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TECHNICAL UPDATE

Date: **10/26/18**

To: Lake & Pond Solutions

PROJECT: Brown's Channel
SAMPLE(s): "Inlet water" and "composite water"
Received: 10/09/18
Analyzed: 10/09/18 – 10/25/18
Sample analyzed by Michael Frett and Deborah Lee, Microbiologist, AQUAFIX
Sediment samples analyzed by Test America, Chicago

Problem(s): Perform water quality analysis and make recommendations for sediment reduction.

Ramp to inlet

Ramp to outlet

Picture of the Boat Ramp area. There did not appear to be much of the large aquatic snails covering the rocks observed in spring.

Picture of the inlet at the beginning of the channel. I have not observed water running over the weir before.

Water:

	BC - In	BC - In	BC - In	BC - In	BC – In	BC – In
	5/24/2016	10/18/2016	5/24/2017	9/27/2017	5/16/18	10/09/18
Conductivity (uS)	711.8	765.5	623.4	773.3	565.4	243.6
Salinity (NaCl) (‰)	0.347	0.375	0.295	0.3794	0.258	0.116
Total Dissolved Solids (ppm)	484	523.4	428.9	534.7	384.2	157.9
Oxidation Reduction Potential (mV)	146	157	241	214	204	220
pH	8.22	8.09	8.17	8.21	8.23	7.98
At Temperature (C)	22.5	21.9	15.4	17	19.7	21.5
NH_3 (ppm)	0.06	0.10	0.10	0.01	0.03	0.08
NO_2 (ppm)	0.023	0.028	0.02	0.03	0.013	0.013
NO_3 (ppm)	2.5	3	1.8	3.9	1.5	0.8
PO_4^{3-} (ppm)	0.39	0.51	0.37	0.25	0.46	0.38
Total Iron, undigested (ppm)	0.06	0.04	0.05	0.08	0.03	0.18
SiO_2 (ppm)	8.4	6.5	8.6	15.6	5.6	5.5
Total Hardness (ppm as $CaCO_3$)	372	416	336	428	296	112
Calcium Hardness (ppm as $CaCO_3$)	152	208	128	224	112	4
Magnesium Hardness (ppm as $CaCO_3$)	220	208	208	204	184	108
Total Alkalinity (ppm as $CaCO_3$)	336	364	260	364	292	424
Phenolphthalein Alkalinity (ppm as $CaCO_3$)	0	0	0	0	0	0

	BC - out	BC - out	BC - all	BC - out	BC – out	BC – out
	5/24/2016	10/18/2016	5/24/2017	9/27/2017	5/16/18	10/09/18
Conductivity (uS)	686	684.9	623.6	583.1	578.5	256.5
Salinity (NaCl) (‰)	0.333	0.333	0.2951	0.2695	0.266	0.123
Total Dissolved Solids (ppm)	465.9	467.8	428.9	399.8	393.3	166.2
Oxidation Reduction Potential (mV)	149	144	249	215	205	219
pH	8.2	7.87	8.17	8.27	8.11	7.76
At Temperature (C)	22.6	20.3	16	17.7	19.6	21.6
NH_3 (ppm)	0.02	0.19	0.25	0.05	0.15	0.07
NO_2 (ppm)	0.026	0.045	0.025	0.029	0.019	0.015
NO_3 (ppm)	1.6	2.5	1.8	1	0.7	1.0
PO_4^{3-} (ppm)	0.22	0.36	0.37	0.07	0.43	0.38
Total Iron, undigested (ppm)	0.06	0.06	0.04	0.03	0.02	0.18
SiO_2 (ppm)	6.7	12.6	7.7	5.6	6.0	5.8
Total Hardness (ppm as $CaCO_3$)	336	300	320	300	272	120
Calcium Hardness (ppm as $CaCO_3$)	144	92	120	108	76	4
Magnesium Hardness (ppm as $CaCO_3$)	192	208	200	192	196	116
Total Alkalinity (ppm as $CaCO_3$)	300	256	248	224	268	96
Phenolphthalein Alkalinity (ppm as $CaCO_3$)	0	0	0	0	0	0

