New England neefc Environmental Finance Center

A New Take on Brewery Wastewater Management

Including High Strength Byproduct Sidestreaming, and Opportunities for Improved Pretreatment Coordination

Luke Truman | luke.truman@maine.edu
Sandlin Preecs | sandlin.preecs@maine.edu

Project Scope

In early 2023, BetterBev began working with breweries and service providers in Rhode Island and Greater Portland, Maine to explore ways to offer scale-building sidestreaming opportunities to reduce:

- The nutrients breweries send down the drain
- BOD and TSS surcharges breweries pay
- The costs associated with sidestreaming

The Reality of the Project

The solutions are not complicated, but he problems are.

The Perceived Problem - Brewer

Brewer's Angle

- Surcharges for the treatment of wastewater are inconsistent from brewery to brewery
- Removing this material beforehand is inconvenient and expensive
- The material is not toxic
- Brewers feel like they're being picked on

US EPA, O. (2013, May 28). *Pollution Prevention (P2)* [Overviews and Factsheets]. https://www.epa.gov/p2

The Perceived Problem - Treatment

Wastewater Treatment Plant (WWTP) and Municipal Angle

- WWTPs have finite treatment capacities
- WWTPs must adhere to strict discharge limits per the EPA
- pH, TSS, and BOD slugs can significantly disrupt or even collapse operations

US EPA, O. (2013, May 28). *Pollution Prevention (P2)* [Overviews and Factsheets]. https://www.epa.gov/p2

What's the Big Deal?

Consider that a typical household generates between 100-200 gallons per day of wastewater with a BOD of about 200 mg/l. The impact of brewery wastewater becomes more obvious when comparing brewery BOD to household BOD. For example, a brewery that produces about 1,000 bbl of beer annually, will generate up to 1,000 gallons/day of wastewater. With a BOD (strength) of about 3,000 mg/l, this brewery discharge is equivalent to about 50 homes.

Parameter	Raw Wastewater	Treated Wastewater
Water to Beer	4-10 liter/liter	Same
Wastewater to Beer Ratio	1.3-2 liter/liter lower than water to beer ratio	Same
Biochemical Oxygen Demand (BOD)	600-5,000 mg/l	100-400 mg/l
Chemical Oxygen Demand (COD)	1,800-5,500 mg/l	
Nitrogen	30-100 mg/l	
Phosphorus	3-12 mg/l	
pH	3-12	6-9
Total Suspended Solids (TSS)	200-1,500 mg/l	50-500 mg/l

