DRAFT FOR REVIEW

TECHNICAL REVIEW REPORT

2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW

TOWN OF JACKSON, WYOMING

July 8, 2022

Project #: 80F-001-001

SUBMITTED BY: Trihydro Corporation

1252 Commerce Drive, Laramie, WY 82070

SOLUTIONS YOU CAN COUNT ON.
PEOPLE YOU CAN TRUST.

Table of Contents

Table of Contents (cont.)

List of Tables

List of Figures

List of Figures (cont.)

List of Appendices

Acronyms

CBOD	carbonaceous biochemical oxygen demand
hp	horsepower
lbs	pounds
mg/L	milligrams per liter
MG	million gallons
MGD	million gallons per day
O&M	operation and maintenance
TSS	total suspended solids
UV	Ultraviolet
WDEQ	Wyoming Department of Environmental Quality
WQD	Water Quality Division
WWTP	Wastewater Treatment Plant
WYDES	Wyoming Pollutant Discharge Elimination System

1.0 INTRODUCTION

Trihydro Corporation (Trihydro) prepared this draft Technical Review Report (Report) for the Town of Jackson, Wyoming's (Town) 2021 Wastewater Treatment Plant (WWTP) Technical Review project (Project). This Report summarizes Trihydro's existing WWTP condition assessment, potential system improvements, and the process used to evaluate potential system improvements. Potential improvements are structured to align with the Town's WWTP priorities, which include:

- Protecting the region's water quality and ecosystem by achieving the Wyoming Department of Environmental Quality (WDEQ) discharge permit standards.
- Maintaining a cost-effective and high level of service to rate-paying customers.
- Reducing energy consumption in wastewater treatment through use of energy efficient treatment methods.
- Aligning treatment objectives with the recently updated Jackson/Teton County Comprehensive Plan.

The Town partnered with a Steering Committee to complete this project. Steering Committee activities included providing oversight and direction, attending project meetings, reviewing and commenting on project memorandums and reports, assisting with developing the Decision Matrix (including criteria, weighting system, and potential improvement alternatives scoring), identifying Stakeholder members, and participating in a Public Engagement session. Steering Committee members are:

- American Rivers, Northern Rockies
- Ducks Unlimited
- Protect Our Water Jackson Hole
- Snake River Fund
- Teton Conservation District
- Wyoming Game and Fish Department (WGFD)

As noted, Stakeholder members were identified to participate in the project Technical Discussions. The Town and Steering Committee nominated local water quality experts as well as individuals they felt could provide insight on WWTP perception, operations, water quality, and potential improvements. Ten Stakeholders were identified to participate in project meetings and provide feedback for additional consideration as the Town and Steering Committee worked through the potential improvement evaluation process.

Trihydro led two Technical Discussion meetings with the Town, Steering Committee, and Stakeholders. The first meeting focused on describing current WWTP operations and summarizing background information. Potential improvements were not presented during the first meeting. The second meeting discussed the proposed Decision Matrix and potential improvements. Trihydro presented these items emphasizing participant input on additional considerations that may not have been included. The Decision Matrix and potential improvements are summarized in Sections 4.0 and 6.0, respectively.

1.1 PROJECT OBJECTIVES

The Town initiated this Technical Review to better understand current WWTP operations and define short- and long-term wastewater treatment and effluent water quality monitoring and discharge improvements. The Town has made sustainability commitments to its citizens and stakeholders to achieve State discharge standards, protect the ecosystem, and provide cost-effective utility services. Figure 1-1 shows the WWTP location in relation to the Town.

This project evaluated existing WWTP data, including influent and effluent water quality and energy consumption. The Town and Steering Committee wanted to understand how the WWTP system currently operates and identify potential improvement areas. The Town prides itself in achieving current WDEQ Water Quality Division (WQD) Wyoming Pollutant Discharge Eliminations System (WYPDES) permit water quality limits and maintaining WWTP operations. The Town currently achieves WYPDES permit water quality requirements and continuously evaluates WWTP improvements to decrease energy demands while achieving effluent permit requirements.

Once the current system evaluation was completed, Trihydro prepared potential improvement alternatives for evaluation and discussion with the Town, Steering Committee, and Stakeholders. These potential improvement alternatives were aligned to not only achieve the current discharge requirements but to continue improving effluent water quality where possible. Through collaboration with the Town, Steering Committee, and Stakeholders, Trihydro prepared high-level cost estimates.

Short-term and long-term potential improvement alternatives are provided in Section 6.0. These improvements incorporated current operation and discharge requirements into the results. The Town will have the opportunity to select the improvement to best meet their priorities and goals.

2.0 CURRENT WWTP OPERATIONS

The WWTP effluent water quality requirements are permitted under WDEQ/WQD WYPDES Permit WY0021458 (Permit). The Town has historically produced effluent water quality better than the Permit requirements by discharging concentrations less than the Permit limits. Under current conditions, the WWTP will continue to operate below Permit limits; however, the community's desire to produce a higher-quality effluent and growth may require WWTP modifications or operational changes.

The WWTP was originally constructed as a facultative lagoon system in the late 1970s. Upgrades were made to the WWTP in 1995 to construct the Preliminary Treatment Building (Headworks Building), Ultraviolet (UV) Disinfection Building, a Blower Building, and the Intermediate Pump Station (Vista 2021). The facultative ponds, currently Cells 1 and 2, were modified to operate as aerated cells during the 1995 upgrade. Figure 2-1 shows the existing WWTP site plan, wastewater flow path, and cell design parameters.

2.1 PROCESS DESCRIPTION AND FLOW

Wastewater flow enters the WWTP from a 30-inch pipeline which splits into a multi-line siphon and is then conveyed into a flow diversion structure on the Preliminary Treatment Building's north side. Grit is removed prior to the mechanical bar screen, which, itself, removes debris and trash before wastewater enters the Influent Pump Station. The Influent Pump Station has five 20-horsepower (hp) pumps with a 6.5-million-gallon-per-day (MGD) total capacity (Vista 2021). The pump station conveys flow equally to Cells 1 and 2 which are the largest and deepest cells. Each of Cell 1 and Cell 2's design volume is approximately 35 million gallons (MG), and their design depth is approximately 16 feet. Together, Cells 1 and 2 provide most of the WWTP's carbonaceous biochemical oxygen demand (CBOD) reduction. The ammonia reduction process also begins in Cells 1 and 2. Natural sludge digestion occurs as sludge settles to the cell bottoms. A large amount of the sludge settles in Cells 1 and 2 with the remaining sludge being conveyed into the subsequent cells as wastewater moves through the system. Aeration and mixing are provided by seven Triton mechanical aerators and six Grid Bee mixers spaced throughout each cell. An estimated oxygen capacity of 1,680 pounds (lbs) per hour can be supplied to Cells 1 and 2 with the mechanical aerators (Vista 2021). However, to reduce energy usage under current operations, not all Triton aerators are being used since CBOD reduction is achieved without the need for additional aeration.

Cells 1 and 2 operate in parallel followed by a series of smaller lagoon cells. Wastewater from Cells 1 and 2 discharges to Cells 3A, 3B1, and 3B2. Cells 3A, 3B1, and 3B2 have retention volumes of 12.4, 15.8 and 12.4 MG, respectively, and design depths average 15 feet. Cell 3A has four Triton mechanical aerators while Cells 3B1 and 3B2 each have two Triton mechanical aerators and one Grid Bee mixer.

Cells 4A, 4B, 4C, and 4D are next in series. Their design volumes range from 6.1 to 9.1 MG each and design depths are 10 to 13 feet. Coarse-bubble diffused air is provided by a single 150-hp HSI (Atlas Copco) air bearing blower. Aeration can also be provided by two Lamson 250-hp multistage blowers. The Lamson blowers have a much higher energy demand, therefore, are only used as needed.

Cell 5 is the final lagoon cell. Cell 5 has a design volume of 16.4 MG and is approximately 10-feet deep. The blowers used for Cells 4A, 4B, 4C, and 4D can also aerate Cell 5; however, Cell 5 is typically not aerated. Cell 5 provides final effluent polishing prior to UV disinfection and WYPDES Permit compliance sampling.

Cell 5 effluent flows to the Intermediate Pump Station. The Intermediate Pump Station has three 50-hp pumps and one 25-hp jockey pump with a 6.5-MGD total capacity (Vista 2021). Treated effluent is pumped via force main to the UV Disinfection Building (Figure 2-1). The UV system water-level control weir provides final flow measurement. Permit compliance sampling is performed following UV disinfection just before the water-level control weir. Once disinfection is complete, treated effluent gravity flows to the Barrow Pond where it is blended with flow from a natural stream. Flow then travels through a series of three WGFD-constructed wetlands. WWTP effluent is the primary wetland water source in the dry season which serves as habitat for migratory waterfowl.

2.1.1 WETLAND EXPANSION

The WGFD, in collaboration with Ducks Unlimited, is currently expanding the wetlands system south of the WWTP. These new wetlands will provide additional habitat for waterfowl and other species, as well as provide additional WWTP effluent nutrient reduction. The Town does not own or operate the wetlands and they have no impact on Permit compliance, but the wetlands do reduce nutrients before the effluent is discharged into the Snake River.

2.2 ENERGY USAGE

WWTP energy demands include aeration, mixing, and UV disinfection. Improvements have been made to reduce energy demands by installing high-efficiency aerators and mixers and performing seasonal operational changes. WWTP pumps are equipped with variable frequency drives for partial operation (Ameresco 2009). Cells 4A, 4B, 4C, 4D and 5 are aerated by centrifugal blowers and static tube diffusers. To further reduce energy consumption, only the single 150-hp turbo blower is typically used for Cells 4A, 4B, 4C, 4D, and 5 while the two 250-hp multi-stage blowers are on standby to meet additional aeration demands, as necessary. A series of solar panel installations (2008, 2010, 2015, and 2018) have also offset WWTP grid energy demands by approximately 13% monthly.

The Town provided Trihydro energy usage and solar panel energy generation data for 9 years through June 2021. WWTP operators prepared the Energy Workbooks to monitor energy usage, solar energy generation, and monthly energy costs. Trihydro used energy data to evaluate the WWTP's energy usage and identify possible improvement areas.

The Town uses three gauges to monitor WWTP energy usage. The Preliminary Treatment Building, Intermediate Pump Station, and UV Disinfection Building each have a gauge. Based on gauge readings, the Preliminary Treatment Building requires the highest energy demand. This gauge includes the Influent Lift Station, headworks, and Cells 1 and 2 aerators and mixers. These processes require high energy demands that the Town continuously works to optimize and reduce.

Trihydro also evaluated solar installation energy generation and its influence on reducing grid energy usage (Town of Jackson 2013-2021). The solar installations generally offset grid energy by approximately 13%. The actual offset varies by WWTP energy demands and seasonal fluctuations (Table 2-1).

Based on 2017 to 2021 usage data, WWTP energy demands generally reach their highest levels in May and June, which coincides with the highest influent flow rates (Figure 2-3). Energy demands directly correlate to aeration and mixing. As WWTP influent flow increases, additional aeration and mixing are required to meet effluent water quality permit requirements.

2.3 GROWTH CONSIDERATIONS

The WWTP currently operates under Phase II of a three-phase design with a 5.0-MGD design flow rate. Phase III allows the plant capacity to increase to 6.5-MGD. Several of the plant's major components are already sized for the Phase III flows. The Town's most recent Capacity Study, *Town of Jackson Water and Sewer Systems Evaluation Report* (Capacity Study), evaluated the current system and potential impacts as system wastewater contributions increase (Vista 2021). Approximately 10,000 permanent residents live in the Town and an additional 10,000 residents are within Teton County. In addition to the year-round population, the Town sees approximately four million visitors per year. The WWTP not only receives flow from the Town, but also several satellite districts.

The Capacity Study determined the current WWTP 5.0-MGD capacity will be exceeded in approximately 30 years. If the Town expands current WWTP operations to the maximum 6.5-MGD design capacity, it is anticipated the capacity will be met in the next 45-50 years (Vista 2021). Additional growth considerations for the WWTP are discussed in Section 3.5.3 below and are estimated from predicted population growth within the WWTP's service area. The WWTP is the largest regional facility in Teton County and may continue to be pressed to receive flows from new development and areas where groundwater issues necessitate conversions from septic systems to a municipal sewer collection system. The impacts of adding new collection areas in the County to the WWTP collection system were not considered in the Capacity Study. This Technical Review Report evaluated potential improvements that can be expanded to accommodate additional influent flows from population growth and/or additional collection areas.

2.4 REGULATORY REQUIREMENTS (WYPDES PERMIT LIMITS)

The WWTP permitted design flow is 5.0-MGD. The Permit stipulates effluent limits and monitoring requirements (Table 2-2), and includes the following technology-based limits:

- Carbonaceous Biochemical Oxygen Demand (CBOD) - 25 milligrams per liter (mg/L) maximum monthly average
- Total suspended solids (TSS) - 300 mg/L daily maximum
- pH between 6.5 and 9.0 standard units

The Permit also requires an 85% CBOD reduction and includes E. coli and total residual chlorine limits. Since UV disinfection is used, chlorine disinfection is not required. The Permit does not currently include ammonia or phosphorus limits, although monthly monitoring and reporting are required.

WDEQ did not establish an ammonia limit due to preexisting nitrogen levels in the Snake River and the high level of dilution immediately downstream of the outfall. A waste load allocation was calculated using historical water quality records and a mixing zone study completed in 2013 on the Snake River. The waste load allocation calculated an in-situ river ammonia concentration greater than the ammonia levels found in raw wastewater.

The Town submits discharge monitoring reports to the WDEQ monthly, quarterly, and annually. No effluent permit limit violations have occurred since 2019.

2.4.1 FUTURE PERMIT MODIFICATIONS

The Town's current Permit expires August 31, 2022. A new permit application was submitted and WDEQ is reviewing. Regulators have not indicated what changes, if any, may be included in the new Permit. As stated, the

Permit does not currently include ammonia or phosphorus limits. However, Trihydro evaluated potential improvements in consideration of more stringent monitoring requirements, including ammonia and phosphorus limits. Lagoon systems require the least amount of power for treatment but are typically incapable of meeting higher water quality standards, especially lower nutrient limits. However, there are operational changes and selective improvements that can increase the nitrification and denitrification processes. Potential improvements to reduce final effluent nutrient levels are discussed in Section 6.0.

Biochemical Oxygen Demand (BOD) is the amount of dissolved oxygen consumed during the microbial biochemical reaction that break down biodegradable organic matter in wastewater. The standard 5-day BOD (BOD_5) measurement of water quality is used widely as a design parameter for wastewater treatment plants. This measurement usually includes a nitrogenous oxygen demand (NOD) component that can cause oversizing of biological processes and under-evaluation of the true plant process capacity. Carbonaceous BOD ($CBOD_5$ or CBOD) more closely represents the oxygen demand associated with wastewater organic constituent biodegradation than does BOD_5 and, therefore, is used as a basis for sizing aerobic treatment processes. The higher the BOD/CBOD, the more oxygen stripping capacity effluent has when discharged into receiving waters, which can potentially increase damage to biological life in those waters.

Ammonia and phosphorus limits are notable potential future Permit changes because of their impact on downstream plants, fish, and other aquatic life. Plants need a balance of three major nutrients to grow: carbon, phosphorus and nitrogen. Carbon is supplied as plants convert carbon dioxide in the air and soil into oxygen. Phosphorus is measured as total phosphorus and ortho-phosphate (the form required by plants). In most fresh waters, the phosphorus concentration available to plants is low enough they cannot grow at their maximum rate. In water bodies where human activities add phosphorus, increased aquatic plant growth can occur. Large duckweed and algal blooms can result from excess nutrients.

Nitrogen, the other major nutrient supporting plant growth, is measured in its various forms as nitrate and ammonia. Nitrate and ammonia are readily absorbed by plants and incorporated into proteins, amino acids, nucleic acids, and other molecules. Like phosphorous, most aquatic plant growth in rivers is limited by the availability of nitrogen in the water. While ammonia can be readily used by plants, high ammonia concentrations are toxic to fish and other aquatic life and can lead to algal blooms. Some algae, such as blue-green algae produce toxins harmful to fish and people. The name is misleading as blue-green algae is neither plants nor algae. They are often called algae because they are free-floating and grow in large colonies, but in reality, blue-green algae are cyanobacteria. Cyanobacteria are found all over the world, on both land and water. They are microscopic but can be seen as a colony or bloom. As the bacteria die, they release toxins in the water. Large blooms can also block sunlight available to submergent vegetation reducing natural habitat and food sources. A second effect of increased ammonia occurs when bacteria oxidize ammonia to nitrate through nitrification. The nitrification process consumes four atoms of oxygen for every atom of nitrogen converted which can dramatically lower dissolved oxygen in the water leading to fish kills.

3.0 WWTP CONDITION ASSESSMENT

Trihydro conducted an onsite condition assessment on November 8 and 9, 2021. The condition assessment included reviewing existing WWTP design plans, permits, previous reports, operations, influent and effluent water quality data, and cell sludge accumulation information. The condition assessment included a field inspection of key WWTP equipment and interviews with WWTP operations staff and managers. The condition assessment was based on visual inspection and, therefore, limited to conditions that could be readily observed at the time of the visit.

Through experience conducting multiple condition assessments, Trihydro has developed a rating system to generally capture current equipment and process conditions in a clear and understandable presentation. The rating scale is defined as:

Rating	Description
Excellent	Normal maintenance required
Good	Minor defects
Fair	Moderate maintenance required
Poor	Significant deterioration, attention needed
Unserviceable	Requires immediate attention or replacement

The ratings considered the following observations:

- Equipment age
- Observed physical condition
- Operational efficiency
- Ability to meet desired function
- Repair history
- Operator input

Operational data and equipment maintenance history were reviewed to determine performance and reliability. Appendix A includes the existing WWTP condition assessment.

This condition assessment was used to identify processes and equipment requiring improvements. Overall, Trihydro found the WWTP to be in good condition and well maintained. The final effluent water quality is typically better than what is expected for lagoon systems of similar size and loading. However, lagoon systems by design are not capable of reducing ammonia and phosphorus during winter conditions as the water temperature drops. Significant operational and process modifications are required to meet more stringent nutrient limits.

3.1 OVERALL TREATMENT PROCESS CONDITION

The WWTP condition and operations were found to generally be in good operating condition. No portions of the treatment process or equipment required immediate repairs or replacement. The WWTP is currently designed to treat 5.0-MGD with current average influent flows in the range of 1.5- to 2.5-MGD. While the influent flow rate is well below the design flow rate, influent waste loadings often exceed the original design criteria. The waste loading is a calculation of the concentration of the permitted parameters such as CBOD, TSS, ammonia, and phosphorous in relation to the influent flow given in pounds per day (lbs/day). For example, a plant can receive wastewater with low concentrations during high flows or low flows with high concentration and the resulting wastewater loading can be the same. The WWTP is currently experiencing the latter condition. Influent loadings exceeding the design criteria can lead to upset conditions and permit exceedances. Trihydro's review of the WWTP's operating history examined how the plant reacts to these higher loading rates with respect to the final effluent limits. The WWTP operator interviews also provided overall treatment process and proposed improvement area details. No operating deficiencies were observed during the condition assessment.

The Town records WWTP wastewater characteristics throughout the facility in annual spreadsheets (Data Workbooks). These Data Workbooks were provided to review influent to effluent reductions and WWTP operations. These Data Workbooks were used to identify WWTP trends, flow characteristics, and system limitations.

3.2 TRENDS

The most effective way to review WWTP loading rates is in terms of lbs/day. This method considers flow and waste concentration variations. Design loading rates are estimated to initially size a wastewater plant including basin volumes, pumps, aeration systems, disinfection system, piping, valves, and other structures. Loading rates differ from the effluent permit limits in that they serve more as guidelines and are not hard limits. Trihydro used the Town's Data Workbooks to evaluate treatment trends and estimate future conditions (Town of Jackson 2012-2021). Trends were developed to better understand the WWTP's current treatment efficiency. Current system operations were compared to the WWTP's design capacities and permit limits to determine potential future limitations. Design capacities were taken from the WWTP's record drawings (Engineering Associates 1998).

Based on a 5.0-MGD influent flow rate, the WWTP is designed to treat influent CBOD and ammonia concentrations of 211 milligrams per liter (mg/L) and 29 mg/L, respectively. These maximum design concentrations were used to calculate the WWTP's maximum CBOD and ammonia design loading rates (Figures 3-1 and 3-2, respectively). Loading rates were calculated by multiplying the design flow rate (5.0-MGD) by the design influent concentration to determine the maximum pounds per day (lb/day) CBOD and ammonia the WWTP was designed to treat (Equation 3-1).

$$LR_{max} = Q_{max} \times C_{max} \times 8.3454 \qquad \text{Equation 3-1}$$

where,

LR_{max} = maximum loading rate, lb/day

Q_{max} = maximum flow rate, MGD

C_{max} = maximum concentration, mg/L

8.3454 = conversion factor, $lb \cdot L/MG \cdot mg$

Maximum CBOD and ammonia effluent concentrations were also calculated (Figures 3-3 and 3-4, respectively). These calculations were performed to estimate the potential future effluent concentrations if the flow rate reaches 5.0 MGD. Trihydro further calculated the difference between influent and effluent CBOD and ammonia concentrations to determine percent reduction through the treatment process (Figures 3-5 and 3-6, respectively). At the full 5.0-MGD capacity, the WWTP design specifications identified a 30-day total plant detention time; however, since 2018, the WWTP has operated between 1.23 MGD and 3.19 MGD. The percent reduction between influent and effluent concentrations was offset by 60 days to account for the average WWTP detention time.

3.3 TEMPERATURE/NUTRIENT CHARACTERISTICS

Lagoon system treatment efficiency is dependent on seasonal water temperature changes (Figures 3-3 through 3-6). The Town tracks weekly water temperatures in the Data Workbooks. The water temperatures used in Figures 3-3 through 3-6 were measured in Cell 1. Cell 1 data were used because Cells 1 and 2 are where most CBOD and ammonia reduction takes place. Water temperature impacts on treatment efficiency can be seen in the effluent CBOD and ammonia concentrations (Figures 3-5 and 3-6, respectively).

Certain bacteria are responsible for removing different nutrients. The bacteria that remove CBOD are known as heterotrophs, and they are more dominant than the bacteria that remove ammonia, known as nitrifiers. The ammonia removal process requires two types of nitrifying bacteria – ammonia-oxidizing bacteria followed by nitrite-oxidizing bacteria. Nitrifying bacteria become almost dormant at temperatures below 15 degrees Celsius (^{o}C) so ammonia reduction is greater during warmer summer conditions than in the winter due to increased microbial activity (bacteria growth and reproduction). Lagoon systems struggle to remove ammonia in the winter due to the following reasons:

- If lagoons freeze over, access to atmospheric oxygen is cut off, which is needed by nitrifying bacteria.
- Nitrifying bacteria require a surface to grow on, which is not plentiful in lagoon systems.
- The heterotrophic bacteria that consume CBOD tend to dominate nitrifying bacteria. CBOD levels need to drop below 25 mg/L before nitrification can begin in earnest. Cold temperatures slow the heterotroph metabolism. More lagoon retention time is required for CBOD removal, reducing the available hydraulic retention time for nitrification.
- Both the reproduction rate and the metabolism of the nitrifiers themselves slow as the water temperature drops. The low reproduction rate means that new biomass does not form quickly enough to make up for the reduced consumption of ammonia that occurs due to the lower metabolism and temperature.

As discussed in Section 3.2 above, a 60-day detention time offset was used to evaluate treatment efficiency. Even with the 60-day detention time offset, the percent CBOD and ammonia reduction in both Figures 3-5 and 3-6 do not correlate precisely. However, the direct correlation between temperature and percent reduction is shown clearly. Ammonia more closely follows the temperature trend compared to CBOD due to the rate that ammonia reducing organisms grow with temperature.

3.4 SLUDGE ACCUMULATION

Lagoon treatment systems do not include a means for solids (i.e., sludge) removal. Over time, solids begin to accumulate and must be removed manually. Sludge build-up reduces the available treatment volume within the cells and more TSS carries over into downstream cells and eventually to the outfall. As cell volumes decrease so does the WWTP efficiency resulting in increased effluent concentrations. Cells 1 and 2 are deeper than the other lagoon cells and are designed as the primary sludge collection and storage cells. Settled sludge accumulates and decays by anerobic digestion at the basin's bottom. The remaining inert solids cannot be reduced further and build up in the basins.

The Town annually measures the sludge accumulation in Cells 1, 2 and 3A (Town of Jackson 1993-2016). The Town divided each of the three cells into a grid where sludge depths are generally measured. Measurements are taken using a sludge judge and ultrasonic bottom sounding. The annual measurements were reviewed, and data compiled to estimate an average cell sludge thickness (Table 3-1).

The Town also worked with outside sources to measure sludge thicknesses using different techniques. Keller Associates, Inc. (Keller Associates) completed two bathymetric surveys of Cells 1, 2, and 3A during 2017 and 2019 (Keller Associates 2017, Keller Associates 2019). The surveys used a remote-controlled watercraft equipped with an echosounder and survey-grade robotic total station prism (Keller Associates 2019). A total of 89 thickness measurements were captured during the 2017 and 2019 surveys each. Based on the average sludge thicknesses, a percent of volume occupied by sludge was calculated (Table 3-2).

H&S Environmental (H&S Environmental, L.L.C., 2021) also performed a survey in September 2021 to estimate sludge volumes in Cells 1, 2, and 3A. A sludge blanket profile was performed to estimate the sludge volume and mass by collecting sludge depth measurements and sludge core samples. A total of 146 depths were measured across the three cells. H&S Environmental prepared estimated sludge volumes using different methods accounting for cell side slopes. Average sludge thicknesses and percent volumes from the H&S Environmental survey are provided in Table 3-3.

Estimated volumes between Keller Associates and H&S Environmental show a decrease in sludge volume between 2019 to 2021. Because each measurement is completed manually with a margin of error in where the thickness is measured, it leads to variation in the thickness measurements. Trihydro applied a line of best fit to the average sludge depths to determine a general increase over time and profile the estimated percent of volume occupied by sludge for Cells 1, 2, and 3A:

- Cell 1 – 24.8%
- Cell 2 – 16.7%
- Cell 3A – 19.7%

Based on Trihydro's experience at similar lagoon systems, the sludge removal zone is a depth when the sludge volume in each cell accumulates between 30% and 50% (Figures 3-7 through 3-9). As sludge accumulation reaches the high end of the sludge removal zone (50%), cell capacity and WWTP efficiency is reduced. This sludge accumulation range aids the Town in starting the sludge-removal planning process. As the service area grows, WWTP contributions will increase, and more sludge will accumulate in the cells over a shorter duration. Trihydro recommends a Sludge Monitoring and Management Plan be developed and implemented. This is discussed in more detail in Section 8.0.

