Winery and Brewery Wastewater Production and Management

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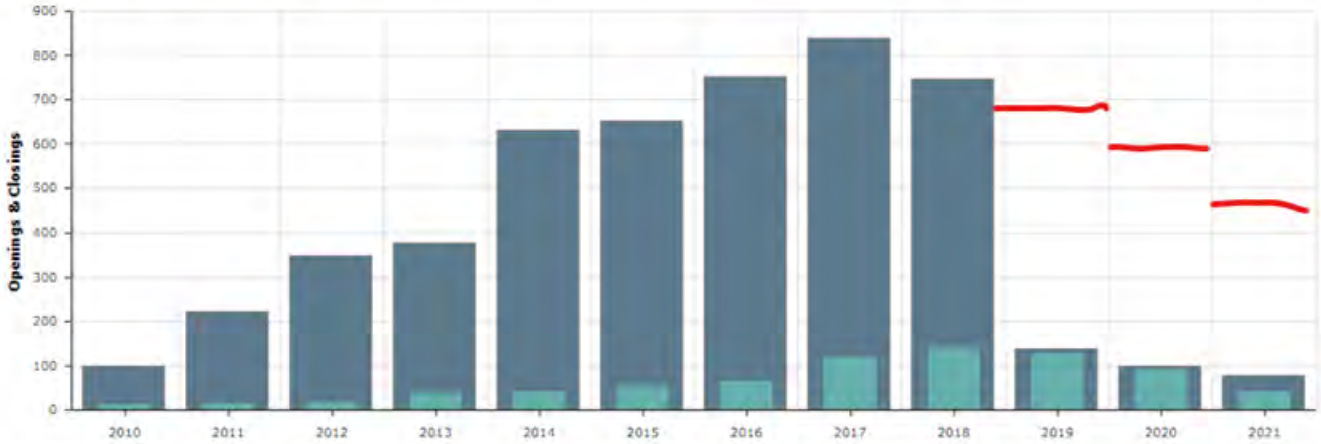
Outline

- Beer
- Wine
- Discharge Flows and Loads
- Treatment/Disposal
  - On-site
  - Discharge to Municipality
- Impacts
- Mitigation Strategies
- High Strength Surcharge

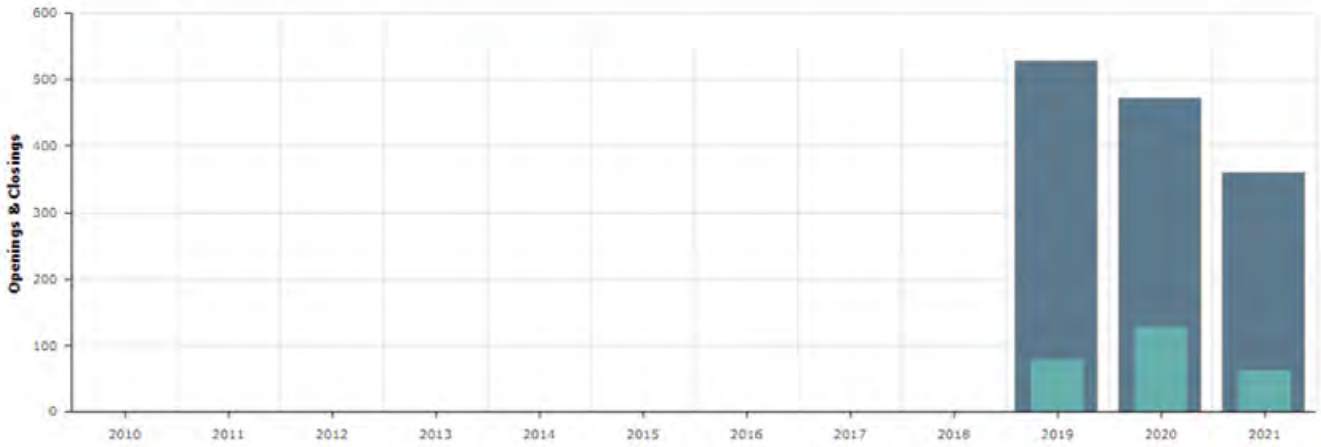
Beer

Micro Openings and Closings*



* Starting in 2019, Taprooms are their own separate category, so for comparable numbers, add 2019 taproom numbers.

Taproom Openings and Closings*



Still Growing

Recent U.S. Brewery Count

	2015	2016	2017	2018	2019	2020	2021	2020 to 2021 % Change
Craft	4,803	5,713	6,661	7,618	8,419	8,905	9,118	4.4%
Regional Craft Breweries	178	186	202	230	240	220	223	1.4%
Microbreweries	2,684	3,319	3,956	4,518	1,917	1,898	1,886	-0.6%
Taprooms					3,091	3,471	3,708	6.2%
Brewpubs	1,941	2,208	2,503	2,870	3,171	3,302	3,307	0.2%
Large/Non-Craft	44	67	106	104	111	120	129	7.5%
Total U.S. Breweries	**4,847**	**5,780**	**6,767**	**7,722**	**8,530**	**9,025**	**9,247**	**2.5%**

2021 – 7.9%


U.S. BEER SALES VOLUME 2021
BREWERS ASSOCIATION
OVERALL BEER 1.0%
187,637,077 BBLS
7.9% CRAFT
24,489,945 BBLS
8.5% IMPORT BEER
39,408,756 BBLS
OVERALL BEER MARKET
$100.2 BILLION
CRAFT BEER MARKET
$26.8 BILLION
21% DOLLAR GROWTH
CRAFT
13.1% SHARE
(24,489,945 BBLS)
IMPORT
21.0% SHARE
(39,408,756 BBLS)
OTHER DOMESTIC
65.9% SHARE
(123,889,486 BBLS)
SOURCE: BREWERS ASSOCIATION

Making Beer

- Growing Grain (Barley, mostly)
- Malting
- Roasting
- Mashing
- Boiling – hops (bitter, flavor, aroma)
- Fermenting – (more hops)
- Bottle / Keg
- Cleaning and Sanitizing (a lot)

Malting

- Seep, Dry, Seep, Dry
- Small Root will Grow
- Germinate
- Keep in cool moist place
- Internal leaflet grow
- Stop germination
- Dry, clean – you have pale malted Barley
  - Pale beers
- Roast as desired
  - Brown and dark beer

Roast

http://blog.brewingwithbriess.com/a-colorful-look-at-the-journey-of-barley-to-beer/

Why Malt

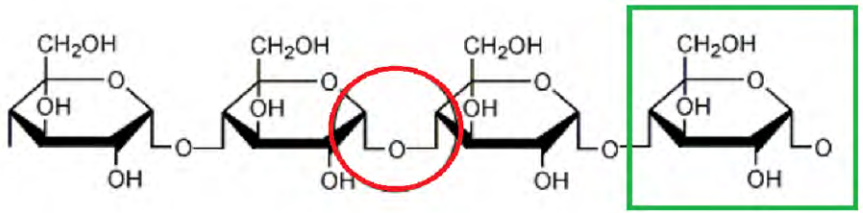
- Preps the Starches
- Develops Diastatic Enzymes
- Enzymes do all the work when mashing

Mashing

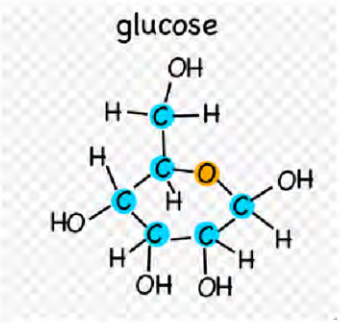
- The grain has a lot of starch molecules
- Enzymes naturally in the grain
- Enzymes convert starch into plant food (sugar)
- Amylase (A and B)

Mashing

- Amylase
- Biomolecule -Catalyze Biochemcial Reactions
- Starch into Fermentable Sugar
- Glucose for example



Amylase



http://montessorimuddle.org

Mashing

- Grain/water at 154 degrees for 60 minutes
- Amylase is an Enzyme
  - protein string bent and shaped into a specific 3D shape, catalyze a reaction
- Convert Grain Starch into Sugars
- Active at specific temperatures
  - Low, not active
  - High, denature

Mashing

- Done in a specific vessel
- After mashing liquid moved to boil kettle
  - Liquid is sweet wort
- Spent grain (2.2 to 5 lb per gallons)
- Cleaning mash vessel
  - Grain removed
    - Pushed into wheeled cart, then dumpster
  - Clean in place with high pressure water
  - High pH

