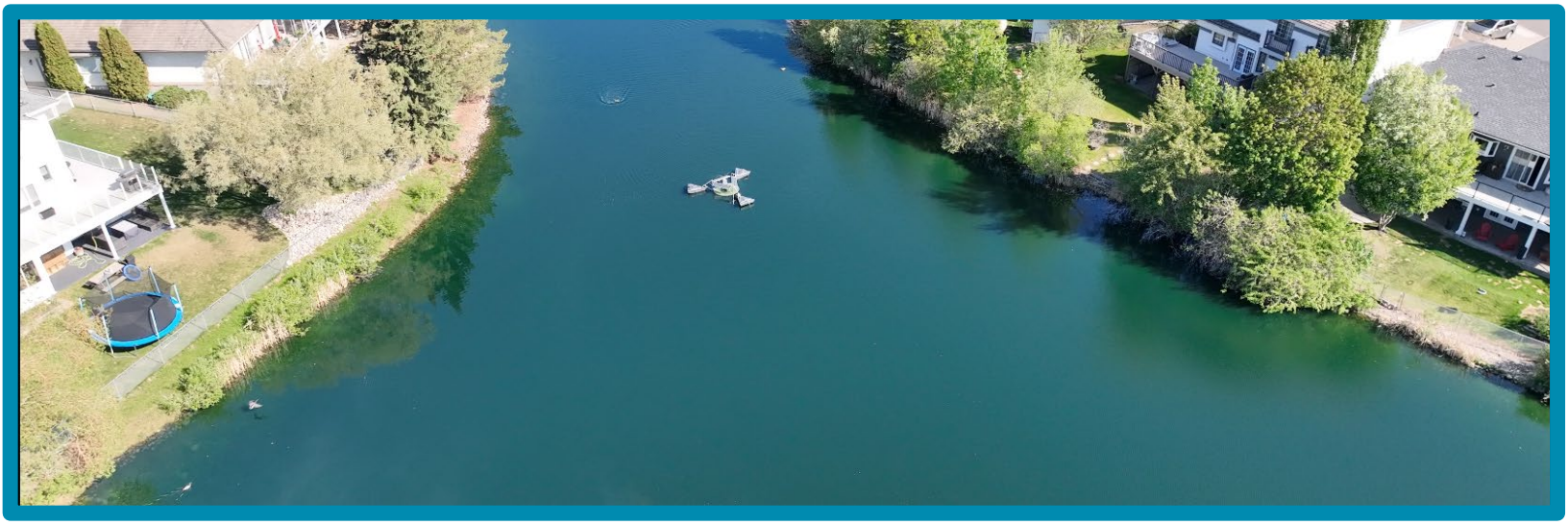
AQUATIC COLORANT PILOT PROGRAM

Project Summary

January 2024

Contents



Introduction

During the summer months it is common to see algae and other aquatic plant growth on waterbodies throughout Strathcona County, including stormwater management facilities (SWMFs). Algae occurs naturally and healthy amounts can provide oxygen and food to other organisms like fish living in our SWMFs. Extra nutrients entering the SWMFs, from practices including lawn fertilization, can cause excessive algae growth followed by decomposition. The decomposition process consumes available oxygen from the surrounding water, which causes oxygen levels to decrease. Lower oxygen levels in the water directly harms fish and other organisms living in the water.

Algae requires sunlight to grow. The addition of aquatic colorants have been used with the belief that they can reduce the amount of light penetrating the water, and slow the growth and occurrence of algal blooms on the SWMF.

Strathcona County has used a variety of aquatic colorants over the years at various SWMFs, including Ball Lake, Upper Nottingham, Broadmoor Lake, Village on the Lake, Woodbridge Farms, Eastgate Lake, Clover Bar Ranch, Fountain Creek and Lakeland Ridge North, with the intent to decrease or limit the amount of algae growth (Strathcona County 2021). In response to elevated resident and Councillor concerns specific to Clover Bar Ranch SWMF, an aquatic colourant was applied late in the 2022 season and additional sampling occurred. However, in order to support long-term and ongoing maintenance decisions, additional data is needed to determine the effectiveness and cost of aquatic colorant application.

Enhanced monitoring and sampling occurred at four SWMFs throughout the growing season

of 2023, including two treatment SWMFs and two control SWMFs. To help manage resident expectations, SWMFs that were historically treated were considered for inclusion in the pilot program, with a preference given to those sites with a poor shoreline design/vegetation and/or higher degree of resident complaints. Clover Bar Ranch (CBR) and Village on the Lake (VOL) were the two treatment SWMFs. Upper Nottingham (UPNOT) and Eastgate Lake (EAST) were the two control SWMFs.

This report includes the results and review of the effectiveness of colorants in controlling algae growth.

Key take-aways:

- There is little documented evidence regarding the effectiveness of applying aquatic colorants to reduce algal growth, particularly within the stormwater management context.

- A stronger relationship between nutrient levels, such as total phosphorus, and chlorophyll-a, was observed than between the application of True Blue™ and chlorophyll-a levels. The application of True Blue ™ may have been effective at shading the water, as temperatures at the treatment sites were generally slightly less than the control sites. However, the significance of this was not investigated.

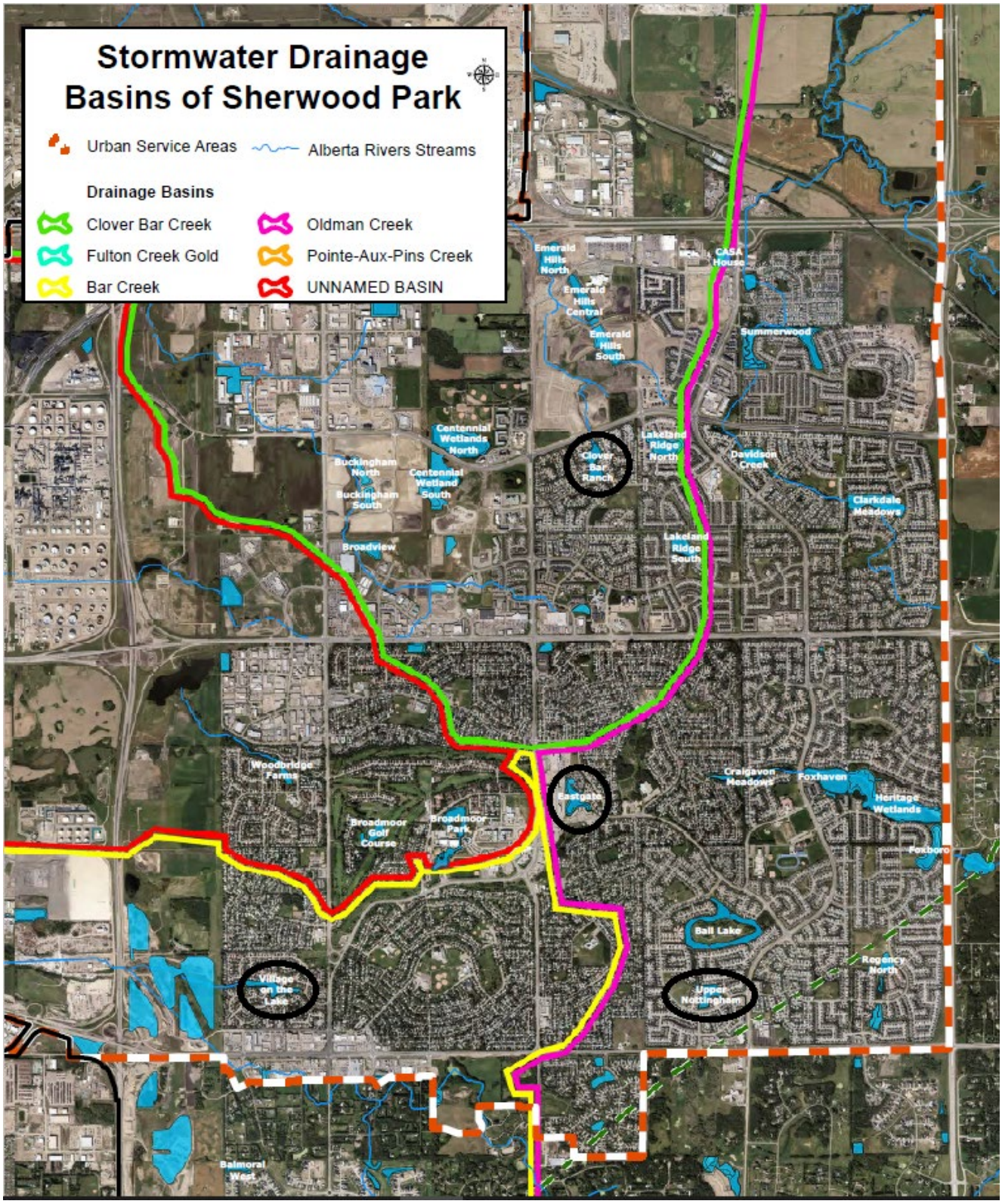
- A clear definition is required for when algal growth is considered a problem, based on water quality and quantity. The primary response to problematic algal growth should focus on the reduction of nutrients into the stormwater system.

