BREWERY CASE STUDY: REDUCING POLLUTION FROM WASTEWATER DISCHARGES

great falls brewing company | north canaan, connecticut

Connecticut has approximately 120 operating breweries. The recent growth in this industry is a welcome addition to Connecticut's economy. The brewing process however comes with environmental impacts. This case study focuses on one issue of concern, the discharge of large volumes of high strength wastewater. There can be problems if waste and wastewater are not managed properly. The study is an example of how implementing best practices can help reduce wastewater pollutants, and may also lower business costs.

The Issue. Breweries typically generate between 5-8 gallons of wastewater per gallon of beer produced. Due to the ingredients used to produce beer, highly concentrated pollutants end up in the wastewater, much higher than levels typically found in domestic sewage. High-strength wastewater comes from spent grains, mash, hops, trub, bad batches of product, first rinses of process tanks, or wasted product from fill stations and bottling lines when the waste product is washed down the drain. It contains high levels of biochemical oxygen demand (BOD), Chemical oxygen demand (COD), total suspended solids (TSS), wide pH swings, high temperatures, and slug loading from batch discharges which can damage the biological balance at a wastewater treatment plant if certain limits are exceeded.

The Brewery. Great Falls Brewing Company (Great Falls) is a small craft brewery which opened its facility located in a historic train depot in North Canaan, CT in December 2018. Their company culture is focused on community - both involvement of community members and commitment to the community. This is demonstrated by their dedication to sustainable brewing practices, including collecting all spent grains for use by local farmers for animal feed.

Originally connected to the Town of North Canaan sewer plant, Great Falls stopped discharging their brewing wastewater due to local concern over potentially high organic load. Since that time, all brewhouse wastewater is collected in a 2,000-gallon holding tank and sent weekly to a local anaerobic digestion and converted to energy. No organic load-related surcharges are paid as part of their sewer bill. Through their involvement with the Connecticut Brewers Guild, Great Falls became aware that the Connecticut Department of Energy & Environmental Protection (CT DEEP) was offering pollution prevention assistance to breweries. They volunteered to take part in a project to identify and implement practices to lower the strength of their effluent and serve as a model for other breweries in the state. Great Falls was hopeful that implementing

Continued Next Page

best management practices in the brewhouse could reduce wasteload sufficiently to allow for a full connection to the municipal wastewater system, allowing them to eliminate weekly wastewater hauling costs.

The brewery consists of a 10-barrel (BBL) brewhouse with 10-barrel fermenters that average an annual production rate of 550 to 600 BBL/year of beer. In addition to the brewhouse, the facility has a tap room which discharges to the municipal wastewater collection system. Facility water consumption averages Approximately 59,000 gallons /year. Most of this water becomes finished product. Because wastewater from the brewhouse is stored, Great Falls is able to accurately approximate brewhouse wastewater generation at 1,250 gallons/week. Comparing their actual measured wastewater generation rate to their annual production of beer, wastewater from this facility is generated at a very efficient rate of 3.4 barrels of wastewater for every barrel of beer produced, which is much more efficient than the craft brewing industry average of 5:1. A site visit was arranged to review brewing operations, pinpoint locations and processes which contribute to high strength wastewater flows and to develop a list of pollution prevention practices that could be implementation within the brewhouse to reduce overall organic load.

The Study. Phase One of the study consisted of identifying potential sampling locations and taking representative composite samples of industrial effluent from Great Falls brewing operation. Fortunately, all drainage from the brewing operation, both brewing and cellaring, pass through trench drains to a small below-grade wastewater pump station. It was at this pump station that most of the samples were collected. In addition, sampling was conducted at the canning line during a canning run. Samples of wastewater were also obtained from waste beer in the taproom (broken cans, dumped glasses, beer tap purge, etc.). Wastewater samples from the tap room were grab samples because it is comprised of beer product and consistent in quality, while canning line and pump station samples were time-weighted composites (collection of a uniform volume sample every hour). Background sampling took place over a three-day period, during which each of the brewing processes, which generate wastewater, were operated. This allowed for calculation of approximate average overall wastewater loadings during a typical brewing week.

