CWSRF Design and Construction – WWTP Improvement Project

Tawas Utilities Authority

November 2021

c2ae
architecture • engineering

106 W. Allegan St. Suite 500
Lansing, MI 48933

BIOSOLIDS DIGESTION AND HANDLING

Two options were considered in the project Plan:

1. Rehabilitation of the Anaerobic Digesters

Properly operating anaerobic digesters produce sufficient methane gas (CH_4) which can be used for heating the digester and or heating the facility.

Issues

1. Temperature in the digester must be maintained above 100 deg F.
2. Although the digesters may be producing methane, none is collected for heating use. There is believed to be a lake in the floating cover on the secondary tank.
3. Influent BOD concentration averages 110 mg/l. Typical domestic raw sewage is typically between 200 and 250 mg/l.
4. Influent BOD is the carbon source for methane production. The low influent levels restrict potential gas generation.
5. Influent BOD is separated in the primary digesters to feed the anaerobic digester. Maintaining the anaerobic digger requires rehabilitation and continued operation of the primary clarifiers.

Advantages

1. Potential for net-neutral energy generation
2. Operator familiarity with current process
3. Simpler retrofit of existing equipment
4. One fo the digesters may be used for sludge storage (see below).

Disadvantages

1. Higher potential for process upset
2. Significantly more complex equipment
3. Requires handling flammable gas.
4. Greater safety hazard.
5. Odor problems when transferring to storage tank.

2. Digester Gas Evaluation

The potential for gas generation in the anaerobic digesters was calculated based on average flow and loadings, and industry standard methods for evaluating gas productions. Based on this analysis, the projected gas production is 800 cubic feet per day. This volume of methane has a heat value of 824,301 BTUs.

As noted, gas production requires maintaining an elevated temperature in the digester. Supplemental heat is needed to 1) raise the temperature of the incoming flow and 2) offset heat losses from the tanks to the atmosphere. Table XX summarizes the heating requirements.

1. Digester gas production is very close to the gas required for heating.
2. Flows and loading to the plant vary considerably, and supplemental gas will likely be needed during extended cold weather for heating.
3. Excess gas will need to burned off in a flare in the summer.
4. Additional energy is required for mixing and circulation the contents of the digester.

3. Conversion of Digesters to Aerobic

An aerobic digester does not produce methane. Energy for mixing and to maintain the aerobic condition is required.

Issues

1. Converting to aerobic digesters allows elimination of the primary clarifiers.
2. The digester will require an odor control system
3. The aeration energy required will increase annual operating costs approximately $8,000 over anaerobic digestion.
4. Process is not highly temperature dependent, but digestion rates will slow down in cold weather.
5. Oxidation ditch plants are not typically constructed with primary clarification.

Advantages

1. Minimal process control and operator attention required
2. Minimal potential for process upset.

Disadvantages

1. Increased energy consumption
2. Lower solids concentration will require more trips to land application site.
3. Requires adding a new heating system for the main building.
4. Potential odor problems when aerating

Summary

Description	Option 1 Upgrade Existing Systems Anaerobic Digestion	Option 2 Eliminate Primary Clarifiers Aerobic Digestion
Opinion of Probable Cost	$1,347,700	$1,212,600
Annual Operations and Maintenance	$16,200	$22,700
Present Worth At 20 years	$1,689,400	$1,691,300

The difference in the cost between option 1 and 2 are well within the level of uncertainty for the costs options with the current construction market conditions and supply chain disruptions.

Recommendation

Either option will provide the necessary sludge processing to the Authority with a minimum 20-year useful life, and the projected costs are for this consideration equal. As such we recommend basing the selection on the non-monetary factors.

C2AE recommends proceeding with Aerobic digestion - Option 2 as selected in the project plan. The primary consideration for this is the relative simplicity of the aerobic digestion compared to anaerobic.

