Appendix C

Technical Memorandum 01 “Biological Process Expansion”
Technical Memorandum 02 “Additional Treatment Plant Recommendations”

Technical Memorandum TM-01

TOWN OF TWISP
WASTEWATER FACILITIES PLAN - 2020

BIOLOGICAL PROCESS EXPANSION AND UPGRADE
Preliminary Sizing, Presentation and Evaluation of Alternative Configurations

July 21, 2020 Draft
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A. INTRODUCTION

This memorandum presents the preliminary presentation of alternatives and recommendations for biological (secondary) treatment facility upgrades required to meet the new design criteria used for Facility Planning for the Town of Twisp. Final biological treatment upgrade alternatives are presented. The alternatives evaluation and comparison includes feasibility, component sizing, implementation considerations, and a comparison of opinion of probable costs. Other elements of the facility, including influent lift station, headworks area, disinfection, and various recommended process improvements and upgrades outside the biological treatment portion of the plant are presented elsewhere in the Facility Plan, with details on treatment components included in TM-02.

Projected influent flows and loads are presented below in Table 1, and incorporate projected growth as provided by Town Staff, and reported by Varela and Associates, including loading anticipated from a significant new industrial discharger expected to establish and grow operations in Town.

The effluent criteria is in Table 2. These effluent criteria are consistent with the current permit. It must be recognized that effluent limitations are subject to change. The Washington State Department of Ecology has not communicated any current or imminent plans to revise or re-consider these limitations. However, the Town has acknowledged that concerns may arise for nutrient loading (nitrogen and phosphorus) to the receiving water. This alternatives analysis includes consideration of the feasibility to incorporate nutrient removal in the future.

Table 1 Twisp WWTP Design Criteria

Criteria	Existing Conditions	Year 2045 (20-year Design)
Population	970	1429
Flow (1)		
Annual Average Flow (AAF), gallons per day	72,000	125,000
Maximum Month Flow (MMF), gallons per day	90,000	156,000
Maximum Day Flow (MDF), gallons per day	181,000	266,000
5-day Biochemical Oxygen Demand (BOD_5) (2)		
5-Day BOD Loading, Annual Average, pounds per day	155	305
5-Day BOD Loading, Maximum Month, pounds per day	198	389
5-Day BOD Loading, Maximum Day, pounds per day (3)	301	592
Total Suspended Solids (TSS) (2)		
TSS Loading, Annual Average, pounds per day	120	209
TSS Loading, Maximum Month, pounds per day	177	308
Total Kjeldahl Nitrogen (TKN) (4)		
TKN Loading, Annual Average, pounds per day	32	63
TKN Loading, Maximum Month, pounds per day	40	80

Notes:
1. Source for current flows: Monthly Discharge Monitoring Reports. Flow projections based on population growth as adopted by City, plus anticipated discharge from new commercial / industrial source Old Schoolhouse Brewery, Inc., (OSB) based on information from OSB provided to the Town of Twisp.
2. Source for current BOD_5 & TSS are Monthly Discharge monitoring Reports. Projections based on per capita loading for population projections adopted by the City, plus anticipated loading (BOD_5) from OSB at build-out, 58 pounds per day average, and 70 pounds per day maximum month in 2024 and beyond.
3. Maximum day BOD_5 loading is listed for information only, and is considered in the component sizing for new and upgraded facilities, but is not intended to be included as "design criteria" of the facility.
4. TKN data for raw sewage is not available. Existing conditions based on typical TKN concentrations for "medium-strong" wastewater (based on projected BOD_5) from *Wastewater Engineering Treatment, Disposal, and Reuse.* Table 3-16. Metcalf and Eddy, Third Edition. Growth in TKN loading based on matching growth rate of BOD_5). Due to uncertainty of TKN existing conditions, an additional 25% loading was assumed for planning purposes. It is critical that the city sample and test for TKN loading prior to designing the planned upgrades to confirm component sizing.

Table 2 Twisp WWTP Effluent Limitations, NPDES Permit WA0023370

EFFLUENT LIMITATIONS			
Parameter	Units	Average Monthly	Average Weekly
Biochemical Oxygen Demand (5-day)	mg/L; lb/d	30; 45.5	45;68.3
Total Suspended solids	mg/L; lb/d	30; 45.5	45;68.3
Fecal coliform Bacteria	# colonies/100 ml	100	200
pH	Standard Units	Daily minimum is equal to or greater than 6.0 and the daily maximum is less than or equal to 9.0	

A significant source of new wastewater loading is the establishment and build-out of a new discharger to the system, Old Schoolhouse Brewery, Inc. (OSB). The loading expected from this new wastewater source has been estimated and provided to the Town of Twisp. The loading will be incorporated into a discharge permit for OSB to it can be predictable for the Town. The OSB permit is expected to require pre-treatment and for them to maintain facilities and discharge parameters within limits that will keep total loading to the projections presented in Table 1.

Constituents of concern in OSB's discharge include increased BOD_5 loading, which is accounted for in the projections presented in Table 1, and additional nitrogen loading, which must be accounted for in design of the facility's biological treatment components, though nitrogen and nitrogen compounds are not regulated parameters for Twisp's effluent. The brewery discharge is also expected to increase the potential for depressed pH in the Town's effluent. pH depression occurs in the treatment plant due to the nitrification of ammonia in the biological portion of the plant, when alkalinity is consumed.

Alkalinity data was limited for this facility evaluation, but relatively low values showed a definite potential to be inadequate to prevent pH depressions at times. It is common for water in this area to have somewhat low alkalinity, and the increased nitrogen loading expected from OSB will result in further consumption in the biological process. Therefore, alkalinity recovery within the process would help to stabilize the overall biological system as well as reduce the risk of low-pH permit violations. Additional collection of alkalinity data prior to commencing with facilities design is recommended to refine the sizing of selected treatment components.

B. BIOLOGICAL TREATMENT ALTERNATIVES FOR MEETING DESIGN CRITERIA AND ADDRESSING DEFICIENCIES

To treat the projected wastewater to the effluent quality presented in Table 2 requires upgrade and expansion of the existing facilities.

Extended Aeration Activated Sludge

The existing wastewater treatment facilities at the Town of Twisp Wastewater Treatment Facility consist of "extended aeration" activated sludge biological treatment. Extended aeration utilizes a relatively long sludge age in comparison to conventional activated sludge. Extended aeration is particularly suitable for small municipalities because it handles wide-ranging fluctuations in influent flows and loads (relative to average), it handles slug loads well (which can more easily impact smaller systems), and it is a stable process that is relatively forgiving, such that it does not require full-time (including nights and weekends) staffing.

Other biological treatment configurations were given cursory consideration with this analysis. Other common configurations and process modifications include Conventional Activated Sludge, Sequencing Batch Reactor (SBR), Membrane Bioreactor (MBR), and Moving Bed Biofilm Reactor (MBBR). These alternatives are summarized below, but do not have any advantages over extended aeration activated sludge for the Twisp Facility.

- Conventional activated sludge – biological treatment that operates with a lower sludge age in comparison to extended aeration activated sludge. The process produces more waste sludge than the existing process as a result. It is not considered suitable for small communities like Twisp because it is more vulnerable to upsets caused by slug loads, accidental spills, and wide hydraulic fluctuations. There is not a significant potential for cost savings with conventional activated sludge, and it is less adaptable to adding nutrient removal if this becomes necessary in the future. Furthermore, the lower sludge inventory overall, in comparison to extended aeration activated sludge, typically requires more operator attention, including responding to seasonal nitrification as opposed to more consistent nitrification with extended aeration.
- Sequencing Batch Reactors (SBR) – biological treatment that can be operated at sludge ages comparable to extended aeration activated sludge, but anoxic, aerobic treatment, and solids separation (clarification) occur sequentially in a single reactor basin, utilizing multiple basins. SBRs have a higher degree of automated control and instrumentation compared with extended aeration activated sludge, and the process itself, while flexible and adaptable, is not intuitive in comparison with extended aeration activated sludge. Existing tanks at the Twisp facility are not particularly adaptable to converting to SBR because they lack depth needed for the multiple-function basins utilized in the SBR process, so there is no potential to have reduced costs in comparison to extended aeration activated sludge making maximum use of existing tank volumes.
- Membrane bioreactors (MBR) – In a membrane bioreactor, biological treatment occurs, just as in extended aeration activated sludge. However, the biological solids are removed by passing the treated water through membranes, which exclude the biological solids. This eliminates the need for secondary clarifiers. In addition to replacing the secondary clarifiers in the biological treatment system, MBRs allow the biological treatment to operate within a smaller volume compared to a "conventional" system, because the biomass can be managed effectively at a higher concentration in the reactor tanks (aeration basin). In some site-specific situations, MBRs have the following advantages (from a cost standpoint) over "conventional" extended aeration activated sludge systems:
    - Smaller reactor volume (anoxic and aerobic tanks can be smaller). However, equalization tanks are typically needed in MBR facilities to minimize the amount of membranes purchased, so the volume reduction is partially offset, and in the case of Twisp, equalization of influent flows would require another stage of pumping due to hydraulic constraints.
    - Elimination of clarifiers.
    - Higher quality effluent where very strict limits must be met.
    - Smaller footprint.