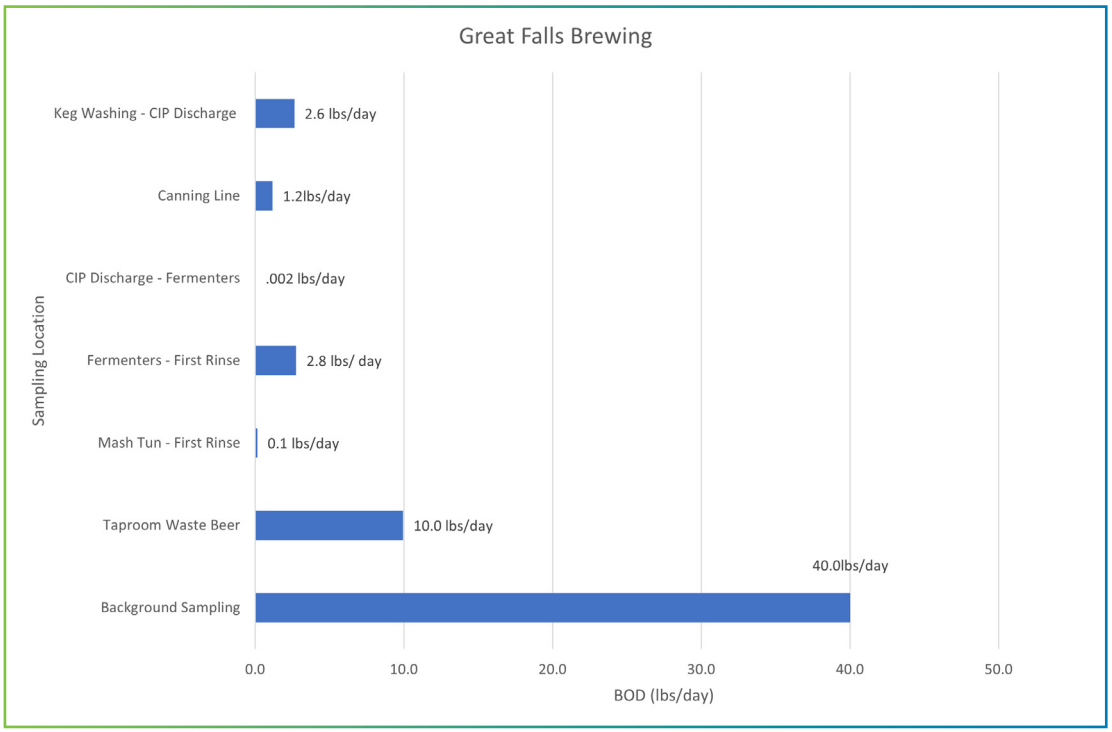
As noted above, Great Falls brewing collects all of their brewing operation wastewater for disposal off-site at an agricultural digester. Since no wastewater is discharged to the municipal wastewater collection system, we chose this opportunity to try to identify load fractions for each of the brewing processes. The configuration of the brewing equipment allowed us to obtain two more rounds of wastewater grab samples from each of the following specific brewing processes:

- Taproom Waste Beer
- Mash Tun First Rinse – After wort is transferred and the spent grain has been removed, but before the Clean-in-Place (CIP) system is connected to the vessel.
- Fermenters First Rinse - After fermented beer is transferred to canning, but before the CIP system is connected to the vessel.
- CIP Discharge – After final cleaning and sanitizing of the fermenters.
- Canning Line Discharge – Foam-over and can rinse collected during the canning process.
- Keg Washing CIP – Includes residual beer, as well as spent CIP washwater from returned beer kegs.

