Final Report

NEIWPCC Job Code: 0100-306-010

Project Code: LS-2011-031

Prepared by: Boquet River Association, Inc.

Date Submitted: June 30, 2015

Date Approved: July 15, 2015

Willsboro Constructed Wetland Demonstration Project

Contact Information

Anita Deming, President BRASS

PO Box 399, Westport NY 12993

Tel 518-962-4810 ext 409, ald6@cornell.edu

This is a Lake Champlain Basin Program funded project
54 West Shore Road
Grand Isle, VT 05482
802.372.3213

This project was funded by an agreement awarded by the [Environmental Protection Agency/Great Lakes Fishery Commission] to the New England Interstate Water Pollution Control Commission in partnership with the Lake Champlain Basin Program. NEIWPCC manages LCBP's personnel, contract, grant, and budget tasks and provides input on the program's activities through a partnership with the LCBP Steering Committee.

Although the information in this document has been funded wholly or in part by the United States Environmental Protection agency under agreement CE982720010 to NEIWPCC, it has not undergone the Agency's publications review process and therefore, may not necessarily reflect the views of the Agency and no official endorsement should be inferred. The viewpoints expressed here do not necessarily represent those of NEIWPCC, the LCBP Steering Committee, or EPA, nor does mention of trade names, commercial products, or causes constitute endorsement or recommendation for use.

Executive Summary

Over the last decade, point sources of phosphorus loading have been reduced to approximately 10 percent of the current total loading within the Lake Champlain Basin but further reduction may be possible using wollastonite tailings in constructed wetlands, especially at some industrial and municipal sites. Additionally, manure management research (e.g., at the University of Vermont), may find constructed wetlands utilizing wollastonite tailings to be an effective and economical approach to further phosphorus reductions on farms within the Basin.

The constructed wetland pilot project in the Town of Willsboro was completed in the summer of 2010 and, prior to wetland planting, initial constructed wetland effluent samples indicated phosphorus (P) reduction of 95 percent from the secondary plant's treated effluent (from 3.2 mg/L to 0.16 mg/L). Biological Oxygen Demand (BOD-5 day) was reduced approximately 69 percent from 7.8 mg/L to < 2.4 mg/L and Total Suspended Solids (TSS) was reduced 86 percent from 7.8 mg/L to 1.1 mg/L.

After the amendment and the reconstruction a second set of samples were taken and the total P was reduced from 1.9 to .2 for an 89% reduction. BOD-5day was reduced from 5 to < 2.2 for a 56% reduction. The TSS was reduced from 3.4 to <1for a 71% reduction. The flow volume was visibly increased from the first design. However, we do not have a flow meter to determine how much effluent is being treated for +P removal.

Lake Champlain Basin Program (LCBP) funding was requested to test the wetland's effluent levels of phosphorus, nitrogen and BOD for a period of one year, purchase and plant the constructed wetland with wetland plants, and to erect signage explaining the constructed wetland and its significance at the adjacent parking lot of a popular boat launch on the Boquet River one mile upstream of Lake Champlain.

The goal of this project was to document and demonstrate the effectiveness of an economical approach to the tertiary treatment of effluent from the Town of Willsboro's Sewage Treatment Plant utilizing wollastonite tailings (a locally-produced mining waste) as the substrate in a constructed wetland. The constructed wetland in Willsboro resulted from a 1999 LCBP-funded study, "Cost-Effective Phosphorus Removal from Secondary Wastewater Effluent through Mineral Adsorption," Project No.: LC-DP94-NYRFP-D-0070-058, and is part of a long-term Town of Willsboro series of projects to upgrade wastewater treatment, stabilize black ash streambanks eroding into the Boquet River, create a recreation/historical trail and productively utilize an abandoned brownfield. The objective of this monitoring project was to document the effectiveness of the system so the constructed wetland cells could be expanded to treat the entire hamlet's treated effluent.

However, a number of challenges were encountered and the project was not executed as planned and laid out in the quality assurance project plan (QAPP). Sampling did not begin in 2011 as planned; the dosing mechanism did not work properly; there was very little or no flow entering one of the wollastonite cells; the Town shut down the system earlier than expected in 2012; and, in late June, 2013, the Town, with consent from the NYS Department of Environmental Conservation (DEC), shut down the system permanently due to what is thought to be engineering design flaws. Once the system was offline, there was no expectation that the pilot project would continue. Therefore, effluent samples were only collected for a period of 21 weeks verses the expected and planned 38 weeks, the principal investigator, Dr. Larry Geohring (Cornell University), made two onsite visits instead of three, however, he used Cornell University funds to cover the travel. He reviewed the analyses, the data, and did an engineering change to increase the rate of intake. The project sign was not designed nor erected at the site. The grasses and forbs were planted, but have yet to become well established.

An amendment to the plan was made to shift the remaining money to re-engineering and construction of the new design in one cell which was done. We then got permission from DEC to re-charge the new cell, and have 2 sample tests showing reductions discussed above. Also the project manager was shifted from Julie Martin (upon her resignation) to Anita Deming (Board President).

In addition to the new intake plan, the project engineer, Doug Ferris, researched a plan for what sort of flow meter would be acceptable at Cell 1 if we decide to continue working on and improving the concept of using wollastonite (calcium meta silicate) to remove phosphorous with a contact time of 24 hrs to achieve a chemical change to calcium meta-phosphate, to evaluate costs and the life of the system.

.

Table of Contents

1 Project Introduction

The purpose of the project was to investigate and promote the feasibility of additional phosphorus reductions at the Willsboro Wastewater Treatment Plant by monitoring phosphorus, nitrogen and biological oxygen demand while demonstrating the use of a constructed wetland in an abandoned brownfield utilizing wollastonite tailings (a waste by-product of a local mining company), as a substrate. If preliminary test results were sustained, the tertiary treatment pilot project would promote sustainable development and a cost-effective method of tertiary treatment; and most importantly, serve as a functioning model for upgrades at other point sources in the Basin.