4. Final Effluent Disinfection

The TUA WWTP is required to disinfect the final effluent from the facility prior to discharge. At present, the disinfection process at TUA utilizes chlorine gas. An analysis of conversion to Liquid chlorine for disinfection was prepared as part fo this Preliminary Design. In addition, the cost opinions for UV disinfection from the project plan were reviewed, and the operating costs verified with an equipment vendor.

5. Gas Chlorine Disinfection

Currently, the WWTP is using chlorine gas to chlorinated and disinfect the final effluent. Chorine gas is stored in one-ton cylinders and is fed to solution with vacuum regulators. The feed capacity of the system is reported to be approximately 7 pounds per day (ppd) of chlorine. During high flow events, the facility is unable to draw sufficient gas form the cylinders to maintain the desired chlorine concentration in the contact tank. The gas is added into the chlorine contact chamber using an induced draft mixer. The chlorine contact tank is partially located under the Disinfection Building and cannot be readily drained for cleaning. The contact tank has a water depth of 13.5-feet with a volume of 113,500 gallons. The contact time is 63 minutes at the design flow. The contact tank is believed to be in good condition. De-chlorination is by sulfur Dioxide gas (SO_2). Both Cl_2 and SO_2 are delivered and stored in 150 lb cylinders. The operations staff are trained in feeding chlorine gas for disinfection. The system was limited in the maximum volume that could be fed, which is being addressed by the operations staff.

Advantages

1. Cost effective
2. Reliable and effective against a wide variety of pathogens.
3. Flexible dosing control.
4. Can remove noxious odors during disinfection.

Disadvantages

5. Chlorine gas is highly toxic. An accidental release upwind from the park has the potential to cause significant harm.
6. Specialized training and safety equipment is necessary for safe handling.
7. Additional treatment is necessary as the water must be de-chlorinated prior to plant effluent.
8. Chlorine is toxic and corrosive. Storage and transport requires significant safety precautions.
9. De-chlorination reduces the dissolved oxygen in the effluent, requiring reaerating.

Elimination of chlorine gas disinfection was recommended in the project plan for safety purposes based on our understanding of the Authorities' concerns. As such, the costs associated with rehabilitation the gas system were note evaluated. If the authority wishes to continue with gas chlorinate rehabilitee fo the contact chamber would be recommended along with addition of residual monitors integrated into a

SCADA system, with the capability to pace the chlorine dose tot eh plant flows. The induced draft system would also likely need to be renovated or replaced.

6. Liquid Chlorine Disinfection

Conversion of the disinfection system to a liquid chlorine solution was evaluated as part of this analysis. liquid chlorine is an industrial strength bleach solution, typically 12.5% liquid sodium hypochlorite solution. For comparison, household bleach is a 5.25% sodium hypochlorite solution.

The hypochlorite solution would be delivered in bulk and stored in a new 5,000 gal tank on site. The tank will require a concrete secondary containment structure, and building enclosure to minimize sunlight on the tank, and prevent rainwater and snow from accumulating in the containment structure. For purposes of this analysis a “Pole Barn” type structure was use as a low cost solution.

The tank size is necessary to allow bulk delivery form a tanker truck, as bulk deliveries will have a minimum quantity. We were advised that vendor in the Detroit metro area had a 4,000-gallon minimum quantity. Lower volumes may be available, but at a significantly increased cost.

The Hypochlorite solution would be pumped from the bulk storage tank to a day tank located inside the chlorine building. Dual chemical metering pumps would be provided to pump the solution into the effluent stream at the entrance to the contact tank. Hypochlorite demand will vary significantly with the suspended solids concentration in the effluent. To optimize dosing efficiency, the proposed system will include a residual analyzer to monitor the chlorine remaining and the end of the contact chamber. A control system would adjust the chlorine dose to provide the optimum concentration.

Our calculations indicate between 19 and 70 gallons would be required. The storage tank will provide approximately 70 to 200 days’ usable volume. Sodium Hypochlorite degrades with time, particularly in warm weather. At 80-deg F, a 12.5% solution will degrade to 9.25% in 60 days. This may not be a significant issue at the plant location, but will need to be monitored by the operation staff.