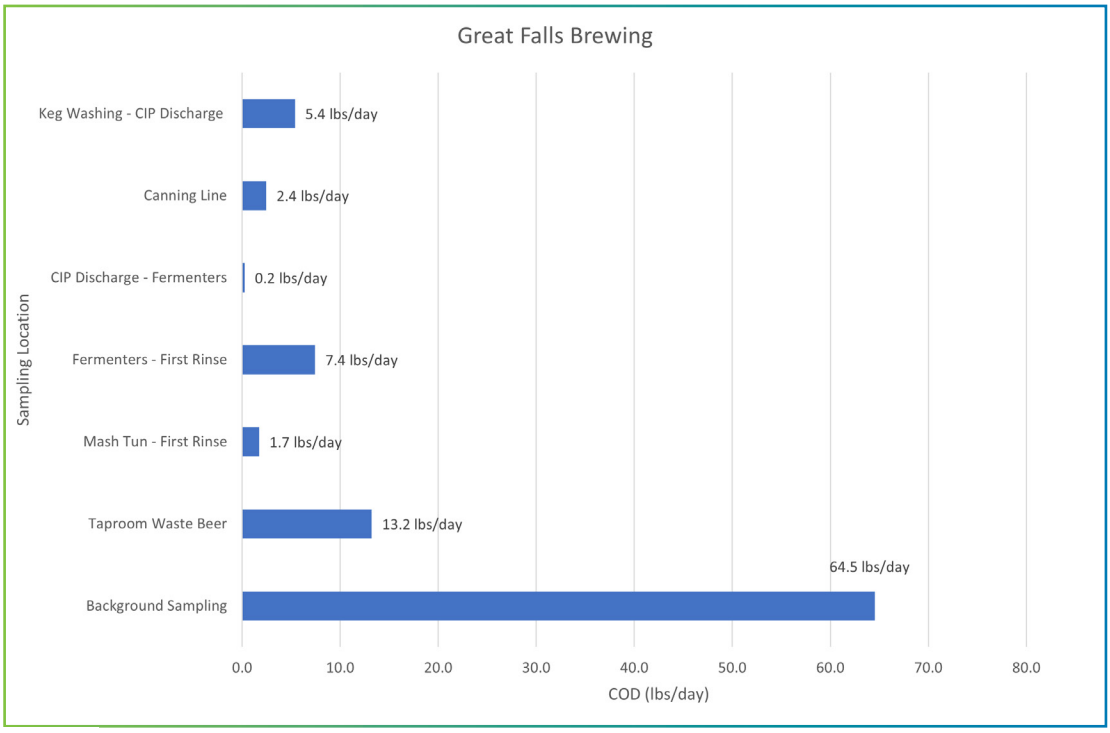
Continued Next Page

The following graphs depict constituent loadings relative to the total brewery loading. Ideally, adding up the total loads from each area sampled should be close to the total loading from the brewery. Variability in brewing operations, seasonal variability in product and production, and the limited number of analyses at each discharge location contributed to the lack of resolution. However, we are able to see where the bulk of the loadings for each constituent are generated through the brewing and cellaring processes.

Biochemical Oxygen Demand (BOD_5)

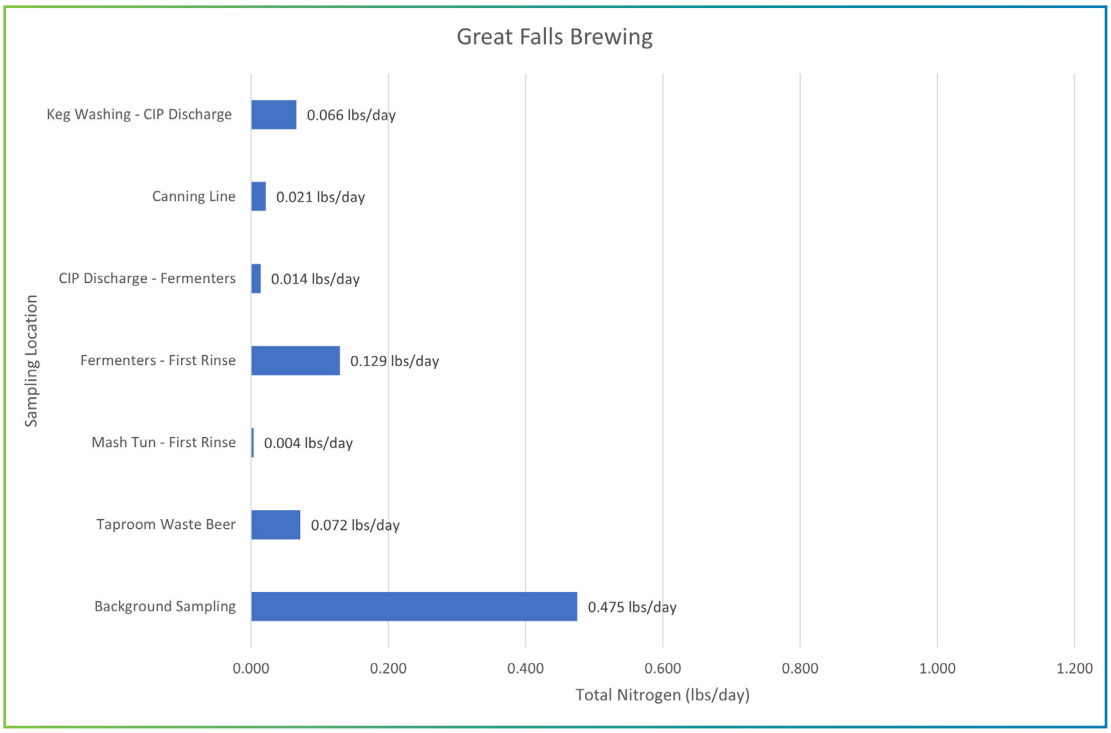


Chemical Oxygen Demand (COD)

