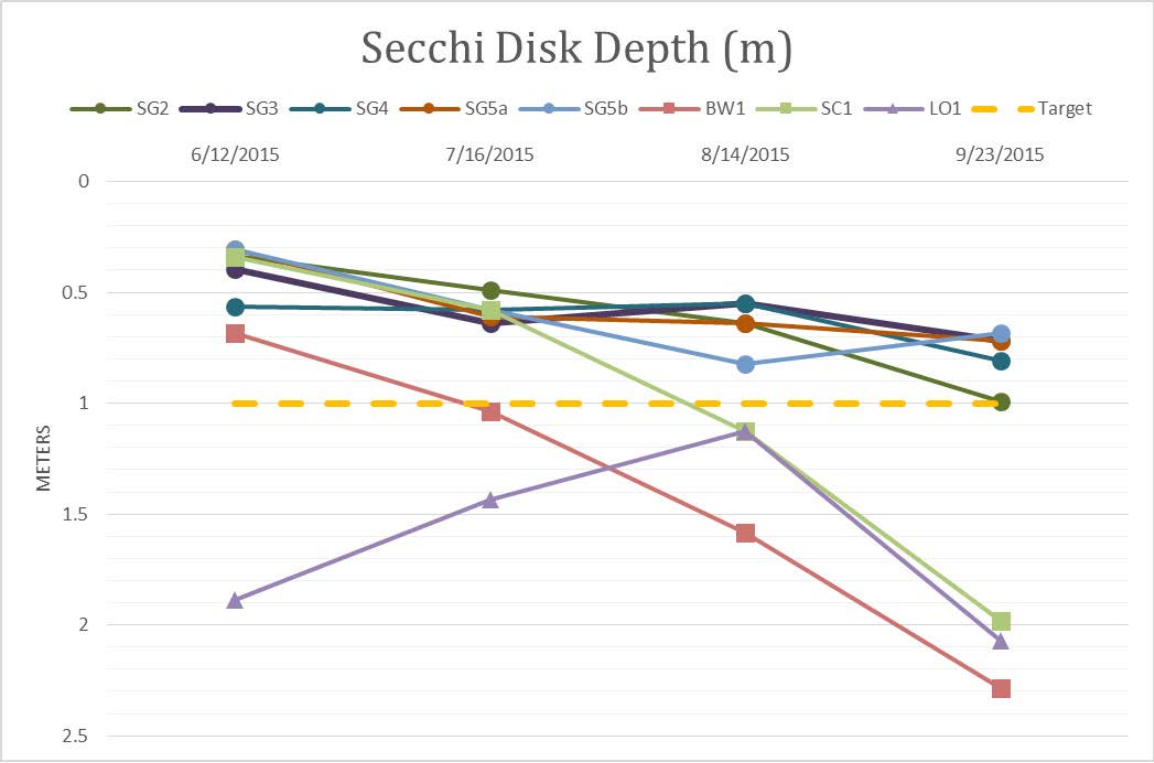

Figure 9. Braddock Bay Secchi disk depths

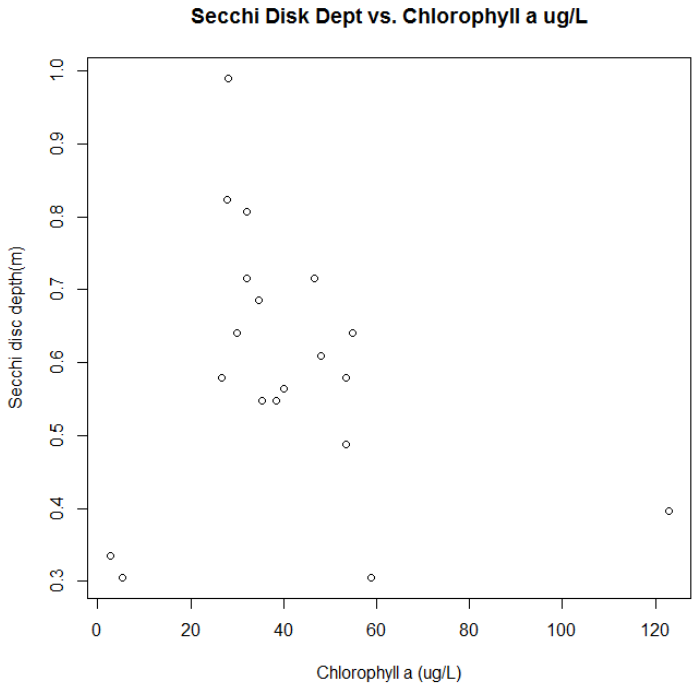

Figure 10. Secchi Disk Depth vs. Chlorophyll a (ug/L) for samples within Braddock Bay

