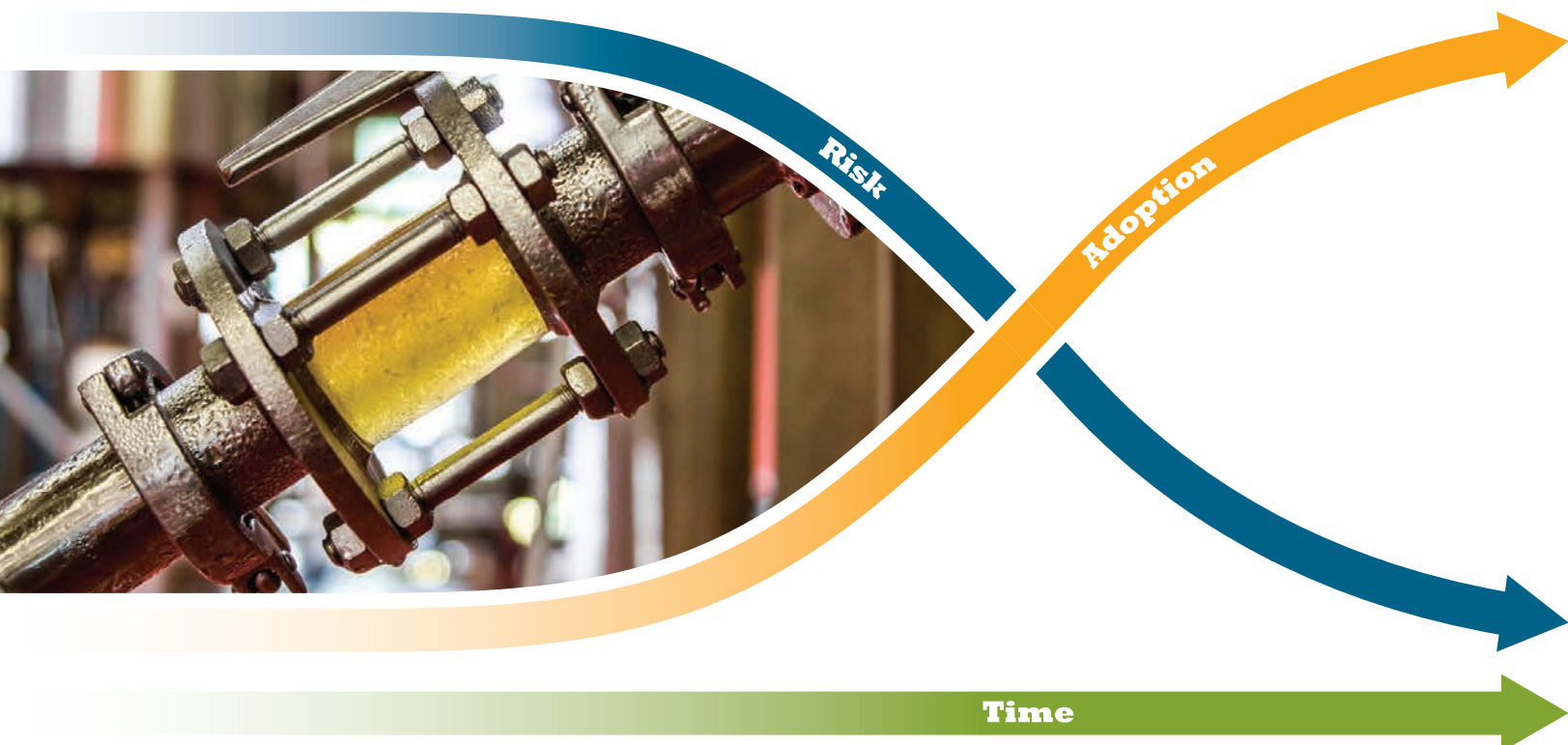




Sustainability Applied®

Driving Adoption of Innovative Solutions at Ontario Craft Breweries

Demonstrating the Performance and Benefits of an Integrated On-site Wastewater Management Solution



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Prepared by The Bloom Centre for Sustainability (BLOOM)

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“Ontario’s craft brewing industry is experiencing tremendous new growth and success. To become a North American centre of excellence in craft brewing, we’ll need to be leaders in every area of the business, which includes minimizing water and resource use and moving towards a vision of zero discharge operations.”