- A focus on resident education, such as through future Pond Parties and signage, can encourage individual actions that can be taken to reduce nutrient input into the stormwater systems. These can include reducing or eliminating the use of synthetic fertilizers and increasing the naturalized shoreline buffer.

- The use of aquatic colorants may be effective at reducing the perceived aquatic vegetation problem. However, as it does not address the primary role of the SWMFs, the use of aquatic colorants, and other management actions such as the use of fountains, for aesthetic purposes would need to be part of a level of service discussion with Council.

- The estimated project cost for the application of the aquatic colorant and additional sampling in 2023 is $18,339.

Site Locations



Photos

Clover Bar Ranch (CBR) - Treatment

Figure 1. July 12, 2023

Figure 2. July 26, 2023

Village on the Lake (VOL) – Treatment

Figure 3. July 12, 2023

Figure 4. July 26, 2023

Eastgate (EAST) – Control

Figure 5. July 12, 2023

Figure 6. August 9, 2023

Upper Nottingham (UPNOT) – Control

Figure 7. May 31, 2023

Figure 8. July 12, 2023

Methods

Communication material was sent out to the residents directly adjacent to the SWMFs that were treated (Appendix A – Letter to Residents). Signage was incorporated into the park space adjacent to CBR with the intent to educate and build awareness around "living next to water" (Appendix B – Educational Signs).

Based on availability, True Blue™ was the chosen treatment for the aquatic colorant pilot program. Treatment was applied to CBR and VOL after ice off, following major rain events, and as maintenance dosages were required due to natural degradation. A drone was used to capture conditions before, after and throughout treatments at all four sites.

All four sites were sampled prior to application and every two weeks following application. The key parameters of concern were Biological Oxygen Demand (BOD), Chlorophyll-a, Total Nutrients and Total Organic Carbon (TOC).

Temperature, electrical conductivity (EC) and pH parameters were taken with the handheld probe. Grab samples were sent to the laboratory (ALS) for analysis. Parameters included Ammonia, Nitrite, Nitrate, Total Kjeldahl Nitrogen (TKN), Total Nitrogen (TN), Total Phosphorus (TP), TOC, BOD, and Chlorophyll-a.

Results

A letter was sent to residents in April, informing them about the process and setting expectations (Appendix A – Letter to Residents). A Pond Party at CBR was held May 30. Despite the thunderstorm causing the event to be called early, 45 people attended the event. Councillor Anderson was also in attendance. Vendors included Wild North, T. Kettle Tea company, North Saskatchewan Watershed Alliance, Alberta Environment and Protected Areas, Alberta Lake Management Society and Arrow Wastewater Treatment Utilities. Strathcona County departments included Family and Community Services, Planning and Development Services, Utilities, Wilderness Centre, and Strathcona County Library.

Five permanent educational signs were installed around CBR with messaging on shoreline plants (naturalization), underwater plants, surface plants, nutrients cycle, and resident actions (Appendix B – Educational Signs). The signs costed approximately $1,400 each for simple design touchups, fabrication, and delivery.

True Blue™ was initially applied May 3. Three re-application treatments occurred: June 7, June 29 and August 1. Re-application dates were chosen due to high precipitation events and degradation of the colour.

The four SWMFs were sampled May 3 prior to the treatment being applied and occurred every two weeks with October 4 being the last sampling date.

The cost of the project associated with the application of the aquatic colorant is estimated at $18,339. This does not include the time to manage the project and compile this report. The total project cost can be broken down into the following costs:

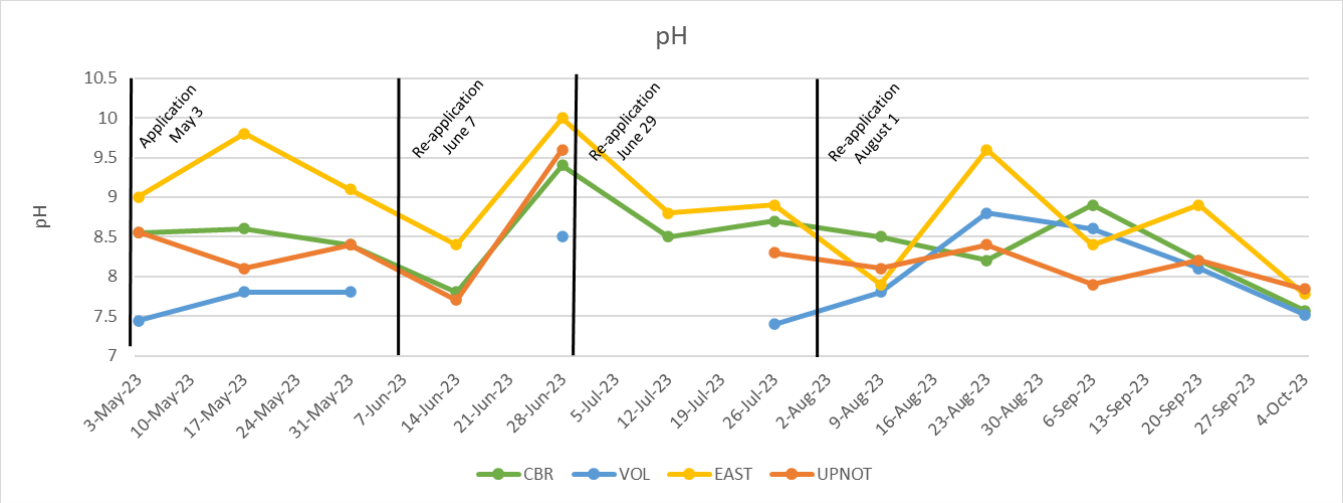
- Two staff members taking approximately 3 hours per site to apply the product, using an operator rate of $30.27/hour ($2,906)
- One staff member taking approximately 2 hours per site for the drone fly-over, using a rate of $48.00/hour ($816)
- Approximately 6.5 jugs of product being used per application, at a rate of $99.00 per jug ($5,192)
- Laboratory analysis of parameters of concern at all four sites ($6,545)
- Two staff members taking approximately 3 hours to complete the sampling every two weeks, using a rate of $48.00/hour ($2,880)

pH

As algae grows, pH can also rise rapidly, related to the consumption of dissolved carbon dioxide (YSI 2021).

Guideline: pH values should be within 6.5 – 9.0 and should not alter more than 0.5 units from background levels.

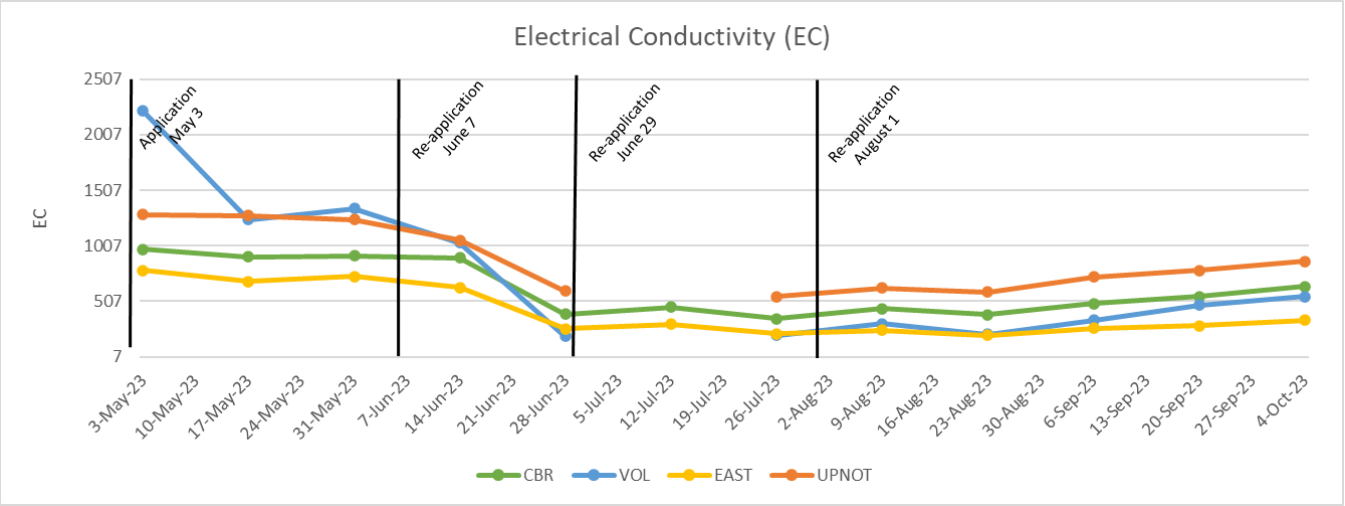
pH at all four sites fluctuated more than 0.5 units. However, fluctuations and maximum values were greater at the control sites, EAST and UPNOT.