4.0 Discussion

Weather and Conditions during Sampling Events

The June samples occurred several days after a large series of storms, and water quality conditions were likely influenced by these events. A small event was also recorded two days before the August sampling and may have influenced water quality conditions. These storms may be responsible for the elevated average TP in June and August across the Bay,

Total Phosphorus

Phosphorus concentrations in the Bay during the summer of 2015 ranged from 30 to 150 ug/L, but did not indicate a month to month trend. Phosphorus concentrations in the tributaries were generally higher than those in the Bay, while concentrations from Lake Ontario were generally lower. This suggests heavy loadings from the tributaries. Total phosphorus in Lake Ontario samples are consistently low. The range of phosphorus concentrations in the Bay spans the range that would be considered eutrophic to hypereutrophic (Carlson, 1977). Concentrations of TP exceeded the established target criteria (48 ug/L, USACE 2015) at least twice in each Bay segment during the summer of 2015. As this target threshold is regularly exceeded during baseline conditions, it should not be used as the sole justification for adaptive management actions associated with the Braddock Bay restoration project. Rather, the year to year trends in

Braddock Bay total phosphorus data should be used to justify the need for adaptive management measures, specifically if year to year trends show increasing concentrations of phosphorus in the Bay.

Chlorophyll a

Chlorophyll α concentrations in the Bay ranged from 2 ug/L to 122 ug/L in the Bay at sampling locations in the summer of 2015. The mean monthly concentrations of chlorophyll α for all ay segments combined were 26, 47, 32, and 34 for June, July, August, and September respectively. The range chlorophyll α in the Bay spans the range that would be considered eutrophic to hypereutrophic (Carlson, 1977). The highest summer average concentration of chlorophyll α in the Bay was observed in segment 5a (46 ug/L). Generally the average chlorophyll a concentrations were greater in the southeastern segments of the Bay (SG3, SG4, SG5a) than the northwestern part of the Bay (SG2, SG5b) in the summer. The monthly variability of chlorophyll α concentrations between locations within the Bay was greatest at the beginning of the summer (June), but converged as the summer progressed.

The "target" performance criteria (20 ug/L) for chlorophyll α was exceeded by 95% (19 of 20) of Bay Samples, and the "action" threshold (30 ug/L) was exceeded in 65% (13 of 20) of samples taken from the Bay during the summer of 2015. The baseline sampling is meant to represent the natural range of variability of Braddock Bay, prior to the barrier beach restoration. The frequent exceedance of the current "target" and "action" thresholds under baseline conditions suggest that these criteria should not be used as the sole justification for adaptive management action. In other words, exceedance of these ecologic criteria does not clearly indicate a shift in eutrophication from the existing conditions. These criteria values could be increased to more accurately represent a threshold between the current condition of Braddock Bay and a more eutrophic condition. Currently, the target criteria and action criteria for chlorophyll α are equivalent to a trophic state index (TSI; Carlson, 1977) of 60 and 63.9 respectively. A TSI score of 70 may be a more appropriate criteria for representing a shift in the trophic state of Braddock Bay from its current state. This TSI score of 70 would be equivalent to a chlorophyll α concentration of 55 ug/L; this value was only exceeded twice in the Bay during baseline sampling. The 20 ug/L value may still be an appropriate target criteria for Braddock Bay chlorophyll α concentrations, however, it is recommended that the action criteria be increased to 55 ug/L to more accurately represent a threshold between the current condition, and a more eutrophic condition.

Based on the high variability of chlorophyll α concentrations in the Bay basing adaptive management actions solely the exceedance of a single criteria may not be appropriate. Rather, the year to year trends in Braddock Bay chlorophyll α should be considered when determining the need for adaptive management measures, along with trends in TP data and data from vegetation surveys of the aquatic community.

Secchi Depth Depth

Secchi disk depth in the Bay ranged from 0.30 to 0.99 meters (Figure 9). No sample locations recorded depths of Secchi disk visibility extending below the 1 meter "target" criteria, indicating that the Bay is consistently more turbid, than what would be expected based solely on Carlson's Trophic State Index (See USACE 2015, Appendix B).