2 Tasks Completed

- 07.17.11 - The QAPP was approved.
- 08.04.11 - BRASS and volunteers planted 200 switchgrass, 150 common rush and 100 woolgrass plugs in the pre-treatment cell, as well as broadcast six pounds of Adirondack Wet Meadow seed mix on the two wollastonite cells. There are only a few plants still alive. There is not enough moisture in the top of the filter cells. We may need to put some top soil on the bed to establish some grasses.
- 06.05.12 - First day of sampling
- 10.25.12 - Last day of sampling
- 10.2013 - Prepared 2013 Final Project Report
- 12.13.14 BRASS, LCBP and NEIWPCC agreed on an amended contract, to move the rest of the funds remaining from the contract to new engineering plans, and constructing the new intake system in one cell.
- A meeting was held in November of 2014 with 3 licensed engineers (Mark Buckley from NYCO), (Doug Ferris contractor) and (Larry Goehring from Cornell Ag. Engineering), the Town Supervisor (Shaun Gillilland), the Town WWTP manager (Steve Benway), and BRASS board members (Anita Deming and Victor Putman). All agreed to serve on the Willsboro WWTF Advisory Committee (WWWTFAC)
- WWWTFAC team held a second meeting in December 2014, on site to dig up Cell 1 and figure out what was happening. The Wollastonite crystals were all packed into the tiny intake holes like little pencils packed into a holder. It was calculated that the PSI was only 4 lb/sq in so there would not be enough pressure to push though. The team agreed to increase the number and size of holes, and put septic system pipe in pea gravel to increase the surface area for the water to move through the system.
- December 2014 Zebra Tech built the new intake system next to the old one. We did not remove the old system.
- December 2014 prepared the 2014 report.

- The Town of Willsboro requested from DEC permission to recharge the system. The DEC wrote that it was OK to start again in June of 2015.
- Two samples from the outflow at the WWTF and at the outflow of the filter were taken twice in June by the WWTF manager according to DEC protocols and tested at Endyne.
- Doug Ferris completed a report on the types of flow meters that would be useable at the Willsboro site and approximate costs.
- 6.30.15 writing of this report.

3 Methodology

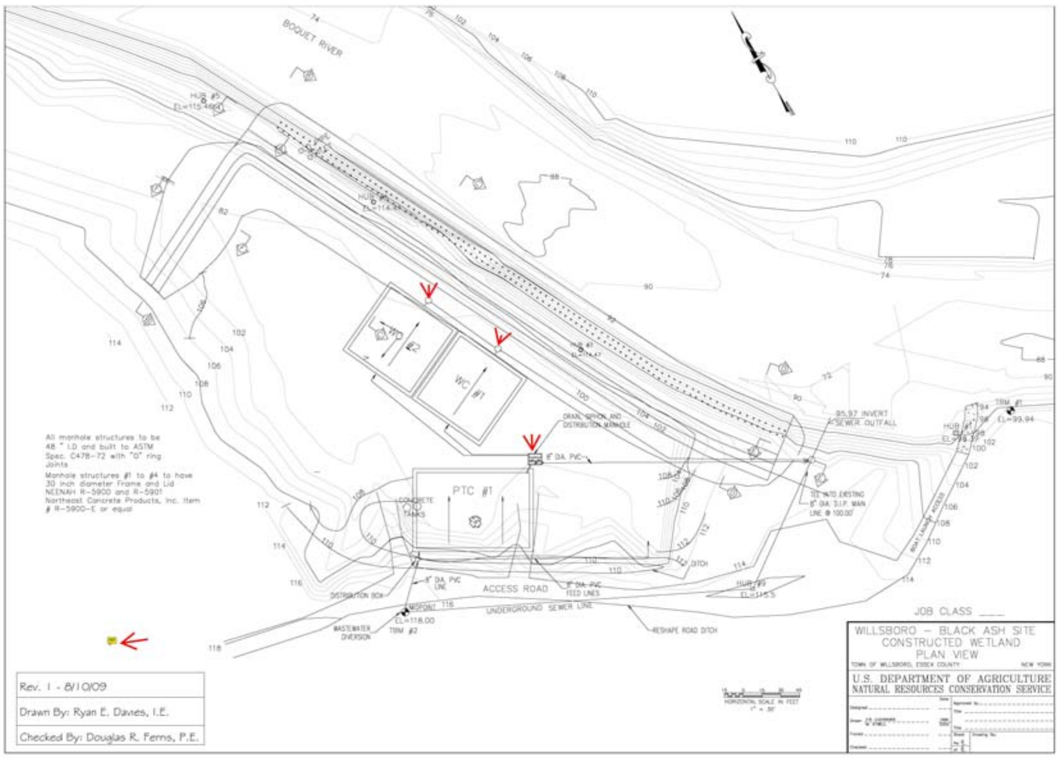
Sampling and Data Acquisition Methods

The goal of the project was to collect grab samples weekly at 4 sampling locations

1. discharge from the wastewater treatment plant (Site 1)
2. discharge from the pretreatment cell (Site 2)
3. discharge from wollastonite cell east (Site 3)
4. discharge from wollastonite cell west (Site 4)

This was changed with the amendment to building the new intake system and taking the samples we could afford. The samples were taken at the outflow from the WWTF and at the outflow of Cell Site #1 or East Cell.

Map of Sampling Locations



Samples were collected and analyzed by Endyne, Inc for Total Phosphorus, Ortho Phosphate, Nitrate and Biological Oxygen Demand. A total of 608 samples were to be collected throughout the life of this project, which would include 152 samples each for Total P, Ortho P, Nitrate and BOD. A total of 38 samples were to be collected for each parameter at each of the four sampling locations. All sample bottles were kept in an ice chest to keep them cold for the trip to Plattsburgh where Endyne, Inc conducted the analysis.

The amended set of tests were for total Phosphorus, Biological Oxygen Demand – 5 day, and Total Suspended Solids. Two sets of samples were taken. It was transported to Endyne on ice with the rest of the Town's samples.

BRASS volunteer, Dr. Gary Chilson, collects a grab sample from the output of the pre-treatment cell

BRASS volunteer, Dr. Gary Chilson, collects a grab sample from the output of a wollastonite cell

BRASS volunteer, Dr. Gary Chilson, collects a grab sample from the output of the wastewater treatment plant

Endyne, Inc. is an EPA certified, NYS ELAP accredited (ELAP # 11892) lab and all sampling bottles were provided by Endyne, Inc. The grab samples were taken consistently from the same discharge points throughout the project. Data collectors labeled all sampling bottles with the parameter, date of the sample and site identification number. For example, TP 5/20/11-A, TP 5/20/11-B etc.

A method blank (Lab Deionized water (or buffer water for BODs) was analyzed with each batch. A known standard, or secondary quality control standard in a clean matrix was analyzed with each batch. A duplicate sample and matrix spike sample ("dirty" matrix) was analyzed with each batch. For BODs, there were 3 dilutions analyzed for each sample, listed as replicates.

Field Blanks are not automatically analyzed by the lab as they are client dependent. NYS ELAP states that quality controls must be analyzed once per batch or 20 samples, whichever is more frequent.

If corrective actions were required, they are documented on a corrective action report form in the lab. Data were qualified if they could not be analyzed within holding time. The root cause of the problem was investigated and the result is documented on the corrective action report form. The laboratory reported any corrective actions taken to the project manager and discussed, when necessary, the consequences of the action in terms of quality standards.