Electrical Conductivity (EC)

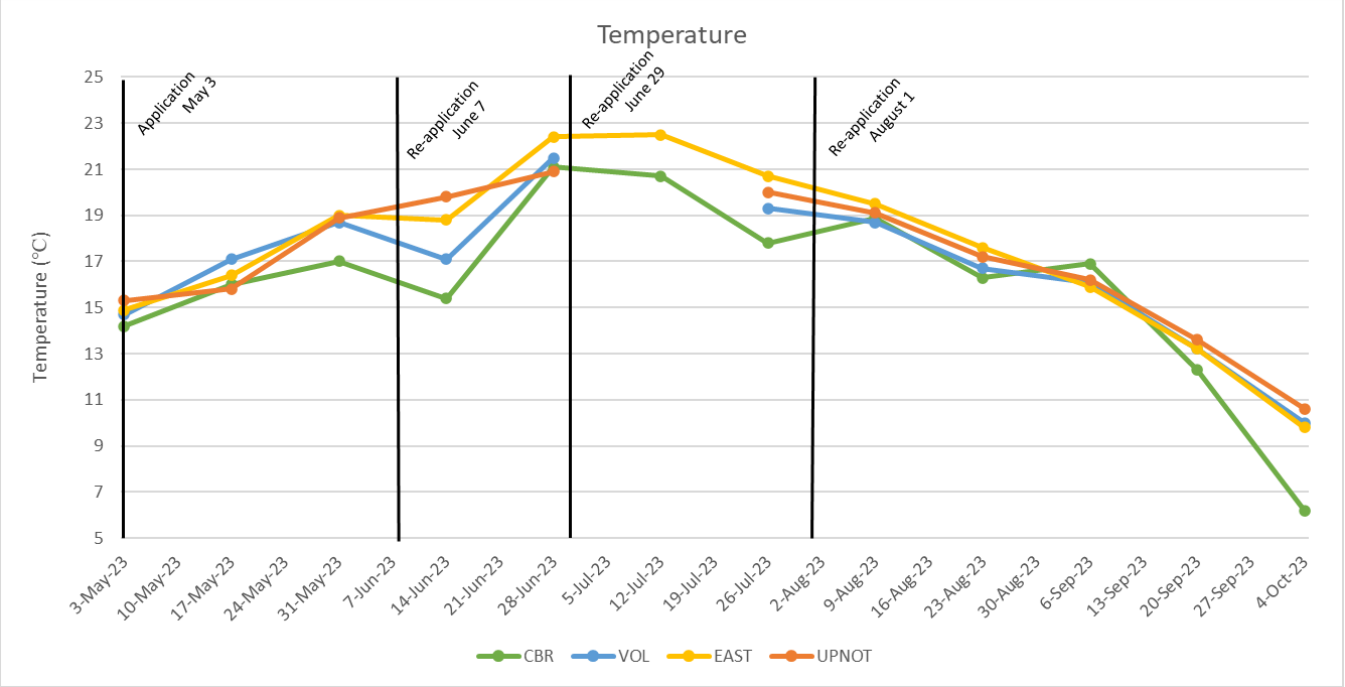
Lower conductivity can be favorable to blue-green algae growth (YSI 2021).

Trends in conductivity values were similar at all four sites. UPNOT generally had the highest values, while EAST generally had the lowest values. As these were both the control sites, there are not many insights from looking at the conductivity data.



Temperature

The temperatures of the water were very similar across the four sites, however, the two control sites, EAST and UPNOT, were generally slightly higher. The treatment sites, CBR and VOL, would be expected to have lower temperatures, as the aquatic dye applied shades the water (Ludwig 2010).

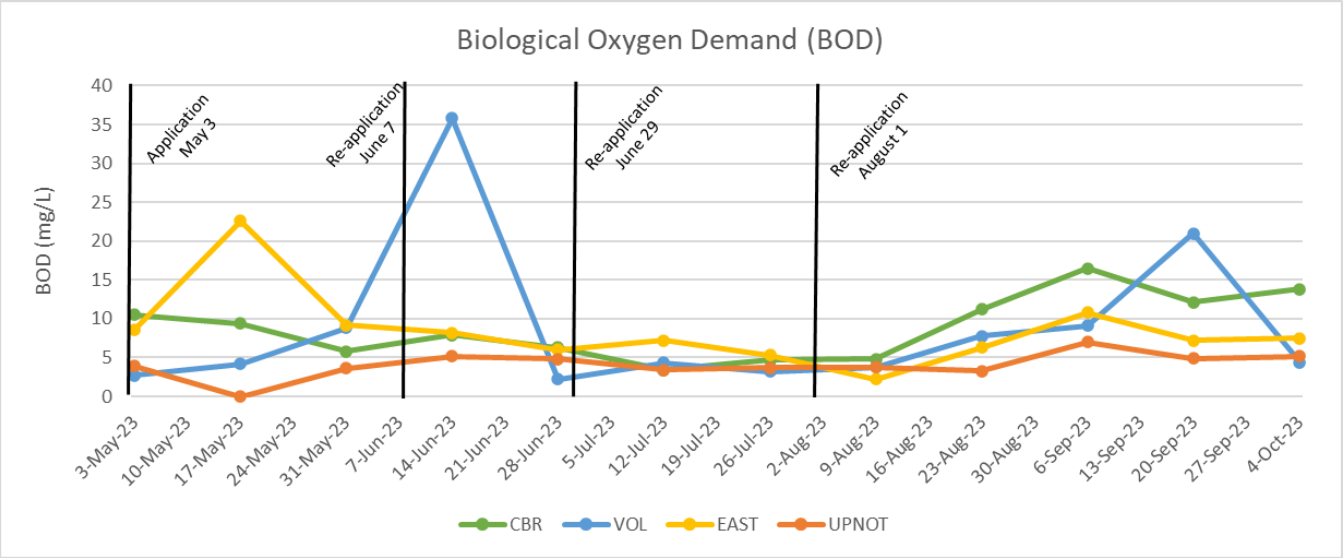


Biological Oxygen Demand (BOD) & Dissolved Oxygen

Dissolved oxygen is the amount of oxygen present in the water through plant

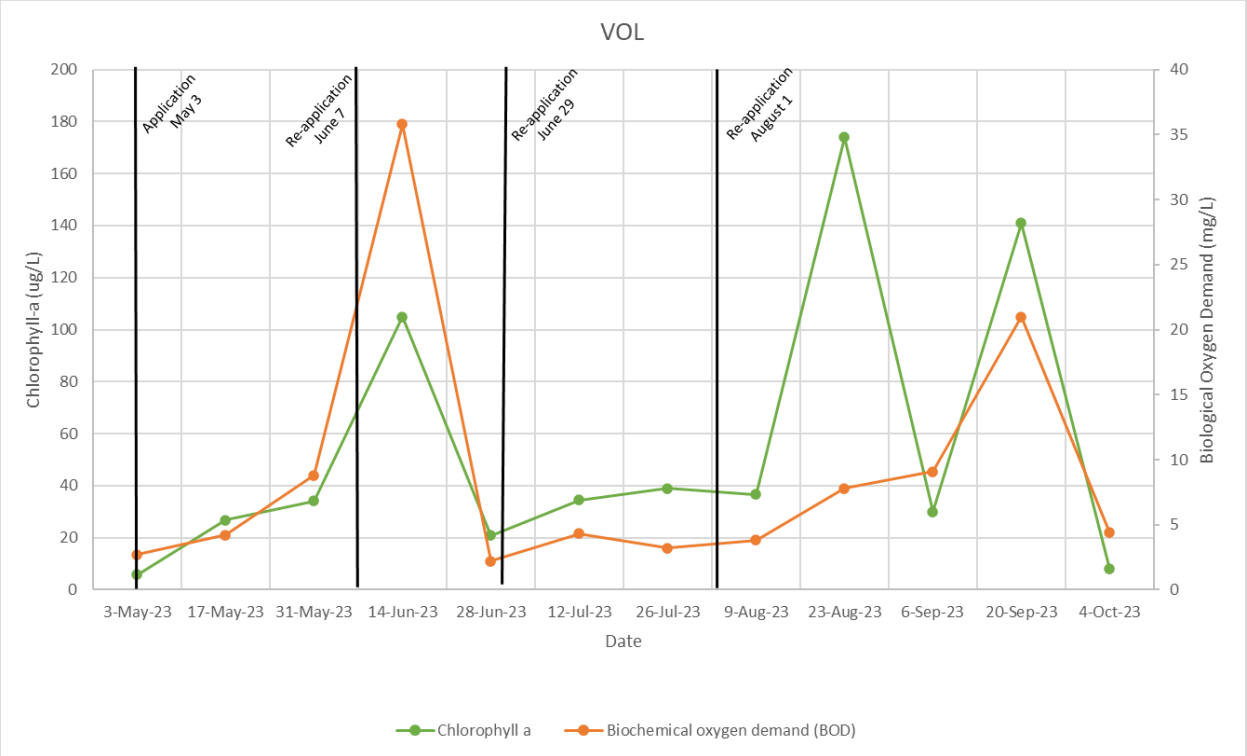
photosynthesis and interactions with the atmosphere. It is required for aerobic respiration of aquatic organisms. As algae grows, it can also cause declines in dissolved oxygen, as it can be consumed both by algae blooms and the bacteria involved with algae decomposition (YSI 2021).