Secchi disk depths only exhibited a moderate correlation with chlorophyll α concentrations in the Bay (Figure 10). This is likely due to the influence of sediments on turbidity resulting from several factors including the resuspension of bed sediment from wave energy and the contribution of fine sediments from the tributaries. The use of Secchi disk depth to represent trophic state may not be suitable at Braddock Bay, due to the confounding influence of sediments on turbidity in the Bay. This is support by the moderate correlation between Secchi disk depth and chlorophyll α. Interpretations of Secchi disk to represent algal productivity be should applied cautiously. Furthermore, the "target" criteria for Secchi Disk depth should not be used as a threshold for determining if adaptive management actions are necessary.

5.0 Conclusions

Nutrient loading to Braddock Bay from its tributaries, Salmon and Buttonwood Creek, is severe and contributes to the eutrophic-hypertrophic state of Braddock Bay. Despite the high chlorophyll α and TP concentrations observed in the Bay during the summer of 2015, no evidence of blue/green algal blooms were observed. Areas with very high coverage of duckweed/water meal were observed in several areas in the Bay especially along the channel edges in Buttonwood Creek, and along the shoreline behind existing land spit in SG3. Reducing the nutrient concentrations in Braddock Bay is critical to improving its ecological function and should be pursued through upstream activities that reduce nitrogen and phosphorus loading to the tributaries.

The 2015 baseline sampling suggests that the pre-determined action and target criteria associated with chlorophyll α, TP, and Secchi disk depth specified in the Adaptive Management Plan (USACE 2015) may not be valid for determining if the trophic state of Braddock Bay is impacted by proposed restoration measures. In other words, exceedance of these criteria would not clearly demonstrate that the trophic state of the Bay has been negatively impacted by the construction of the proposed barrier beach restoration as exceedances were frequently observed in the Summer 2015 baseline monitoring.

The concentrations of chlorophyll α (20 ug/L) and TP (48 ug/L) are still suitable for use as target criteria for representing a goal that should be strived for in Braddock Bay through reductions in nutrient loadings to the bay. However, it should be noted that these criteria were frequently exceeded during the 2015 baseline sampling, and thus should not be used as sole justification for adaptive management actions. It is recommended that the action criteria established for chlorophyll α of 30 ug/L be increased to 55 ug/L to more accurately represent a threshold between the current condition, and a more eutrophic condition. Lastly, the use of Secchi disk depth to represent trophic state may not be suitable at Braddock Bay, due to the confounding influence of sediments on turbidity in the Bay. Therefore, the “target” criteria for Secchi Disk depth should not be used as a threshold for determining if adaptive management actions are necessary.

Determinations of the necessity of adaptive management actions related to water quality should be based on an analysis of the yearly trends in TP and chlorophyll α data while also considering changes in the aquatic vegetation community. Increasing trends of TP and chlorophyll a concentrations with an observed shift in the aquatic vegetation community to a more eutrophic composition would be strong evidence that the trophic state of the Bay is shifting and adaptive management actions are necessary.

Monitoring could benefit from more frequent sampling dates throughout the summer; this will help to better capture the full range and average concentration of the Bay under baseflow conditions. Sampling protocols could also be improved by implementing a longer settling period

5 days or more following a storm events; this will help to reduce the influence that high flow storm events and produce a more accurate assessment of baseflow conditions.

6.0 **References**

Carlson, R. E. 1977. A trophic state index for lakes. Limnology and oceanography, 22(2), 361-369.

U.S. Army Corps of Engineers. 2015. Braddock Bay Restoration: Monitoring and Adaptive Management Plan. Buffalo District.