Dechlorination will be required after disinfection. The typical dechlorination agent used in combination with hypochlorite is sodium bisulfite ($NaSO_2$). This is typically delivered in 50 lb sacks and mixed on site into a 5% solution. Bisulfite use is estimated to be approximately 5 lb per day. Dual liquid metering pumps will be used to pump the solution into the end of the chlorine contact chamber.
Below are advantages and disadvantages of liquid chlorine disinfection.

Advantages

1. Reliable and effective against a wide variety of pathogens.
2. Flexible dosing control.
3. Can remove noxious odors during disinfection.

Disadvantages

1. Requires on sit bulk chemical storage.
2. Water must be de-chlorinated prior to plant effluent.
3. Sodium Hypochlorite is toxic and corrosive. Delivery, storage and handling require special safety precautions.
4. De-chlorination reduces the dissolved oxygen in the effluent, requiring reaerating.

7. UV Light Disinfection

UV light is commonly used as disinfection method in wastewater treatment facilities. Typical system consists of a bank of mercury vapor light tubes designed to produce ultraviolet light at a specific wavelength known to disrupt pathogens. The tubes are contained in quartz sleeves and submerged in the final effluent stream. UV system are either an open channel or closed vessel configuration. For TUA closed vessel system was selected as a best fit into the existing hydraulic profile at the facility. In this system the bulbs and sleeves are inside of a circular chamber that is sealed to be water tight. Maintenance is performed by isolating the chamber, and opening an access hatch. Two units will be required to meet the redundancy requirements. The quartz tubes are equipped with mechanical wipers that periodically travel back and forth along the tubes to remove any solids. The systems will also have a UV light sensor that to monitor the intensity of the light transmitted through the effluent and adjust the light intensity to minimize operating costs.

All available UV systems are proprietary, with multiple manufactures in the market. Once the equipment is selected, spare parts will need to be obtained from the original vendor. Bulb life is estimated to be 1-2 years. The control system will monitor bulb usage and advise when replacement is required. In addition, the ballasts, wipers, and sensors also require periodic replacement.

Advantages

1. Reliable and effective against a wide variety of pathogens.
2. Minimal operator labor required.
3. No bulk chemicals required.
4. Safest disinfection system.
5. Least likely to be adversely effected by changing regulations.

Disadvantages

1. High capital cost.
2. High operating cost
3. Locked into a specific supplier for replacement parts.

8. Summary

Description	Option 1 UV	Option 2 Liquid Chlorine
Opinion of Probable Cost	$882,000	$358,000
Annual Operations and Maintenance	$22,776	$24,919
Present Worth At 20 years	$1,362,300	$883,500

We would note that the O&M costs for the liquid chlorine system may vary significantly based on plant effluent quality and flow. The number provided is intended to be fairly conservative.

<u>Recommendations</u>

Liquid Chlorine is clearly the lowest cost option. UV should be considered to minimize risks to the staff and community safety concerns. The general trend within the industry is to UV disinfection, primarily due to the safety and ease of operation of the systems available. C2AE recommends UV disinfection as identified in the project plan. We understand that the additional costs are a significant concern to the Authority and the two communities. However, we believe that the safety and operations benefits should guide the decisions. Should the authority disagree with this, we understand and will proceed with liquid chlorination solution.

Appendices

Digestion 1

Digestion 2

Digestion 3

Digestion 4

Digestion 5

Digestion 6

Digestion 7

Disinfection 1

Disinfection 2

Disinfection 3

Disinfection 4

Disinfection 5

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Tawas Utilities Authority SRF Project Plan