Boiling Sweet Wort

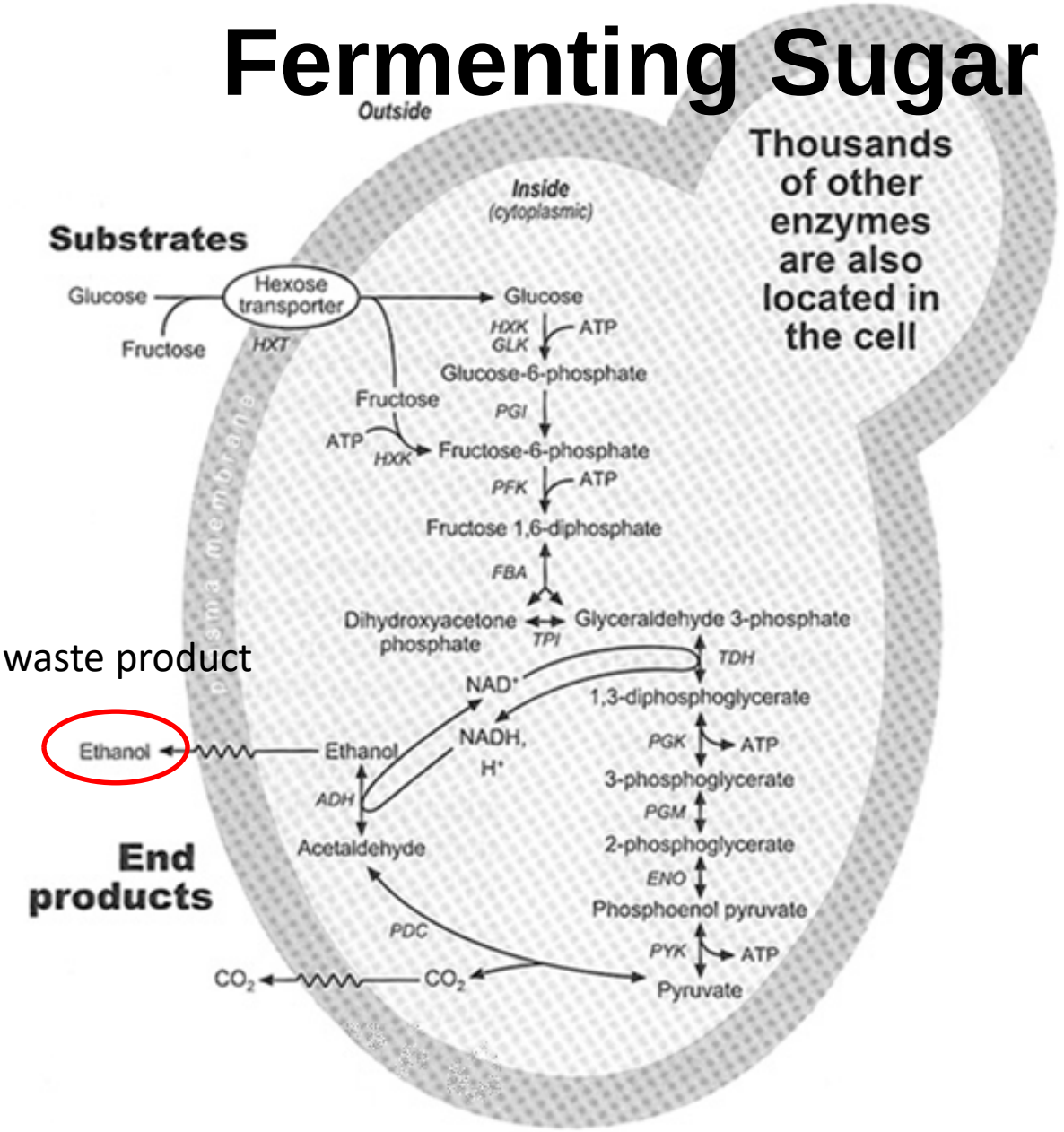
- Sweet Wort move to Boil Kettle
- Boiled for 60 minutes (sanitize)
  - Add Bittering hops (60-minute boil)
  - Add Flavor hops (15-minute boil)
  - Add Aroma hops (5-minute boil)
- Now you have hopped wort, moved to fermenter
- And another vessel to clean
- CIP, hot, high pH

Fermenting

- Hopped Wort cooled to ~<70 degrees
- Hopped Wort move to fermenter
- Plant food converted to alcohol
- “Beer” in fermenter
- Transferred to bottles, cans, kegs (also cleaning and sanitizing)
- Clean fermenter, CIP, High pH, Low pH sanitizer

Fermenting Sugar to Ethanol

Yeast



A waste product

Boulton et al., 1006; Pretorious, 2000

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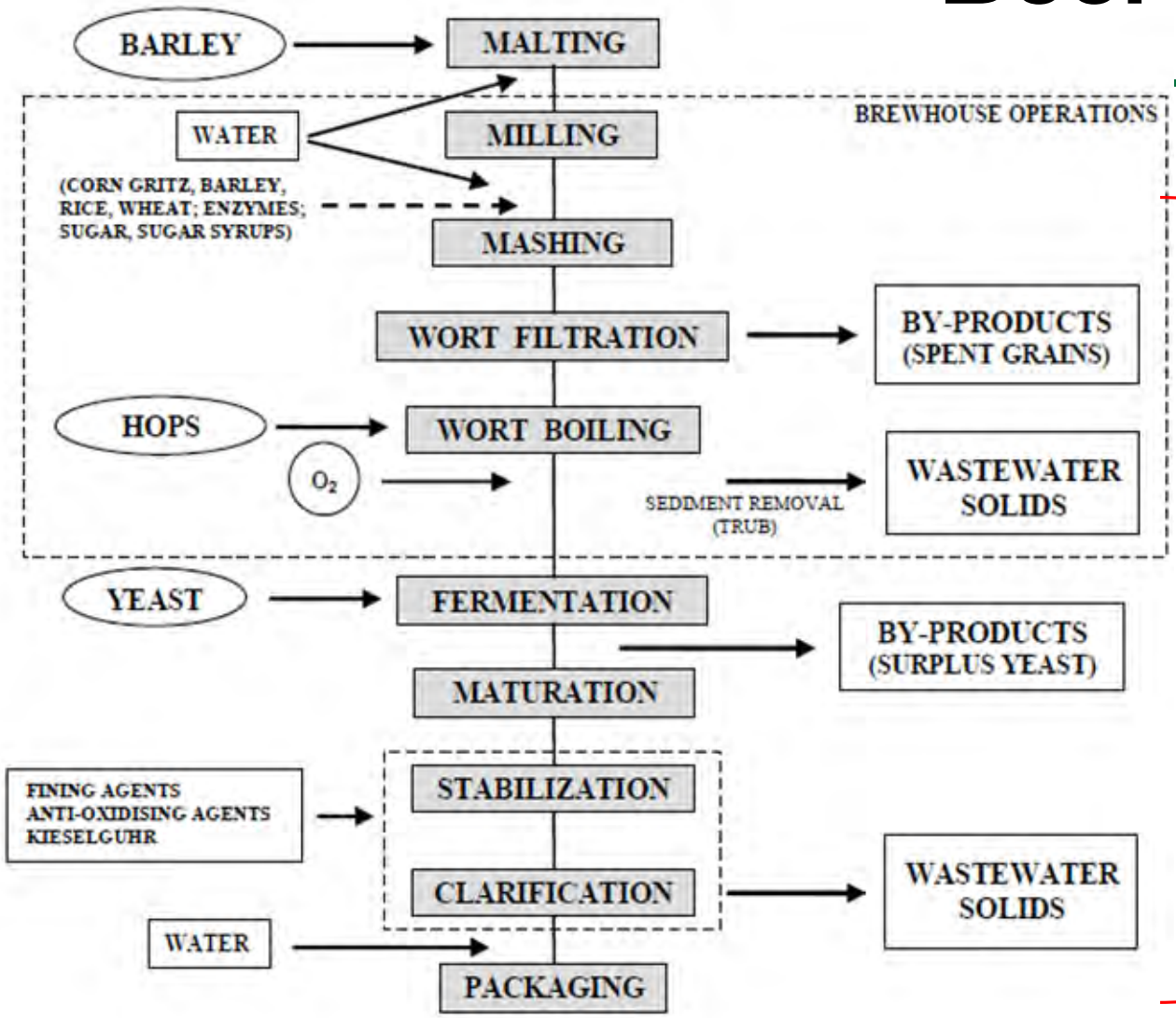
Beer Making