APPENDIX A FIELD DATA SHEETS

Project: Braddock Bay AM Baseline			Location: Braddock Bay, Monroe County				Sampler : Joshua Unghire, Andrew Hannes				
Date: 6/12/2015			Weather: Cloudy, Flashy Rain to clear. 70 Deg F								
Sample ID	Time	Temp C	pH	DO mg/L	% DO %	ORP mV	Conductivity mS/cm	Turbidity NTU	Water Depth ft	Secchi Disk Depth ft	DO Profile mg/L
SG2	1050	20.11	7.41	4.87	55.2%	202	0.744	111.0	5.00	1.10	4.86 @ 1'
SG3	1215	20.667	8.21	5.91	67.8%	220	0.680	67.8	5.80	1.30	6.57 @ 1' / 6.08 @ 5'
SG4	1140	20.5	7.76	5.16	59.3%	200	0.694	58.9	4.65	1.85	5.16@ 1'
SG5a	1125	20.167	7.45	4.61	52.4%	219	0.777	132.0	5.90	1.00	4.40 @ 1'
SG5b	1110	19.944	7.55	4.35	49.2%	212	0.755	162.0	5.70	1.00	4.21 @1'
SC1	1040	19.722	6.83	5.27	59.4%	184	0.744	86.8	6.54	1.11	-
BW1	1155	20.944	7.39	3.71	42.8%	210	0.835	33.9	8.75	2.25	3.66@7.8' / 3.67 @ 1'
LO1	1240	12.889	8.3	7.06	69.4%	222	0.456	4.4	-	6.20	-

Notes:
WQ Reading taken from approximately 3' below water surface
Water Samples Taken 1 - 1.5' below water surface
Lake Level Elevation IGLD - 245.94
Both Buttonwood Creek and Salmon Creek were backflowing.
Flashy rain storms occurred the morning before sampling and large rainstorms occurred earlier in the week.
Bay was visually turbid and waves were choppy. Turbidity appeared to be from wave driven sediment resuspension. Water color was brown.
No evidence of green or blue/green algal blooms were observed.
Horiba Calibrated: 6/12/2015

Project: Braddock Bay AM Baseline			Location: Braddock Bay, Monroe County				Sampler : Joshua Unghire, Jay Miller				
Date: 7/16/2015			Weather: Sunny, Clear, Calm, 78 F								
Sample ID	Time	Temp F	pH	DO mg/L	% DO %	ORP mV	Conductivity mS/cm	Turbidity NTU	Water Depth ft	Secchi Disk Depth ft	DO Profile mg/L
SG2	1045	74.00	7.73	5.34	64.4%	183	0.736	53.9	3.00	1.60	DO = 4.8 Temp = 73.3 @3'
SG3	1230	74.6	8.41	7.15	86.4%	194	0.509	80.2	4.00	2.10	DO = 7.4 Temp = 72.8 @3'
SG4	1150	73.2	7.79	5.6	66.9%	233	0.520	52.2	2.00	1.90	DO = 5.47 Temp = 72.8 @2'
SG5a	1135	70.8	8.09	6.92	78.6%	197	0.495	59.5	5.00	2.00	DO = 5.51 Temp = 70.0 @5'
SG5b	1110	71.4	8.05	8.08	90.0%	183	0.507	43.8	4.30	1.90	DO = 5.6 Temp = 69.8 @4'
SC1	1030	75.1	7.57	6.81	82.4%	185	0.966	36.2	5.00	1.90	-
BW1	1205	71.5	6.78	2.77	32.5%	176	0.830	1.2	6.00	3.40	-
LO1	1130	68.9	7.99	5.78	65.8%	210	0.446	18.5	6.00	4.70	DO = 5.7 Temp = 68.9 @7'

Notes:
WQ Reading taken from approximately 1-2' below water surface
Water Samples Taken 1 - 1.5' below water surface
Lake Level Elevation IGLD - 246.75
Both Buttonwood Creek and Salmon Creek were clearly flowing towards Lake Ontario (No backwelling).
Buttonwood Creek had high cover of duckweed.
Bay was calm. Water color appeared light brown.
No evidence of green or blue/green algal blooms were observed.
Horiba Calibrated: 6/30/2015
Depths taken from onboard SONAR