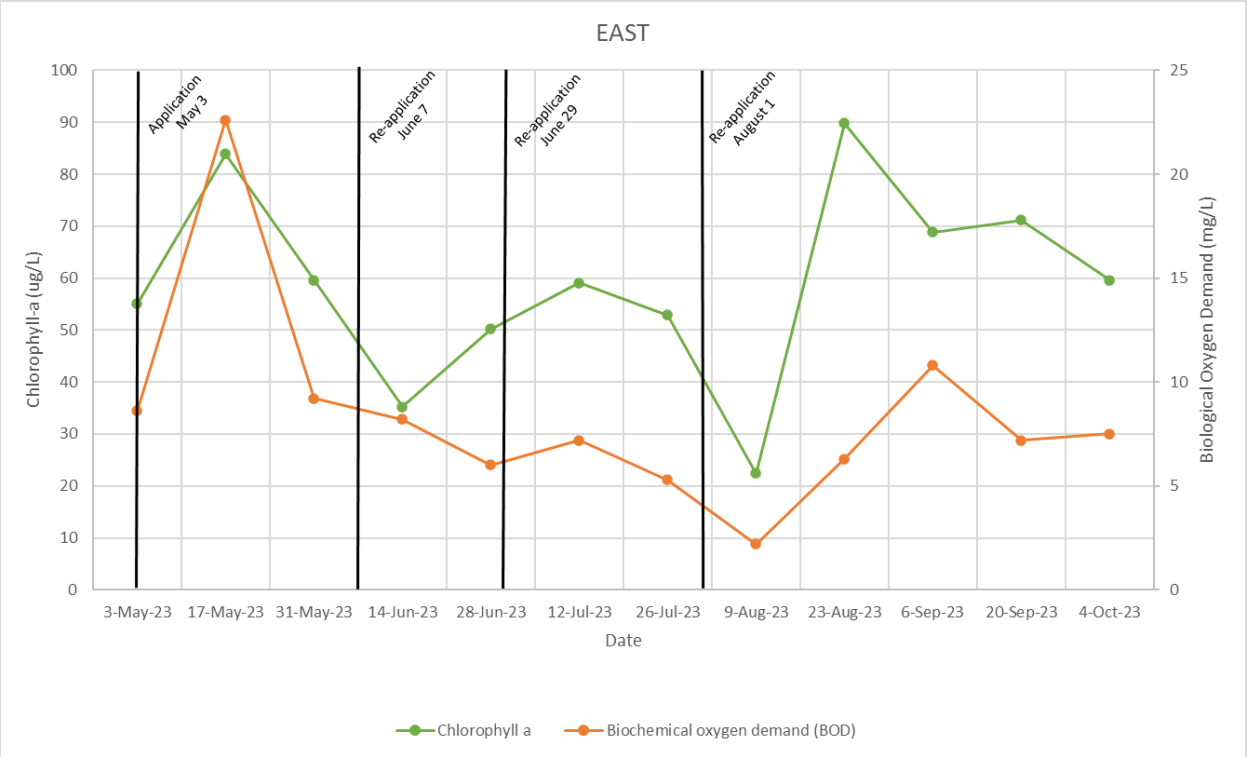
BOD is a measure of the amount of oxygen needed for microorganisms to convert organic matter to inorganic matter. BOD and DO are related, as high BOD levels can disrupt the ecosystem and can cause large swings in DO. In addition, the death and decay of algae can lead to decreased concentrations of dissolved oxygen. High chlorophyll-a levels can cause decreased levels of DO.

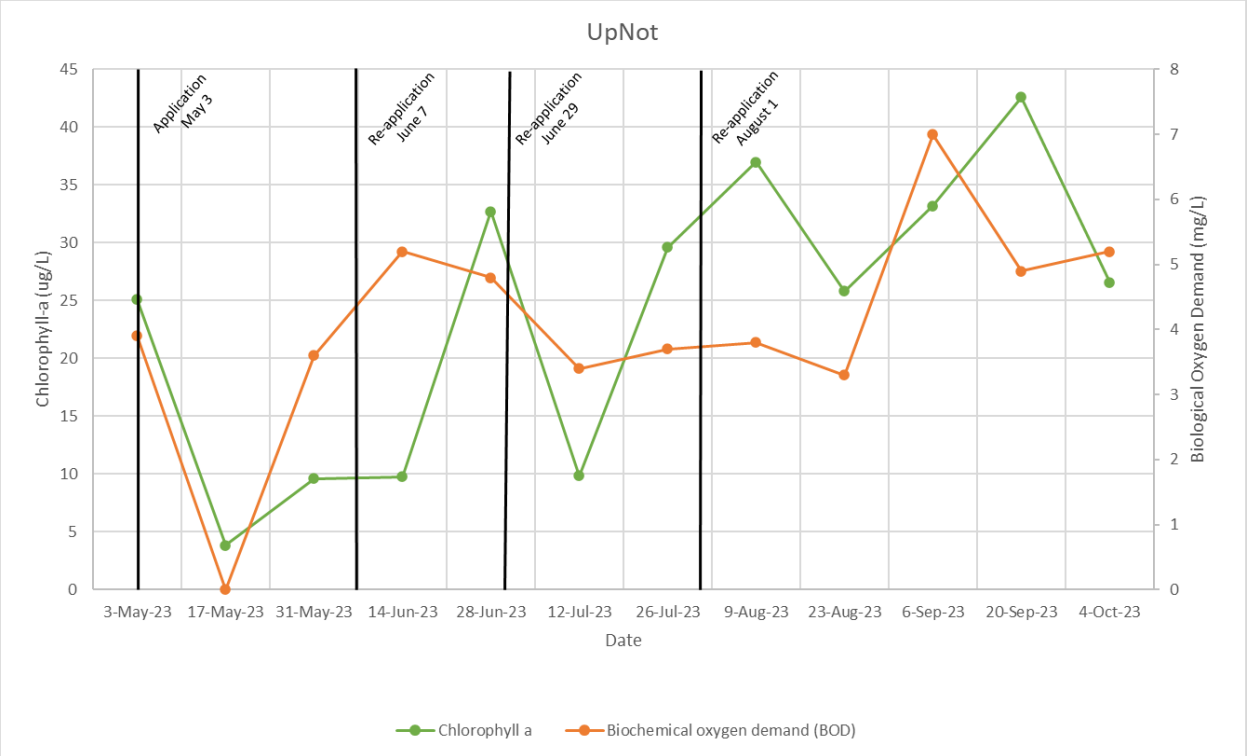


There appears to be a correlation between BOD and chlorophyll-a levels.