Summary

- Brown's Channel had murky water with low visibility during this sampling time. This is probably due to the high amount of rainfall that had been occurring leading to constant inflow of upstream particles. There were still lots of aquatic plants still growing. Both submerged plants (Coontail, Eelgrass, and Eurasian watermilfoil) and floating/floating leaf plants (Duckweed and water lily) were still relatively healthy at this time. There were also a lot of floating tree leaves on the water surface and recently sunk to the bottom of the channel. There may have still been some filamentous green algae attached to the submerged plants.

- Water grab samples were taken at the inlet of the channel and at the outlet of the channel about 2 feet above the sediments. The water grab samples were analyzed as discrete samples. The inlet water and outlet water were pretty similar in composition. The pH in the water samples were in a good range for aquatic life. The pH of the samples collected on 10/9/18 were a little lower than in previous years. This may be due to increased flow through in this system. The ammonia, nitrite and nitrate in both water samples may be a little lower than previously observed in fall. This could be due to fast flow though at the time of sampling and the months before. The amount of orthophosphours in these samples are about the same as spring and fall in previous years and may be due to incoming particulates that are more likely to occur with high rain and washout events. I'm not entirely certain why the hardness decreased in the water of Brown's Channel, but it could be due to very high increases in rain water, which tends to be more acidic and less hard than surface water. This may have also caused the alkalinity to decrease at the outlet.

- It looks like Brown's Channel had experienced pretty heavy washout prior to the fall sampling for this year. The water levels upstream of Brown's Channel may still be rather high since we observed water flowing over the weir at this sampling time and there was a noticeable current through the channel.