A new design for the intake was agreed upon by the WWTFAC. It is important to note that there are a number of variables that can affect the hydraulic conductivity of the media. Factors that were consideration include, but are not limited to:

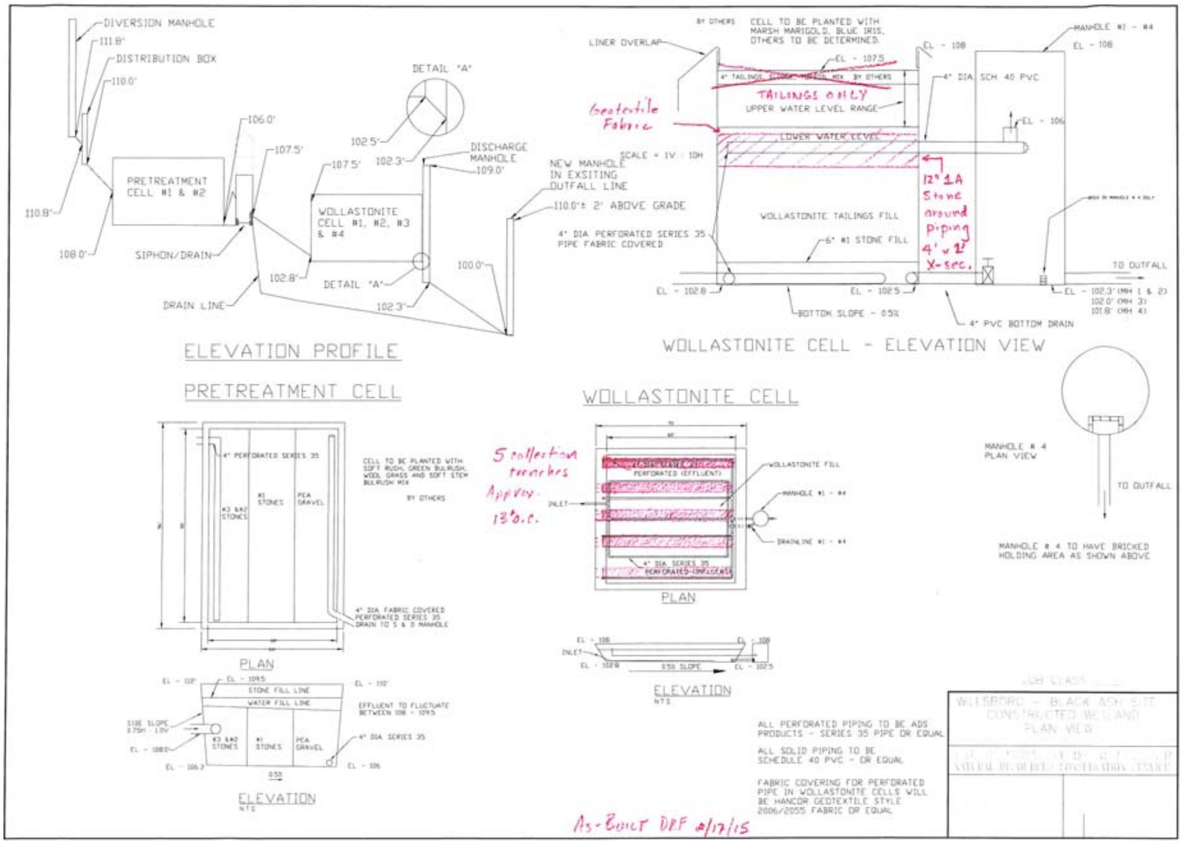
1) Hydraulic compaction of the filter media due to system operation, i.e., ponding.
2) Hydraulic compaction due to precipitation, freeze-thaw cycles, and snow loading.
3) Hydraulic conductivity reduction due to organic clogging of the interstitial spaces within the media.
4) Natural filter media variability as the media is poorly graded and always has been a waste product. As such the waste product being produced is not subjected to measured manufacturing processes ensuring particle size distribution or uniformity coefficients, etc.
5) Filter media variability due to natural variation in the raw ore produced from the quarry.
6) Filter media variability due to evolution of manufacturing processes over time thereby altering the characteristic of the waste product as secondary markets were discovered for garnet, lime, etc., and eventually the tailings themselves.

After the on-site exploration performed during November 2014, we confirmed the supposition that the reduction of hydraulic conductivity through the Wollastonite Treatment Cell (WTC) was largely due to clogging of the geotextile fabric enwrapping the effluent collection piping. Geotextile wrap is commonly used to prevent fines intrusion and blockage of collection piping, however, it is likely that the fine dust within the WTC media was washed through the fabric during operation and clogged the fabric prematurely. The system could've been constructed with stone trenches encasing the collection piping or stone trenches enwrapped in fabric.

Remediation consisted of excavating trenches, removing the existing piping laterals and installing stone trenches with new laterals connected to the existing effluent manifold.

An informal hydraulic conductivity test was performed by Cornell University on a field tube sample collected from the sidewall of one of the existing trenches. The results indicate the hydraulic conductivity for the WTC media has decreased from flow rates seen during the conceptual design phase of the project.

Changes made to Cell 1 at Willsboro WWTF



We realized that there is a major need with this project as we need some accounting for the water moving through the system in addition to the concentration of the parameters being measured. He suggested 2 different systems: An EM Sensor that requires electricity. It will measure variable flows and the data downloaded to a thumb drive. Hach charges between $5,000 and $10,000. OR a precast concrete manhole with bypass piping and a turbine flowmeter. This would cost between $20,000 and $30,000. This does not require electricity but it must be read manually at set intervals.

4 Quality Assurance Tasks Completed

Laboratory blanks were completed once per batch or 20 samples, whichever was more frequent. Field blanks are determined by the client and are submitted to the lab as an additional sample. Matrix spikes are completed once per batch or 20 samples, whichever is more frequent. Sample duplicates are completed once per batch or 20 samples, whichever is more frequent.

Typical acceptance criteria are +20% of the acceptable value, unless a method requires stricter criteria. Corrective actions are to reanalyze wherever possible, and qualify the final data if necessary.

Sampling QC excursions are evaluated by the Project Manager. Field duplicate sample results are used to assess the entire sampling process, including environmental variability; therefore the arbitrary rejection of results based on predetermined limits is not practical. The professional judgment of the Project Manager and QA Officer will be relied upon in evaluating results. Rejecting sample results based on wide variability is a possibility. Evaluation criteria noted in this section and in Section A7 above will be used for data review. Notations of field duplicate excursions and blank contamination will be noted in the final report.

Corrective action will involve identification of the cause of the failure where possible. Response actions will typically include re-analysis of questionable samples, if possible. In some cases, a site may have to be re-sampled to achieve project goals.

The second batch of samples were taken by Scott Benway the WWTF manager for the Town of Willsboro. The above protocol was followed, but fewer samples were taken (only at WWTF outflow and Cell 1) and only total P, BOD and TSS were measured. We believe that more testing should continue and that nitrogen components should be measured as well.