OPINION OF COST FOR PROCESS CAPITAL IMPROVEMENTS

Description	**Option 1**	**Option 2**
	Upgrade Existing Systems	**Eliminate Primary Clarifiers**
	Anaerobic Digestion	**Aerobic Digestion**
Capital Costs		
Option 1 - Primary Clarification - Anaerobic Digestion		
Primary Clarifier Rehabilitation	$267,000	
Digester Rehabilitation	$711,000	
Subtotal - Option 1 Items	**$978,000**	
Option 2 - No Primary clarification - Aerobic Digestion		
Primary Clarifier Deletion		$20,000
Digester Conversion to Aerobic		$860,000
Subtotal - Option 2 Items		**$880,000**
Construction Cost	**$978,000**	**$880,000**
Engineering Planning and Contingencies	$293,400	$264,000
Total Project Cost, Current Dollars	$1,271,400	$1,144,000
Escalation to 2023 Construction, 3% per Year	$76,300	$68,600
Opinion of Probable Project Cost, 2023 Construction	**$1,347,700**	**$1,212,600**

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Tawas Utilities Authority SRF Project Plan
Sludge Digestion Alternatives

PRESENT WORTH VALUE CALCULATIONS 20 YEAR LIFE

		Alt. 1		Alt. 2
Capital Cost		$1,347,700		$1,212,600
O&M		$16,200		$22,700
Interest (i)		-0.50%		-0.50%
Years (N)		20		20
Salvage				
$(1+i)^N$		0.9046		0.9046
PW of O&M	**$**	**341,700**	**$**	**478,700**
Present Worth	**$**	**1,689,400**	**$**	**1,691,300**

PRESENT WORTH VALUE CALCULATIONS 30 YEAR LIFE

	Alt. 1	Alt. 2
Capital Cost	$1,347,700	$1,212,600
O&M	$16,200	$22,700
Interest (i)	-0.50%	-0.50%
Years (N)	30	30
Salvage		
$(1+i)^N$	0.8604	0.8604
PW of O&M	**525,800**	**736,700**
Present Worth	**1,873,500**	**1,949,300**

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Tawas Utilities Authority SRF Project Plan

Electrical cost, KWH $ 0.12

Opinion of Operations and Maintenance Costs

Option 1 - Primary Clarification - Anaerobic Digestion				
Electrical & Utilities	HP	Hrs/Day	KWH/Year	Annual Cost
Clarifier Drives	3.5	24.0	45,101	$ 5,412.10
Primary Sludge Pumps	7.5	2.0	4,027	$ 483.22
Digester Mixer	12.0	12.0	38,658	$ 4,638.94
Sludge Transfer Pumps	4.0	1.0	1,074	$ 128.86
Circulation Pump	4.0	24.0	25,772	$ 3,092.63
Heating Gas				$ (97.00)
				$ 13,658.74
Replacement Parts				$ 2,500.00
Annual O&M For Option 1 Items				**$ 16,200.00**

Option 2 - No Primary Clarification - Aerobic Digestion				
Electrical & Utilities	HP	Hrs/Day	KWH/Year	Annual Cost
Aeration blower	27.0	16.0	115,973	$ 13,916.82
Mixing compressor	8.0	24.0	51,544	$ 6,185.25
Sludge Transfer Pumps	4.0	1.0	1,074	$ 128.86
				$ 20,230.93
Replacement Parts				$ 2,500.00
Annual O&M For Option 2 Items				**$ 22,700.00**

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PROJECT	**Tawas Utilities Authority WWTP**	**PROJECT NO.**	**21-0334**
ITEM	**Rehabilitate Anaerobic Digesters**	**BY:**	**MPF**
		DATE:	**11/1/21**