Source: MEWEA

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Source: MEWEA

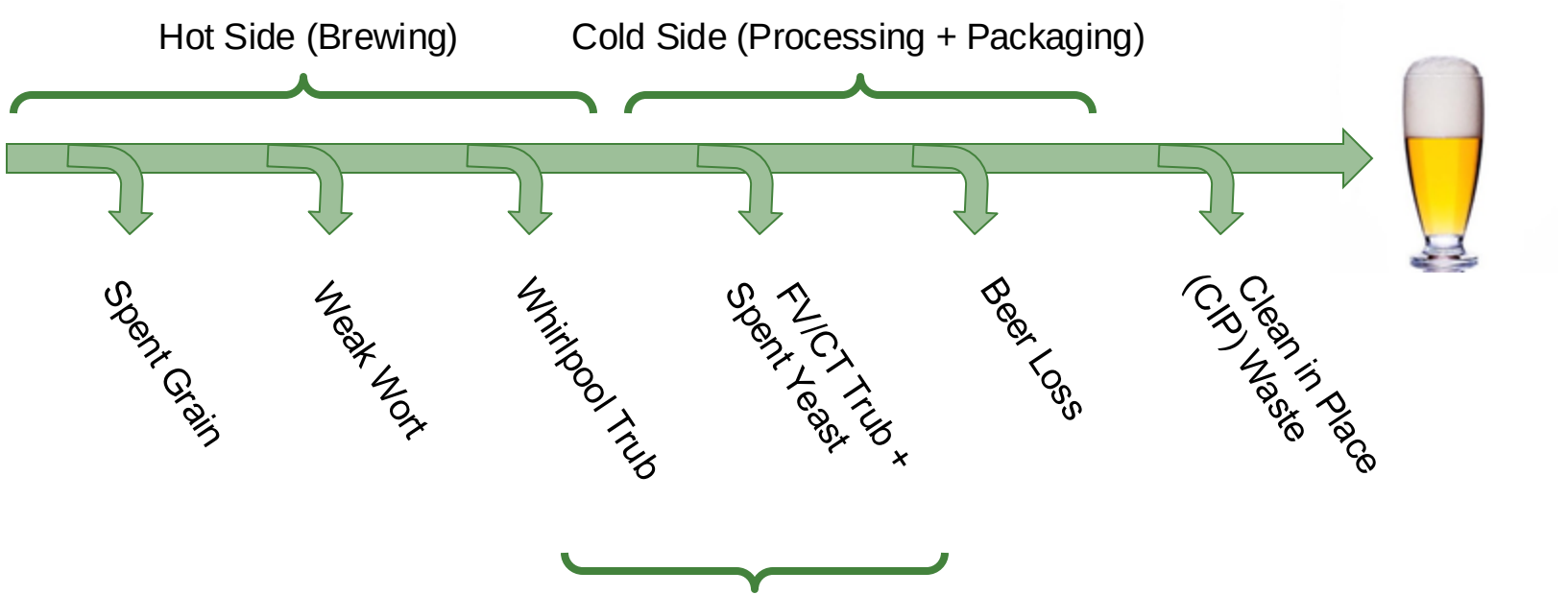
Sources of High Strength Wastewater

Main Areas Of Wastewater Generation

SOURCE	OPERATION	CHARACTERISTICS
Mash Tun	Rinsing	Cellulose, sugars, amino acids. ~3,000 ppm BOD
Lauter Tun	Rinsing	Cellulose, sugars, spent grain. SS ~3,000 ppm, BOD ~10,000 ppm
Spent Grain	Last running and washing	Cellulose, nitrogenous material. Very high in SS (~30,000 ppm). Up to 100,000 ppm BOD
Boil Kettle	Dewatering	Nitrogenous residue. BOD ~2,000 ppm
Whirlpool	Rinsing spent hops and hot trub	Proteins, sludge and wort. High in SS (~35,000 ppm). BOD ~85,000 ppm
Fermenters	Rinsing	Yeast SS ~6,000 ppm, BOD up to 100,000 ppm
Storage tanks	Rinsing	Beer, yeast, protein. High SS (~4,000 ppm). BOD ~80,000 ppm
Filtration	Cleaning, start up, end of filtration, leaks during filtration	Excessive SS (up to 60,000 ppm). Beer, yeast, proteins. BOD up to 135,000 ppm
Beer spills	Waste, flushing etc	1,000 ppm BOD
Bottle washer	Discharges from bottle washer operation	High pH due to chemical used. Also high SS and BOD, especially thru load of paper pulp.
Keg washer	Discharges from keg washing operations	Low in SS (~400 ppm). Higher BOD.
Miscellaneous	Discharged cleaning and sanitation materials. Floor washing. flushing water. boiler blow-down etc.	Relatively low on SS and BOD. Problem is pH due to chemicals being used.

Source: MEWEA

A Simplification of the Sources



Excluding spent grain, wort, beer, and CIP waste, **a typical brewery will generate ~9.6 gallons of high strength waste per barrel produced at ~130,000 mg/L BOD