Garnet Pratt Siddall, President and CEO of Side Launch Brewing Company
and Chair of Ontario Craft Brewers

Water Management Matters

Craft breweries can realize significant benefits from taking a proactive approach to water management. These benefits include: reduced water and wastewater management costs; increased revenues; operational efficiencies and enhanced community relations.

Getting ahead of issues allows a brewery to integrate water management practices into their operations and business strategy to maximize these benefits. The challenge that many craft breweries face is not knowing what they can do, how to do it and what benefits they can expect.

BLOOM’s strategy in the craft beer sector has been to undertake projects to test and develop a portfolio of complementary technologies and approaches, with the goal to demonstrate that there are feasible on-site wastewater management solutions for craft brewers. The various pilots have all been used to determine, refine and obtain technical and business performance data.

Information materials, such as this case study, can be used by existing craft breweries to improve their water management performance as well as new breweries that are at the facility planning and design stage.

BLOOM has developed the Water & Beer online platform to make it easier for craft brewers to understand the Ins, Outs and In-Betweens of Water Management.

**Information
is the key to
helping Ontario
craft breweries in
their efforts to be
sector leaders in
water resource
management.**

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**WATER
& BEER**

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The Challenge and the Opportunity

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“Sustainability in all of our operations is a top priority. Wastewater management is the most crucial issue facing the craft brewing industry in Ontario.”

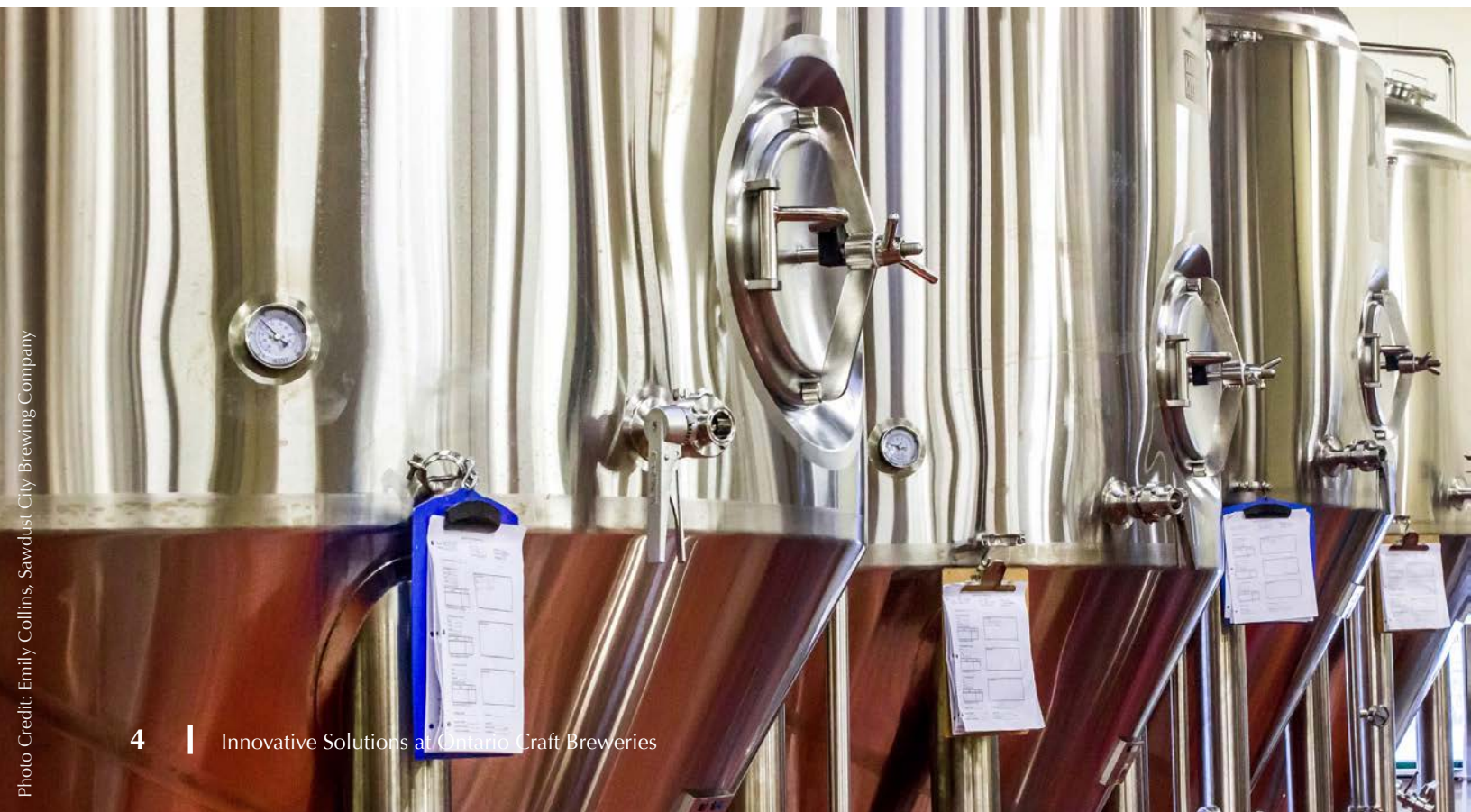
Rob Engman, President,
Sawdust City Brewing Company