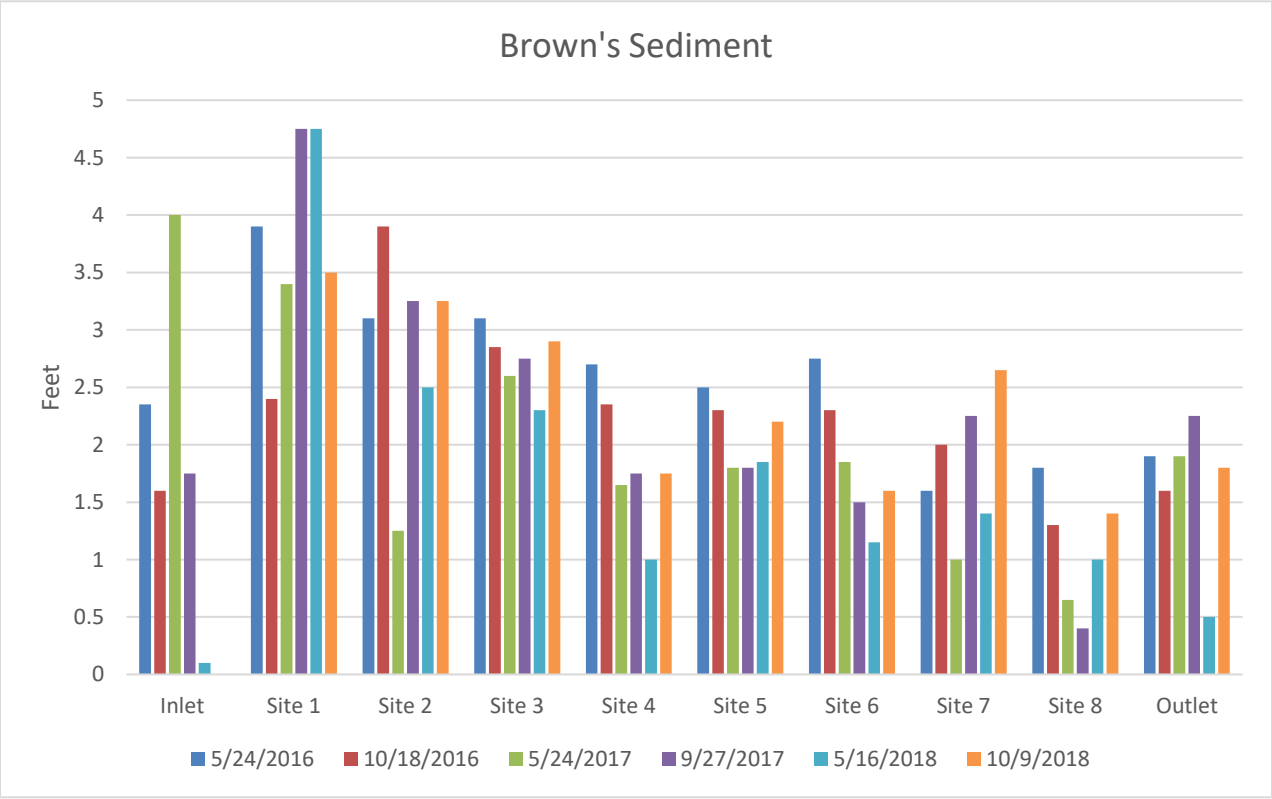
Field Data

Site	Date	Water Depth (ft)	Sludge depth (ft)	sludge color	Sludge texture
Inlet	6/2/2015	1		gray/black	clay
Inlet	9/25/2015	3.5		black	clay
Inlet	5/24/2016	2.5	2.35	black	fine
Inlet	10/18/2016	2.75	1.6	black	clay
Inlet	5/24/2017	1	4	black	clay
Inlet	9/27/17	3.25	1.75	Black	clay
Inlet	5/16/18	5.5	0.1	Dk brown	silt
Inlet	10/9/18	5.9	0	None	None
Site 1	5/24/2016	1.4	3.9	black	fine
Site 1	10/18/2016	1.6	2.4		
Site 1	5/24/2017	1.5	3.4	black	clay
Site 1	9/27/17	1.25	4.75	Black	clay
Site 1	5/16/18	1.75	4.75	Black	silt
Site 1	10/9/18	2.6	3.5	Grey	Silt
Site 2	5/24/2016	3.5	3.1	black	fine
Site 2	10/18/2016	3.25	3.9	black	clay
Site 2	5/24/2017	3.5	1.25	black	clay

Site 2	9/27/17	2.75	3.25	Black	clay
Site 2	5/16/18	3.6	2.5	Black	Silt
Site 2	10/9/18	3.5	3.25	Grey	Silt
Site 3	5/24/2016	4.15	3.1	black	fine
Site 3	10/18/2016	4	2.85		
Site 3	5/24/2017	3.9	2.6	black	clay
Site 3	9/27/17	3.75	2.75	Black	clay
Site 3	5/16/18	3.6	2.3	Black	silt
Site 3	10/9/18	3.9	2.9	Black	Clay
Site 4	5/24/2016	4.3	2.7	black	fine
Site 4	10/18/2016	4.4	2.35	black	clay
Site 4	5/24/2017	4.75	1.65	black	clay
Site 4	9/27/17	4.75	1.75	Black	clay
Site 4	5/16/18	4.75	1	Black	clay
Site 4	10/9/18	4.75	1.75	Black	Clay
Site 5	5/24/2016	5.5	2.5	black	fine
Site 5	10/18/2016	5.1	2.3		
Site 5	5/24/2017	5.2	1.8	black	clay
Site 5	9/27/17	5	1.8	Black	clay
Site 5	5/16/18	4.4	1.85	Black	clay
Site 5	10/9/18	4.2	2.2	Black	Clay
Site 6	5/24/2016	6.1	2.75	black	fine
Site 6	10/18/2016	5.6	2.3	black	clay
Site 6	5/24/2017	4.75	1.85	black	clay
Site 6	9/27/17	5.25	1.5	Black	clay
Site 6	5/16/18	5.25	1.15	Black	clay
Site 6	10/9/18	5.1	1.6	Black	Clay
Site 7	5/24/2016	5.6	1.6	black	fine
Site 7	10/18/2016	5.7	2		
Site 7	5/24/2017	5.1	1	black	clay
Site 7	9/27/17	4.25	2.25	Brown	clay
Site 7	5/16/18	4.5	1.4	Black	clay
Site 7	10/9/18	4.1	2.65	Black	Clay
Site 8	5/24/2016	6	1.8	black	fine
Site 8	10/18/2016	5.5	1.3	black	clay
Site 8	5/24/2017	5.25	0.65	black	clay
Site 8	9/27/17	5.5	0.4	Brown	clay
Site 8	5/16/18	5.1	1	Black	Clay
Site 8	10/9/18	5.1	1.4	Black	Clay
Site 9	5/24/2016	5.75	1.8	black	fine
Site 9	10/18/2016	5.25	1		
Outlet	5/24/2016	5.8	1.9	black	fine
Outlet	10/18/2016	4.8	1.6	black	clay
Outlet	5/24/2017	4	1.9	black	clay
Outlet	9/27/17	3.75	2.25	Brown	clay