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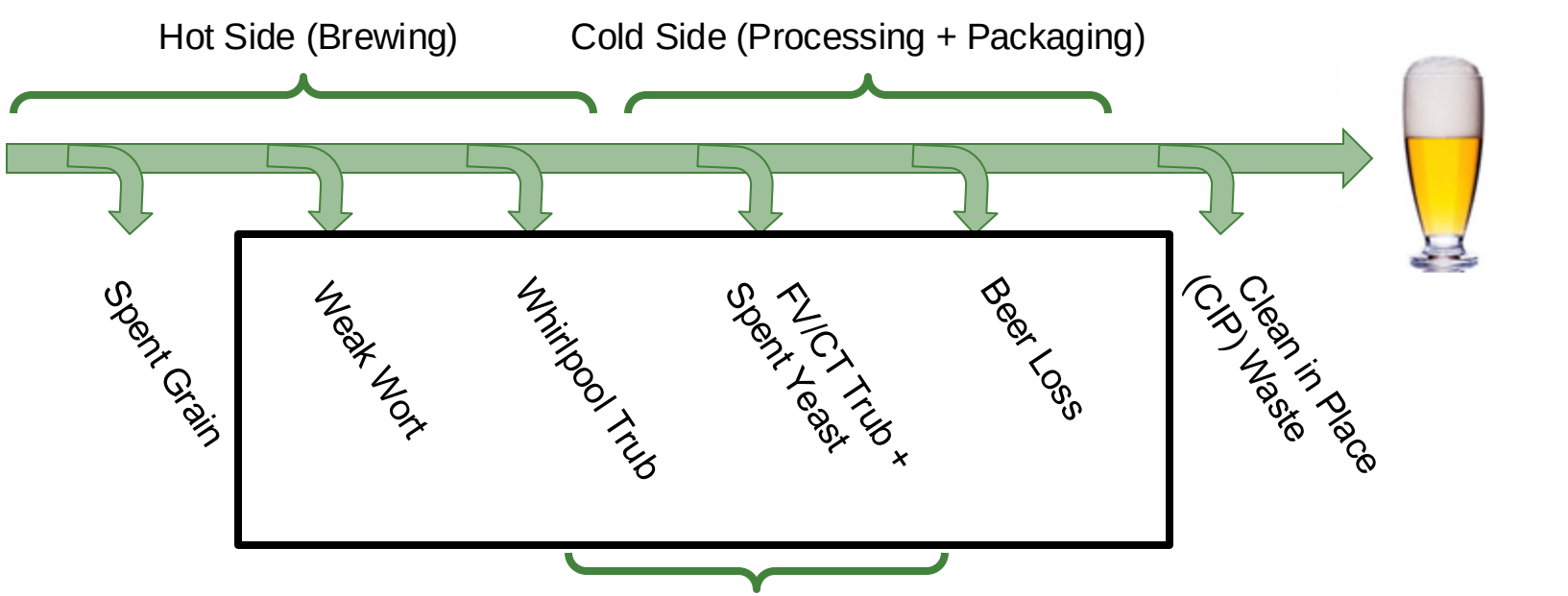

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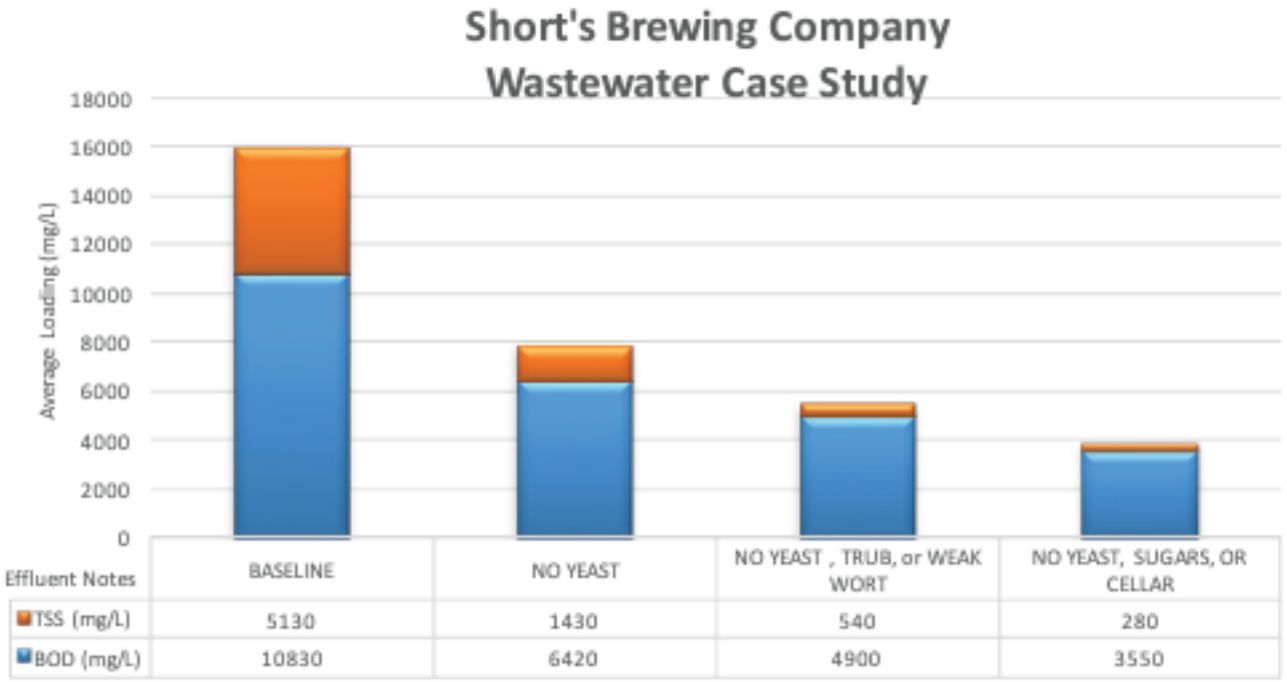
Quantities and Impacts