4:1, ww:beer

Varnam and Sutherland 1994, adapted

Making Beer Summary

- Growing Barley, off-site by farmer
- Malting, off-site by maltster
- Roasting, off-site by roaster
- Mashing, Starch to Sugar
- Boiling
- Hopping
- Fermenting
- Bottle / Keg (more cleaning)

Beer Wastewater

- 1 gallon of Beer (3-5) gallons of WW
- BOD
  - 1,500 mg/l, Low
  - 4,500 mg/l, average (large SD)
  - 35,000 mg/l, Dump bad batch (3.5%)
  - 55,000 mg/l, Imperial (9%)
- TSS
  - Function of solids capture (target 200<TSS<1000)
- pH < 3 ranges ph>10
- N & P, 30 to 100 mg/l
- Anytime, Year-round, can store ingredients
- Grains & Hops can’t go down the drain

Impacts - Beer, Smallish

- 3 Barrel Brew House
- 375 gallons of ww
  - 1.65 EDUs – hydraulic load just for brew
- BOD = 4,500 mg/l
  - 14 lb of BOD (~1 hp of air)
  - 24 EDUs – organic load just for brew
- Grains don’t go down the drain!

EDU at $50/month

- 3-barrel brew house
- 1.65 EDUs – hydraulic load
  - $82 / month
  - $0.11 per pint
- 24 EDUs – organic load
  - $1,220 / month
  - $1.64 per pint
- The day discharged, not the next? 80 pounds of biomass (17.5%)

Impacts - Beer, Larger

- 10,000 Barrels per year
- 21 EDUs - hydraulic
- 310 EDUs – organic
- 4 to 7 days per week

Fear Beer

- Concerned ? (Yes, but address)
  - Relative flow and load
    - 10,000 barrel/yr, 310 EDUs – YES
    - 3-barrel batch, 24 EDUs (day of) - Maybe
  - Existing capacity and ability
  - Growth, domestic and beer
- What to charge?
- Be fair - Charge for service
- Fair Fare

Addressing Flow and Load

- Pre-treatment
  - pH adjustment
  - Flow equalize
    - Over days, over hours
    - Break up discharge to minimize impact.
  - Source separation
    - High strength – manage separately
    - Low strength – to sewer with surcharge fee?
- Actual treatment – get to later

Wine

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Wine

- Wine Grape
  - Smaller than table grapes
  - Seeds
  - Sugar already in grapes
  - More sugar
  - More juice
  - Thicker skins

Grape Harvest

- Harvest, what comes into the winery
  - Grapes
  - Stems
  - Seeds
  - Pulp
  - Skins
  - Fresh Water
  - Chemicals, cleaning, pH adjustment, O_2 scrubbing

Grapes

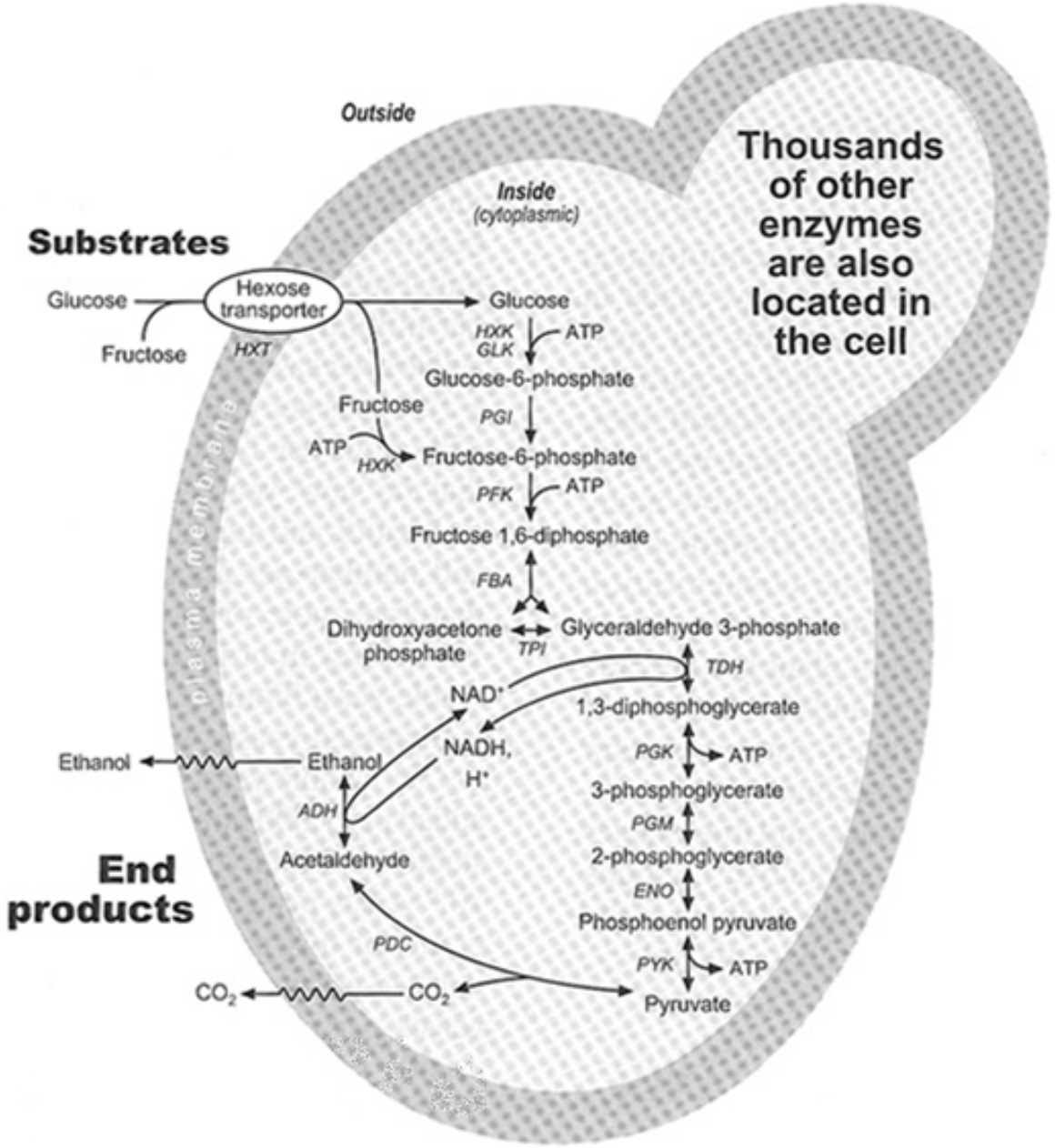
- What Winery Keeps
  - Grapes, relieved of Juice converted to wine
    - Must (Fresh Juice with skins, seeds, stems
    - Pomace = Solids
  - ~~Stems~~
  - ~~Seeds~~
  - ~~Pulp~~
  - ~~Skins~~

Grapes

- What Leaves the Winery
  - Wine
  - Lees (yeast cells, skins, other particles)
  - Wastewater
  - Carbon dioxide

Making Ethanol

- Glycolysis
- Glucose (Sugar) into pyruvate (1:2)
- And so on to Ethanol
- Complete pathway, 10 reactions
  - 1 molecule of glucose (6 carbons), into
  - 2 molecules of Ethanol (each with 2 C), and
  - 2 molecules of carbon dioxide (each with 1 C)



Boulton et al., 1006; Pretorious, 2000

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Making Wine (with apologies)

- Juice
  - 22% sugar (22 grams sucrose in 100 grams juice)
  - $C_{12}H_{24}O_{12} \rightarrow 4C_2H_5OH + 4CO_2$
  - (100g → 51g)
  - About 22% sugar turns into ~11% alcohol wine

Making Wine (with apologies)

- Remove Stems
- Crush (more like breaking)
- Pressing (get all the juice)
- Clarification of must (white)
- Condition must
- Ferment
- Press
- Tank
- Barrel
- Filter (clarified/stabilized)
- Bottle
- Age