Outlet	5/16/18	5.4	0.5	Brown	clay
Outlet	10/9/18	4.6	1.8	Black	Clay

- The inlet site was dredged in summer this year. There does not appear to be any sediment there currently, not even sand.
- The sediments in site 1 and 2 are still more like silt than clay. Sediments in site 3 have returned to more a clay-like texture than the silty texture they had in spring of 2018. This could be due to settling of incoming particles and/or decaying plant life by fall 2018.
- The sediments in all of the other sites down the channel have slightly increased since spring 2018. Compared to fall 2017, we seem to have a slight increase in sediment levels.
- We seem to be back at sediment levels last seen in Fall 2016 (if you exclude the inlet site, which was dredged this summer).
- Overall we may be seeing sediment levels in Brown's Channel hold steady or slightly decrease. We are currently not at the peak sediment depth for any sites except site 7. Site 7 sediments seem to increase every fall and have been for the past three years. It may be that this site also grows more aquatic plant life than the other sites that die by fall and contribute to fall sediment increases at this site.
- Heavy rain and flooding events before the fall sampling time this year may have brought in an influx of particles that can contribute to sediment build up.
- There is a possibility that MD Pellets are helping to hold the sediment levels where they are, but the effect of MD Pellets seems to be highly dependent on rain evens and flow rate of the upstream water shed for Brown's Channel. With the heavy rains this year and last year, Brown's Channel may have seen a slight increase in sediment depths. Compared to the more moderate rain events of 2016, Brown's Channel may only see large sediment reduction with MD Pellets in years that are drier or at least in years with limited flooding events.



Sediment samples were sent to Test America, Chicago for analysis.

Name	BC - Inlet	BC - Inlet	BC - Inlet	BC - Inlet	BC- Inlet	BC – Site 1
Date	5/24/16	10/18/16	5/24/17	9/27/17	5/16/18	10/9/18
Total Solids (%)	22.0	20.0	22.0	28.0	46.0	36.0
Total Volatile Solids (%)	24.0	20.0	27.0	11.0	5.6	14.0
Total Organic Carbon (mg/Kg)	100,000.0	91,000.0	120,000.0	<600	29,000.0	48,000.0
Total Nitrogen (mg/Kg)	6,300.0	4,900.0	4,900.0	3,500.0	1,700.0	2,300.0
Total Kjeldahl Nitrogen (mg/Kg)	6,300.0	4,900.0	4,900.0	3,500.0	1,700.0	2,300.0
Nitrate (mg/Kg)	<2.0	<2.2	2.0	<2.0	1.6	<1.1
Total Phosphorus (mg/Kg)	1,500.0	1,500.0	1,600.0	420.0	640.0	460.0
Orthophosphate (mg/Kg)	38.0	25.0	36.0	11.0	12.0	25.0
Aluminum (mg/Kg)	10,000.0	9,000.0	7,500.0	7,000.0	5,600.0	6,700.0
Calcium (mg/Kg)	22,000.0	50,000.0	20,000.0	170,000.0	15,000.0	20,000.0
Copper (mg/Kg)	22.0	40.0	17.0	290.0	8.9	13.0
Iron (mg/Kg)	21,000.0	18,000.0	17,000.0	7,900.0	8,000.0	11,000.0
Magnesium (mg/Kg)	6,500.0	8,800.0	5,300.0	12,000.0	5,500.0	6,700.0