- **Spent Grain:** Not put down the drain
  - Not the issue here
- **Weak Wort:** Typically put down the drain
  - ~.3 gallons/barrel (still in the works)
  - 75K - 120K mg/L BOD (to be determined)
- **Hot Side Trub:** Often put down the drain
  - ~2.6 gallons/barrel
- **Cold Side Trub/Spent Yeast**: The first to be sidestreamed
  - ~7 gallons/barrel
- **Beer Loss:** Typically put down the drain
  - 75K - 180K mg/L BOD (quantities to be determined)
- **CIP Waste:** Easily collected and neutralized
  - Not the issue here

130,000 mg/L BOD

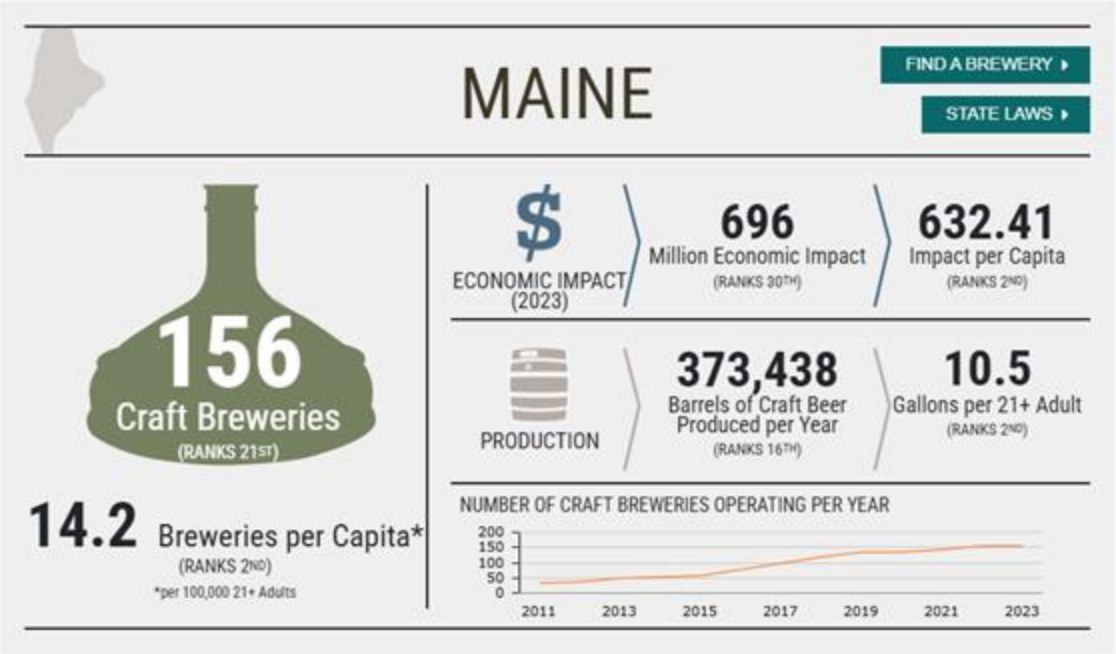
A Noteworthy Case Study



Effluent Notes	BASELINE	NO YEAST	NO YEAST , TRUB, or WEAK WORT	NO YEAST, SUGARS, OR CELLAR
TSS (mg/L)	5130	1430	540	280
BOD (mg/L)	10830	6420	4900	3550

Source: Brewers Association

What Does This Mean New England Wide?