Clean

And

Sanitize

Throughout

The

Process

Waste

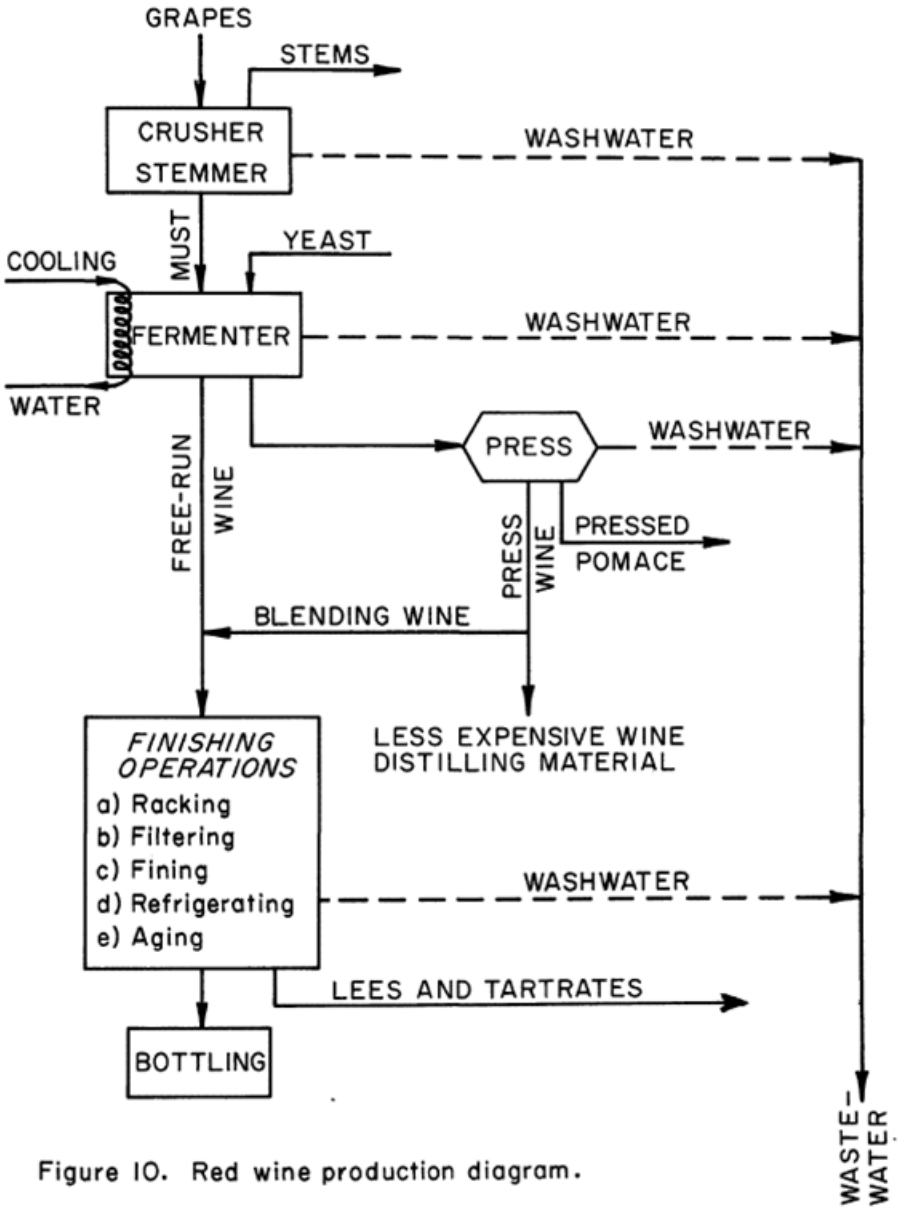


Figure 10. Red wine production diagram.

EPA-600/2-77-048

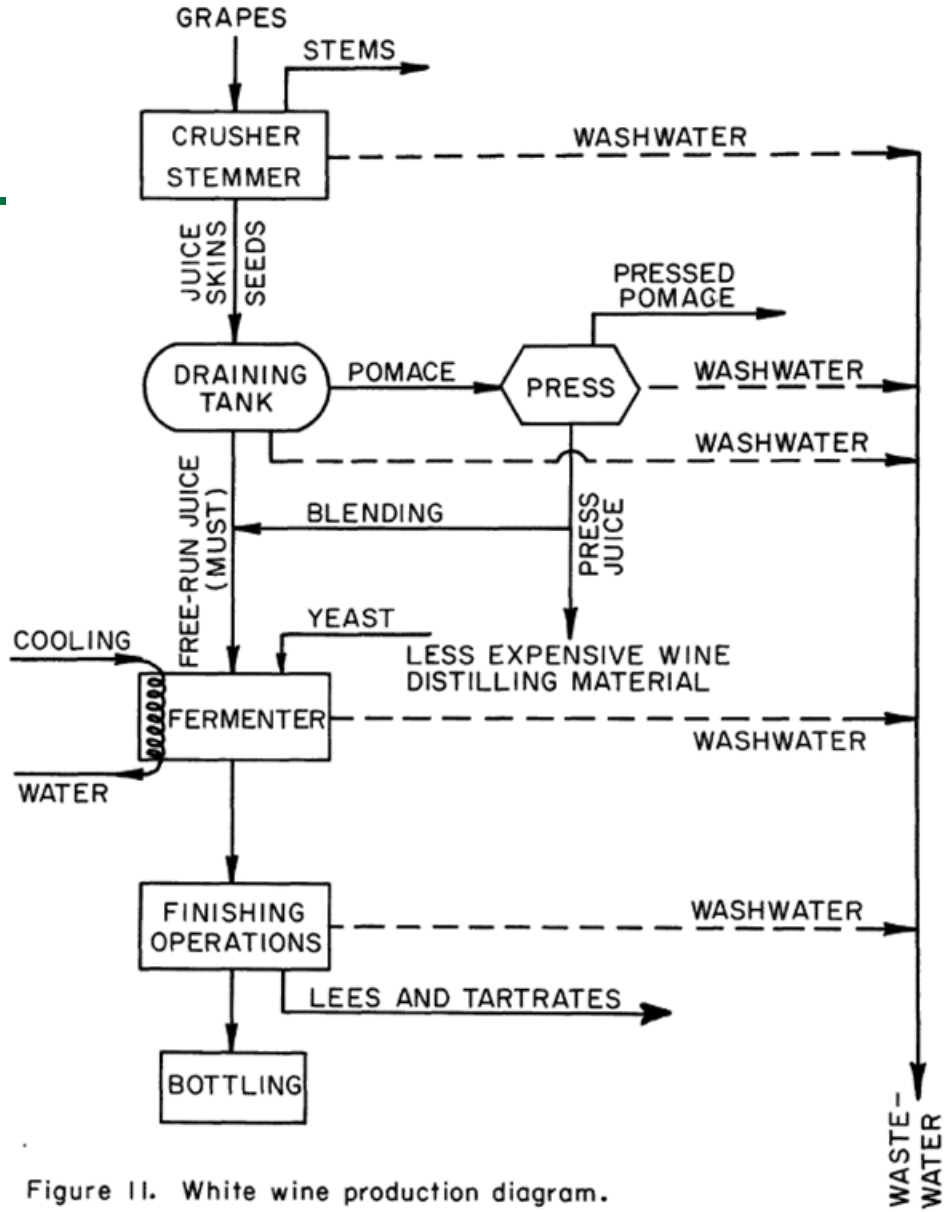
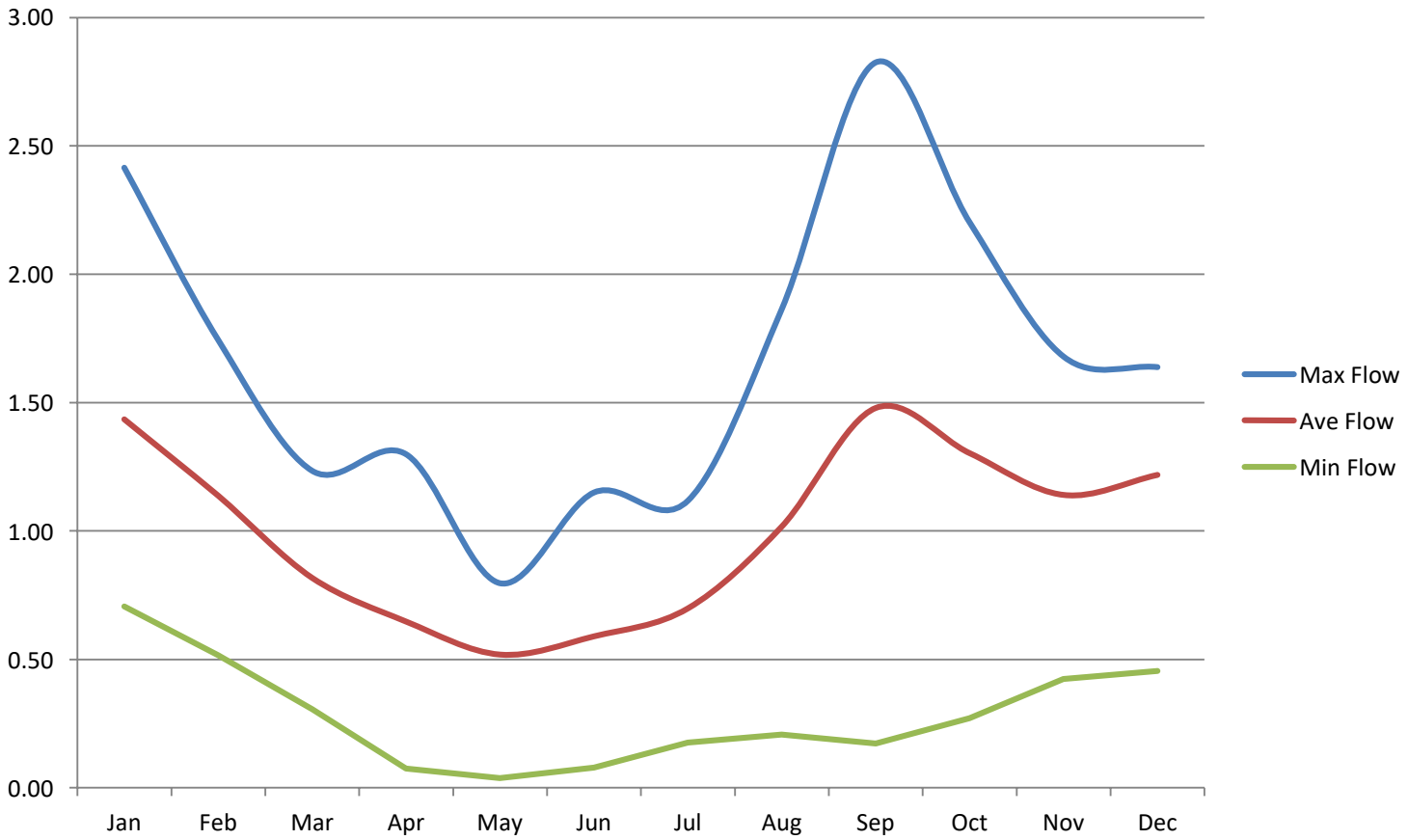