- **Sediment at Inlet**
  - This year used Site 1 as approximation for inlet, since inlet was dredged and did not have sediments at time of sampling.
  - Generally, nutrients decrease from spring to fall. In fall 2018 we all an increase in nearly all nutrients compared to spring 2018. We did see a decrease in total solids from spring to fall in 2018.
  - Compared to fall 2017, the amounts of total solids and total volatile solids has increased. Along with an increase in the amount or orthophosphate and iron. There appeared to me much more total organic carbon in fall 2018 than in fall 2017, although this may be due to an error with testing in fall 2017. The amount of total organic carbon is still lower than observed in fall 2016.
  - The amount of total nitrogen and total Kjeldahl nitrogen was lower in fall of 2018 than in fall 2017. The amounts of total phosphorus were about the same for fall 2018 and fall 2017.
  - Overall, there appears to be less nutrients in the sediments at the inlet than there was in fall 2016.
  - Aluminum has been steadily decreasing in the sediments since 2016. This could be due to formation of inorganic precipitate with other elements, such as phosphorus. Calcium and copper levels were also lower than previously observed. Magnesium tends to be lower in spring than in fall.

Name	BC - comp	BC - comp	BC - comp	BC - comp	BC - comp	BC - comp
Date	5/24/16	10/18/16	5/24/17	9/27/17	5/16/18	10/9/18
Total Solids (%)	18.0	20.0	19.0	20.0	22.0	31.0
Total Volatile Solids (%)	21.0	27.0	24.0	11.0	19.0	16.0
Total Organic Carbon (mg/Kg)	79,000.0	130,000.0	100,000.0	46,000.0	52,000.0	60,000.0
Total Nitrogen (mg/Kg)	6,600.0	5,100.0	5,400.0	4,100.0	5,800.0	2,800.0
Total Kjeldahl Nitrogen (mg/Kg)	6,600.0	5,100.0	5,400.0	4,100.0	5,800.0	2,800.0
Nitrate (mg/Kg)	<2.6	<2.3	<0.21	<2.0	2.0	<1.3
Total Phosphorus (mg/Kg)	230.0	2,000.0	1,100.0	2,200.0	1,600.0	1,300.0
Orthophosphate (mg/Kg)	31.0	28.0	31.0	33.0	22.0	27.0
Aluminum (mg/Kg)	11,000.0	11,000.0	5,500.0	8,800.0	13,000.0	8,300.0
Calcium (mg/Kg)	42,000.0	23,000.0	28,000.0	21,000.0	33,000.0	22,000.0
Copper (mg/Kg)	45.0	21.0	25.0	21.0	30.0	21.0
Iron (mg/Kg)	20,000.0	23,000.0	12,000.0	22,000.0	21,000.0	15,000.0
Magnesium (mg/Kg)	9,000.0	5,800.0	5,200.0	5,500.0	8,500.0	5,700.0

- **Sediment composite**
    - The percent of total solids is higher for fall 2018 than it was in either 2016 or 2017. The percent volatile solids is lower in fall 2018 than it has previously been. Lower volatile solids may correlate with the sandy/silty texture of the sediments observed during the spring 2018 sampling. It seems unlikely that there would suddenly be an influx of sand to the Brown's Channel inlet, so this may be the cumulative effect of years of MD Pellet treatments.
    - The total organic carbon content has increased a little from spring 2018 to fall 2018 but is lower this fall than it has been in fall 2016 and fall 2017.
    - The total nitrogen and total Kjeldahl nitrogen values were lower in fall 2018 than spring 2018 and also lower than they have ever been.
    - The total phosphorus and orthophosphate levels in fall 2018 appear to be slightly lower than they have been in previous fall samples.
    - The amounts of metals may have decreased a little since spring of this year.
    - In this system, composite sampling may not show nutrient reduction or reflect the sediment changes observed and discrete sampling at various locations throughout the channel may have been more informative.