There is broad variation in the operational characteristics and practices of individual craft brewery operations. This can become a challenge for breweries when dealing with water and wastewater issues.

Usually, the first time a craft brewer becomes aware that it has a wastewater issue is when they are informed by the municipal or provincial regulator. This then leads to business disruption, higher costs and reputational risk.

Human nature being what it is, when faced with an unexpected problem, the first instinct is to focus on making the problem go away as quickly as possible.

For craft breweries, their tendency is to focus on treating the high strength wastewater at the ‘end of the pipe’. Unfortunately, this is a reactive approach that focuses on a ‘symptom’ – high-strength wastewater – rather than on the underlying root causes.



Ins



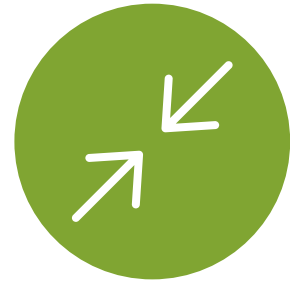
The volume of water entering the brewery to make beer, AND wash and clean the equipment and floors.

Outs



The wastewater – its volume and strength. Wastewater is clean water with all the ‘stuff’ in it from the brewery operation – ingredients, beer, and by-products such as spent grain and excess yeast.

In-Betweens



The various spots within the operations – the brewhouse, the fermenter, and the packaging lines – where water is used and stuff enters the wastewater.

Getting to the Goal – Starts with the Right Steps

Addressing the root causes requires a three-step structured approach.

Step 1: Understand the contributors to wastewater volume and strength.

Step 2: Undertake strategic interventions in the process to improve operational and cleaning practices.

Step 3: Treat the remaining lower volume and strength wastewater to regulatory discharge levels, and identify options to reuse and recycle the water through further treatment.

With this as a basis, craft breweries can decide what and how they can improve, as well as the correct order to undertake strategic interventions.

Good water management means understanding the ‘Ins, the Outs and the In-Betweens’ of water management.

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Why Demonstrations?

BLOOM undertakes collaborative pilot and demonstration projects for three key reasons: to raise awareness that potential solutions are available; to show what is involved to adopt these solutions; and to prove that a representative commercial-based solution can work.

The representative solution that was demonstrated at craft breweries was the BRÜ CLEAN System by Econse Water Purification Systems Inc. (ECONSE). This is a small footprint, modular and chemical free wastewater treatment solution. It involved the integration of leading-edge process technology components, supported by in-brewery source reduction and design improvements. The treatment solution consists of a primary mechanical module followed by a polishing module.

Practical, commercially relevant demonstrations, where outcomes and key performance metrics can be quantified and communicated, are key to reducing uncertainties associated with adopting something new.

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The components of each module are proven technologies that are customized for a given application.

BLOOM collaborated with ECONSE to demonstrate their solution in three Ontario craft breweries, one large and two of medium capacity. The demonstration consisted of two primary parts:

- ▶ Part One was an initial technology pilot of the various technology components of the solution using actual wastewater from the large Ontario craft brewery. This was a critical requirement before a fully integrated solution could be designed and piloted.
- ▶ Part Two was the fully integrated solution that was piloted at two medium sized breweries. This solution combined source reduction through side-streaming, installing a balancing tank and wastewater treatment.

The objectives of these pilots were to:

- ▶ Prove that a representative on-site wastewater solution consisting of both improved source reduction practices and technology is available and has the necessary performance to meet and exceed wastewater discharge goals.
- ▶ Gain insight into how the various solution steps impact brewery wastewater composition and strength.
- ▶ Obtain quantitative and qualitative performance data relative to wastewater discharge regulatory targets: Biological Oxygen Demand (BOD) (300 mg/L), Total Suspended Solids (TSS) (350 mg/L), Total Phosphorous (TP) (10 mg/L) and Total Kjeldahl Nitrogen (TKN) (100 mg/L).