CBR
Application May 3
Re-application June 7
Re-application June 29
Re-application August 1
Chlorophyll-a (ug/L)
Biological Oxygen Demand (mg/L)
0
20
40
60
80
100
120
140
0
2
4
6
8
10
12
14
16
18
3-May-23
17-May-23
31-May-23
14-Jun-23
28-Jun-23
12-Jul-23
26-Jul-23
9-Aug-23
23-Aug-23
6-Sep-23
20-Sep-23
4-Oct-23
Date
Chlorophyll a
Biochemical oxygen demand (BOD)


VOL
Application May 3
Re-application June 7
Re-application June 29
Re-application August 1
Chlorophyll-a (ug/L)
Biological Oxygen Demand (mg/L)
0
20
40
60
80
100
120
140
160
180
200
0
5
10
15
20
25
30
35
40
3-May-23
17-May-23
31-May-23
14-Jun-23
28-Jun-23
12-Jul-23
26-Jul-23
9-Aug-23
23-Aug-23
6-Sep-23
20-Sep-23
4-Oct-23
Date
Chlorophyll a
Biochemical oxygen demand (BOD)


EAST
Application May 3
Re-application June 7
Re-application June 29
Re-application August 1
Chlorophyll-a (ug/L)
Biological Oxygen Demand (mg/L)
3-May-23
17-May-23
31-May-23
14-Jun-23
28-Jun-23
12-Jul-23
26-Jul-23
9-Aug-23
23-Aug-23
6-Sep-23
20-Sep-23
4-Oct-23
Date
Chlorophyll a
Biochemical oxygen demand (BOD)

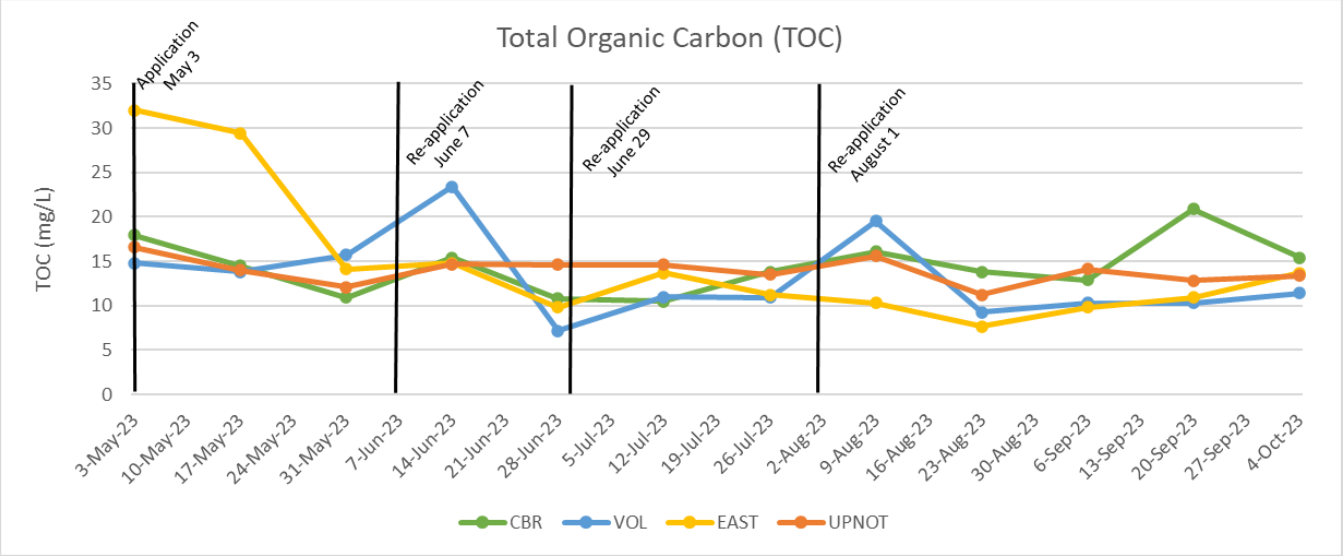

UpNot
Application May 3
Re-application June 7
Re-application June 29
Re-application August 1
Chlorophyll-a (ug/L)
Biological Oxygen Demand (mg/L)
3-May-23
17-May-23
31-May-23
14-Jun-23
28-Jun-23
12-Jul-23
26-Jul-23
9-Aug-23
23-Aug-23
6-Sep-23
20-Sep-23
4-Oct-23
Date
Chlorophyll a
Biochemical oxygen demand (BOD)

Total Organic Carbon (TOC)

Nguyen et al (2005) found that algae growth contributes to Total Organic Carbon (TOC), which is a measurement of the organic matter present within the water (BC Environment 1998). While the CCME does not have organic carbon guidelines, BC Environment have developed proposed guidelines (1998). In developing the guidelines, they found that generally, surface waters see TOC concentrations less than 10 mg/L (BC Environment 1998). Reductions in TOC can impact productivity and increase susceptibility of the ecosystem to toxicity and acidification effects (BC Environment 1998). Increases in TOC can also be detrimental, as it may increase bacterial activity associated with decomposition to the point of depleting oxygen available in the water (BC Environment 1998).

Guideline: The proposed guideline focuses more on the change from seasonally-adjusted median background levels.

UPNOT had the most consistent TOC levels, while EAST saw the greatest fluctuations. There appears to be little connection between the treatment and TOC stability.



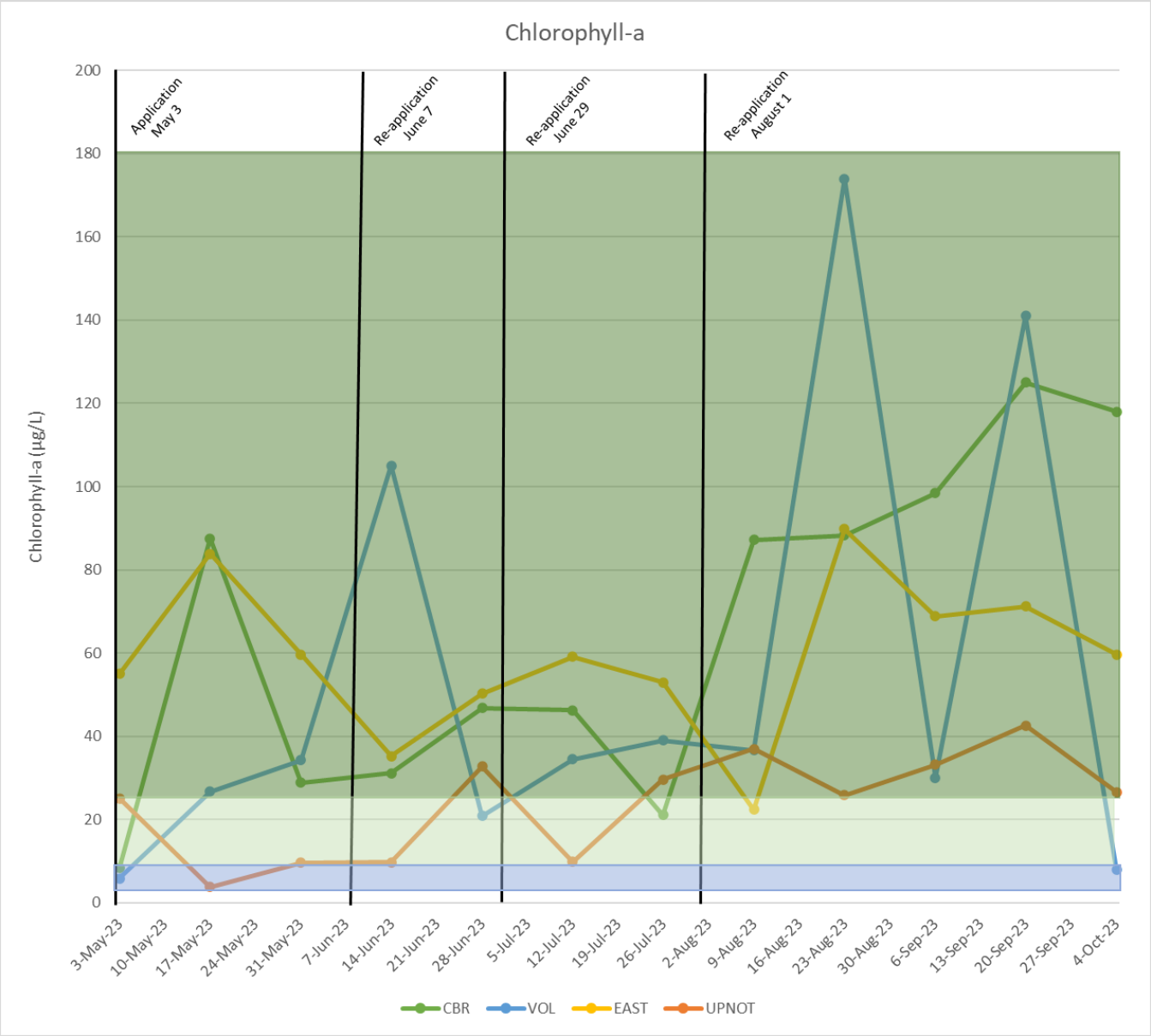
Chlorophyll-A

Chlorophyll-a is a common proxy parameter to monitor algae, or phytoplankton (de Winton M et. a., 2013). Chlorophyll is a pigment found in most algae and is a common method of monitoring the growth of algae in aquatic systems (YSI 2014, YSI 2021). "Chlorophyll-a is the most abundant form of chlorophyll within photosynthetic organisms" (YSI 2014).