We had 3 NYS Licensed Engineers adjust the design and all agreed to the new design.

- Larry Geohring a senior extension associate from Cornell University Agricultural Engineering Department
- Mark Buckley, environmental engineer from NYCO where the Wollastonite comes from,
- Doug Ferris, the contract engineer that built the wollastonite cells

They looked at the plans, considered all possibilities described in "methodology", and visited the site and dug into treatment cell #1. All agreed on revising the plan to increase the intake of the treated effluent. The plans were drawn and built per the agreed upon decision.

Doug Ferris Licensed engineer made a report to BRASS on what it would take to put a flow meter in Cell #1 so we could determine the amount of water that was being treated.

5 Deliverables Completed

BRASS and volunteers planted 200 switchgrass, 150 common rush and 100 woolgrass plugs (small) in the pre-treatment cell, as well as broadcast six pounds of Adirondack Wet Meadow seed mix on the two wollastonite cells in August 2011. The planting project was completed later than expected because the Town's contractor was attempting to repair the dosing mechanism.

Time series data and a final report are the other measurable project outcomes. Samples were collected for 21 weeks and analysed for orthophosphate, Total P, Nitrate and BOD. However, due to the lack of flow through wollastonite cell west, samples were only collected four times throughout the project. And, total P was not collected for 2 weeks in October 2012 due to budget restrictions. June 5, 2012 was the first day of sampling and October 25, 2012 was the last day of sampling.

Because the project was discontinued before samples were collected for the QAPP-approved 38 weeks, signage at the parking lot of the popular Boquet River boat launch was not designed or erected.

A new engineering design was developed for intake of Cell 1 using sewer pipe and pea gravel with no filter fabric. Rebuild was completed.

Received DEC permission to start flow again.

Tested water weekly in June

Received a follow up engineering plan for adding flow meters to the site in 2015.

Completed final report on 6.30.15

6 Conclusions

The following three tables summarize the data collected from the four sampling sites. In all three tables, Site 1 refers to the samples collected from the treated effluent released from the Willsboro Wastewater Treatment Plant that is otherwise released directly to the Boquet River. Site 2 data refers to the samples collected from the outlet of the Pre-Treatment Cell which is composed of three grades of stones and planted with a mixture of grasses. Sites 3 and 4 are samples collected from the output of the Treatment Cells (east and west respectively) following the effluent's passage through wollastonite tailings. Site 3 (east) consistently had a low flow through the Treatment Cell while the second Treatment Cell at Site 4 (west) only had a detectable flow on four occasions throughout the sampling period.

Table 1: Biological Oxygen Demand

		BOD mg/L		
	Site 1	**Site 2**	**Site 3**	**Site 4**
Date				
6.5.12	10	3	3	3
6.12.12	9.2	2.2	2.2	
6.19.12	9.2	2.2	2.2	
6.26.12	10	2.2	2.2	2.2
7.5.12	9.6	2.3	2.2	
7.10.12	16	2.2	2.2	
7.18.12	2.6	2.2	2.2	
7.25.12	33	2.2	2.2	
8.1.12	9.3	2.2	2.2	
8.9.12	9.5	2.2	2.2	
8.15.12	8.6	2.2	2.2	
8.23.12	7	2.2	2.2	
8.29.12	17	2.2	2.2	
9.5.12	9.3	2.7	2.2	2.2
9.14.12	13	2.2	2.2	
9.20.12	7.1	2.2	2.2	
9.26.12	7.5	2.2	2.2	
10.2.12	8.6	2.2	2.2	2.2
10.11.12	6.6	2.2	2.2	
10.18.12	8	2.2	2.2	
10.25.12	11	2.2	2.2	
Average	10.58	2.27	2.24	2.4
Difference		8.31	8.34	8.18
% Diff		78.54%	78.83%	77.32%
Treatment Difference			0.03	- 0.13
Treatment % Difference			1.32%	-5.73%

	BOD Mg/L	
	Site 1 WWTF	Site 3 (cell 1)
Date		
6.4.15	3	<2.2
6.9.15	5	<2.2
Ave	4	<2.2
% reduction 45%		

Table 1 presents the biological oxygen demand data collected. Based on the 21 weekly samples analysed by Endyne Lab, the average (BOD) of the wastewater released by the Willsboro Plant is 10.56 mg/L. Following passage through the Pre-Treatment Cell (Site 2), composed of three grades of stones and topped by a variety of grasses, BOD is reduced, on average, 8.31 mg/L to 2.27 mg/L, or 78.54 percent. Following passage through wollastonite Treatment Cell east (Site 3), the total removed from both the Pre-Treatment Cell and the Treatment Cell was 8.34 mg/L or 78.83 percent. The Treatment Cell's contribution to the total BOD removed was determined to average only 0.03 mg/L or an additional 1.32 percent. Insufficient samples from Treatment Cell (west, Site 4) make no contribution to the analysis but are presented, nevertheless, to preserve the data collected. It appears that passage through the wollastonite Treatment Cell does not contribute to the removal of BOD. Statistical significance of the averages was not calculated due to the fact that an insufficient sample size was collected to achieve the confidence level desired in the research design.

At the second testing times in 2015 the quality of the water coming from the WWTF was substantially improved so there was not as a reduction

Table 2: Nitrate

		Nitrate mg/L		
-	**Site 1**	**Site 2**	**Site 3**	**Site 4**
Date				
6.5.12	11	5.9	2.5	3.4
6.12.12	12	3	2.1	
6.19.12	11	2.7	0.8	
6.26.12	12	6.1	0.86	3
7.5.12	16	1.2	1.9	
7.10.12	14	7.4	1.4	
7.18.12	15	8.3	0.29	
7.25.12	18	7.5	1	
8.1.12	13	7.2	1.2	
8.9.12	16	9.5	0.99	
8.15.12	12	7.5	2.8	
8.23.12	12	8.8	2.4	
8.29.12	14	9.8	2.4	
9.5.12	8	8.4	1.2	1.4
9.14.12	21	14	2.8	
9.20.12	18	12	2.2	
9.26.12	18	13	3.6	
10.2.12	13	9.3	3.9	1.6
10.11.12	12	11	3.2	
10.18.12	16	12	2.8	
10.25.12	13	13	1.9	
Average	14.05	8.46	2.01	2.35
Difference		5.59	12.04	11.7
% Diff		39.79%	85.69%	83.27%
Treatment Difference			6.45	6.11

Treatment % Difference	76.24%	72.22%

Table 2 presents the nitrate data collected. Based on the 21 weekly samples analysed by Endyne Lab, the average nitrate levels of the wastewater released by the Willsboro Plant is 14.05 mg/L. Following passage through the Pre-Treatment Cell (Site 2) nitrate is reduced, on average, 5.59 mg/L to 8.46 mg/L, or 39.79 percent. Following passage through the wollastonite Treatment Cell (Site 3), the total nitrate removed from both the Pre-Treatment Cell and the Treatment Cell was 12.04 mg/L or 85.69 percent. The Treatment Cell's contribution to the total nitrate removed was determined to average 6.45 mg/L or an additional 76.24 percent to the Pre-Treatment Cell alone. The wollastonite Treatment Cell appears to absorb additional nitrate over the Pre-Treatment Cell alone. Insufficient samples from Treatment Cell (west, Site 4) make no contribution to the analysis but are presented, nevertheless, to preserve the data collected. Statistical significance of the averages was not calculated due to the fact that an insufficient sample size was collected to achieve the confidence level desired in the research design.