3.5 SYSTEM LIMITATIONS

Lagoon systems have limitations with expansion, energy demands, sludge removal, and nutrient removal that can reduce performance. Lagoon systems require large footprints of land to produce effluent concentrations that meet their permit limits. Several lagoon cells may be needed to maintain retention time, or additional lagoon cells may be required to accommodate flow rate increases. Lagoons have a limited ability to reduce nutrients due to seasonal temperature fluctuations and will retain TSS as wastewater is conveyed through the treatment system. Nutrients released to the receiving stream may cause algae blooms that can degrade fish populations, and TSS may also accumulate downstream. As these solids continue to naturally decay after discharge, stream oxygen levels are reduced, and additional nutrients are released. System limitations are discussed in more detail below.

3.5.1 SEASONAL CHANGES

WWTP operations fluctuate seasonally due to temperature changes and influent volume fluctuations. These seasonal changes impact effluent characteristics such as CBOD, ammonia, and TSS concentrations. Temperature increases largely improve ammonia reduction while CBOD and TSS also see concentration reductions.

Trihydro performed WWTP modeling to evaluate current seasonal treatment fluctuations. Modeling is discussed in Section 5.0. Appendix B presents model outputs of existing system operational information during both winter and summer months, including temperature impacts on effluent water quality. In addition to the lower water temperature effects on biological activity, cell surfaces freeze during the winter reducing natural oxygen transfer rates. Aeration and mixing help prevent surface icing.

3.5.2 SYSTEM FLOW

The WWTP influent flow varies with seasonal precipitation rates and tourism. The Town of Jackson can see as many four million visitors per year. Peak flows are observed during the summer months, historically with the highest flows in June and July. This coincides with inflow and infiltration from snowmelt and precipitation as well as the large tourist influx. Average summer flow rates are approximately 2.5-MGD and average winter flow rates are approximately 1.7 MGD. The highest flow rate observed in the past 5 years was 3.5-MGD in June 2017.

WWTP influent flow rates are expected to increase with population growth. The WWTP currently receives wastewater flow from several satellite districts that will likely expand to meet population growth demands. Additionally, there are many residences within Teton County maintaining septic systems. Teton County is currently evaluating water quality and preparing a Water Quality Master Plan, anticipated to be completed in August 2023. This Water Quality Master Plan will wholistically evaluate trends and correlations between surface water, groundwater, septic systems, and water/sanitary sewer districts. Since the WWTP serves as a regional wastewater treatment provider, additional satellite districts may consider connecting to the Town’s WWTP, further increasing influent flow rates and loading.

3.5.3 INFLUENT/EFFLUENT LOADING

The WWTP design influent nutrient loading is based on a 5.0-MGD flow rate. Influent design concentrations are not permitted but are the basis for the WWTP's overall design and basin sizing. The WWTP receives influent concentrations much higher than the original design concentrations. However, because the WWTP does not receive 5.0 MGD, the actual loading rate does not exceed the design loading rate. As WWTP system demands increase, the higher loading rates will likely limit the WWTP's hydraulic capacity to a flow rate less than the designed and permitted 5.0 MGD flow rate.

The WWTP's CBOD design loading rate is 8,798 lb/day (Engineering Associates 1998). The WWTP is operating below the design loading rate limits based on current flow and CBOD concentration data. If the WWTP flow rate were to increase to the 5.0-MGD design capacity and the CBOD concentrations remain the same, the WWTP may exceed the original CBOD design loading (Figure 3-1). High influent CBOD levels may lead to system overloading and shock conditions.

The WYPDES Permit stipulates a 25 mg/L monthly average CBOD discharge limit. Between 2019 and 2021, the WWTP's effluent CBOD averaged 3.9 mg/L in the summer and 9.2 mg/L in the winter. Based on current process operations and projected future use, it is anticipated the WWTP can still achieve its WYPDES Permit limits even if the flow rate increases to 5.0 MGD (Figure 3-3). Additionally, the WYPDES Permit also requires a minimum 85% CBOD reduction between influent and effluent concentrations (Equation 3-2). Current operations have achieved over 95% CBOD reduction over the past 3 years, even though the 310 mg/L average influent CBOD concentration is approximately 47% higher than the 211 mg/L design concentration (Figure 3-5).

$$\%_{reduction} = \frac{C_{influent} - C_{effluent}}{C_{influent}} \text{ x } 100\% \qquad \text{Equation 3-2}$$

where,

$\%_{reduction}$ = Percent Reduction

$C_{influent}$ = Influent Concentration, mg/L

$C_{effluent}$ = Effluent Concentration, mg/L

Ammonia influent and effluent concentrations were also evaluated. The WYPDES Permit does not currently stipulate ammonia discharge limits, but effluent limits may be added in future WYPDES Permit renewals. Current influent ammonia loadings are below the 1,193 lb/day design loadings. However, similar to CBOD, if the WWTP flow rate increases to 5.0 MGD, influent ammonia loadings are projected to surpass design loadings (Figure 3-2).

4.0 DECISION MATRIX PREPARATION

A Decision Matrix was prepared in collaboration with the Town and Steering Committee. A Decision Matrix provides an objective view of the WWTP potential improvement alternatives. The goal of the Decision Matrix is to establish pre-selected criteria prior to developing potential improvements/alternatives. The pre-selected criteria are meant to align with project goals and specific items important to decision makers. Once pre-selected criteria are established, a weight is applied to each criteria. The criteria weight signifies the importance of that specific criteria in meeting project goals. The final weight summation equals 100%. Once the criteria weights are designated, each potential improvement alternative is ranked from 1 to 5 (least to most favorable) on the various criteria. This provides a mechanism for recommendations and prioritizing alternatives.

Trihydro worked with the Town and Steering Committee to develop Decision Matrix criteria. The criteria were selected to support a specific area of the treatment process area of concern and are intended to be mutually exclusive. The goal is that none of the criteria overlap to avoid "double dipping" when scoring the alternatives. The final Decision Matrix Criteria included:

- Water Quality
- Energy Demands
- Capital Costs
- Operation and Maintenance (O&M) Costs
- Training and Licensing
- Odor and Noise
- Footprint
- Public Perception
- Expandability
- Permitting Requirements

The Town and Steering Committee members evaluated the criteria and provided weighting recommendations. The Town and Steering Committee members' weighting recommendations were averaged for each criteria to determine the final criteria weights.

Similar to the criteria weighting evaluation, the Town and Steering Committee members evaluated each of the potential improvement alternatives to score the alternative per the criteria. The Town and Steering Committee members' scoring recommendations were averaged for each criteria to determine the final scores. The final Decision Matrix criteria and weighting is provided as Table 4-1.

A summary of the criteria and final weights are provided in the following sections and the Decision Matrix results are presented in Section 7.0.

4.1 WATER QUALITY

Effluent water quality monitoring and limits are established in the Permit. The water quality criteria were developed to meet the Town's desire to continue producing effluent quality concentrations lower than the Permit requirements. The water quality goal is to not only continue maintaining discharge concentrations below the Permit requirements but to meet future water quality expectations. Each alternative was evaluated for its ability to meet or exceed this goal.

Potential improvements were compared to each other to determine which technology can provide the best effluent quality. This criteria focused on effluent water quality, and no additional considerations were included with this criteria.

Water quality was identified to be the most impactful criteria. Water quality is weighted at 21%.

4.2 ENERGY DEMANDS

Lagoon systems traditionally have lower energy demands than mechanical wastewater treatment plants. However, the lagoon system treatment process is limited due to natural biological constraints and seasonal fluctuations. The goal for the energy demands criteria is to understand how the various alternatives affect and reduce energy demands. Higher nutrient removal will likely increase energy demands. Mechanical plants have a much higher energy demand than lagoon systems but also have more potential to reduce nutrients. Potential improvement alternatives were compared with each other to determine scoring.

This criteria was determined to be the second most important by the Town and Steering Committee. The weight was calculated to be 15%.

4.3 CAPITAL COST

WWTP improvements will likely require capital costs. Capital costs are the initial costs for a potential improvement's design and construction. More efficient or reliable alternatives tend to have higher capital costs but over their lifecycle (e.g., 20 to 30 years) they tend to have lower O&M costs. Higher efficiency, reliability, and energy efficiency generally come with a higher capital cost. Maintaining the existing lagoon system and adjusting the operation of existing equipment or installing smaller processes to aid discharge concentrations may have a lower capital cost.

The Town has historically used self-funded enterprises to complete WWTP upgrades. Funding opportunities and rate impacts should be evaluated as capital cost is considered.

This criteria was calculated to be 11%. The Town can apply for federal and state grants or loan to help fund capital costs. Outside funding mechanisms were not considered in the overall scoring for each improvement. The capital costs per each potential improvement alternative were compared against each other for scoring.

4.4 OPERATION AND MAINTENANCE COSTS

In addition to capital costs, potential improvements will likely increase WWTP O&M costs. O&M costs include power, chemicals, parts, and labor. Alternatives having higher reliability, leading to lower O&M (e.g., repairs or replacement) were considered. Funding opportunities and rate impacts should be evaluated as O&M costs are considered.

This criteria was calculated to be 14%. The O&M costs were determined to have a greater weight than capital costs. O&M costs are recurring and will have long-term impacts to the Town and WWTP service area. Similar to capital costs, the O&M costs per each potential improvement alternative were compared against each other for scoring.

4.5 TRAINING AND LICENSING

The State of Wyoming has operator licensing and training levels based on WWTP operations, size, and complexity. More advanced treatment alternatives require additional training and may require licensing upgrades. This scoring accounted for current operator licenses and training and additional requirements to upgrade licensing to accommodate expanded WWTP operations.

This criteria was calculated to be 5%. The Town and Steering Committee members recognized additional licensing and training may be required depending on the selected improvements and is committed to maintaining these requirements.

4.6 ODOR AND NOISE

Unsatisfactory odors and noises can be associated with a WWTP. There are certain processes that can increase odor such as anaerobic digestion, which produces hydrogen sulfide to break down sludge. Noise can increase with additional blower and aerator installations which may be required for some potential improvements. Trihydro considered odor and noise changes from potential improvements as compared to current operations.

This criteria was calculated to be 6%. The Town and Steering Committee selected a lower weight due to the WWTP's proximity to nearby residences and businesses as the large amount of Town-owned property around the WWTP helps create a buffer for noise and odor. Considerations could include sound dampening appurtenances to reduce impact to adjoining residents.

4.7 FOOTPRINT

Potential improvements may increase the existing WWTP footprint. The Town owns approximately 143 acres at the WWTP site, while the WWTP itself is approximately 30 acres. Trihydro considered how potential improvements could fit within the current operations footprint and WWTP site. Additional considerations include lay-down areas, equipment assembly areas, and contractor access. A level of master planning may be necessary to account for the future required footprint of phased improvements. Also, there may be rules regarding land use based on natural constraints (e.g., floodplains, wetlands, animal habitat and natural resources).

This criteria was calculated to be 6%. The Town owns a sizeable property which is available for expansion to accommodate potential improvements.

4.8 PUBLIC PERCEPTION

Potential improvements were prepared based on widely accepted treatment processes. The Town's Community Engagement Specialist participated in meetings to understand the potential improvements selection process, Decision Matrix, weightings, and scorings to help educate the community. Potential improvements were evaluated based on how they may be perceived by the community.

This criteria was calculated to be 8%. Trihydro, in coordination with the Town, Steering Committee, and Stakeholders, held a Public Engagement meeting to review current WWTP operations, discuss potential improvements, and provide insight to the project.

4.9 EXPANDABILITY

The expandability criteria differs from the footprint criteria in that expandability focuses on how an alternative can grow to accommodate future demands. Recent studies indicate the WWTP will reach capacity in approximately 45-50 years as influent contributions increase (Vista 2021). These studies did not evaluate additional contributions from satellite sanitary sewer districts being added to the WWTP service area, which could result in WWTP capacity being met sooner. Potential improvements were assessed for expandability to accommodate future flow rates. Expandability included considering modular alternatives that match potential improvements and allow integration without system upset.

This criteria was calculated to be 10%. Expandability was an important consideration to ensure future demands are met and the WWTP does not overload.

4.10 PERMITTING REQUIREMENTS

New treatment processes will likely require Permit modifications. Furthermore, construction activities (e.g., expansion) will likely require additional permits through the WDEQ, such as a Permit to Construct. Permit modifications and additions were evaluated for potential improvements.

This criteria was calculated to be 5%. The Town is committed to addressing permit requirements necessary to implement potential improvements.

5.0 MODEL DEVELOPMENT

Trihydro developed a site-specific WWTP model using the software BioWin®. BioWin®, a wastewater process simulation software, incorporates biological, chemical, and physical process models to provide wholistic insight into WWTP operations. BioWin® is used to design, upgrade, and optimize WWTPs, and the software allows the user to input operational data to accurately model a WWTP.

Trihydro used water quality data from the Town's Data Workbooks to define influent and effluent stream flow and chemical characteristics. The 1995 WWTP record drawings were provided for system review and model development (Engineering Associates 1995). The 1995 record drawings were used to input cell dimensions into the model. The process model was calibrated using existing operational data to develop an accurate system representation.

The model was used to help confirm potential improvement validity based on current WWTP characteristics. The model is a high-level representation of WWTP effluent results if the Town were to implement changes and improvements.

5.1 EXISTING SYSTEM

The existing system model was created using influent flow characteristics and the built-in BioWin® software design parameters. The modeling process was calibrated using effluent data from 2018 through 2021 including temperature, pH, CBOD, ammonia, and TSS. Model calibration works by adjusting preset kinetic parameters to reflect site conditions. The initial calibration parameters included water temperatures and dissolved oxygen levels from the Town's Data Workbooks. These parameters affect CBOD and ammonia reduction rates throughout the WWTP process. Trihydro modeled average flow characteristics during both winter months (December, January, and February) and summer months (July, August, and September) to further calibrate operations during seasonal changes. Winter and summer operating scenarios were created based on current operating data. The existing system model was prepared to understand the WWTP's baseline operations and seasonal treatment fluctuations. Model results were used to determine system limitations and possible improvement areas.

5.2 POTENTIAL IMPROVEMENTS

Once the existing system model was calibrated, the model was then used to evaluate potential improvement alternatives and their effluent impacts. The modeling results were then applied specifically to the Decision Matrix Water Quality criteria for a high-level comparison of potential improvements' effluent quality. Modeled effluent water quality is summarized in Table 5-1 and compared to current effluent concentrations.

The Biowin® software was developed primarily for mechanical wastewater treatment plants. Trihydro modeled the WWTP to understand general operating conditions and evaluate potential operational adjustments and potential improvements. A margin of error can be introduced when modeling lagoon systems; however, the results provide guidance for preparing conceptual-level designs. As long as these limitations are considered, the model provides a consistent means to compare potential improvement alternatives. An example is the mechanical plant ammonia and CBOD effluent concentrations shown in Table 5-1 are higher than the aeration modifications, clarifier, and bioreactor results. Most likely, the mechanical plant would produce higher quality effluent year-round than the other alternatives. Water reuse and sludge removal add-ons were not modeled; however, if implemented, they will noticeably improve effluent water quality. Projected potential improvement effluent water quality benefits are discussed in Section 6.0 below.

6.0 POTENTIAL IMPROVEMENTS

Potential improvements were developed based on the Town's priorities and goals. Each approach was presented to the Town, Steering Committee, and Stakeholders during meetings over the course of the evaluation. These are high-level, conceptual alternatives, and final layouts and operation will need to be evaluated in the future as part of a preliminary design review. The Decision Matrix was used to evaluate each potential improvement based on the established criteria. Several add-on options were also considered, and these options can be combined with the each of the proposed improvements. These add-ons were also scored using the Decision Matrix. Decision Matrix results are discussed in Section 7.0. Appendix C includes supporting information used to help evaluate the Decision Matrix criteria for each potential improvement. Trihydro provided the Town and Steering Committee initial Decision Matrix scoring as an example based on the system evaluation. However, Trihydro's scores were not used in the final analysis which only included the Town and Steering Committee scores. The supporting information incorporated high-level discussion on potential improvement capital and O&M costs, effluent water quality expectations, estimated energy demands, required training and licensing, odor and noise impacts, footprint modifications, public perception, expandability potential, and permitting requirements.

Winter operating conditions were used to evaluate potential improvements. Winter conditions were used as the worst-case scenario since biological activity changes seasonally and curtails during colder winter months. After completing the initial modeling results Trihydro presented several operational ideas to the Town in December 2021 for improved winter season operations. These suggestions included:

- Partially reducing aeration and mixing in Cells 1 and 2 to increase anoxic ammonia reduction. Anoxic conditions increase the conversion of ammonia to nitrate.
- Restore aeration in Cell 5 to strip nitrogen from the water.
- Create a recycle flow from Cell 5 to the WWTP head by tapping the effluent line to the UV Disinfection Building and diverting some flow into Cell 2. This would increase WWTP detention time and nitrate reduction.
- Increase the water levels in the cells prior to the onset of colder weather. Once the cells freeze and ice is approximately 12-inches thick, reduce the water level. The gap between the water and ice will allow for improved oxygen transfer and forms an insulating layer over the cells.

The wastewater model was used to develop and verify a series of more permanent solutions all with the goal of reducing nutrients in the final effluent. The proposed improvements can be implemented in a phased approach, allowing the Town to plan for proposed improvements incrementally rather than all at one time. The potential improvements discussed below are based on the 5.0-MGD design flow.

6.1 AERATION MODIFICATIONS

Trihydro modeled the existing WWTP with modifications to current aeration supply and upgrades to Cells 1 through 3B2. These proposed improvements would provide better control of aeration and dissolved oxygen in the upstream cells and increase mixing.

Before the last major plant upgrade Cells 1 and 2 were unaerated facultative lagoons. Their primary purpose was to catch and store incoming solids. After the plant upgrades, aeration was installed in Cells 1 and 2. This improved CBOD reduction but allowed more sludge to transfer into the downstream basins. One scenario would partially restore the solids settling capacity in Cells 1 and 2 by only aerating the half of each cell. This modeling scenario divides Cells 1 and 2 into two halves of equal size to create anoxic (without air) and aerobic (with air) zones. This alternative also recommends installing a turbidity curtain across Cells 1 and 2. A turbidity curtain is a semipermeable membrane that would lay across the center of Cells 1 and 2. The curtain is porous so water can flow through it, but sludge remains on the upstream side. If installed in Cells 1 and 2, the anoxic and aerobic environments would be separated by the turbidity curtain (Figure 6-1A).

The initial anoxic zone would allow sludge to settle and expedite the conversion of ammonia into nitrate. Mixers and aerators would be removed from the anoxic zone and relocated downstream to increase the oxygen transfer rate in the aerobic zone. Removing the anoxic zone aeration and mixing will provide increased ammonia reduction (Figure 6-1B). The model indicates that TSS and CBOD reduction levels remain unchanged in this scenario. This scenario assumes higher dissolved oxygen levels and full mixing within the aerated zone. Sludge removal should be considered with this proposed improvement.

Trihydro recommends a centralized blower and an air distribution system be installed to increase dissolved oxygen levels in the aerated portions of Cells 1 and 2 through Cell 3B2. Instrumentation, electrical, and supervisory control and data acquisition (SCADA) improvements should also be implemented. A blower building, similar to the one used for Cells 4A through 4D, is also recommended to protect and house new equipment.

6.2 CLARIFIER

The clarifier installation alternative proposes installing two 25-foot clarifiers in Cell 5. The remainder of Cell 5 could potentially be used as a sludge storage wetland to store accumulated sludge from Cells 1 and 2 and the waste sludge from the clarifiers (Figure 6-2A). The clarifier waste sludge may also be returned to the head of the plant depending on the selected alternatives. This alternative also requires the previously discussed aeration modifications to be fully effective. The aeration modifications improve the overall reduction of BOD and ammonia while the clarifiers improve TSS removal. This scenario also creates a hybrid treatment system similar to mechanical treatment processes.

Chemical additions (polymer, coagulates) are required to increase solids collection. The sludge collected in Cell 5 could be naturally dewatered and stabilized by wetland vegetation. Plants such a reeds and cattails naturally dewater and breakdown sludge over time. A sludge wetland could also be placed elsewhere within the Town's property. The BioWin® model shows that this alternative reduces both ammonia and total nitrogen in the final effluent (Figure 6-2B). The chemical additives could also help remove TSS and phosphorous in the effluent.

6.3 BIOREACTOR

Trihydro modeled a bioreactor to reduce ammonia effluent concentrations by converting ammonia to nitrate and nitrite. The bioreactor would be installed in a series of modules facilitating expandability as influent flow increases.

The bioreactor functions as an attached growth system which is preferred by nitrifying bacteria. This attached growth bacteria convert ammonia to nitrate which is less toxic to fish. The bioreactor design is modular and would allow the Town to expand to meet future demands. The bioreactor system has a relatively small footprint and could potentially be placed in the western side of Cell 5. The remainder of Cell 5 could operate as a finishing pond following treatment through the bioreactor system (Figure 6-3A). One bioreactor system limitation is that it reduces ammonia, but not total nitrogen. The remaining portion of Cell 5 would still be required as a finishing pond downstream of the bioreactor system, as the anoxic zone aids to reduce total nitrogen (Figure 6-3B). The removal of sludge accumulated in Cell 5 would be required in this scenario.

6.4 MECHANICAL PLANT

The mechanical plant alternative has a much smaller footprint and can be expanded as wastewater demands increase (Figure 6-4A). The mechanical plant considered during this evaluation is an Aero-Mod Sequox system. The system has the ability to reduce dissolved oxygen levels to meet demands, thus reducing aeration and power. Installations in cold weather climates have demonstrated the ability to reduce ammonia to below 1 mg/L, total nitrogen to 3 mg/L and phosphorus to 1 mg/L even in the winter (Figure 6-4B). While the Aero-Mod system is one of many packaged mechanical treatment systems, its design has no moving parts in the aeration basins or clarifiers which reduces maintenance and increases reliability. Compared to other types of mechanical treatment systems, the Aero-Mod Sequox is highly efficient. However, all mechanical treatment plants use drastically more energy than the current lagoon system and have a high initial capital cost to install.

The mechanical treatment plant also includes effluent filtration to potentially produce Class A reuse quality water. The mechanical treatment system has a high capital cost for construction but consistently removes both nitrogen and phosphorous from the effluent stream year-around.

Cells 1 and 2 could be converted to sludge storage ponds from the mechanical plant. The Town would not need to remove current sludge accumulation in Cells 1 and 2.

6.5 ADD-ONS

In addition to the abovementioned alternatives, Trihydro considered add-ons that can be combined with each of the potential improvements. Trihydro proposed these add-ons to enhance the treatment process rather than replace the potential improvements.

6.5.1 WATER REUSE

Water reuse is the concept of beneficially reusing highly treated effluent for irrigation on nearby properties. Water reuse would reduce the nutrient loading to the Snake River because the total volume of water discharged to the river is reduced. The add-on can be combined with all the alternatives discussed above. It includes pumps, a distribution system, and effluent filtration (Figure 6-5). Permitting modifications are required to distribute reuse water on public and private lands. The filtration system would reduce TSS in the effluent. Consideration items for this add-on include identifying property on which to reuse treated effluent, designing and constructing a distribution system, permitting, and operation.

To achieve reused water quality requirements, a filtration system should be installed prior to UV disinfection. The filter would remove solids which will increase UV disinfection efficiency and reduce energy demands. A filter could also be added to the current WWTP or in conjunction with any of the abovementioned alternatives.

6.5.2 SLUDGE REMOVAL

Sludge removal is eventually required as a part of all lagoon wastewater treatment system operations. Based on WWTP sludge measurements, Trihydro recommends the Town develop a Sludge Monitoring and Management Plan (Plan) to remove accumulated sludge in Cells 1 and 2. The Town has measured sludge using three different methods with varying results. The Plan would outline a consistent sludge measurement method, providing a coherent annual accumulation comparison. Future sludge removal can be completed in a phased approach and will be necessary to maintain and improve WWTP operations. The Plan allows the Town to operationally and fiscally prepare for this event. As the sludge volumes in Cell 1 and Cell 2 increase, there is a higher possibility of sludge entering the remaining cells and ultimately discharging. Additionally, the abovementioned potential improvement alternatives, other than the mechanical plant, will all require sludge removal to operate efficiently.

On-site and off-site sludge disposal was considered during this evaluation. Sludge removed from the lagoon system cells will need to be dewatered and treated before its final placement (on-site or off-site). Lime application is a common treatment process to reduce water content and stabilize sludge volumes. The stabilized sludge will have reduced organic and pathogenic content. The two sludge removal disposal options are discussed in detail below.

6.5.2.1 ON-SITE SLUDGE DISPOSAL

On-site sludge removal involves constructing a sludge holding pond or possibly using a portion of an existing basin depending on the potential improvement alternative selected (Figure 6-6). A contractor dredges and partially dewaters the collected sludge which is then placed in the basin. The basin could potentially be converted to a sludge wetland where plants will naturally reduce the sludge volume over time. Permitting is required if a separate sludge holding pond is constructed. On-site sludge disposal is less costly than off-site sludge removal. This option may not impact WYPDES discharge compliance as the on-site sludge holding pond would be separate from the discharge compliance point. The on-site sludge holding pond would need to meet WDEQ requirements including lining and groundwater protection.

Alternatively, the Town could consider constructing a sludge wetland for disposal (Figure 6-7). This type of wetland would reduce odors and promote growth of organisms and bacteria.

6.5.2.2 OFF-SITE SLUDGE DISPOSAL

Off-site sludge disposal involves the same sludge removal steps discussed above except the sludge is hauled off-site and disposed of by a contractor. Transport and sludge disposal fees significantly increase off-site disposal cost as compared to on-site disposal costs. The sludge removal contractor is responsible for locating and permitting land application sites or landfills that are permitted to accept lagoon sludge. This relieves the Town from the responsibility and liability of sludge removal and disposal but comes at an increased cost.

7.0 DECISION MATRIX RESULTS

Several different tools were used to provide the Town with potential WWTP improvements. These tools included BioWin® model results, the Decision Matrix evaluation and results, and several Technical Discussion meetings. The Decision Matrix results are discussed below.

As previously discussed, Trihydro provided the Town and Steering Committee the initial scoring weights and Decision Matrix scores as an example. However, Trihydro's scores were not included in the final scoring averages which only includes the Town and Steering Committee scores. The Town and Steering Committee members provided scores for each potential Decision Matrix improvement based on ten previously weighted criteria. Their scores were averaged and are shown in Table 7-1.