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“There can be significant wastewater fluctuations in pH, solid loading and BOD, depending on what is happening operationally, and an effective wastewater management solution must address this.”

Derek Davy, ECONSE

Part One: Initial Technology Pilot



Pilot equipment trailer in parking lot



Pilot equipment trailer interior

The majority of the components of the pilot system are housed in a 10' x 14' trailer. Outside the trailer are the various holding tanks. The system was designed to allow for the modular adjustment of various treatment solution components and to test various configurations. The treated water was collected in a small holding tank and then discharged back into the drain.

Prior to beginning the pilot testing, ECONSE collected samples from the bottom, mid and top of the brewery's wastewater interceptor tank for analysis and preliminary understanding of the raw wastewater.

The wastewater was treated inside the trailer, samples were taken and then the processed water was returned to the wastewater interceptor.

Common brewery practices can contribute to major variations in wastewater composition, particularly organic strength and solids, which can have a detrimental effect on the operation and performance of any wastewater treatment solution. This was the case during the pilot work as the system was exposed to the unanticipated and highly variable quantity of solids in the raw wastewater to be treated by the pilot equipment. In one instance, a spike of high solids clogged the system and it had to be disassembled and flushed out.

To mitigate this issue, additional pre-treatment was required. This involved installing a coarse screen mesh inside the interceptor to protect the intake pump, and two 1,000 L holding/settling tanks were added ahead of the processing equipment in the trailer.

The testing was first done only with mechanical treatment components in order to confirm how far the non-biological treatment could go. The results were confirmed by both third party laboratory tests in addition to on-site use of the Mantech 'real-time' PeCOD® analytical monitoring system. During this test run, various wastewater qualities were tested, and treatment processes re-adjusted with the goal of process optimization.

This work was then repeated with the addition of a down-stream polishing treatment technology to treat the output water from the mechanical treatment.

Major Findings:

As shown in the table below, there was significant spiking and considerable variability in the raw wastewater during the pilot at the large brewery.

The photographs to the right are raw wastewater samples from the interceptor showing the colour and amount of solids.



Initial Interceptor Wastewater Samples



Interceptor Wastewater Samples – 24hr Settling

Large Brewery – Combined Raw Wastewater Data

PARAMETERS	AVERAGE RAW WASTEWATER SAMPLES	REGULATION DISCHARGE LIMITS
BOD (mg/L)	~5,000 – 9,800	300
TKN (mg/L)	150 – 297	100
TP (mg/L)	~70 – 95	10
TSS (mg/L)	~1,000 – 5,500	350



Untreated and treated wastewater

Wastewater fluctuations tended to be part of the ‘norm’ during the pilot. This was largely due to the existing wastewater management/procedures at the brewery and the practice of having all wastewater combined into one interceptor before going down the drain.

At the same time, part one of this pilot also confirmed that a significant amount of dissolved BOD and other nutrients remain in the wastewater in a soluble form, despite the elimination of some BOD through removal of fine suspended solids. To ensure reduction of BOD and other nutrients to meet wastewater discharge requirements, a small footprint secondary polishing component was added to the existing equipment and the work repeated with this optimized technical approach.

The results of this are shown in the table below and confirm that under actual operating conditions, an integrated wastewater treatment system such as the BRÜ CLEAN by Econse is a feasible option to treat brewery wastewater.

Large Craft Brewery – Combined Data

PARAMETERS	AVERAGE RAW WASTEWATER SAMPLES	OPTIMIZED TECHNICAL APPROACH – TREATED WASTEWATER	REGULATION DISCHARGE LIMITS
BOD (mg/L)	~5,000 – 9,800	Less than 300 – Non detect	300
TKN (mg/L)	150 – 297	Less than 60	100
TP (mg/L)	~70 – 95	~2.5	10
TSS (mg/L)	~1,000 – 5,500	~30 – 50	350

These results reinforce the learnings and guidance that BLOOM has provided in the Water & Beer online platform. Any successful solution will start with implementing procedural and operational best practice improvements to ‘keep stuff out of the drain’, followed by optimized treatment technologies.

Part Two: Integrated Solution Pilot

Building on the key learnings from Part One, the objective of Part Two was to demonstrate a step-wise 'full solution' that integrated source reduction practice and design improvements, as well as treatment technologies.

This full solution is outlined in the sidebar and described below, along with results data attributable to the various steps.