Guideline:

Trophic State	Chlorophyll-a (µg/L)
Oligotrophic	<3.5
Mesotrophic	3.5-9
Eutrophic	9-25
Hypereutrophic	>25

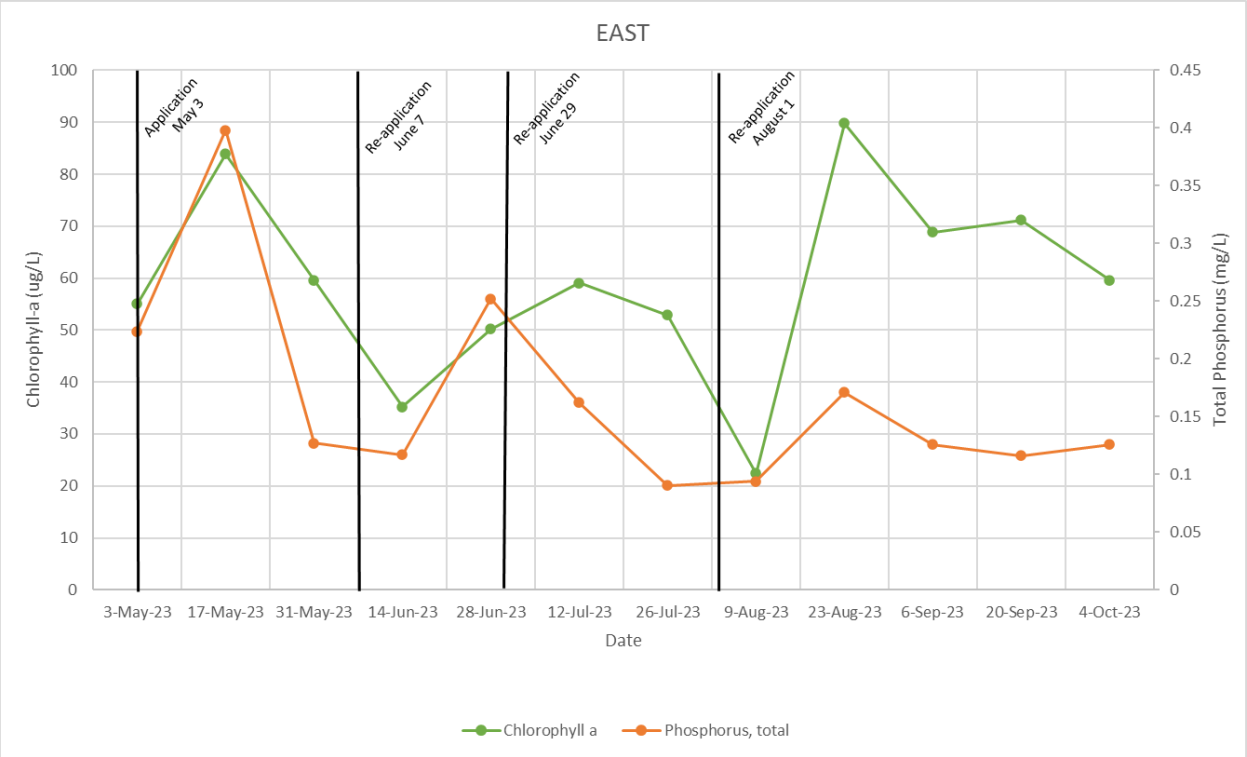
The majority of values were in the hypereutrophic state. VOL had the highest chlorophyll-a values. There is no observable trend in comparing the application sites (CBR, VOL) to the control sites (EAST, UPNOT) or in comparing the chlorophyll-a values before and after application events. The shading provided by the aquatic colourant appears to not have impacted the algae growth, as demonstrated by chlorophyll-a levels.

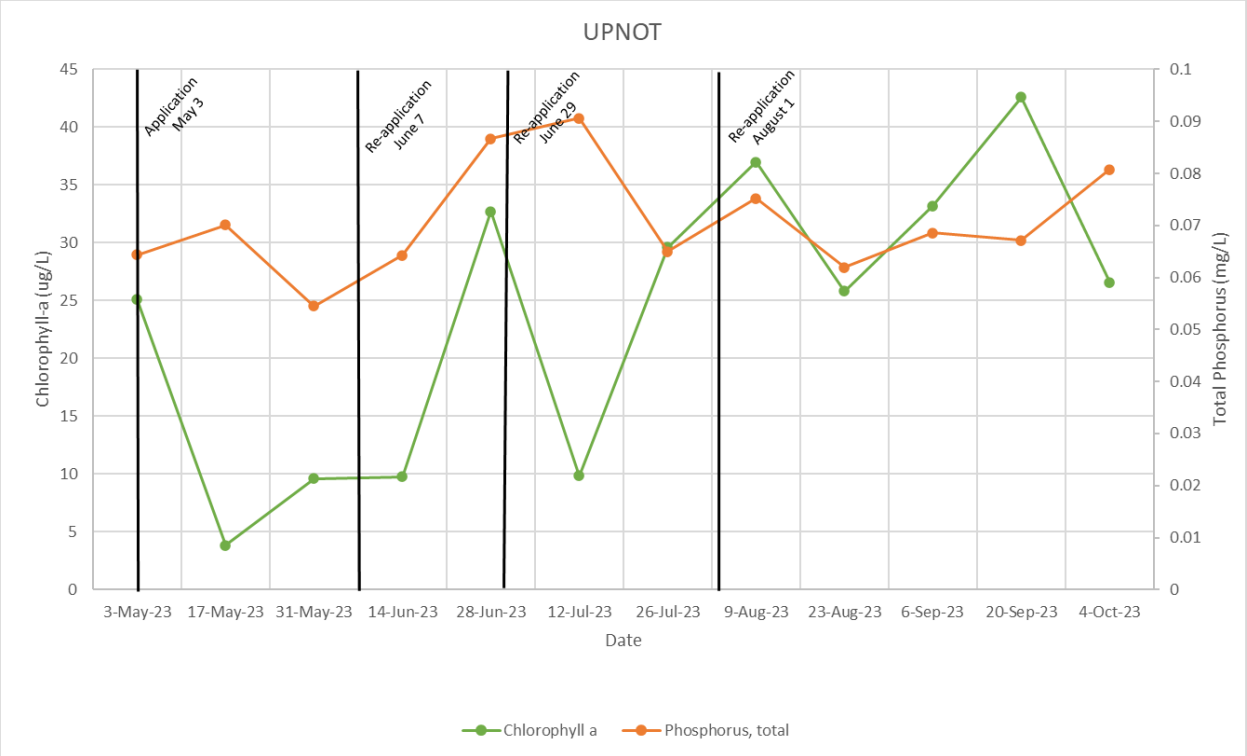


While not a direct comparison, it has been found that in freshwater lakes, there is a close link between chlorophyll-a levels and the concentration of phosphorus (AEPA 2024). That was observed at all four sites.


CBR
Application May 3
Re-application June 7
Re-application June 29
Re-application August 1
Chlorophyll-a (ug/L)
Total Phosphorus (mg/L)
0
20
40
60
80
100
120
140
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
3-May-23
17-May-23
31-May-23
14-Jun-23
28-Jun-23
12-Jul-23
26-Jul-23
9-Aug-23
23-Aug-23
6-Sep-23
20-Sep-23
4-Oct-23
Date
Chlorophyll a
Phosphorus, total


VOL
Application May 3
Re-application June 7
Re-application June 29
Re-application August 1
Chlorophyll-a (ug/L)
Total Phosphorus (mg/L)
0
20
40
60
80
100
120
140
160
180
200
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
3-May-23
17-May-23
31-May-23
14-Jun-23
28-Jun-23
12-Jul-23
26-Jul-23
9-Aug-23
23-Aug-23
6-Sep-23
20-Sep-23
4-Oct-23
Date
Chlorophyll a
Phosphorus, total


EAST
Application May 3
Re-application June 7
Re-application June 29
Re-application August 1
Chlorophyll-a (ug/L)
Total Phosphorus (mg/L)
3-May-23
17-May-23
31-May-23
14-Jun-23
28-Jun-23
12-Jul-23
26-Jul-23
9-Aug-23
23-Aug-23
6-Sep-23
20-Sep-23
4-Oct-23
Date
Chlorophyll a
Phosphorus, total


UPNOT
Application May 3
Re-application June 7
Re-application June 29
Re-application August 1
Chlorophyll-a (ug/L)
Total Phosphorus (mg/L)
3-May-23
17-May-23
31-May-23
14-Jun-23
28-Jun-23
12-Jul-23
26-Jul-23
9-Aug-23
23-Aug-23
6-Sep-23
20-Sep-23
4-Oct-23
Date
Chlorophyll a
Phosphorus, total