Figure 11. White wine production diagram.

Summary of Production

- Grapes are an Annual Crop; the industry is cyclic based on the season and winery activity
- Can not store grapes
- Different winemaking processes produce different wastewater
- Seasonal wastewater flows and loads

Normalized Flow



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Characteristics

Characteristic[a]	Units	Crusher Wash[b]	Pomace Conveyor Wash	Fermentation Tank Wash	Press & Area Wash	Storage & Bottle Wash	Storage Tank Floor Wash	Cooling & Refrigeration Blowdown & Misc.
pH	--	3.85	4.20	4.08	3.80	6.6	7.13	6.65
Suspended Solids	mg/l	3,220	3,050	2,440	1,046	290	108	4
BOD_5	mg/l	27,300	4,650	8,300	1,540	1,130	2,800	373
Portion of Daily Flow	%	2.5	5	10	7.5	50	10	15

EPA 600/2-77-048 (60/124)

Characteristics

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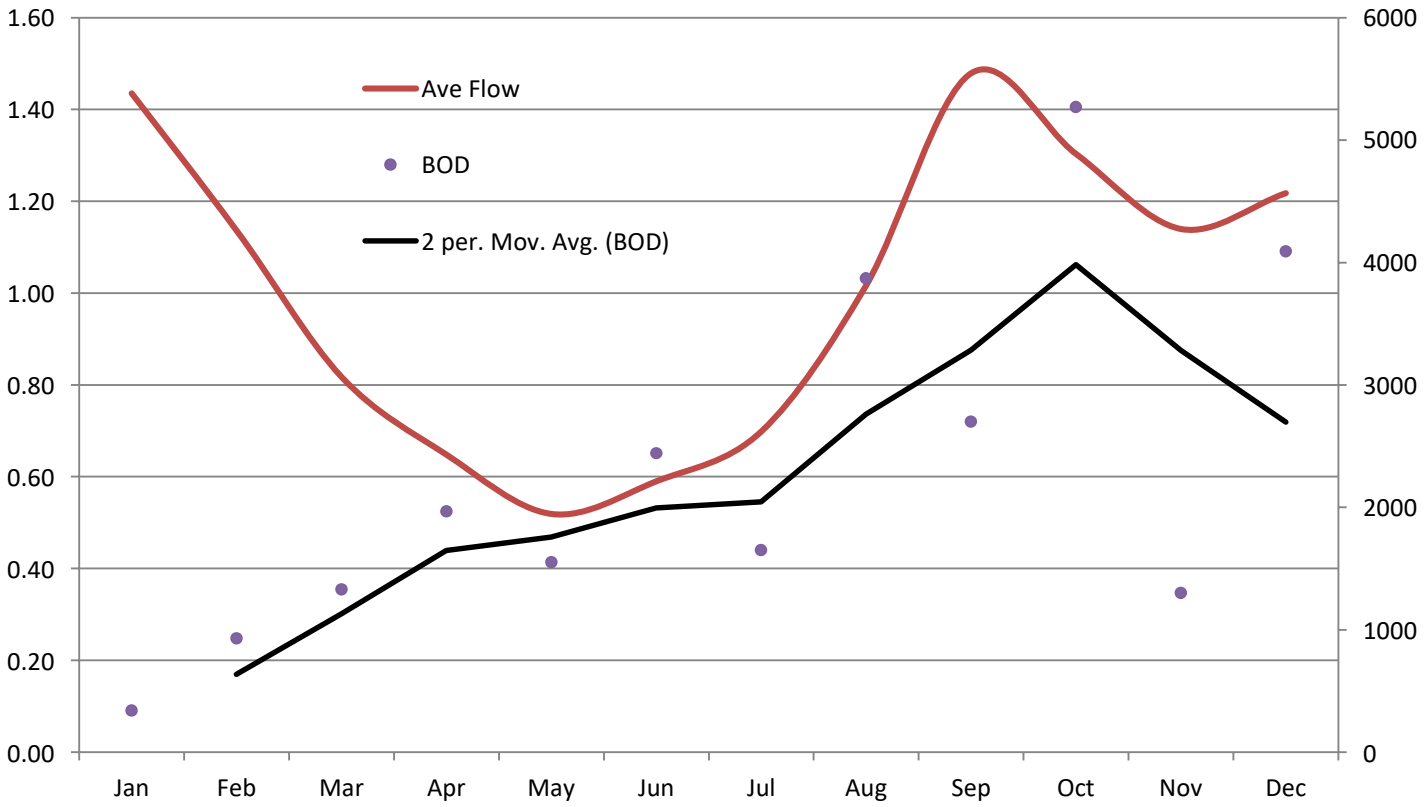
27,300 mg/l

8,300 mg/l

EPA 600/2-77-048 (60/124)

Normalized Flow and BOD_5 mg/l



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Trends in Industry

- Recover liquid waste, valuable
  - Juice (SBOD)
  - Alcohol (SBOD) Could be distilled
- Technology allows Separation
  - centrifuge, membrane, vacuum systems…
- Strength could be Dropping
- TSS managed on-site, dryer due to separation of liquid (valuable)

Lesson

- Could be Function of Scale
  - Small facility 1 wine : 5 wastewater
  - Large facility 1 wine : 1 wastewater
- Confirm Process
  - How much
  - How strong
  - When

Wastewater Production, Small

- 20,000 cases
  - 9 liters per case, (12 bottles per case, 0.75 liters/bottle)
  - 3:1 wastewater : wine (typical to high)
- 142,000 gallons per year
- 22,000 gallons in September
  - 20 pounds of BOD_5 / day
- 57,000 gallons in October
  - 70 pounds of BOD_5 / day (280 People)
- 22,000 gallons in November
  - 17 pounds of BOD_5 / day
- 41,000 gallons the rest of the year
  - 2.5 pounds of BOD_5 / day

Wastewater Production, Medium

- 300,000 cases
- 2.1 MG gallons per year
- 320,000 gallons in September
  - 300 pounds of BOD_5 / day
- 860,000 gallons in October (28,000 gpd)
  - 1,000 pounds of BOD_5 / day (4,300 People)
- 320,000 gallons in November
  - 250 pounds of BOD_5 / day
- 41,000 gallons the rest of the year
  - 40 pounds of BOD_5 / day (August) (170 People)

Winery Wastewater

- Seasonal Flow
- Seasonal Load
- Load Increases Rapidly
- Confirm
  - Small, not economical to maximize liquid recovery and manage solids
  - Large, economical to recovery

Now What ?