STEP 1: Identify and implement source reduction practices



High Strength Material Entering the Drain



High Strength Material Being Collected in a Tote

As part of the pilot, brewery staff were trained by ECONSE in wastewater management and new or improved standard operating procedures (SOPs) were put in place to keep stuff out of the drains. One such SOP involved side-streaming high strength materials (i.e., spent grains, fermentor tank bottoms) by collecting them in a tote for beneficial use applications or disposal.

FULL SOLUTION OVERVIEW



STEP 2: Install a balancing tank to smooth spikes and swings in wastewater composition and strength

Balancing tanks result in more consistent wastewater composition that is easier to manage.

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Installed BRÜ CLEAN Pilot Balancing Tanks

The impacts from both side-streaming and a balancing tank resulted in significant reductions in the strength of the wastewater before the application of any technical treatment, as shown in the table on the next page. Additionally, concentration spikes and the swings were significantly diminished, resulting in a more predictable and consistent wastewater suitable for further treatment.

Although reductions in wastewater strength and composition were achieved, wastewater was still over-strength and would require further treatment (steps 3 and 4) to meet regulatory discharge limits.

Wastewater Pre-treatment Comparison Data

PARAMETERS	REGULATORY DISCHARGE LIMITS	WASTEWATER STRENGTH W/ NO SIDESTREAMING AND NO BALANCING TANK			WASTEWATER STRENGTH W/ IMPROVED ECONS SOPs/SIDESTREAMING AND BRÜ CLEAN BALANCING TANK		
		AVG	LOW	HIGH	AVG	LOW	HIGH
BOD (mg/L)	300	4,151	1,150	14,000	2,569	837	3,260
TP (mg/L)	10	33.9	10.8	92.6	24.9	10	57.2
TSS (mg/L)	350	806	56	3,520	243	27	595
pH	6 to 8	7.7	4.3	12.7	10.6	10.4	12.2

STEP 3: Mechanical Treatment

This step involved an integrated chemical free mechanical process treatment. This removes solids, colloidal solids (TSS) and the majority of BOD and nutrients (TP, TKN).



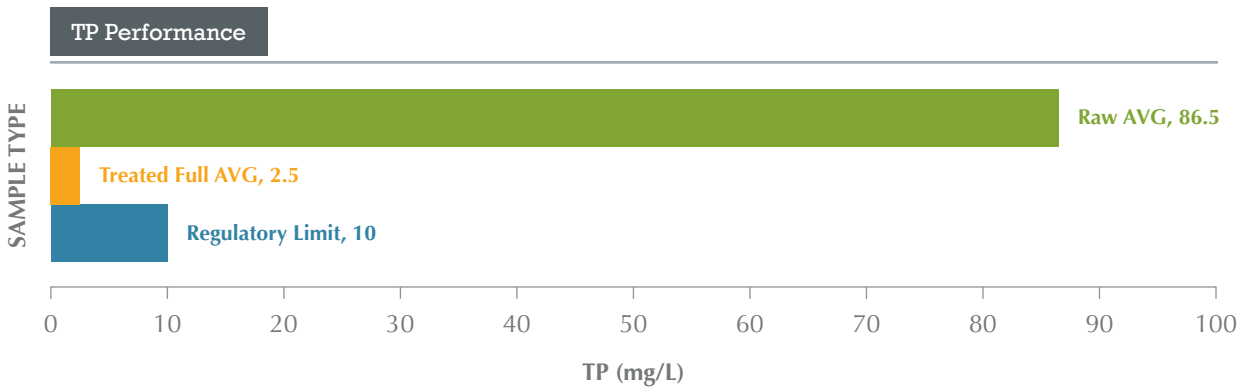
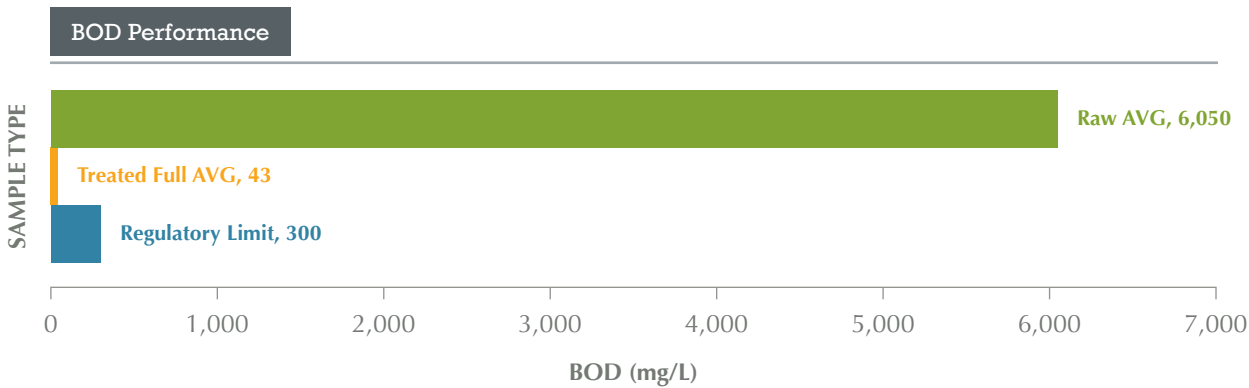
BRÜ CLEAN Treatment Skid