Project: Braddock Bay AM Baseline			Location: Braddock Bay, Monroe County				Sampler : Joshua Unghire, Andrew Hannes				
Date: 8/14/2015			Weather: Overcast, Slight wind, mostly Calm, 70 F								
Sample ID	Time	Temp F	pH	DO mg/L	% DO %	ORP mV	Conductivity mS/cm	Turbidity NTU	Water Depth ft	Secchi Disk Depth ft	DO Profile mg/L
SG2	1120	74.10	7.77	8.61	103.5%	182	0.855	37.0		2.10	DO 9.37 mg/L @ 5' Temp 71.1 @ 5'
SG3	1245	74.2	8.23	9.62	115.9%	149	0.549	44.0	6.40	1.80	DO 7.88 mg/L @ 5' Temp 74.0 @ 5'
SG4	1210	74.3	7.87	8.33	100.2%	188	0.562	55.1	5.40	1.80	DO 7.96 mg/L @ 5' Temp 74.2 @ 5'
SG5a	1200	73	8.4	9.34	111.4%	184	0.550	45.1	6.30	2.10	DO 9.42 mg/L @ 5' Temp 72.7 @ 5'
SG5b	1135	72.7	8.5	9.79	116.0%	157	0.525	26.9	5.80	2.70	DO 9.53 mg/L @ 5' Temp 74.1 @ 5'
SC1	1100	74.3	7.57	9.95	119.8%	187	0.984	12.0	-	3.70	DO 9.37 mg/L @ 5' Temp 71.1 @ 5'
BW1	1220	73.6	7.15	5.78	69.2%	176	0.788	3.9	8.70	5.20	DO5.58 mg/L @ 5' Temp 73.6 @ 5'
LO1	1145	71.3	8.49	9.65	112.9%	164	0.049	10.4	-	3.70	DO 9.37 mg/L @ 5' Temp 71.1 @ 5'

Notes:
WQ Reading taken from approximately 1-2' below water surface
Water Samples Taken 1 - 1.5' below water surface
Lake Level Elevation IGLD - 246.3
Buttonwood Creek slight visual backwelling
Buttonwood Creek had high cover of duckweed.
Bay was calm. Water color appeared light brown.
No evidence of green or blue/green algal blooms were observed.
Horiba Calibrated: 8/14/2015
Depths taken with survey rod

Project: Braddock Bay AM Baseline			Location: Braddock Bay, Monroe County				Sampler : Joshua Unghire, Andrew Hannes				
Date: 23 September 2015			Weather: Clear, Calm, 68 deg F								
Sample ID	Time	Temp F	pH	DO mg/L	% DO %	ORP mV	Conductivity mS/cm	Turbidity NTU	Water Depth ft	Secchi Disk Depth ft	DO Profile mg/L
SG2	1135	68.00	7.79	9.31	105.6%	202	0.680	24.6	3.80	3.25	@ 3.5' T = 66.8 F, DO = 9.0 mg/L
SG3	1355	69.6	8.49	11.55	134.2%	137	0.529	26.9	4.80	2.35	@ 4' T = 67.3 F, DO = 10.52 mg/L
SG4	1245	69	8.13	9.51	108.9%	168	0.579	33.5	4.00	2.65	@ 3' T = 68.7 F, DO = 8.8 mg/L
SG5a	1225	67.9	8.5	10.1	113.3%	165	0.526	36.4	5.40	2.35	@ 4' T = 66.2 F, DO = 8.79 mg/L
SG5b	1145	67.7	8.35	9.83	111.0%	176	0.580	37.8	4.50	2.25	@ 4' T = 65.7 F, DO = 9.54 mg/L
SC1	1115	66.8	6.85	10.45	116.5%	196	0.800	3.8	6.50	Bottom	@ 6' T = 66.2 F, DO = 9.1 mg/L
BW1	1300	66.8	7.48	7.4	82.8%	179	0.722	3.3	8.00	7.50	@ 7' T = 66.6 F, DO =7.3 mg/L
LO1	1210	67.7	8.36	9.39	105.8%	179	0.465	3.5	6.80	Bottom	@ 6.5' T = 67.5 F, DO =9.15 mg/L

Notes:
WQ Reading taken from approximately 1-2' below water surface
Water Samples Taken 1 - 1.5' below water surface
Lake Level Elevation IGLD - 245.4
Thick dusckeed observed along shore north of Marina
No bluegreen algal blooms observed in bay
Thick duckwee observed in mouth of Buttonwood Creek and along buttonwood Creek
Green algae attached to vallisneria and coontail in mouth of buttonwood creek