Each alternative was compared to both the criteria and each other and scored from one (low) to five (high). The overall scores provided by the Town and Steering Committee were generally similar and indicated a consensus of opinions on most alternatives and add-ons. Appendix D includes a summary of the contributors' results and reasonings.

The Decision Matrix results indicate the potential improvements considered each benefit the Town's primary goals, but in different ways. The Town will need to evaluate these alternatives based on the WWTP priorities listed in Section 1.0. Potential improvement benefits and limitations as well as final Decision Matrix scoring are discussed below. The Decision Matrix scoring summary is also presented graphically in Figure 7-1.

7.1 AERATION MODIFICATIONS

Aeration modifications can reduce WWTP effluent ammonia concentrations. This modification focuses on adjusting dissolved oxygen concentrations throughout the WWTP process to allow for anoxic and aerobic zones to target different nutrients in the treatment stream.

The aeration modifications will increase energy demands and require operator manipulation or programmable logic controller (PLC) SCADA as concentration demands change. TSS and CBOD concentrations generally remain unchanged with this alternative. A limitation to this alternative is it will still require sludge removal in Cells 1 and 2, which is an additional cost. Aeration modifications scored 3.4 out of 5.

7.2 CLARIFIER

The clarifier installation was proposed to reduce final effluent ammonia and total nitrogen. This potential improvement would also reduce effluent TSS and phosphorous through chemical additives.

One limitation to this alternative is the need for the aeration modifications and sludge removal from Cells 1 and 2, which are additional costs. The improvement could be installed in a phased approach beginning with the aeration modification. Sludge could potentially remain on-site in a portion of Cell 5, creating a sludge wetland, or disposed off-site. Winter operational improvements are most notable as compared to the current lagoon system. Clarifier installation scored 3.3 out of 5.

7.3 BIOREACTOR

The bioreactor functions as an attached growth system to facilitate nitrifying bacteria growth. The bioreactor can be constructed modularly, allowing the Town to expand the system to meet future demands. Similar to a clarifier, the bioreactor system could potentially be placed in a portion of Cell 5 with the remainder of Cell 5 operating as a finishing pond.

A limitation is the system reduces ammonia but not total nitrogen. This proposed improvement continues to use Cell 5 as a finishing pond (anoxic basin) to further reduce total nitrogen. Sludge removal in Cells 1 and 2 needs to be considered, which is an additional cost. The bioreactor scored 3.4 out of 5.

7.4 MECHANICAL PLANT

The mechanical plant is able to meet the WWTP's growth demands through modular construction and operates consistently, independent of seasonal changes. A mechanical plant could also meet additional demands from water and sewer districts. The small footprint could allow the remaining land to be evaluated for other uses (e.g., open space, solar energy, leasing opportunities, etc.). This alternative also provides the best opportunity to consistently reduce nutrient discharge to the Snake River.

A mechanical plant has the highest capital costs and requires more energy than current WWTP operations or other potential improvements. Steering Committee members suggested installing additional solar arrays or a micro-hydroelectric facility at the WWTP compliance point to offset electricity demands. No sludge removal from Cells 1 and 2 would be required. The mechanical plant scored 3.4 out of 5.

7.5 WATER REUSE

Water reuse involves pumping WWTP effluent through a distribution system for local irrigation. Effluent would need to be filtered prior to pumping to meet WDEQ water quality human contact standards. The reuse water distribution system would be sized to accommodate a portion of the effluent flow rate depending on available irrigatable land area. Additionally, the pumping system can be configured with variable frequency drives to account for varying flow rates or additional future flow rates. The pumping system can also be phased by adding new pumps as needed to meet future demands. This alternative will reduce total nutrient loading to the Snake River because much of the effluent is diverted from the Snake River for beneficial water reuse for irrigation. The effluent would be filtered prior to UV disinfection and a portion of effluent flow will be redirected for irrigation purposes. Water reuse can be combined with any potential improvements or installed as a standalone system.

Water reuse will require more energy than current WWTP demands to operate the pumping system. This alternative will have a high capital cost to purchase and install the filtration unit, pumps, electrical, SCADA, and distribution piping; however, O&M costs will be relatively low. The pumping system would be largely automated and would require routine maintenance. The Town would need to coordinate with local landowners to identify irrigatable property and the WYPDES Permit would need to be modified for treated domestic wastewater reuse. Water reuse scored 4.4 out of 5.

7.6 ON-SITE SLUDGE DISPOSAL

Sludge removed from Cells 1 and 2 could be disposed within the existing WWTP property in a sludge holding pond. The holding pond will need to meet WDEQ lining and groundwater protection requirements. This alternative will have relatively low capital costs compared to other potential improvements, and O&M costs and energy demands will be largely non-existent. Sludge removal will also increase overall WWTP efficiency, improving effluent water quality.

The sludge holding pond will require a larger footprint than other potential improvements. Expandability will be limited; however, future sludge removal will likely not be required for several decades. Potential odor and noise concerns could occur during removal operations but would be temporary. This alternative can supplement other potential improvements but can also operate independently. On-site sludge disposal scored 4.5 out of 5.

7.7 OFF-SITE SLUDGE DISPOSAL

Rather than constructing an on-site sludge holding pond, sludge removed from Cells 1 and 2 could be hauled off-site to a landfill or other handling facility. Prior to hauling and disposal, sludge will need to be stabilized per WDEQ requirements. Capital costs will be noticeably higher than on-site disposal due to transportation and landfill fees; however, O&M costs and energy demands will be largely non-existent.

Off-site sludge disposal will have no impact on the WWTP footprint. Similar to on-site disposal, odor and noise will likely increase during removal operations but will cease after removal is completed. This alternative will enhance other potential improvements but can also be completed independently. Off-site sludge disposal scored 3.9 out of 5.

8.0 CONCLUSIONS

The primary goals of this Technical Review Report are to provide a better understanding and alignment of current WWTP operations with priorities in the community including:

1. Protecting the region's water quality and ecosystem by exceeding the Wyoming Department of Environmental Quality discharge permitting standards.
2. Maintaining a cost-effective and high level of service to the Town of Jackson's rate-paying customers.
3. Reducing energy consumption in wastewater treatment through use of energy efficient treatment methods.
4. Aligning with the recent update to the Jackson/Teton County Comprehensive Plan.

Through this study, the Town has made substantial commitment to its citizens and stakeholders to achieve these goals for a more sustainable future. The Town prides itself in achieving current WYPDES Permit water quality limits and maintaining superior WWTP operations. The Town currently meets and exceeds WYPDES Permit water quality requirements and continuously evaluates possible improvements to decrease energy demands while achieving effluent permit requirements.

Trihydro was hired to evaluate existing plant influent and effluent water quality data, energy consumption, plant operations and maintenance and sludge accumulation in the various treatment cells. In the process of developing this report, Trihydro provided the Town and Steering Committee members with a greater understanding of how a lagoon treatment system operates and identified potential improvement areas.

Once the current system evaluation was completed, Trihydro thoroughly reviewed the plant operations and modeled the current treatment process. The model was calibrated using existing influent and effluent water quality results. The calibrated model was then used to develop potential improvements that would improve the WWTP's ability to reduce effluent nutrients that can affect river water quality and aquatic life. Several potential improvement alternatives were prepared by Trihydro for evaluation and discussion with the Town, Steering Committee, and Stakeholders. Each alternative was considered to not only achieve the current discharge requirements but to continue improving effluent water quality where possible in the future.

These improvements, discussed in detail in Section 6.0, incorporated current operational and discharge requirements into results that were compared in a weighted Decision Matrix. The Town and Steering Committee were provided an opportunity to weigh the pros and cons of each alternative based on ten specifically selected criteria on how each improvement might best meet the community's priorities and goals.

8.1 TREATMENT FACILITY REVIEW

Trihydro conducted a thorough site visit, reviewed several years of WWTP data, design plans, previous reports, and conducted staff interviews as part of the condition assessment. Trihydro found the WWTP to be well maintained and performing at a level that exceeds expectations when compared to other large lagoon treatment systems. The WWTP continually achieves water quality below permitted requirements for discharging into the Snake River. Trihydro understands influent flows will likely increase with population growth and the potential to add satellite sanitary sewer districts as part of Teton County's regionalization goals.

The Town has submitted a renewal application for its WDEQ/WQD WYPDES Permit that expires August 31, 2022. The application is under review by the WDEQ, but no timeline has been provided by the State for the issuance of a draft permit. Once issued, the draft permit will include a comment period and, if requested, a public hearing. The Town has not been made aware of new permit requirements, but a more restrictive permit is always possible. The final permit requirements may have a direct effect on which potential improvements are best suited to achieve any new permit requirements and community goals. To this end, this Technical Review Report considered discharge limits based on the current permit limits as well as possible future permit limits on nutrients such as ammonia and phosphorus. Once the new permit is received, an update to this report may be required to determine what impacts possible new water quality limits have on the current WWTP operations.

Additionally, future WWTP operations may be impacted by agreements between the Town and new satellite areas within Teton County which continue to grow beyond these areas' ability for sustainable on-site (septic tank) treatment. Possible wastewater treatment regionalization issues will be addressed as part of the Teton County Water Quality Master Plan.

8.2 SHORT-TERM RECOMMENDATIONS

Trihydro developed several short-term recommendations the Town could implement in the near future. Short-term recommendations were developed prior to Decision Matrix results but provide less costly interim measures to improve water quality by using existing equipment in different configurations. While short-term recommendations may not be as efficient as the long-term recommendations, most of the changes can be done with inhouse labor and do not require WYPDES Permit changes or Permits to Construct. After completing the initial modeling results Trihydro presented several operational ideas to the Town in December 2021 for improved winter seasonal operations. Biological activity changes seasonally and curtails during colder winter months. Trihydro's suggested short-term measures include:

- Partially reducing aeration and mixing in Cells 1 and 2 to increase anoxic ammonia reduction. Anoxic conditions increase the conversion of ammonia to nitrate.
- Restore aeration in Cell 5 to strip nitrogen from the water.
- Create a recycle flow from Cell 5 to the head of the WWTP by tapping the effluent line to the UV Disinfection Building and diverting some flow into Cell 2. This increases WWTP detention time and nitrate reduction.
- Increase the water levels in the cells prior to the onset of colder weather. Once the cells freeze and ice is approximately 12-inches thick, reduce the water level. The gap between the water and ice will allow for improved oxygen transfer and forms an insulating layer over the cells.

8.3 LONG-TERM CONSIDERATIONS

The Town and surrounding areas continue to grow, which will ultimately impact WWTP operations. Additionally, potential wastewater regionalization in Teton County may contribute to increased demands on the WWTP. As the Town considers long-term treatment, there are several factors that will impact decision-making:

- New Permit requirements may play a role in system improvements or adjustments. As noted previously, each of the potential improvement alternatives would benefit the existing system in different ways but all of them address the likelihood of a more nutrient-restrictive permit (e.g., ammonia and phosphorous limits). The new permit requirements may steer the Town's decision in a more definitive direction.
- The Town prides itself on operating well below current permit limits. The Town proactively makes system modifications to keep the WWTP operating efficiently. In an effort to provide the best effluent water quality (i.e., the gold standard), Trihydro recommends the Town continue to engage the community and develop what this water quality standard should be and what costs are acceptable to the community. Once specific criteria are established, this will guide decision making for future WWTP improvements.
- Teton County is currently evaluating and preparing a County-wide Water Quality Master Plan, in which the Town is a stakeholder. Results from this master-planning effort will likely impact future WWTP operations, to the extent the Town accepts the regional WWTP initiative. Regionalization will increase flows conveyed through the system as well as impact influent water quality and the overall treatment processes.
- The Town should develop a Sludge Management Plan that coincides with any new discharge permit requirements and the potential improvement selected as most favorable to meet the future treatment goals. Sludge removal was listed as an "Add-On" measure because the course of action selected is directly impacted by specific process

changes. For example, if the mechanical plant were selected, sludge could remain in the cells and be abandoned in place. This saves money in sludge disposal costs which would act like a credit towards a new mechanical plant.

9.0 REFERENCES

Ameresco. 2009. Draft Investment Grade Audit. July.

Engineering Associates – Cody, Wyoming, Consulting Engineers & Surveyors (Engineering Associates). 1998. Record Drawings for: Wastewater Treatment Facility Expansion & Modification Phase I, Town of Jackson, Wyoming. January 14.

Environmental Protection Agency (EPA). 2002. Wastewater Technology Fact Sheet – Facultative Lagoons. September.

H&S Environmental, L.L.C. 2021. Report on the Sludge Volume and Mass for the Town of Jackson Wyoming Wastewater Lagoon System. October 15.

Keller Associates, Inc. (Keller Associates). 2017. Wastewater Treatment Plant Bathymetric Survey. October 5.

Keller Associates. 2019. Wastewater Treatment Plant Bathymetric Survey. September 3.

Town of Jackson. 1993-2016. Sludge Depth Workbooks – Internal Documentation. 1993 – 2016.

Town of Jackson. 2012-2021. Data Workbooks – Internal Documentation. January 2012 – October 2021.

Town of Jackson. 2013-2021. Energy Workbooks – Internal Documentation. July 2013 – June 2021.

Vista Engineering L.L.C. (Vista). 2021. Town of Jackson Water and Sewer Systems Evaluation Report. June.

TABLES

TABLE 2-1. ENERGY USAGE AND SOLAR GENERATION
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

	Electricity Used	Solar Generated	Grid Energy	% Solar	% Grid
Jul-17	212,130	35,966	176,164	17.0%	83.0%
Aug-17	209,809	45,874	163,935	21.9%	78.1%
Sep-17	174,023	39,923	134,100	22.9%	77.1%
Oct-17	128,927	19,936	108,991	15.5%	84.5%
Nov-17	124,880	24,384	100,496	19.5%	80.5%
Dec-17	183,118	15,672	167,446	8.6%	91.4%
Feb-18	166,284	18,495	147,789	11.1%	88.9%
Mar-18	185,353	28,922	156,431	15.6%	84.4%
Apr-18	182,444	33,533	148,911	18.4%	81.6%
May-18	175,536	39,837	135,699	22.7%	77.3%
Jun-18	254,924	45,708	209,216	17.9%	82.1%
Jul-18	224,448	42,119	182,329	18.8%	81.2%
Aug-18	238,707	39,332	199,375	16.5%	83.5%
Sep-18	191,265	36,985	154,280	19.3%	80.7%
Oct-18	178,982	27,644	151,338	15.4%	84.6%
Nov-18	178,805	17,521	161,284	9.8%	90.2%
Dec-18	169,077	6,451	162,626	3.8%	96.2%
Jan-19	187,863	13,822	174,041	7.4%	92.6%
Feb-19	173,733	11,187	162,546	6.4%	93.6%
Mar-19	183,053	26,465	156,588	14.5%	85.5%
Apr-19	235,343	28,674	206,669	12.2%	87.8%
May-19	243,001	32,604	210,397	13.4%	86.6%
Jun-19	210,974	28,730	182,244	13.6%	86.4%
Jul-19	220,247	34,855	185,392	15.8%	84.2%
Aug-19	212,258	42,833	169,425	20.2%	79.8%
Sep-19	193,755	34,476	159,279	17.8%	82.2%
Oct-19	212,256	20,567	191,689	9.7%	90.3%
Nov-19	167,371	9,905	157,466	5.9%	94.1%
Dec-19	200,766	11,114	189,652	5.5%	94.5%
Jan-20	230,908	13,541	217,367	5.9%	94.1%
Feb-20	182,440	19,923	162,517	10.9%	89.1%
Mar-20	192,215	27,974	164,241	14.6%	85.4%
Apr-20	191,470	27,910	163,560	14.6%	85.4%
May-20	206,871	13,925	192,946	6.7%	93.3%
Jun-20	278,060	28,810	249,250	10.4%	89.6%
Jul-20	267,795	35,778	232,017	13.4%	86.6%
Aug-20	237,159	39,161	197,998	16.5%	83.5%
Sep-20	242,547	39,065	203,482	16.1%	83.9%
Oct-20	261,552	32,909	228,643	12.6%	87.4%
Nov-20	176,165	22,766	153,399	12.9%	87.1%
Dec-20	175,151	22,100	153,051	12.6%	87.4%
Jan-21	226,321	24,852	201,469	11.0%	89.0%
Feb-21	180,920	18,731	162,189	10.4%	89.6%
Mar-21	196,605	37,254	159,351	18.9%	81.1%
Apr-21	249,891	23,991	225,900	9.6%	90.4%
May-21	244,219	20,905	223,314	8.6%	91.4%
Jun-21	246,797	23,441	223,356	9.5%	90.5%

TABLE 2-2. PERMIT LIMITS AND MONITORING REQUIREMENTS
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

	Monthly Average (mg/L)	Weekly Average (mg/L)	Daily Maximum (mg/L)	% Removal
CBOD5	25	40	80	85%
TSS	100	150	300	
Discharge	5.0 MGD			
pH	6.5-9			
E.Coli (May-Sep)*	126/100 mL			
E.Coli (Oct-Apr)	630/100 mL			
Total res. Cl	0.011 mg/L			
Annual Measurements (no limits)				
Ammonia				
DO				
Nitrate/Nitrite				
TKN				
Oil and Grease				
Total P				
TDS				

Notes
*Monthly average. Daily max based on Chapter 1, WWQ Rules and Regs
CBOD5 = Carbonaceous Biochemical Oxygen Demand
DO = dissolved oxygen
mg/L = milligrams per liter
MGD = million gallons per day
mL = milliliters
P = Phosphorus
res. Cl = residual Chloride
TKN = total Kjeldahl nitrogen
TDS = total dissolved solids
TSS = total suspended solids

TABLE 3-1. HISTORIC SLUDGE MEASUREMENTS
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

Year	Cell 1	Cell 2	Cell 3A
1993	11.2	NM	NM
1994	12.5	NM	NM
1995	11.6	5.1	NM
2000	NM	13.9	NM
2004	NM	15.0	NM
2005	15.3	NM	NM
2006	12.8	NM	11.6
2007	16.9	18.9	17.9
2012	20.2	14.2	14.8
2013	21.3	18.1	12.9
2014	23.3	18.0	35.9
2015	44.4	27.5	50.4
2016	29.4	16.9	27.8
2017	46.0	37.6	43.1
2019	55.7	50.4	48.8
2021	49.1	34.0	40.2

Notes:

Years not shown had no available data

Thicknesses shown in inches

NM - not measured

Measurements taken by Town personnel using a sludge judge and ultrasonic bottom sounding

TABLE 3-2. 2017 AND 2019 CONTRACTOR ESTIMATED SLUDGE VOLUMES
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

Cell No.	Cell Depth	2017 Average Sludge Thickness	2017 Percent Full	2019 Average Sludge Thickness	2019 Percent Full
Cell 1	198	46	23.20%	55.7	28.10%
Cell 2	204	37.6	18.40%	50.4	24.70%
Cell 3A	204	43.1	21.10%	48.8	24.00%

Notes:

Thicknesses and cell depth shown in inches

Measurements taken from Keller Associates 2017 and 2019 bathymetric surveys.

TABLE 3-3. 2021 CONTRACTOR ESTIMATED SLUDGE VOLUMES
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

Cell No.	Cell Depth	2021 Average Sludge Thickness	2021 Percent Full
Cell 1	198	49.1	24.80%
Cell 2	204	34	16.70%
Cell 3A	204	40.2	19.70%

Notes:

Thicknesses and cell depth shown in inches

Measurements taken from H&S Environmental Survey, 2021.

TABLE 4-1. FINAL DECISION MATRIX CRITERIA AND WEIGHTING
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

Criteria	Description	Weights
Water Quality	How will the recommendation help meet the Town of Jackson's goal of exceeding effluent water quality expectations?	21%
Energy Demands	How will the recommendation help meet the Town of Jackson's priority of reducing net energy demands?	15%
Capital Cost	Consider the capital cost compared to the other recommendations.	11%
O&M Costs	Consider the annual O&M costs compared to the other recommendations.	14%
Training & Licensing	What level of operator training and licensing is required with the recommendation compared to the current training and licensing?	5%
Odor and Noise	How will the recommendation impact the potential for odors and noise?	6%
Footprint	How well does the recommendation fit in the current operations footprint on available ToJ property?	6%
Public Perception	How will the recommendation impact public perception?	7%
Expandability	How well does the recommendation allow for expansion to accommodate future demands?	10%
Permitting Requirements	What level of permitting will be required to implement the recommendation?	5%
		100%

TABLE 5-1. POTENTIAL IMPROVEMENTS MODELED EFFLUENT WATER QUALITY
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

Nutrient	Current Effluent Concentration*	Potential Improvement Alternative				Add-On	
		Aeration Modifications	Clarifier	Bioreactor	Mechanical Plant	Water Reuse**	Sludge Removal**
Ammonia	29.37	0.07	0.02	0.01	1.00	N/A	N/A
Total Nitrogen	34.04	10.55	2.43	10.41	5.00	N/A	N/A
Total Phosphorus	4.50	8.00	5.17	8.00	1.00	N/A	N/A
CBOD	9.36	7.91	1.65	6.23	10.00	N/A	N/A

*Concentrations taken from 2021 Discharge Monitoring Reports, January - March (Winter conditions)
**Water Reuse and Sludge Removal Add-Ons were not modeled.

TABLE 7-1. FINAL DECISION MATRIX RESULTS
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

Criteria	Description	Weights	Final Results						
			Potential Improvement Alternative				Add-Ons		
							Water Reuse	Sludge Removal	
			Aeration Modifications	Clarifier	Bioreactor	Mechanical Plant		On-Site Disposal	Off-Site Disposal
Water Quality	How will the recommendation help meet the Town of Jackson's goal of exceeding effluent water quality expectations?	21%	2.3	4.0	2.3	5.0	5.0	5.0	4.5
Energy Demands	How will the recommendation help meet the Town of Jackson's priority of reducing net energy demands?	15%	3.0	2.8	2.8	1.5	4.8	4.5	4.0
Capital Cost	Consider the capital cost compared to the other recommendations.	11%	3.8	3.0	3.5	1.8	4.0	4.3	2.3
O&M Costs	Consider the annual O&M costs compared to the other recommendations.	14%	4.8	3.0	4.0	2.3	4.8	5.0	4.5
Training & Licensing	What level of operator training and licensing is required with the recommendation compared to the current training and licensing?	5%	4.3	3.0	3.8	2.8	4.0	5.0	5.0
Odor and Noise	How will the recommendation impact the potential for odors and noise?	6%	3.5	4.3	5.0	3.5	5.0	2.0	2.0
Footprint	How well does the recommendation fit in the current operations footprint on available ToJ property?	6%	4.8	4.8	4.3	5.0	1.8	4.0	3.5
Public Perception	How will the recommendation impact public perception?	7%	2.3	2.3	2.8	4.5	4.8	4.8	3.5
Expandability	How well does the recommendation allow for expansion to accommodate future demands?	10%	3.5	3.0	4.8	5.0	5.0	5.0	5.0
Permitting Requirements	What level of permitting will be required to implement the recommendation?	5%	4.8	3.3	3.8	2.8	1.5	4.0	3.0
		100%	**3.4**	**3.3**	**3.4**	**3.4**	**4.4**	**4.5**	**3.9**

FIGURES

QUADRANGLE LOCATION

N

0 3,000'

Trihydro CORPORATION
1252 Commerce Drive
Laramie, Wyoming 82070
www.trihydro.com
(P) 307/745.7474 (F) 307/745.7729

DRAFT

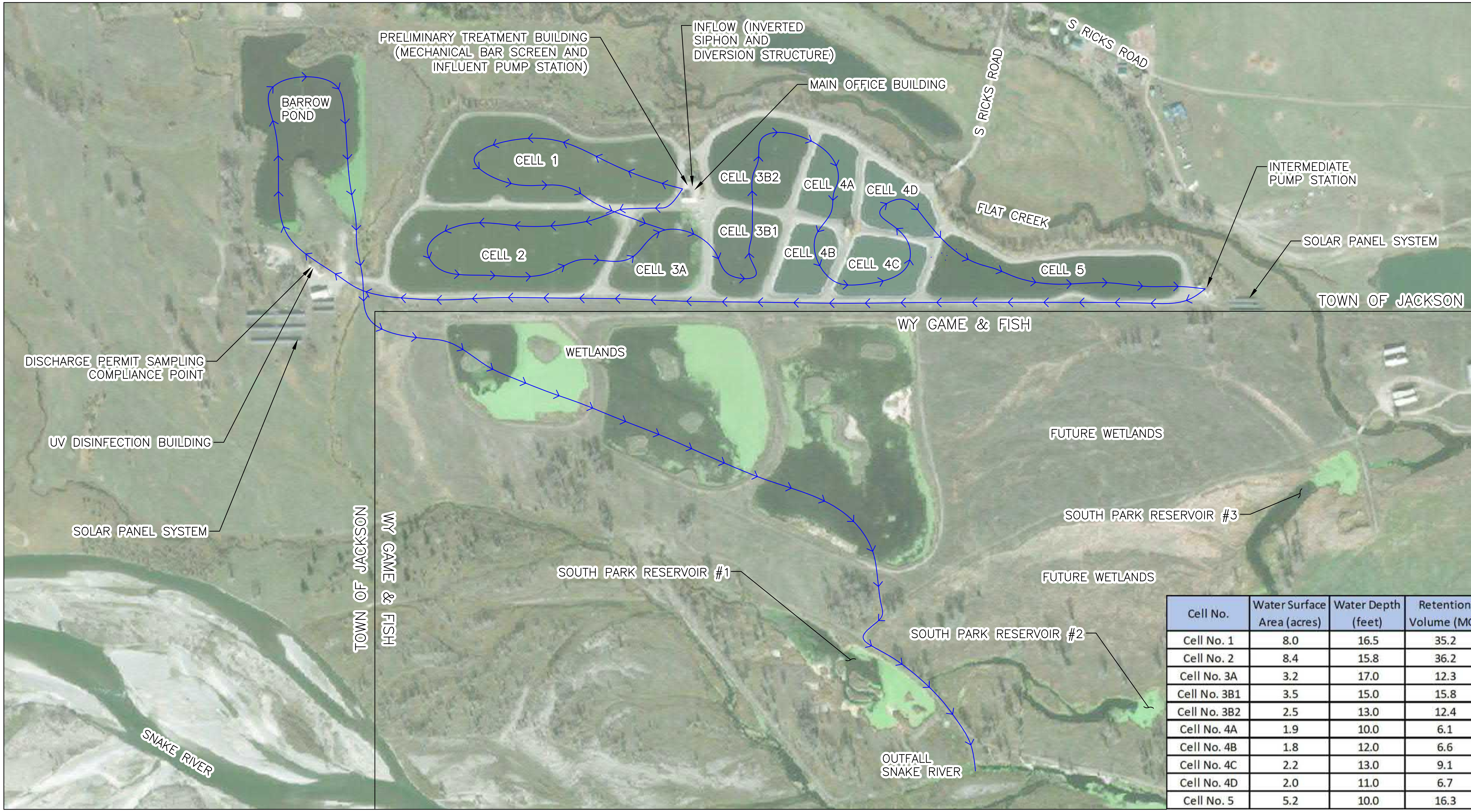
FIGURE 1-1

SITE LOCATION MAP

TECHNICAL REVIEW REPORT
2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW, TOWN OF JACKSON, WYOMING

Drawn By: KML	Checked By: CF	Scale: 1" = 3,000'	Date: 5/23/22	File: 80F-JK-WWTP-SITELOCMAP