Easy expansion for additional capacity. Footprint approx: W 1m x L 2m x H 2m (not including tanks).

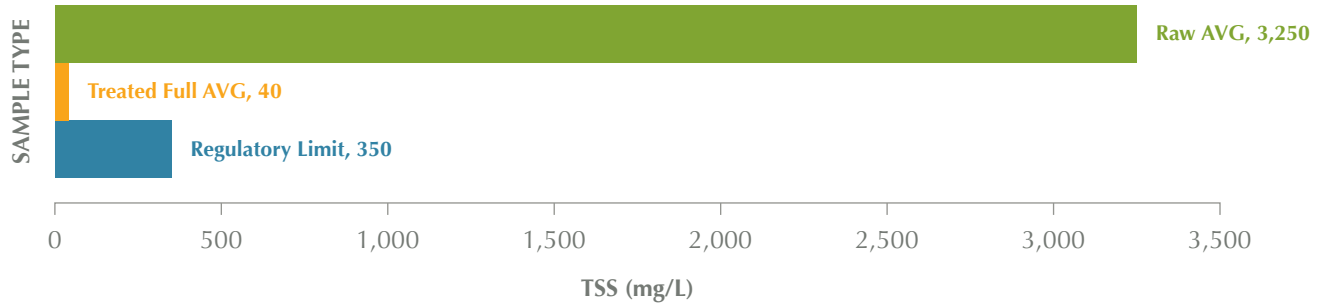
STEP 4: Final Polishing

This step involved final polishing through an innovative process technology to remove residual nutrients and BOD to achieve compliance.

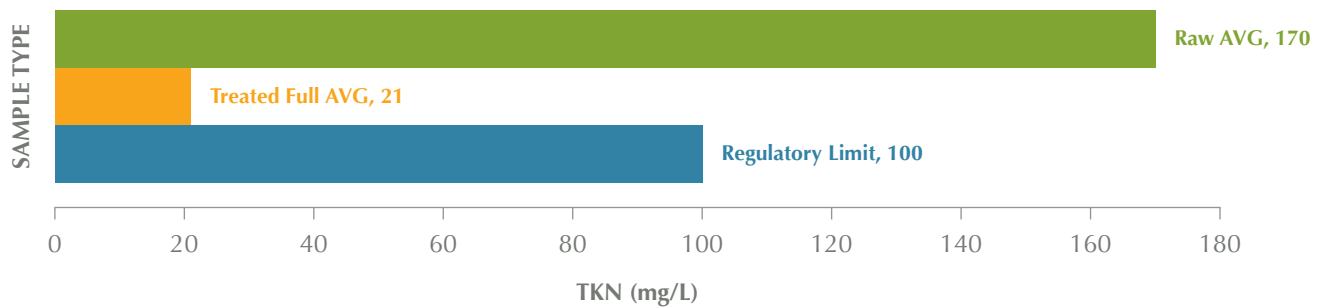
The data presented below represents the average results of full treatment (Steps 1 through 4) relative to the average raw wastewater and regulatory discharge limits.



TSS Performance



TKN Performance



Before and After

Untreated Raw Wastewater
and Fully Treated Wastewater
(suitable for discharge)



**No single step
on its own will
be enough to
reduce the
wastewater
strength to
suitable levels.**

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Key Learnings and Insights from the Demonstration Projects

Brewery Operations and Design

While the intention is not to oversimplify the issue, the foundation for wastewater management starts with the understanding that wastewater is essentially clean water mixed with all the stuff from the brewing process that is put down the drain.

To manage this wastewater, an integrated 4-step approach is required that links practice and process improvements with technology.