Source: Brewer's Association 2023

Production Volume/Yr

CT - 347K barrels

MA - 448K barrels

ME - 373K barrels

NH - 124 K barrels

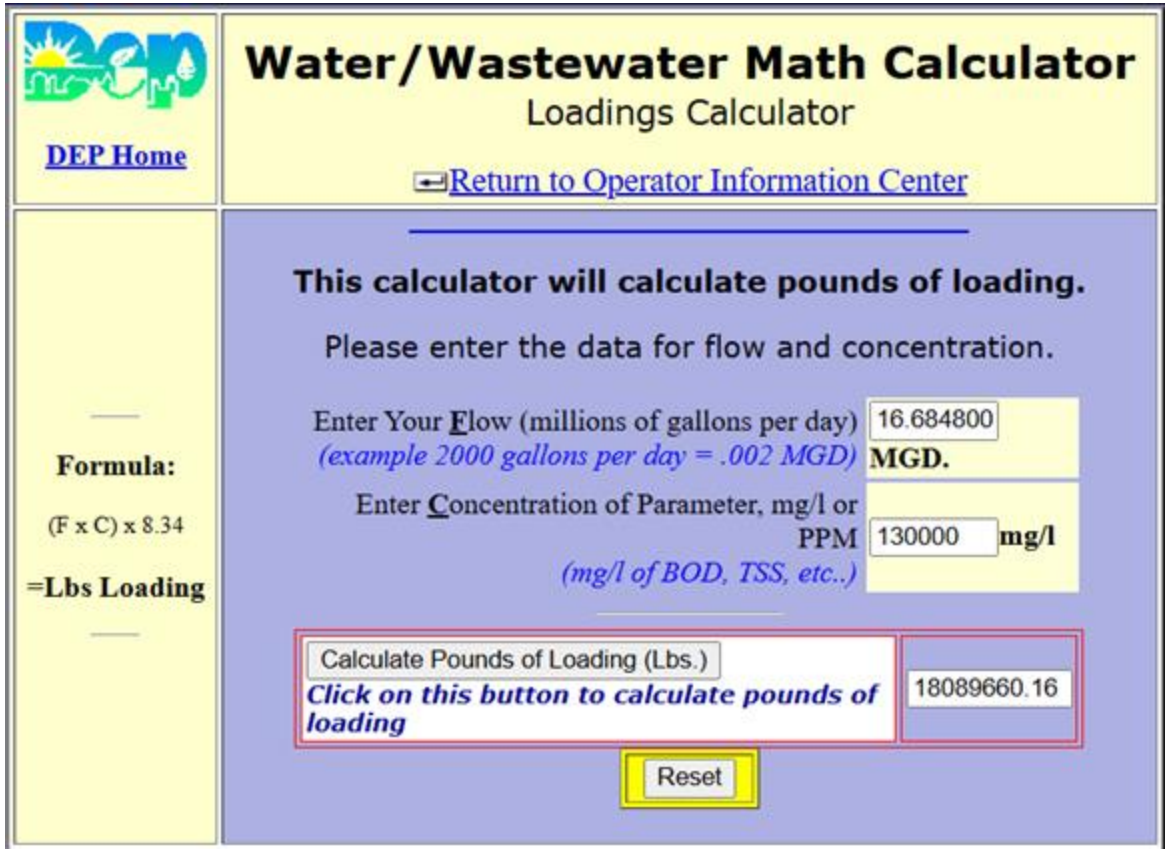
RI - 93K Barrels

VT - 353K Barrels

Total **~ 1,738K** barrels produced

resulting in **~538K barrels of waste/yr**

How Much Sludge is This?



DEP Home

Water/Wastewater Math Calculator

Loadings Calculator

Return to Operator Information Center

This calculator will calculate pounds of loading.

Please enter the data for flow and concentration.

Enter Your Flow (millions of gallons per day) 16.684800 **MGD.**
(example 2000 gallons per day = .002 MGD)

Enter Concentration of Parameter, mg/l or PPM 130000 **mg/l**
(mg/l of BOD, TSS, etc..)

Formula:

(F x C) x 8.34

=Lbs Loading

Calculate Pounds of Loading (Lbs.) 18089660.16

Click on this button to calculate pounds of loading

Reset

538K barrels = 16.684800 million gallons

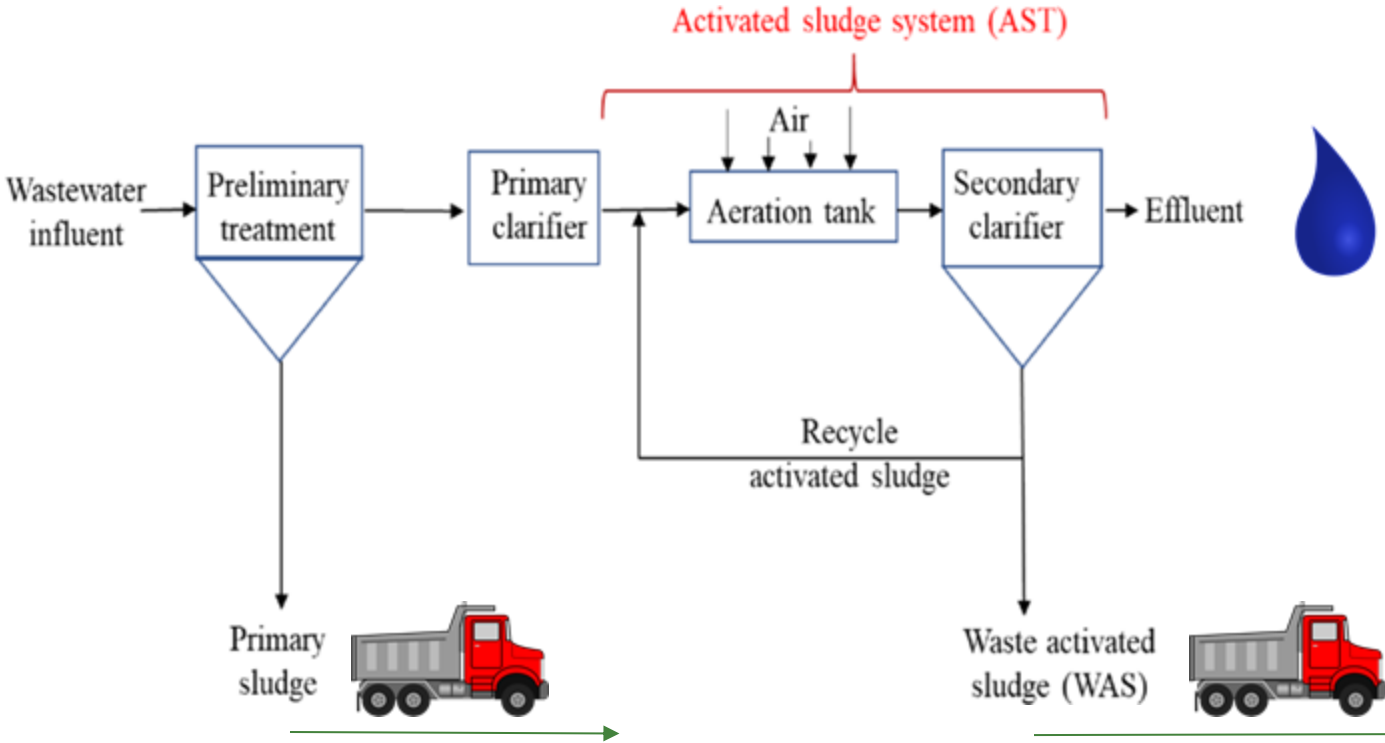
At 130,000 mg/L BOD this = 18,089,660 lbs of BOD

Treating 18,089,660 lbs of BOD generates ~ 4,500 tons of sludge

Direct TSS (solids content ~ 4 lbs of hops/barrel) ~ 3,476

TSS + BOD sludge available ~ 7,976 tons/yr

Overview of WWTP



Typically Landfill or Incineration

Benton et al, JMR 2023

Where Does the Sludge Go? Cost?

We typically send out about 2 trucks/wk, or roughly 3,100 tons of sludge annually. This number is pretty consistent, varying by only about 5% year to year.

- Small WWTP Operator in Maine

We had a rate study performed by Arcadis in 2015-2016. The cost to treat CBOD was calculated at $0.51/lb. The cost to treat TSS was calculated at $0.43/lb.

- Small WWTP Operator in Rhode Island

The Fallout - Rhode Island

WOONSOCKET, R.I. —The operators of a Woonsocket wastewater treatment facility are being sued, again.

Last month local residents Maurice Doire and Joshua Hoye filed a class-action lawsuit in Rhode Island District Court against Synagro Woonsocket LLC and Jacobs Engineering Group Inc. over their alleged mismanagement of the wastewater treatment plant and sewage sludge incinerator on the banks of the Blackstone River.

In the complaint, the plaintiffs allege Baltimore-based Synagro and Texas-based Jacobs, which have a history of odor complaints and Rhode Island Department of Environmental Management violations, "have, and continue to, unnecessarily and unreasonably cause noxious odors to be emitted off-site and into Plaintiffs homes and similarly situated neighboring residential properties in Woonsocket."