L:\TOWN OF JACKSON -- DOCUMENTS\CADD_BASEMAPS\80F-JK-WWTP-SITELOCMAP



Cell No.	Water Surface Area (acres)	Water Depth (feet)	Retention Volume (MG)
Cell No. 1	8.0	16.5	35.2
Cell No. 2	8.4	15.8	36.2
Cell No. 3A	3.2	17.0	12.3
Cell No. 3B1	3.5	15.0	15.8
Cell No. 3B2	2.5	13.0	12.4
Cell No. 4A	1.9	10.0	6.1
Cell No. 4B	1.8	12.0	6.6
Cell No. 4C	2.2	13.0	9.1
Cell No. 4D	2.0	11.0	6.7
Cell No. 5	5.2	10.0	16.3

EXPLANATION

WASTEWATER FLOW FROM INFLUENT TO OUTFALL

N

0 400'

Trihydro CORPORATION
1252 Commerce Drive
Laramie, Wyoming 82070
www.trihydro.com
(P) 307/745.7474 (F) 307/745.7729

DRAFT

FIGURE 2-1

SITE PLAN AND WASTEWATER FLOW PATH

TECHNICAL REVIEW REPORT
2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW, TOWN OF JACKSON, WYOMING

Drawn By: JH	Checked By: CF	Scale: 1" = 400'	Date: 5/18/2022	File: 80f-JK-WWTP-SitePlan

L:\TOWN OF JACKSON - DOCUMENTS\CADD_BASEMAPS\80F-JK-WWTP-SITEPLAN

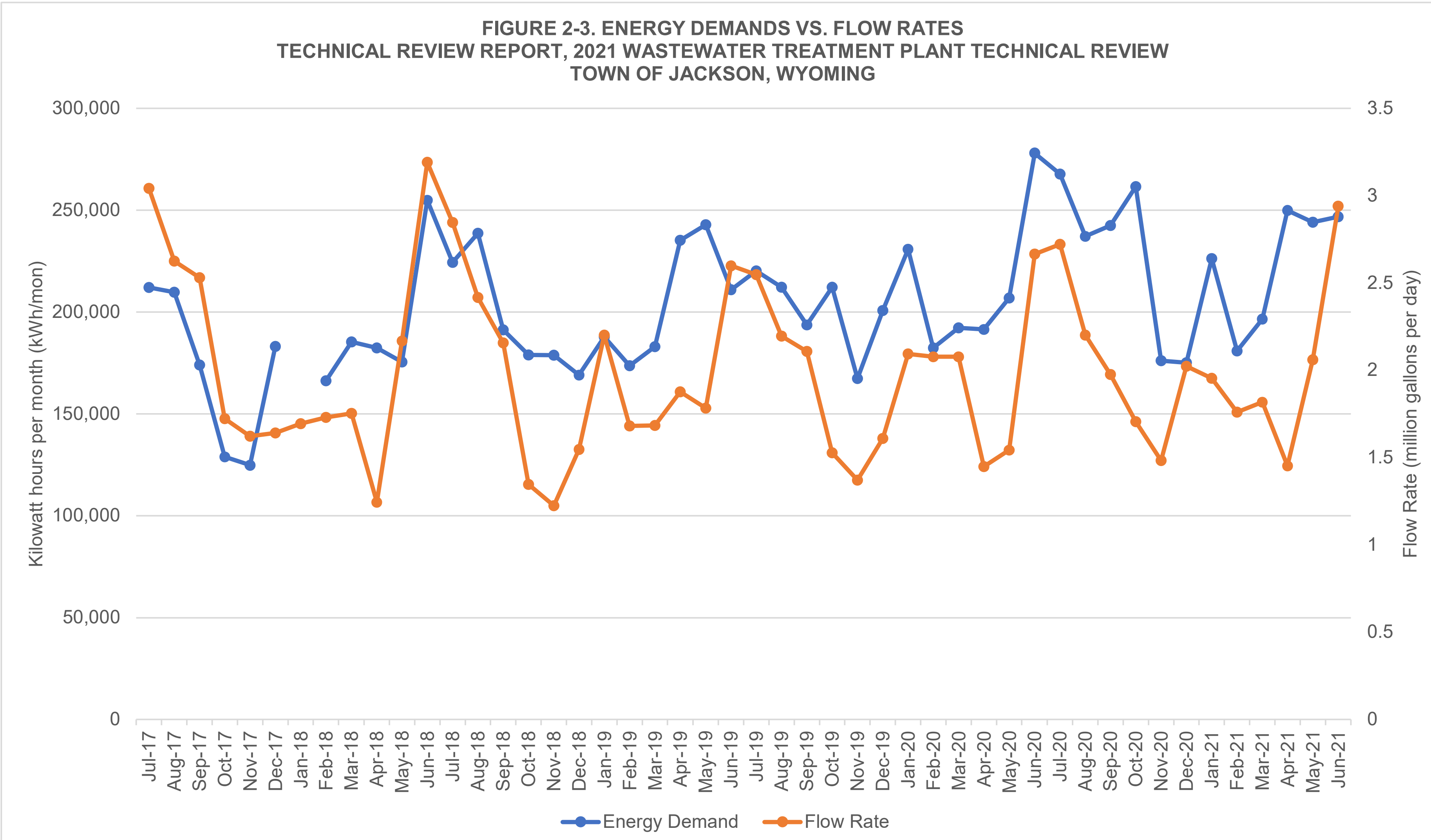
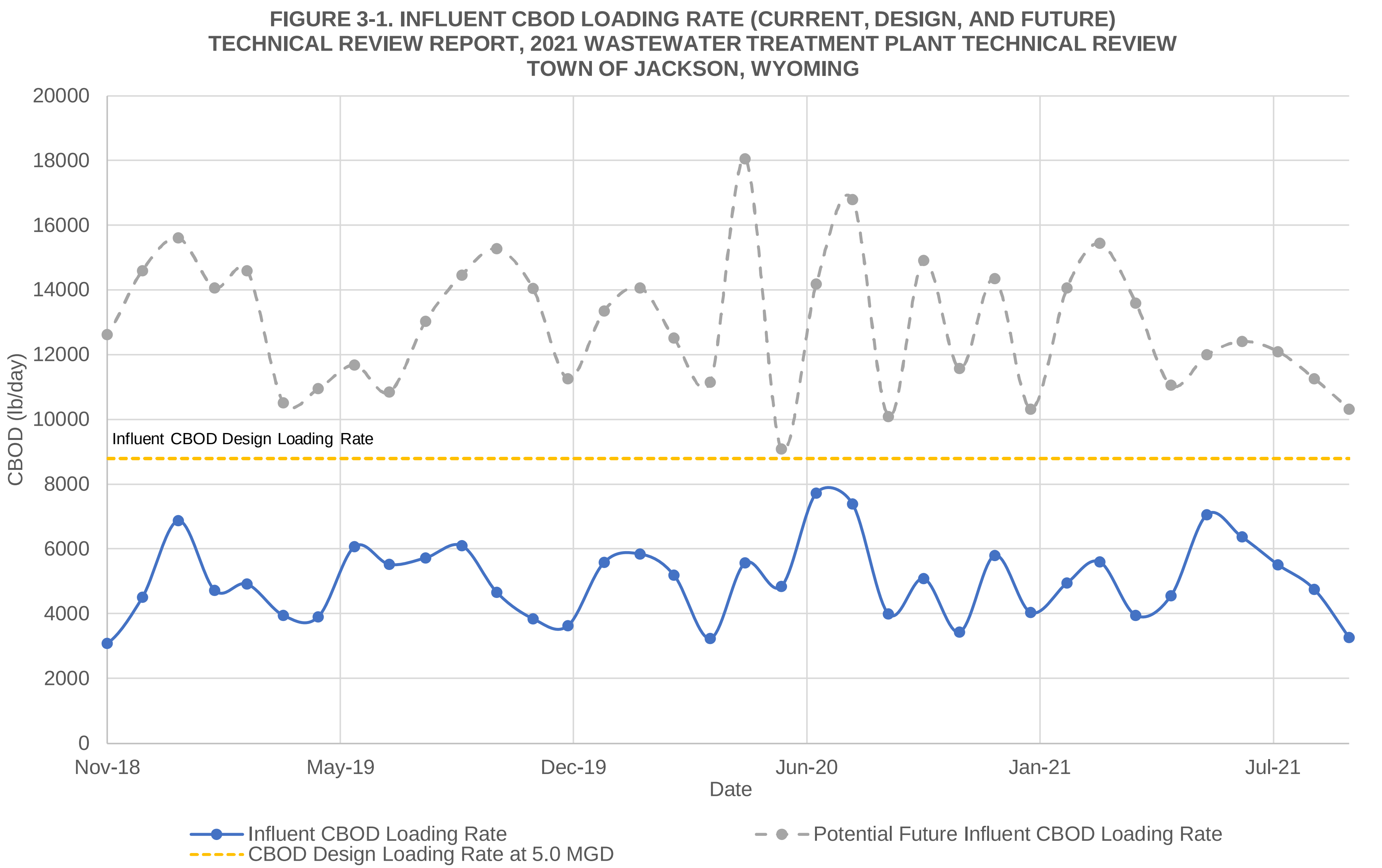
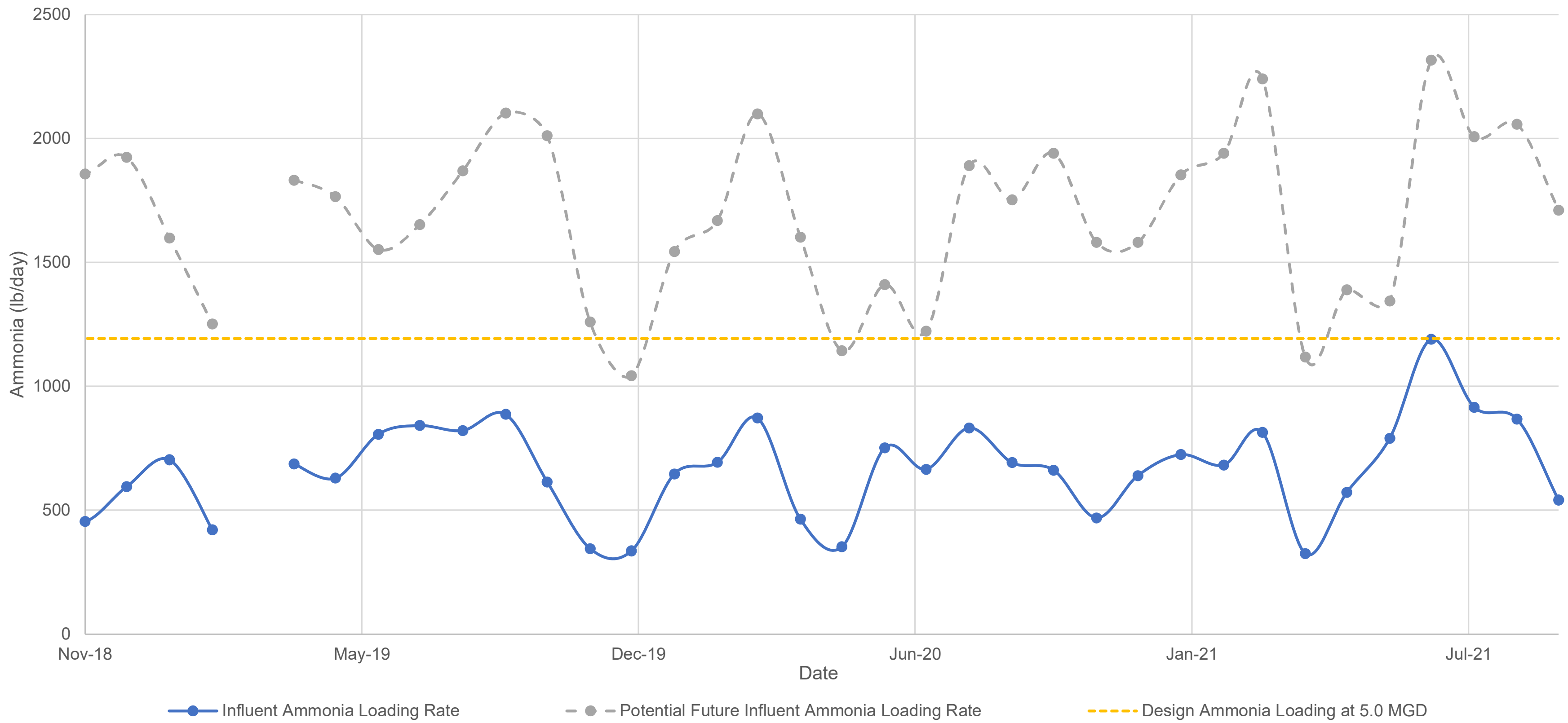


FIGURE 2-3. ENERGY DEMANDS VS. FLOW RATES
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING
Kilowatt hours per month (kWh/mon)
Flow Rate (million gallons per day)
300,000
250,000
200,000
150,000
100,000
50,000
0
3.5
3
2.5
2
1.5
1
0.5
0
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
Mar-18
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Jan-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19
Jan-20
Feb-20
Mar-20
Apr-20
May-20
Jun-20
Jul-20
Aug-20
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21
Mar-21
Apr-21
May-21
Jun-21
Energy Demand
Flow Rate

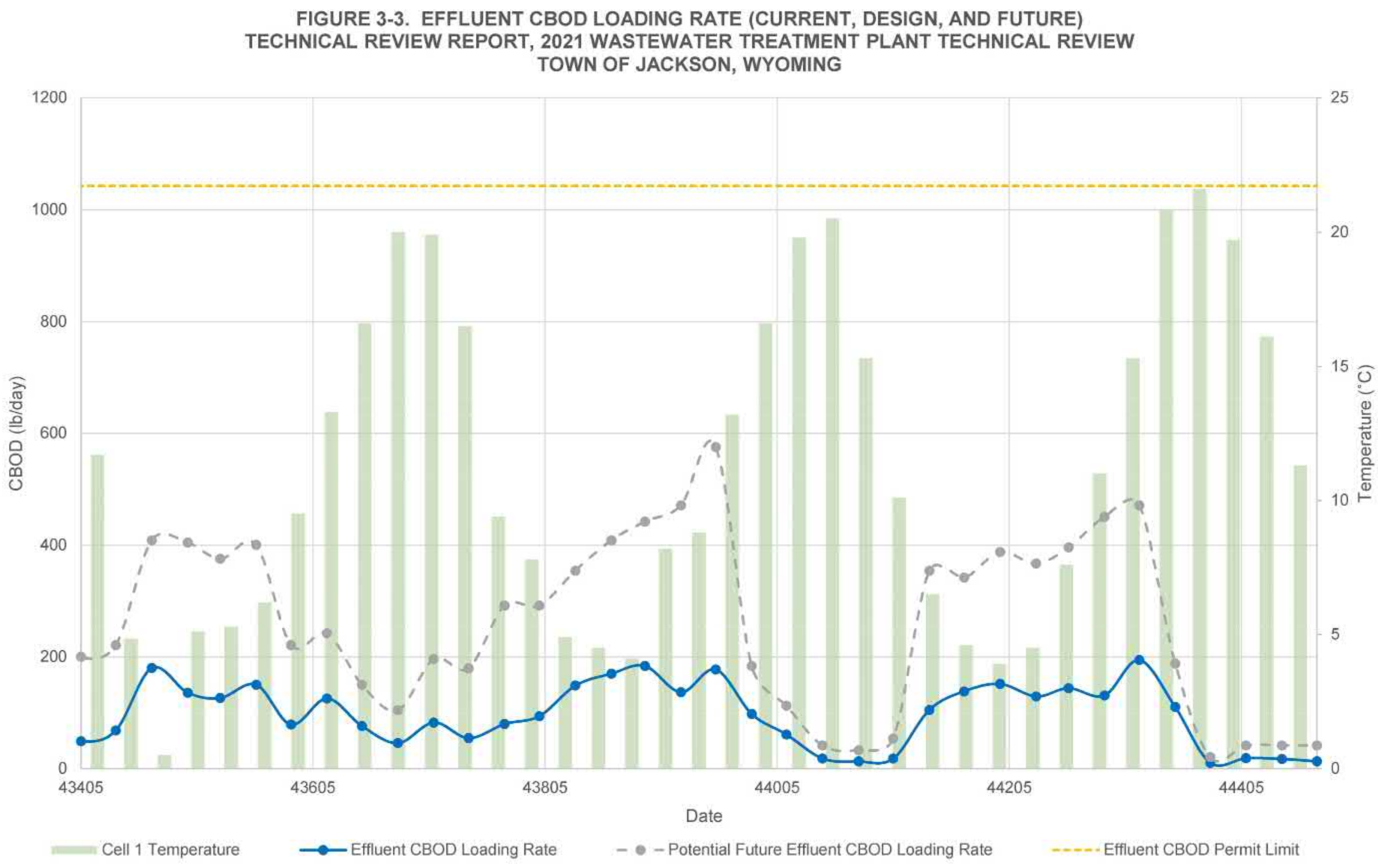


Notes:
Potential Future Influent CBOD Loading Rate is calculated using current influent concentrations and the design flow rate of the WWTP (5.0 MGD)
CBOD Design Loading Rate at 5.0 MGD is from the WWTP's CBOD Design Capacity (211 mg/L) and maximum flow rate (5.0 MGD)

FIGURE 3-2. INFLUENT AMMONIA LOADING RATE (CURRENT, DESIGN, AND FUTURE)
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

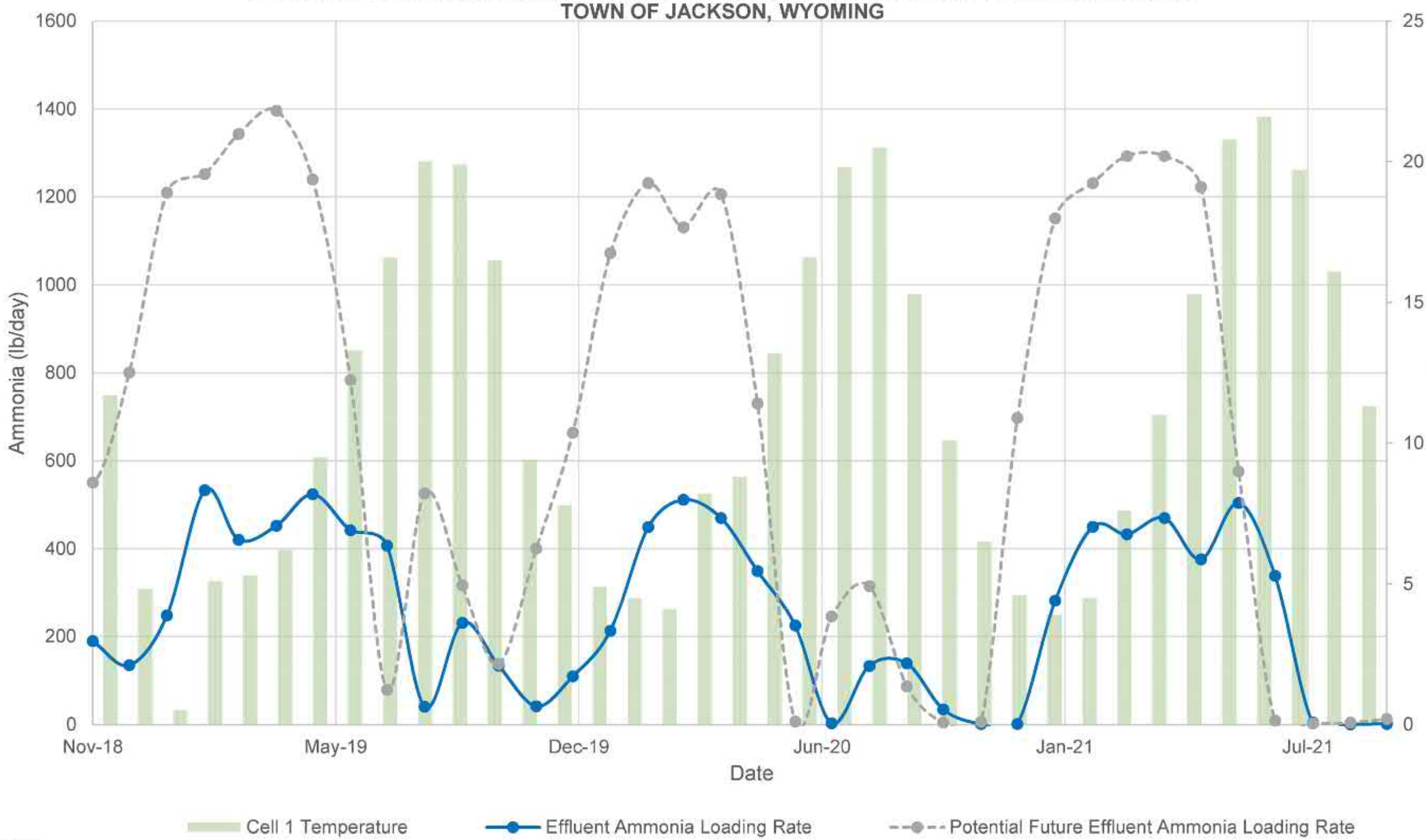


Notes:
Potential Future Influent Ammonia Loading Rate is calculated using current influent concentrations and the design flow rate of the WWTP (5.0 MGD)
Ammonia Design Loading Rate at 5.0 MGD is from the WWTP's Ammonia Design Capacity (29 mg/L) and maximum flow rate (5.0 MGD)

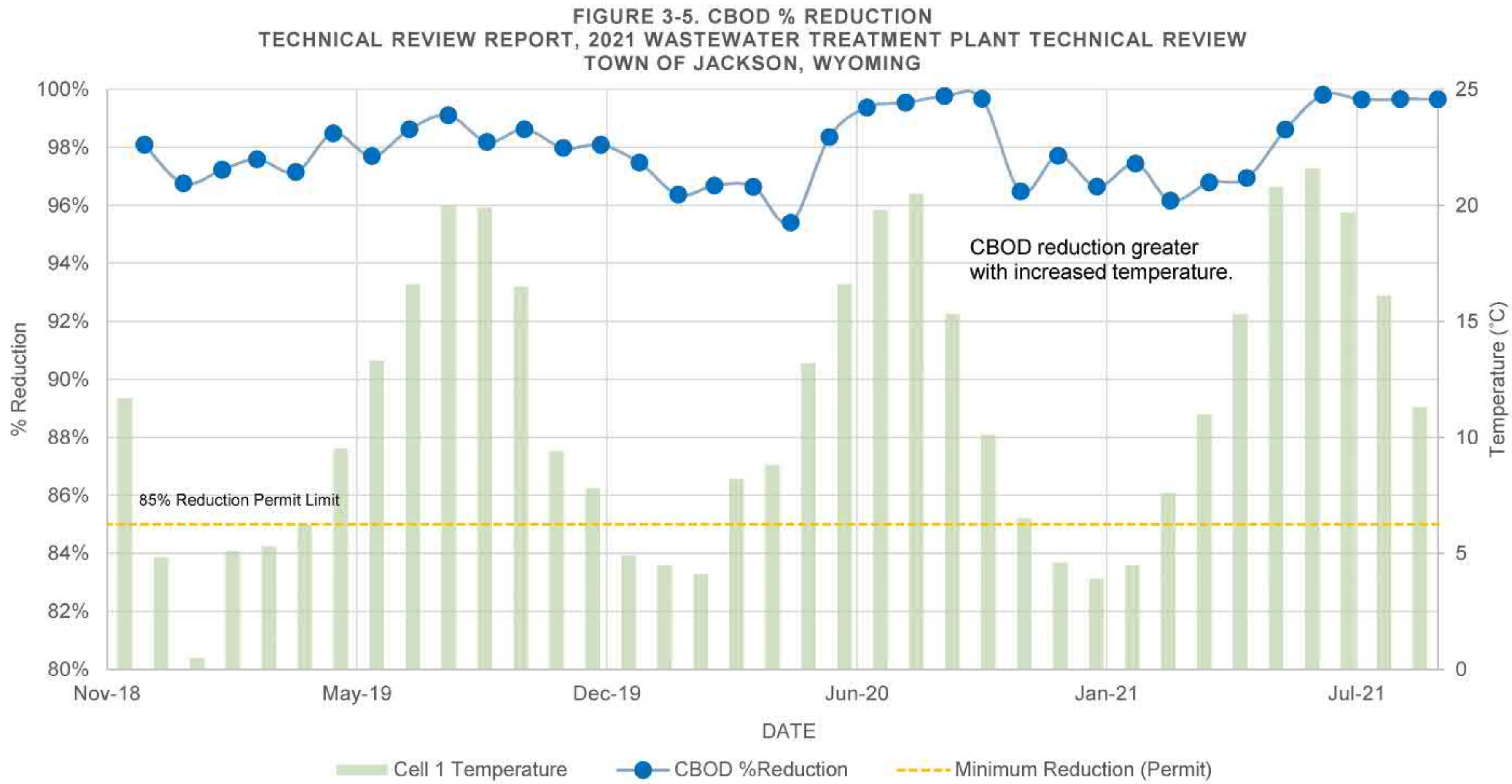


Notes:
Potential Future Effluent CBOD Loading Rate is calculated using current effluent concentrations and the design flow rate of the WWTP (5.0 MGD)
Effluent CBOD Permit Limit calculated using design flow rate of WWTP (5.0 MGD) and CBOD permit limit (25 mg/L)