Table 3: Ortho and Total Phosphorus

	Ortho-P mg/L				Total-P mg/L			
	Site 1	Site 2	Site 3	Site 4	Site 1	Site 2	Site 3	Site 4
Date								
6.5.12	2.8	2.9	0.74	0.81	3	3	0.72	0.8
6.12.12	3.7	2.9	0.62		3.8	2.9	0.6	
6.19.12	3.7	3.4	0.6		3.7	3.4	0.61	
6.26.12	3.5	3.5	0.54	0.6	3.6	3.5	0.53	0.59
7.5.12	3.5	3.4	0.44		3.7	3.4	0.46	
7.10.12	3.8	3.7	0.5		3.9	3.5	0.5	
7.18.12	3.7	3.4	0.47		3.8	3.4	0.45	
7.25.12	4.2	3.4	0.51		4.6	3.6	0.52	
8.1.12	4.2	3.6	0.55		4.4	3.6	0.58	
8.9.12	4.1	3.9	0.52		4.4	4.1	0.5	
8.15.12	3.7	3.2	0.37		3.9	3.2	0.41	
8.23.12	4.2	3.8	0.44		4.5	4	0.48	
8.29.12	4.8	3.5	0.47		4.9	3.8	0.49	
9.5.12	2.6	3.2	0.31	0.18	2.8	3.2	0.32	0.2
9.14.12	3.9	4.9	0.41		4.2	4.5	0.4	
9.20.12	3.7	4.2	0.44		3.9	4.4	0.46	
9.26.12	3.7	3.6	0.47		3.9	3.8	0.48	
10.2.12	3.4	3.2	0.52	0.27	3.5	3.3	0.54	0.28
10.11.12	2.5	2.5	0.53					
10.18.12	3.3	2.7	0.47					
10.25.12	2.6	2.6	0.46		2.8	2.6	0.42	

Average	3.6	3.4	0.49	0.47	3.86	3.54	0.5	0.47
Difference		0.2	3.11	3.13		0.32	3.36	3.39
Total % Diff		5.56%	86.39%	86.94%		8.29%	87.05%	87.82%
Treatment Difference			2.91	2.93			3.04	
Treatment % Difference			85.59%	86.18%			85.88%	86.72%

Total P
Mg/L

Date	Site 1 WWTF	Site 3 (cell 1)
6.4.15	1.2	0.21
6.9.15	1.9	0.2
Ave	1.55	0.2

% reduction = 89%

Table 3 presents the Ortho-Phosphorus (Ortho-P) and Total-Phosphorus (Total-P) data collected. Based on the 21 weekly samples analysed by Endyne Lab, the average Ortho-P levels of the wastewater released by the Willsboro Plant (Site 1) is 3.6 mg/L. Total-P samples, which includes Ortho-P as measured alone as well as condensed and organic phosphorous converted to Ortho-P for analysis, averaged higher than the Ortho-P samples as expected at 3.86 mg/L. Recalling the primary purpose of this project was to document the effectiveness of the wollastonite Treatment Cell's ability to reduce phosphorus, the results from this table are most important to the project's goal. Following passage through the Pre-Treatment Cell (Site 2) Ortho-P is reduced, on average, 0.2 mg/L to 3.4 mg/L, or a mere 5.56 percent. Similarly, Total-P after passage through the Pre-Treatment cell was reduced by only 0.32 mg/L to 3.54 mg/L or just 8.29 percent. A large reduction of phosphorus was not expected from passage through the Pre-Treatment Cell.

Following passage through the wollastonite Treatment Cell (Site 3), however, the additional Ortho-P removed from the wastewater stream by the Treatment Cell was 2.91 mg/L or 85.59 percent of the Pre-Treatment Cells Ortho-P content. Similarly, Total-P removed by the Treatment Cell from the outflow of the Pre-Treatment Cell was 3.04 mg/L or 85.88 percent.

Insufficient samples from the second Treatment Cell (Site 4) make no contribution to the analysis but are presented, nevertheless, to preserve the data collected. Statistical significance of the averages was not calculated due to the fact that an insufficient sample size was collected to achieve the confidence level desired in the research design.

It is expected that P will be the nutrient that is removed from the Wollastonite Treatment Cell. The test results firmly conclude this

Table 4 shows the Total Suspended Solids removed from the effluent in 2015

Total Suspended Solids
Mg/L

Date	Site 1 WWTF	Site 3 (cell 1)
6.4.15	1.9	<1
6.9.15	3.4	<1
Ave	2.65	<1

% reduction = 62%

Discussion

First Half of Project

The results obtained indicate that the Pre-Treatment Cell removed 78 percent of the BOD from Willsboro's wastewater. The wollastonite Treatment Cells did not contribute much to BOD removal at all. The weekly sampling period was conducted during the growing season so the grasses and sedges planted on top of the Pre-Treatment Cell helped remove nearly 40 percent of the nitrate released from Willsboro's wastewater. The wollastonite Treatment Cell removed 76 percent of the nitrate from the Pre-Treatment Cells outflow. Together, nearly 86 percent of nitrate was removed by the constructed wetland's Pre-Treatment and Treatment Cells. It is in phosphorus removal, however, that the effectiveness of using wollastonite as a substrate is demonstrated in this pilot project. Because phosphorus is the limiting factor in Lake Champlain's nutrient balance, every milligram per litre removed from wastewater effluent is significant for the health of the Lake. The constructed wetland pilot project at Willsboro removed 86 percent of the phosphorus from the treated wastewater from the wastewater treatment plant.

Despite such remarkable results, the Willsboro pilot project was temporarily shut down. Like most pilot projects that attempt to take laboratory results and apply them in the real world, unexpected problems arise that require fixing to bring theory into practice. The initial problem was that very little of the wastewater treatment plant's effluent actually flowed through the wollastonite treatment cell. So little flowed through, in fact, that the tremendous reductions found in BOD, Nitrate and Total Phosphorus did not significantly reduce these nutrients from Willsboro's total effluent released.