MBRs also require fine-screening ahead of the reactors to protect the membranes from physical damage as well as clogging at the potted ends. The existing fine screen in Twisp is not adequate for this type of protection because the openings are too large. Additionally, a fully-redundant back-up screen would be recommended to protect the membranes when one screen is out of service.

The high cost of the membranes themselves typically make MBRs not cost-competitive with conventional systems unless the following factors are significant for a particular facility:

- Effluent will be re-used as class-A reclaimed water (irrigation to landscaping, parks, golf courses). In these situations, the MBR can also take the place of a separate tertiary filter, helping its cost-competitiveness.
- Space constraints – in facilities where footprint is at a premium, or ground and soil conditions make footprint considerations significant in cost comparisons.

Neither of the above factors are present in the Twisp facility, and effluent criteria are well within the capabilities of extended aeration treatment, so MBRS do not appear to be cost effective at this time. This could be reconsidered if conditions or circumstances change.

- Moving Bed Biofilm Reactors (MBBR) – MBBRs utilize biosolid “carriers” to support attached-growth (or “fixed film”) microbiology for treatment of the wastewater. MBBRs are sometimes appropriate where ammonia removal is critical but footprints are limited, because they allow for a larger mass of microbial solids to be retained in the reactors. The carriers are small plastic units with high surface area to support growth. The reactor has screens to prevent the carriers from exiting the reactor basin and entering the clarifiers. MBBRs can use traditional clarifiers, but the sloughed solids from the fixed-film typically do not settle as well as suspended solids from an activated sludge (including extended aeration) system, which is why some MBBR facilities utilize dissolved air flotation instead of traditional clarifiers for solids separation. Twisp would not be considered a good application of MBBRs, since it would not be expected to be cost competitive nor would it be expected to improve effluent quality (in fact it would likely have poorer effluent quality unless the solids separation process was changed).

Continued use of extended aeration activated sludge is recommended for expansion to treat the projected design flows and loadings. Component sizing is presented in the next section, and alternatives configurations for the expansion are presented in Section D.

C. EXTENDED AERATION ACTIVATED SLUDGE COMPONENT SIZING

Unit processes in the biological treatment system include Selector Basins, Aeration Basins, Clarifiers, and sludge recycle and wasting pumps for sludge inventory control. Sometimes, upstream and down-stream unit processes can impact the operations or the capacity of the biological unit processes. For example, facilities to handle the waste sludge can contribute side-stream flows and loads and waste sludge storage volumes can limit wasting operations. Specific issues that could impact biological treatment system sizing and design are being addressed in this upgrade project. Refer to the main body of the Facility plan for details of those improvements. With these upgrades, there are no anticipated upstream or downstream restrictions that could impact the biological sizing.

Sizing of the biological unit processes is summarized below with discussion.

1. Anoxic / Selector Basin

Selector Tanks. There are currently no anoxic selector basins in use at the Twisp facility, although the return activated sludge is currently routed through the aerated grit chamber, effectively initiating biological activity prior to the wastewater entering the aeration basin (oxidation ditch). Since the aerated grit chamber has a nominal volume of 1,615 gallons, the 10-20 minute retention time at current flows (including recycled sludge) may be resulting in a 'selector' effect to some degree by favoring organisms that are best at rapidly uptaking soluble, readily degradable BOD in the raw wastewater. In general, favoring these organisms would be expected to promote a micro-organism population with good settling characteristics.

With increased projected flows as shown in Table 1, the volume of the aerated grit chamber will be too small to elicit any selector effect from recycling sludge through the chamber due to such low retention time. Additionally, operating in this manner would be expected to impact the grit removal performance of the grit chamber.

New selector basins designed specifically for this function are a recommended component of the treatment facility upgrade. Selector basins improve performance of biological treatment by selecting organisms with better settling characteristics. Selectors can be aerobic (including aeration), or anoxic (without free oxygen, requiring mixing using mechanical (not diffused air) mixing. Aerobic and anoxic selectors encourage the growth of organisms that are capable of rapid uptake of soluble BOD. These organisms generally have good settling characteristics. Anoxic selectors are generally more effective than aerobic selectors for the purposes of achieving a well-settling sludge, since they introduce a second selection mechanism (absence of free oxygen). They also have the advantage of reducing overall energy consumption by reducing the oxygen demand before the wastewater reaches the aeration basin. However, there are some specific bulking organisms that are not selected out well using strictly anoxic selectors, so it is advantageous for the facility operator to have flexibility to utilize aerobic, anoxic, or a combination of selectors, depending on the specific organisms of interest.

The selector basins recommended for this upgrade are sized to balance the following functions:

- Promote well-settling organisms in the activated sludge microbial population.
- Recover alkalinity that has been consumed through nitrifying ammonia in the aeration basin. A limited amount of alkalinity data from 2005-2009 was included in the town's permit Fact Sheet, and it showed average alkalinity in the effluent of 85 mg/L as $CaCO_3$,

with a significant number of grab samples tested at less than 50 mg/L. When the alkalinity is below 50, there is increased potential for pH violations, and the new load from the brewery is likely to increase that potential even more. Therefore, alkalinity recovery will be a very important function of the anoxic selector basins.

- Flexibility for future adaptation to incorporate nutrient removal.
- Flexibility to add oxygen to at least one of the smaller selector basin cells, to allow the facility operators to target specific bulking organisms when they are prevalent.

The influent is expected to be generally well-aerated because the headworks system upstream utilizes air for mixing in the grit chamber to maintain the proper velocity to settle grit. Preliminary sizing of the selector tank volume for Twisp accounts for the incoming oxygen levels, and the retention time needed to drive the basin to anoxic conditions, when operating in the normal, fully anoxic, mode.

A total volume of 36,000 gallons is recommended for this facility, divided into multiple compartments (3 or 4), with the capability to add oxygen to one of the compartments, but all compartments capable of being mixed mechanically.

It is recommended the new selector tanks be constructed with the capability to isolate tanks to allow them to be taken out of service; and with influent and effluent piping to allow operators maximum flexibility in making use of the new volume. This should include the ability to utilize the cells as anaerobic tanks, before mixing raw sewage with RAS, or after mixing, or to operate one of the tanks as the initial or secondary aerobic selector, when the aeration is turned on for that tank.

Internal recycle of mixed liquor – from the aeration basin outlet back through the anoxic basins - is employed in facilities that biologically remove total nitrogen. Internal recycle can also be advantageous to maximize alkalinity recovery. Internal recycle pumping is not included in this upgrade, since based on limited data, alkalinity recovery will be sufficient without it, and additional recovered alkalinity would come at a high operational cost to operating the internal mixed liquor pumps continuously. However, during design, when additional alkalinity and nitrogen data is available, this conclusion will be revisited.

2. Aeration Basin

Aeration basin sizing is based on providing volume to maintain an adequate population of microorganisms to treat the wastewater aerobically, and sufficient residence time for the treatment to keep up with the rate of incoming wastewater. In facilities with an ammonia limitation, the volume is typically governed by the need to keep sufficient nitrifying organisms to convert ammonia even in cold temperatures. Twisp does not have an ammonia limitation, but nitrification is predicted to occur the majority of the time anyway, due to the long sludge age associated with the extended aeration process.

Based on available operational records to make slight adjustments to account for likely operational parameters in Twisp, as well as a thorough review of discharge monitoring reports to account for critical environmental conditions such as temperature and pH, extended aeration activated sludge was modelled for treating future influent wastewater loading. The resulting aerobic volume for planning and preliminary design purposes is 135,000 gallons.

Oxygen must be provided to the aeration basin for the micro-organisms to consume the waste and thus reduce the BOD_5 in the liquid. Oxygen can be provided by mechanical agitation, as with the old horizontal rotor aerators, or by pumping air into the basin through diffusers in the basin.

In 2015, as a result of ongoing maintenance issues with the horizontal rotor aerators, Twisp embarked on a pilot study to determine the effectiveness of diffused aeration. The Town utilized a temporary fine-pore, EPDM diffuser arrangement with air from existing positive displacement blowers. The study found EPDM diffusers to be effective and reliable, with improved operational capability and good treatment results. This outcome resulted in the decision to incorporate a permanent diffused aeration system into the treatment plant upgrade project. The findings are not un-expected, as diffused aeration using fine-pore EPDM diffusers is a very common and cost-effective solution to providing oxygen to aeration basins at wastewater treatment plants of all sizes.

Aeration needs for the 2045 design year are estimated to be 730 scfm of air, with a nominal discharge pressure of 6 psi (diffusers at a nominal depth of 7.5 feet). This could be provided by utilizing a single 730 scfm blower (with another identical blower for redundancy) or two blowers, each at 365 scfm (and a third for redundancy). Positive displacement blowers are recommended for maximum efficiency, with variable frequency drives to allow turn-down to match actual oxygen demand according to in-basin instrumentation.