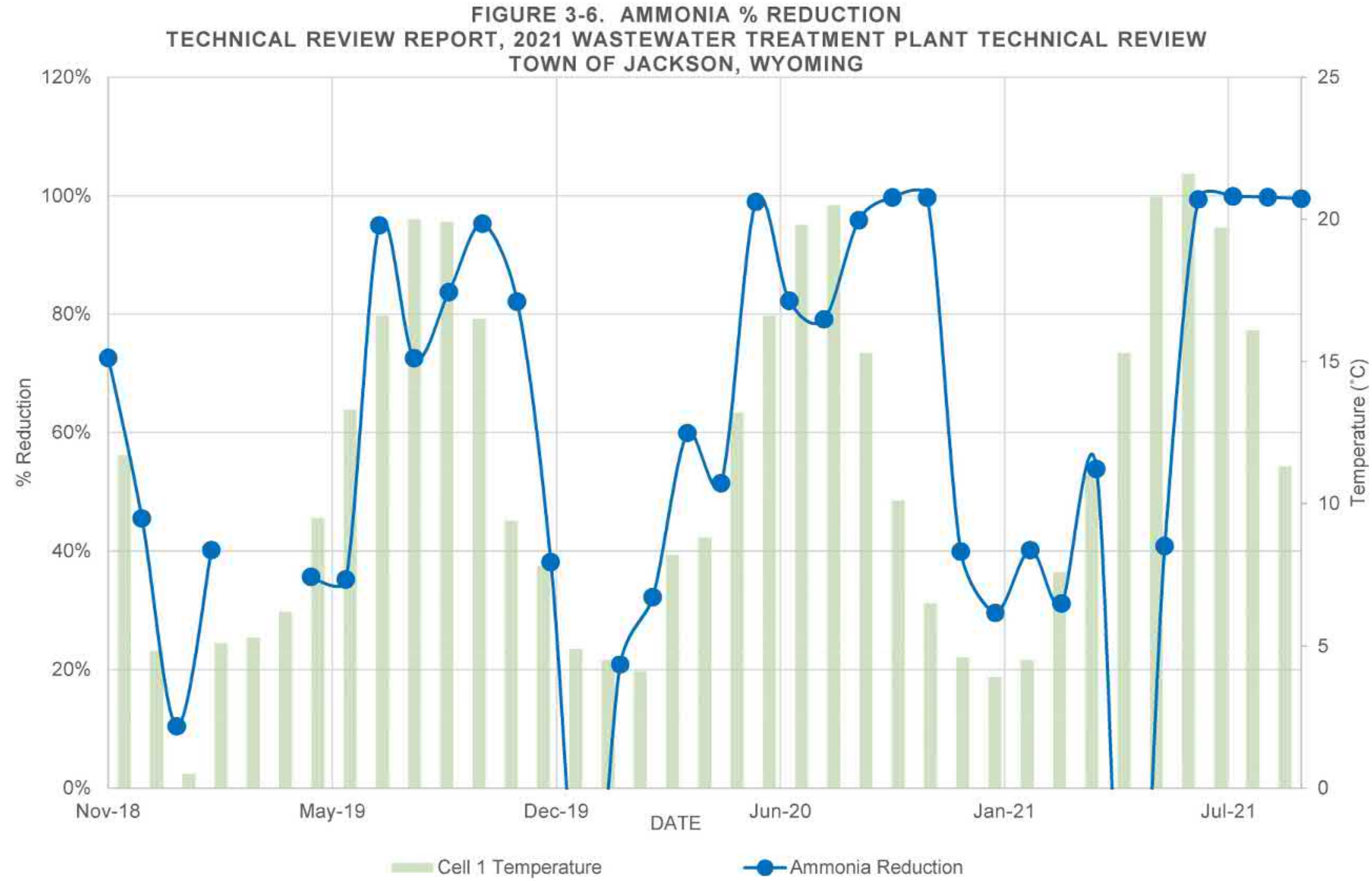
FIGURE 3-4. EFFLUENT AMMONIA LOADING RATE (CURRENT, DESIGN, AND FUTURE)
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING



Notes:
Potential Future Ammonia Loading Rate is calculated using current effluent concentrations and the design flow rate of the WWTP (5.0 MGD)
No permit limits exist for ammonia discharge



Notes:
CBOD % reduction calculated using influent and effluent CBOD loading. The effluent CBOD loading is shifted by 60 days to account for average detention time.
Cell 1 temperature used to account for area in WWTP where most of the reduction takes place.



Notes:
Ammonia % reduction calculated using influent and effluent ammonia loading. The effluent ammonia loading is shifted by 60 days to account for average detention time.
Cell 1 temperature used to account for area in WWTP where most of the reduction takes place.

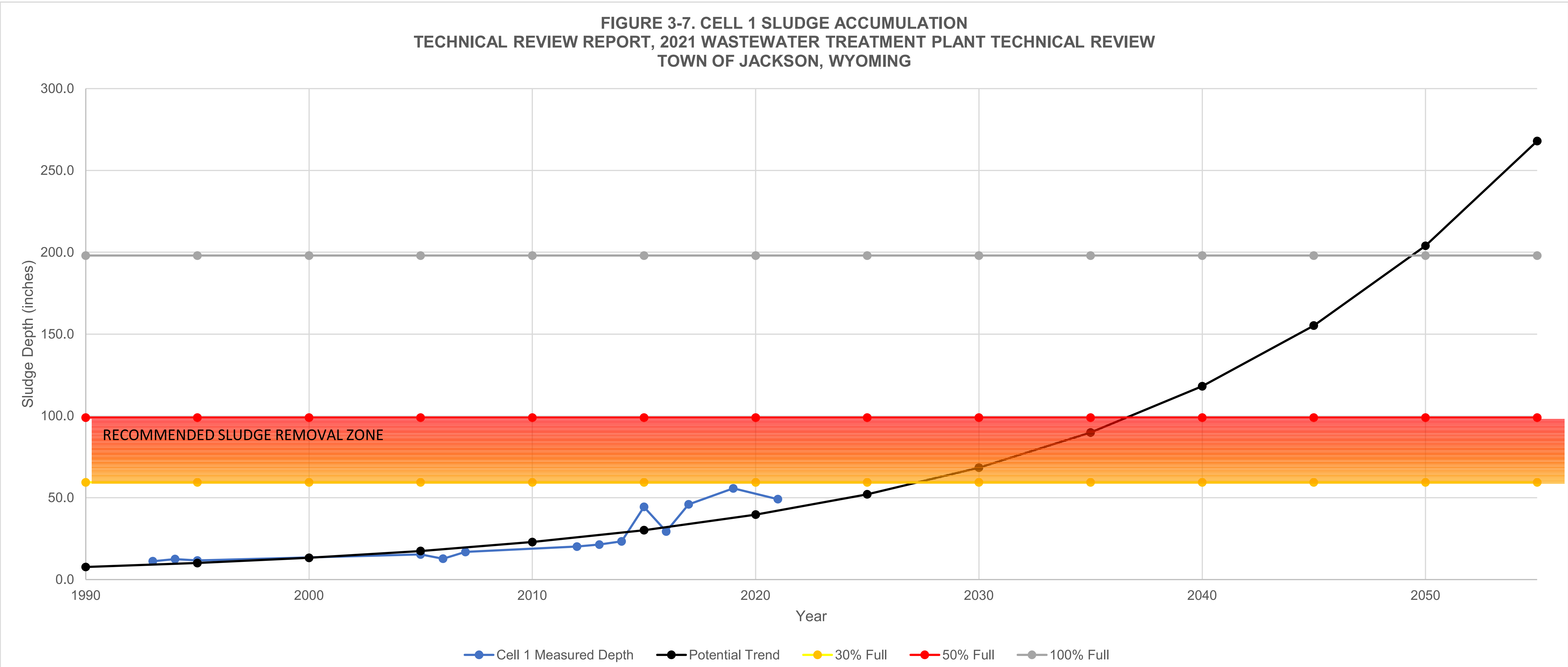


FIGURE 3-7. CELL 1 SLUDGE ACCUMULATION
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING
Sludge Depth (inches)
300.0
250.0
200.0
150.0
100.0
50.0
0.0
RECOMMENDED SLUDGE REMOVAL ZONE
1990
2000
2010
2020
2030
2040
2050
Year
Cell 1 Measured Depth
Potential Trend
30% Full
50% Full
100% Full

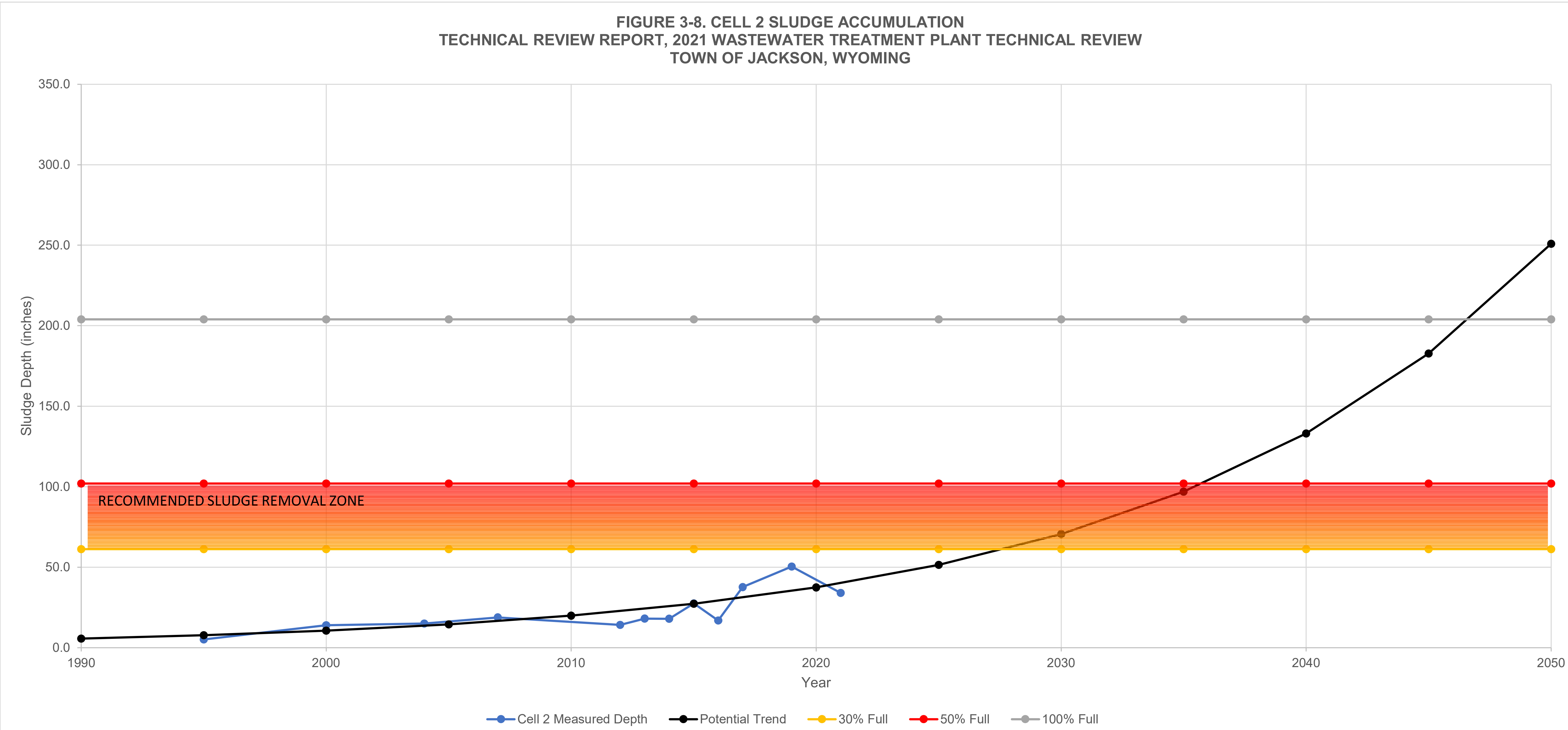


FIGURE 3-8. CELL 2 SLUDGE ACCUMULATION
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING
Sludge Depth (inches)
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
1990
2000
2010
2020
2030
2040
2050
Year
RECOMMENDED SLUDGE REMOVAL ZONE
Cell 2 Measured Depth
Potential Trend
30% Full
50% Full
100% Full

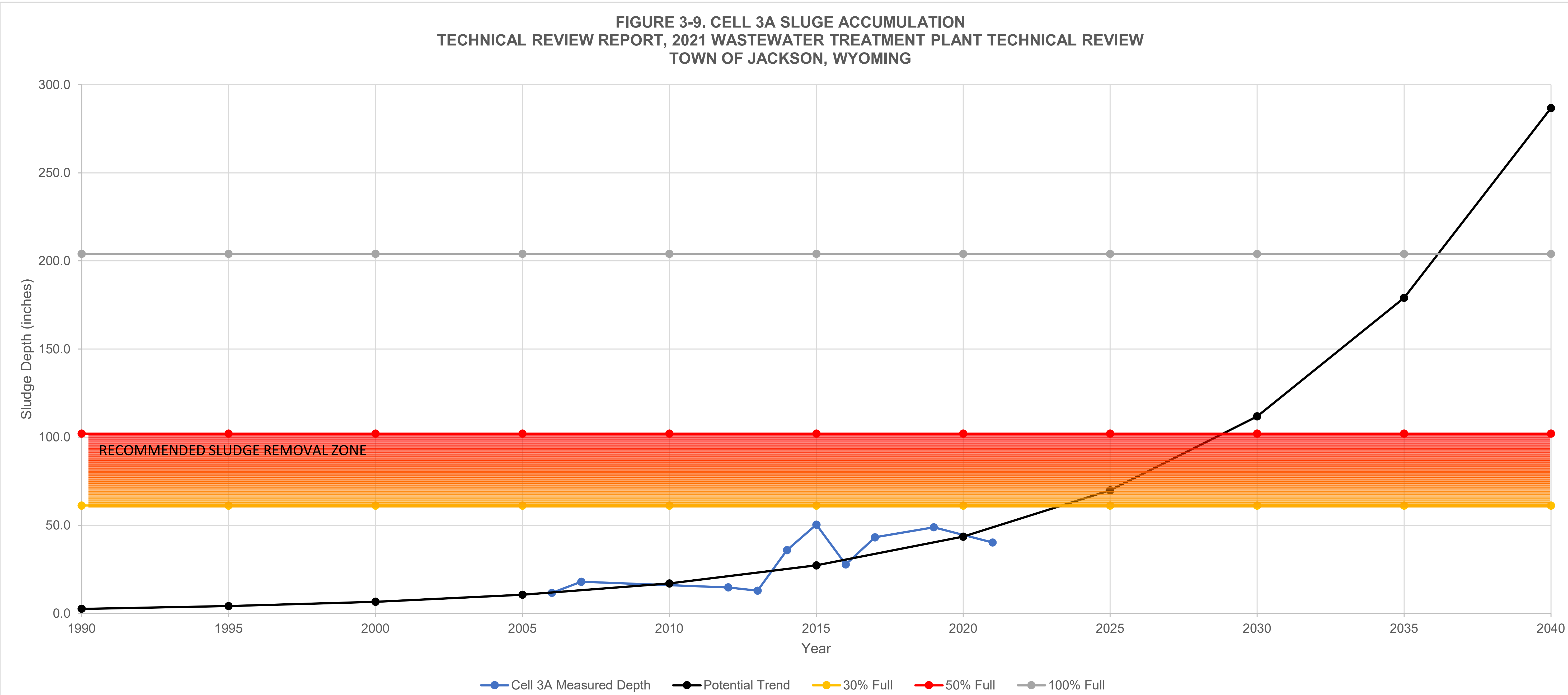
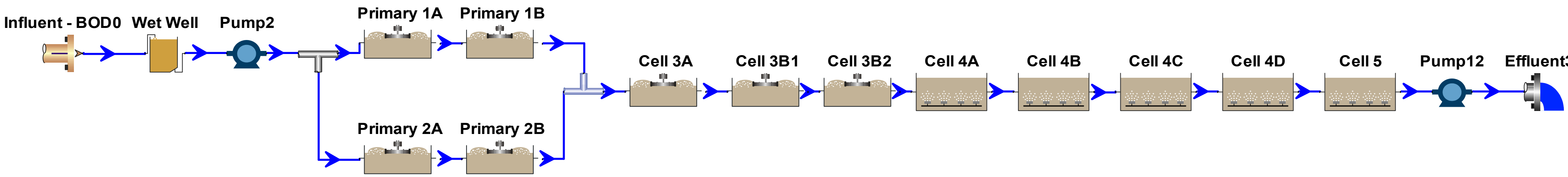


FIGURE 3-9. CELL 3A SLUGE ACCUMULATION
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING
RECOMMENDED SLUDGE REMOVAL ZONE
Sludge Depth (inches)
Year
300.0
250.0
200.0
150.0
100.0
50.0
0.0
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
Cell 3A Measured Depth
Potential Trend
30% Full
50% Full
100% Full

FIGURE 6-1A. AERATION MODIFICATIONS
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

FIGURE 6-1B. AERATION MODIFICATIONS BIOWIN MODELING RESULTS
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

Aeration Basins	Primary 1A	Primary 1A	Primary 1B	Primary 2B	Cell 3A	Cell 3B1	Cell 3B2	Cell 4A	Cell 4B	Cell 4C	Cell 4D	Cell 5
DO setup point (mg/l)	0	1	0	1	1.5	2	1.5	1	0	1	2	0



Influent Characteristics

Flow	5.00 mgd
COD - Total	713.69 mg/L
N - Total Kjeldahl Nitrogen	46.10 mgN/L
P - Total P	8.00 mgP/L
ISS Total	45.30 mg/L
S - Total S	8.00 mg/L
Volatile suspended solids	167.00 mg/L
Total suspended solids	212.30 mg/L
BOD - Total Carbonaceous	350.00 mg/L
pH	8.50

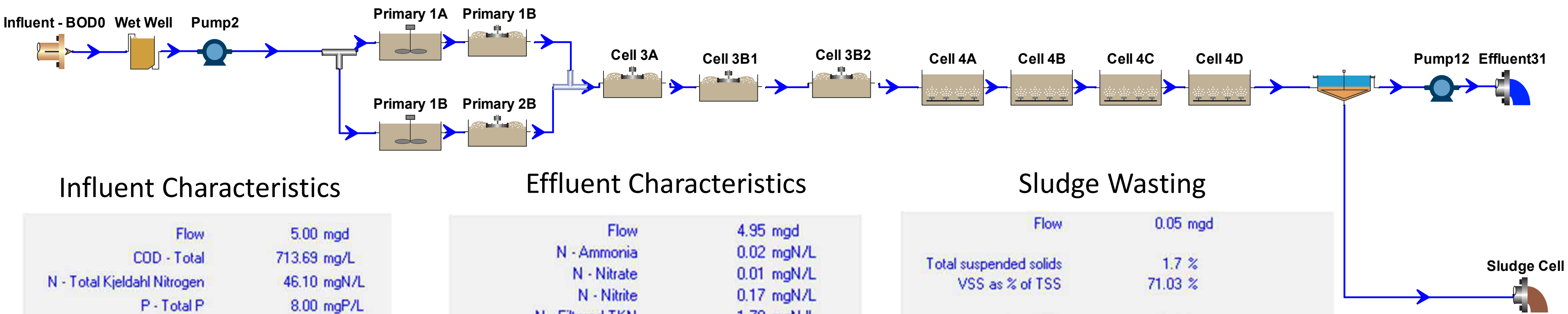
Effluent Characteristics

Flow	5.00 mgd
N - Ammonia	0.07 mgN/L
N - Nitrate	0.00 mgN/L
N - Nitrite	0.00 mgN/L
N - Filtered TKN	1.46 mgN/L
N - Total N	10.55 mgN/L
P - Soluble phosphate	5.13 mgP/L
P - Total P	8.00 mgP/L
Total suspended solids	171.12 mg/L
COD - Total	212.83 mg/L
BOD - Total Carbonaceous	7.91 mg/L
pH	7.79

FIGURE 6-2A. CLARIFIER
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

FIGURE 6-2B. CLARIFIER BIOWIN MODELING RESULTS
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

Aeration Basins	Primary 1A	Primary 1A	Primary 2B	Primary 2B	Cell 3A	Cell 3B1	Cell 3B2	Cell 4A	Cell 4B	Cell 4C	Cell 4D	Cell 5 as sludge digester
DO setup point (mg/l)	0	1.25	0	1.25	1.25	1.25	0	1.25	1.25	1.25	1.25	1.5



Influent Characteristics

Flow	5.00 mgd
COD - Total	713.69 mg/L
N - Total Kjeldahl Nitrogen	46.10 mgN/L
P - Total P	8.00 mgP/L
ISS Total	45.30 mg/L
S - Total S	8.00 mg/L
Volatile suspended solids	167.00 mg/L
Total suspended solids	212.30 mg/L
BOD - Total Carbonaceous	350.00 mg/L
pH	8.50

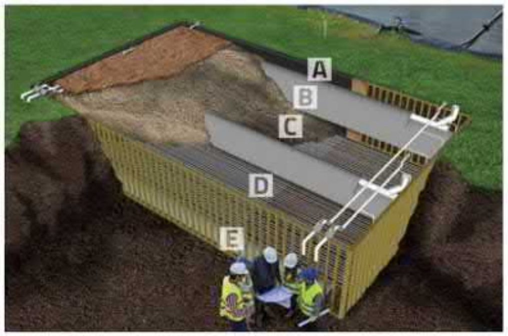
Effluent Characteristics

Flow	4.95 mgd
N - Ammonia	0.02 mgN/L
N - Nitrate	0.01 mgN/L
N - Nitrite	0.17 mgN/L
N - Filtered TKN	1.78 mgN/L
N - Total N	2.43 mgN/L
P - Soluble phosphate	5.02 mgP/L
P - Total P	5.17 mgP/L
Total suspended solids	8.84 mg/L
COD - Total	46.53 mg/L
BOD - Total Carbonaceous	1.65 mg/L
pH	7.61

Sludge Wasting

Flow	0.05 mgd
Total suspended solids	1.7 %
VSS as % of TSS	71.03 %
N as % of TSS	5.42 %
P as % of TSS	1.74 %
pH	7.47
Volatile suspended solids	4915.98 lb/d
Total suspended solids	6921.20 lb/d

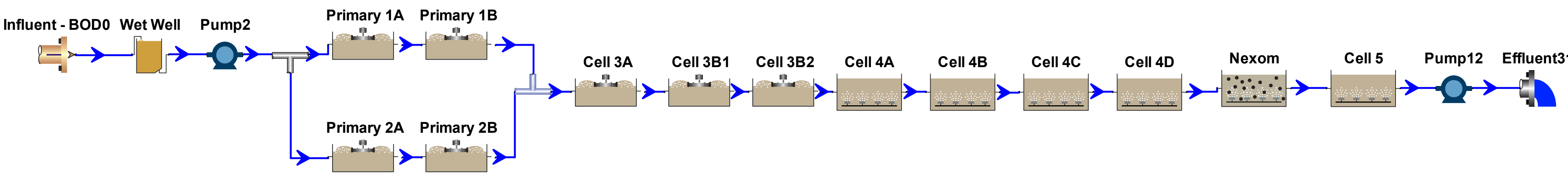
FIGURE 6-3A. BIOREACTOR
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING



LEGEND
A. HDPE LINER
B. INFLUENT DISTRIBUTION CHAMBER
C. CLEAN STONE MEDIA
D. AERATION SYSTEM
E. EFFLUENT COLLECTION CHAMBER

FIGURE 6-3B. BIOREACTOR BIOWIN MODELING RESULTS
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

Aeration Basins	Primary 1A	Primary 1A	Primary 1B	Primary 2B	Cell 3A	Cell 3B1	Cell 3B2	Cell 4A	Cell 4B	Cell 4C	Cell 4D	Nexom	Cell 5
DO setup point (mg/l)	0	1	0	1	1.5	2	1.5	1	0	1	3	0	1.25



Influent Characteristics

Flow	5.00 mgd
COD - Total	713.69 mg/L
N - Total Kjeldahl Nitrogen	46.10 mgN/L
P - Total P	8.00 mgP/L
ISS Total	45.30 mg/L
S - Total S	8.00 mg/L
Volatile suspended solids	167.00 mg/L
Total suspended solids	212.30 mg/L
BOD - Total Carbonaceous	350.00 mg/L
pH	8.50

Effluent Characteristics

Flow	5.00 mgd
N - Ammonia	0.01 mgN/L
N - Nitrate	0.00 mgN/L
N - Nitrite	0.03 mgN/L
N - Filtered TKN	1.55 mgN/L
N - Total N	10.41 mgN/L
P - Soluble phosphate	5.21 mgP/L
P - Total P	8.00 mgP/L
Total suspended solids	168.27 mg/L
COD - Total	210.25 mg/L
BOD - Total Carbonaceous	6.23 mg/L
pH	7.87

FIGURE 6-4A. MECHANICAL PLANT
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