Second Half of Project

BRASS, LCBP and NEWIWPIC decided to try and figure out why so little effluent flowed through the pilot project's wollastonite cell. The Willsboro WWTF Advisory committee was created. A joint plan to increase the porosity of the intake from Cell 1 was implemented. The new design was implemented and once again great reductions in Total P was found. This is very encouraging and we hope to continue the project in 2015 and 2016 with more testing and including a flow meter to know how much water is being treated, and to refine the design.

7 References

8 Appendices

Appended Documents:

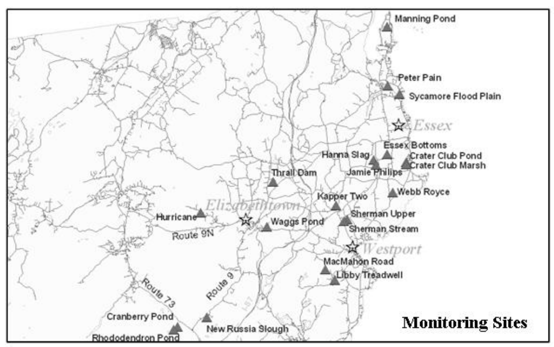
Volume 27 • Issue 1

BRASSnews

Newsletter of the Boquet River Association, Inc. | Spring 2011 Issue

BRASS Awarded Two LCBP Grants

The Boquet River Association (BRASS) was awarded a $14,018 ***Aquatic Invasive Species Spread Prevention*** grant through the Lake Champlain Basin Program (LCBP). The wetland monitoring program, with an emphasis on invasive species in the Boquet River watershed, was initiated in 2005. Initially, a hydrologic and vegetation survey of 40 wetlands was conducted in 2005. Of these, 20 wetlands were selected for long-term monitoring and a hydrologic and vegetation survey was conducted again in 2006. Funding constraints allowed a vegetation survey on one of the wetlands in 2007 and 2008. In 2010, BRASS funded a vegetation survey of 10 of the 20 wetlands. With LCBP funding, a vegetation survey of the remaining 10 wetlands will be conducted in 2011. The data, which includes information on aquatic invasives such as ***Lythrum salicaria*** (purple loosestrife), will be analyzed for possible trends that will facilitate watershed wetland invasive species management planning and provide recommendations in the Boquet River Watershed Management Plan.



Monitoring Sites

Dr. Dennis Kalma will survey 10 wetlands in 2011 and, once complete, a final report summarizing data and possible trends gathered on 20 wetlands monitored since 2005 will be prepared. BRASS will also create a poster presentation to display at local libraries and the 2012 Adirondack and Lake Champlain Research Consortium's annual conferences.

The Boquet River Association does not have the manpower or resources to monitor and manage invasive species throughout the 280 square miles of the Boquet River watershed. Therefore, focusing our invasive species management efforts on our most sensitive and diverse wetlands is a more feasible approach at this time.

BRASS was also awarded a $23,928 ***Pollution Prevention*** grant through the LCBP. This project seeks to document and demonstrate the effectiveness of an economical approach to the tertiary treatment of effluent from the Willsboro sewage treatment plant utilizing wollastonite tailings (a locally-produced mining waste) as the substrate in a constructed wetland. Grant funds will allow us to test the wetland's effluent levels of phosphorus, nitrogen and Biological Oxygen Demand (BOD) for a period of one year. The samples will be delivered to, and analyzed by Endyne Lab in Plattsburgh. Wetland plants will also be purchased and planted in the pretreatment and treatment cells and a sign will be designed and erected at the popular boat launch site explaining what visitors see, how it works and why utilizing a locally-produced mining waste benefits the environment and the economy.

Over the last decade, point sources of phosphorus loading have been reduced to approximately 10 percent of the current total loading within the Lake Champlain Basin. Further reduction may be possible using wollastonite tailings in constructed wetlands, especially at some industrial and municipal sites. The constructed wetland pilot project was completed in the summer of 2010 and, prior to wetland planting, initial constructed wetland effluent samples indicate phosphorus reduction of 95 percent from the secondary plant's treated effluent (from

(Continued on page 2)

A Message from the Director...

It is hard to believe that I have been the director of BRASS for three years. It seems like only yesterday that I was commuting to Willsboro from Glens Falls. Today, I am even more appreciative of what the organization represents. BRASS' mission is unique. It is dedicated to enhancing the quality of water and life in the watershed. Those who founded BRASS more than 26 years ago understood the interconnectedness of nature and people. The river is what weaves us together and BRASS works to improve its quality, as well as the quality of life of those who live within its boundaries.

When accepting this position three years ago, strengthening BRASS' foundation was one of my first goals. I am working to streamline our administrative processes which I think is an important cost-effective measure. BRASS has reorganized its board committee structure, developed organizational policies and updated its strategic plan. The association has also assessed fish passage barriers in the watershed, provided funding toward the new septic system at the Whallonsburg Grange Hall and worked with partners to stabilize a section of The Branch in Elizabethtown. We continue to host our annual events and have planted thousands of trees and shrubs along the river with volunteers. BRASS' board treasurer, Schell McKinley, was instrumental in creating the Boquet Land Trust to promote public access to the river.

In March, the final paperwork was submitted to close out BRASS' Empire State Development Corporation grant. BRASS is currently managing grants to update the Boquet River watershed management plan, continue its wetland monitoring program and do additional water quality testing at the Willsboro constructed wetland. These are some really exciting projects. Although I am proud of what we have accomplished so far, I know there is so much more to do.

I have to admit that when I feel overwhelmed with the responsibility of running this non-profit organization efficiently and effectively, I think of our members, donors and volunteers who believe in BRASS' mission. It is you and the next generation I am working for. I received an email a short time ago that said, "It is people like you who my kids will be thanking 40 years from now when they still have a place up north to enjoy." This is what it is all about. Thank you all for your continued support of our efforts.

(Continued from page 1)

3.2 mg/L to 0.16 mg/L). BOD was reduced approximately 69 percent (from 7.8 mg/L to < 2.4 mg/L) and Total Suspended Solids was reduced 86 percent (from 7.8 mg/L to 1.1 mg/L). If these preliminary test results are sustained, the tertiary treatment pilot project would serve as a functioning model for upgrades at other point sources in the Basin.

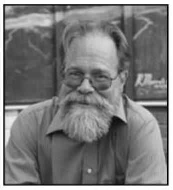
The pretreatment cell, which will be planted with wetland vegetation.

Dr. Larry Geohring (Cornell University) was involved with the original 1999 LCBP-funded study, "Cost-Effective Phosphorus Removal from Secondary Wastewater Effluent through Mineral Adsorption." He will serve as the principal investigator on the project and will help develop the testing protocol and prepare the final project report analyzing and summarizing the data collected. Water quality samples will be collected weekly and delivered to the lab by BRASS and a BRASS volunteer.