A large blower capable of providing all the aeration from a single unit may not have adequate turn-down to efficiently provide oxygen at low loading. Without adequate turn-down, significant parts of each day when the new facilities first come on-line would have the basin over-aerated (impacting the effectiveness of the anoxic basins and wasting energy). Alternatively, the blowers could be cycled on and off, and supplemental mechanical mixing would need to be installed to prevent solids separating when the blowers cycle off. If using two smaller blowers, then a single blower could be used when loading is low, because it could be turned down with the variable frequency drive to match estimated oxygen demand at low loading.

The advantage of having a single blower capable of providing all oxygen is the ability to utilize the existing aeration blower as the redundant blower, thus reducing the project expense for this upgrade, and also allowing for reduced footprint. The existing blower is reported to be capable of delivering 650 SCFM at 7.0 psi. This would exceed the minimum redundancy requirements for oxygen supply for the current demand, and for projected future demand at least through year 2035 (or when nominal maximum month BOD_5 loading exceeds 294 lb/day). The oxygen demand will need to be re-assessed by about 2035 to determine if a new blower will be needed with greater capacity to serve as the redundant blower.

3. Clarifiers and Sludge Pumping

Twisp has two existing clarifiers. Clarifier #1 is part of the original facility, placed into service in 1976. Clarifier #2 was constructed as part of the facility upgrade completed in 2002. The new clarifier (#2) is deeper, larger in diameter, and is configured to perform better. #2 is the only one used on a regular basis.

The existing clarifiers were evaluated for adequacy under the projected future flows and loadings. Existing clarifier #2 (the larger and newer unit) meets all sizing criteria at the future projected conditions, and is recommended for continued service as the main settling unit. Sludge pumping and piping (return, waste, and scum) from clarifier #2 is addressed in TM-02.

Clarifier #1 (the smaller, older one) serves to meet reliability and redundancy requirements for the treatment facility, except that it is not currently functional. By itself, clarifier #1 meets all sizing criteria if operable, but may be slightly undersized at maximum day flow conditions due to solids loading criteria, depending on operational conditions and total sludge inventory.

It is recommended that the treatment plant upgrade include work required to get clarifier #1 operational again. For planning purposes, it is assumed the upgrade will include a complete mechanism replacement, as well as re-configuration of inlet and outlet piping to accommodate the new mechanism.

Upgrades to the clarifier #1 sludge pumping system are also recommended. New pumps with variable frequency drives are recommended, as well as upgrades and partial replacement of some of the sludge piping.

4. Reliability and Redundancy

The Town's NPDES permit requires the facility maintain EPA class II reliability and redundancy of units. These requirements, as they specifically apply to the biological treatment system, are listed in Table 3.

Table 4 presents a summary of the above discussions, listing the upgrades and expansions for the biological treatment process components.

Table 3 Compliance with EPA Reliability Requirements (Biological Treatment)

Component	Class II Reliability Requirement (1)	Facilities to Meet Requirement
Unit Operations Bypassing	The design of the wastewater treatment system shall include provisions for bypassing around each unit operation…Unit operations with two or more units and involving open basins, such as sedimentation basins, aeration basins, disinfectant contact basins, shall not be required to have provisions for bypassing if the peak wastewater flow can be handled hydraulically with the largest flow capacity unit out of service.	Existing unit bypass piping will be retained. New selector tanks will incorporate provisions for bypassing entire unit process and for taking individual cells out of service while keeping the remaining units in service.
Hydraulic Capacity	With the largest flow capacity unit out of service, the hydraulic capacity (not necessarily the design-rated capacity) of the remaining units shall be sufficient to handle the peak wastewater flow. There shall be system flexibility to enable the wastewater flow to any unit out of service to be distributed to the remaining units in service.	Existing piping and process units are capable of handling hydraulic peak flows with largest units out of service. Piping for new selector basins will be sized to allow any combination of units in or out of service during peak flow events.
Aeration Basin	A backup basin shall not be required; however, at least two equal volume basins shall be provided, unless aeration equipment can be serviced and maintained without draining basin or otherwise taking the basin out of service – for example, with mechanical aerators accessed from outside the tank, or with retrievable diffusers.	There is currently a single aeration basin that can only be taken out of service with a pre-scheduled temporary diversion to utilize aerobic digester capacity for temporary operations. Upgrades will consider cost-effective ways to meet the intent of the reliability requirement more practically.
Aeration Blowers	There shall be a sufficient number of blowers or mechanical aerators to enable the design oxygen transfer to be maintained with the largest capacity unit out of service. It is permissible for the backup unit to be an uninstalled unit, provided that the installed unit can be easily removed and replaced. However, at least two units shall be installed.	Multiple blowers will be provided with the upgrade, sized to meet the criteria (one standby unit). Blowers will be capable of providing the design oxygen transfer with the one unit out of service. The existing aeration blower can meet this redundancy requirement until loading increases to the projected load in 2035.
Air Diffusers	The air diffusion system for each aeration basin shall be designed such that the largest section of diffusers can be isolated without measurably impairing the oxygen transfer capability of the system.	The air diffuser system will be sized to transfer the design standard oxygen requirements with one isolatable section of diffusers out of service. IF multiple basins are provided, each basin's diffusers will be isolated, and multiple diffuser section per basin may be also provided if it is cost-effective.
Final Sedimentation Basins (Clarifiers)	Multiple basins required, with capability to isolate and take out of service. With the largest unit out of service, the remaining units have capacity for at least 50% of design flow.	The existing clarifiers fully meet this criteria, and exceed the 50% capacity requirement. However, the old clarifier (#1) and its accompanying sludge pumping facilities require significant upgrades to be put into service. The project will include improvements to clarifier #1 and clarifier #1 sludge pumps so this unit can regularly be rotated into service periodically, allowing inspection and servicing of clarifier #2.

Table 4 Biological Process Upgrade and Expansion Main Elements

Biological Treatment Upgrade and Expansion – Components	
Selectors	36,000 gallons total, in compartments of 6,000 - 12,000 gallons each, with mixing equipment, 0.5 - 2 hp per compartment (depending on size). Selector basins improve pollutant removal efficiency for TSS and BOD by selecting for organisms that are more easily removed in the secondary clarifiers. The basins also work to stabilize the biological process and make it more resistant to upset due to influent fluctuations in flow and slug loads. Anoxic basins incorporated into the activated sludge process will partially recover alkalinity consumed by nitrification, to help prevent pH depression, and will reduce overall energy costs by reducing oxygen demand prior to the aeration basin. Anoxic basins can be converted to become an integral part of biological nutrient removal (future treatment considerations). One of the initial selector compartments can be aerated to allow targeting of specific bulking organisms when they are prevalent.
Aerobic zone	135,000 gallons. Multiple basins are recommended for reliability and redundancy. A single basin can be acceptable if aeration equipment is maintainable/replaceable without taking basin out of service.
Aeration equipment	1x 730 SCFM blower initially, and utilize existing blower for redundancy as long as it can meet redundancy requirement (projected to be until 2035), then 2x blowers, 730 scfm each to satisfy oxygen demand through the design year 2045. Alternatively, 3x20 HP blowers, 365 scfm at 6 psi. Fixed, fine-bubble diffusers in multiple, isolatable diffuser sections. Single new blower option allows for addition to sludge handling building to house new blower. 3x blower option would require new blower building.
Secondary clarification	Existing, 1 @ 22’ diameter and 1 @ 30 ft diameter. The mechanism in existing clarifier #1 is currently inoperable but is needed to meet reliability and redundancy criteria.

D. DEVELOPMENT OF ALTERNATIVES

The necessary facilities for meeting the 2045 design criteria were listed in Table 4. Multiple layout alternatives were developed conceptually to accommodate the facilities generally outlined above.

By considering the following priorities, two final alternative configurations emerged for further evaluation.

a. Utilization of existing facilities to the extent possible where it can result in cost savings.
b. Preserving options for future adaptation of new facilities to evolving effluent criteria, such as the possibility of future nutrient limitations.
c. Impact of construction activities on treatment performance, and associated added costs to maintain operations during construction.
d. Future maintenance considerations, including ability to access basins and equipment for service, maintenance, inspection, and repairs.

<u>Alternative 1.</u> New selector tanks, existing aeration basin

Aeration Basin

The present aeration basin, configured as an oxidation ditch, would have adequate volume (135,000 gallons per Table 4) to meet future needs if the water level can be raised to nominally 8.5 feet deep. As currently configured, the aeration basin is operated at approximately 7.5 feet deep. At this depth, the old oxidation ditch horizontal rotor aerators do not interfere with operations. To raise the water depth, the rotors would be removed for the Town to salvage, and minor tank adjustments or patches where the rotors came out would be done to result in a clean and functional installation. Any necessary adjustments to the outlet weirs and outlet boxes would also be made. Additional modifications may include removal of the turning-vane walls on the ends of the oxidation ditch. Those details would be defined during the facility design phase.

Increasing the liquid depth in the tank will also improve oxygen transfer efficiency for the diffused aeration system.

One concern with continued use of the existing aeration basin is the lack of isolatable compartments, meaning access to components in the tank requires taking the entire tank out of service. As noted in Table 3, the Town has conceptual plans in place to be able to do this by pre-scheduling utilization of the aerobic digester as a temporary activated sludge aeration tank during work on or in the aeration basin. This is an inconvenient arrangement that puts effluent quality at risk, substantially interrupts solids processing operations, and is not possible to arrange in short notice situations.