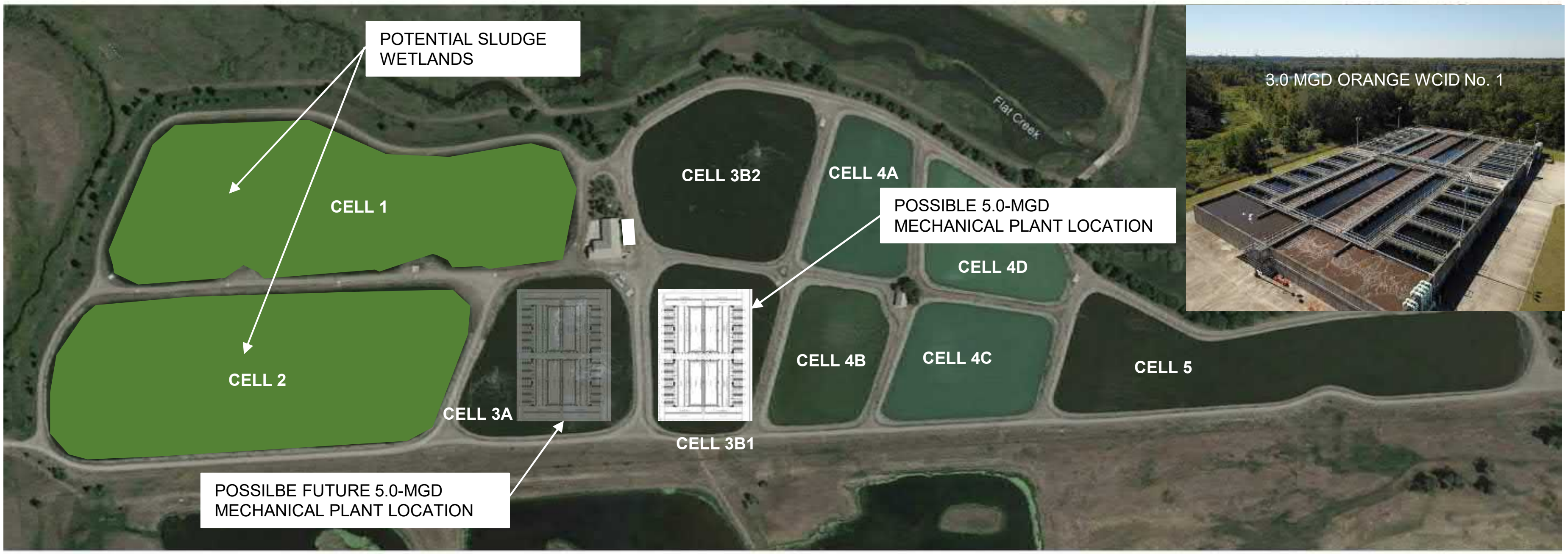
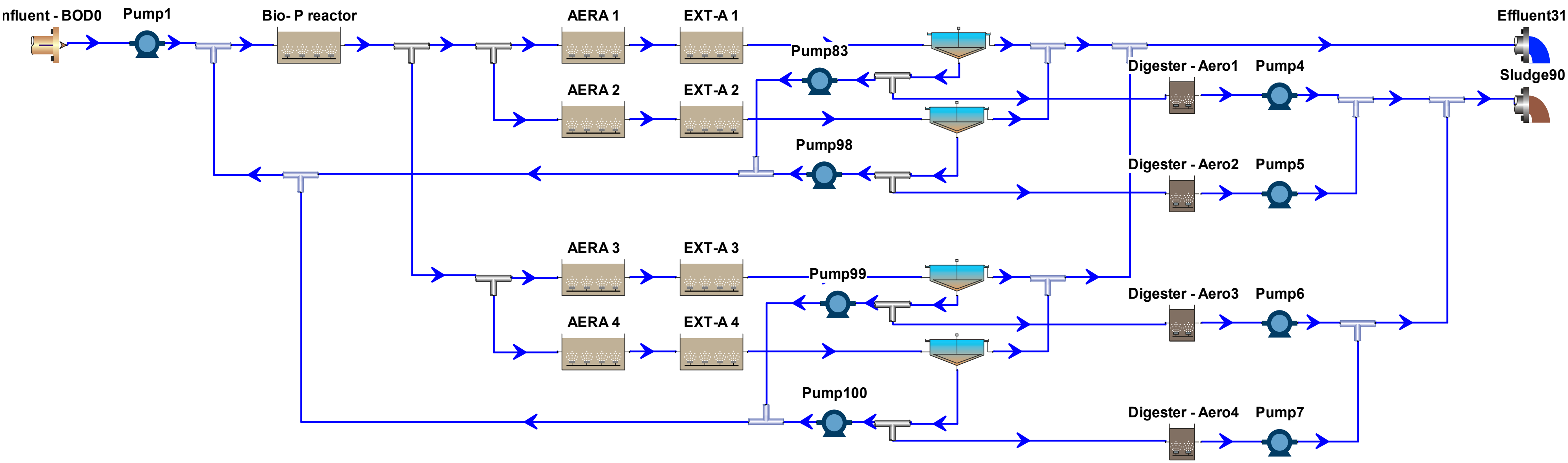


FIGURE 6-4B. MECHANICAL PLANT BIOWIN MODELING RESULTS
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING



Influent Characteristics

Flow	5.00 mgd
COD - Total	713.69 mg/L
N - Total Kjeldahl Nitrogen	50.00 mgN/L
P - Total P	8.00 mgP/L
ISS Total	67.50 mg/L
S - Total S	8.00 mg/L
Volatile suspended solids	182.50 mg/L
Total suspended solids	250.00 mg/L
BOD - Total Carbonaceous	350.00 mg/L
pH	8.50

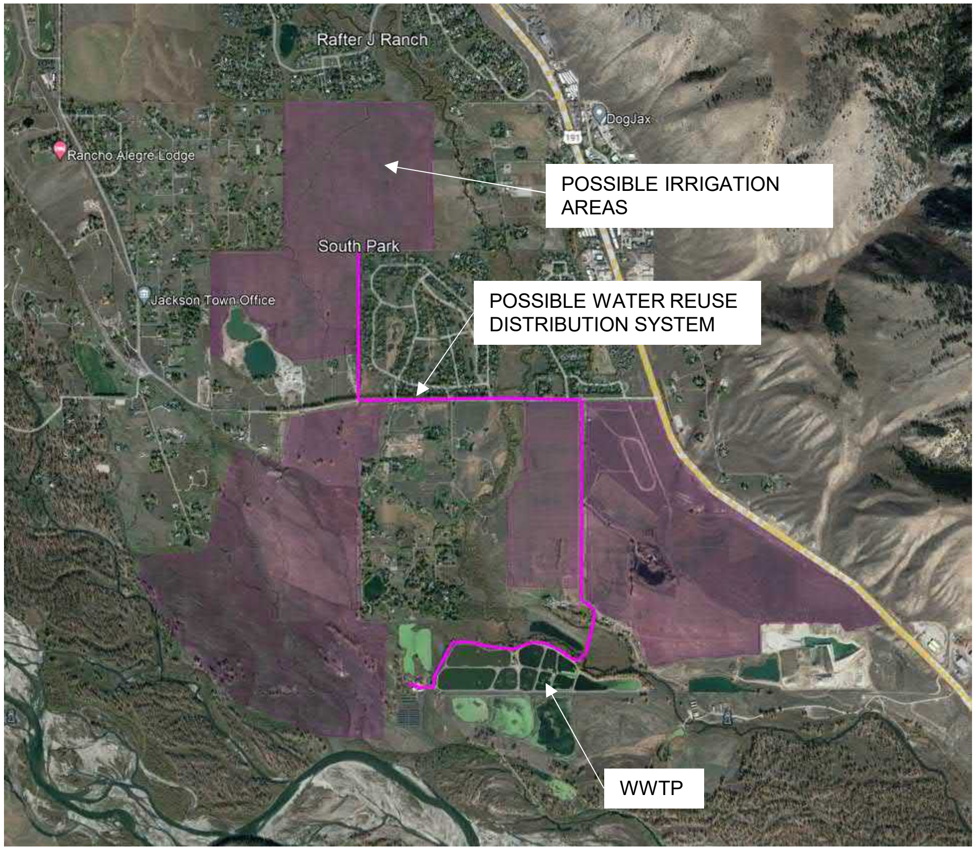
Effluent Characteristics

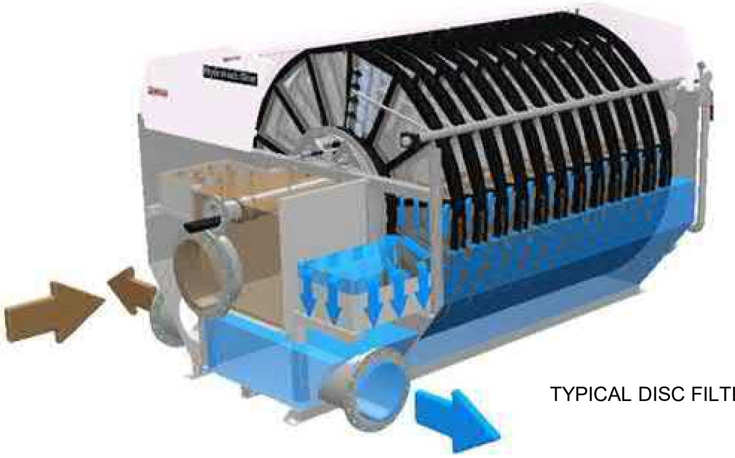
Flow	5.00 mgd
N - Ammonia	1.00 mgN/L
N - Nitrate	2.61 mgN/L
N - Nitrite	0.23 mgN/L
N - Filtered TKN	2.16 mgN/L
N - Total N	5.00 mgN/L
P - Soluble phosphate	2.77 mgP/L
P - Total P	1.00 mgP/L
Total suspended solids	7.43 mg/L
COD - Total	44.37 mg/L
BOD - Total Carbonaceous	10.0 mg/L
pH	8.18

Sludge Wasting

Flow	0.31 mgd
Total suspended solids	0.4 %
VSS as % of TSS	67.02 %
N as % of TSS	7.65 %
P as % of TSS	2.33 %
pH	8.21
Volatile suspended solids	6313.79 lb/d
Total suspended solids	9420.14 lb/d

FIGURE 6-5. WATER REUSE
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING





TYPICAL DISC FILTERS

FIGURE 6-6. ON-SITE SLUDGE HOLDING POND
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

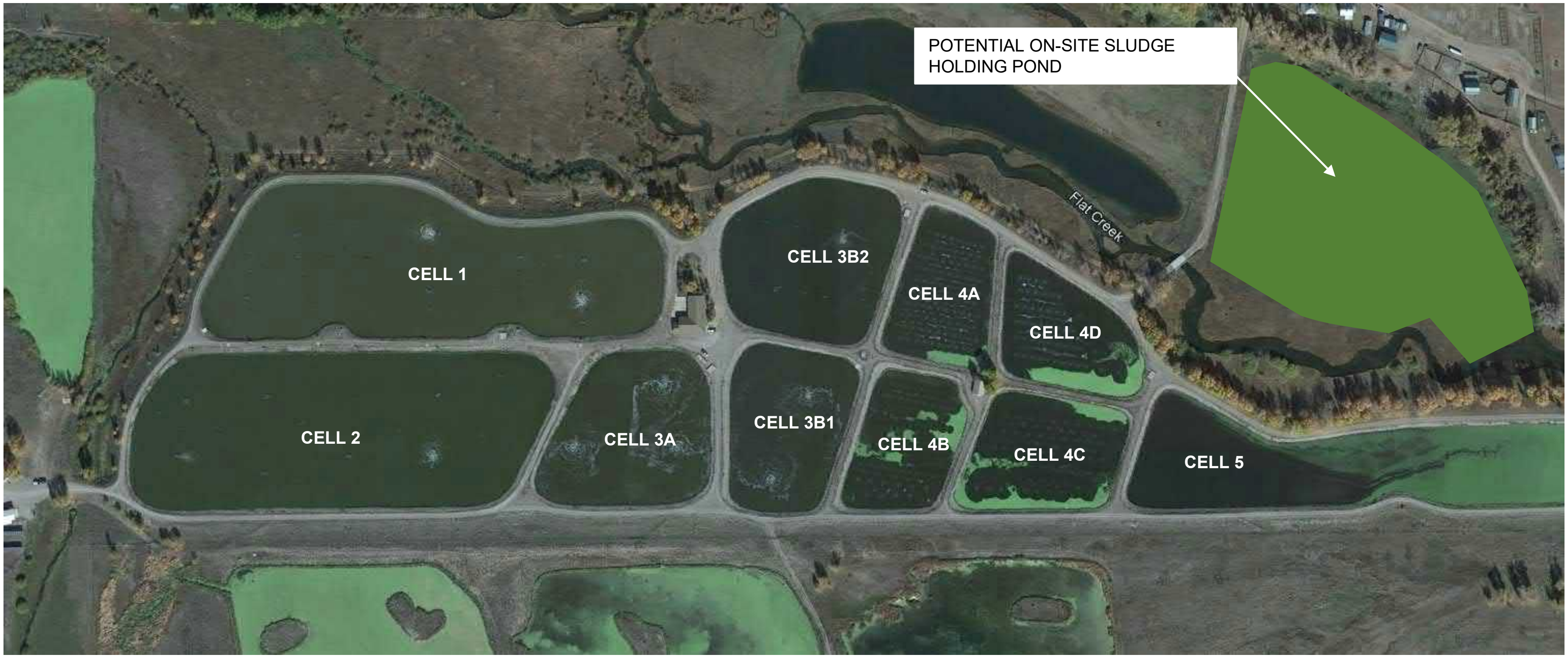
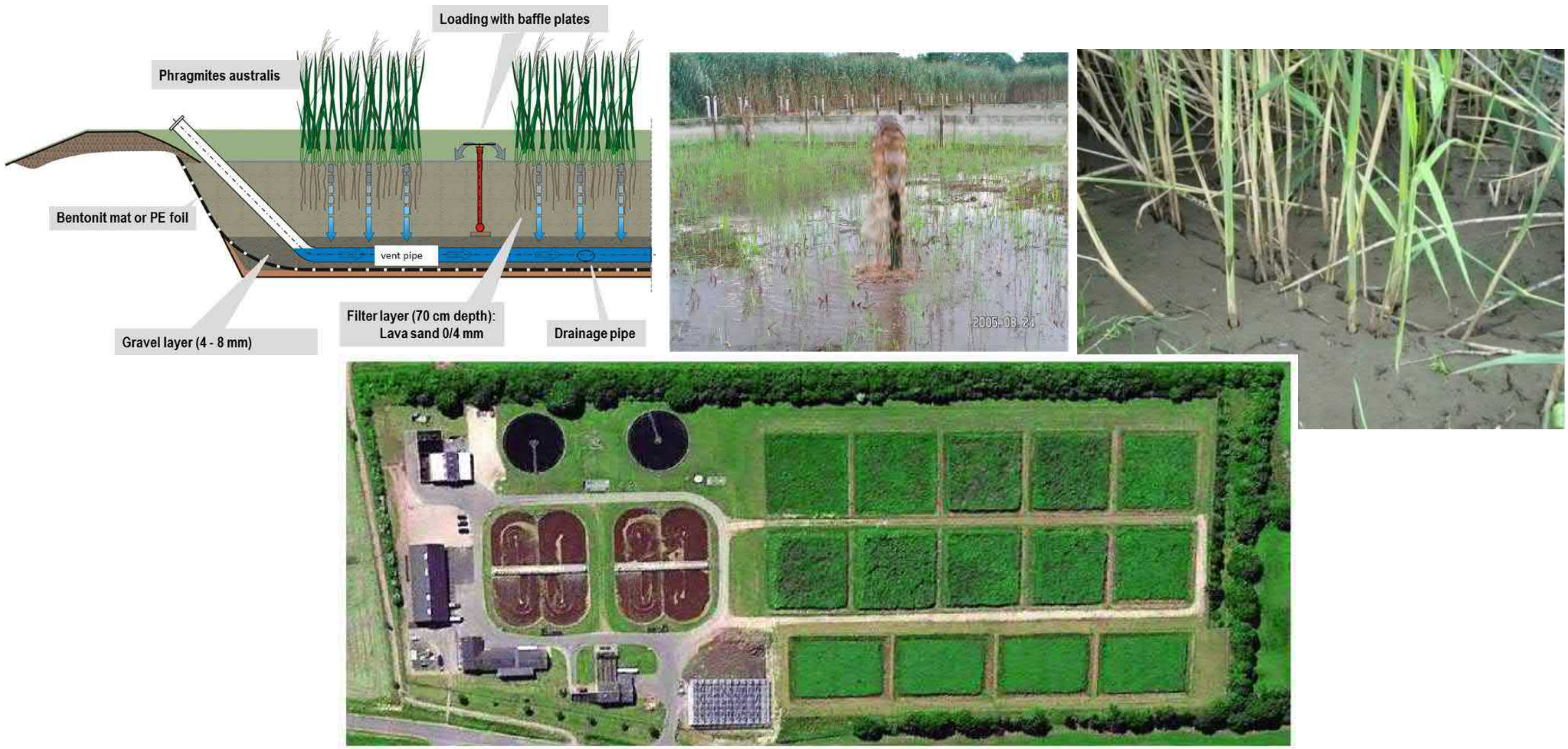


FIGURE 6-7. SLUDGE WETLANDS
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING



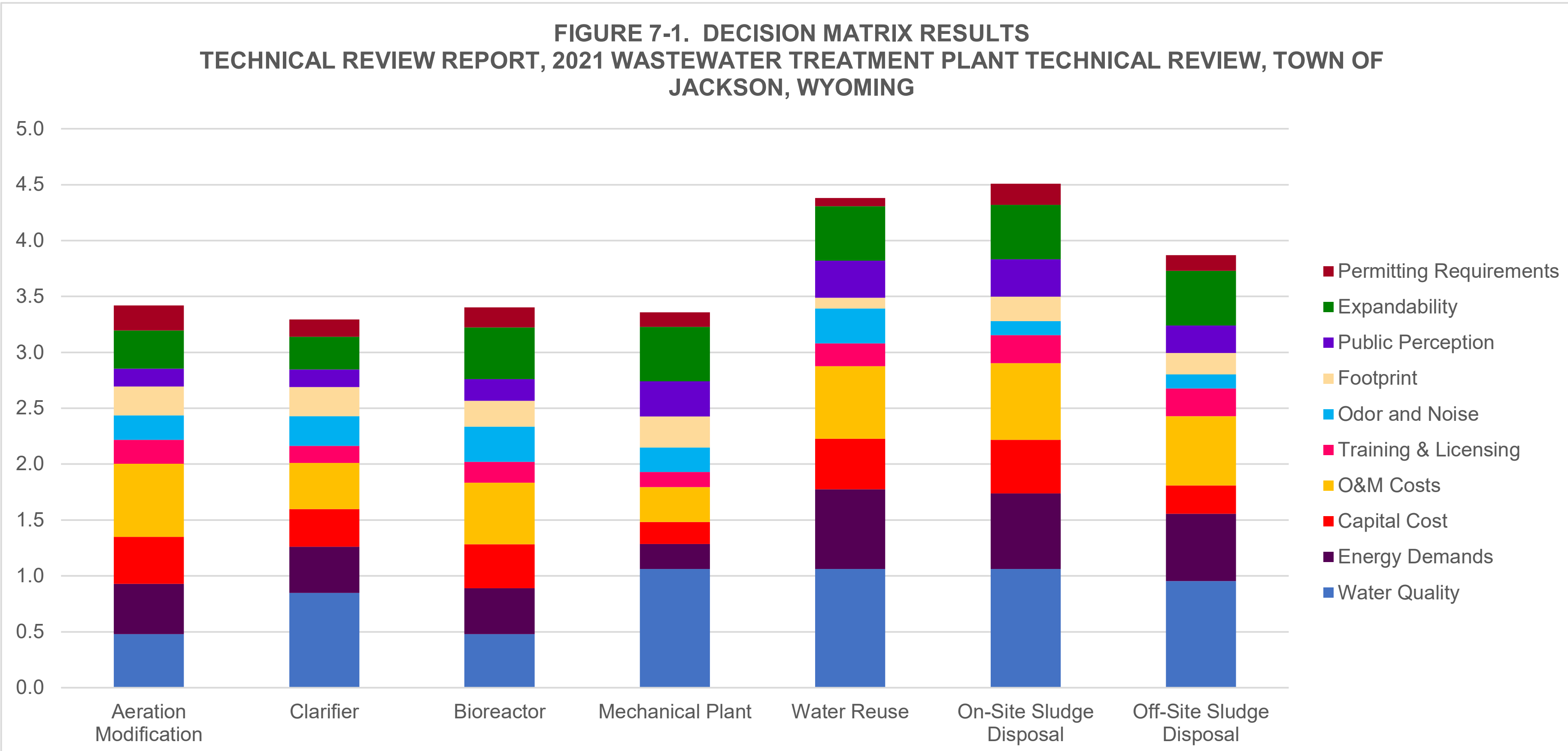


FIGURE 7-1. DECISION MATRIX RESULTS
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW, TOWN OF JACKSON, WYOMING
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Aeration Modification
Clarifier
Bioreactor
Mechanical Plant
Water Reuse
On-Site Sludge Disposal
Off-Site Sludge Disposal
Permitting Requirements
Expandability
Public Perception
Footprint
Odor and Noise
Training & Licensing
O&M Costs
Capital Cost
Energy Demands
Water Quality

APPENDIX A

TOWN OF JACKSON – WASTEWATER TREATMENT PLANT CONDITION ASSESSMENT

Influent Water Control Structure

Wastewater flow from the Town congregates into the wastewater treatment plant's (WWTP) influent lift station before entering the Headworks Building. Trihydro did not note any deficiencies or excessive concrete corrosion and the structure was in generally good condition.

Asset	Asset Type	Asset Class	Condition Rating	Current Performance
Influent Water Control Structure	Structure	Civil	Excellent	Excellent
	Function	Civil	Excellent	Excellent
	Pipes & Valves	Valves	Good	Good

Photo 1.1. Influent Structure

Headworks

The headworks process includes the grit chamber, mechanical bar screen and washer/compactor. The piping, troughs and equipment had minor deficiencies due to normal age and wear, but the processes were operating as designed and noted to be in good condition. Debris and trash are collected in a dumpster stored in the Headworks Building. No major deficiencies were noted during the assessment.

Asset	Asset Type	Asset Class	Condition Rating	Current Performance
Headworks	Structure	Civil	Good	Good
	Equipment	Mechanical	Good	Good
	Electrical & Controls	Electrical	Good	Good
	Pipes & Valves	Valves	Good	Good

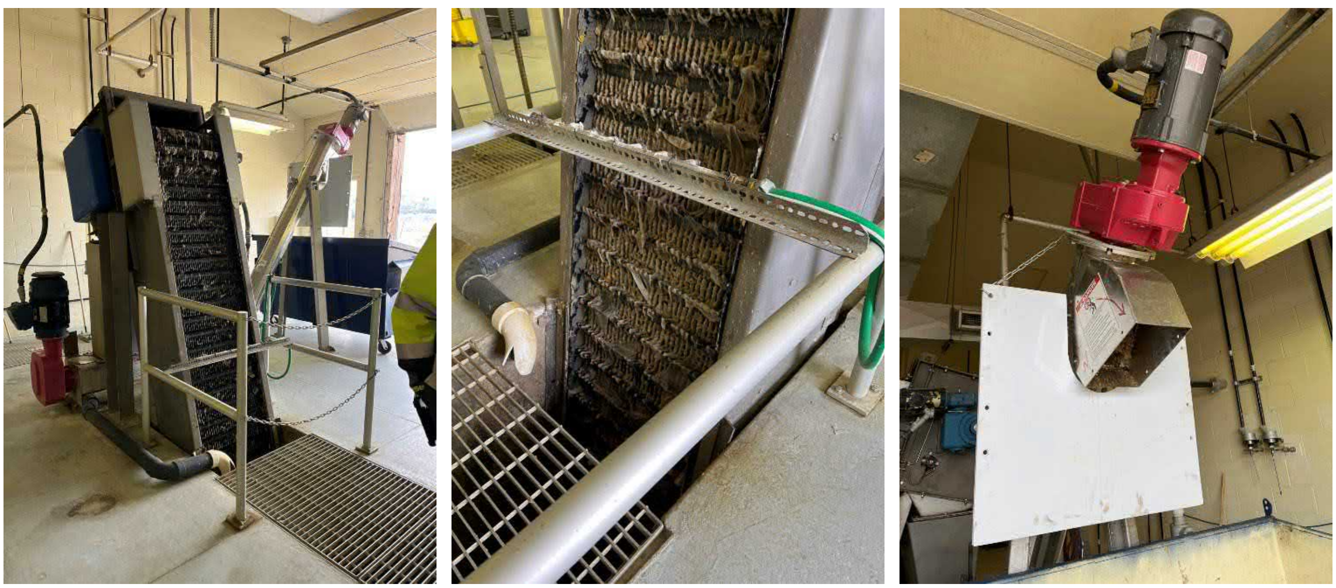


Photo 1.2. Headworks/Grit Chamber

Lagoons and Levees

The WWTP consists of ten cells with various operating characteristics. Equipment assessed with the lagoon cells included aerators/mixers (evaluated separately), levees, water control structures (evaluated separately), and piping and values. The dissolved air (DO) probes were not directly assessed but staff reports them to be in good working order. The lagoons were generally in good condition with some erosion of the banks noted. Trihydro recommends staff check levees quarterly and make repairs as needed to avoid more serious issues.

Asset	Asset Type	Asset Class	Condition Rating	Current Performance
Lagoon System	Structure	Civil	Good	Good
	Function	Civil	Good	Good
	Pipes & Valves	Valves	Good	Good

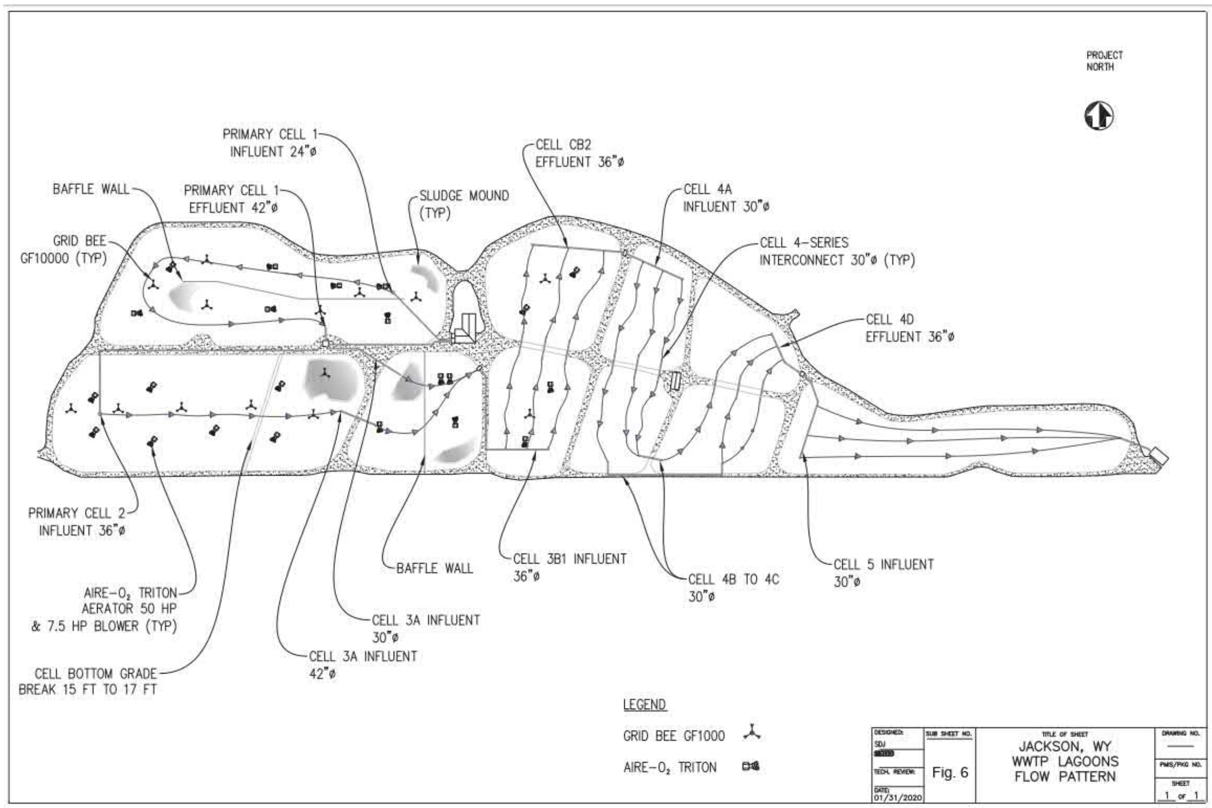


Photo 1.3. Lagoons Flow Path
Vista Engineering L.L.C. 2021. Town of Jackson Water and Sewer Systems Evaluation Report.