APPENDIX B ANALYTICAL DATA TABLES

Braddock Bay Baseline Water Quality Samples Summary

Sample	Lat.	Long.	Chlorophyll a	OrthoP	NH4	NO2NO3	TP	TSS	TKN	pH	Dissolved O2	ORP	Conductivity	Turbidity	Sechi Depth
			ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		mg/L	mV	mS/cm	NTU	ft
SG2	43.31592	-77.72115													
9/23/2015			28.035	0.129	0.063	0.61	0.1700	6	1.8	7.79	9.31	202	0.680	24.6	3.25
8/14/2015			29.904	0.045	0.080	ND	0.1400	14	0.19	7.77	8.61	182	0.855	37.0	2.10
7/16/2015			53.400	0.028	0.021	ND	0.1100	27	1.2	7.73	5.34	183	0.736	53.9	1.60
6/12/2015			2.670	0.092	0.300	0.77	0.1500	32	1.40	7.41	4.87	202	0.744	111.0	1.10
SG3	43.30835	-77.70874													
9/23/2015			32.040	0.010	0.038	2.40	0.0430	9	2.2	8.49	11.55	137	0.529	26.9	2.35
8/14/2015			35.244	0.012	0.060	ND	0.0750	18	1.50	8.23	9.62	149	0.549	44.0	1.80
7/16/2015			54.735	0.010	0.022	ND	0.0530	16	1.70	8.41	7.15	194	0.509	80.2	2.10
6/12/2015			122.820	0.011	0.038	ND	0.0740	24	1.40	8.21	5.91	220	0.680	67.8	1.30
SG4	43.307486	-77.715767													
9/23/2015			32.040	0.029	0.027	0.70	0.0670	12	1.8	8.13	9.51	168	0.579	33.5	2.65
8/14/2015			38.448	0.031	0.050	ND	0.1100	19	1.4	7.87	8.33	188	0.562	55.1	1.80
7/16/2015			53.400	0.010	0.011	ND	0.0470	17	1.6	7.79	5.60	233	0.520	52.2	1.90
6/12/2015			40.050	0.015	0.210	0.28	0.0950	19	1.30	7.76	5.16	200	0.694	58.9	1.85
SG5a	43.311131	-77.713595													
9/23/2015			46.725	0.010	0.017	0.13	0.0320	14	1.6	8.50	10.10	165	0.526	36.4	2.35
8/14/2015			29.904	0.010	0.027	ND	0.0590	16	1.2	8.40	9.34	184	0.550	45.1	2.10
7/16/2015			48.060	0.010	0.011	ND	0.0330	14	1.4	8.09	6.92	197	0.495	59.5	2.00
6/12/2015			58.740	0.015	0.150	0.20	0.0860	42	1.30	7.45	4.61	219	0.777	132.0	1.00
SG5b	43.314579	-77.716726													
9/23/2015			34.710	0.016	0.020	0.08	0.0530	13	1.1	8.35	9.83	176	0.580	37.8	2.25
8/14/2015			27.768	0.010	0.055	ND	0.0420	11	0.81	8.50	9.79	157	0.525	26.9	2.70
7/16/2015			26.700	0.010	0.013	ND	0.0300	13	1.30	8.05	8.08	183	0.507	43.8	1.90
6/12/2015			5.340	0.091	0.260	0.06	0.1600	53	1.70	7.55	4.35	212	0.755	162.0	1.00
BW1	43.302059	-77.722529													
9/23/2015			1.335	0.201	0.056	0.39	0.2100	2	7.2	7.48	7.40	179	0.722	3.3	7.50
8/14/2015			3.204	0.156	0.062	ND	0.2000	2	0.29	7.15	5.78	176	0.788	3.9	5.20
7/16/2015			5.340	0.206	0.076	ND	0.3300	2	1.30	6.78	2.77	176	0.830	1.2	3.40
6/12/2015			5.340	0.081	0.310	0.21	0.1400	8	1.70	7.39	3.71	210	0.744	33.9	2.25
SC1	43.313794	-77.73115													
9/23/2015			1.335	0.168	0.069	1.50	0.1800	ND	1.4	6.85	10.45	196	0.800	3.8	6.50
8/14/2015			6.408	0.119	0.047	ND	0.1600	6	0.92	7.57	9.95	187	0.984	12.0	3.70
7/16/2015			30.705	0.057	0.017	ND	0.1500	10	1.80	7.57	6.81	185	0.966	36.2	1.90
6/12/2015			5.340	0.090	0.220	0.11	0.1400	22	1.30	6.83	5.27	184	0.835	86.8	1.11
LO1	43.316156	-77.708835													
9/23/2015			6.675	0.010	0.035	1.70	0.0082	2	1	8.36	9.39	179	0.465	3.5	6.80
8/14/2015			20.292	0.010	0.034	0.089	0.0220	7	0.13	8.49	9.65	164	0.049	10.4	3.70
7/16/2015			1.335	0.010	0.010	ND	0.0059	ND	0.74	7.99	5.78	210	0.446	18.5	4.70
6/12/2015			2.670	0.010	0.027	0.32	0.0079	8	0.92	8.30	7.06	222	0.456	4.4	6.20