The Fallout - Maine

ENVIRONMENT, FOREVER CHEMICALS, INVISIBLE AND INDESTRUCTIBLE, WABANAKI NATIONS · 14 minute read

Compound Injustice: PFAS may concentrate over time in landfills near the Penobscot Indian Reservation

By Marina Schauffler
September 10, 2022

Share this story:

Potential risks from PFAS and other contaminants threaten the traditional foods and tribal traditions of the Penobscot Indian Nation.

More Fallout - Maine

Local & State

Lawmakers clash over bill to delay out-of-state trash ban

Supporters say Maine needs the trash to solve its sludge disposal crisis, but critics say the state-owned landfill should be reserved for in-state waste and accused the operator of prioritizing profits over solving the problem.

Posted May 8, 2023 Updated May 8, 2023

Penelope Overton
Portland Press Herald

What We Consider a Win

Local & State News

Maine sludge crisis is over – for 2 years, at least

A temporary compromise reached by lawmakers means Maine communities are once again burying sewage sludge in the state-owned landfill at Juniper Ridge near Old Town, and don't have to pay extra to haul the waste to New Brunswick, Canada.

Posted August 7, 2023 Updated August 7, 2023

Penelope Overton
Portland Press Herald

The Solution?

Local & State News

Maine DEP says expansion of state's largest landfill would benefit public

The decision allows the state to apply to add 61 acres to the state-owned Juniper Ridge Landfill, which takes in 52% of the state's waste.

Posted October 2 Updated October 2

Penelope Overton
Press Herald

It's Important to Acknowledge

This is not the fault of WWTPs

Brewers and those handling the industry are complicit when they aren't actively looking for solutions