Aerators, Mixers and Diffusers

All lagoon cells in the WWTP have the ability to be aerated and mixed. Equipment associated with aeration and mixing including the Grid Bee Mixers and Triton aerators in Cells 1 through 3B2 and static tube diffusers in the remaining cells (Vista 2021). The Triton aerators are noted as fair because of their limitations to aerate and mix the cells. They have no adjustment to the mixing angle and tend to scour the bottom of Cells 1 and 2 preventing sludge to settle and digest. This also causes sludge to resuspend and transfer into Cell 3A. The Triton aerator's performance was rated as fair because they must be tilted out of the water in the winter if not in use to protect the ceramic bearing from permanent damaged by ice if left submerged while not in operation.

The operator noted many of the air distribution valves to Cells 4A, 4B, 4C and 4D may not be operable and should be replaced. This limits the staff's ability to distribute air as needed each cell.

Asset	Asset Type	Asset Class	Condition Rating	Current Performance
Aeration	Aerators	Mechanical	Good	Fair
	Mixers	Mechanical	Good	Good
	Power & Controls	Electrical	Good	Good

Photo 1.4. Cell 1

Photo 1.5. Cell 2

Photo 1.6. Cell 3A

Photo 1.7. Cell 3B1

Photo 1.8. Cell 3B2

Photo 1.9. Cell 4A

Photo 1.10. Cell 4B

Photo 1.11. Cell 4C

Photo 1.12. Cell 4D

Photo 1.13. Cell 5

Photo 1.14. Grid Bee Aerator

Photo 1.15. Grid Bee Aerator

UV Disinfection System

The Ultraviolet (UV) Disinfection Building is located on the west side of the plant, opposite from Cell 5, near the Barrow Pond. Trihydro visually observed the system and noted it to be in excellent condition. Flow measurement and effluent sampling occurs at the end of the UV channel. Permits for lagoon treatment systems allow for higher effluent TSS. High TSS results in more turbid water which effects transmittance of the UV disinfection. More energy is therefore required.

Asset	Asset Type	Asset Class	Condition Rating	Current Performance
UV Disinfection	Structure	Civil	Good	Excellent
	Function	Civil	Good	Good
	Power & Controls	Electrical	Excellent	Excellent

Photo 1.16. UV Disinfection

Photo 1.17. UV Disinfection

Barrow Pond and Tertiary Wetland Ponds

Following UV disinfection, the final plant effluent flows to the Barrow Pond where it is blended with water from a creek and discharged to three constructed wetland ponds. The wetland ponds are owned and maintained by Wyoming Game and Fish Department (WGFD). WGFD has partnered with Ducks Unlimited to build additional constructed wetlands (anticipated construction 2022) to increase the waterfowl habitat along the Snake River. Trihydro was only able to observe the wetlands from a distance during our assessment. There appeared to be large areas of algae and duckweed floating on the downwind sides of the ponds. This is an indication of an overabundance of nutrients (ammonia and phosphorous) that may be present. The overgrowth of floating vegetation prevents sunlight from penetrating the water and limits the growth of submergent vegetation. This reduces the treatment capabilities and habitat of the wetlands due to the overgrowth of vegetation.

The Barrow Pond provides mostly blending of the plant effluent with a natural creek. There is little polishing of water quality occurring.

The flow through the Tertiary Wetland Ponds appears to short circuit via a central channel from inlet to outfall. This limits their effective detention time. The sustained high-water depth and the amount of floating vegetation (duckweed), limits the growth of both emergent and submergent vegetation, thus reducing effectiveness.

Asset	Asset Type	Asset Class	Condition Rating	Current Performance
Barrow Pond	Structure	Civil	Good	Good
	Function	Civil	Good	Fair
Tertiary Wetland Ponds	Structure	Civil	Good	Good
	Function	Civil	Good	Fair

Photo 1.18. Barrow Pond

Photo 1.19. Wetland 1

Photo 1.20.Wetland 2

Photo 1.21.Wetland 3

Receiving Stream Characterization

The permitted outfall immediately follows the UV disinfection system, then treated wastewater flows into the Barrow Pond. The final outfall is from the last of the three tertiary wetland ponds and flows into the Snake River. Trihydro did not visually observe the wetland outfall or the condition of the Snake River as part of the assessment. Trihydro was not provided with river characteristics to review at the time of the assessment.

Asset	Asset Type	Asset Class	Condition Rating	Current Performance
Snake River Outfall	Structure	Civil	Good	Good
	Function	Civil	Good	Good

Photo 1.22. Barrow Pond Diversion to Wetlands

Photo 1.23. Snake River Outfall

Water Control Structures, Gates, Valves, and Transfer Piping

There were several water control structures (WCS) observed by Trihydro between the cells. These structures ranged from fair to good condition. The WCS are original to the WWTP. While still functional, wood covers and concrete has deteriorated. Trihydro recommends cleaning and lubricating valves and gates to extend their life and improve operability.

Asset	Asset Type	Asset Class	Condition Rating	Current Performance
Influent Water Control Structure	Structure	Civil	Excellent	Excellent
	Function	Civil	Excellent	Excellent
	Pipes & Valves	Valves	Good	Good
Cell 1 and 2 Control Structure	Structure	Civil	Fair	Good
	Function	Civil	Good	Good
	Pipes & Valves	Valves	Good	Good
Cell 3A Control Structure	Structure	Civil	Good	Good
	Function	Civil	Good	Good
	Pipes & Valves	Valves	Good	Good
Cell 4 Control Structure	Structure	Civil	Good	Good
	Function	Civil	Good	Good
	Pipes & Valves	Valves	Good	Good
Cell 5 Control Structure	Structure	Civil	Good	Good
	Function	Civil	Good	Good
	Pipes & Valves	Valves	Good	Good

Photo 1.24. Influent Water Control Structure

Photo 1.25. Cell 1 and 2 Water Control Structure

Photo 1.26. Cell 3A Water Control Structure

Photo 1.27. Cell 4 Water Control Structure

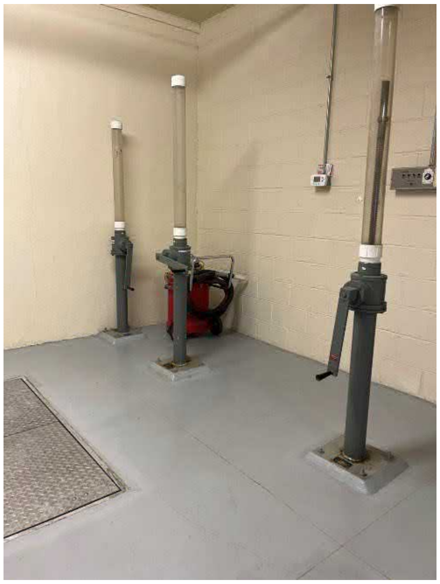


Photo 1.28. Cell 5 Water Control Structure

Motor and Pump Control Centers

Trihydro observed the three main pump stations and motor and control centers associated with the WWTP. The pumps appeared to generally be in good condition and the Town did not note any issues or deficiencies. Trihydro observed several SCADA-instrumentation panels and controls throughout the WWTP. Based on discussions with staff, the equipment appeared to be generally in excellent condition. The Town did not note any issues or concerns with their current operations.

The two Lamsom multi-stage blowers are 250 horsepower each. The blowers are rated as fair because they are inefficient to operate and therefore rarely used. They are maintained in good condition in case they are needed.

The single HIS high-speed turbo blower is in excellent condition but is run continuously. Its capacity is rated as fair because there is no redundancy to this blower.

Asset	Asset Type	Asset Class	Condition Rating	Current Performance
Influent Pumps	Structure	Civil	Good	Good
	Power & Controls	Electrical	Good	Good
	Pumps	Mechanical	Good	Good
	Pipes & Valves	Valves	Good	Good
	Capacity	Mechanical	Good	Good
Intermediate Pumps	Structure	Civil	Good	Good
	Power & Controls	Electrical	Good	Good
	Pumps	Mechanical	Good	Good
	Pipes & Valves	Valves	Good	Good
	Capacity	Mechanical	Good	Good
UV Effluent Pumps	Structure	Civil	Good	Good
	Power & Controls	Electrical	Good	Good

Asset	Asset Type	Asset Class	Condition Rating	Current Performance
	Pumps	Mechanical	Good	Good
	Pipes & Valves	Valves	Good	Good
	Capacity	Mechanical	Good	Good
Lampson Blowers	Structure	Civil	Good	Good
	Power & Controls	Electrical	Good	Good
	Blowers	Mechanical	Good	Fair
	Pipes & Valves	Valves	Good	Good
	Capacity	Mechanical	Good	Good
HSI Blower	Structure	Civil	Good	Good
	Power & Controls	Electrical	Good	Good
	Blowers	Mechanical	Good	Good
	Pipes & Valves	Valves	Good	Good
	Capacity	Mechanical	Good	Fair
Generators	Structure	Civil	Good	Good
	Power & Controls	Electrical	Good	Good
	Genset	Mechanical	Good	Good
	Pipes & Valves	Valves	Good	Good
	Capacity	Mechanical	Good	Good

Photo 1.29. Influent Pumps

Photo 1.30. Influent Pumps SCADA

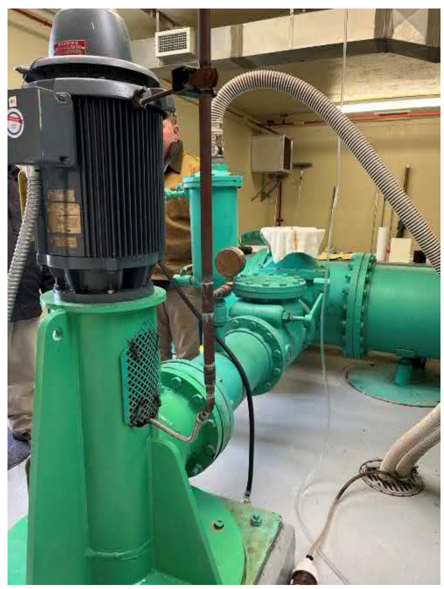


Photo 1.31. UV Pumps

Photo 1.32. UV SCADA

Photo 1.33. Lamson Blower

Photo 1.34. HSI Blower

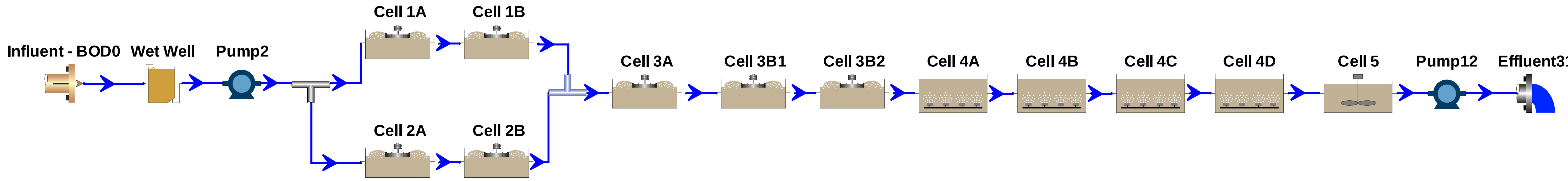
Photo 1.35. UV Generator

APPENDIX B

TOWN OF JACKSON – WASTEWATER TREATMENT PLANT CURRENT CONDITIONS BIOWIN® MODELING RESULTS

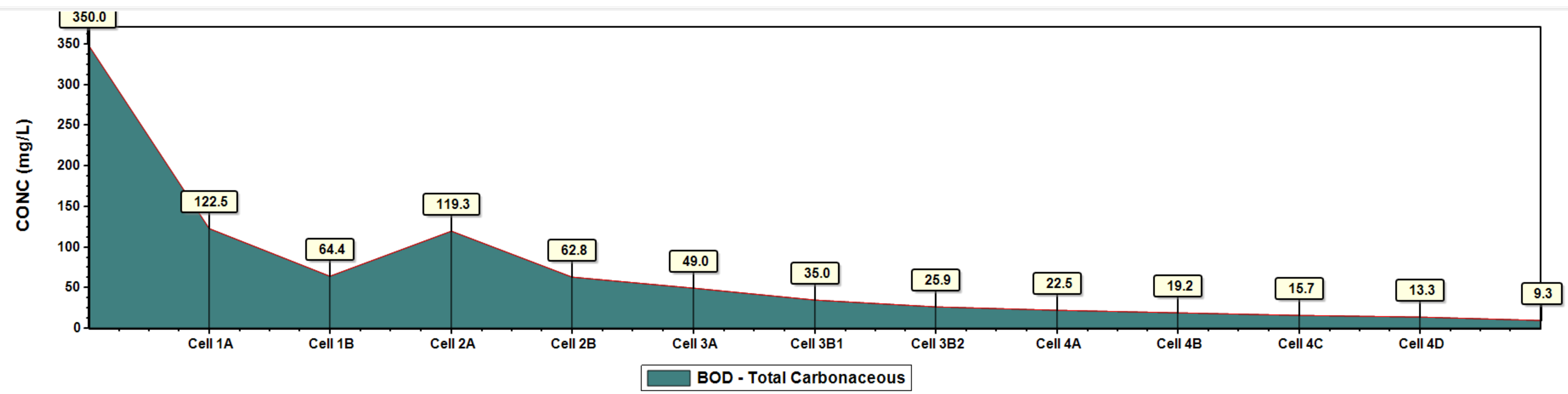
TOWN OF JACKSON
WASTEWATER TREATMENT PLANT

CONDITION: Winter, Existing Conditions, All Cells Aerated and Mixed except Cell 5



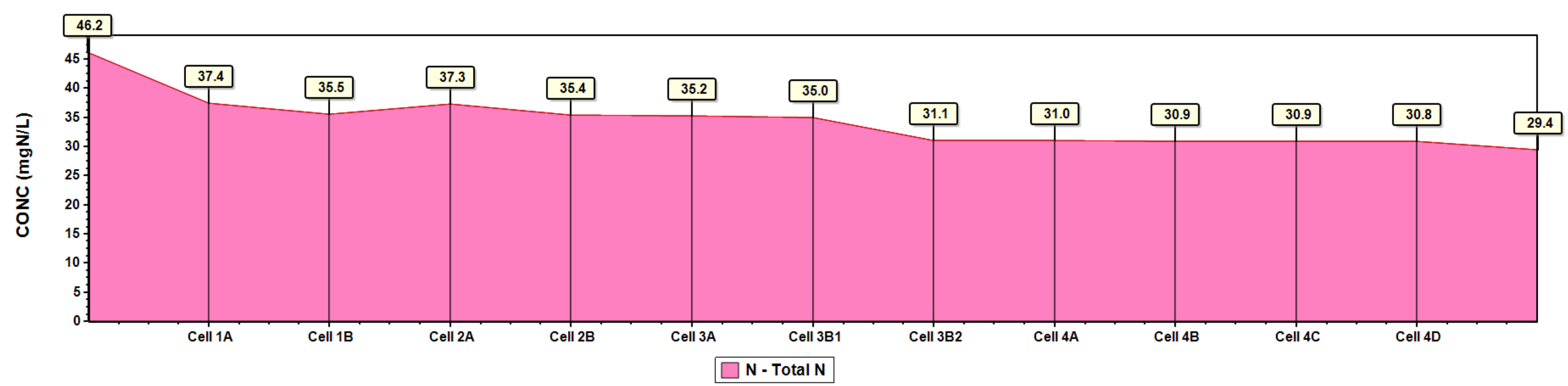
Influent Characteristics

Flow	2.50 mgd
COD - Total	713.69 mg/L
N - Total Kjeldahl Nitrogen	46.10 mgN/L
P - Total P	8.00 mgP/L
ISS Total	45.30 mg/L
S - Total S	8.00 mg/L
Volatile suspended solids	167.00 mg/L
Total suspended solids	212.30 mg/L
BOD - Total Carbonaceous	350.00 mg/L
pH	8.50



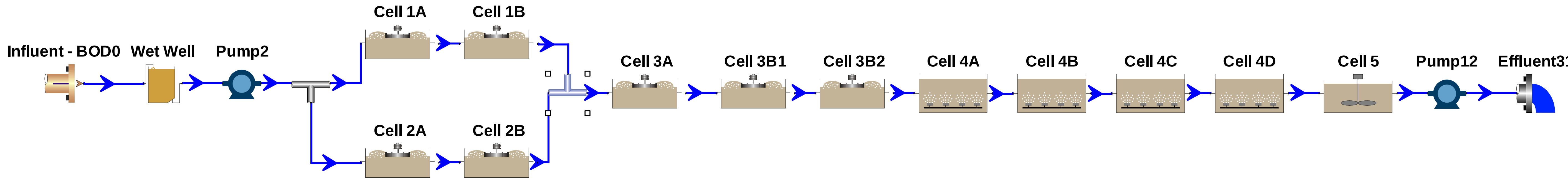
Effluent Characteristics

Flow	2.50 mgd
N - Ammonia	0.48 mgN/L
N - Nitrate	17.89 mgN/L
N - Nitrite	0.10 mgN/L
N - Filtered TKN	1.59 mgN/L
N - Total N	29.38 mgN/L
P - Soluble phosphate	4.92 mgP/L
P - Total P	8.00 mgP/L
Total suspended solids	179.13 mg/L
COD - Total	222.61 mg/L
BOD - Total Carbonaceous	9.27 mg/L
pH	8.27



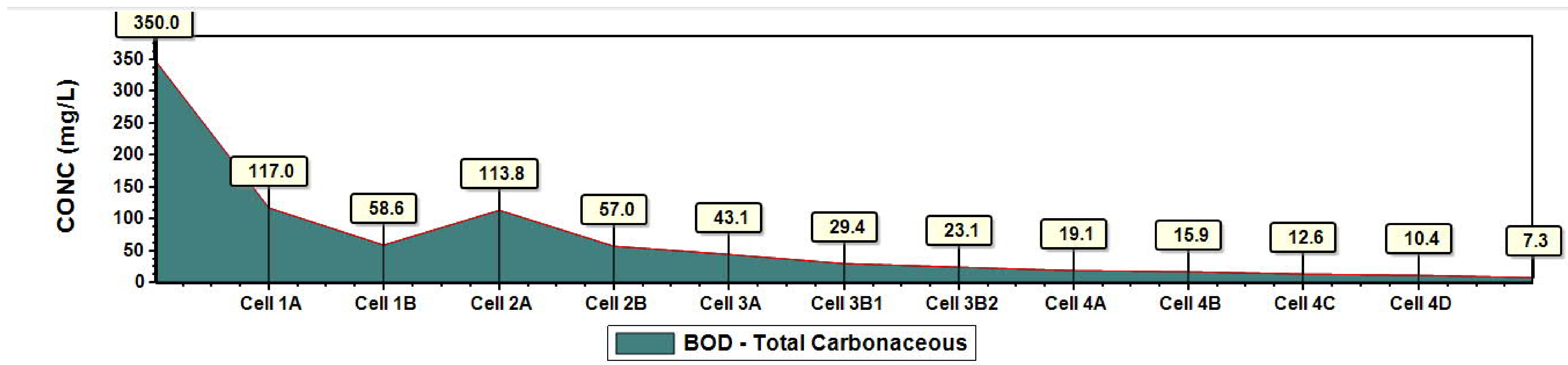
TOWN OF JACKSON
WASTEWATER TREATMENT PLANT

CONDITION: Summer, Existing Conditions, All Cells Aerated and Mixed except Cell 5



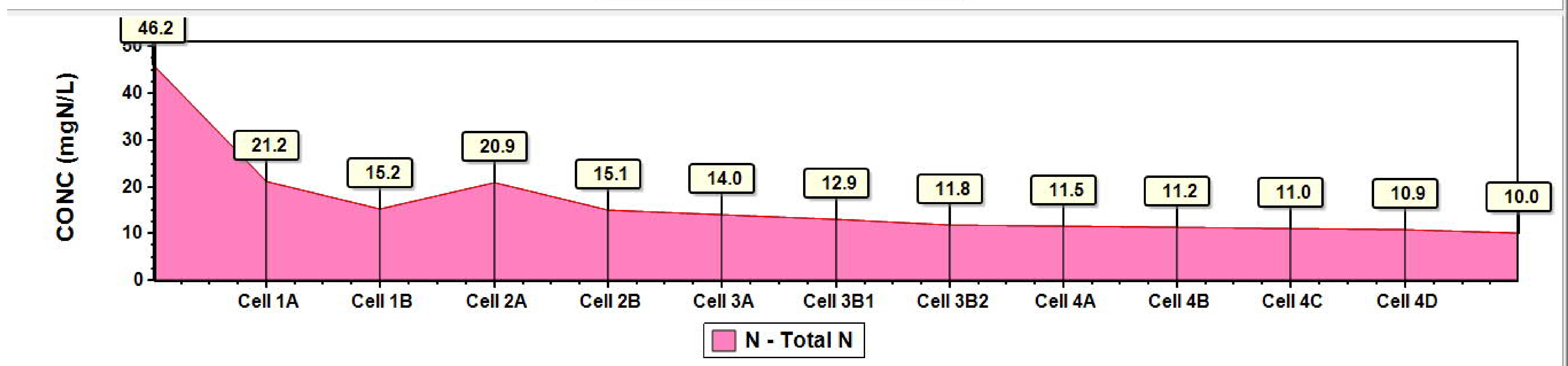
Influent Characteristics

Flow	2.50 mgd
COD - Total	713.69 mg/L
N - Total Kjeldahl Nitrogen	46.10 mgN/L
P - Total P	8.00 mgP/L
ISS Total	45.30 mg/L
S - Total S	8.00 mg/L
Volatile suspended solids	167.00 mg/L
Total suspended solids	212.30 mg/L
BOD - Total Carbonaceous	350.00 mg/L
pH	8.50



Effluent Characteristics

Flow	2.50 mgd
N - Ammonia	0.14 mgN/L
N - Nitrate	0.01 mgN/L
N - Nitrite	0.00 mgN/L
N - Filtered TKN	1.15 mgN/L
N - Total N	9.97 mgN/L
P - Soluble phosphate	5.23 mgP/L
P - Total P	8.00 mgP/L
Total suspended solids	167.92 mg/L
COD - Total	208.10 mg/L
BOD - Total Carbonaceous	7.32 mg/L
pH	8.55



APPENDIX C

DECISION MATRIX SCORING SUPPORTING INFORMATION

DRAFT FOR REVIEW

DECISION MATRIX SCORING SUPPORTING INFORMATION

Alternative - Aeration Modifications

Capital Cost Estimate — **Score**

Tasks and Activities

1. Engineering Costs	$ 700,000
2. Equipment Modifications and Contingency	$ 5,005,000

Assumptions

Total Cost $ 5,705,000

Engineering Costs

Tasks and Activities	Tasks and Activities	
- Project management	Engineering and Design	$ 400,000
- Design and project coordination	Permitting	$ 40,000
- Bid phase services	Bid Documents	$ 10,000
- Construction oversight (RPR) and startup	Construction Oversight	$ 250,000

Engineering Cost $ 700,000

Equipment Modifications and Contingency

Description	Estimated Quantity	Unit	Unit Price	Extended Price
High Efficiency Turbo Blowers, 200 HP	5	EA	$ 200,000	$ 1,000,000
Air Headers	1	EA	$ 1,000,000	$ 1,000,000
Air Diffuser	1	EA	$ 1,000,000	$ 1,000,000
Electrical	1	LS	$ 500,000	$ 500,000
SCADA	1	LS	$ 200,000	$ 200,000
Blower Building	1	LS	$ 150,000	$ 150,000
30% Contingency				$ 1,155,000

Note: Costs based on 2022 (current) costs

Equipment Cost $ 5,005,000

Annual Operating and Maintenance Cost Estimate — **Score**

Tasks and Activities

Operations and Maintenance	$ 30,000
Electrical Demands	$ 156,776
Chemical Additives	$ -
25% Contingency	$ 46,694

Total Cost $ 233,470

Water Quality Expectations — **Score**

Water quality will improve for Total Nitrogen; however, TSS and BOD will remain relatively stable.

Energy Demands Estimate — **Score**

New aeration demands and equipment installation will increase energy demands. Blowers would be high efficiency and there is a possibility some current equipment may be replaced.

Equipment	HP	Loading	KW/hr/Yr	$ KW/hr	Annual Power
5	200	60%	3,919,399	$ 0.04	$ 156,776

Training and Licensing Requirements — **Score**

Minimal training will be required.

Odor and Noise Impacts — **Score**

Addition of new equipment could result in increased noise. There is a possibility for odor development as well as the system is fine tuned.

Footprint Modifications — **Score**

There will be no footprint modification.

Public Perception — **Score**

Public perception will likely not change much due to lack of understanding.

Expandability Potential — **Score**

The aeration system is expandable to accommodate future WWTP expansion.

Permitting Requirements — **Score**

There are no additional permitting requirements or modifications.

DECISION MATRIX SCORING SUPPORTING INFORMATION

Alternative - Clarifier

Capital Cost Estimate — Score

Tasks and Activities

1. Engineering and Contingency Costs	$ 195,000
2. Clarifier Construction	$ 2,424,500

Assumptions

Aeration improvements will be required	$ 5,705,000

Activity	Description	Total Cost	$ 8,324,500

Engineering and Contingency Costs

Tasks and Activities	Tasks and Activities	
- Project management	Engineering and Design	$ 75,000
- Design and project coordination	Bid Documents	$ 15,000
- Bid phase services	Certification Report	$ 5,000
- Construction oversight (RPR) and startup	Construction Oversight	$ 100,000
	Engineering Cost	**$ 195,000**

Clarifier Construction

Description	Estimated Quantity	Unit	Unit Price	Extended Price
Clarifiers	2	EA	$ 175,000	$ 350,000
Equipment Installation	2	EA	$ 270,000	$ 540,000
Waste Activated Sludge Pumps, 100 HP	1	LS	$ 175,000	$ 175,000
Return Piping - Estimated 12" diameter	3,000	LF	$ 150	$ 450,000
Excavation and Fill	1	LS	$ 250,000	$ 250,000
Electrical and Instrumentation	1	LS	$ 100,000	$ 100,000
30% Contingency				$ 559,500

Note: Costs based on 2022 (current) costs — **Equipment Cost $ 2,424,500**

Annual Operating and Maintenance Cost Estimate — Score

Tasks and Activities

Operations and Maintenance	$ 10,000
Electrical Demands	$ 20,903
Chemical Additives	$ 200,000
25% Contingency	$ 57,726
Aeration Operations and Maintenance	$ 233,470
Total Cost	**$ 522,099**

Water Quality Expectations — Score

This will improve water quality as Total Nitrogen, TSS, and CBOD will all be decreased.