Chl a	APHA (2012) Method 10200H.2 (Spectrophotometric)
TSS	SM_2540D
TKN	EPA_351.2
TP	SM_4500-P-F
NH4	SM_4500-NH3-D
NO2NO3	SM_4500-NO3-H
pH, DO, ORP,Conductivity,Turbidity	Insitu - Horiba

Lab Qualifiers

U	The Analyte concentration is less than the detection limit
J	Estimated Result. Greater Uncertainty is associated with this result

Braddock Bay Water Quality - Trophic State Index and Ecologic Threshold Exceedance

	Chlorophyll a		TP		Sechi Depth	
	ug/L	TSI	ug/L	TSI	m	TSI
Ecologic Threshold						
Target	**20**	60.0	48.0	60.0	1.00	60.0
Action Level	**30**	63.9	-	-	-	-
SG2						
9/23/2015	**28.035**	**63.3**	**170.0**	**78.2**	**1.0**	**60.1**
8/14/2015	**29.904**	**63.9**	**140.0**	**75.4**	**0.6**	**66.4**
7/16/2015	**53.400**	**69.6**	**110.0**	**72.0**	**0.5**	**70.4**
6/12/2015	2.670	40.2	**150.0**	**76.4**	**0.3**	**75.8**
SG3						
9/23/2015	**32.040**	**64.6**	43.0	58.4	**0.7**	**64.8**
8/14/2015	**35.244**	**65.5**	**75.0**	**66.4**	**0.5**	**68.7**
7/16/2015	**54.735**	**69.8**	**53.0**	**61.4**	**0.6**	**66.4**
6/12/2015	**122.820**	**77.8**	**74.0**	**66.2**	**0.4**	**73.4**
SG4						
9/23/2015	**32.040**	**64.6**	**67.0**	**64.8**	**0.8**	**63.1**
8/14/2015	**38.448**	**66.4**	**110.0**	**72.0**	**0.5**	**68.7**
7/16/2015	**53.400**	**69.6**	47.0	59.7	**0.6**	**67.9**
6/12/2015	**40.050**	**66.8**	**95.0**	**69.8**	**0.6**	**68.3**
SG5a						
9/23/2015	**46.725**	**68.3**	32.0	54.2	**0.7**	**64.8**
8/14/2015	**29.904**	**63.9**	**59.0**	**63.0**	**0.6**	**66.4**
7/16/2015	**48.060**	**68.6**	33.0	54.6	**0.6**	**67.1**
6/12/2015	**58.740**	**70.5**	**86.0**	**68.4**	**0.3**	**77.1**
SG5b						
9/23/2015	**34.710**	**65.4**	**53.0**	**61.4**	**0.7**	**65.4**
8/14/2015	**27.768**	**63.2**	42.0	58.1	**0.8**	**62.8**
7/16/2015	**26.700**	**62.8**	30.0	53.2	**0.6**	**67.9**
6/12/2015	5.340	47.0	**160.0**	**77.4**	**0.3**	**77.1**
BW1						
9/23/2015	1.335	33.4	**210.0**	**81.3**	2.3	48.1
8/14/2015	3.204	42.0	**200.0**	**80.6**	1.6	53.4
7/16/2015	5.340	47.0	**330.0**	**87.8**	1.0	59.5
6/12/2015	5.340	47.0	**140.0**	**75.4**	**0.7**	**65.4**
SC1						
9/23/2015	1.335	33.4	**180.0**	**79.1**	2.0	50.1
8/14/2015	6.408	48.8	**160.0**	**77.4**	1.1	58.3
7/16/2015	**30.705**	**64.2**	**150.0**	**76.4**	**0.6**	**67.9**
6/12/2015	5.340	47.0	**140.0**	**75.4**	**0.3**	**75.6**
LO1						
9/23/2015	6.675	49.2	8.2	34.5	2.1	49.5
8/14/2015	**20.292**	**60.1**	22.0	48.7	1.1	58.3
7/16/2015	1.335	33.4	5.9	29.8	1.4	54.8
6/12/2015	2.670	40.2	7.9	34.0	1.9	50.8

*TSI calculation based on Carlson, 1977)

Exceed Target

Exceed Action