- Wine Maker and Brewer
  - Just want to make product
  - Want the wastewater to just go away
  - Maybe, some municipal systems take it
  - Others cannot
- Municipality
  - The City - Welcome here
  - WWTP - Don’t cause any issues

Mitigation

- Applicable To:
  - Beer
  - Wine
  - Hard Cider
  - Cheese
  - Yogurt
  - Restaurants
  - Super Stores
  - Labor Camps

Warning !

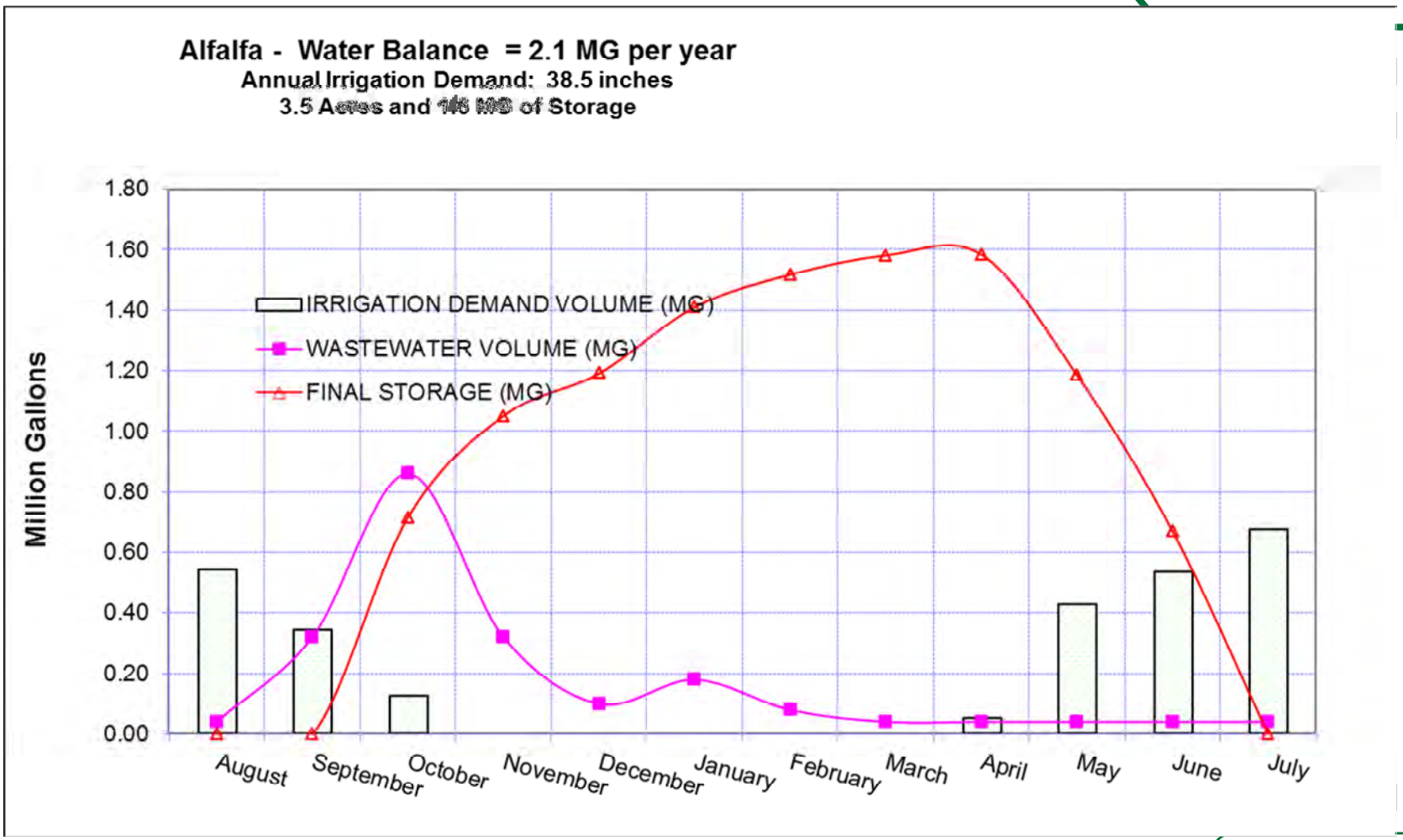
- Heavy Industry (potato, onion, fruit *etc*.)
  - Study specifically
  - Get independent help
- Data Center
  - Study specifically
  - Get independent help
  - Low strength
  - 75 degrees
  - 1.3 MGD per center

Treatment and Disposal

- Disposal, Answer this First
- The answer will control level of treatment
  - On site (very little, manage odors)
    - Irrigation, crop, landscaping
    - Drain-field, and other subsurface options
    - Evaporation
  - Off site
    - Surface water discharge (highly treated)
    - Industrial treatment facility (maybe none)
    - Municipal treatment facility (pre-treatment)
    - Irrigation someone else's crop (very little)

On-Site

- Irrigation, Medium Size 2.1 MG/year
  - Seasonal Discharge, irrigation season
  - Winter Storage
  - 3.5 Acres of Crop
  - 1.6 MG of Storage
  - Manage TDS
  - Industrial discharge
  - Facultative pond for treatment, settling basin
  - Aeration for odor control



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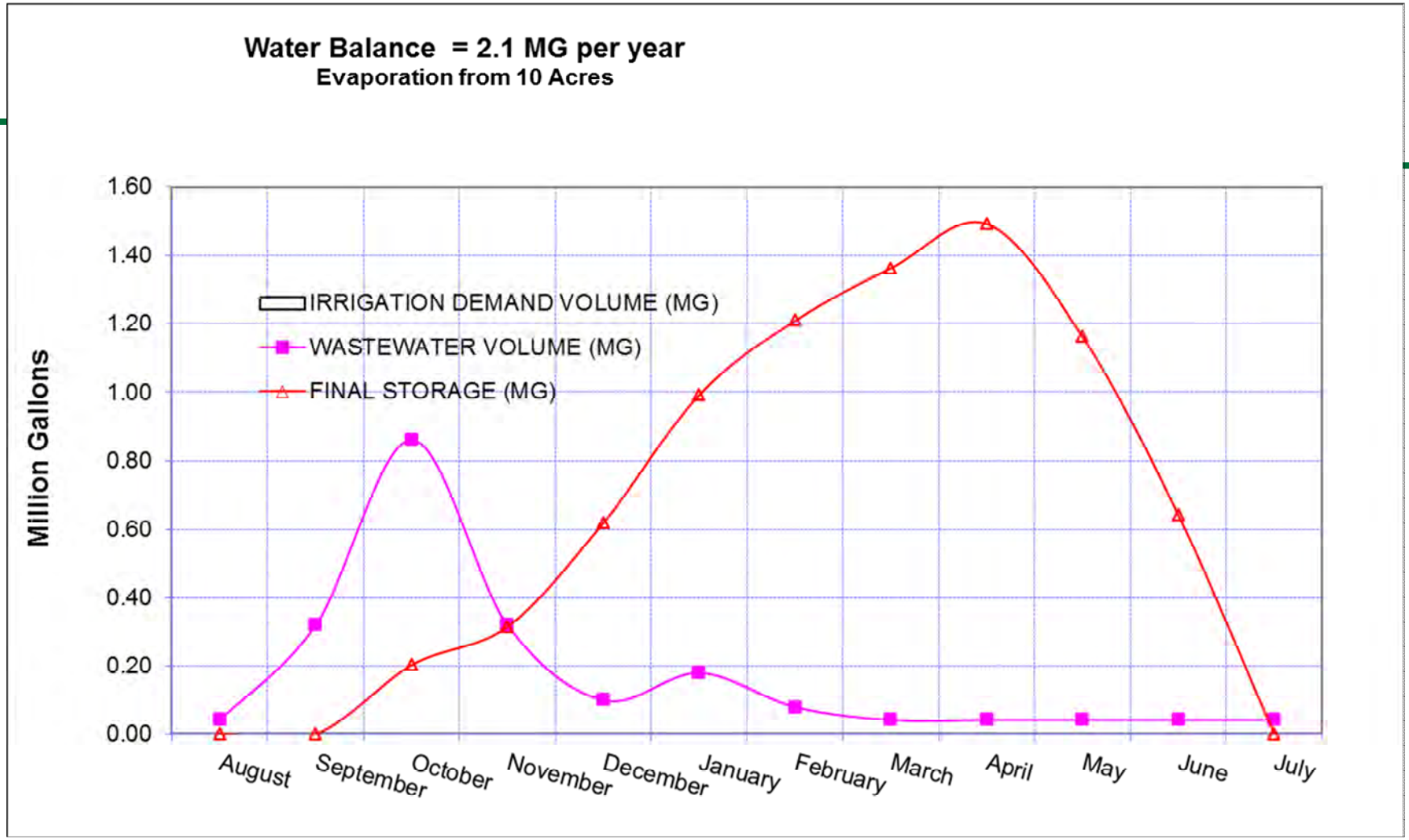
On-Site