A key learning from the demonstrations is that no single step on its own will be enough to reduce the wastewater strength to consistently meet or exceed regulatory discharge limits.

To summarize, craft breweries should follow these four steps.

1. Process and procedure improvements to keep stuff out of the drain

- ▶ This reduces the load of contaminants in the wastewater, which reduces the size and cost of any treatment equipment
- ▶ More information:
<http://waterandbeer.bloomcentre.com/the-basics/water-management-hotspots/>



Drivers for Change – Craft Brewing

Water is a vital resource in the craft brewing sector, both in the product itself and as part of the production process. Water use and wastewater generation varies significantly among breweries, and is influenced by the size of the brewery and the processes used within the operation.

The wastewater challenge for breweries goes beyond volume to ‘what is in it’. There are a variety of process steps associated with beer production, each with significant differences in contributions to both wastewater volume and composition.

Wastewater will continue to grow as a business hurdle that directly affects breweries and their growth. Given the expected future risks of increasing wastewater treatment costs, competition for treatment capacity, not to mention the challenges of rural operation, craft brewers need to be mindful of the need to improve their practices.

The long-term sustainability and growth of the craft brewing sector will be impacted by the ability to cost-effectively reduce water use and manage wastewater.

A more consistent and predictable wastewater composition is important when specifying any follow-on wastewater treatment technology.

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2. Installation of a Balancing Tank

- ▶ Also known as an equalization or EQ tank, this is designed to contain a large volume of wastewater relative to what is flowing in and out.
- ▶ The large volume averages out the swings and spikes.
- ▶ Concentration swings are blended into the whole volume to provide a more predictable average.
- ▶ By eliminating concentration and pH spikes and swings, this results in a more consistent wastewater composition that is easier to manage and if necessary treat.
- ▶ Lastly, a more consistent and predictable wastewater composition is important when specifying any follow-on wastewater treatment technology as it makes it easier for the solution provider to design a solution that not only works as required, but is also of an appropriate size and cost.
- ▶ More information:
<http://waterandbeer.bloomcentre.com/how-to/improve-brewery-design/balancing-tank/>

3. Primary Treatment – Mechanical

- ▶ This removes suspended solids that contribute to wastewater parameters such as TSS and BOD.
- ▶ This also ensures that there will not be any residual solids in the wastewater that could clog or in any other way impede the performance of the the biological treatment component.

4. Secondary Treatment – Biological

- ▶ This largely eliminates the remaining organic components that are dissolved in the wastewater.

If wastewater is not properly managed, the variation in strength and flowrate can cause problems for municipal treatment facilities and result in potential high surcharge costs for craft breweries.