To address this reliability concern, it is recommended the project in alternative 1 include construction of divider walls in the existing aeration basin to allow half of the tank to be taken out of service. Conceptually, one divider wall would be placed in the south side of the oxidation ditch-configured tank, where the west side of the new effluent box is (between the two effluent boxes) to the center divider wall. The center divider wall would remain. The other new diver wall would be placed opposite of the first one, in the north half of the tank, from the center wall to the north outside wall, approximately 11 feet west of the east end of the center wall. The hydraulic profile would not allow flow splitting for operation of the two aeration compartments in parallel, but inlet piping from the new selector basin would be installed to allow either of the new aeration basin compartments could be taken out of service, while the other one would remain in service. In normal operation, with both compartments in service, flow from the selector tanks would enter at the west end of the tank, adjacent to the new short divider wall, and travel through both aeration basins in series (clockwise around the ditch), through gated opening in the east-side divider wall, and to the existing newer outlet box.

A new submersible mixer (or re-purposed existing submersible mixer) would be located in the ditch to allow both compartments of the aeration basin to be operated as a single complete-mix reactor, by forcing circulation of mixed liquor through both compartments. The mixer would be installed to also keep the mixed liquor in suspension if one or more aeration grids is shut down to match incoming oxygen demand.

In addition to addressing the redundancy concern and adding the ability to maintain diffusers, another component of the upgrade will be to add a means to drain the existing structure (both sides independently) by gravity to the extent possible. The existing structure currently has no means to drain it other than pumping it out.

One drawback of the concept to divide the aeration basin as described above is it will not be possible to split flow to both clarifiers simultaneously to run them in parallel unless there are modifications made to the outlet box leading to clarifier #1 to make it possible to split the flow (proportional to clarifier surface area) to both clarifiers. This alternative includes modifications to the outlet box to allow both clarifiers to be operated in parallel, to allow utilization of both clarifiers at any time, and to facilitate seamlessly switching operation between the two clarifiers to prevent interruptions in performance when performing regular maintenance tasks. Eliminating this modification to the outlet box could be considered as a way to potentially reduce overall project costs if necessary due to budget constraints.

Aeration Equipment

Aeration supply, as noted in section C.2, could be supplied by a single blower with a second blower for standby. A single new blower to meet the full oxygen demand would be installed in a new sound-attenuating addition on the East end of the sludge handling building (adjacent to the existing blower room). New instrumentation and controls (on-line dissolved oxygen instrumentation feed-back control through variable frequency drives) would adjust blower speed (and air output) to match demand as measured by dissolved oxygen setpoint.

Selector Tanks

The selector tank would be constructed with multiple compartments in a new, separate structure. The new structure is recommended to consist of compartments of 6,000 to 12,000 gallons each, for a total of 36,000 gallons to provide residence time to recover alkalinity, uptake soluble BOD_5, and select for well-settling organisms in a variety of loading conditions and operating scenarios. The tank would incorporate piping to allow raw sewage to flow into any of the compartments, and for the recycle sludge to be directed into any of the compartments. Outlet piping from any compartment would also be included, to allow isolation of compartments, mixing of raw sewage and recycle sludge in any of the compartments to drive contents to either anoxic or anaerobic conditions, and for the operator to effectively adjust the residence times to meet a variety of objectives, including selector effect for improved settling, alkalinity recovery to buffer pH changes, and energy savings by reducing oxygen demand. Compartmentalization also allows reduced retention time during low flows to prevent potential odors from occurring due to septicity.

One of the selector compartments will be outfitted with an aeration diffuser gird to allow it to serve as an aerobic selector. The contents of the tanks will require continuous mixing to prevent solids from settling.

Alternative locations for the new selector tank structure were considered as follows

A. Between the existing headworks structure and the existing aeration basin. This could potentially include utilizing the west, curved end-wall of the existing aeration basin as part of the wall for the new structure. There is nominally 18' feet between these existing structures. To utilize the common-wall concept limits the depth of the selector tanks to nominally 9 feet in order to be compatible with the footing for the existing aeration basin. This would require the tank to be off-set from the headworks structure footing by approximately 5.5 feet to allow excavation and construction while protecting the adjacent structure. This leaves nominally 12.5 feet for the selector tank at its narrowest point, with additional width where the tank wraps around the existing aeration basin structure to the north. During design, existing geotechnical reports as well as new geotechnical studies will need to be reviewed to develop a plan for excavation and construction in the area to protect all existing structures. Additionally, re-configuration of the raw sewage piping and recycled sludge piping where it currently enters the aeration basin will be needed, though piping will have to be modified significantly anyway for incorporation of the new selector tanks.

The depth and width restrictions of the selector tank at this position result in the tank extending significantly to the north. The result is only approximately 20 feet of common wall with the existing aeration basin along its curved western end (about 17% of total wall length for the new structure). Alternately, the tank could continue to wrap around the aeration basin along the north wall, but this would complicate the outlet piping, particularly the ability to provide maximum flexibility to bring individual compartments in and out of service while delivering the selector effluent to the inlet of the aeration basin.

Considering complications to the piping, the construction risk and uncertainty of geotechnical mitigation due to proximity to existing structures, and the unknown condition of the buried parts of the existing concrete and associated dowelling and concrete tank sealing along the existing walls, it is not expected that utilizing existing concrete to serve as common walls with the new selector tank has any potential to reduce costs for this specific application, in comparison to alternate selector tank locations discussed below.

B. A second alternative location for the selector tanks is a separate structure to the north of the area between the headworks structure and the west end of the existing aeration basin. Construction in this area could be done with much lower impact to ongoing treatment operations, and the tank and internal compartments could be built to more efficient dimensions for mixing and operations. In-coming raw sewage and recycle sludge lines could be buried outside the tank with easy distribution to any compartment as selected by the operators, and effluent piping could come from each compartment and deliver contents to a single inlet at the aeration basin to maximize aeration basin volume (and aeration system effectiveness). The 2" plant water line north of the existing aeration basin would be impacted, and would require re-routing.

   Orientation of the nominally 40'x14' structure could be either north-south or east-west, depending on geotechnical considerations and the Town's preference regarding encroachment on the existing fence line to the north (it was reported the Town owns the land on the north side of the fence).

C. Cursory consideration was given to converting existing secondary clarifier #1 into a selector. Conversion would involve removal of the existing mechanism, re-configuring the inlet and outlets, raising the walls of the tank so it would fit within the existing hydraulic profile between the headworks and the aeration basin, then adding divider walls to compartmentalize the tank to provide some level of operational flexibility as described in section C.1.

The principal draw-back to this alternative would be the need to construct a new secondary clarifier to meet the reliability requirements. A new clarifier would be significantly higher costs than the upgrades proposed for the existing clarifier, off-setting the cost savings of the tank modifications compared to a new selector structure. Additionally, the converted tank would have lower volume than the recommended preliminary sizing of 36,000 gallons, so performance would be compromised. Furthermore, the tank would be less suitable to adaptation in the future for other treatment functions such as nutrient removal.

A new structure, separate and apart from existing structures is recommended (selector tank alternative B) since it is the most likely to have the lowest cost, least risk, and can be constructed with the maximum amount of flexibility for operations, and with adaptability for future uses.

<u>Alternative 2.</u> Selector compartments in portion of existing aeration basin, construct new aeration volume.

Aeration Basin

A new aeration tank would be constructed with nominally one half of the total necessary aerobic volume, and the existing basin would be divided such that the other half of total necessary aeration volume would be in the existing oxidation ditch structure. The remainder of the existing oxidation ditch tank would then be available for compartmentalization into anoxic and aerobic selector cells.

The new aeration basin would be located north of the existing aeration basin, and would be rectangular in shape (as opposed to oxidation ditch configuration) to reduce construction costs. The depth of the new tank could be deeper than the existing tank to improve oxygen transfer efficiency, although there would be limitations on depth to allow a single blower to be used simultaneously for the new (deeper) tank and the existing (shallower) tank. Utilization of a single blower for both tanks, when operating at different depths introduces some complications for dividing the air flow properly. The complication could be overcome by using automatic modulating valves or manually set throttling valves and air-flow meters. This instrumentation would have a minor impact on project budget and make operations slightly more complex, while imposing a slightly increased energy cost.

Modifications to the aeration basin include adding the ability to drain it by gravity to the extent possible. This retrofit will need to be done for each of the selector compartments within the new structure, as well.

Having the aeration volume in two distinct structures effectively eliminates the potential to operate the entire volume as a single complete-mix reactor without being cost prohibitive, so this reduced flexibility is considered a disadvantage of this alternative compared to alternative 1.

Aeration Equipment

Aeration equipment for this alternative is the same as for the above alternative, except as noted above, if the new aeration basin volume is deeper than the existing (to improve oxygen transfer efficiency), then the blower will be operating with different discharge pressures (also impacting air volume required). There would need to be automatic or manual throttling of the air to each basin to balance flows, resulting in an increase in plant operational complexity and instrumentation requirements.