- Evaporation, Medium Size 2.1 MG/year
  - 10 Acre Evaporation Pond
    - Mechanical Evaporation → 2.5 Acres (location)
  - Settling basin to capture solids
    - Dredging plan
  - Aeration for odor control



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Treatment for Disposal to a Municipal Sewer

- Local Limits
- BOD < 300 mg/l (match domestic)
- Surcharge
  - Limit BOD < 300 mg/l
  - Not to exceed BOD < 1500 mg/l
  - Pay XX $/ pound discharged
    - $0.25 per pound of TSS
    - $0.30 per pound of BOD_5

Treatment for Disposal to a Municipal Sewer

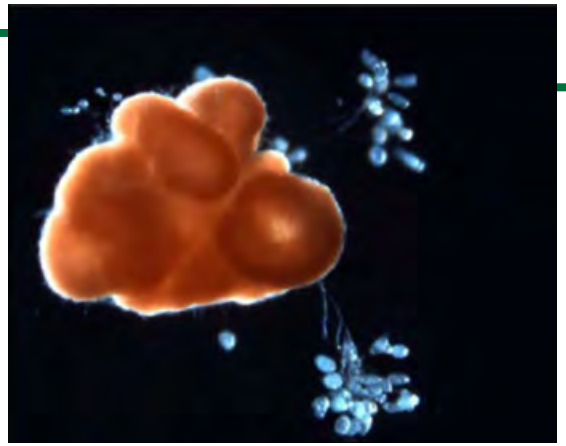
- Aerobic facultative lagoons
- Anaerobic
  - Granular Sludge ?
  - Followed by Aeration
- Activated sludge – Conventional, SBR and MBR
- Fixed film bioreactors
- Moving bed Bioreactors
- Direct Discharge to a Municipality

Treatment for Disposal to a Municipal Sewer (most likely ?)

- Anaerobic
  - Granular Sludge
  - Followed by Aeration
- Activated sludge

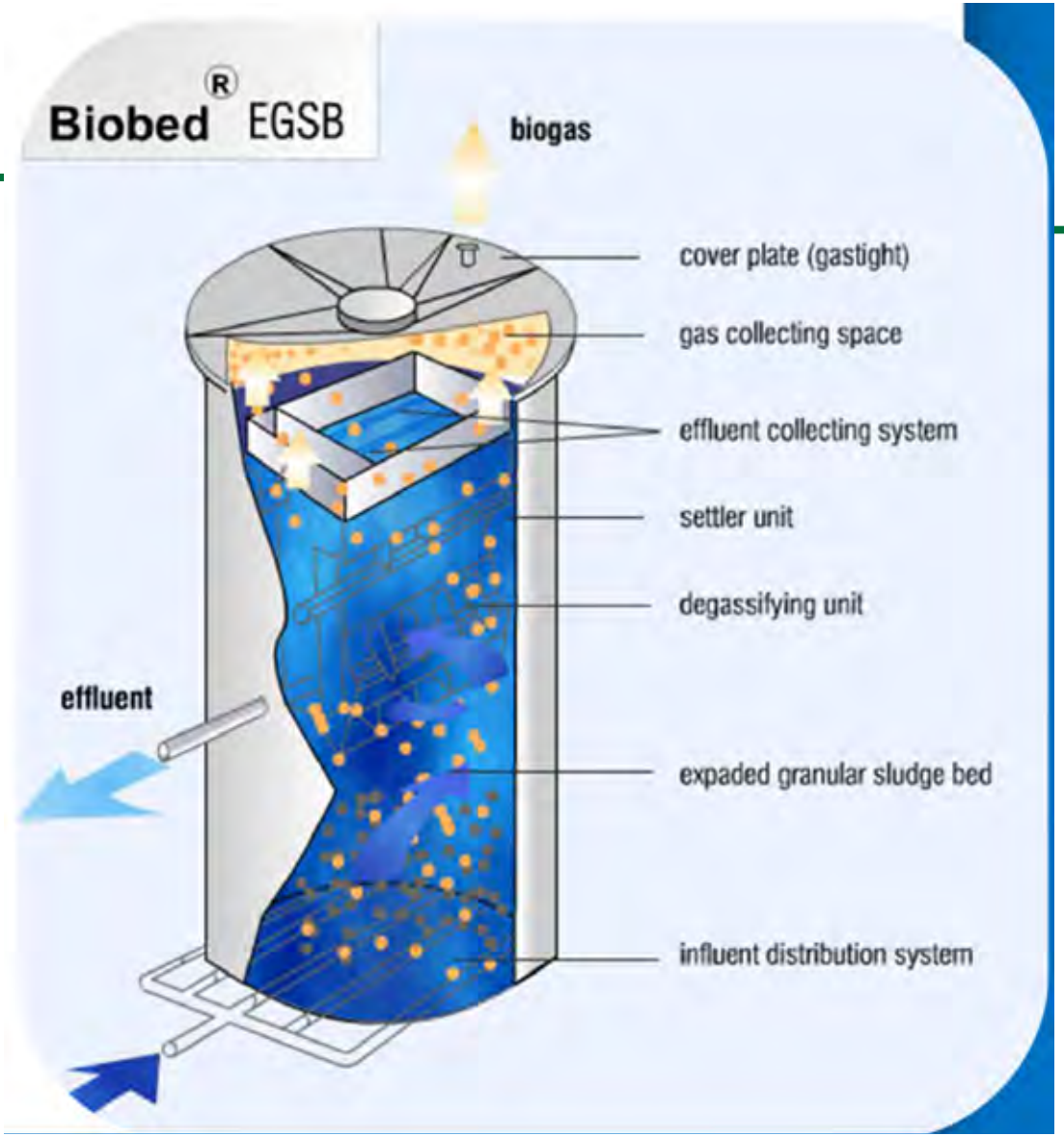
- Direct Discharge to a Municipality

Granular Sludge



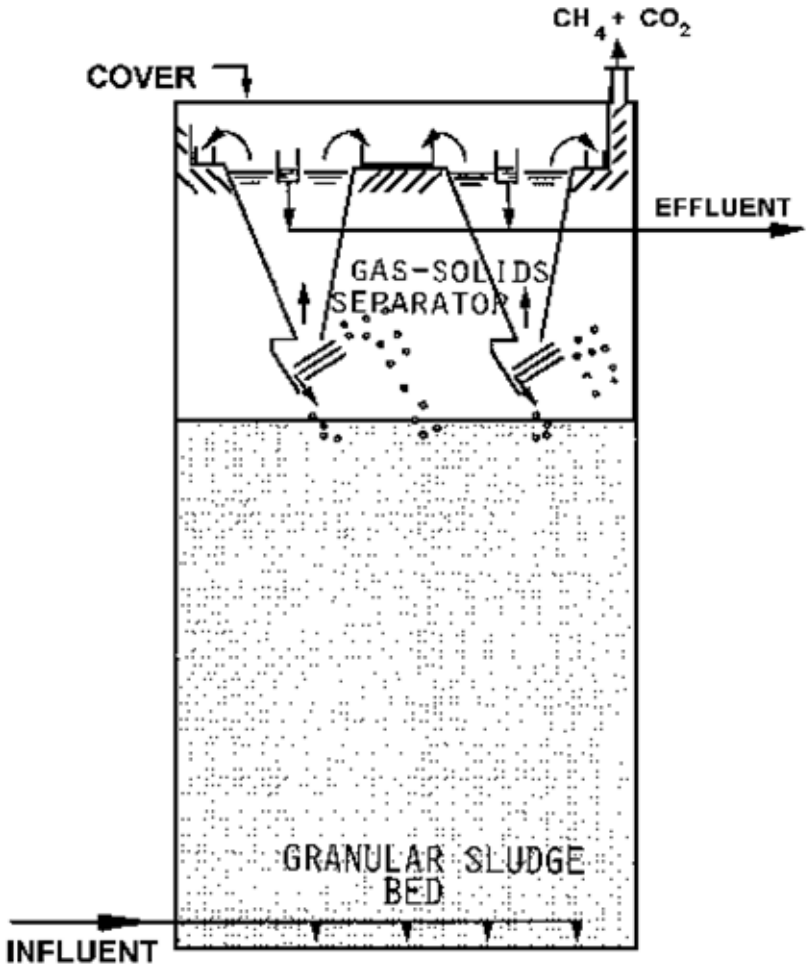
- Granular sludge
- Settles fast
- Expanded granular sludge bed
- High loading rates are lowering capital cost for digestion.
- Followed by aeration
- Can survive periods without food ? Yes.