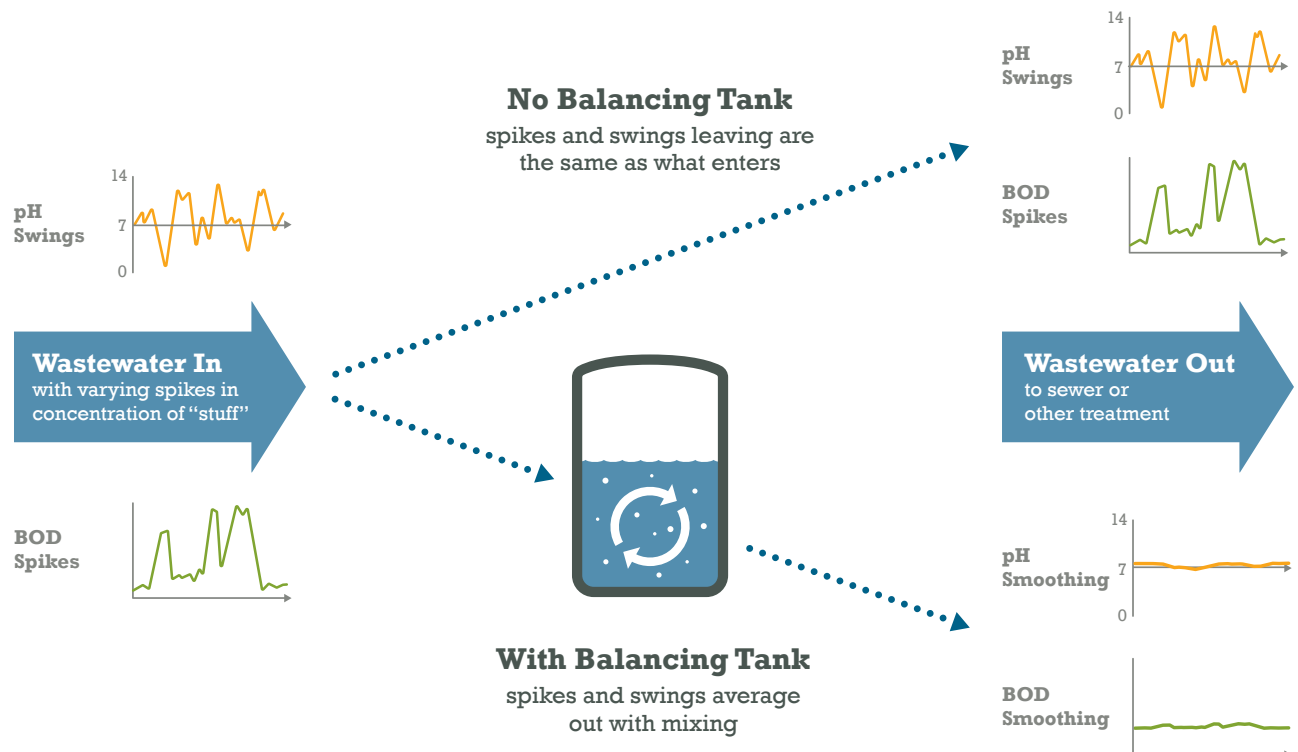




Photo Credit: Emily Collins, Sawdust City Brewing Company

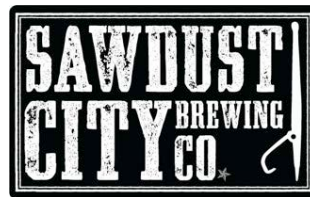
Early Adoption

Following the completion of these demonstration projects, one of the pilot host breweries is moving forward with a full-scale installation of the integrated wastewater solution.

Sawdust City Brewing Company announced in April 2017 that it is partnering with ECONSE to install the first commercial system.

Being located in the Muskoka region of Ontario and surrounded by beautiful lakes, they appreciate water as a precious resource. Through their participation in this demonstration project and subsequent investment in a full scale commercial system, Sawdust City has shown its leadership as both an early adopter and a water steward.

This is an exciting step forward for the craft brewing sector in Ontario. Not only will this provide positive impact for the brewery and its community, it will also help to further illustrate the benefits of an integrated approach to wastewater management. Early adopters such as Sawdust City Brewing Company play a critical role in helping to reduce sector concerns and perceived risks around the adoption of innovative approaches and technologies.





There will be craft brewers who through choice or necessity want to improve their performance beyond regulatory requirements.

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Positioning for the Future – What it Means for the Ontario Craft Brewing Sector

Understanding what this can mean for the craft brewing sector starts with recognizing that this project informs craft brewers that there are practical and pragmatic solutions available to manage high-strength wastewater. Integrating these solutions into new brewery design or expansion retrofits, will allow Ontario's craft brewers to become leaders in moving toward zero discharge operations.

Through the adoption of integrated wastewater solutions such as the BRÜ CLEAN system, many breweries will be content to be able to manage their wastewater to meet or exceed discharge limits. However, there will be others who through choice or necessity will want to improve their performance even further.

An exciting outcome from this demonstration project is the value of such integrated wastewater treatment solutions as a 'bridging' option to further water management opportunities.

Rural and Small Towns

A good example are the growing number of small town and rural craft breweries. For those with connections to municipal infrastructure, they can unknowingly place a strain on their local community's wastewater treatment system. And for those breweries without municipal connection, they can build on the capability of an integrated wastewater solution and implement further treatment to achieve regulated levels for discharge to septic beds. For brewers considering opening in rural settings without access or feasible connection to municipal treatment infrastructure, this capability can be the difference between being able to start-up a brewery or not.

Water Reuse

For all craft breweries, there is also the potential for additional treatment to generate near potable or potable water for recycled use in brewery cleaning and other 'non-ingredient' applications. Whereas an Ontario craft brewer with a focus on minimizing water use could use best practices to achieve 3 to 4 L of water per L of beer produced, by recycling even a portion of that water, the brewery can reduce this ratio even further.

By minimizing their incoming water requirements and outgoing wastewater demands on any treatment infrastructure, Ontario's craft breweries are not only making some of the best beer in the world, they can also become great water stewards in their communities.

And that is a win-win for everyone.



waterandbeer.ca

The Water & Beer online platform is a go-to resource designed to guide craft brewers through the Ins, Outs and In-Betweens of their water use.

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