Selector Basin

67,500 gallons of the existing oxidation-ditch configured aeration basin would be used for aerobic volume as outlined above, assuming the water level is raised to nominally 8.5 feet (to improve aeration efficiency and maximize available existing volume). This would leave nominally 65,000 gallons available for dividing into selector volume (excludes the volume needed for divider walls). This exceeds volume necessary for the selector tanks (36,000 gallons). Some of the excess volume could be used for piping gallery so that valves used to control process flow (isolation valves, for example) can be installed in an accessible, exposed location. Excess volume would still likely be available to expand selector tank size somewhat, which could make future conversion to nutrient removal (if needed) possibly more cost effective, since the upgrade project could account for the additional volume.

E. FINAL ALTERNATIVES COMPARISON

Two primary layout and configuration alternatives are presented in the comparison matrix in Table 5. Both alternatives meet biological treatment requirements for the projected flows and loading in 2045.

Both alternatives are functionally equivalent, offering very similar operational flexibility (and constraints), with the minor exception noted where balancing air distribution will be needed with alternative 2. Both alternatives are equally adaptable to most conceptual modifications for biological nutrient removal, although if additional anoxic or anaerobic volume is required in the future (for example if implementing nitrogen removal), it would be easier to add volume in alternative 1 than it would be in alternative 2, and probably less costly with alternative 1.

In both alternatives, the existing hydraulic profile is maintained to allow continued utilization of the headworks facilities in the existing structure, and the existing clarifiers.

Engineer's opinion of probable costs has been prepared for the biological treatment expansion Alternatives 1 and 2, presented below in Tables 6, and 7. It is important to note that these costs do not reflect total project costs, as they are strictly presented for the purposes of comparing alternative configurations of the biological treatment expansion portion of the upgrade. Other elements of the project, including upgrades to the influent lift station, addition of variable frequency drives for some process motors, consideration of fine-screen equipment replacement, maintenance building upgrades, cross connection control improvements, are addressed in TM-02. The costs for comparison also do not include contractor mobilization costs, contractor overhead and profit, taxes, contingencies, and engineering. All of those project cost adders are reflected in the summary of the recommended improvements at the end of this TM, for incorporation into overall project costs for financial planning purposes in the Facility Plan.

Table 5 Biological Process Feasible Layout Alternatives Summary

	1. New separate selector, existing aeration basin	**2. Selector in portion of existing aeration basin, add aeration volume**
Selector basins	New structure, north of the west half of the oxidation ditch 14' x 40' outside x 11.5' liquid depth. Multiple cells, isolatable with gates. One cell with aeration equipment. Inlet piping to any cell (with isolation valves), RAS to any cell, effluent to Aeration from any cell.	In existing ox. ditch footprint, within the west half of the tank – including the full bend on the west, and 38' feet of the length in the north channel. Multiple cells, isolatable with gates. One cell with aeration equipment. Inlet piping to any cell (with isolation valves), RAS to any cell, effluent to Aeration from any cell. Most piping submerged in the tanks.
Aeration basin	Existing footprint, increase depth (removing old horizontal rotor aerators). New total depth 8.5'±. Divide basin into two equal cells, with divider walls with gates to allow isolation of cells. Operation in series or single cell with one out of service. Minor modifications as needed.	Half of existing ditch used for aeration basin with depth raised to 8.5 feet. Remove old rotors. Other half converted to selector and piping gallery. New aeration basin of 67,500 gallons single cell, located north of existing oxidation ditch. MLSS piping from new aeration basin to existing outlet boxes
Aeration Equipment	Fine bubble diffused air. New blower building with three (3) 20-hp positive displacement tri-lobe blowers to deliver 365 scfm at 5.5 psi each.	Fine bubble diffused air. New blower building with three (3) 20-hp positive displacement tri-lobe blowers to deliver 365 scfm at 5.5 psi each. And second design operating point of 215 SCFM at 7.5 psi.
Distribution box	None between headworks and aeration basin – operation is either series or only one basin at a time. Use existing aeration basin outlet boxes, with upgrades for new water level. Modifications to the existing oxidation ditch outlet structures will be made to allow proportional split for operating clarifiers in parallel. This increases flexibility and operability but is not strictly necessary for treatment performance or reliability/redundancy, so this part of the upgrade would be a candidate for cost savings if project budget requires.	None between headworks and aeration basin – operation is either series or only one basin at a time. Use existing aeration basin outlet boxes, with upgrades for new water level. Allow aeration zone of existing structure to be able to use both existing outlet boxes. Minor modifications to the existing oxidation ditch outlet structures may be needed for proportional split for operating clarifiers in parallel, but only when the "ditch" compartment of the total aerobic volume is in service (the second compartment in series in normal operations).
Clarifiers and sludge pumping	Upgrades to #1 to make it functional, continue use #2. See TM-02 for Clarifier #2 RAS/WAS and scum pump and piping mods.	Upgrades to #1 to make it functional, continue use #2. See TM-02 for Clarifier #2 RAS/WAS and scum pump and piping mods.

Table 6 Biological Process Layout Alternative 1 Opinion of Probable Costs

Alt 1 New Separate Selector, Existing Aeration Basin				
	Item	Description	Quantity	Item Cost
1	Selector Tanks	New construction - Tanks, including excavation, concrete, mixer bridges, access grating & stair	36,000 gal (multiple cells)	144,000
		Process mechanical - gates, valves and piping, etc.		49,000
	Mixers	Vertical shaft bridge-mount, installed	0.5 - 2 hp each cell	78,000
	Aeration	One compartment to increase operational flexibility to respond to specific bulking incidences.	Single grid fine pore diffusers	20,000
2.	Aeration Basin	Tank modifications to existing oxidation ditch including demo of rotors and turning vane walls, construct divider walls, mods – divider walls, demo rotor aerators, mods to outlet.	135,000 gallons, existing volume divided into 2 cells	45,000
	Aeration Equipment	Diffusers and air piping, installed, instrumentation equip. New submersible mixer to allow complete-mix operation through entire basin		135,000
		Process mechanical - gates, valves and in-basin piping		62,000
	Distribution box	Modification to outlet boxes to allow parallel clarifier operation in any mode of operation.		30,000
3	Blower Building	Addition to solids handling building		60,000
	Blowers	1 at 730 scfm @ 6 psi, 35 hp, installed	1 ea	90,000
	Process Air piping	In-building, exposed, installed	LS	35,000
4	Clarifier #1 re-hab	New mechanism, installed	1 @ 22’ dia.	255,000
		Inlet and outlet piping modifications	center feed	25,000
		Update sludge pumping and piping at Clarifier #1		65,000
5	Process Site Piping (biological treatment upgrades)			103,000
6	Electrical (biological treatment upgrades) -			192,000
7	Instrumentation and Control (biological treatment upgrades) -			115,000
8	Site work (biological treatment upgrades), fencing, paving, etc.			75,000
9	Comparison Cost (Biological treatment, does not include contractor O&P, taxes, contingency, engineering, administration costs)			1,578,000

Table 7 Biological Process Layout Alternative 2 Opinion of Probable Costs

Alt 2 Selector in Portion of Existing Aeration Basin, Add Aeration Volume				
	Item	Description	Quantity	Item Cost
1	Selector Tanks	Modify existing oxidation ditch to include new selector cells, mixed by mechanical mixers with one cell aerobic capable. Gated and valved to make cells isolatable. Include divider walls, mixer bridges, access. Includes demo of existing equipment.	36,000 gal (multiple cells)	75,000
		Process mechanical - gates, valves and piping, etc.		78,000
	Mixers	Vertical shaft bridge-mount, installed	0.5 - 2 hp each cell	78,000
	Aeration	One compartment to increase operational flexibility to respond to specific bulking incidences.	Single grid fine pore diffusers	20,000
2.	Aeration Basin	Modify existing costs are above. This line: Construct additional, necessary basin volume as a new, separate tank, north of existing ditch.	67,500 gallons NEW volume, nominally 76,000 gallons of existing.	270,000
	Aeration Equipment	Diffusers and air piping, installed, instrumentation equip.		100,000
		Process mechanical - gates, valves, in-basin and between-basin piping to isolate cells or run in series.		73,000
	Distribution box	Volume available to extend aerobic cell to utilize both outlet boxes simultaneously. Modification to outlet boxes to allow parallel clarifier operation (in most operational modes)		-
3	Blower Building	CMU, 20’ x 36’, including building misc. mechanical, architectural	720 SF	60,000
	Blowers	3 at 365 scfm @ 5.5 psi, 20 hp, installed	3 ea	90,000
	Process Air piping	In-building, exposed, installed	LS	35,000
4	Clarifier #1 re-hab	New mechanism, installed	1 @ 22’ dia.	255,000
		Inlet and outlet piping modifications	center feed	25,000
		Update sludge pumping and piping at Clarifier #1		65,000
5	Process Site Piping (biological treatment upgrades)			104,000
6	Electrical (biological treatment upgrades) -			193,000
7	Instrumentation and Control (biological treatment upgrades) -			116,000
8	Site work (biological treatment upgrades), fencing, paving, etc.			82,000
9	Comparison Cost (Biological treatment, does not include contractor O&P, taxes, contingency, engineering, administration costs)			1,719,000

F. SUMMARY / CONCLUSIONS

Costs favor the alternative 1 configuration for upgrades. Other considerations, such as operability, functionality, reliability and performance expectations are essentially equal between the two alternatives.