Biothane
Expanded Granular Sludge Bed



Up flow
Velocity

Settling
Velocity



EGSB REACTOR (Biothane)

Package MBR

- Activated sludge – Package MBR
- 5,000 gallons per day
- 100,000 gallons per day
- 2 mm screen before package MBR (included)

Package MBR

- Concentrated Oxygen, dense biology
- High quality reuse water
- Seeded with WAS (discharge to sewer)

Package MBR
City of West Richland

Pre-Engineered Metal Building

Entire plant fits neatly inside one building!

Overview of Site

50,000 gpd
Re-use Ready

Direct Discharge

- Direct Discharge to a Municipality
- Minimum pre treatment
  - Lower TSS, skins settle in the sewer pipe
  - Adjust pH, concrete pipe, neutral pH, (dilution)
  - Generally easy to manage on-site
- What about BOD_5

Direct Discharge

- Example
- Medium Winery (300,000 cased)
- 860,000 gallons in October (28,000 gpd)
  - 1,000 pounds of BOD_5 / day
  - (4,300 People)

Biology to Treat, Approximate

- Biomass needed for 1,000 pounds of BOD_5 / day
- 6850 pounds of biomass, about
- Increase in MLSS
  - 0.5 MG reactor → from 2000 to 3640 mg/l
  - 2.58 MG reactor → from 2000 to 2320 mg/l
  - 6 MG reactor → from 2000 to 2140 mg/l
- 55,000 gallons of RAS/WAS (at 1.5%)
- 65 pounds of O_2 per hour
- 45 horsepower aeration

Managing Winery WW at WWTP

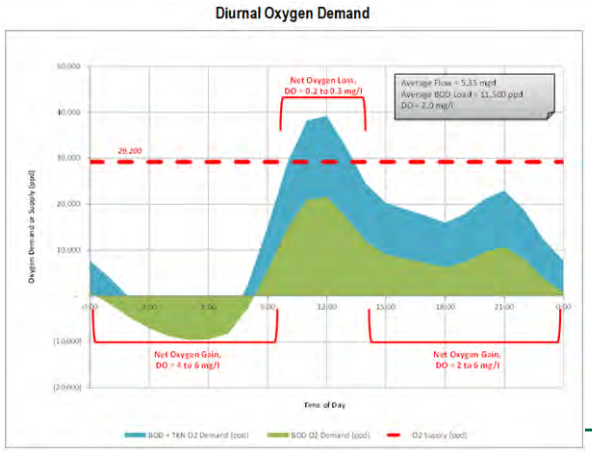
- Can you come up with the biology?
- Can you provide the air?
- Can you manage the extra biosolids?

Managing Winery WW at WWTP

- Can you come up with the biology?
  - Likely, depending on time of day
- Can you provide the air?
  - Likely, depending on time of day
- Can you manage the extra biosolids?
  - 600 to 800 pound per day, dry
  - 2.3 tons per day of dewatered biosolids
  - maybe

Flow Equalization, Load Shift

- Large WWTP, Small initial winery flow
- pH adjustment tanks large enough to provide flow equalization on-site
- Meter discharge into sewer
- As flow increased evaluate performance and the need for pretreatment
- And bank fees



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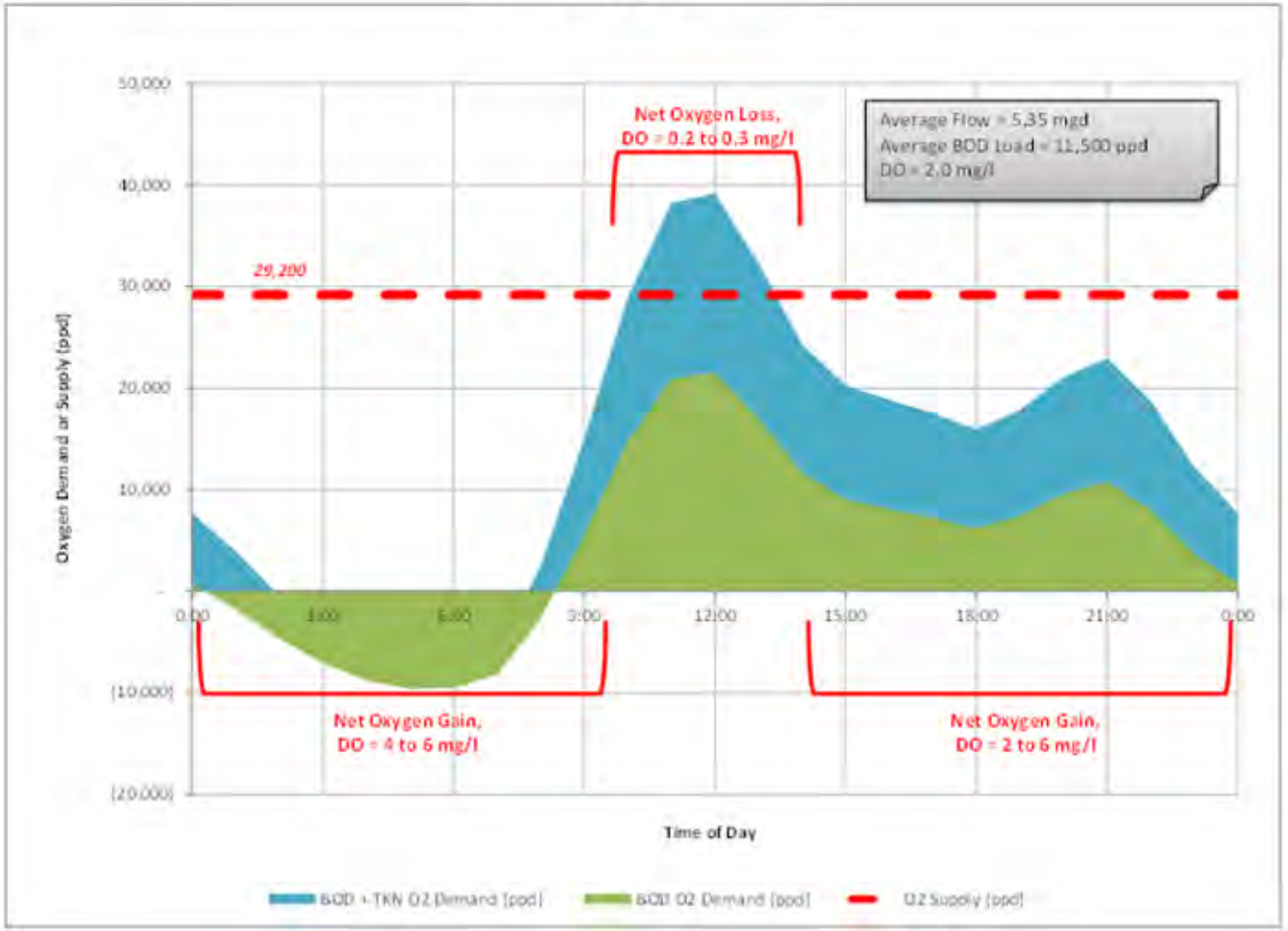
Diurnal Oxygen Demand



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High Strength Surcharge

- Uniform Cost for Uniform Service
- Pay a fee for extra service in lieu of pre-treatment
- Discharge at night for a lower fee

Questions


SIGNATURE BREWS
BEND BREWING CO.
High Desert Hefeweizen
Pinnacle Porter
Metolius Golden Ale
Outback Old Ale
Elk Lake IPA