Recommend

- In dynamic systems, such as Brown's Channel, it may take up to three years to see the cumulative benefits of using MD Pellets.
- Continue with current treatment plan using a dose rate of MD Pellets of 45 lbs per acre and concentrate a good portion of the dose in areas of high sediment levels.
    - Since the inlet was dredged this year, it would be reasonable to go back to normal treatment levels rather than using more MD Pellets at the inlet.

Understanding Your Lab Results

Conductivity	Desirable Pond Range 100 to 2,000 µS/cm Acceptable Pond Range 30 to 50,000 µS/cm Seawater is 50,000 to 60,000 µS/m	Conductivity is correlated with salt content. Some salt is needed for fish to maintain osmotic balance. Conductivity also gives a rough estimate of total dissolved solids (TDS) in water. Usually TDS in ppm is about half the conductivity in µS/cm.
Salinity (NaCl)	Fresh water < 0.5 ‰ Brackish water = 0.5 to 30 ‰	Measures the amount of sodium chloride in water. Salinity affects what species of algae will grow. 1 ‰ = parts per thousand
Total Dissolved Solids	Unpolluted = 17-30 ppm Polluted = 400 ppm	Total amount of solids both organic and inorganic that are in water. Includes sodium, calcium, magnesium, sulfates, orthophosphates, dissolved chemicals. Similar to conductivity.
Oxidation Reduction Potential	Done for Aquafix research purposes	Measures ability perform a chemical task such as oxidizing contaminants. Negative ORP denotes antioxidant activity; positive ORP oxidizing activity.
pH	Surface layer commonly 7 to 8.5 Bottom layer commonly 6 to 7.5 Ideal 7.2 to 7.6 Acceptable 6.8 to 8	pH in samples is artificially high due to decomposition. Field testing of pH is more accurate.
NH_3	< 0.1 ppm is considered non-polluted Lethal levels for fish vary 0.05 to 2.0 ppm	Sources ag runoff, lawn fertilizer, ducks and geese, fish, decaying organisms including plants and algae.
NO_2^-	Typically present at < 1 ppm	High concentrations require further research.
NO_3^-	< 0.05 ppm preferred	Top layer of lake may have low levels due to algae uptake. Bottom layer will be higher due to decay. Algae uses NO3 as nitrogen source for growth.
PO_4^{3-} **Orthophosphate**	< 0.02 ppm = Ideal > 0.1ppm = Plant growth is stimulated, expect problems with weed and algae growth.	Algae and aquatic plants use only the orthophosphate (PO_4) form.
Total Iron (undigested sample)	Desirable range is < 0.1 ppm	Responsible for the presence of some algae. At 0.3 ppm Pithophera will proliferate. Iron will concentrate in the bottom layer.
SiO_2	The lower, the better	Forms diatomaceous algae that are impervious to treatment.
Total Hardness	0-60 ppm = soft 120-180 ppm = hard Desirable range is 50 to 150 ppm Minimum acceptable 10 ppm	Total hardness measures calcium and magnesium concentrations. Expect reduced effectiveness of copper-based algaecides in hard water.
Calcium Hardness	Desired range 11 to 23 ppm	Calcium is used in plant cell walls.
Magnesium Hardness	Done for Aquafix research purposes	Research parameter
Total Alkalinity	Optimal is 50 to 150 ppm Acceptable 20 to 400 ppm	Measures ability to withstand changes in pH (buffering capacity). Algae often causes high pH swings.
Phenolphthalein Alkalinity	Done for Aquafix research purposes	Research parameter