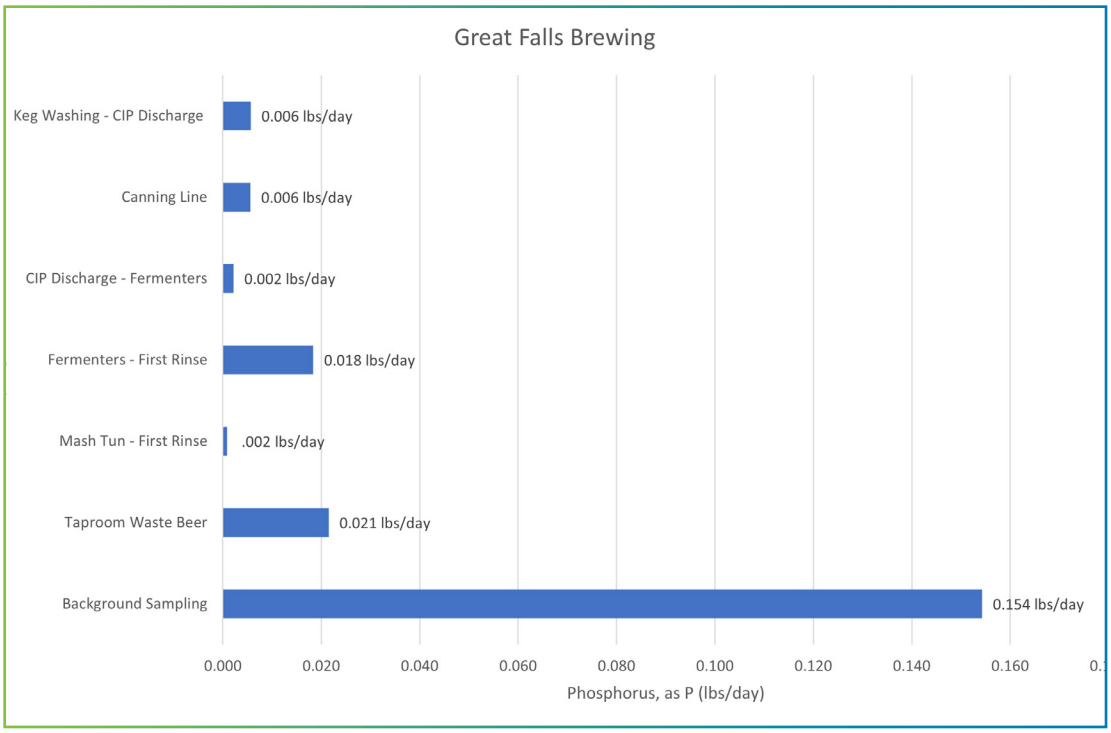


Continued Next Page

Total Nitrogen

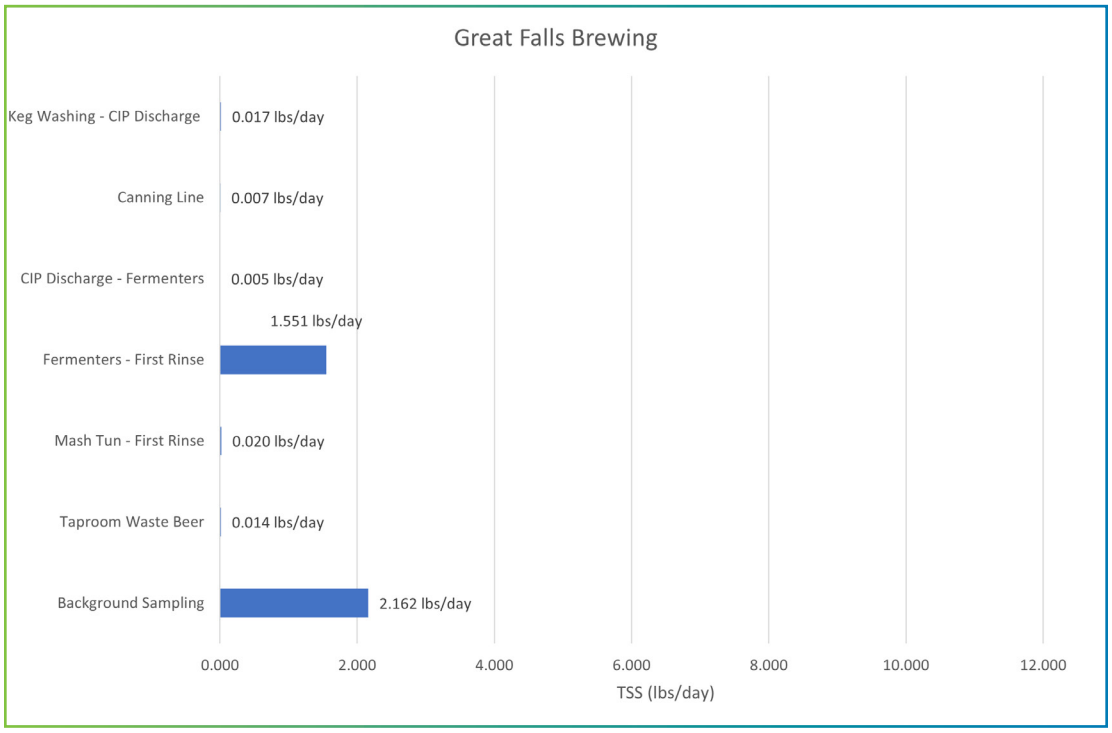


Phosphorus



Continued Next Page

Total Suspended Solids (TSS)



Most municipal wastewater treatment facilities are concerned with organic, oil and grease, solids, and nutrient loadings from industrial dischargers. Breweries are typically not sources of oils and grease. From a review of our study data, we observed that a significant contributor of organic load at Great Falls (both BOD and COD) is Taproom Waste, followed closely by Fermenter First Rinse and then Keg Washing. For total suspended solids (TSS), the most significant contributor is Fermenter First Rinse. Most of the nutrient loadings (phosphorus and nitrogen) are from the Fermenter First Rinse and Taproom Waste.

More generally, we see that implementing pollution prevention measures that keep beer product from entering the wastewater will provide the largest reduction in organic load.

Cost Considerations. Brewery Best Management Practices (BMPs) serve as low-cost operational improvements which will result in a significant reduction in sewer surcharge costs. The New England Interstate Water Pollution Control Commission (NEIWPCC) states that the average concentrations of BOD and TSS in domestic wastewater are 250 milligrams per liter (mg/l) and 300 mg/l, respectively. Wastewater generators whose discharge characteristics exceed these limits are typically subject to a surcharge based on the cost of treating the additional organic load above the average organic loadings noted above. Many communities have sewer use ordinances which state that loadings over those based on a domestic strength of 200 mg/L will be the basis for a surcharge.

Since Great Falls has no sewer surcharges from brew operations to use as a starting point, we are providing the calculation below using regional average values to show approximate the magnitude of savings from the few BMPs that were undertaken at this brewery. Using the 3.4:1 wastewater to beer production ratio noted above, Great Falls generates approximately 1,250 gallons of wastewater per operating week. Assuming an average wastewater BOD of 19,200 mg/L (Great Falls flow-weighted average brewery baseline), their BOD mass loading is likely 40 lb/day before any process sidestreaming. Since they ultimately would only pay a surcharge on loadings in excess of 200 mg/L, approximately 39.5 lb/day would be