Certain aspects of future adaptability favor alternative 1 – ease and cost of adding more anoxic or anaerobic volume to implement nutrient removal would be easier and likely lower cost.

The greater depth of diffuser submergence for one-half of the aeration basin volume in alternative 2 would result in better aeration efficiency for that portion of the aerobic volume (from approximately 15% overall oxygen transfer efficiency at standard conditions to 22%, for just one half of the aerobic volume). This amount of efficiency increase potentially results in power bill savings of about $525 per year. This is not enough savings to offset the capital cost difference in any financing scenario.

Alternative 1 is the recommended configuration for upgrade and expansion of the biological portion of the treatment facilities. Refer to Table 5 for planning-level details for the recommended alternative, alternative 1

The main elements of the Biological Treatment Upgrade and Expansion portion of the treatment plant project will include the following:

- New selector tank with multiple, isolatable compartments, primarily as anoxic selectors, but with at least one compartment that can be operated as an aerobic selector, with aeration diffusers fed from the aeration basin blower.
- Piping, gates and valves to maximize flexibility in operation of the selector tank compartments.
- Replace existing ‘temporary’ aeration diffuser grids with permanent fixed diffusers to meet future projected oxygen demand.
- A redundant blower for the aeration system.
- Modifications to the existing oxidation ditch structure, including dividing into two isolatable cells to allow maintenance of diffusers, with gates to allow operation of the aerobic cells in series, and mechanical mixing to allow operation as a complete-mix reactor and to maintain mixed liquor suspension if aeration grids are shut down.
- Drains installed in the existing oxidation ditch structure, as well as incorporated into the design of the new selector structure.
- Re-furbished clarifier #1

Refer to TM-02 for additional project elements, including sludge pumping and piping for clarifier #2.

The following Table summarizes costs included herein with an estimate of other project costs. This does not include the elements of the treatment plant addressed in TM-02.

Table 8 Biological Process Expansion Recommended Upgrades, Opinion of Probable Costs, with Project Cost Adders for Budgetary Purposes.

TM-01 Biological Process Expansion and Upgrade Description	Est. Cost
Selector and Appurtenances	$291,000
Aeration Basin and Appurtenances	$272,000
Blower Upgrade	$185,000
Clarifier #1 Re-habilitation	$345,000
Secondary Process – site piping	$103,000
Secondary Process – site electrical	$192,000
Secondary Process – Instrumentation and control upgrades	$115,000
Site Work - Secondary Process Upgrades – Associates Only	
Sub-Total (comparison, see Table 6):	$1,578,000
Contractor mob/admin/overhead/profit (15%)	$237,000
Sub-Total Construction:	$1,815,000
Tax (8.7%)	$158,000
Contingency (25%)	$454,000
Construction Total:	$2,427,000
Engineering and admin (30%)	$728,000
Total:	**$3,155,000**

Technical Memorandum TM-02

TOWN OF TWISP
WASTEWATER FACILITIES PLAN - 2020

Additional Treatment Plant Recommendations

August 13, 2020 Draft
August 21, 2020
September 25, 2020 Final

1.0 Introduction

This Technical Memorandum (TM) supplements TM-01 (July 21, 2020) which presents biological process upgrade recommendations for Twisp's Wastewater Treatment Facility. This memorandum provides additional evaluation and recommendations for other plant components.

This evaluation is based on document review and site visit on February 18, 2020 with the Town's Public Work Director (Andrew Denham), who is also a treatment plant group IV operator. Improvements herein were initially identified by Town staff and developed in this evaluation to allow operation of the treatment plant for the next 20-year planning period.

The following treatment plant components are evaluated elsewhere:

- Biological process expansion/upgrades – see TM-01
- Clarifier upgrades – see TM-01
- Biosolids processing upgrades – see General Sewer Plan (October 2019)
- Outfall evaluation – see General Sewer Plan (October 2019)
- UV Disinfection System– being prepared separately by Town and Vendor

2.0 Background / Design Flows and Loads

See TM-01.

3.0 Treatment Plant Improvements

This section provides evaluation and recommendations for treatment plant improvements needed to extend the life of the wastewater treatment plant for the next 20-year planning period. The major components of the treatment plant are briefly described followed by observations/issues, recommended improvements, and estimated costs. A summary of the cost estimates for each component is provided in Section 4.0.

<u>Influent lift station</u>:

- Description:
  - The treatment plant influent lift station is located at the northwest corner of the site—on the north side of the access road across from the headworks and operations building.

  - The lift station was constructed in 1976 and consists of a 6' diam. concrete wetwell (14.5' deep; working volume = 1,272 gallons) w/ separate dry pit that houses the pumps, valving, electrical, and influent flow metering.
  - Pumps consist of 2 vertical centrifugal 5HP pumps (370 gpm @ 28.3').
  - The lift station doses influent flows to the headworks facility intermittently as the wet well fills.
  - A bubbler level control system was added to the lift station during the 2001 treatment plant upgrades. Influent metering (Siemens magnetic meter) was later added around 2005.

- Observations and Issues:
  - The Town reports that despite the age of the lift station the overall structure and performance of the lift station is satisfactory.
  - The overall flow capacity of the lift station meets the projected future peak flow. ECY criteria states a lift station must be sized to provide 100 percent of the design capacity with one pump out of service. Based on updated flow projections for the planning period in TM-01 (and peak factor of 3.8) the lift station will operate at 89% capacity during peak flow condition w/ the largest pump out of service.
  - Electrical components for the lift station are located within the lift station dry pit which requires frequent access to confined spaces for Town staff. The Town would like the electrical (pump starters, telemetry, etc.) relocated outside the dry pit. The Town has suggested the administration building would be a good location for the panels.
  - The existing pump station intermittently doses flow to the headworks facility and is not ideal. Addition of variable frequency drives will allow for the lift station to flow pace influent flows rather than the on/off surge that occurs now. Addition of VFDs will allow for flow-based controls as well as flow paced influent sampling (which is currently only time based).
  - Given the age of the pumps, it is recommended they be rebuilt or replaced to provide reliable service for the 20-year planning period. If VFDs are added, it is likely the existing pumps are not inverter duty rated (and thus new motors needed); therefore, it is recommended the Town plan to replace the existing pumps with new inverter duty pumps.
  - The Town would like to upgrade/modernize the existing lift station level control and instrumentation. This should include ultrasonic level sensor or pressure transducer and associated telemetry.

- Recommended capital improvements and costs (not including additional project costs such as contractor overhead/profit, mobilization, administrative, as well as contingency and engineering):

Influent Lift Station Upgrade Description	Est. Cost
New pump control panel, VFD drives, and telemetry located in administration building	$45,000
Electrical installation and site electrical	$20,000
New 5HP inverter duty pumps	$25,000
Piping, plumbing, valves	$15,000
Pump installation	$10,000
Instrumentation upgrades (ultrasonic level transducer)	$5,000
Bypass pumping	$30,000
Total:	$150,000

Headworks:

- Description:
  - The headworks structure is located near the northwest corner of the site.
  - The headworks was constructed as part of the treatment plant upgrade completed in 2001, and includes the following components:

    Fine Screen:
  - The fine screen consists of an in-channel, inclined perforated plate screen, curved into a cylindrical shape. Wastewater passes through the screen (from the inside of the half-cylinder to the outside) and solids (screenings) are captured on the inside of the cylindrical "drum". The screen is cleaned with a motor-driven spiral screw, which conveys the captured screening up the incline, out of the liquid flow path, into the washing and compaction zone part of the equipment. The screenings are sprayed to wash out the degradable materials, compacted in an enclosed tube section, and conveyed to drop into a bin. The washing and compacting result in screenings that are suitable for landfilling.
  - The screening equipment is located outdoors, and includes a weather-protection jacket with heat tracing to prevent freezing. Freezing in the screen (of washwater or screenings) would severely damage the equipment.
  - The openings in the perforated plate are 0.2 inches in diameter, so the screen could be classified as "fine", and would be expected to remove identifiable non-degradable trash from the wastewater. This level of screening satisfies the criteria for removing identifiable manufactured inerts in producing biosolids suitable for any type of beneficial utilization (WAC-173-308-205).
  - The fine-screen equipment is nearing the end of its expected service life, having been in service for nearly 20 years. This is approximately the useful life for this type of equipment, and it would not be expected to last deep into the next planning cycle, much less to the end of the 20-year planning period.

    Grit Removal:
  - Grit removal is an important element of the wastewater treatment plant. Removing most of the grit prevents it from causing excessive wear to pumps and other

downstream equipment, and reduces the accumulation of grit in the aeration basin or other unit processes.