DIVISION	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
	General Conditions	1	Ls	$41,627	$41,627
	Conceptual Design Contingencies	1	Ls	$52,034	$52,034
	Remove Existing Equipment	1	Ls	$15,000	$15,000
	Concrete Repair	1	Ls	$16,500	$16,500
	Concrete Coating	1	Ls	$28,500	$28,500
	Sediment Trap	1	Ea	$11,287	$11,287
	Flame Trap	1	Ls	$7,650	$7,650
	Pressure Regulator	1	Ea	$7,100	$7,100
	Replace Sludge Recirculation Pumps	2	Ea	$17,500	$35,000
	Yard Burner Relief Valve & Pressure Regulator	1	Ea	$6,400	$6,400
	Waste Gas Burner and Ignition System	1	Ls	$46,141	$46,141
	Gas Flow Meter	1	Ls	$4,200	$4,200
	Digester Pressure/Vacuum Relief System	2	Ls	$32,212	$64,424
	Mixing system	1	Ls	$96,000	$96,000
	Remove Existing Foam Insulation	2	Ls	$9,850	$19,700
	Replace floating cover	1	Ls	$45,000	$45,000
	Replace Heat Exchanger	1	Ea	$36,000	$36,000
	Replace Boiler	1	Ea	$37,200	$37,200
	Digester Cladding	2	Ea	$18,570	$37,140
	Misc. Piping and Valves	1	Ls	$7,100	$7,100
	Equipment Installation	1	Ls	$96,733	$96,733
	Construction Subtotal				**$711,000**
	Engineering, Planning and Contingencies				**$214,000**
	Total Capital Cost				**$925,000**

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PROJECT	**Tawas Utilities Authority WWTP**	**PROJECT NO.**	**21-0334**
ITEM	**Aerobic Digestion**	**BY:**	**MPF**
		DATE:	**11/1/21**

DIVISION	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
	General Conditions	1	Ls	$58,296	$58,296
	Conceptual Design Contingencies	1	Ls	$72,870	$72,870
	Remove Existing Digester Equipment	1	Ls	$15,000	$15,000
	Remove Boiler and Heat Exchanger	1	Ls	$7,500	$7,500
	Remove Existing Foam Insulation	2	Ls	$3,400	$6,800
	Remove Existing Digester Cover	1	Ls	$6,500	$6,500
	Al Dome Cover	2	Ls	$35,000	$70,000
	Misc. Piping and Valves	1	Ls	$25,000	$25,000
	Aeration and Mixing System	1	Ea	$325,000	$325,000
	Sludge Transfer Pumps	2	Ea	$14,000	$28,000
	Odor Control Bio Filter	1	Ea	$65,000	$65,000
	Fan and Duct to Odor Control	1	Ls	$20,000	$20,000
	Equipment Installation	1	Ls	159,900.00	$159,900
	Construction Subtotal				**$860,000**
	Engineering, Planning and Contingencies				**$258,000**
	Total Capital Cost				**$1,118,000**

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DIGESTER HEATING ANALYSIS

Gas Production @ 1.05 MGD	800	ft^3/d	824,301	BTU	
Primary Sludge to Digester	8030	lb/day			
Digester Temp (°F)	100	°F			
Heating System Efficiancy	75%		**Natural Gas Cost, $/CCF**	$	0.45

	Energy to Heat Influent flow			Energy to Off-set Digester Heat Loss			
Month	**Influent Temp**	**Delta Temp (°F)**	**Required BTU/Day**	**Outside Temp**	**Delta Temp (°F)**	**Required BTU/Hour**	**Required BTU/Day**
Jan	53	47	377,410	21	32	10,887	261,292
Feb	56	44	353,320	23	33	11,221	269,305
Mar	55	45	361,350	31	24	8,216	197,183
Apr	56	44	353,320	43	13	4,543	109,033
May	58	42	337,260	54	4	1,538	36,911
Jun	67	33	264,990	64	3.5	1,371	32,904
Jul	67	33	264,990	69	0	-	-
Aug	63	37	297,110	68	0	-	-
Sep	66	34	273,020	60	6	2,206	52,938
Oct	64	36	289,080	48	16	5,545	133,074
Nov	59	41	329,230	38	21.5	7,381	177,149
Dec	64	36	289,080	27	37.5	12,724	305,366