Nutrients

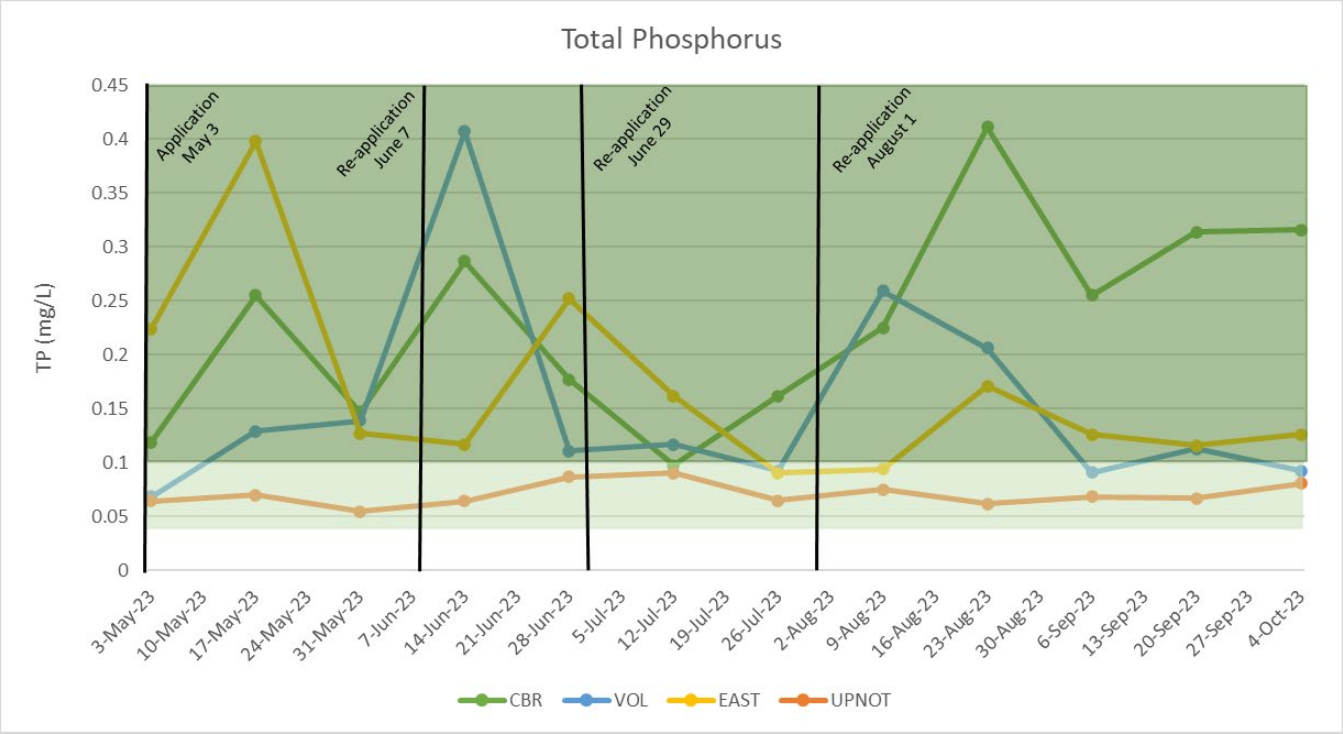
"Ammonium, nitrate, total nitrogen, and total phosphorus can all be useful parameters, as they can stimulate the growth of potentially toxic blue-green algae" (YSI 2021).

Total Phosphorus

Guideline: Narrative. Concentrations should be maintained.

Trophic State	TP (mg/L)
Oligotrophic	<0.01
Mesotrophic	0.01-0.03
Eutrophic	0.03-0.1
Hypereutrophic	>0.1

The majority of TP values were in the hypereutrophic state. CBR and VOL generally had the highest TP values. UPNOT generally had the most consistent TP values. As shading does not have an affect on the amount of phosphorus entering the system, there is no observable trend in TP values with the application dates, as expected.

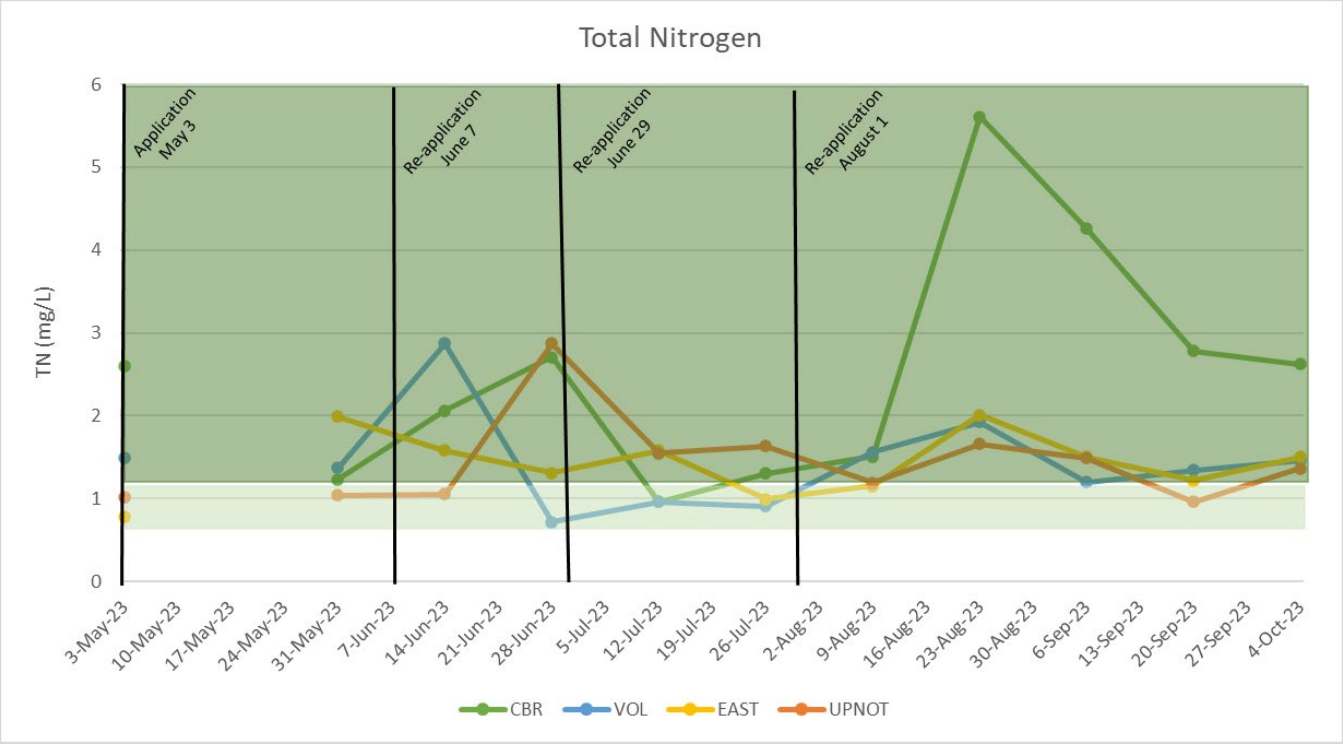


Total Nitrogen

Guideline: Narrative. Concentrations should be maintained.

Trophic State	TN (mg/L)
Oligotrophic	<0.35
Mesotrophic	035-0.65
Eutrophic	0.65-1.2
Hypereutrophic	>1.2

The majority of TN values were in the hypereutrophic state. CBR has the greatest fluctuation of TN values, although this primarily occurs in the later part of the season, from mid-August to October. Comparatively, TN values at the other sites appear to have flattened out in the later part of the season, from late-July to October. As shading does not have an affect on the amount of nitrogen entering the system, there is no observable trend in TN values with the application dates, as expected.



Discussion

The role of the SWMF network must remain central when discussing the management goals and objectives. As described in de Winton et al (2013), the primary role of SWMFs is the management of water, or the protection against flooding and risk to the environment. Auxiliary roles include other ecosystem services and then amenity values. As defined in the Design and Construction Standards, SWMFs are areas designed to collect and retain stormwater runoff for the purpose of flood prevention and/or improving water quality prior to release back into natural waterways (Strathcona County 2023). The Design and Construction Standards focus on encouraging naturalized systems that mimic wetlands to further elevate the focus from water quantity management to include ecosystem services (Strathcona County 2023). Stormwater in Strathcona County is managed using a watershed approach and focuses first on managing water quality and quantity (Strathcona County 2021). The implementation of Best Management Practices, then looks to protection of aquatic ecosystems (Strathcona County 2021).

Aquatic vegetation can help assist in reaching the primary and secondary objectives of the SWMFs by retaining water, providing habitat or food, and processing or retaining nutrients and contaminants (de Winton et al 2013). Furthermore, they are natural and integral components of aquatic ecosystems. The negative impact of algae and other floating aquatic vegetation on the primary role of SWMFs as managing water quantity and quality is quite limited. Yet there are times, particularly in instances of excessive growth, where algae blooms can be toxic and disruptive to the natural ecosystem.