- The grit-removal system consists of an aerated grit chamber. This type of grit system uses air to impart a controlled mixing velocity to the grit chamber, designed to allow settling of dense solids (grit), but maintain less dense biological and degradable solids in suspension to pass through to biological treatment.
- Aerated grit chambers are designed for continuous aeration to be most effective. Controlling the air flow rate is important for achieving good grit removal while allowing degradable material to pass. Air-adjustment valves are an important component for maintaining good performance.
- Aerated grit chambers add oxygen to the wastewater, but the amount is relatively low compared to the oxygen demand, and when there is no active, biological solids to utilize the oxygen, it has a minor impact to the sludge conditioning and would not be expected to significantly impact downstream biological systems.

- Observations and Issues:

Fine Screen:

- As noted above, the screen as reached the end of its useful life, and will be due for replacement with this upgrade project.
- There have been no reported problems associated with the outdoor installation, so a weather protection system similar to the existing one should be specified for the replacement.
- The replacement screen can be installed in the existing channel without channel modifications.

Grit Removal:

- Chamber may be somewhat oversized at current average flows, as the design volume is based on maintaining a minimum hydraulic residence time (HRT) at the current design peak hour flow of 0.5 mgd. At current average flow of 72,000 gallons per day, there is nominally 30 minutes of HRT in the chamber. However, the recycled sludge (RAS) is being directed through the grit chamber in current operations so actual HRT is in the 16 minute range. The long HRT should not adversely impact performance as long as the air is evenly distributed along the length of the grit chamber and the air can be adjusted to impart the appropriate agitation to provide good grit removal as well as a clean grit.
- The HRT in the grit chamber is long enough with the recycled sludge that an aerobic selector effect is likely occurring. The new selector basins in the upgrade will allow for more controlled selector mechanisms in the process while eliminating the practice of returning sludge via the grit chamber. Refer to the Biological Process Expansion and Upgrade technical memorandum.
- Internal piping and baffles in the grit chamber are subject to the same erosive wear from grit as pumps and piping. The grit chamber should be emptied periodically, to inspect the aeration piping and diffuser, as well as the grit removal piping. The air-lift pump is particularly vulnerable to wear, and if damaged will reduce performance and limit the ability to adjust the pumping rate.

  - The grit chamber has likely experienced significant wear, having been in service for 20 years in a corrosive and erosive environment.
  - The grit pumping system (air-lift pump) is prone to blockage from rags and other items that can get caught in the system. There are not great solutions to this issue except to maximize the accessibility of the system to make observation and maintenance easy.
  - Direct observation of the internal (submerged) components of the grit system (air piping, grit removal piping, steel baffles) is not possible without taking the unit out of service and draining it. The as-built plans (from the 2001 upgrade) and schematic do not show a way to bypass the grit chamber without also bypassing the oxidation ditch. Bypass piping to allow the grit chamber to taken out of service without bypassing the fine screen or the biological treatment system is recommended to be included in the upgrade project. During the project, the buried piping will be exposed to allow the piping revisions and valve installation to add this functionality.

- Recommended capital improvements and costs (not including additional project costs such as contractor overhead/profit, mobilization, administrative, as well as contingency and engineering):

Headworks Area Upgrade Description	Est. Cost
Replace existing cylindrical fine screen with like equipment, including weather and freeze protection, controls	$150,000
Installation; including removal of old screen	$20,000
Allowance for modifications and adaption to fit existing	$10,000
Inspect and assess grit system air piping and grit removal piping; allowance to coat and replace sections of pipe as necessary.	$5,000
Yard piping modifications for grit bypass piping	$15,000
Replace grit blower/airlift system	$40,000
Total:	$240,000

Process Sludge Pumping and Piping (RAS/WAS):

- Description:
  - Sludge that settles in the clarifiers is pumped back (RAS) to the aeration basin to remove additional pollutants.
  - The biological treatment process generates excess biological solids that must be wasted out of the system (WAS) to keep control of the process sludge inventory.
  - The existing sludge pumps for the old clarifier (#1) are not functional and will be replaced in the upgrade, in conjunction with rehabilitation of clarifier #1. Two sludge pumps dedicated to clarifier #1 will be included in the upgrade.
  - The new clarifier #1 sludge pumps will be designed to be able to automatically recycle and waste sludge using a combination of pump speed control and timer control.
  - The sludge discharge piping from the new pumps for clarifier #1 sludge will be arranged to allow either pump to be utilized for either RAS or WAS (for

redundancy), but in normal operation, one pump will be for RAS, and the other pump for WAS, to avoid the need to re-position discharge valves every wasting cycle.

- Clarifier #2 has two pumps dedicated to RAS and WAS.
- The clarifier #2 pumps are sized appropriately for the current wastewater flows and for most normal operations at projected future flows. For some non-normal operating conditions (such as prolonged, unusually high inflows coinciding with biological upset conditions), higher pumping rates would be helpful. If this type of condition occurs in Twisp, it is possible to run the pumps in parallel, directing the discharge from both pumps to either RAS or WAS by manually changing the discharge valve position in the RAS/WAS discharge valve utility vault.
- RAS-WAS discharge piping from clarifier #2 is set up to dedicate RAS/WAS pump #1 to waste (WAS) and RAS/WAS pump #2 to recycle sludge (RAS). The discharge valving can then be manually placed in the appropriate position to accomplish this, as long as the pumps are controlled independently, to cycle on-and-off according to their own timers. If one pump is out of service, a single pump is used for both RAS and WAS, but requires manually re-positioning valves for each wasting cycle.

- Observations and Issues:
  - The costs for upgrades for existing clarifier #1 sludge pumping were included in the technical memorandum for Biological Process Expansion and Upgrades.
  - The pumps have been in service for nearly 20 years and have likely lost some efficiency due to wear, and would likely need to be replaced before the end of the planning period. It is recommended for the replacement be included in this upgrade project, as there will be an opportunity to perform this work with old clarifier #1 coming back into service.
  - The new clarifier #2 pumps will be specified with variable frequency drives, to allow varied pumping rates. With the SCADA upgrades scheduled for this project, the RAS/WAS control strategy will also be updated, to allow for flow rate set-point control on RAS (using the existing RAS flowmeter signal), as well as cycle timers. This would give the operators more flexibility in how they manage sludge inventory control.
  - Replacing the RAS/WAS pumps and utilizing VFDs presents the opportunity to slightly increase the maximum capacity of the pumps to give the facility operator additional flexibility when dealing with upset and unusually high flow conditions. With the VFDs, the pump turn-down will still allow for energy-efficient pumping at normal operating flowrates, also.
  - Piping in the RAS/WAS valve vault is sufficient for WAS and RAS operations to occur simultaneously. However, this capability may be limited as it may be necessary to suspend recycling for some period of time prior to a wasting cycle (to prevent coning the clarifier sludge blanket. Putting the pumps on VFDs would help mitigate the issue and allow for operators to base waste cycling periods more on process control and less on avoiding complications.
  - The existing clarifier #2 sludge discharge piping does not offer full flexibility for scum pumping without manually re-positioning and manually running the scum

pump. As it is currently arranged, the scum pump discharges into the sludge pumping discharge manifold on the WAS side, allowing scum to be pumped to waste (aerobic digesters) without manually re-positioning valves. Pumping scum elsewhere (back to the biological system via the RAS piping) requires suspending WAS pumping and re-positioning valves, so this is not a practical normal mode of operation. Additional piping and valving could be installed in the valve vault that would allow re-directing scum to a different destination without suspending or interrupting RAS or WAS. This is not considered to be an essential operational or control issue, and it is not expected to be a priority for the next upgrade unless there are specific problems with current operations with the existing piping arrangement. The new piping and valving would be 3" pipe, and may be something the facility could consider self-performing at a future date if it is deemed to be a valuable addition. It is not recommended at this time.

- The piping in the RAS/WAS valve vault shows some of the paint beginning to fail. Re-coating the valves and piping is recommended to be included in the next upgrade.

- Recommended capital improvements and costs (not including additional project costs such as contractor overhead/profit, mobilization, administrative, as well as contingency and engineering):

RAS/WAS Upgrade Description	Est. Cost
NEW submersible RAS/WAS pumps, rails and appurtenances to replace existing pumps at clarifier #2	$35,000
Pump installation	$10,000
Re-coat RAS/WAS valves and piping in existing RAS/WAS valve vault	$2,000
Variable Frequency Drives for each clarifier #2 RAS/WAS pump	$18,000
Programming upgrades with new SCADA system to allow flow setpoint / feedback control loop in addition to on-off cycle timer operator adjustable setpoints, and volume wasting capability	$8,000
Total:	$73,000

Cross connection control:

- Description:
    - Cross connection for Twisp's WWTP is currently accomplished by use of individual backflow assemblies at various locations throughout the treatment plant. Premise isolation for the site is not provided.
    - A reuse pump system was installed to utilize plant effluent for various treatment water requirements which offsets the treatment plant's potable water requirement.

- Observations and Issues
    - Department of Health (DOH) provides guidance on requirements for cross connection control for wastewater treatment plants. DOH guidance considers

wastewater treatment plants "high severity" and requires premise isolation. This means typically treatment plants are required to provide complete hydraulic separation from the Town's potable water supply; this is typically done using a reduced pressure backflow preventer with an additional air gap and repump system for process isolation. This requirement for Twisp's WWTP should be confirmed with the Town's cross connection control specialist.