	Total Heat Required BTUs/Day	**Heat Input Required, BTU/Day**	**Required Gas volume Cft/Day**	**Excess volume CFT/Day**	**Excess Gas Value Per Day**	**Annual Heating Offset**
Jan	638,702	798,377	775	25	$ 0.11	$ 3.40
Feb	622,625	778,282	756	45	$ 0.20	$ 5.63
Mar	558,533	698,166	678	122	$ 0.55	$ 17.08
Apr	462,353	577,942	561	239	$ 1.08	$ 16.14
May	374,171	467,714	454	346	$ 1.56	
Jun	297,894	372,368	362	439	$ 1.97	
Jul	264,990	331,238	322	479	$ 2.15	
Aug	297,110	371,388	361	440	$ 1.98	
Sep	325,958	407,448	396	405	$ 1.82	
Oct	422,154	527,693	512	288	$ 1.30	$ 19.44
Nov	506,379	632,974	615	186	$ 0.84	$ 25.08
Dec	594,446	743,058	721	79	$ 0.35	$ 11.00
						$ 97.77

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DIGESTER GAS PRODUCTION ESTIMATE

S_0	657.1296	**lb/day**	75	**mg/L**
S	3.28	**mg/L**		
Q	1.05	**MGD**	3974.25	**m^3/d**
SRT	22.87	**d**		
Y	1.167683	**-**		
VSS	3.83	**mg/L**		
b	0.02	**1/d**		

P_x	228.3714	**kg/d**	$YQ(S_0-S)(1\ kg/10^3\ g)/(1+b\,(SRT))$
V_{CH4}	19.83165	**m^3/d**	$(0.4)[(S_0-S)Q(1\ kg/10^3\ g) - 1.42P_x]$
Qavg	1050000	GD	3974.25 **m^3/d**

Gas Production

22.66 **m^3/d**

800.292 **ft^3/d**

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Tawas Utilities Authority SRF Project Plan

Sludge Storage Tank Volumes

Existing Tanks Volume	Dia, ft	Depth, Ft	Vol, CFT	Vol, Gallons
Sludge Storage Tank	67	19.26	67,902	507,907
Less solids	67	3	10,577	79,113
			57,325	428,794
Existing Digester				
top section	35	23.5	22,609	
bottom cone	35	3.5	1,678	
			24,287	181,664

Remove Solids	Vol, CFT	Vol, Gallons	% Increase
Existing Tank	57,325	428,794	
Remove solids	10,577	79,113	
	67,902	507,907	18%

Remove Solids and use digester	Vol, CFT	Vol, Gallons	% Increase
Existing Tank	57,325	428,794	
Remove solids	10,577	79,113	
Digester	19,429	145,331	
	87,331	653,239	52%

Construct New Storage Tank	Vol, CFT	Vol, Gallons	% Increase
Existing Tank	57,325	428,794	
Remove solids	10,577	79,113	
New Tank	67,902	507,907	
	135,804	1,015,815	137%

Note: Full digester volume not usable for storage. The available fraction is estimated at: 80%

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Tawas Utilities Authority SRF Project Plan

OPINION OF COST FOR PROCESS CAPITAL IMPROVEMENTS

Description	Option 1	Option 2
	UV	Liquid Chlorine
Capital Costs		
Option 1 - UV Disinfection	$678,000	
Option 2 - Liquid Chlorine		**$275,000**
Construction Cost	**$678,000**	**$275,000**
Engineering Planning and Contingencies	$203,400	$82,500
Total Project Cost, Current Dollars	$881,400	$357,500
Escalation to 2023 Construction, 3% per Year	$52,900	$21,500
Opinion of Probable Project Cost, 2023 Construction	**$934,300**	**$379,000**

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Tawas Utilities Authority SRF Project Plan
Disinfection Alternatives

PRESENT WORTH VALUE CALCULATIONS 20 YEAR LIFE

	UV	Liquid
Capital Cost	$882,000	$358,000
O&M	$22,776	$24,919
Interest (i)	-0.50%	-0.50%
Years (N)	20	20
Salvage		
$(1+i)^N$	0.9046	0.9046
PW of O&M	**$ 480,300**	**$ 525,500**
Present Worth	**$ 1,362,300**	**$ 883,500**