Energy Demands Estimate — Score

There are very little energy demands associated with this system. A small pump will be installed to move the waste activated sludge. Energy demands will largely be increased from the aeration modifications.

Equipment	HP	Loading	KW/hr/Yr	$ KW/hr	Annual Power	
1	100	80%	522,587	$ 0.04	$ 20,903	Clarifier

Equipment	HP	Loading	KW/hr/Yr	$ KW/hr	Annual Power	
5	200	60%	3,919,399	$ 0.04	$ 156,776	Aeration Modifications

Training and Licensing Requirements — Score

Training will be necessary for system operations and maintenance required for a new clarifier.

Odor and Noise Impacts — Score

No long-term odor or noise would be added with this system.

Footprint Modifications — Score

No footprint modification is anticipated. The clarifier system is assumed to be contained within Cell 5.

Public Perception — Score

Public perception may be negatively impacted with this modification due to lack of education and understanding. Cell 5 would potentially be used as a sludge holding basin which could cause confusion since sludge has been perceived as being discharged into the Snake River. As sludge accumulates in the final basin, the community may think it has been discharged all along.

Expandability Potential — Score

The clarifier could be expanded; however, it won't necessarily improve discharge with population growth.

Permitting Requirements — Score

Permitting would likely be required for the sludge holding pond and clarifier operation. A Wyoming Department of Environmental Quality/Water Quality Division Permit to Construct would be required for construction.

Alternative - Bioreactor

Capital Cost Estimate — **Score**

Tasks and Activities

1. Engineering and Contingency Costs	$ 700,000
2. Bioreactor Construction	$ 5,657,600

Assumptions

Activity	Description	Total Cost	$ 6,357,600

Engineering and Contingency Costs

Tasks and Activities	Tasks and Activities	
- Project management	Engineering and Design	$ 400,000
- Design and project coordination	Permitting	$ 40,000
- Bid phase services	Bid Documents	$ 10,000
- Construction oversight (RPR) and startup	Construction Oversight	$ 250,000
	Engineering Cost	**$ 700,000**

SAGR Bioreactor Construction

Description	Estimated Quantity	Unit	Unit Price	Extended Price
Rock Media	41,300	TON	$ 40	$ 1,652,000
High Efficiency Turbo Blowers, 200 HP	6	EA	$ 200,000	$ 1,200,000
Aeration System	6	EA	$ 75,000	$ 450,000
Walls and Liner of Bioreactor	6	EA	$ 75,000	$ 450,000
Excavation and Fill	1	LS	$ 100,000	$ 100,000
Piping and Valves	1	LS	$ 225,000	$ 225,000
Electrical and Instrumentation	1	LS	$ 275,000	$ 275,000
30% Contingency				$ 1,305,600

Note: Costs based on 2022 (current) costs — **Equipment Cost $ 5,657,600**

Annual Operating and Maintenance Cost Estimate — **Score**

Tasks and Activities	
Operations and Maintenance	$ 30,000
Electrical Demands	$ 188,131
Chemical Additives	$ -
25% Contingency	$ 54,533
Total Cost	**$ 272,664**

Water Quality Expectations — **Score**

Water quality will improve for Ammonia but Total Nitrogen will remain similar.

Energy Demands Estimate — **Score**

Because of the new aeration demands and installation of equipment, energy demands will go up slightly. The blowers would be high efficiency and there is a possibility it will replace some of the current equipment.

Equipment	HP	Loading	KW/hr/Yr	$ KW/hr	Annual Power
6	200	60%	4,703,279	$ 0.04	$ 188,131

Training and Licensing Requirements — **Score**

Minimal training will be required.

Odor and Noise Impacts — **Score**

There will be no long-term odor or noise impacts.

Footprint Modifications — **Score**

No footprint modifications should be encountered with the exception of new piping for the system.

Public Perception — **Score**

The bioreactor should not negatively impact public perception.

Expandability Potential — **Score**

The bioreactor will be installed in a series of modules. Additions can be made as expansion is required.

Permitting Requirements — **Score**

There will be some permitting requirements for this improvement, including, a permit to construct and changes to the current WYPDES discharge permit.

DRAFT FOR REVIEW

DECISION MATRIX SCORING SUPPORTING INFORMATION

Alternative - Mechanical Plant

Capital Cost Estimate — **Score**

Tasks and Activities

1. Engineering and Contingency Costs	$ 3,120,000
2. 5 MGD Mechanical Plant	$ 29,055,000

Assumptions

Activity	Description	Total Cost	$ 32,175,000
Engineering and Contingency Costs			
Tasks and Activities	Tasks and Activities		
- Project management	Engineering and Design		$ 2,000,000
- Design and project coordination	Permitting		$ 100,000
- Bid phase services	Bid Documents		$ 20,000
- Construction oversight (RPR) and startup	Construction Oversight		$ 1,000,000
		Engineering Cost	**$ 3,120,000**

5 MGD Mechanical Plant Construction

Description	Estimated Quantity	Unit	Unit Price	Extended Price
Mechanical BNR Equipment	1	LS	$ 9,000,000	$ 9,000,000
Concrete Basins	1	LS	$ 8,000,000	$ 8,000,000
Piping and Valves	1	LS	$ 1,500,000	$ 1,500,000
Filtration	1	LS	$ 2,000,000	$ 2,000,000
Pumps	1	LS	$ 900,000	$ 900,000
Electrical	1	LS	$ 500,000	$ 500,000
SCADA	1	LS	$ 200,000	$ 200,000
Excavation and Backfill	1	LS	$ 250,000	$ 250,000
30% Contingency				$ 6,705,000
			Equipment Cost	**$ 29,055,000**

Note: Costs based on 2022 (current) costs

Annual Operating and Maintenance Cost Estimate — **Score**

Tasks and Activities	
Operations and Maintenance	$ 75,000
Electrical Demands	$ 640,169
Chemical Additives	$ -
25% Contingency	$ 178,792
Total Cost	**$ 893,961**

Water Quality Expectations — **Score**

A mechanical plant has the ability to achieve the lowest consistent effluent concentrations.

Energy Demands Estimate — **Score**

Energy demands will increase with a mechanical plant. This will include aeration of the new basins, the aerobic digesters, and operation of the sludge wasting pumps.

Equipment	HP	Loading	KW/hr/Yr	$ KW/hr	Annual Power
1	3,500	70%	16,004,213	$ 0.04	$ 640,169

Training and Licensing Requirements — **Score**

A mechanical plant would require additional training and licensing to operate.

Odor and Noise Impacts — **Score**

Noise would likely increase with the improvement. Odor could also occur with the digester operation.

Footprint Modifications — **Score**

No footprint modifications are required. The mechanical plant can fit within current Cell 3B1.

Public Perception — **Score**

Mechanical plants are widely used around the country. However, capital costs, operations and maintenance costs, and energy useage will significantly increase.

Expandability Potential — **Score**

The mechanical plant can be expanded with module additions to meet future demands.

Permitting Requirements — **Score**

The mechanical plant would require a new WYPDES Permit and a Permit to Construct.

Add On - Water Reuse

Capital Cost Estimate

Score

Tasks and Activities

1. Engineering and Contingency Costs	$ 620,000
2. Equipment Additions	$ 5,596,500

Assumptions

Total Cost $ 6,216,500

Engineering and Contingency Costs

Tasks and Activities	Tasks and Activities	
- Project management	Engineering and Design	$ 300,000
- Design and project coordination	Permitting	$ 60,000
- Bid phase services	Bid Documents	$ 10,000
- Construction oversight (RPR) and startup	Construction Oversight	$ 250,000

Engineering Cost $ 620,000

Equipment Additions

Description	Estimated Quantity	Unit	Unit Price	Extended Price
Filtration System	1	EA	$ 2,000,000	$ 2,000,000
High Service Pumps	1	LS	$ 100,000	$ 100,000
Distribution Piping - Estimated 12" diameter	15,000	LF	$ 130	$ 1,950,000
Pneumatic Tank, 5,000 gallons	1	EA	$ 30,000	$ 30,000
Electrical	1	LS	$ 150,000	$ 150,000
SCADA	1	LS	$ 75,000	$ 75,000
30% Contingency				$ 1,291,500

Note: Costs based on 2022 (current) costs

Equipment Cost $ 5,596,500

Annual Operating and Maintenance Cost Estimate

Score

Tasks and Activities

Operations and Maintenance	$ 20,000
Electrical Demands	$ 36,581
Chemical Additives (Sodium Hypochlorite for increased disinfection)	$ 75,000
25% Contingency	$ 32,895

Total Cost $ 164,476

Water Quality Expectations

Score

Higher quality filtered effluent would discharge to the Snake River (if any). Filtration removes solids and improves water quality.

Energy Demands Estimate

Score

Some additional energy would be required to pump the water through the distribution piping.

Equipment	HP	Loading	KW/hr/Yr	$ KW/hr	Annual Power
1	200	70%	914,526	$ 0.04	$ 36,581

Training and Licensing Requirements

Score

Some level of training will be required to operate the high service pumps and filtration system.

Odor and Noise Impacts

Score

There would be no change in odor and noise.

Footprint Modifications

Score

Piping would need to be installed outside the current WWTP footprint to where reuse water would be discharged.

Public Perception

Score

Water reuse could improve public perception. There would be less discharge to the Snake River.

Expandability Potential

Score

As more water enters the WWTP, more water can be discharged for reuse.

Permitting Requirements

Score

Water reuse would require changes to the WYPDES permit.

Add-On - On-site Sludge Disposal

Capital Cost Estimate — **Score**

Tasks and Activities

1. Engineering and Contingency Costs	$ 323,000
2. Removal Costs	$ 3,905,000

Assumptions

Activity	Description	Total Cost	$ 4,228,000
Engineering and Contingency Costs			
Tasks and Activities	Tasks and Activities		
- Project management	Engineering and Design		$ 125,000
- Design and project coordination	Permitting		$ 40,000
- Bid phase services	Bid Documents		$ 8,000
- Construction oversight (RPR) and startup	Construction Oversight		$ 150,000
		Engineering Cost	**$ 323,000**

Sludge Removal Costs

Description	Estimated Quantity	Unit	Unit Price	Extended Price
Dredge, Dewater, Landfill Application Cell 1	32,000	CY	$ 25	$ 800,000
Dredge, Dewater, Landfill Application Cell 2	30,000	CY	$ 25	$ 750,000
Dredge, Dewater, Landfill Application Cell 3A	12,000	CY	$ 25	$ 300,000
Sludge Disposal Pond (8 acres)	1	EA	$ 1,500,000	$ 1,500,000
30% Contingency				$ 555,000
Note: Costs based on 2022 (current) costs			**Equipment Cost**	**$ 3,905,000**

Annual Operating and Maintenance Cost Estimate — **Score**

Tasks and Activities

Operations and Maintenance		$ -
Electrical Demands		$ -
Chemical Additives		$ -
25% Contingency		$ -
	$0.00	**$ -**

Water Quality Expectations — **Score**

Removing the sludge will increase overall WWTP efficiency.

Energy Demands Estimate — **Score**

No energy would be associated with this improvement.

Training and Licensing Requirements — **Score**

No training or licensing would be required.

Odor and Noise Impacts — **Score**

There would be noise increases during sludge removal. Odor could also be an issue as sludge moved.

Footprint Modifications — **Score**

There would need to be some modification to the current footprint to construct a sludge disposal pond.

Public Perception — **Score**

The Town is getting rid of the sludge which could improve public perception.

Expandability Potential — **Score**

There would be no need for expandability. It will, however, improve current operations as influent flow increases.

Permitting Requirements — **Score**

Some permitting may be required to apply the sludge on-site.

DECISION MATRIX SCORING SUPPORTING INFORMATION

Add-On - Off-site Sludge Disposal

Capital Cost Estimate | **Score**

Tasks and Activities

1. Engineering and Contingency Costs	$ 86,000
2. Removal Costs	$ 9,139,000

Assumptions

Activity	Description	Total Cost	$ 9,225,000
Engineering and Contingency Costs			
Tasks and Activities	Tasks and Activities		
- Project management	Engineering and Design		$ 50,000
- Design and project coordination	Permitting		$ 30,000
- Bid phase services	Bid Documents		$ 6,000
- Construction oversight (RPR) and startup	Construction Oversight		$ -
		Engineering Cost	**$ 86,000**

Sludge Removal Costs

Description	Estimated Quantity	Unit	Unit Price	Extended Price
Dredge, Dewater, Landfill Application Cell 1	32,000	CY	$ 95	$ 3,040,000
Dredge, Dewater, Landfill Application Cell 2	30,000	CY	$ 95	$ 2,850,000
Dredge, Dewater, Landfill Application Cell 3A	12,000	CY	$ 95	$ 1,140,000
30% Contingency				$ 2,109,000
Note: Costs based on 2022 (current) costs			**Equipment Cost**	**$ 9,139,000**

Annual Operating and Maintenance Cost Estimate | **Score**

Tasks and Activities

Operations and Maintenance	$ -
Electrical Demands	$ -
Chemical Additives	$ -
25% Contingency	$ -
$0.00	**$ -**

Water Quality Expectations | **Score**

Removing the sludge will increase overall WWTP efficiency.

Energy Demands Estimate | **Score**

No energy would be associated with this improvement.

Training and Licensing Requirements | **Score**

No training or licensing would be required.

Odor and Noise Impacts | **Score**

There would be noise increases during sludge removal. Odor could also be an issue as sludge is moved.

Footprint Modifications | **Score**

The collected sludge would be removed off-site. A footprint would need to be accounted for to place the removed sludge.

Public Perception | **Score**

The Town is getting rid of the sludge which could improve public perception.

Expandability Potential | **Score**

There would be no need for expandability. It will, however, improve current operations as influent flow increases.

Permitting Requirements | **Score**

Permitting will be required to apply the sludge at a landfill offsite.

APPENDIX D

TOWN OF JACKSON – 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW, DECISION MATRIX SCORING SUMMARY

DRAFT FOR CLIENT REVIEW

TOWN OF JACKSON - 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
DECISION MATRIX SCORING SUMMARY
TOWN OF JACKSON, WYOMING

Trihydro received 2021 Wastewater Treatment Plant Technical Review Decision Matrix criteria/alternative scoring recommendations from the Town of Jackson (Town) and three Steering Committee members: Protect Our Water Jackson Hole (POWJH), American Rivers, and Teton Conservation District.

Trihydro provided the Town and Steering Committee example scoring and supporting documents for reference. The Town and Steering Committee provided scores for each alternative based on the ten criteria. The Decision Matrix was populated with the Town- and Steering Committee-provided scoring and results averaged to determine final scoring. Trihydro's example scoring was not averaged into the final scoring. A summary of the contributors' results and reasonings are discussed below.

As has been discussed, all alternatives can be implemented in a phased approach. Trihydro recommends evaluating funding opportunities and rate impacts as the Town and Steering Committee consider a path forward.

ALTERNATIVES

Aeration Modifications

The aeration modifications scores ranged from 2.5 to 4.1 with a final average score of 3.4. The Water Quality, Public Perception, and Expandability criterion had the broadest scoring ranges.

Steering Committee consideration items:

- Sludge removal (on-site or off-site) would be an additional cost.

Clarifier System

The clarifier system scores ranged from 2.9 to 3.8 with a final average score of 3.3. Water Quality had the broadest scoring range.

The aeration modification would be required with the clarifier system alternative, which could be completed in a phased approach. The clarifier system alternative will require sludge disposal as an additional cost.

The clarifier system has the ability to reduce effluent nutrients year-round.

Steering Committee consideration items:

- The clarifier system has the ability to reduce ammonia, phosphorus, and nitrate concentrations in the effluent. Winter improvements are the most notable improvements over the current lagoon system.
- Sludge removal (on-site or off-site) would be an additional cost.

Bioreactor

The bioreactor scores ranged from 2.9 to 3.9 with a final average score of 3.4.

Steering Committee consideration items:

- Sludge removal (on-site or off-site) would be an additional cost.

Mechanical Wastewater Treatment Plant

The mechanical wastewater treatment plant scores ranged from 3.0 to 3.7 with a final average score of 3.4. The Permitting Requirements and Public Perception criterion had the broadest scoring ranges.

This alternative will produce stable effluent concentrations year-round. The water quality improvements would most likely yield the highest improvements annually.

Steering Committee members consideration items:

- Consider additional solar arrays to offset electricity demands
- Install a micro-hydro facility at the outfall to address increased energy demands
- Mechanical plant operation and maintenance (O&M) costs are high
- Increased electrical demands
- No sludge disposal (on-site or off-site) required
- A long-term, expandable solution with the ability to meet future demands including connections from surrounding water and sewer districts
- The small footprint allows for evaluating using the remaining land for other beneficial use (i.e., open space, solar energy, etc.)
- Land could potentially be leased to help offset the mechanical plant capital costs
- Mechanical treatment plant provides best opportunity to reduce nutrients to the Snake River

ADD-ONS

Water Reuse

The water reuse alternative scores ranged from 4.0 to 4.5 with a final average score of 4.4. Scores were generally the same between the four contributors.

Sludge Removal - On-Site Application

Sludge removal for on-site application scores ranged from 4.4 to 4.6 with a final average score of 4.5. Scores were generally the same between the four contributors.

Sludge Removal – Off-Site Disposal

Sludge removal with off-site disposal scores ranged from 2.9 to 4.5 with a final average score of 3.9. Public Perception had the broadest scoring range (1 to 5).

TABLE 1. FINAL DECISION MATRIX
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

			TOWN						
			Alternatives				**Add-Ons**		
								Sludge Removal	
Criteria	**Description**	**Weights**	**Aeration Modifications**	**Clarifier System**	**Bioreactor**	**Mechanical WWTP**	**Water Reuse**	**On-Site Application**	**Off-Site Removal**
Water Quality	How will the recommendation help meet the Town of Jackson's goal of exceeding effluent water quality expectations?	21%	3	5	3	5	5	5	5
Energy Demands	How will the recommendation help meet the Town of Jackson's priority of reducing net energy demands?	15%	4	3	3	1	4	5	5
Capital Cost	Consider the capital cost compared to the other recommendations.	11%	5	3	4	1	4	5	3
O&M Costs	Consider the annual O&M costs compared to the other recommendations.	14%	5	3	4	2	4	5	5
Training & Licensing	What level of operator training and licensing is required with the recommendation compared to the current training and licensing?	5%	5	3	4	2	4	5	5
Odor and Noise	How will the recommendation impact the potential for odors and noise?	6%	4	4	5	3	5	2	3
Footprint	How well does the recommendation fit in the current operations footprint on available ToJ property?	6%	5	5	5	5	1	4	3
Public Perception	How will the recommendation impact public perception?	7%	4	2	5	3	4	4	3
Expandability	How well does the recommendation allow for expansion to accommodate future demands?	10%	4	3	5	5	5	5	5
Permitting Requirements	What level of permitting will be required to implement the recommendation?	5%	4	3	4	2	1	4	3
		100%	**4.1**	**3.5**	**3.9**	**3.0**	**4.0**	**4.6**	**4.3**

			PROTECT OUR WATER JACKSON HOLE						
			Alternatives				**Add-Ons**		
								Sludge Removal	
Criteria	**Description**	**Weights**	**Aeration Modifications**	**Clarifier System**	**Bioreactor**	**Mechanical WWTP**	**Water Reuse**	**On-Site Application**	**Off-Site Removal**
Water Quality	How will the recommendation help meet the Town of Jackson's goal of exceeding effluent water quality expectations?	21%	1	3	2	5	5	5	3
Energy Demands	How will the recommendation help meet the Town of Jackson's priority of reducing net energy demands?	15%	2	2	2	2	5	4	3
Capital Cost	Consider the capital cost compared to the other recommendations.	11%	2	2	2	2	4	4	1
O&M Costs	Consider the annual O&M costs compared to the other recommendations.	14%	4	3	4	3	5	5	4
Training & Licensing	What level of operator training and licensing is required with the recommendation compared to the current training and licensing?	5%	4	3	3	3	4	5	5
Odor and Noise	How will the recommendation impact the potential for odors and noise?	6%	4	5	5	4	5	2	1
Footprint	How well does the recommendation fit in the current operations footprint on available ToJ property?	6%	4	4	4	5	2	4	3
Public Perception	How will the recommendation impact public perception?	7%	1	2	2	5	5	5	1
Expandability	How well does the recommendation allow for expansion to accommodate future demands?	10%	2	3	4	5	5	5	5
Permitting Requirements	What level of permitting will be required to implement the recommendation?	5%	5	4	4	4	1	4	3
		100%	**2.5**	**2.9**	**2.9**	**3.7**	**4.5**	**4.4**	**2.9**

TABLE 1. FINAL DECISION MATRIX
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

			AMERICAN RIVERS						
			Alternatives				**Add-Ons**		
								Sludge Removal	
Criteria	**Description**	**Weights**	**Aeration Modifications**	**Clarifier System**	**Bioreactor**	**Mechanical WWTP**	**Water Reuse**	**On-Site Application**	**Off-Site Removal**
Water Quality	How will the recommendation help meet the Town of Jackson's goal of exceeding effluent water quality expectations?	21%	2	3	2	5	5	5	5
Energy Demands	How will the recommendation help meet the Town of Jackson's priority of reducing net energy demands?	15%	3	3	3	2	5	4	3
Capital Cost	Consider the capital cost compared to the other recommendations.	11%	4	3	4	2	4	4	2
O&M Costs	Consider the annual O&M costs compared to the other recommendations.	14%	5	3	4	2	5	5	4
Training & Licensing	What level of operator training and licensing is required with the recommendation compared to the current training and licensing?	5%	4	3	4	3	4	5	5
Odor and Noise	How will the recommendation impact the potential for odors and noise?	6%	2	3	5	3	5	2	2
Footprint	How well does the recommendation fit in the current operations footprint on available ToJ property?	6%	5	5	4	5	2	4	3
Public Perception	How will the recommendation impact public perception?	7%	2	2	2	5	5	5	5
Expandability	How well does the recommendation allow for expansion to accommodate future demands?	10%	4	3	5	5	5	5	5
Permitting Requirements	What level of permitting will be required to implement the recommendation?	5%	5	3	3	3	2	4	3
		100%	**3.4**	**3.0**	**3.4**	**3.5**	**4.5**	**4.4**	**3.8**

			TETON CONSERVATION						
			Alternatives				**Add-Ons**		
								Sludge Removal	
Criteria	**Description**	**Weights**	**Aeration Modifications**	**Clarifier System**	**Bioreactor**	**Mechanical WWTP**	**Water Reuse**	**On-Site Application**	**Off-Site Removal**
Water Quality	How will the recommendation help meet the Town of Jackson's goal of exceeding effluent water quality expectations?	21%	3	5	2	5	5	5	5
Energy Demands	How will the recommendation help meet the Town of Jackson's priority of reducing net energy demands?	15%	3	3	3	1	5	5	5
Capital Cost	Consider the capital cost compared to the other recommendations.	11%	4	4	4	2	4	4	3
O&M Costs	Consider the annual O&M costs compared to the other recommendations.	14%	5	3	4	2	5	5	5
Training & Licensing	What level of operator training and licensing is required with the recommendation compared to the current training and licensing?	5%	4	3	4	3	4	5	5
Odor and Noise	How will the recommendation impact the potential for odors and noise?	6%	4	5	5	4	5	2	2
Footprint	How well does the recommendation fit in the current operations footprint on available ToJ property?	6%	5	5	4	5	2	4	5
Public Perception	How will the recommendation impact public perception?	7%	2	3	2	5	5	5	5
Expandability	How well does the recommendation allow for expansion to accommodate future demands?	10%	4	3	5	5	5	5	5
Permitting Requirements	What level of permitting will be required to implement the recommendation?	5%	5	3	4	2	2	4	3
		100%	**3.7**	**3.8**	**3.4**	**3.3**	**4.5**	**4.6**	**4.5**

TABLE 1. FINAL DECISION MATRIX
TECHNICAL REVIEW REPORT, 2021 WASTEWATER TREATMENT PLANT TECHNICAL REVIEW
TOWN OF JACKSON, WYOMING

			Final Results						
			Alternatives				Add-Ons		
								Sludge Removal	
Criteria	**Description**	**Weights**	**Aeration Modifications**	**Clarifier System**	**Bioreactor**	**Mechanical WWTP**	**Water Reuse**	**On-Site Application**	**Off-Site Removal**
Water Quality	How will the recommendation help meet the Town of Jackson's goal of exceeding effluent water quality expectations?	21%	2.3	4.0	2.3	5.0	5.0	5.0	4.5
Energy Demands	How will the recommendation help meet the Town of Jackson's priority of reducing net energy demands?	15%	3.0	2.8	2.8	1.5	4.8	4.5	4.0
Capital Cost	Consider the capital cost compared to the other recommendations.	11%	3.8	3.0	3.5	1.8	4.0	4.3	2.3
O&M Costs	Consider the annual O&M costs compared to the other recommendations.	14%	4.8	3.0	4.0	2.3	4.8	5.0	4.5
Training & Licensing	What level of operator training and licensing is required with the recommendation compared to the current training and licensing?	5%	4.3	3.0	3.8	2.8	4.0	5.0	5.0
Odor and Noise	How will the recommendation impact the potential for odors and noise?	6%	3.5	4.3	5.0	3.5	5.0	2.0	2.0
Footprint	How well does the recommendation fit in the current operations footprint on available ToJ property?	6%	4.8	4.8	4.3	5.0	1.8	4.0	3.5
Public Perception	How will the recommendation impact public perception?	7%	2.3	2.3	2.8	4.5	4.8	4.8	3.5
Expandability	How well does the recommendation allow for expansion to accommodate future demands?	10%	3.5	3.0	4.8	5.0	5.0	5.0	5.0
Permitting Requirements	What level of permitting will be required to implement the recommendation?	5%	4.8	3.3	3.8	2.8	1.5	4.0	3.0
		100%	**3.4**	**3.3**	**3.4**	**3.4**	**4.4**	**4.5**	**3.9**