Therefore, the situations where aquatic vegetation requires active management depends also on ecological, economic, and social considerations, as SWMFs are perceived as more than managing water quantities (de Winton et al 2013). Some of the public concerns

related to aquatic vegetation, arises from odours from decaying material and the perceived connection to health (de Winton et al 2013).

Many management actions have been taken, primarily at CBR, to combat the social perceptions. These actions have included the use of aquatic colorants, along with the fountains and use of solar bees. The cost of fountain replacement is approximately $20,000 per fountain. The solar bees offer minimal treatment, however the annual cost is minimal, as it is restricted to annual maintenance.

The issue of algae blooms is summarized succinctly in the review by de Winton et al (2013):

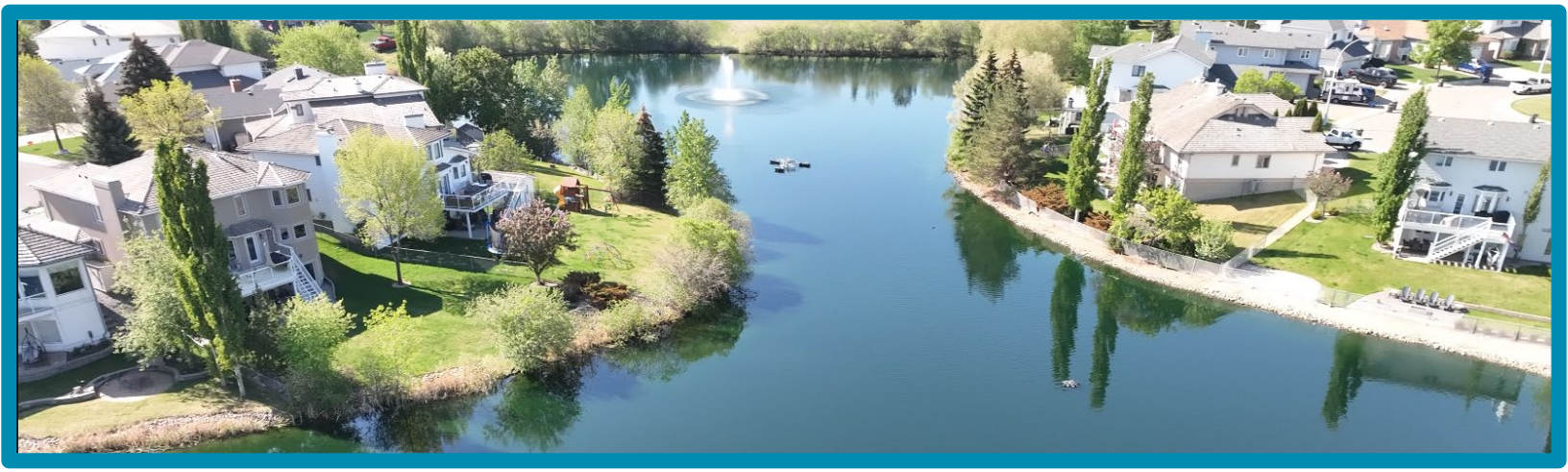
> *Highly eutrophic water bodies are particularly susceptible to algae blooms, and reduction of nutrient inputs from the catchment is a critical management action to reduce the incidence of algae blooms. However, nutrients may accumulate in sediments, and then be slowly released into the water column, enhancing algal growth even when nutrient inputs from the catchment have been minimised. In this situation, if algal growth has been determined to be a problem, then other management options may also be required to reduce the occurrence of algae blooms.*

The review by de Winton et al (2013) looked at a number of control options, however, acknowledged that many of them, including shading by dyes, "have not been rigorously tested or proven under the conditions expected in stormwater systems". Additionally, it was found that the "most common use for aquatic dyes is for aesthetic reasons in ornamental and golf course ponds" (de Winton et al 2013). The effect of shading remains unclear, as research into the effect on problematic plants and algae is very limited (de Winton et al 2013).

Two studies were reviewed that looked at the effect of Aquashade®, however, neither showed reduction of algal growth, particularly at the recommended application rate (Spencer 1984, Ludwig 2010).

The following aquatic colorants have been used in Strathcona County:

- Aquashade: "Aquashade contains a blend of blue and yellow dyes designed to absorb specific wavelengths of light critical to plant photosynthesis" (Aquashade®).
- Wavex: "WAVEX is a flexible, concentrated non-toxic water colorant. It creates a beautiful natural appearance for lakes and ponds. This product is an excellent complement to the beauty of golf courses and park fountains and large aquariums"



(WAVEX). "Application of dye helps block UV rays entering a pond that is necessary to unwanted submerged aquatic plants and algae."

- Oasis: "OASIS is a flexible, concentrated non-toxic water colorant. It creates a beautiful natural appearance for lakes and ponds. This product is an excellent complement to the already existing beauty of golf courses and park fountains" (Oasis™).

- True Blue: "True Blue Liquid Pond Dye: helps filter out sunlight; is ideal for closed and non-flowing bodies of water; creates an aesthetically pleasing blue colour for pond and lake water; can be sed safely around fish, plants, birds, swimming ponds, irrigation, and other wildlife when used according to label directions; liquid form allows for ease of measurement and controlled applications of colour" (True Blue™).

Aquashade® is registered for aquatic use with the United States Environmental Protection Agency (EPA 2005). It is unclear of whether any of the other aquatic colorants used have the dyes referenced in Aquashade®. While previously registered for use in Canada, its registration expired in 2004 and it is no longer available for use in Canada.

The results from the 2023 pilot program generally are not supportive of the claim that the addition of aquatic colorants reduces algae growth. A stronger relationship between nutrients levels, such as total phosphorus, and chlorophyll-a levels was observed than a relationship between the application of True Blue™ and chlorophyll-a levels. This was also supported by observations made throughout the experiment – as visible algae was most frequently observed at CBR and VOL.

However, there may have been an impact of the dye on the shading of the water, as the control sites had slightly higher temperatures than the treatment sites. The significance of this was not investigated.

While it is possible that the addition of the aquatic colorant may have an impact on algae growth, the impact of nutrient levels may simply be more significant.

Recommendations

The practice of using aquatic colorants within the stormwater management network should be discontinued, as there is little documented evidence regarding the effectiveness of applying aquatic colorants to reduce algal growth, particularly within the stormwater management context.

A clear definition should be developed for when algal growth is considered a problem, based on water quality and quantity. The primary response to problematic algal growth should focus on the reduction of nutrients into the stormwater system.

When problematic facilities are identified, management actions should focus on larger catchment-scale practices to avoid further development of algal and other aquatic plant problems. These practices should focus on the reduction of nutrient sources and sediment to stormwater (de Winton M et. al, 2013).

Additionally, resident education, such as through future Pond Parties and signage, should be used to focus on individual actions that can be taken to reduce nutrient input into the stormwater systems. These should include reducing or eliminating the use of synthetic fertilizers and increasing the naturalized shoreline buffer.

The use of aquatic colorants may be effective at reducing the perceived aquatic vegetation problem. However, as it does not address the primary role of the SWMFs, the use of aquatic colorants for aesthetic purposes would need to be part of a level of service discussion with Council.

The use of other management actions at SWMFs with a primarily aesthetic purpose, such as fountains, should be re-visited and should be part of the larger service level discussion with senior administration and Council.

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Appendix A – Letter to Residents

April 2023

RE: Aquashade treatment to control algae growth

Dear Resident,

Strathcona County will be applying a vegetable-based dye to two stormwater ponds in Sherwood Park during the first week of May. The dye, called Aquashade, will be applied to Village on the Lake and Clover Bar Ranch stormwater management facilities. Further applications may occur throughout the summer as the concentration of the dye may drop over time, especially after heavy rainfall.

Aquashade has previously been used for algae/vegetation control in County stormwater management facilities, but results have been mixed. This year the County is performing a controlled experiment to study the effects of its application to help inform whether treatment with Aquashade should continue in the future. If the results show that it has minimal benefit, applications will not continue in future years.

Following the application, you may notice an aqua-blue color to the water. The color tint will vary somewhat depending upon depth, sediment on the bottom and the bottom color. Please keep pets away and avoid contact with the stormwater ponds during this time as the dye may stain fur, skin and clothes.

Algae requires sunlight to grow. The Aquashade dye is intended to temporarily block sunlight from the algae, slowing its growth and reducing the occurrence of the algal blooms on the pond. Other wildlife, including ducks, geese and pets will not be harmed by the blue dye, but feathers and fur may be temporarily discolored following contact with the water.

For more information, call Strathcona County Utilities at 780-467-7785.

Regards,

Randy Fisher, C.E.T.
Supervisor, Distribution & Collection
UTILITIES

Appendix B – Educational Signs


Floating plants
Producing food from pollution


Shoreline plants


Wetlands are doing their part ...And so can you!