Continued Next Page

used in this BOD surcharge calculation. Using a low regional average BOD surcharge of $0.15/lb/day, Great Falls could hypothetically see surcharges over $2,100 per year above their annual sewer bill if the brewery was actually connected to a municipal wastewater system.

Using the limited data we were able to gather, if Great Falls sidestreams their three significant organic load generators (Taproom Waste, Keg Wash and Fermenter First Rinse) they could potentially see a 38.5% reduction in BOD concentrations in wastewater from all brewing operations. This reduction is equivalent to an average reduction in concentration of 7,392 mg/L. A reduced average effluent BOD loading of 11,800 mg/L yields a reduction of 24.1 lb/day of BOD (after domestic load is backed out). At $0.15/lb/ day this is equivalent to a savings of $2.32/day ($850/year) based on BOD alone. While this does not seem like a lot of money, it does represent a 40% organic load reduction and commensurate reduction in wastewater surcharge if the brewery was discharging to a municipal wastewater system.

Conclusions. Great Falls provided us with a great opportunity to (1) see how individual brewing process wastewater discharges contribute to the total loadings from a brewery, (2) see how different brewing processes contribute higher concentrations of different constituents and (3) demonstrates the impact of implementing BMPs in these various areas of their facility. Should BMPs be implemented throughout the brewery and taproom, we expect that significant waste load reductions will be achieved. While this may not allow for connection to a small wastewater system without some pretreatment, it will significantly reduce the implementation cost for such pretreatment.

Acknowledgements. This project was funded by an EPA P2 grant (FY 2020). CT DEEP utilized a consulting firm, Weston & Sampson to identify P2 opportunities and conduct sampling. The CT Brewers Guild helped identify volunteer facilities.

For More Information, visit CT DEEP's Sustainable Breweries (ct.gov) webpage.