PRESENT WORTH VALUE CALCULATIONS 30 YEAR LIFE

	UV	Liquid
Capital Cost	$882,000	$358,000
O&M	$16,200	$22,700
Interest (i)	-0.50%	-0.50%
Years (N)	30	30
Salvage		
$(1+i)^N$	0.8604	0.8604
PW of O&M	**525,800**	**736,700**
Present Worth	**1,407,800**	**1,094,700**

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Tawas Utilities Authority SRF Project Plan

Electrical cost, KWH $ 0.11

Opinion of Operations and Maintenance Costs

Option 1 - UV Disinfection	
	Annual Cost
Electricity	$ 16,188.48
Lamps	$ 4,290.00
wipers	$ 348.00
Sleeves	$ 300.00
Ballasts	$ 1,400.00
Misc. Replacement Parts	$ 250.00
Annual O&M For Option 1 Items	**$ 22,776.48**

Option 2 -Hypochlorite disinfection				
	Unit	Unit Cost	Qty	Annual Cost
Hypochlorite	Gal	$ 0.85	26,000	$ 22,100.00
Sodium Bisulfite	Lb	$ 0.65	3,200	$ 2,068.80
Replacement Parts	Ls	1	750	$ 750.00
Annual O&M For Option 2 Items				**$ 24,918.80**

Current Gas system				
	Unit	Unit Cost	Qty	Annual Cost
Hypochlorite	150 lb/Cyl	$ 340.00	24	$ 8,160.00
Sodium Bisulfite	150 lb/Cyl	$ 340.00	7	$ 2,380.00
Misc. Replacement Parts	Ls	500	1	$ 500.00
Annual O&M				**$ 11,040.00**

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PROJECT Tawas Utilities Authority WWTP
ITEM UV Disinfection

BY: MPF
DATE: 3/5/21

DIVISION	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
	General Conditions	1	Ls	$45,920	$45,920
	Conceptual Design Contingencies	1	Ls	$57,400	$57,400
	Primary Clarifier Modifications	1	Ls	$65,000	$65,000
	Cast in Place Concrete	30	Cyd	$750	$22,500
	Roof with Support System	720	ft	$95	$68,400
	UV Disinfection	1	Ls	$255,000	$255,000
	Piping and valves	1	LS	$25,000	$25,000
	Effluent Weirs	1	Ls	$12,000	$12,000
	Electrical Supply	1	Ls	$38,500	$38,500
	Equipment Installation	1	Ls	$87,600	$87,600
	Construction Subtotal				**$678,000**
	Engineering, Planning and Contingencies				**$204,000**
	Total Capital Cost				**$882,000**

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PROJECT	**Tawas Utilities Authority WWTP**	**PROJECT NO.**	**21-0334**
ITEM	**Liquid Chlorine Disinfection**	**BY:**	**MPF**
		DATE:	**11/1/21**

DIVISION	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
	General Conditions	1	Ls	$18,595	$18,595
	Conceptual Design Contingencies	1	Ls	$23,244	$23,244
	Chlorine Contact Tank Modifications	1	Ls	$35,000	$35,000
	Chlorine Day Tank and Scales	1	Ea	$2,600	$2,600
	Hypochlorite Bulk tank	1	Ea	$12,000	$12,000
	Bulk Tank Secondary Containment	1	Ls	$5,400	$5,400
	Secondary Containment Enclosure	1	Ls	$12,000	$12,000
	Transfer pumps and piping	1	LS	$8,500	$8,500
	Liquid dosing pumps	4	Ea	$2,400	$9,600
	Sodium Bisulfite day tank and scale	2	Ls	$2,600	$5,200
	Residual analyzers	2	Ls	$17,500	$35,000
	Instrumentation	1	Ls	$35,000	$35,000
	Equipment Installation	1	Ls	$72,135	$72,135
	Construction Subtotal				**$275,000**
	Engineering, Planning and Contingencies				**$83,000**
	Total Capital Cost				**$358,000**