The next step, for both grants, is to develop a quality assurance project plan, which needs to be approved by the Lake Champlain Basin Program before any monitoring or sampling can be done.

Sampling at Willsboro

By Gary Chilson



Gary lives in Elizabethtown and is a BRASS member and volunteer. He also serves on BRASS' Strategic Planning Committee and is a member of the Technical Advisory Committee overseeing the watershed management planning process.

Each week since spring, I've volunteered to go to Willsboro's wastewater treatment plant to sample effluent for a BRASS project. A smelly job you might think, but, it really isn't. BRASS is sampling Willsboro's effluent because the town installed an experimental treatment system to remove phosphorus and other nutrients from their already cleaned and chlorine-treated wastewater that normally just flows into the Boquet River. I'm sampling to test the effectiveness of the experimental system.

Many years ago, raw sewage was routinely dumped into the river. It was okay back then because our population was small and the river purified itself after just a few miles downstream. It was a little smelly and unhealthy but a really cheap solution to pollution. Since then, our population increased and our sense of values changed. Passage of the federal Clean Water Act in 1972 meant billions of federal dollars to help communities large and small construct wastewater treatment plants. These early treatment plants were built to reduce the solids and kill the germs in sewage and they did a great job. Those of us old enough to remember what it used to be like certainly appreciate the difference.

Now the plants are old, too, and many need to be replaced but they were not designed to eliminate the nutrients in wastewater we now know are killing Lake Champlain. The principle nutrient in question is phosphorus which contributes to the excessive algae and plant growth in lakes and rivers. The problem is cost. Constructing wastewater treatment plants that also reduce nutrients, called tertiary treatment, is unbelievably more expensive than just eliminating solids and germs. It would be wonderful if there was an inexpensive add-on solution to removing phosphorus.

There just might be an inexpensive solution and we need to know if it works in reality and not just on a laboratory table. Cornell University scientist, Dr. Larry Geohring, experimented with several different waste byproducts of local mining operations. He discovered that wollastonite tailings, the waste product from NYCO's processing plant in Willsboro, adsorb a lot of phosphorus from wastewater. So a grant was secured to construct a pilot project to test the laboratory results in actual practice. The basic idea is to divert some of the already treated wastewater flowing out to the river from Willsboro's treatment plant into two different types of man-made wetlands. The first, what we call the "pre-treatment cell", is just an excavated, plastic-lined hole filled up with different sized stones and planted with reeds and grasses on top. Its purpose is to further reduce the amount of solid material suspended in the wastewater from entering into the second constructed wetland. This second wetland is another big hole lined with plastic but filled with wollastonite tailings. What comes out of this "treatment cell" then flows into the river. The question is whether or not what flows into the river from this treatment cell has less phosphorus and other nutrients in it than what normally flows right out from the

Dave Kavner

Gary collecting a sample at the outlet of the pre-treatment cell.

Town of Willsboro's treatment plant.

The first sample I take is from the output of the pre-treatment cell, then I take a sample from the output of the treatment cell, followed by a sample from the output of the wastewater treatment plant itself. I take samples in that order so that, at the end, I can wash my hands at the sink in the treatment plant's office. All sample bottles are kept in an ice-filled chest to keep them cold for the trip north to Plattsburgh where Endyne Lab conducts the analysis. The whole process, from the time I leave E'town until I return from dropping off the samples in Plattsburgh, takes about 3 and a half hours and 87 miles.

Endyne Lab analyzes the samples for Biological Oxygen Demand (BOD), a measure of how much oxygen will be consumed by decomposer organisms to remove the remaining suspended solids in the wastewater; Nitrate, a fertilizer-like nutrient we have far too much of in our environment; and, Total Phosphorus, the key nutrient we seek to reduce. The results of the sampling have not yet been analyzed by Dr. Geohring nor have we sampled enough to really be sure about the final results but I can't resist telling you what we've gotten so far from just 16 weeks of samples.

The preliminary results are clearly encouraging! Overall, more than 80 percent of the three contaminants normally and legally released by the treatment plant are removed by the pilot project's constructed wetlands. Looking closer, the simple pre-treatment cell, made of just different sized stones and growing plants on top, removed 80 percent of the Biological Oxygen Demand (BOD), nearly half of the Nitrate but only 9 percent of Total Phosphorus released by the wastewater treatment plant. The treatment cell, made of wollastonite tailings, removed very little additional BOD, just 1.7 percent, but 77 percent more of the Nitrate and a whopping 86 percent more of the Total Phosphorus.

Gary collecting a sample at the outlet of the treatment cell.

Despite such wonderful results, all is not well with the Willsboro pilot project. Like most pilot projects that attempt to take laboratory results and apply them in the real world, unexpected problems arise that require fixing to bring theory into practice. The problem here is that very little of the wastewater treatment plant's effluent actually flowed through the wollastonite treatment cell. So little flowed through, in fact, that even the tremendous reductions we found in BOD, Nitrate and Total Phosphorus did not significantly reduce these nutrients from Willsboro's total effluent. Fortunately, the effluent from Willsboro's treatment plant does not need the additional reductions hoped for from the pilot project to meet its allowed levels of BOD, Nitrate and Total Phosphorus.

Why so little effluent flowed through the pilot project's wollastonite cell is still under investigation. Whatever the problems are will have to be fixed if the pilot project is to become a complete success as an affordable tertiary treatment system other communities and businesses could use as a model. With so little flow through the experimental system, however, it is in danger of freezing so the treatment plant operator will have to shut the experiment down for the winter. I'll probably miss my little trips to Willsboro every week.

The Constructed Wetland system was shut down for the winter at the end of October 2012. Samples were collected for twenty-one weeks between June 5th and October 25th. Thank you, Gary, for donating your time toward this exciting project. Our plan is to resume testing in the Spring.

Attach any articles, press releases (which should acknowledge partnership with LCBP), a list of acronyms and published documents pertaining to this project

Electronic Data: Email or mail a CD to your Project Officer with any electronic datasets you have generated through your project.