- An air gap repump system to serve Twisp's treatment plant should be sized to accommodate anticipated current and future water demands. System should include duplex pumps with flow pacing via VFD / pressure tank combination. Controls for the system should be integrated into the treatment plant SCADA system.
- Based on discussed w/ Town Staff a new air gap repump system could be housed in an addition/expansion to the existing operations building. Expansion would include constructing a new room on the north side of the building. Based on preliminary sizing of the CCC system, it is anticipated the building addition would need to be roughly 10'x20'.
- An option for the Town to consider is to use the existing reuse pump system for all treatment plant water requirements; and only provide potable water to the operations building. This will allow for a physical separation between the potable and repump system. Feasibility of this option needs to be confirmed; but this option would be less expensive as compared to adding a new air gap repump system. However, it is possible treatment plant effluent may not be ideal for some process requirements (including polymer makeup for the new screw press). Because of this, it is recommended the Town plan for a new air gap repump system. During design, the feasibility of this option can be explored further for potential cost savings based on input from the Town's cross connection control specialist and actual process equipment selected.

- Recommended capital improvements and costs (not including additional project costs such as contractor overhead/profit, mobilization, administrative, as well as contingency and engineering):

Cross Connection Control Upgrade Description	Est. Cost
Reduced pressure backflow assembly for premise isolation	$25,000
Building expansion—expand operations building to the north (assume 10'x20' addition at $300/SF)	$60,000
Skid mount cross connection control repump system	$140,000
CCC system installation	$30,000
Site piping revisions to accommodate new cross connection system	$10,000
Allowance for upgrade to plant reuse pump system	$15,000
Electrical, controls, SCADA for CCC system	$40,000
Total:	$320,000

Plant SCADA & PLC:

- Description:
  - The existing plant PLC panel was installed during the 2001 treatment plant upgrades. The main plant PLC is a MicroLogix 1500, manufactured by Rockwell Automation. The MicroLogix 1500 has been discontinued by the manufacturer and is no longer supported.
  - The existing plant SCADA system is Wonderware InTouch. The Wonderware InTouch software has widespread adoption in the region and local programmers are familiar with the platform.

- Observations and Issues:
  - Given the age of the PLC panel and discontinued support and replacement components from the manufacturer, it is recommended that the PLC system be replaced. New PLC system should include manufacturer migration support for transition to the new controller system. Converting the existing code and checking line by line for errors will take an estimated 8 hours of programming time. Due to the age of the other control panel components, it's recommended that the entire control panel be replaced to include new relays, auto dialer, touchscreen interface, UPS, etc. This approach will allow all new control panel components to be factory tested along with functional testing of the migrated programming at the control panel manufacturing shop and ensure minimal interruption to plant operations.
  - The existing SCADA system has been operating reliably, however, some tags and screens require cleanup and additional I/O points are desired. A list of desired points and labor is currently being developed by plant operations.
  - Network Communication utilizing Ethernet IP (Industrial Protocol) over fiber cable is recommended for communication between the main plant PLC and influent pump station control panel PLC, as well as the headworks control panel PLC. This approach will maximize spare I/O availability at the main PLC and allow functionality to be added in the future without running additional I/O cables.
  - Integration of the two town remote Lift Stations as well as remote Wells and Reservoir, are also desired. Optional costs to install telemetry radio panels at the main treatment plant and remote I/O stations as well as SCADA integration are included in the recommended costs section. Costs are based on one new wastewater plant telemetry radio and telemetry panels and radios at 5 remote stations (6 total).

- Recommended capital improvements and costs (not including additional project costs such as contractor overhead/profit, mobilization, administrative, as well as contingency and engineering):

Plant SCADA / PLC Upgrades Description	Est. Cost
Clean up existing SCADA program and add up to 10 additional points	$15,000
SCADA integration/programming for biological process upgrades and treatment plant improvements	$80,000
Main plant PLC control panel replacement and programming	$40,000
Fiber PLC Network	$15,000
Option: Remote Telemetry Panels, Radios and programming (Assumes 6 Stations @ $20,000 each)	$120,000
Total:	$270,000

Backup Generator:

- Description:
  - Existing backup generator is a 200 KW generator installed during the 2001 treatment plant upgrades and is located in the solids handing building.

- Observations and Issues:
  - Given the age of the generator it is likely the remaining service life of the generator will be adequate for the next 20 year planning period.
  - Additional loads are being added to the plant which will increase loading on the generator. Based on an initial estimate of added load (in the 20HP range based on added blower HP and some additional components) the existing generator can meet anticipated loads as-is or with load sharing control measures implemented.
  - Based on final selected equipment, it is recommended a pre-design task be completed to review existing plant electrical load and proposed load calculations for the plant (with new selected equipment) to confirm adequacy of the existing generator.
  - For reference, a new 250KW generator will be in $90K range. This cost does not include installation or building modifications which may be necessary to fit a larger generator into the existing generator space.

Operations / Laboratory Building:

- Description:
  - The treatment plant's existing operations building is a 750 SF CMU structure located at the NW corner of the treatment site. The operations building includes a laboratory, an office that includes the SCADA interface, a storage room, and a bathroom. The building was originally constructed in 1976 during construction of the original treatment plant. Building upgrades including new widows/doors and building mechanical systems were completed during the 2001 treatment plant upgrade project.

- Observations and Issues:
  - In general, the operations building is in satisfactory condition. Building utilities and appurtenances are not in need of immediate upgrade; and the Town does not plan for major improvements to the building.
  - The laboratory cabinets are original to the building and nearing the end of their service life. It is recommended the laboratory be equipped with new cabinetry.
  - The Town would like to have a budget to upgrade some of the laboratory equipment which is outdated and/or at the end of its service life. Based on discussions with the Town a budget of $40K is recommended.
  - Given the age of the facility and the possibly that additional items are needed, we recommend an allowance for miscellaneous building upgrades/repairs be included as well.

- Recommended capital improvements and costs (not including additional project costs such as contractor overhead/profit, mobilization, administrative, as well as contingency and engineering):

Operations / Lab Bldg. Improvement Description	Est. Cost
Replace laboratory cabinets including demo and retrofitting	$50,000
Laboratory equipment budget	$40,000
Misc.	$20,000
Total:	$110,000

WWTP Site:

- Description:
  - Twisp's treatment plant is located on the south half of a 4.96 acre parcel owned by the Town (parcel number: 332217.0290). The majority of the existing site is surfaced with gravel with little to no landscaping. The perimeter of the site is fenced with a 6' chain link fence. Access to treatment components and structures appears adequate.

- Observations and Issues:
  - The general aesthetics of the site are poor; the Town reports weeds are an issue with the current gravel surfacing. The Town would like to provide site improvements to improve site aesthetics and reduce site maintenance.
  - Based on discussions w/ Town staff we recommend driveway areas and selected parking / access areas be paved with asphalt paving. We recommend the interior of the site be lawn seeded with an automatic irrigation system installed; and all other areas receive new gravel surfacing. See attached site surfacing figure.
  - The town would like to install additional hose bibs: one at the new anoxic basin, and 2 at the existing oxidation ditch (one at each end) for a total of 3 new hose bibs.
  - Some fencing modifications will be needed to accommodate the new anoxic basins

- Recommended capital improvements and costs (not including additional project costs such as contractor overhead/profit, mobilization, administrative, as well as contingency and engineering):

Site Improvements Description	Est. Cost
New asphalt driveway and parking area including grading, subgrade prep, and crushed surfacing (2,800 SY @ $45/SY)	$126,000
Landscape/lawn areas with the irrigation system	$15,000
Gravel surfacing (2,200 SY @ $8/SY)	$18,000
Additional hose bibs or hydrants (3) connected to plant reuse water system; located at new anoxic basis and each end of the existing oxidation ditch	$15,000
Fencing modifications to accommodate anoxic basins	$10,000
Total:	$184,000

4.0 Summary of Estimated Costs for TM-02

Following summarizes costs included herein with an estimate of other project costs.

TM-02 Add'l WWTP Improvements Description	Est. Cost (1)
Influent lift station upgrade	$150,000
Headworks area upgrade	$240,000
RAS/WAS pumping and piping upgrade	$73,000
Cross connection control system	$320,000
Plant SCADA/PLC upgrades	$270,000
Operations / lab building improvements	$110,000
Site improvements	$184,000
UV Equipment Replacement (2)	$210,000
Sub-Total:	$1,557,000
Contractor mob/admin/overhead/profit (15%)	$234,000
Sub-Total Construction:	$1,791,000
Tax (8.7%)	$158,000
Contingency (25%)	$486,000
Construction Total:	$2,435,000
Eng, admin, const mgt, insp (30%)	$730,000
Admin/Environmental/Funding	$40,000
Total:	**$3,205,000**

(1) Costs rounded to the nearest thousand dollars.
(2) Estimated cost is preliminary and represents replacement of the in-channel UV equipment without channel modification or building addition. An evaluation of the UV system with recommendations and costs is being completed by the Town and manufacturer. Costs will be updated after evaluation is complete.