- This problem with breweries can't be surcharged away

Maine's Food Economy

Industry Summary for Maine's Food Economy, 2018-2023

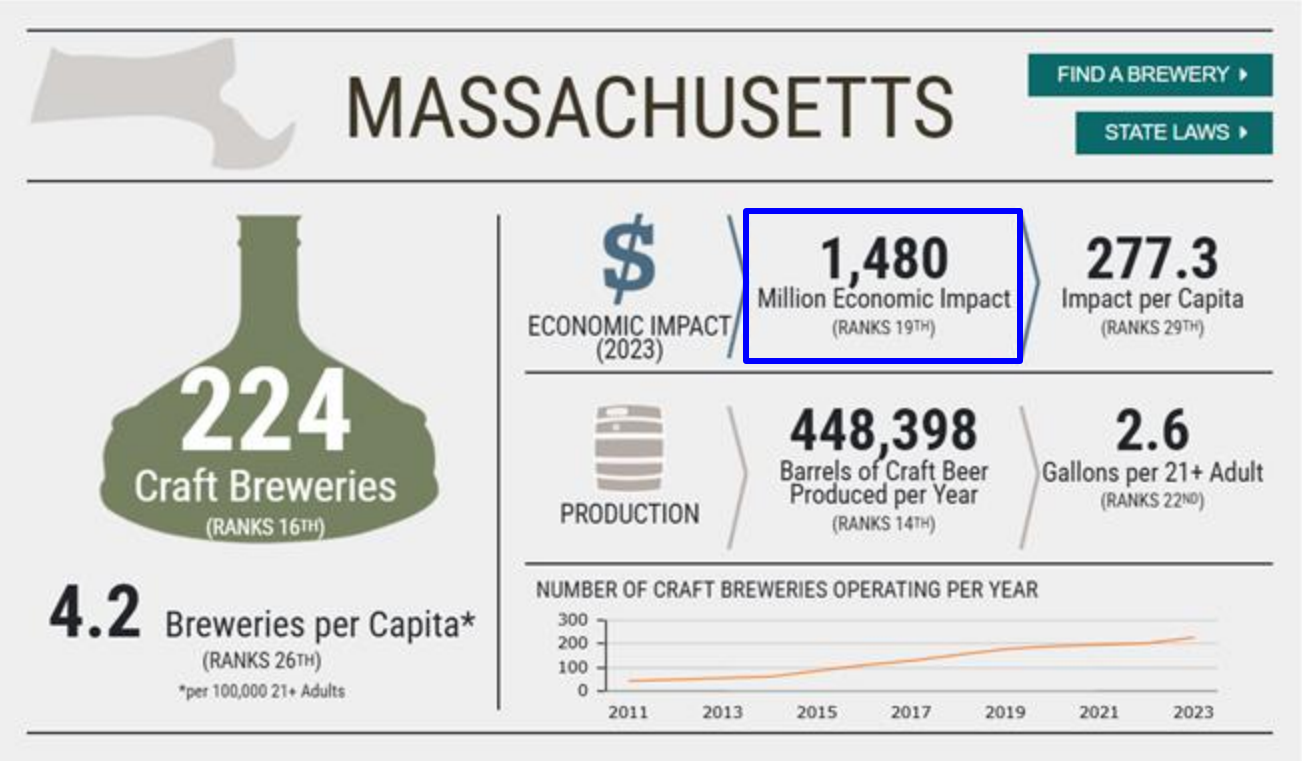
NAICS	Description	2018 Jobs	2023 Jobs	Avg. Earnings Per Job	2023 Employment Concentration	2022 GRP	GRP Per Job
1110	Crop Production	4,033	6,260	$43,724	1.68	$639,807,209	$102,213
1120	Animal Production (includes aquaculture)	1,816	1,991	$43,218	1.01	$150,664,626	$75,662
1141	Fishing	5,116	5,129	$62,532	43.05	$645,675,970	$125,897
1151	Support Activities for Crop Production	1,050	1,097	$33,443	0.52	$55,702,662	$50,786
1152	Support Activities for Animal Production	109	134	$36,412	0.72	$11,952,016	$89,499
3111	Animal Food Manufacturing	85	73	$78,082	0.23	$15,949,449	$218,784
3112	Grain and Oilseed Milling	56	81	$77,688	0.29	$19,655,004	$243,735
3113	Sugar and Confectionery Product Manufacturing	231	368	$37,419	1.06	$27,747,942	$75,307
3114	Fruit and Vegetable Preserving and Specialty Food Manufacturing	1,295	1,211	$69,017	1.58	$160,717,628	$132,740
3115	Dairy Product Manufacturing	520	476	$83,547	0.68	$78,893,632	$165,605
3116	Animal Slaughtering and Processing	486	573	$62,388	0.24	$63,907,316	$111,581
3117	Seafood Product Preparation and Packaging	744	689	$61,161	4.82	$56,848,627	$82,478
3118	Bakeries and Tortilla Manufacturing	1,627	1,887	$47,183	1.23	$109,157,694	$57,844
3119	Other Food Manufacturing	634	592	$61,762	0.54	$75,818,352	$127,987
3121	Beverage Manufacturing	1,938	2,631	$71,731	1.88	$697,950,464	$265,292
	Total	**19,741**	**23,191**	**$54,475**	--	**$2,810,448,592**	**$121,185**

Note: Support activities for Animal Production includes operations that offer breeding services, boarding services, sheep shearing, etc. Support Activities for Crop Production includes soil preparation, crop harvesting services, farm management services, etc.

Source: Lightcast

In Maine's food economy, beverage manufacturing is only 3rd to fishing and crop production in jobs created.

Economic Impact of MA Breweries



Source: Brewers Association

Alternative Value of Brewery Waste

Methane is about $5/thousand ft^3

Compost is about $50/yard if bought in bulk or $13/bag

Denatured Ethanol is about $100 for 5 gallons

The Bigger Problem - Overview

We are spending insane amounts of money and resources to rely on treatment and disposal while we wait for market forces and regulations (surcharges) to drive innovation.

The Responsibility - Brewer

By putting nutrient-rich waste down the drain, breweries are throwing out materials that have alternative uses in the market, and the value of this material is lost as a result.

The Responsibility - Municipal/Treatment

By focusing on a limit and surcharge (aka stick) model, municipalities and WWTPs are promoting a broken system that benefits noone.

The Opportunities

Policy:

- Build around the value of sidestreaming materials
- Offer discounted surcharges to good actors
- Streamline expectations across municipalities
- Shift the lens and management of food waste bans
  - Replicate what has worked elsewhere

Collaboration:

- Address slugs first
- Involve municipal operations to drive the market
  - Are you buying fertilizer? Ethanol? Nutrients for your WW plant?
- What other industries could be part of this?
- Seek grant funding together for:
  - Scale building side-streaming projects
  - Methane and heat recovery projects

A Couple of Examples

Whalers Brewing, South Kingstown, RI

ReMix Organics, RI

New England neefc Environmental Finance Center

Thank you! Questions?

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