Wastewater Treatment Plant (Site 1)

Date	BOD mg/L	Nitrate mg/L	Ortho-P mg/L	Total-P mg/L
6.5.12	10	11	2.8	3
6.12.12	9.2	12	3.7	3.8
6.19.12	9.2	11	3.7	3.7
6.26.12	10	12	3.5	3.6
7.5.12	9.6	16	3.5	3.7
7.10.12	16	14	3.8	3.9
7.18.12	2.6	15	3.7	3.8
7.25.12	33	18	4.2	4.6
8.1.12	9.3	13	4.2	4.4
8.9.12	9.5	16	4.1	4.4
8.15.12	8.6	12	3.7	3.9
8.23.12	7	12	4.2	4.5
8.29.12	17	14	4.8	4.9
9.5.12	9.3	8	2.6	2.8
9.14.12	13	21	3.9	4.2
9.20.12	7.1	18	3.7	3.9
9.26.12	7.5	18	3.7	3.9
10.2.12	8.6	13	3.4	3.5
10.11.12	6.6	12	2.5	
10.18.12	8	16	3.3	
10.25.12	11	13	2.6	2.8
Average	10.58	14.05	3.6	3.86

Pre-Treatment Cell (Site 2)

Date	BOD mg/L	Nitrate mg/L	Ortho-P mg/L	Total-P mg/L
6.5.12	3	5.9	2.9	3
6.12.12	2.2	3	2.9	2.9
6.19.12	2.2	2.7	3.4	3.4
6.26.12	2.2	6.1	3.5	3.5
7.5.12	2.3	1.2	3.4	3.4
7.10.12	2.2	7.4	3.7	3.5
7.18.12	2.2	8.3	3.4	3.4
7.25.12	2.2	7.5	3.4	3.6

8.1.12	2.2	7.2	3.6	3.6
8.9.12	2.2	9.5	3.9	4.1
8.15.12	2.2	7.5	3.2	3.2
8.23.12	2.2	8.8	3.8	4
8.29.12	2.2	9.8	3.5	3.8
9.5.12	2.7	8.4	3.2	3.2
9.14.12	2.2	14	4.9	4.5
9.20.12	2.2	12	4.2	4.4
9.26.12	2.2	13	3.6	3.8
10.2.12	2.2	9.3	3.2	3.3
10.11.12	2.2	11	2.5	
10.18.12	2.2	12	2.7	
10.25.12	2.2	13	2.6	2.6
Average	2.27	8.46	3.4	3.54
Difference	8.31	5.59	0.2	0.32
% Diff	78.54%	39.79%	5.56%	8.29%

Treatment Cell East (Site 3)

Date	BOD mg/L	Nitrate mg/L	Ortho-P mg/L	Total-P mg/L
6.5.12	3	2.5	0.74	0.72
6.12.12	2.2	2.1	0.62	0.6
6.19.12	2.2	0.8	0.6	0.61
6.26.12	2.2	0.86	0.54	0.53
7.5.12	2.2	1.9	0.44	0.46
7.10.12	2.2	1.4	0.5	0.5
7.18.12	2.2	0.29	0.47	0.45
7.25.12	2.2	1	0.51	0.52
8.1.12	2.2	1.2	0.55	0.58
8.9.12	2.2	0.99	0.52	0.5
8.15.12	2.2	2.8	0.37	0.41
8.23.12	2.2	2.4	0.44	0.48
8.29.12	2.2	2.4	0.47	0.49
9.5.12	2.2	1.2	0.31	0.32
9.14.12	2.2	2.8	0.41	0.4
9.20.12	2.2	2.2	0.44	0.46
9.26.12	2.2	3.6	0.47	0.48
10.2.12	2.2	3.9	0.52	0.54
10.11.12	2.2	3.2	0.53	
10.18.12	2.2	2.8	0.47	
10.25.12	2.2	1.9	0.46	0.42

Average	2.24	2.01	0.49	0.5
Difference	8.34	12.04	3.11	3.36
% Diff	78.83%	85.69%	86.39%	87.05%
Treatment Difference	1.32%	76.24%	85.59%	85.88%

Treatment Cell West (Site 4)

Date	BOD mg/L	Nitrate mg/L	Ortho-P mg/L	Total-P mg/L
6.5.12	3	3.4	0.81	0.8
6.12.12				
6.19.12				
6.26.12	2.2	3	0.6	0.59
7.5.12				
7.10.12				
7.18.12				
7.25.12				
8.1.12				
8.9.12				
8.15.12				
8.23.12				
8.29.12				
9.5.12	2.2	1.4	0.18	0.2
9.14.12				
9.20.12				
9.26.12				
10.2.12	2.2	1.6	0.27	0.28
10.11.12				
10.18.12				
10.25.12				
Average	2.4	2.35	0.47	0.47
Difference	8.18	11.7	3.13	3.39
% Diff	77.32%	83.27%	86.94%	87.82%

Appendix B: Weekly Field Sample Data Form

Weekly Field Sample Data Form (rev. 6.29.12)

Name of sampler:____________________________

Date of sample:__________________ Actual time of day: ___________________

Willsboro treatment plant discharge rate: ___________________

Precipitation Amt. - Last 24-hrs (*data from Cornell University Willsboro Field Station*):

____

Sampling Site 1 (Treatment plant discharge)

Bottle I.D. 1A _________________________

Bottle I.D. 1B _________________________

Sampling Site 2 (Pretreatment cell discharge)

Bottle I.D. 2A _________________________

Bottle I.D. 2B _________________________

Sampling Site 3 (East Wollastonite cell #1 discharge)

Bottle I.D. 3A________________________

Bottle I.D. 3B_________________________

Sampling Site 4 (West Wollastonite cell #2 discharge)

Bottle I.D. 4A________________________

Bottle I.D. 4B_________________________

Other Comments:

____

____

ZEBRA-TECH, LLC

"THE DESIGN-BUILD COMPANY"

Professional Engineering Provided By:
Earth Science Engineering, P.C.

June 30, 2015

Ms. Anita Deming
Executive Director CCE Essex
P.O. Box 388
Westport, NY 12993

Re: Flow Measurement Recommendations
Tertiary Treatment Facility
Wastewater Treatment Plant
Willsboro, NY

Dear Anita:

Per your request, and based on our familiarity with the referenced facility, we believe there are two (2) alternatives for monitoring and recording flow through the facility. Data can be recorded with either an electromagnetic (EM) sensor or a turbine flow meter.

The EM Sensor requires electricity. Power can either be provided by battery or AC if power is extended to the facility. The meter will measure and record the variable flows and the data can be downloaded to a thumb drive to produce graphs and tables at the office. Hach is just one of the manufacturer's of these types of instruments. For the design and installation of a battery powered unit, an estimated project budget would be in the $5,000 to $10,000 range.

The second alternative consists of the installation of a precast concrete manhole, bypass piping, and a turbine flowmeter. Engineering and construction for this would be approximately $20,000 to $30,000. The unit does not require electricity. Manual readings at set intervals by staff would be required.

Please contact me if you have any questions or if I can be of further assistance. Thank you.

Zebra-Tech, L.L.C.
Douglas R. Ferris, P.E.

Design-Build
Construction Management
General Contracting
Sitework
Foundations
U.S.T. Removal
Wetlands Mitigation
Pond Construction
Retaining Walls
Environmental Remediation
Septic Systems
Shoreline Protection
Zebra Mussel Control
Commercial Diving